

e - SOURCEBOOK



## ICT IN AGRICULTURE

Connecting Smallholders to  
Knowledge, Networks,  
and Institutions

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**Cover photo:** Neil Palmer, CIAT. A Kenyan farmer uses a mobile phone in the field.

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## FOREWORD

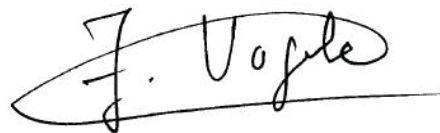
The livelihoods of the world's poor rise and fall with the fate of agriculture. Enhancing the ability of smallholders to connect with the knowledge, networks, and institutions necessary to improve their productivity, food security, and employment opportunities is a fundamental development challenge. Where once rural areas were largely disconnected from the greater world, today, networks of information and communication technologies (ICTs) enmesh the globe and represent a transformational opportunity for rural populations, both as producers and consumers. However, climate change and price fluctuations in the global food market remind us that realizing this opportunity requires a long-term commitment to mobilizing appropriate resources and expertise.

It is for this reason that we are particularly pleased to introduce the *ICT in Agriculture e-Sourcebook*. This resource was designed to support practitioners, decision-makers, and development partners who work at the intersection of ICT and agriculture. Our hope is that it becomes a practical guide in understanding current trends, implementing appropriate interventions, and evaluating the impact of those programs. It combines cutting-edge expertise in ICT with empirical knowledge of a wide range of agricultural sectors, from governance to supply chain management. As an online knowledge source, it will continue to evolve and be updated to reflect the emerging and changing challenges and opportunities facing the sector.

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# ACRONYMS AND ABBREVIATIONS

2G, 3G, 4G	second-, third-, and fourth-generation [developments in mobile wireless technology]
ACDI/VICA	Agricultural Cooperative Development International/Volunteers in Overseas Cooperative Assistance
AIS	agricultural innovation system
B2B	business-to-business
BSE	bovine spongiform encephalopathy
C	Celsius
CaFAN	Caribbean Farmers Network
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical (International Center for Tropical Agriculture)
CIC	community information center (Bhutan)
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo (International Maize and Wheat Improvement Center)
CKW	community knowledge worker
DIT	Department of Information Technology (Bhutan)
DFID	Department for International Development (UK)
DNE	Dairy Network Enterprise
DOQ	digital orthophoto quad
e-	electronic
EAP	East Asia and Pacific
ECA	Europe and Central Asia
ERP	enterprise resource planning
EU	European Union
FAPRI	Food and Agricultural Policy Research Institute
FEPASSI	Fédération Provinciale des Professionnels Agricoles de la Sissili (Federation of Agricultural Producers of Sissili Province)
FINO	Financial Inclusion Network and Operations
G2P	government-to-person (cash transfer)
GAP	good agricultural practice
Gbps	gigabit per second
GDP	gross domestic product
Ghz	gigahertz
GigE	gigabit Ethernet
GIS	geographical information systems
GLN	global location number
GM	genetically modified
GNSS	global navigation satellite systems
GPRS	general packet radio service

GPS	global positioning system
GSM	Global System for Mobile Communications
GTIN	global trade item number
HACCP	hazard analysis and critical control point
HIC	high-income countries
IBLI	index-based livestock insurance
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICT	information communication technology
ICTs	information communication technologies
IDI	ICT Development Index
IFAD	International Fund for Agricultural Development
IFC	International Finance Corporation
IFFCO	Indian Farmer's Fertilizer Cooperative Limited
IFMR	Institute for Financial Management and Research (India)
IFPRI	International Food Policy Research Institute
IICD	International Institute for Communication and Development
IITA	International Institute of Tropical Agriculture
IKSL	IFFCO Kisan Sanchar Limited
ILRI	International Livestock Research Institute
IP	Internet Protocol
IPS	Innovative Practice Summary
IRRI	International Rice Research Institute
IT	information technology
ITU	International Telecommunications Union
LAC	Latin America and Caribbean
Lao PDR	Lao People's Democratic Republic
LiDAR	light detection and ranging
m-	mobile
Mbps	megabit per second
MENA	Middle East and North Africa
MFI	microfinance institution
Mhz	megahertz
MNO	mobile network operator
NAIP	National Agricultural Innovation Project (India)
NARO	National Agricultural Research Organisation (Uganda)
NGN	next-generation network
NGO	non-governmental organization
NSDI	national spatial data infrastructure
OECD	Organisation for Economic Co-operation and Development
OS	operating system
PDA	personal digital assistant
PIN	personal identification number
PKGFS	Pudhuaaru Kshetriya Gramin Financial Services

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PSTNs	public switched digital telecommunication networks
RFID	radio-frequency identification
RML	Reuters Market Light
Rs	rupees
SA	South Asia
SCM	supply-chain management
SDI	spatial data infrastructure
SIM	subscriber identification module
SMS	short messaging service
SSA	Sub-Saharan Africa
U Sh	Uganda shillings
UA	universal access [to communication networks for ICTs]
UA/USFs	universal access/universal service funds
UK	United Kingdom
UNECE	United Nations Economic Commission for Europe
US	universal service [from communication networks for ICTs]
USA	United States
VANS	value added network services
VAT	value-added tax
VHRI	very high resolution image
VoIP	Voice over Internet Protocol
VSAT	very small aperture terminal
WFP	World Food Programme
WG-DSM	International Working Group on Digital Soil Mapping
WHO	World Health Organization
WiMAX	Worldwide Interoperability for Microwave Access
Y	Yuan
ZNFU	Zambia National Farmers Union



## SECTION 1

Overview of ICT in Agriculture:  
Opportunities, Access, and  
Cross-Cutting Themes



## Module 1: INTRODUCTION: ICT IN AGRICULTURAL DEVELOPMENT

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### INFORMATION AND COMMUNICATION TECHNOLOGY: FINDING A PLACE IN THE AGRICULTURE SECTOR

Information and communication have always mattered in agriculture. Ever since people have grown crops, raised livestock, and caught fish, they have sought information from one another. What is the most effective planting strategy on steep slopes? Where can I buy the improved seed or feed this year? How can I acquire a land title? Who is paying the highest price at the market? How can I participate in the government's credit program? Producers rarely find it easy to obtain answers to such questions, even if similar ones arise season after season. Farmers in a village may have planted the "same" crop for centuries, but over time, weather patterns and soil conditions change and epidemics of pests and diseases come and go. Updated information allows the farmers to cope with and even benefit from these changes. Providing such knowledge can be challenging, however, because the highly localized nature of agriculture means that information must be tailored specifically to distinct conditions.

Agriculture is facing new and severe challenges in its own right (see box 1.1). With rising food prices that have pushed over 40 million people into poverty since 2010, more effective interventions are essential in agriculture (World Bank 2011). The growing global population, expected to hit 9 billion by 2050, has heightened the demand for food and placed pressure on already-fragile resources. Feeding that population will require a 70 percent increase in food production (FAO 2009).

Filling the stomachs of the growing population is only one reason agriculture is critical to global stability and development. It is also critical because one of the most effective ways of reducing poverty is to invest in and make improvements in the agricultural sector. Even after years of industrialization and growth in services, agriculture still accounts for one-third of the gross domestic products (GDP) and three-quarters of employment in sub-Saharan Africa. Over 40 percent of the labor force in countries with per capita incomes in the US\$ 400 to 1,800 range works in agriculture (World Bank 2008). Because agriculture accounts for the vast majority of the poor's livelihood activities, it is also the sector that holds

the most promise for pro-poor economic growth. In fact, agriculture is around four times more effective at raising incomes among the poor than other sectors (World Bank 2008). No less important, improved agriculture also has a direct impact on hunger and malnutrition, decreasing the occurrences of famine, child stunting, and maternal infirmity.

Given the challenges, the arrival of information communication technology (ICT) is well timed. The benefits of the green revolution greatly improved agricultural productivity. However, there is a demonstrable need for a new revolution that will bring lower prices for consumers (through reduced waste and more-efficient supply chain management), contribute to "smart" agriculture, and incentivize farmers (for example, through higher income) to increase their production. Public and private sector actors have long been on the search for effective solutions to address both the long- and short-term challenges in agriculture, including how to answer the abundant information needs of farmers. ICT is one of these solutions, and has recently unleashed incredible potential to improve agriculture in developing countries specifically. Technology has taken an enormous leap beyond the costly, bulky, energy-consuming equipment once available to the very few to store and analyze agricultural and scientific data. With the booming mobile, wireless, and Internet industries, ICT has found a foothold even in poor smallholder farms and in their activities. The ability of ICTs to bring refreshed momentum to agriculture appears even more compelling in light of rising investments in agricultural research, the private sector's strong interest in the development and spread of ICTs, and the upsurge of organizations committed to the agricultural development agenda.

But what exactly are ICTs? And can they really be useful and cost-effective for poor farmers with restricted access to capital, electricity, and infrastructure? First, an ICT is any device, tool, or application that permits the exchange or collection of data through interaction or transmission. ICT is an umbrella term that includes anything ranging from radio to satellite imagery to mobile phones or electronic money transfers. Second, these ICTs and others have gained traction even in impoverished regions. The increases in their affordability,



accessibility, and adaptability have resulted in their use even within rural homesteads relying on agriculture. New, small devices (such as multifunctional mobile phones and nanotechnology for food safety), infrastructure (such as mobile telecommunications networks and cloud computing facilities), and especially applications (for example, that transfer money or track an item moving through a global supply chain) have proliferated. Many of the questions asked by farmers (including questions on how to increase yields, access markets, and

adapt to weather conditions) can now be answered faster, with greater ease, and increased accuracy. Many of the questions can also be answered with a dialogue—where farmers, experts, and government can select best solutions based on a diverse set of expertise and experience.

The types of ICT-enabled services that are useful to improving the capacity and livelihoods of poor smallholders are growing quickly. One of the best examples of these services

### **BOX 1.1: Globalizing Food Markets and New Challenges for Smallholder Farmers**

Understanding and addressing global agriculture developments—both advantageous and not—are critical to improving smallholder livelihoods, in which ICT can play a major role. The continued increase in globalization and integration of food markets has intensified competition and efficacy in the agriculture sector, and has brought unique opportunities to include more smallholders into supply chains. Yet in the same vein, agriculture faces a range of modern and serious challenges, particularly in developing countries exposed to price shocks, climate change, and continued deficiencies in infrastructure in rural areas.

When commodity prices rise quickly and steeply, they precipitate concerns about food insecurity, widespread poverty, and conflict—more so in countries that import high volumes of staple foods. Globalized food markets also increase the risk that some countries and many smallholders will remain marginalized from the expanding and more profitable agricultural value chains (such as premium foods, which have seen an increase in demand due to an expanding middle class) that rely on technical sophistication to ensure speed, scale, and customization.

Climate change has also played an acute role in keeping smallholders in the underbelly of value chains. Farmers can no longer rely on timeworn coping strategies when all of their familiar benchmarks for making agricultural decisions—the timing of rains for planting and pasture, the probability of frost, the duration of dry intervals that spare crops from disease—are increasingly less reliable. Severe and unexpected weather are shrinking already-limited yields and promoting migration from rural areas and rural jobs. Weather-related events leave developing-country governments, who lack the resources and the private sector investment to provide risk management instruments, to cope with major crop failures and the displaced victims only after the fact.

It is in the context of globalizing agriculture where the need for information becomes most vivid. The smallholders, who still provide a significant portion of the world's food, need information to advance their work just as much as industrial-scale producers. Comparing the two types of farmers—industrial and small-scale—exemplifies the latter's disadvantages. Where wealthier industrial producers can use the Internet, phone, weather forecasts, other digital tools, and technologies as simple as vehicles and infrastructure as basic as electricity to glean information on prices, markets, varieties, production techniques, services, storage, or processing, smallholders remain dependent primarily on word of mouth, previous experience, and local leadership.

The smallholder disadvantage does not stop there. Financial and insurance services are often out of reach and poorly understood. Key intermediaries like producer organizations and rural institutions (including local government) could help alleviate the disadvantage, but in many places, the former are just emerging and the latter are inefficient and nontransparent. Both require a variety of technical and financial support to grow and become inclusive and effective. Many of these challenges and others can be addressed by using ICT effectively.

*Source: Authors.*

**IMAGE 1.1:** Soil Data Can Be Collected and Disseminated by a Variety of ICT



Source: Neil Palmer, CIAT.

is the use of mobile phones as a platform for exchanging information through short messaging services (SMS). Reuters Market Light, for example, services over 200,000 smallholder subscribers in 10 different states in India for a cost of US\$ 1.50 per month. The farmers receive four to five messages per day on prices, commodities, and advisory services from a database with information on 150 crops and more than 1,000 markets. Preliminary evidence suggests that collectively, the service may have generated US\$ 2–3 billion in income for farmers (Mehra 2010), while over 50 percent of them have reduced their spending on agriculture inputs<sup>1</sup>.

ICT-enabled services often use multiple technologies to provide information (image 1.1). This model is being used to provide rural farmers localized (non-urban) forecasts so that

they can prepare for weather-related events. In resource-constrained environments especially, providers use satellites or remote sensors (to gather temperature data), Internet (to store large amounts of data), and mobile phones (to disseminate temperature information to remote farmers cheaply)—to prevent crop losses and mitigate effects from natural adversities.

Other, more-specialized applications, such as software used for supply chain or financial management are also becoming more relevant in smallholder farming. Simple accounting software has allowed cooperatives to manage production, aggregation, and sales with increased accuracy. The Malian Coprokazan, involved in shea butter production, began using solar-powered computers with keyboards adapted to the local language to file members' records electronically. Along with electronic administration, the coop plans to invest in Global Positioning System (GPS) technology to obtain certifications and use cameras and video as training materials to raise the quality of production. From 2006 to 2010 alone, the coop's membership grew from 400 to 1,000 producers (<http://www.coprokazan.org/>).

These examples represent only a minute subset of the information and communication services that can be provided to the agricultural sector through increasingly affordable and accessible ICTs. Hundreds of agriculture-specific applications are now emerging and are showing great promise for smallholders, as illustrated in the more than 200 project-based case studies and examples in this Sourcebook. In order to exploit the possibilities, countries have two tasks:

**(A) To empower poor farmers with information and communication assets and services that will increase their productivity and incomes as well as protect their food security and livelihoods, and**

**(B) to harness ICTs effectively to compete in complex, rapidly changing global markets (avoiding falling behind the technology curve).**

Accomplishing these tasks requires the implementation of a complex set of policy, investment, innovation, and capacity-building measures, in concert with beneficiaries and other partners, which will encourage the growth of locally appropriate, affordable, and sustainable ICT infrastructure, tools, applications, and services for the rural economy.

<sup>1</sup> See Topic Note 9.4 in Module 9.

Importantly, ICT is not an end to agricultural development. The excitement generated by ICTs as they spread throughout developing countries has often masked the fact that their contributions to agriculture are both rapidly evolving and poorly understood. It is too early to have a clear idea, supported by rigorous analysis, of how ICTs support agricultural development, and under what conditions. While there is credible evidence of positive impact, questions remain about how to make these innovations replicable, scalable, and sustainable for a larger and more diverse population. A central goal of this Sourcebook is to analyze and disseminate evidence of the impact of ICTs on agricultural development and rural poverty reduction, exploring opportunities for long-term and expansive efforts.

### THE WAY FORWARD: UNDERSTANDING THE WHY AND THE HOW

Each module in the Sourcebook discusses the key challenges, enablers, and lessons related to using ICTs in a specific subsector of agriculture. These are derived from a range of experiences, and summarize the knowledge gained during pilot projects and wider initiatives. While different in type of intervention and approach, a string of themes emerges from the modules. These themes—namely the why and how of using ICT in agricultural development—demonstrate the great potential of ICT and help to clarify the way forward.

#### The Why: Drivers of ICT in Agriculture

Five main trends have been the key drivers of the use of ICT in agriculture, particularly for poor producers: (1) low-cost and pervasive connectivity, (2) adaptable and more affordable tools, (3) advances in data storage and exchange, (4) innovative business models and partnerships, and (5) the democratization of information, including the open access movement and social media. These drivers are expected to continue shaping the prospects for using ICT effectively in developing-country agriculture.

#### Low-Cost and Pervasive Connectivity

The pervasiveness of connectivity—to mobile phones, Internet, and other wireless devices—is due to a number of factors, including decreases in costs, increases in competition, and expansion of last-mile infrastructure. Several trends, working in tandem, are making ICT devices and services more affordable in ways that also extend access to small-scale producers.

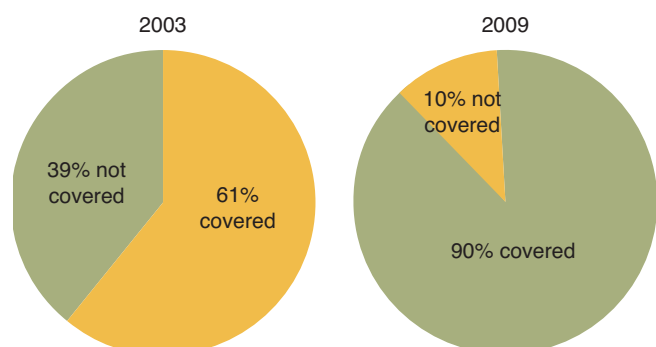
Mobile phones are in the vanguard of ICTs in agriculture. By the end of 2011, over 6 billion mobile phone subscriptions—or

more accurately, subscriber identity module (SIM) cards—are expected to be in use worldwide (Wireless Intelligence 2011). Mobile phone penetration in the developing world now exceeds two subscriptions for every three people, driven by expanding networks in Asia and in Africa. The ability to purchase a low-cost mobile phone is complemented by the expansion in telecommunications infrastructure; most countries now have more than 90 percent of their population served by a cell phone signal, including coverage in rural areas (see figure 1.1). This rapid expansion results from enabling regulations that ensure competition in the telecommunications sector as well as from high demand for mobile phone subscriptions.

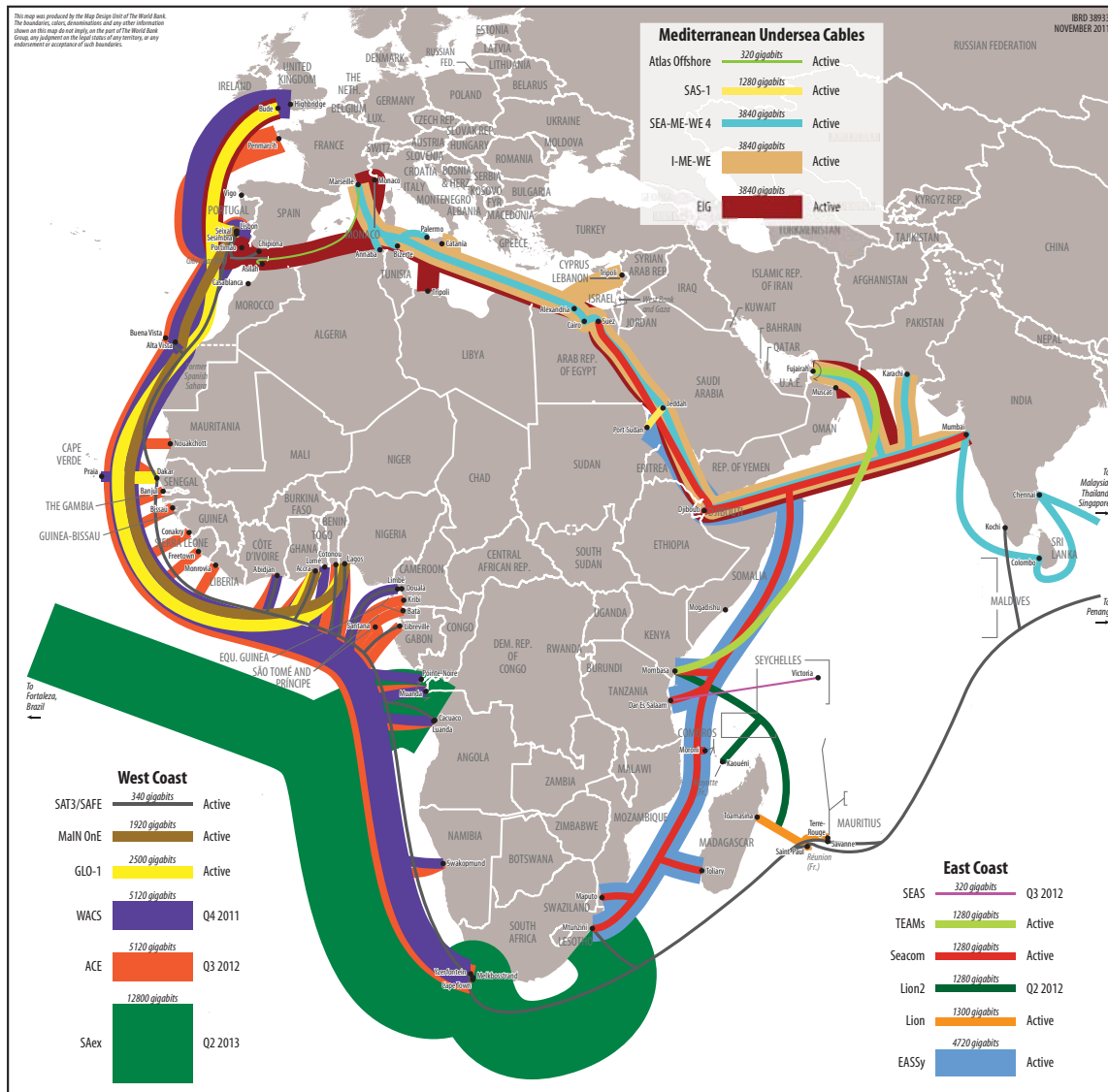
The reach and affordability of broadband Internet is also improving dramatically—though somewhat slower—in developing regions. In 2010, the number of Internet users surpassed 2 billion and over half of these users are now in developing countries. Internet connectivity around the world has grown exponentially since 2000, by over 480 percent (Internet World Statistics, 2011). The price of bandwidth has continued to drop as well, driving down the costs of extending connections to isolated communities. In sub-Saharan Africa, which lags other regions in ICT accessibility, a recent surge of investments in international undersea cables and inland infrastructure to complete those connections is making ICTs services substantially more accessible and affordable across Africa (figure 1.2). By 2010, 12.3 terabits per second of backbone capacity was operational in Africa, up from less than 1 gigabit per second at the start of the decade (TeleGeography 2011).

Telecenters or other community-based facilities can provide Internet access in locations where broadband is too expensive

**FIGURE 1.1: Percentage of the World's Population Covered by a Mobile Cellular Signal**



Source: International Telecommunications Union.

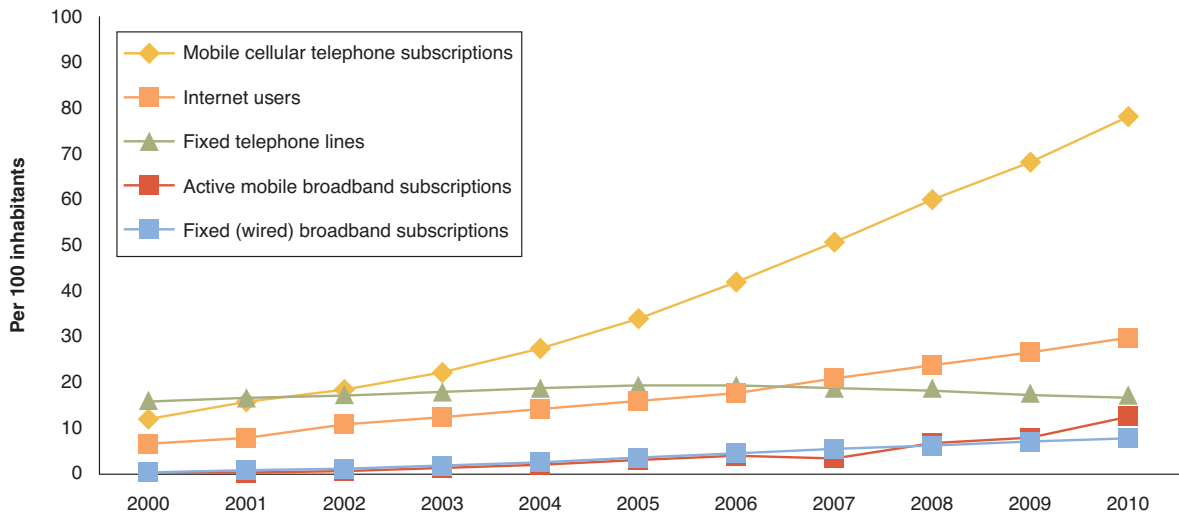
**FIGURE 1.2:** African Undersea Cables, Those Working and Those in Development

Source: Adapted from Steve Song, <http://manypossibilities.net> and TeleGeography.

for individuals to use on their own. Internet access is also expected to increase through the continued rollout of third- and fourth-generation (3G and 4G) mobile networks that greatly improved capacity for carrying data. Smartphones, such as BlackBerries or iPhones, which include 3G mobile services with remote Internet connection, will increase access to information even to poor farmers. The International Telecommunication Union (2010) reports that at the end of 2010, 143 countries offered commercial 3G services, providing at least 256 kilobits per second of bandwidth and supplying voice and data simultaneously (figure 1.3 shows the slow, but increasing rate of uptake of mobile broadband) and other ICT tools.

### *Adaptable and More Affordable Tools*

The proliferation of adaptable and more affordable technologies and devices has also increased ICT's relevance to small-holder agriculture. Innovation has steadily reduced the purchase price of phones, laptops, scientific instruments, and specialized software. Agricultural innovation in developed countries has become more applicable to developing-country needs. The intuitive design of many technologies and their capacity to convey information visually or audibly make them useful to people with limited formal education or exposure to technology.

**FIGURE 1.3:** Global ICT Development from 2000–2010

Source: International Telecommunications Union's World Telecommunication/ICT Indicators database.

Mobile-based applications are also becoming more suitable for poor and isolated communities, especially through feature phones. Drawing on simple, available technologies such as SMS, service providers can offer mobile banking, other transactional services (selling inputs, for example), and information services (market price alerts). Other publicly and privately provided services such as extension and advisory services are delivered over mobiles, which are increasingly not just “phones” but are actually multifunctional wireless devices.

Geospatial information is also becoming easier to access and use as mapping tools, such as Microsoft Earth or Google Maps (image 1.2), bring geographical data information to nonspecialist users. Scientists and development organizations have created substantial sets of georeferenced data on population, poverty, transportation, and any number of other public goods and variables through more affordable, usable geographic information systems available on standard PCs and mobile devices using web-based tools. Satellite images and similar representations have improved exponentially in quality and detail. These tools and remote sensors use less energy and require less human attention than in previous years. The capacity to overlay geospatial information with climate and socioeconomic data opens many options for analyzing biophysical trends (such as erosion or the movement of pathogens), making projections (about the effects of climate change or the best location of wholesale markets in relation to transport infrastructure), and selecting particular groups to test new technologies or farming practices (for instance, identifying farmers that are

most likely to benefit from using e-vouchers to purchase fertilizer).

#### *Advances in Data Storage and Exchange*

Greatly increased data storage capacity and the ability to access data remotely and share it easily have improved the use of ICT in agriculture. Sharing knowledge and exchanging data have created opportunities to involve more stakeholders in agricultural research—involvement facilitated by an

**IMAGE 1.2:** Google Map of Kampala, Uganda.

Source: Google Maps.

improved e-learning environment and networking capacity. Advances in data storage and sharing have improved the ability to exchange information—for instance, between departments and levels of government—and avoid costs associated with data transmission charges.

Improvements in data storage and sharing have underlying causes. The capacity of hard drives and the speed of micro-processors have continued to rise, making it dramatically cheaper to store data. Cloud computing offers access to numerous shared computing resources through the Internet, including sharable tools, applications, and intelligently linked content and data. These advances address some of the information and communication constraints of agricultural research institutions, government offices, cooperatives, and development organizations. Benefits of enhanced data capacity range from more accurate targeting of agricultural development programs to better preparation for handling surpluses or scarcities at the farm level.

#### *New Business Models and Public-Private Partnerships*

The development and use of many ICTs originated in the public sector but were quickly dominated by the private sector when their profit potential became clear. The public sector maintains great interest in ICT as a means of providing better public services that affect agriculture (for instance, land registration, forest management, and agricultural extension services), as well as for connecting with citizens and managing internal affairs. Private sector involvement in some of these efforts has enhanced the access, affordability, and adaptability of ICTs for development. Unlike other development strategies, which often struggle to survive or be scaled because the public sector cannot fund them, development strategies featuring ICTs have benefited from growing private sector interest and public demand (image 1.3).

The entrepreneurial nature of ICTs attracts new partnerships and forms of investment. Mobile phone applications, software design, local language customization, and remote transaction services represent only a fraction of the opportunities for continued innovation. Private companies that have invested in technology and applications are often interested in working with the public sector to provide their products and services to smallholders. Mobile network operators, for example, can invest by providing large text packages at a lower price, collecting premiums, distributing payments, or participating in extending networks to rural areas. Commercial enterprises such as processors, input suppliers, and exporters are also motivated to invest in ICT

because they often lead to increased efficiency and revenue as well as extensions to client bases like isolated farmers.

New forms of business incubation and knowledge brokering are also contributing to ICT in agriculture. The private sector has a keen interest in investing in firms that come out of such incubation schemes, speculating on the ability of an innovative idea to expand into a highly profitable enterprise. Incubators identify additional investors and other suitable partners, including technical experts. In many instances, they develop enterprises through which private and public providers of agricultural services collaborate to deliver products more efficiently to farmers; in developing, sharing, and capitalizing on innovations for agricultural development, they almost always use ICT and often develop new ICT tools.

#### **IMAGE 1.3:** Public-Private Partnerships Often Lead to More-Sustainable Services for Rural People



Source: Nokia.

Knowledge brokering, in which a private enterprise provides information for a fee (for example, farmers obtain market, price, crop, and weather information via their mobile phones), is also gaining traction. This business model reduces the burden on the public sector while increasing the abilities of brokers and farmers to profit from information sharing.

#### *Democratization of Information, the Open Access Movement, and Social Media*

The democratization of information and science facilitated by ICTs is also contributing to agriculture and rural development more broadly. Vast quantities of information held by institutions and individuals are becoming visible, publicly accessible, and reusable through the open access movement. Many governments and organizations such as the World Bank, the

Food and Agriculture Organization, the Consultative Group on International Agricultural Research are aiming to make data—like national surveys or research findings—publicly available. These actions have not only improved transparency and accountability but have invited the public, private, and research sectors to participate in solving long-term economic and social problems, including those involving agriculture.

The expansion of open access software also enables grassroots community organizations to share knowledge with one another. Social media, once used purely for entertainment, has great potential to be used for knowledge sharing and collaboration even in agriculture. Although penetration of the most popular social medium, Facebook, was estimated at just 3 percent in Africa and almost 4 percent in Asia in 2010, compared to 10.3 percent (over half a billion users) globally (Internet World Statistics, 2011), recent geopolitical events highlight the effectiveness of social media for sharing information and motivating collective action—two key features of agriculture development.

Finally, crowdsourcing, in which scientists, governments, and development organizations request feedback from farmers and consumers through devices like mobile phones, is also facilitating agriculture development. Farmers can use SMS to send critical local agricultural information like incidences of pests or crop yields that was previously difficult to obtain without expensive surveys by researchers. Using the digital tools available, consumers can also provide information related to changing consumption patterns and tastes to private enterprise.

### **The How: Lessons Learned So Far**

A number of key lessons related to ICT-in-agriculture policies and projects were gleaned during the research for this e-sourcebook. Using ICT to achieve agricultural development goals requires supplementary investments, resources, and strategies. Flexible but strongly supportive policies and regulations, complementary investments in physical infrastructure, support to men and women farmers of different age groups, technological appropriateness, and the enabling environments for innovation and new businesses will determine the long-term impact and sustainability of these efforts. These lessons are not conclusive—much remains to be learned—but they serve as sound considerations as investments are made in future interventions.

### ***Concentrate on the Demand, Not on the Technology***

The versatility and near-constant innovation that characterize ICT can be a distraction: They can cause interventions to focus more on the technology than on the priorities of the intended clients and the tradeoffs imposed by resource-constrained environments. It is important to begin any ICT-in-agriculture intervention by focusing on the need that the intervention is purposed to address—not the need for ICT—but the need for better and more timely market information, better access to financial services, timely and appropriate crop and disease management advice, stronger links to agricultural value chains, and so forth. In some cases, ICT will not be an effective means to meet these needs at all.

Years of agricultural development experience show that projects that involve new technologies require farmers' engagement, right from the start. Interventions that make meager efforts to involve farmers in planning and design result in low uptake, trust, and interest. The same is true for programs or strategies involving ICTs for development. A weak focus on farmers' needs at the expense of ICT will ignore ancillary needs for investment in human capacity, community participation, or infrastructure.

### ***Use Appropriate Technologies***

The attractiveness of the newest ICTs can lead to a preference for the latest technologies at the expense of older technologies (such as radio), yet the newest, most elaborate, or most innovative technology is not automatically the most appropriate one. Moreover, an innovative mix of technologies (for instance, radio programs with a call-in or SMS facility for feedback) can be the most cost-effective solution. Well-reasoned assessment of the tradeoffs between the added cost of a technology or service and benefits relative to other options (technological and other) is important.

The wide coverage of mobile devices reduces but does not eliminate these tradeoffs. In considering the appropriateness of technology, assessing the human capital available for developing and disseminating the ICT device or application is critical. The more complex the technology, the more training and (qualified) extension support it will require. In environments where infrastructure is not conducive to a particular instrument, other means should be used.

Finally, it is important to recognize that these newer technologies do not automatically replace the more traditional forms of communication, knowledge sharing, and collective action

that have evolved within a given community or region. In designing ICT interventions, it is necessary to research and understand local information and communication practices, barriers to ICT-enabled empowerment, and priority information and communication needs of end users. Using conventional information and communication tools to address the needs of those who cannot access the ICT because of limitations related to literacy, isolation, and social norms is often required.

#### *Focus on Affordable Access and Use, Not Ownership*

In designing ICT-in-agriculture interventions, it is vital to bear in mind that “access” refers not only to the physical proximity and accessibility of ICT infrastructure, tools, and services but also to their affordability, use, and usage models that are appropriate for the local physical, environmental, and cultural constraints. The specific mix of individual-user and shared-use/public-access models that is most appropriate and locally sustainable will vary depending on local needs and resources, and will change over time as devices and services diversify further and become even more affordable. As the costs of ownership of ICTs have come down, the affordability and accessibility divide has improved, especially for individual user services. However, it also may be that in some cases, learning is better facilitated through shared access than individual access facilities.

Actual use of the technology should also be monitored, as a supplied technology does not necessarily imply that it is being used for economic means. Many times, mobile phones and other devices function strictly as a tool for basic communication or entertainment. This is often a result of participants’ low exposure to ideas or methods on how the ICT can be used to achieve agriculture or other economic goals.

#### *Be Aware of Differential Impacts, Including Gender and Social Differences in Access and Use*

Under certain conditions, ICT interventions can worsen rather than alleviate underlying economic, social, and political inequalities, including those between women and men. Rural women, face significant disadvantages in accessing information and communication assets and services. Many of the fixed-location ICT projects designed to enhance rural access to information assets and services were or are owned or managed by men. Cultural attitudes and women’s multiple roles and heavy domestic responsibilities often exclude them from these services. The same attitudes and lack of control over

family income can prevent women from owning or even using phones. However, the growing availability and lower cost of mobile phones, as well as other contributing factors, has the potential to meet women’s agricultural needs (image 1.4).

#### **IMAGE 1.4: Determining Levels of Inclusiveness Is a Critical Factor in ICT Interventions**



Source: Nokia.

Social access issues extend beyond gender. A full understanding of the local, national, and regional agricultural economy is important for ensuring that ICT interventions do not restrict poor producers’ participation to the low end of agricultural value chains like other technologies have. ICT in itself does not guarantee full participation by all social groups. Efforts to be inclusive must focus on the full range of capacities and resources that small-scale producers will need to benefit from an intervention. Questions of social access should be raised consistently when using ICT to improve rural livelihoods. Do sociocultural norms or divisions prevent certain groups from using the technology? Will better-off groups benefit more than poor groups? Will floods of entertainment and spurious information dilute the knowledge needed for sustainable agricultural and rural development? Broad-based rural development depends on monitoring and evaluating outcomes and making adjustments along the way.

#### *Create an Enabling Environment for Innovation in Infrastructure Investment, Business Models, Services, and Applications*

Effective design and consistent, transparent implementation of appropriate policies and regulations guiding a country’s investment in and provision of ICT infrastructure, tools, and



services is key to enabling ICT interventions. In creating a supportive environment for ICT innovation and service provision, effective policies and regulations in a number of other key areas are equally important, such as public and private financing of infrastructure, the business environment, support for innovation, and intellectual property. ICT-in-agriculture interventions require a strong, but flexible, regulatory environment; the policy environment is further strengthened by incentives for the private sector to make investments.

### ***Develop Sustainable Business and Investment Models through Partnerships***

Public-private partnerships are now considered essential to the long-term viability of most interventions that use ICT in agriculture. The public sector in developing countries particularly may need guidance in providing technological services; a lack of human and financial resources as well as the overwhelming needs of the agrarian population weaken its ability to provide widespread services of acceptable quality.

With private investment, public service provision can be more sustainable. Other partnerships also appear important to sustainability (image 1.5). Technical experts with experience in various subsectors; information technology (IT) teams for technological maintenance, design, and troubleshooting;

### **IMAGE 1.5: A Collaborative Effort Among Many Actors Is Important for ICT in Agriculture**



Source: Neil Palmer, CIAT.

multi-level policy makers; and farmers and farmers' organizations who can provide local know-how, are also often all needed in one way or another.

### ***Promote Leadership and Find Champions***

Last, but not certainly not least, ICT interventions require leadership. Champions are needed to push projects forward in the development agenda and make them visible and interesting to the stakeholders—farmers, businesses, and others—who need them. These leaders must operate at the national level where budgetary and strategic decisions are made. They must also operate at local levels, modeling the effective use of a technology and building farmers' trust in its efficacy. Leaders build public confidence in an intervention. Uptake is typically low if confidence in the chosen ICT and its potential impact is minimal. Leaders are needed for the long haul, as interventions that require new infrastructure or policy and institutional reforms take years to complete.

### **USING THIS E-SOURCEBOOK**

The *ICT for Agriculture e-Sourcebook* has been developed jointly by the World Bank's Agricultural and Rural Development Sector and *infoDev*, and has benefited from generous funding from the Government of Finland under the Finland/*infoDev*/Nokia program *Creating Sustainable Businesses in the Knowledge Economy*. It is designed to support practitioners and policy makers in taking maximum advantage of the potential of ICTs as tools for improving agricultural productivity and smallholder incomes, strengthening agricultural markets and institutions, improving agricultural services, and building developing-country linkages to regional and global agricultural value chains. It focuses primarily on how ICT can assist small-scale producers and the intermediate institutions that serve them, yet it also looks at how to link smallholders to ICT-enabled improvements in larger-scale farming, markets, and agribusiness to stimulate the broader rural economy.

The Sourcebook provides users with a fairly comprehensive overview of current and upcoming ICT-in-agriculture applications and how they might improve agricultural interventions or strategies. The Sourcebook is not a primary research product nor does it claim to be the definitive treatment of a sector that is evolving so rapidly. The modules are intended to serve as a practical resource for development professionals seeking a better understanding of the opportunities and existing applications offered by ICT as tools for agricultural development.

Overall, each module seeks to provide guidance through real examples for development practitioners in the following areas:

- Providing a landscape of existing ICT applications that assesses applications in their local context.
- Understanding current trends in ICTs as they pertain to agriculture and the contributions that ICT can make to enhance agricultural strategies and their implementation.
- Designing, implementing, and evaluating appropriate and sustainable ICT components of agricultural projects.
- Building effective partnerships—public and private—to promote ICT access and innovation for agriculture.
- Including ICT in policy dialogue and planning with country counterparts on agricultural and rural development goals and priorities.

To facilitate learning, the Sourcebook is split into this introductory module plus 14 modules focusing on specific aspects of the agricultural sector in relation to ICTs (table 1.1). Each module provides:

- An overview of how ICT is used in each focus area, along with the current trends;
- The challenges, lessons, and key enablers for using ICTs;

- A number of Topic Notes that address subjects related to each focus area, pinpointing how ICTs can be used to meet specific objectives; and
- Innovative Practice Summaries and other examples that demonstrate success and failure in interventions.

In the beginning of each module, an “In this Module” Box briefly describes the content in the modules, including the overview, Topic Notes, and Innovative Practice Summaries. The Innovative Practice Summaries are bulleted underneath the description of the Topic Note, and can be viewed directly by clicking on the title. Many of the tools, examples, and projects discussed also include links to websites and other useful resources.

Due to the changing nature of ICT, the Sourcebook is provided electronically at <http://www.ictinagriculture.org/>. The website provides a wide array of additional resources, follows new private and public sector applications, reviews impact assessments and research, and presents updates from interventions discussed in the modules. In addition, the website maintains occasional forums and discussions, creating a space for practitioners from various disciplines to share knowledge and experiences. The online version also allows users to “build their own Sourcebook” by downloading modules relevant to their needs and linking directly from hyperlinks in the text to projects or technologies of interest in the other modules or on the web.

Over time, the World Bank and *infoDev* will continue to build collaborations with other organizations and subject matter experts to expand and update the Sourcebook as new examples, evidence, and good practices emerge. Given the still-limited evidence on how to implement ICT-in-agriculture initiatives, the World Bank plans to further develop its operational practices and country-specific technical assistance as evidence and analysis accumulates.

**TABLE 1.1: Themes Treated in Sourcebook Modules**

OPPORTUNITIES, ACCESS, & CROSS-CUTTING THEMES	ENHANCING PRODUCTIVITY ON THE FARM	ACCESSING MARKETS AND VALUE CHAINS	IMPROVING PUBLIC SERVICE PROVISION
Access and affordability Mobile applications Gender and ICT services	Increasing productivity Agriculture innovation systems Rural finance Farmer organizations	Market and price information Supply chain management Risk management Traceability and food safety	Rural governance Land administration Forest governance

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## Module 2: **MAKING ICT INFRASTRUCTURE, APPLIANCES, AND SERVICES MORE ACCESSIBLE AND AFFORDABLE IN RURAL AREAS**

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### IN THIS MODULE

**Overview.** What are “accessible” and “affordable” information communication technologies (ICTs)? What general policy strategies, infrastructure, technology, and business models mediate ICTs’ accessibility and affordability? Partnerships among organizations with different specialties, capacities, and profit motives are key to improving access and affordability. The task of regulation policy is to keep pace with technological developments and reduce inequalities within countries while maintaining sound business reasoning within the telecommunications sector. Policy interventions must consider ICTs and their users as a socio-technical system through which equitable access to ICTs translates into sustainable benefits for rural residents.

**Topic Note 2.1: Making ICTs Affordable in Rural Areas.** In developing countries, infrastructure, appliances, and services influence the delivery of affordable ICTs. What wired and wireless infrastructure can improve domestic backbone and “last mile” connectivity in rural areas? What tradeoffs exist between quality and quantity of service? What devices appear most adaptable to the needs of rural users? Finally, how can services benefit from synergies among network infrastructure, connectivity modalities, access devices, and content?

**Topic Note 2.2: Public Innovations in Universal Access to Telecommunications.** It is within the domain of government to provide innovative methods for access to ICTs in rural areas. Public agencies help develop infrastructure where incentives for private investment are insufficient; public policy encourages demand for telecommunications through such mechanisms as universal access/universal service funds or support for low-cost devices.

- **Passive Infrastructure Sharing in Nigeria**
- **Turkey’s Oligopolistic Infrastructure Sharing Model**
- **Dabba’s Experience with Unlicensed Wireless Services in South Africa**
- **Bhutan’s Community Information Centers Adapt to the Geographical and Consumer Context**

**Topic Note 2.3: Mobile Money Moves to Rural Areas.** In developing economies worldwide, companies deliver financial services and new sources of income outside of conventional bank branches, through mobile phones and nonbank retail agents. Mobile financial and income-generating services cost little and operate on all handsets, making them advantageous on a large scale, even in more remote rural areas.

- **M-PESA’s Pioneering Money Transfer Service**
- **Zain Zap Promotes Borderless Mobile Commerce**
- **Pakistan’s Tameer Microfinance Bank for the Economically Active Poor**
- **Txteagle Taps a Vast Underused Workforce**

**Topic Note 2.4: Delivering Content for Mobile Agricultural Services.** New services offer critical information for farmers to improve their livelihoods. The technical aspects of delivering content and services that rural users value are influenced by the partners engaged in providing the service, the regulatory environment, business model, and the networks, infrastructure, and devices available.

- **First Mover Advantage Benefits Reuters Market Light**
- **Long Experience in Farm Communities Benefits Indian Farmer’s Fertilizer Cooperative Limited (IFFCO) Kisan Sanchar Limited**
- **Farmer’s Friend Offers Information on Demand, One Query at a Time**

## OVERVIEW

ICTs have a demonstrably positive effect on income growth in developing and developed countries (Röller and Waverman 2001; Waverman, Meschi, and Fuss 2005). In rural areas, ICTs can raise incomes by increasing agricultural productivity (Lio and Liu 2006) and introducing income channels other than traditional farm jobs. Current limited evidence from individual farmers and fishers in India supports the conclusion that ICTs improve incomes and quality of life among the rural poor (Goyal 2010; Jensen 2007). The idea that wider access to and use of ICTs throughout a country will reduce inequalities in income and quality of life between rural and urban residents is compelling. Despite the scarcity of evidence to support this notion (Forestier, Grace, and Kenny 2002), it underlies widespread policy initiatives to ensure equitable access to ICTs in all areas.

Creating affordable ICT services in rural areas is a complex challenge. In these areas, the “last mile” of telecommunications infrastructure is provided at a very high cost that may not be justified by the resulting use and effects of the telecommunications network. Affordable access to ICTs in rural areas can be frustrated at the supply as well as the demand end of the service-provision chain. To supply ICTs and related services in rural areas, the main challenge is the high level of capital and operating expenses incurred by service providers. On the demand side, rural adoption of ICTs in developing countries is curtailed by low availability of complementary public services, such as electricity and education, and by the relative scarcity of locally relevant content.

Recognizing the equity implications of access to ICTs, governments have adopted regulatory policies to enable the rollout of ICT infrastructure and the supply of services in rural areas, and they have addressed low rural demand by introducing locally relevant content in the form of e-government and e-agriculture services. The task of regulation policy has been to keep pace with technological developments while maintaining licensing policies geared toward equity; in other words, to reduce inequalities within countries while maintaining sound business reasoning within the telecommunications sector.

This module describes what is meant by “accessible” and “affordable” ICTs and discusses the more general policy strategies that influence rural access to ICTs. Topic Note 2.1 is a relatively technical review of the infrastructure, networks, devices, and services for delivering ICTs affordably in rural areas. Topic Note 2.2 considers the role of public innovation in achieving universal access to infrastructure and appliances. The compounded access problem, consisting of limited rural access to ICTs and limited rural access to financial services, is discussed in Topic Note 2.3. The discussion focuses on business models that enable

the mobile microfinance industry to grow. Topic Note 2.4 explores efforts to build on expanding mobile networks in rural areas to deliver value-added livelihood services to farmers (primarily information to reduce agricultural losses and increase income).

### “Access” in Relation to Two Broad Concepts in Telecommunications Policy: Universal Access and Universal Service

Within telecommunication policy, “access” can be understood in relation to two broad concepts: universal service and universal access (Gasmi and Virto 2005). “Universal service”<sup>1</sup> is a policy objective primarily used in developed countries. It focuses on upgrading and extending communication networks so that a minimum level of service is delivered to individual households, even in the least accessible areas. US objectives are generally pursued by imposing universal service obligations on network operators. “Universal access,”<sup>2</sup> a policy objective more typical for developing countries, seeks to expand the geographic access to ICTs of the population at large, and often for the very first time. UA obligations provide for a minimum coverage, especially of remote communities, thereby allowing all citizens to “use the service, regardless of location, gender, disabilities, and other personal characteristics” (Dymond et al. 2010). Table 2.1 outlines the characteristics of universal access and universal service in terms of their availability, accessibility, and affordability.

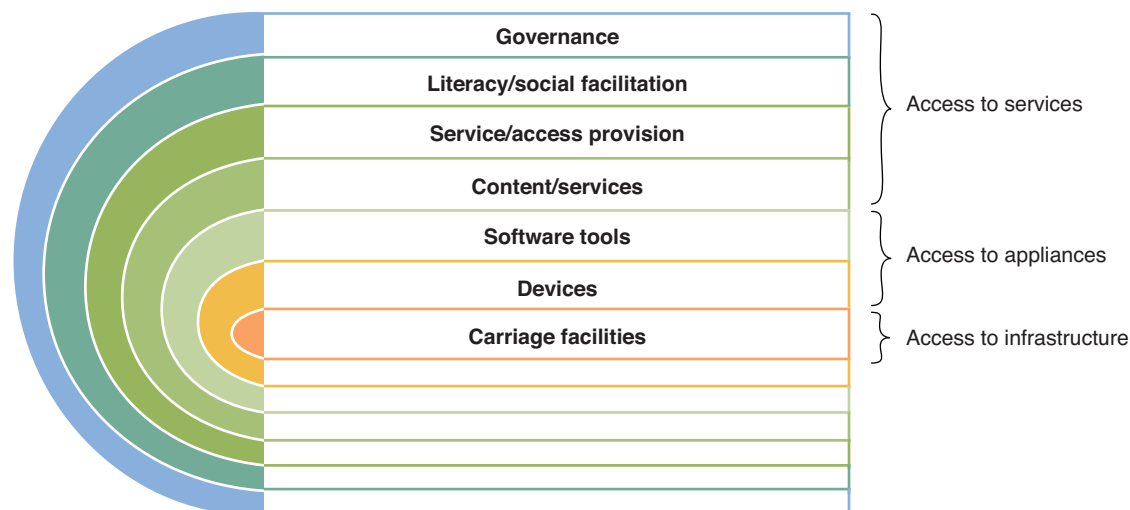
In designing policy interventions to promote equitable access to ICTs, the technology and its users must be considered as forming a socio-technical system through which improved ICT access translates into improved rural livelihoods and sustainable benefits for rural residents. Many authors have considered access to ICTs holistically, with an aim of understanding different aspects of how access is enabled or impeded, including technological, socioeconomic, and cultural aspects.<sup>3</sup> This module uses the Access Rainbow Framework (Clement and Shade

- 1 “Universal service (US) describes when every individual or household can have service, using it privately, either at home or increasingly carried with the individual through wireless devices. For some services, a goal of full US would be too ambitious at present in a developing country, because the services must be affordable as well as available. Goals may relate to the proportion of the population that can afford private service (i.e., subscriber penetration targets)” (Dymond et al. 2010).
- 2 “Universal access (UA) describes when everyone can access the service somewhere, at a public place, thus also called public, community or shared access. . . . In general there would be at least one point of access per settlement over a certain population size” (Dymond et al. 2010).
- 3 For example, Benkler (2006) focuses on technological aspects and proposes a model of access consisting of a content layer, a service layer, a network layer (physical transport and logical transmission), and a device layer (logical device operating system (OS) and physical machinery).

**TABLE 2.1:** Characteristics of Universal Access and Universal Service

ASPECT	UNIVERSAL ACCESS	UNIVERSAL SERVICE
<b>Availability</b>	Focused coverage	Blanket coverage
	Public access (e.g., at a pay phone or telecenter)	Private service on demand
	Free emergency calls	Free emergency calls
<b>Accessibility</b>	Walking distance, convenient locations and hours	Simple and speedy subscription
	Inclusively designed premises (e.g., for wheelchair users); inclusively designed terminals or available assistance (e.g., for the blind or deaf)	Inclusively designed terminals and services (e.g., for blind or deaf people)
	Assistance from an attendant	Assistance through the terminal (e.g., by making calls or viewing help pages for the web)
	Adequate quality of service (e.g., having few failed call attempts)	Reasonable quality of service (e.g., having few dropped calls)
<b>Affordability</b>	Options of cash and card payment	Cost of average monthly usage is a small percentage of monthly GNI per capita
	Options of cash and card payment	Options of cash, card, and electronic payment
	Payment per use (e.g., for a single call or message or an hour of Internet access)	Flat rate, bundles of services or low monthly subscription fee

Source: Dymond et al. 2010.

**FIGURE 2.1:** Access to ICT Infrastructure, Appliances, in Services and the Access Rainbow

Source: Authors, following Clement and Shade 2000.

2000), depicted in figure 2.1, to understand access to ICTs. The Access Rainbow Framework demonstrates the multifaceted nature of access to ICTs and captures the socio-technical architecture instrumental to it. The framework goes beyond a mechanical understanding of ICT access by including enablers of ICT such as locally relevant content, ICT literacy, proximal ICT use,<sup>4</sup> and social mechanisms for governing ICT use.

The Access Rainbow provides a framework for discussing access to ICT infrastructure, appliances, and services. The “carriage facilities” layer is a physical technology layer

consisting of installed network capacity, network connectivity, and interoperability standards. In this module, this layer is interpreted as access to ICT infrastructure. Access to ICT appliances is captured by the physical layer of ICT hardware devices and the logical layer of software tools on these devices. With its twofold (hardware and software) nature, access to ICT appliances links the supply of ICT infrastructure with the provision of services targeted at end users. Access to ICT services is a more amorphous concept, consisting of: (1) the ready availability of content (resources), fulfilling users’ roles as citizens, producers, and consumers; (2) the ready availability (to those who are not experts in the technology) of network access and appropriate support services through commercial vendors;

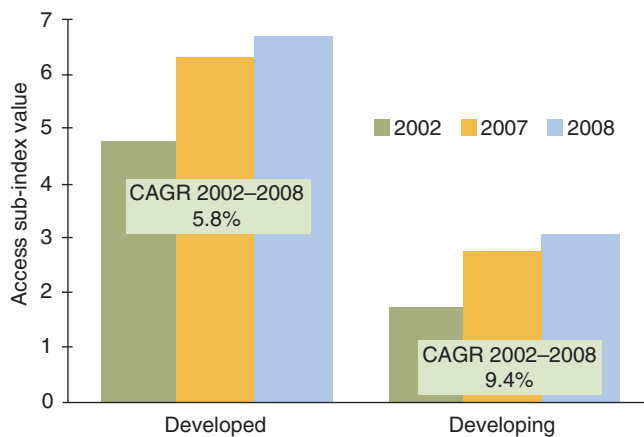
4 ICT use intermediated by skilled users in the rural community.

(3) the availability of formal and informal learning facilities for developing network literacy; and (4) the ready availability of channels through which individual users can participate in decisions about telecommunications services, their social inclusiveness, and the public accountability of their provision.

In considering interventions to improve access to ICTs, practitioners must consider the complexity of access to ICT infrastructure, appliances, and services. It is important to locate the access layer within which an intervention is anchored and to assess how it relates to contingent aspects of access.

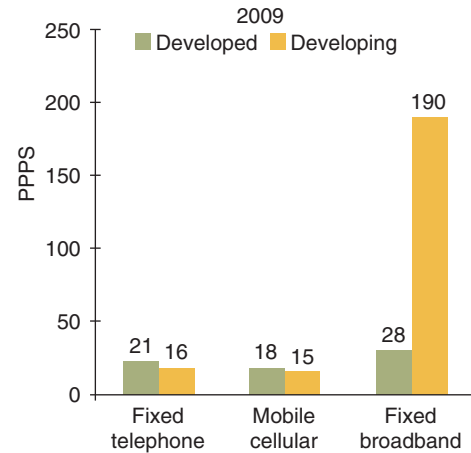
For public policy makers, a comprehensive understanding of the processes determining ICT access is best achieved within a holistic framework, but policy makers may also find some value in quantifying ICT access within countries and drawing comparisons across countries. To measure the digital divide between countries and assess countries' ICT development potential, the International Telecommunication Union (ITU) introduced the ICT Development Index (IDI) as an indicator of countries' level of ICT development. The IDI measures access by considering ICT readiness and five additional indicators: fixed telephony, mobile telephony, international Internet bandwidth, households with computers, and households with Internet (ITU 2010). Figure 2.2 shows that in recent years (2002–08) developing countries have exhibited considerably greater access values than developed countries, largely owing to explosive growth in mobile telecommunications in developing countries.

**FIGURE 2.2: Access to ICTs by Level of Development, Based on the ICT Development Index**



Source: ITU 2010.  
 Note: For each year, the figures use the simple average value of the IDI access subindex over all developed or developing countries. The compound annual growth rate (CAGR) of the IDI access subindex is computed by the formula  $(P_v / P_0)^{(1/n)} - 1$ , where  $P_v$  = present value,  $P_0$  = beginning value,  $n$  = number of periods. The result is multiplied by 100 to obtain a percentage.

**FIGURE 2.3: ICT Price Subbaskets by Level of Development**



Source: ITU 2010.  
 Note: PPP\$ = GNI per capita in current international dollars, obtained using Purchasing Power Parity (PPP) conversion factors.

**“Affordability” as a Function of Pricing and Business Model**

An affordable universal service is one in which the “cost of average monthly usage is a small percentage of monthly gross national income (GNI) per capita” (Dymond et al. 2010). As a concept, affordability is easier to measure than access. As a measure of affordability, ITU uses the ICT price basket, which includes price indicators for fixed telephones, mobile phones, and fixed broadband service (ITU 2010).<sup>5</sup> Figure 2.3 clearly shows that by this measure fixed-line broadband was the single most expensive and least affordable service in developing countries as of 2009. In using this means of assessing affordability, however, it is vital to determine if the contents of the price basket are relevant to the access problem at hand (for example, Topic Note 2.1 questions whether in some contexts the affordability of fixed-line broadband infrastructure merits concern).

The Access Rainbow Framework (introduced in the “Access Concept” section) helps in understanding issues of affordability and sustainability, because it represents the layered system of interdependencies within which technology diffusion, business development, and regulatory policies take

5 The fixed telephone sub-basket captures the average monthly cost of a basic, local, fixed residential telephone service. The mobile cellular sub-basket represents low monthly mobile usage, namely 25 outgoing calls per month (on-net, off-net, and to a fixed line, and for peak, off-peak, and weekend periods) plus 30 SMS messages. The fixed broadband sub-basket represents a typical monthly offer based on a 256 kilobit connection and a minimum of 1 gigabyte of data.

place. For example, the ICT layer carrying the highest value proposition for end users is the content/service layer.<sup>6</sup> The framework makes it possible to consider the financial viability of all contingent layers (network capacity, availability of appliances, customer support, and so on) and how they may affect the value derived from the content/service layer.

From a regulatory standpoint, the Rainbow approach captures the significance of the separation between layers, most prominently the separation between the carriage and the content layers. Focusing regulatory efforts within layers and enabling competition within and between layers is central to achieving quality end-user services at affordable prices. From a regulatory policy perspective, the layered structure illustrates the trend in policy to enable competition among technologies delivering comparable functionality by following the principles of competition, technology neutrality, and licensing flexibility.

Ensuring competition within each of the layers is a longstanding policy priority, especially where the economies of scale are conducive to monopolistic market structure.<sup>7</sup> Market liberalization and free entry give incumbents incentives to pursue a higher quality of service. For example, starting in 1992 Thailand sought to break up the Communication Authority of Thailand's monopoly over international gateway services by introducing concessions to private companies under build-transfer-operate agreements. The entry of the private sector alongside state-owned enterprises, such as the Telephone Organization of Thailand, led to remarkable expansion of subscriptions for both fixed and mobile services. Yet the level and the degree of competition in the fixed line and mobile subsectors varied considerably because of the number of concessions and their terms and conditions (Nikomborirak and Cheevasittayanon 2008). Competition in the mobile market yielded improved connectivity and affordability, while the fixed-line subsector stagnated.

The lesson is that the welfare benefits of market liberalization are achieved by implementing complementary policies on competition that enable market pricing and restrict predatory pricing by incumbents facing new entrants throughout the structural layers of the ICT sector. In Thailand, fixed-line concessions were restricted by stipulated fixed-call rates

<sup>6</sup> Layer number 4 in figure 2.1.

<sup>7</sup> International Internet gateways and local-loop or "last mile" fixed networks are examples. Local-loop networks are the fixed networks that deliver connectivity from the local exchange to the homes of end-users. Because of the high cost of entry in developing these networks, this segment is conducive to a monopolistic market structure.

and upper bounds on the number of subscribers, which skewed the viability of fixed-line rollouts by private concession holders.

In addition to competition, technology neutrality is another leading regulatory policy principle for ensuring the affordability of ICTs. Technology neutrality is the principle of refraining from specifying technology requirements within telecommunications licenses. Historically, specifying technology requirements was a means of stimulating domestic equipment manufacturing, but technology neutrality is advisable within the present rapidly evolving IT industry, because regulatory decisions on technology selection can be risky (box 2.1 presents an example from Korea).

### **BOX 2.1: The Risks of Picking Winners in the Rapidly Evolving IT Industry**

In Korea, the licensing of new technologies arguably led to market growth for domestic equipment manufacturers such as Samsung and LG, yet this strategy may prove more risky in the IT domain. Government support for WiBro, a Korean version of mobile WiMAX (a telecommunications protocol that provides fixed and mobile Internet access), has since been viewed as misguided. By the end of 2008, WiBro had attracted only 170,000 customers for Korea Telecom and SK Telecom combined, a fraction of the government's expected 1.4 million subscribers. Within the Korean market, LTE<sup>a</sup> mobile broadband services were emerging as a more viable alternative to WiBro, and both Korea Telecom and SK Telecom announced plans to launch commercial LTE services at the expense of languishing WiBro services.

*Source:* Author, based on Kim 2009a, 2009b.

(a) Long Term Evolution (LTE) is a preliminary mobile communication standard, formally submitted as a candidate 4G system to ITU-T in late 2009. Commitment to LTE among mobile network operators has been growing steadily.

Because no specific technology standards are designated, technology neutrality widens the scope for competition within each layer of the Access Rainbow. Competing operators choose the technology standards that allow them to deliver services cost-effectively. The regulatory policy drift toward technology neutrality is supported by technology developments that lead to increased standards of interoperability (see Rossotto et al. 2010).

The main policy lever for assuring market competition and technology neutrality is flexible licensing policies and the



enforcement of flexible spectrum rights. Strict licenses and spectrum rights can be counterproductive if they restrict the services that can be provided or the technologies used to provide the services (for example, WiMAX licenses have been issued limiting service provision to fixed broadband, to the exclusion of mobile broadband). In addition to limiting the technology possibilities, restricted licenses and spectrum rights can also reduce the bidding incentives in spectrum auctions. Technology flexibility can be achieved within each of the interconnected layers of the ICT system through unified licenses and simplified licenses (Rossotto et al. 2010). Box 2.2 describes Singapore's experience with facilities-based and service-based operating licenses.

**BOX 2.2: Singapore's Simplified Licenses Encourage Innovative, Cost-effective ICT Infrastructure**

By ensuring that the installation and operation of any network infrastructure in Singapore is covered by a license, the Infocomm Development Authority of Singapore ensures the development of innovative and cost-effective infrastructure. Simplified licenses are issued to facilities-based operators (FBOs) and services-based operators (SBOs) of telecommunications networks. FBOs include companies deploying submarine cables to improve international connectivity infrastructure, companies rolling out fiber-optic cables to improve domestic backhaul connectivity, and companies setting up broadband Internet Protocol (IP) or infrared networks. Wireless networks making demands on scarce spectrum resources are licensed separately and subject to comparative selection or auctioning. The operations of FBOs effectively remain within the carriage layer, but FBOs have the flexibility to deploy and/or operate any form of telecommunication networks, systems, and/or facilities on a technology-neutral basis.

SBOs remain within the service/access provision layer, but they have full flexibility to choose their technology. Individual SBO licenses are intended for companies that plan on leasing international connectivity capacities installed by FBOs. Individual SBO licenses cover services such as international simple resale, public Internet access services, and store-and-forward value-added services. SBO class licenses cover store-and-retrieve value-added network services, Internet-based telephony, resale of public switched telecommunication services, and other services.

*Source:* Halewood 2010.

*Note:* One result of this clear, flexible approach to ICT development is Singapore's extensive e-governance system, described in Module 13.

**KEY CHALLENGES AND ENABLERS**

The challenges and enablers related to making ICTs more widely and affordably available to rural people in developing countries are discussed in the sections that follow. Particular attention is given to the kinds of partnerships, regulations, and policies needed to reach that goal.

**Partnerships**

Considering the multilayered nature of the problem of ensuring affordable rural access to infrastructure, devices, and services, partnerships among organizations with different specialties, capacities, and profit motives appear to be a key way to improve access and affordability. Partnerships serving as critical mechanisms for improving rural ICT access can take the form of partnerships within the public sector, negotiated public-private partnerships, private agreements among stakeholders in the telecommunications sector, or informal understandings between service providers and stakeholders at the community level.

Enabling such partnerships and maintaining them remains a key government role. For example, the public sector played a considerable within the M-PESA collaborative partnership (see IPS "M-PESA's Pioneering Money-Transfer Service" in Topic Note 2.3). This role involved financially supporting the collaboration among mobile network operators (MNOs) during software development. In Bhutan, partnerships among departments within government were instrumental to the rollout of community information centers in remote areas (see IPS "Community Information Centers: Bhutan," in Topic Note 2.2).

A variety of motives engender private partnerships that improve rural access to infrastructure and services. For example, in infrastructure-sharing arrangements discussed in Topic Note 2.2, explicit agreements were enacted to share passive infrastructure costs and implement 3G technology. Agreements between commercial and nonprofit partners also make a compelling case for the significance of partnership in implementing projects to deliver improved rural access to ICTs. For example, the Farmer's Friend service could be implemented only through collaboration incorporating Grameen Foundation's understanding of the nonprofit sector, Google's technology expertise, MTN's network coverage, and the local agricultural knowledge of the Busoga Rural Open Source Development Initiative.

**Regulation and Policy Challenges**

Although the evolution of ICTs in developing countries has far to go, it has moved significantly forward in the past decade.

The rapid expansion of mobile phone networks and market uptake of Global System for Mobile Communication (GSM) technologies<sup>8</sup> following liberalization and deregulation are the most frequently cited examples of this evolution.

Informed and effective regulation is necessary for creating an enabling environment that will maximize entrepreneurs' abilities to expand market offerings and minimize the negative effects of competition on consumers. Barriers such as a monopoly operator, excessive licensing regimes in some contexts (for example, requiring local community networks to have licenses) can negatively affect business potential. At the other end of the spectrum, a supportive fiscal and financial environment and entrepreneurs' access to financial services can enable and increase the number of socially oriented services.

Significant regulatory issues in the telecommunications sector include taxes, licensing, liberalization, and competition policies. Taxes on communication services strongly influence the affordability of ICTs in Africa, for example, given the low average incomes. Import duties on IT equipment, value-added tax (VAT) (ranging from 5 to 23 percent) on goods and services, and excise taxes on communications services all raise prices, discouraging use. Excessive licensing can also stifle the delivery of various content-based ICT services. Regulations on content broadcasting should be synchronized

with pure data transmission regulations (UNCTAD 2010). In terms of competition, policies fostering the effective management of competitive markets, interconnection regimes, and mobile termination rates can provide incentives to invest in quality of service, differentiation, and innovation.

With the increasing adoption of ICTs and growing prominence of ICT-enabled services in consumers' lives in developing countries, it is worth emphasizing the significance of consumer protection regulation for ensuring the effective governance of multilayered ICT access. Recurrent problems include gaps between advertised "headline" broadband access speeds and what subscribers actually experience, lack of transparency in the pricing of mobile voice and data services, lack of effective mobile number portability, and excessive SMS pricing. Consumer-focused regulations should also target improvements in the legibility and ease of comprehension of transactions, made possible through improved ICT access. Consumer protection can pursue such goals through measures for mobile phone number registration, identity verification, confidentiality, and privacy.

Finally, the advent of financial services implemented on mobiles makes it essential to create an environment that integrates financial regulation and telecommunication regulations. These services are discussed in greater detail in Topic Note 2.3.

## Topic Note 2.1: MAKING ICTS AFFORDABLE IN RURAL AREAS

### TRENDS AND ISSUES

"Fixed-mobile convergence" is the increasingly seamless connectivity among wired and wireless networks, devices, and applications, which permits users to send and receive data regardless of device and location. Convergence is the result of converting content formats (text, images, audio, video), devices for creating and communicating this content, and telecommunications infrastructure to digital standards.

Device convergence allows devices to support different functionalities and different network access technologies. Service convergence means that end users are able to receive comparable services via different devices and technologies for accessing networks. Network convergence means that a single network is able to carry voice and data formats and can support access by different technologies.

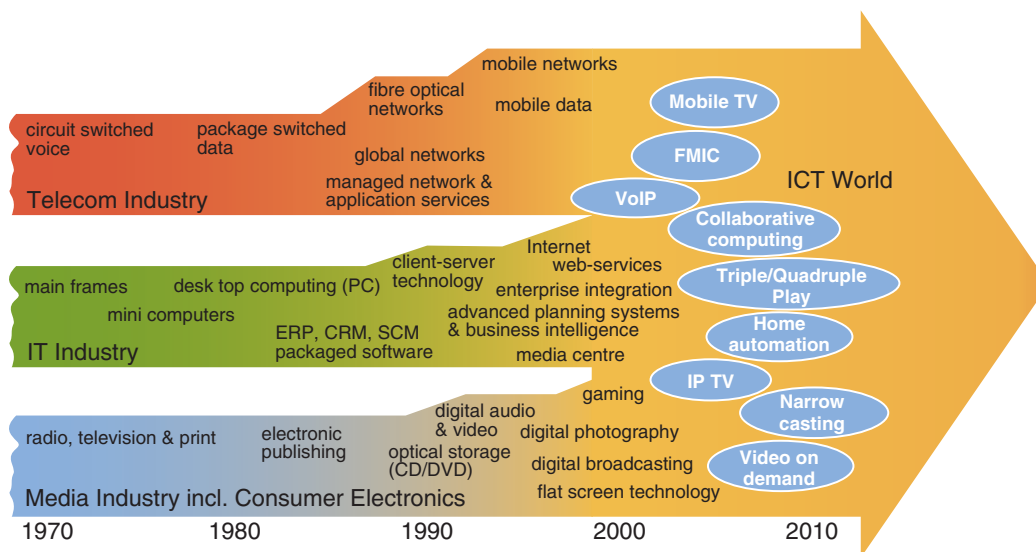
Convergence (as the name implies) blurs the distinctions between the domains of Internet service providers, cable television media companies, fixed-line telecommunication companies, and operators of mobile telephony networks (figure 2.4).<sup>9</sup> With this context in mind, the discussion that follows examines how technology trends in infrastructure, appliances, and services can influence the delivery of affordable ICTs in developing countries.

### INFRASTRUCTURE

What are the current wired and wireless options to improve domestic backbone and "last mile" connectivity? As noted, wired telecommunications infrastructure tends to reach rural areas in the wake of complementary rural access infrastructure such as roads and electricity and the expansion of public

8 GSM standards for 2G cellular networks serve an estimated 80 percent of the global mobile market, according to the GSM association (<http://www.gsm.org/>).

9 Offers that span three out of these four services have become known as "triple play" offers. (Sunderland 2007) points to such offers in Cape Verde and the Caribbean.

**FIGURE 2.4:** Telecommunications, IT, and Media Industry Convergence

Source: Caneval Ventures, "ICT and media industry" (<http://www.caneval.com/vision/ictmediaindustry.html>, accessed July 2011).

services such as education. The lag between the arrival of complementary infrastructure and public services and the establishment of wired ICT infrastructure in rural areas can be considerable, but the introduction of wireless, especially mobile, infrastructure is bound neither by the presence of roads nor by access to the electricity grid.

Rural infrastructure development needs to be considered in light of the different opportunities offered by wired and wireless technologies and the fixed-mobile convergence occurring throughout the ICT sector. Sunderland (2007) notes that fixed-mobile convergence differs in developed and developing countries, where fixed-line teledensity is low. As a result, convergence in developing countries largely amounts to convergence in the delivery of Internet access and voice telephony services over wireless networks. For example, in rural Africa where the teledensity of fixed networks is low and their roll-out can be prohibitively expensive, fixed-mobile convergence enables the use of wireless "last mile" infrastructure, while the backhaul traffic is carried on fixed fiber-optic cables because of their high capacity. In small-island developing countries, fixed-mobile convergence allows for international connectivity via satellite rather than undersea cable.

Telecommunications networks comprise a hierarchy of links that connect users at the "edge" of a network to its "core," also called the "backbone" (the high-capacity links between switches on the network). The backhaul portion of a network consists of the intermediate links between subnetworks at the users' end and the core network.

In considering how best to develop affordable telecommunications infrastructure in developing countries, all three connectivity segments of the network need to be taken into account: (1) the international and domestic connectivity that makes up the network's backbone capacity, (2) the domestic backhaul connectivity that enables the intermediate links, and (3) the local loop or "last mile" connectivity that serves end-user access at the edges of the network. (Each of these networks segments is discussed in greater detail in "Domestic backbone and rural backhaul connectivity" and "local loop or 'last mile' connectivity.") The expansion of backhaul connectivity and the provision of "last mile" connectivity pose particular challenges to extending ICTs to rural areas in an affordable way (box 2.3).

Wireless infrastructure may be an economical option, but it has certain cost constraints. Buys et al. (2009) show that the probability of the presence of mobile tower base stations is positively correlated with the potential demand (population density, per capita income), as well as with the absence of factors that increase operational and capital expenditures, such as elevation, slopes, lack of all-weather roads, unreliable power supplies, and even insecurity. (See IPS "Passive Infrastructure Sharing in Nigeria" in Topic Note 2.2.)

At the carriage level, network convergence is associated with the transformation from circuit-based public switched digital telecommunication networks (PSTNs) to packet-switched networks using the Internet Protocol (IP) and known as next-generation networks (NGNs). Both PSTNs and NGNs are

### **BOX 2.3: Balancing Quality and Service in Reaching Rural Areas: Fixed-line versus Wireless Backhaul**

Even though wireless is accepted as an economical option for delivering “last mile” connectivity, backhaul traffic is usually carried via fiber-optic networks because of their high capacity. Connectivity is often limited by the limited penetration of the fixed-line backhaul that supports it. The delivery of connectivity to rural areas lacking fixed-line backhaul involves balancing concerns about ICT access, connection quality, and the expenditures and delays entailed in rolling out fixed lines and supporting infrastructure. The benefits of wireless backhaul technology are worth considering in such cases.

Wireless backhaul is increasingly recognized as an option for combating the expenditures involved in providing fixed-line rural connectivity. Wireless network backhaul solutions can take the form of point-to-point or point-to-multipoint wireless Ethernet bridges or wireless mesh networks. They can use licensed or unlicensed microwave links (see Unlicensed Wireless Use). With throughput from as low as 10 Mbps up to GigE full duplex (with gigabit wireless), a licensed microwave link or wireless bridge can provide sufficient capacity for many rural applications. Because it is compatible with mobile phone standards (GSM, CDMA), the WiMAX standard offers opportunities for rolling out affordable wireless rural backhaul. Advocates of the technology are optimistic about its potential for linking wireless fixed-location base stations to the core network.

*Source:* Authors.

*Note:* Mbps = megabit per second; GigE = Gigabit Ethernet; GSM = Global System for Mobile Communication; CDMA = Code Division Multiple Access (CDMA) 2000, a wireless air interface standard; WiMAX = Worldwide Interoperability for Microwave Access.

made up of telephone lines, fiber-optic cables, microwave transmission links, mobile networks, communications satellites, and undersea telephone cables.

The difference between the two kinds of networks lies in their switching mechanisms. Under circuit switching, the connection is established on a predetermined, dedicated, and exclusive communication path for the whole length of the communication session. Consequently, PSTN connectivity is costly. In packet-switching protocols, such as IP, the communicated data are broken into sequentially numbered packets, each of which is transmitted to the destination via an independent path, and then the packets are reassembled. In packet-switching, the potential for congestion, packet loss,

and delay can mar the quality of the connection. A comparison between traditional fixed-line telephone services and voice over IP (VoIP) clearly demonstrates the difference between the two types of networks. NGNs completely separate the packet-switched transport (connectivity) layer and the service layer, enabling any available fixed-line carriage infrastructure to be used efficiently for any service.

### **Domestic Backbone and Rural Backhaul Connectivity**

As end users’ demand for additional bandwidth grows, insufficient domestic backbone can pose a considerable challenge to the roll-out of fixed-line broadband services. In the mobile sector, insufficient backhaul capacity is becoming a limitation, particularly with the increase of rural 3G data use. Government interventions in support of rural backhaul solutions have included the introduction of public-private funding mechanisms (as in Korea and Chile; see box 2.4), construction subsidies (as in Canada), and the rollout of fiber-optic networks connecting public institutions (Rossotto et al. 2010). Complementary regulations can be used to ensure competitive conditions in the provision of domestic backbone and rural backhaul. The policy tools for supporting domestic backbone rollout and rural backhaul connectivity include infrastructure sharing,<sup>10</sup> functional separation,<sup>11</sup> and cross-ownership restrictions, allowing for interplatform competition<sup>12</sup> (Dartey 2009).

### **Local Loop or “Last Mile” Connectivity**

The delivery of network access in the “last mile” is the most costly and challenging element of rural deployments. The technology options for delivering wired local loop broadband connectivity include the rollout of xDSL,<sup>13</sup> cable, and fiber to the home infrastructure. Wireless options include the rollout of mobile (2G, 3G, 4G),<sup>14</sup> wireless broadband (WiMAX, Wi-Fi,

10 “Infrastructure sharing” is a mechanism for reducing capital expenditures and operating expenditures. Passive infrastructure sharing consists of colocating competitors. Active infrastructure sharing consists of sharing the network base station controllers, both circuit-switched and packet-oriented domains, mobile services switching center, GPRS support node, and so on.

11 In “functional separation,” an incumbent operator is required to establish separate divisions for managing fixed-line services and providing wholesale services to retail competitors.

12 Cross-ownership restrictions prevent operators, such as telephony operators, to control competitive network infrastructure, such as cable television networks. For example, restrictions may be placed on the simultaneous control of telephony and cable television network infrastructures in a specified area.

13 xDSL refers to all digital subscriber line (DSL) technologies.

14 2G mobile wireless has basic functionality: voice and short messaging service (SMS); 3G has advanced functionality: general packet radio service; and 4G has broadband functionality: long-term evolution (LTE).

### **BOX 2.4:** Chile's ICT Policies for Connectivity and Economic Growth

Chile regards ICT policies as important tools for increasing the nation's economic growth. The government has introduced policies addressing both the supply of and demand for ICT. These policies go beyond infrastructure to include programs for e-literacy, e-government, and ICT diffusion.

Chilean ICT policies consistently distinguish between the domains of the private and public sector and rely primarily on market forces to dictate the development of the telecommunications sector. For example, the broadband market in Chile has high levels of interplatform competition: Multiple operators offer competing broadband services through different networks. Government involvement is limited to cases where market forces alone fail to provide incentives for growth in the sector. Starting in 2002, for example, government investments focused on improving the connectivity of rural schools, developing fiber backbone infrastructure, and training people in remote areas in computer skills. In 2008, the government embarked on a more ambitious project to extend at least 1 megabits per second connectivity to 92 percent of the population and intensify the use of ICTs in agriculture and tourism. Candidates for delivering this project were selected through a reverse auction. The Chilean government participated by offering a subsidy of US\$ 70 million and the spectrum in the 3.5 gigahertz band.

The Chilean Universal Access/Universal Service Fund has been praised for its accomplishments. Between 1994 and 2002, by providing public pay phones to more than 6,000 rural locations, the fund reduced the fraction of the population living without access to basic voice communication from 15 percent to 1 percent. The subsidies required to achieve this goal cost less than 0.3 percent of telecommunications sector revenue over the same period. The opportunity for existing and new operators to use the subsidized pay phone infrastructure to provide individual telephone lines and value-added services (voice mail, Internet access, and so on) was key to success. An interconnection rate with access charges capable of surpassing 40 percent of rural operating revenues was the other key to commercial success.

*Source:* Mulas 2010; Wellenius 2002.

WLAN),<sup>15</sup> and satellite very small aperture terminal (VSAT) infrastructure. Within cell-based (mobile) wireless standards, all users connect to a single base station, and the transmission bandwidth has to be shared among all users in the cell's coverage area.

Within a short range, wireless broadband transmission is possible at relatively high data rates—hundreds of megabits (Mbps) to a few gigabits (Gbps)—but services of such high quality are not foreseeable for existing mobile standards. Conversely, mobile technologies have the advantage of reliability within a greater access range. Point-to-multipoint solutions, combining VSAT terminals with wireless broadband local access, are increasingly viable and promising. Unlike cell-based connectivity, satellite connectivity does not distribute the available bandwidth among the users; instead, each user is connected independently, so satellite solutions can offer better quality of service. Yet the low density of wired infrastructure, combined with the limited domestic fiber backbone in developing countries, makes wireless a practical option for connectivity in rural areas, despite the limitations imposed on users by sharing capacity.

As this discussion implies, finding the network solution that can ensure affordable ICT in rural areas can be an innovative, challenging, and exhausting process. The choice depends largely on the availability of technology, of rural backhaul, and of complementary infrastructure. It also depends on the flexibility and responsiveness of the regulatory framework to the prevailing technology constraints and opportunities.

Policies related to the development of rural wireless infrastructure require careful study of the trade-offs between affordability and usability. Policy makers must determine where the value lies (in terms of use) in developing the infrastructure. Regulatory policy must consider the trade-offs between reach, speed, frequency, and transmission. For example, the choice to use technology with low transmission power can lead, on the one hand, to a great increase in the available bandwidth per user, but on the other hand, it may require a direct line of sight between the antenna and the user. Consequently, the number of access points needed to cover a fixed area, and therefore the required capital expenditures, will rise considerably.

<sup>15</sup> WiMAX (worldwide interoperability for microwave access); Wi-Fi (wirelessly connecting electronic device); WLAN (wireless local area network).

Several key technology parameters should be considered in decisions about the expansion of rural connectivity and the choice of technological delivery mechanism. They include the availability of spectrum frequencies, number of base stations needed to cover an area of specific size given a fixed operating frequency, achievable connection speed, data transmission rates, and downlink and uplink speeds.

Given the complexity of such decisions, the role of the regulatory environment should be to expand the set of viable technology options. Flexibility in allowing licensed and unlicensed use of operational frequencies can be advisable. Wellenius (2002) describes how Chile identified cost-effective solutions to reduce the gap between urban and remote areas in access to basic communications technology.

The “digital dividend” has been widely hailed as the solution to urban-rural inequities in digital ICT access. The “digital dividend” is the reassignment of operational frequencies that become available following the switch from analog to digital television broadcasting. The Geneva 2006 Agreement sets June 17, 2015 as the final date for protecting currently assigned analogue television transmission frequencies. The digital dividend spectrum is found between 200 megahertz (MHz) and 1 gigahertz (GHz). It offers a combination of transmission capacity and distance coverage conducive to the extension of wireless broadband infrastructure in rural areas. Using this spectrum, a few stations can transmit with high power, thereby providing Internet coverage to large rural areas where population is low and demand sparse. The advantage is the low capital expenditure required; the downside is the low bandwidth available to individual users. The process is accepted as inevitable, however, and it provides opportunities for efficient spectrum management in rural areas.

How to reassign digital dividend frequencies efficiently remains open to debate. Some advocate the reassignment of analog transmission frequencies to MNOs, without imposing requiring that rural infrastructure investments be tied to urban infrastructure investments (Picot et al. 2010). Others propose allocating the digital dividend frequencies to short-range communications. Countries’ experiences with the crossover to digital television have varied and remain difficult to evaluate, as the process is still unfolding (box 2.5 has an example from South Africa).

Some observers (Nedeveschi et al. 2010) have considered CDMA450 a solution to rural connectivity problems (it is

### **BOX 2.5: Lessons from South Africa’s Experience in Migrating to Digital Television**

South Africa developed a digital migration strategy to stimulate growth in its electronics manufacturing sector. The strategy featured a digital switch-on date in 2008 and an analog switch-off date at the end of 2011. The reduced costs of simultaneous analog and digital broadcasting (€ 750 million for three years) were considered a strong advantage of the ambitious, three-year migration plan. Other expected costs included € 800 million for the digital rollout, as well as € 2.5–3.5 billion for subsidies to local manufacturers producing digital set-top boxes. In early 2011, the South African minister of communications announced that the switch from analog would be postponed until December 31, 2013. Observers have raised questions about the practicality of the plans and even the postponed date. The lesson is that the certain costs of switchover plans need to be balanced against their uncertain benefits, including the uncertain demand for the released telecommunications spectrum and for additional digital TV services.

*Source:* Author, based on Pham 2009; Armstrong and Collins 2011; and Government of South Africa, “Statement by Minister of Communications,” January 14, 2011 ([http://www.doc.gov.za/index.php?option=com\\_content&view=article&id=478:statement-by-the-honorable-minister-of-communications-mr-radhakrishna-l-padayachie-roy-on-progress-made-with-regards-to-the-digital-migration-process&catid=88:press-releases](http://www.doc.gov.za/index.php?option=com_content&view=article&id=478:statement-by-the-honorable-minister-of-communications-mr-radhakrishna-l-padayachie-roy-on-progress-made-with-regards-to-the-digital-migration-process&catid=88:press-releases), accessed July 2011).

used for this purpose in Kazakhstan; see box 2.6). CDMA450 is a cellular technology based on the CDMA2000 standard, with an operating frequency of 450 MHz. The technology uses the same air interface as CDMA2000 but operates at a lower frequency and is able to offer the same basket of high-speed voice and data connectivity over a greater range, thereby implying lower capital expenses. In rural settings, CDMA450 has a range of up to 50 kilometers. Owing to a process known as “cell breathing,” however, such ranges are not achievable under cell loads approaching cell capacity. CDMA450 appears to be best suited to mixed urban-rural deployments, in which urban deployments are capacity-centric and rural deployments are coverage-centric. Another disadvantage of CDMA450 is the large antenna required to allow the extended coverage for meeting low rural demand. The major limitation of CDMA450 solutions is the scarcity of mobile devices that can use the 450 MHz frequency (the majority operate at 900–1800 MHz).

### **BOX 2.6: CDMA450 Technology Connects Rural Kazakhstan**

Kazakhtelecom, the biggest telecommunications operator in Kazakhstan, introduced CDMA450 technology in rural areas in the north. The CDMA450 base stations cover 25–35 kilometers and can serve up to 1,000 subscribers. The project, which began in 2008, had installed 399 base stations by 2010, providing connectivity to approximately 1,800 rural settlements. The project intends to roll out 900 base stations throughout the country by 2013, enabling voice and Internet access services at speeds up to 3.1 Mbps.

*Source:* Author, based on “Implementation of CDMA-450 in North Kazakhstan,” August 5, 2009, Cellular News (<http://www.cellular-news.com/story/38960.php>, accessed July 2011) and “Base stations WLL CDMA cover about 80% rural settlements in Kyzylorda oblast,” Kazakhtelecom press release ([http://www.telecom.kz/?muin=1240831664&mchapter=1272548824&lang=eng&n\\_date=2010-04-29&act=archive](http://www.telecom.kz/?muin=1240831664&mchapter=1272548824&lang=eng&n_date=2010-04-29&act=archive), accessed July 2011).

## **APPLIANCES**

From a user’s perspective, device convergence has two main aspects. First, users can access content in different formats (audio, data, location data, pictures, maps, text) and with different dynamic properties,<sup>16</sup> produced by different authors, on the same device. Second, users can take advantage of different options (radio, GSM, Wi-Fi, Bluetooth, satellite) for accessing that content.

The evolution of appliances in the mobile phone market illustrates these two trends. The discussion that follows focuses on portable devices that support multiple functionalities or multiple connectivity options, because they are vast majority of ICT appliances available in the world today.

Portable devices, including but not limited to mobile phones, are starting to allow users dual (or multiple) mode flexibility. For example, dual connectivity (Wi-Fi/GSM and Bluetooth/GSM) enables mobile phones to conduct both VoIP and standard mobile calls. Dedicated telephone devices are able to process VoIP phone calls using Session Initiation Protocol, as well as regular phone calls using analog signals. Gains in processing power allow functions with higher technology requirements to work on smaller devices (high-end

<sup>16</sup> Such as “online” and “offline” content; “online” content is communicated but not recorded or reusable (such as a radio broadcast), whereas “offline” content is recorded and reusable, once it has been communicated (such as audio podcasts, SMS messages, or voice mail).

smartphones and Netbook appliances). Conversely, bulkier stationary devices such as the desktop computer have evolved functionalities traditionally associated with more portable devices, such as VoIP telephony and on-demand radio and TV broadcasts.

Among rural users in developing countries, the trend is to move from mobile phones with basic voice and text message capabilities to feature phones. Feature phones are low-end phones that access various media formats in addition to offering basic voice and SMS functionality, capturing the functionalities of multiple ICT devices that are also available as standalone appliances. Rural consumers prefer the combined devices because of their affordability. Features appreciated by consumers in developing countries include digital camera, voice recorder, flashlight, radio, and MP3 player. Bluetooth and general packet radio service (GPRS) are the most widely available connectivity options in addition to GSM. Chinese mobile phone manufacturers tend to be at the forefront of making devices that are particularly affordable and attuned to the needs of rural users in developing countries (box 2.7).

The demand for features tends to vary depending on the availability of complementary rural services. For example, radio is a feature very commonly targeted at the rural market, owing to the traditional significance of radio broadcasting in rural areas. Nonetheless, the choice of radio devices by rural residents is largely determined by the availability of electricity. The radio feature of mobile phones tends to consume the device battery fairly fast. Rural residents off the electricity grid find this feature uneconomical, because the cost of recharge services provided by local entrepreneurs are not negligible. Rural residents at locations off the electricity grid in Ghana report paying 0.50 cedis per charging, comparable to the price for one kilogram of plantains or oranges.<sup>17</sup> In agricultural areas such as northern Ghana, solar-powered and windup charging devices have durability and maintenance issues (although they appear useful elsewhere; see IPS “Long Experience in Farm Communities Benefits IFFCO” in Topic Note 2.4).<sup>18</sup> By comparison, traditional, battery-powered, dedicated radio receivers appear to be a more affordable choice.

## **SERVICES**

Services entail much more than access to hardware; they encompass affordable access to locally relevant rural content

<sup>17</sup> See Esoko (<http://www.esoko.com>).

<sup>18</sup> Details available from the authors.

**BOX 2.7: Mobile Phones with Features Attract Rural Users in China and Beyond**

Chinese mobile phone producers are concentrated in the city of Shenzhen, Guangdong Province. They, as well as their products, have become known as *shanzhai*.<sup>a</sup> At least two innovative features associated with shanzhai devices have wider relevance to rural consumers' use of, and preferences for, devices in developing countries.

The first feature is that they allow users to store multiple (physical) SIM cards within the device, which allows them to switch between carriers without having to reboot the device. This feature responds to the price sensitivity of rural consumers in developing countries, who switch between carriers to take advantage of preferential termination rates for the carrier of their calling destination. Because the choice of mobile network operator can be limited in rural areas, consumers have strong incentives to take advantage of cost-saving opportunities when they exist. This demand-driven innovation has made no inroads into the products of popular mobile phone manufacturers, which are reluctant to undermine the business models of mobile network operators worldwide. Consumers who cannot purchase these devices can achieve the same results through street-level hack services offering software to configure from 6 to 16 SIM card identities on one physical SIM card, enabling users of unlocked mobile phones to switch conveniently among carriers.

A second feature of devices from Chinese mobile phone manufacturers (relevant to convergence in the "infocom" sector) is the addition of analog television reception. This feature is found in phones with large LCD screens like those of smartphones.

The features in these devices illustrate ways that the global mobile phone industry could choose to respond to the demands and constraints of rural consumers—but has not. The preference of rural consumers in developing countries for access to television over radio is well established but constrained by poor access to the electricity grid. Unlike dedicated radio receivers, television sets have not evolved to operate on dry cell battery power alone, and mobile phone devices with analog television functionality are the exclusive option for rural populations. Given that television remains an effective means of delivering agricultural extension messages, the lack of support for these and other innovative features introduced by Chinese phone manufacturers represents a missed opportunity in rural communication.

Source: Authors; Chipchase 2010; Abbey-Mensah 2001.

(a) Shanzhai signifies Chinese imitation and pirated brands and goods, particularly electronics (<http://en.wikipedia.org/wiki/Shanzhai>, accessed July 2011).

through connectivity providers, content creators and disseminators, information intermediaries, social facilitators, information literacy educators, and the governance channels steering the performance of these services.<sup>19</sup> Concerns with rural content have traditionally been alien to public policies aimed at universal service and universal access, but the convergence of the mass media and telecommunications sector, as well as the rise of the information society, make such concerns increasingly prominent and crucial to unleashing a virtuous cycle of ICT adoption and use in rural areas. The delivery of content-based agricultural services is discussed in Topic Note 2.4.

The service layer reflects the synergies (or lack thereof) among network infrastructure, connectivity modalities, access devices, and content. The dynamics of the worldwide content marketplace point to the dying out of traditional communications business models, which centered on tariffs anchored in

use time, quantity of data transferred, or communications distance covered. Such models increasingly are replaced by more flexible subscription models and models centered on realized interactions and transactions, paid for via micropayments. In developing countries, where consumers are more price sensitive and less willing to pay, the trend toward micropayments poses a considerable challenge to content and value-added service providers. The challenge is compounded by the marginal success of government and donor efforts to provide content-driven rural services in developing countries.

Traditionally, rural information services focused on providing broadcasting ("push") content, such as rural radio programming, but the ubiquity of mobile devices enables the sourcing and sharing ("pull") of rural content. The presence of mobile technology as an authoring tool in rural areas presents an untapped opportunity to engage rural users in authoring content, thereby increasing the demand for existing rural infrastructure. Mobile devices, in combination with broadcasting technologies such as radio, enable rural residents to

19 See the earlier discussion of the layered nature of access ("Access Concept") and the Access Rainbow Framework.



participate in public discourse and influence decision making. In reviewing communication and media needs at the community level in Ghana, (Dartey 2009) points out that call-in radio programs have become widely popular. Such programs allow Ghanaians to express their opinions on issues of local concern.

The provision of rural ICT-based services in developing countries has a few discernible characteristics. One recurrent characteristic in successful business models is found at the literacy/social facilitation level of the Access Rainbow Framework. Successful business models manage to leverage social networks and social value (UNDP 2008). Engaging rural residents as individuals rather than as beneficiaries appears to be essential in delivering a worthwhile value proposition. Allowing rural residents to be trainers, to facilitate access to content, and to provide local support and maintenance appears to be a successful business strategy for the delivery of rural services (image 2.1).

**IMAGE 2.1:** Cell Services in Rural South Africa



Source: John Hogg, World Bank.

Even though the diffusion of personal mobile phones has eroded the business logic behind well-documented models such as the Grameen Village Phone (an owner-operated GSM payphone) (Futch and McIntosh 2009), the significance of social value remains a key building block of business models aimed at delivering rural ICT-based services. As pricing plans have changed over the past few years, the mobile payphone has become less profitable as a business asset. Even so, the impersonal nature of mobile payphones is instrumental to addressing concerns related to equal access. From the standpoint of public service provision, equal access to public phones continues to be significant, especially for women

who cannot afford their own phones or are not permitted to use personal phones of family members (Burrell 2010). The sharing and collaborative use of personal mobile phones can enhance social ties but may also cement social inequalities.

Another trend to be noted is the divergence in focus and targets of local (especially rural) demand-driven information services relative to supply-driven services. Content-focused service innovations tend to respond to local needs within the entertainment, social networking, game, and music domains. If managed carefully, such services can be legitimate drivers of ICT use for demand-driven services in education, public awareness, health, and agriculture. Introducing immediately popular content is a way to attract and retain users. Once the user base is established, there is room for introducing more practical content, such as mobile banking (box 2.8).

### **BOX 2.8:** MXit Blends Entertainments and Practical Content in South Africa

Founded in 2003, MXit is a pioneering mobile media and social networking company based in South Africa. Initially community issues and causes formed a strong focus for the networking it facilitated. Subsequently it has expanded to cover entertainment (music downloads, multiplayer games, TV polls), dating, classifieds, education, counseling (drugs, youth helpline), and mobile banking.

The primary MXit product is software allowing mobile users to use instant messaging to participate in community forums on different topics. The software can be installed for free, and there is no subscription and no charge for messaging. By using IP-based (GPRS, 3G) connectivity, MXit allows instant messaging at a cost per character hundreds of times smaller than the cost of an equivalent SMS message. These costs are covered by revenues from advertising (wallpapers, promotions, brand portals) and content sales (skinz, music, classifieds).

Source: Chigona et al. 2009; Prows 2009; Ramachandran 2009.

Currently, prepaid subscription models appear to be the standard operational mode for providing services in developing-country markets. Yet as Topic Note 2.4 indicates, this strategy may be impractical for rural content providers, given the risks involved in subscription renewal and the high fixed costs of generating relevant rural content.

## Topic Note 2.2: PUBLIC INNOVATIONS IN UNIVERSAL ACCESS TO TELECOMMUNICATIONS

### TRENDS AND ISSUES

With technology moving toward fixed-mobile convergence, the provision of minimum services (other than telephony) and public access to ICT devices has fallen within the mandate of universal service regulations. This note examines the public sector's changing and recently expanding role in providing affordable access to ICT infrastructure, appliances, and services, including the growing use of universal access/universal service funds.

#### Changing Role of the Public Sector

Public involvement in the telecommunications sector evolved in a nonlinear way (Gómez-Barroso and Feijóo 2010). An early monopolistic stage after the Second World War was succeeded by a series of crises in the 1970s as services came to be considered a “public matter” demanding closer government involvement. In the 1980s, the public sector started giving way to the private sector, which was considered better equipped to deliver value and efficiency.

The public sector's current role in telecommunications can be described as promoting the information society. Governments act as facilitators and enablers of universal access to telecommunications, and the public sector has re-emerged as an active participant in the sector. In both developed and developing countries, public agencies are regarded as partners in funding infrastructure in areas where the incentives for private investment are insufficient; they are also regarded as partners by virtue of their role in encouraging demand for telecommunications. In developing countries, local governments and international development partners actively facilitate access to ICTs at all levels (infrastructure, appliances, and services).

It is within the domain of local government and public administration to provide innovative methods for access to ICTs in rural areas. Effective partnerships and public support are capable of overcoming obstacles at different access layers. Until recently, the public sector was not considered an investor in telecommunications, but under the increasing pressure of the international financial crisis, governments have looked to ICTs as fiscally sound investments relative to other public stimulus options. Investments in broadband and next-generation networks are proving to work as countercyclical tools for creating jobs and as building blocks of long-term economic recovery (Qiang 2010).

#### Broadening Mandate of Universal Access/Universal Service Funds

The main vehicles for improving access to ICTs in rural areas have been the universal access/universal service funds (UA/USFs) established in the 1990s. The funds originally offered an opportunity for funding and access to ICT solutions in underserved areas (Hudson 2010). Dedicated at first to increasing the penetration of landline telephone services, the funds now support mobile network development and Internet services in most countries.<sup>20</sup>

In some countries, such as Ghana and Mongolia, funds are disbursed to aid the provision of rural public access telephony and Internet facilities. Although the expansion of mobile networks has reduced the urgency of public access to voice telephony, arguments based on gender inequality and perceptions of social obligation still favor the provision of public access (Burrell 2010). In allocating UA/USF funds toward services other than voice telephony, some governments specify additional criteria such as the nearby presence of public-access facilities (telecenters, libraries, Internet cafes, and so on).

Since cost-effective technologies for the delivering rural access to ICTs are evolving constantly, it is essential that UA/USFs do not limit their technological scope and maintain technological neutrality. It is advisable for UA/USFs' tender requirements to specify coverage, bandwidth, quality of service, target price, and so on—but not technology. Rural areas where the profitability of telecommunications services is low can be of limited commercial interest to telecommunications companies. Consequently, the UA/USF levy can run the risk of becoming a simple direct tax on the operator, and a strategic approach is needed to deliver ICT services and “unlock” the potential of UA/USFs (especially in Africa) (UNCTAD 2010).

#### Public Support for Low-Cost Devices

Unlike public support for the provision of infrastructure, public support for the provision of low-cost devices has experienced considerable criticism. The most prominently instance

<sup>20</sup> The objectives of UA/USFs can be at very different stages of development and maturity. Hudson (2010) reviews key lessons related to UA/USFs' management, professional capacity, size of funding, and expanding mandate. Stern, Townsend, and Stephens (2006) recommend the accelerated, simplified, and diversified use of UA/USFs. UNCTAD (2010) discusses in detail the challenges and opportunities for financing ICTs in rural areas of developing countries through UA/USFs.

### **BOX 2.9: India Exemplifies Evolution in the Public Provision of Low-Cost Devices**

India's Union Minister for Human Resource Development announced that the government would continue to support development of a low-cost device with computing and communication capabilities. The cost of the tablet device, commonly known as the "Sakshat" ("before your eyes"), currently stands at US\$ 35, but it is projected to decline to US\$ 10 through continuing research and development cooperation with private manufacturers. The government is committed to first provide the technology to 110 million schoolchildren.

The Indian program clearly demonstrates how the scope of public initiatives providing access to low-cost devices has evolved, largely as a result of the comprehensive approach of the One Laptop per Child project. Government initiatives aimed at the development of low-cost technology devices include the active participation of technology development partners (for example, the Indian Institute of Technology Rajasthan) as well as further development and investment in communication layers other than the appliance itself. The Indian Ministry for Human Resource Development is simultaneously tackling the problems of device/hardware affordability and content creation by ensuring that electronic content for the devices is generated under the National Programme on Technology Enhanced Learning.

*Source:* Author, based on "India to Unveil £ 7 Laptop," *The Guardian*, February 2, 2009 (<http://www.guardian.co.uk/world/2009/feb/02/india-computer-cheapest>, accessed July 2011); "India Unveils World's Cheapest Laptop," *The Guardian*, July 23, 2010 (<http://www.guardian.co.uk/world/2010/jul/23/india-unveils-cheapest-laptop>, accessed July 2011); "Low Cost access-Cum-Computing Device Unveiled by Shri Kapil Sibal," *The Hindu*, July 23, 2010 (<http://www.thehindu.com/news/resources/article529944.ece>, accessed July 2011).

was government involvement in the One Laptop per Child project (Burke 2006; Hollow 2009; Kleine and Unwin 2009). Yet government efforts to provide low-cost devices persist and are evolving (box 2.9).

### **INNOVATIVE PRACTICE SUMMARY** **Passive Infrastructure Sharing in Nigeria**

"Passive infrastructure sharing" is the sharing of nonelectronic infrastructure, equipment, and services at mobile network base stations, including the site space, buildings, towers, masts, and antennas; power supply, back-up batteries, and generators; security; and maintenance. Passive

infrastructure sharing is distinguished from "active infrastructure sharing," which can involve the shared use of electronic infrastructure such as network components (for example, access node switches), radio transmission equipment, and core network software systems (Ghosh, Aggarwal, and Marwaha 2009). Although active infrastructure sharing can raise concerns among mobile network operators, passive infrastructure sharing has become established as a reliable mobile network expansion strategy, particularly for expensive rural sites with high transmission and power costs.

Nigeria has been named one of the telecommunications markets with the most promising potential for growth. Even so, the National Communications Commission has identified several issues as detrimental to this growth, including poor public power supply, poor security, and high operational costs (Onuzuruike 2009). In Gupta and Sullivan (2010) found unreliable electricity and insecurity to be the main challenges to operating mobile networks. These challenges were much more prominent in Nigeria compared to other West African countries with more reliable access to the electricity grid (such as Ghana, Cameroon, and Côte d'Ivoire). Gupta and Sullivan (2010) calculated that costs of fuel for generators, including a minimum of 20 percent of fuel lost to theft, amounted to 60–90 percent of the costs of running network sites in Nigeria. Base station costs in Nigeria add up to US\$ 200,000–250,000, 3.5 times higher than in India (US\$ 60,000–70,000). Some of these limitations are at last being overcome through passive infrastructure sharing.

Helios Towers Nigeria (<http://www.heliostowers.com/homepage>) significantly decreases the impact of such issues. In 2005 Helios Towers became Africa's first independent mobile tower company, enabling wireless network operators to share infrastructure. The organization buys nonelectronic infrastructure at the cell site from telecommunications providers, such as towers and power supplies, or develops new infrastructure where none exists. Telecommunications companies rent space at the towers and access to other elements of the communications infrastructure, sharing it with other providers.

Helios Towers estimates that clients colocating on one of their towers can save over US\$ 200,000 in capital expenditures and up to 20 percent in operating expenditures. Helios Towers also provides wireless operators with power, round-the-clock security and access (shelters have typically been subject to vandalism), as well as other services such as installation and maintenance. According to its website, the company's large-scale and numerous sites allows it to offer a guarantee of 99.9 percent uptime for service users,

compared to a 70 percent industry average. Network operators thus improve the quality of service for customers and can pass the associated cost reductions on to them.

The economies of scale that Helios Towers and companies like it generate enable them to provide access in areas where it would not be financially advantageous for other companies, such as the network operators, to do so. Access is increased in rural areas, for example, or areas where power supplies previously were poor.

Helios Tower's first site went live in June 2006, and since then the company has expanded to include over 1,000 four-operator sites across Nigeria's six geopolitical zones. Through them, MTN Nigeria provides services in 223 cities and towns, more than 10,000 villages and communities, and a growing number of highways across the country. In August 2004, MTN had coverage in all 36 states and the Federal Capital Territory Abuja, and their signal reached 80.9 percent of Nigeria's total population, living in 58.33 percent of its landmass.<sup>21</sup> Similarly, through Helios Towers, Zain Nigeria<sup>22</sup> (MTN Nigeria's largest competitor) currently covers over 1,500 towns and 14,000 communities across all six geopolitical zones. Zain was the first telecom operator to serve all of the zones.<sup>23</sup> Considerable overlap in the coverage offered by these and other network operators provides significant advantages to end users: The resulting competition lowers tariffs and enhances choice.

The National Communications Commission supported this new business model and developed a regulatory framework for potential colocators. This framework suggests how to share infrastructure to promote fair competition and infrastructure sharing among the telecoms' licensees. It effectively enables organizations such as Helios Towers to operate with state support and gives network operators a strong incentive to align with such a powerful ally.

The business model developed by the growth of tower management companies such as Helios Towers has helped erase

problems faced by operators in operating and managing wireless infrastructure. As Onuzuruike (2009) notes, tower management companies usually enjoy scalable and long-term recurring revenues with contracted annual escalations. They also benefit from low churn rates and low operating and capital costs. Hence they are able to ensure the fair treatment of new entrants while satisfying incumbents (by purchasing their infrastructure and allowing the operators to outsource at a lower cost), at the same time providing more comprehensive service to end users.

Helios Towers depends on wireless operators buying into its service. The company is able to offer a basis for partnership that makes their proposition highly attractive to corporate clients: infrastructure sharing lowers the risk represented by investment in network expansion and upgrades. The company counters the rising price of site rentals by sharing this cost among partners; site owners, in response to the rising demand for provision in underserved areas, have increased their rents, and local government restrictions on new tower construction owing to health and environmental hazards have only increased the attractiveness of passive infrastructure sharing.

To retain its many partners (aside from MTN and Zain, they include EMTs, Starcomms, Reliance Telecoms, and Visafone) and provide comprehensive nationwide service, Helios offers services to the full range of wireless operators: GSM, CDMA, and WiMAX operators utilizing 2G, 3G, and 4G technology platforms. It is also prepared to build towers where there are none, even when it is not financially advantageous in the short to medium term, to improve its network and remain the dominant supplier. As a result, operators can expand into rural markets and other underserved areas while keeping their costs—and, crucially, their tariffs—low.

### INNOVATIVE PRACTICE SUMMARY

#### Turkey's Oligopolistic Infrastructure Sharing Model

The Turkish mobile telecommunications market is dominated by Turkcell, Vodafone Turkey, and Avea (a wholly owned subsidiary of Turk Telekom, the largest telecommunications company in Turkey). Following an agreement announced by Turkcell and Turk Telekom in August 2009, the two companies (and to a lesser extent Vodafone) have made strides to reduce the costs of introducing 3G mobile broadband technology in Turkey through passive infrastructure sharing.<sup>24</sup>

21 See <http://www.mtnonline.com/index.php/about.html>, accessed July 2011.

22 In 2010 Bharti Airtel of India completed the acquisition of the Zain Group in a US\$ 10.7 billion deal (Pan 2010), which included ownership of Zain's assets in Africa (network operations in Burkina Faso, Chad, Democratic Republic of Congo, Republic of Congo, Gabon, Kenya, Ghana, Malawi, Madagascar, Niger, Nigeria, Tanzania, Sierra Leone, Zambia, and Uganda). In these countries, Zain operations are currently known as Bharti Airtel. This section maintains references to Zain Nigeria.

23 Coverage information publicized online (<http://www.ng.zain.com/System/AboutUs/tabid/59/Default.aspx>) by Zain Nigeria, prior to its acquisition by Bharti Airtel.

24 "3G in Turkey: By Sharing Infrastructure?", *Developing Telecoms*, August 12, 2009 (<http://www.developingtelecoms.com/3g-in-turkey-by-sharing-infrastructure.html>), accessed July 2011.

They have signed contracts with Huawei, ZTE, and Ericsson for this purpose.

This highly interesting development in infrastructure sharing involves competition from both ends of the partnership. Unlike in Nigeria, where Helios Towers enjoyed unparalleled relationships with both Zain and MTN, here the infrastructure managers must fight to retain convivial relationships with their clients. This competitive landscape reflects the business model promoted by Turkey's regulatory framework.

Turkey's ICT sector lags its European counterparts in some areas, with declining numbers of fixed telephone lines (27.3 percent of the population in 2000, compared with 24.6 percent in 2007) and slow penetration of the Internet market (2.2 percent in 2000 to 6.3 percent in 2007) but rapid growth in mobile subscriptions (rising from 23.9 percent penetration in 2000 to 83.9 percent in 2007) (Rossotto et al. 2010:229–30). This sector profile reflects Turkey's young population: 92.9 percent are under the age of 64 (Rossotto et al. 2010:230). This demographic suggests the huge potential of wireless broadband in Turkey, which is why international players such as Vodafone, Huawei, and Ericsson are keen to invest heavily in the country and compete among themselves for market dominance. Because contracts were exchanged only recently (2009), it is still difficult to evaluate the impact of the technology or the competitive business model under which it is provided.<sup>25</sup>

Regulatory reform of the Turkish telecommunications industry has been a concern. Rossotto et al. (2010) report that regulators seek to promote a fully competitive market sector through plans modeled loosely around the EU framework. Although Turk Telekom (privatized in 2005) dominates the telecommunications industry with its 93 percent market share, this dominance is being most convincingly challenged in mobile communications. Turkcell and Vodafone both enjoy greater market share in this subsector, thanks to the regulatory efforts made to ensure fair competition.

Despite these efforts at promoting competition, a market share analysis demonstrates that the market is moving toward an oligopolistic structure in terms of competition among mobile network operators as well as among infrastructure managers such as Ericsson. This shift is reflected

by the highly competitive business models of infrastructure providers, which enable more and later entrants to the market (such as ZTE). The price-competitive business model has also enabled customers to receive services at lower prices: Ericsson, Huawei, and ZTE must streamline their own profits to offer the MNOs maximum cost savings (to gain market share), and Turkcell, Vodafone, and Telekom Turk must pass on a significant proportion of these savings to customers (again to achieve greater market share).

Although the partnership structure that has evolved in Turkey is less convivial than that in Nigeria, it has still been key to implementing 3G technology. The agreement between Turkcell and Telekom Turk to jointly reduce infrastructure costs has been particularly instrumental in avoiding another false start in bringing 3G to Turkey (Rossotto et al. 2010).

The competition among key players in the infrastructure provision industry has ensured comprehensive coverage of the different routes and technologies into mobile broadband: Ericsson's Converged Package Gateway, for example, is suitable for operators "providing high performance broadband LTE services, CDMA operators moving to LTE, and operators wanting to provide mobility between LTE, 3GPP and 'non-3GPP' access networks such as wireless LAN or Wimax."<sup>26</sup> ZTE and Huawei provide similarly encompassing services.

## INNOVATIVE PRACTICE SUMMARY

### Dabba's Experience with Unlicensed Wireless Services in South Africa

One obstacle to expanding wireless technologies is the unlicensed use of wireless services. The main problem associated with unlicensed multipoint wireless services is interference arising from the operations of other wireless networks within an area. Interference often causes unlicensed wireless services to have much higher error rates and interruptions than equivalent wired or licensed wireless networks (for example, copper telephone, coaxial cable, and mobile networks). For these reasons, unlicensed multipoint services often grow slowly and lose customers; their operators may be required to rethink their business model.

Interference problems have yielded several responses. An organizational response has been to establish voluntary

25 "Ericsson to Build 3G Network for Turkcell," Ericsson, March 11, 2009 (<http://www.ericsson.com/news/1296824>, accessed July 2011).

26 See <http://www.ericsson.com/ourportfolio/telecom-operators>, accessed July 2011.

spectrum coordination organizations, entirely independent of government, to coordinate the actions of unlicensed wireless network operators and minimize disruptions through the maintenance of an operator frequency and sources database. Cooperation with the voluntary coordination body is enforced through peer pressure by cooperative operators on uncooperative operators.<sup>27</sup>

A technology-centered approach to the interference issue is the development of adaptive and mesh network technologies. Adaptive networking improves performance by developing dynamic interference and fault detection and reconfiguration protocols. Mesh networking optimizes quality over routing and the possible paths for the delivery of service to customers. Neither technology is yet capable of delivering high-speed, low-latency, business-class, and reliable local loop service, however.<sup>28</sup>

As partners of The Village Telco service in South Africa, the company Dabba and the Shuttleworth Foundation in the Orange Farm Settlement provide telephone and mobile access through VoIP wireless routers. Founded by Rael Lissous in 2004, Dabba reprogrammed Wi-Fi routers as base stations and used open source firmware to make up the components of a telecommunications network. Following complaints to the Independent Communications Authority of South Africa by the incumbent operator Telkom that Dabba was interfering with its licensed service provision, Dabba's equipment was seized in February 2009. Dabba has since returned to work with a new business partner, Cisco, the international networking and communications expert.

Dabba is an example of innovation to avoid the high costs typically associated with telecommunication service provision to rural and unserved areas. Wi-Fi enables access to large areas at a low cost, as hot spots with amplifiers can cover ranges of up to 8 kilometers, allowing Dabba to serve entire townships with minimal outgoing expenses. In the densely populated townships, this has proved a winning formula for providing telecommunications to large numbers of people and for passing on the low costs to the end user.

27 BANC (Bay Area Network Coordination), the first voluntary coordination body, was founded in 2003 by NextWeb, Etheric Networks, GateSpeed and a handful of other companies. BANC comprised the majority of operators in California's Bay Area and used peer pressure to get uncooperative operators to conform. BANC was subsequently deployed in Los Angeles. Despite their efforts, some members of BANC switched to licensed operations because of the high costs of interruptions, and the system foundered.

28 The source for this paragraph is [http://en.wikipedia.org/wiki/Wireless\\_local\\_loop](http://en.wikipedia.org/wiki/Wireless_local_loop).

Dabba offers free calls within the local network and pay-as-you-go cards for users who wish to place distance calls (avoiding subscription fees).

Initially, Dabba exploited the new regulatory freedom provided by an August 2008 High Court Ruling, which ruled that anyone in possession of a Value Added Network Services (VANS) license (which Dabba held) was entitled to "self-provide" and compete in the formerly oligopolistic market (Esselaar et al. 2010). The market grew from four players to potentially hundreds overnight. Dabba took this relative freedom beyond its regulatory limits, however, and was found to be using ISM (industrial, scientific, and medical) Wi-Fi bands, for which it was not licensed, and using equipment that was not type-approved.<sup>29</sup>

Such unlicensed use perhaps derived from Dabba's business model, with its ever-pressing need to reduce operating costs. Dabba adds value for consumers by offering them the least expensive rates (free local calls, pay-as-you-go distance calls, no subscriptions). Cheap service compensates for the lower quality of service that Dabba's technologies sometimes provide. Although this model enabled Dabba to grow quickly in its pilot area, where customers had little to lose by joining the network, it generated enormous pressure to operate cost-effectively.

This pressure has abated through Dabba's new partnership with Cisco. Cisco has provided new equipment and support and has provided 100,000 rand to initiate an ICT entrepreneur program, enabling Dabba to expand into two new townships.<sup>30</sup> Dabba has also received additional support from the Shuttleworth Foundation, which underwrites all of their work. Dabba can now pursue its original business model while remaining more firmly within South Africa's regulatory framework.

The lightweight Ubiquiti equipment employed since Cisco's involvement is inexpensive. It uses solar energy and battery packs connected by locally made antitheft brackets to reduce costs further. This setup, combined with the use of Wi-Fi and wireless mesh networks, make Dabba well-suited to provide coverage for small, local groups and

29 "ICASA defends Wi-Fi equipment confiscation in South Africa," *Balancing Act*, Issue 443, February 27, 2009 (<http://www.balancingact-africa.com/news/en/issue-no-443/internet/icasa-defends-wifi-e/en>), accessed June 2011).

30 "Low-cost phone and voice operator bounces back with entrepreneur support from Cisco," *Balancing Act*, Issue 451, April 23, 2009 (<http://www.balancingact-africa.com/news/en/issue-no-451/top-story/low-cost-phone-and-v/en>), accessed June 2011).

townships, where large, centralized projects could not provide services that most users could afford. Dabba has renewed its operations so recently, however, that its impact remains unclear.

### **INNOVATIVE PRACTICE SUMMARY** **Bhutan's Community Information Centers Adapt to the Geographical and Consumer Context**

Bhutan's Department of Information Technology (DIT) has established a series of community information centers (CICs) to provide sustainable, commercially viable ICT services in rural areas. DIT provides all of the equipment for offering CIC services, and the local community provides an individual who is employed to promote and maintain those services. Services available at the CICs include basic and advanced computer training, non-Internet-based games, digital reproduction, Internet, telephone facilities, government information and forms, and lamination and scanning.

In line with the government's ninth five-year plan, the CICs represent an updated effort to provide rural Bhutan (just over 79 percent of the population) with some telecommunications connectivity. Bhutan's mountainous, forested terrain (forests occupy nearly three-quarters of its land area)<sup>31</sup> have made wired Internet and telephone connectivity prohibitively expensive for operators and end users. The CICs reduce the costs for the end user, who pays on demand only for the services required, and public access through CICs renders service provision more attractive by expanding the customer base. Individuals who could never afford their own personal connection to the telecommunications network may still prove a significant source of income to the CIC, especially when such individuals are considered in the aggregate (villages average 43 households).<sup>32</sup>

The CIC initiative is still in its infancy; the decision to move from government-owned facilities to commercial, locally managed centers was made in late 2008. Microsoft's baseline surveys suggest that when access to telecommunications was available, "the population was adept at using the devices and their usage permeated . . . the community."<sup>33</sup>

They also suggest that Bhutan's relatively young population is an indication of the potential impact of the telecommunications sector.

A key factor enabling development of the CICs is that they not only receive strong government support but are in fact government led and organized and in effect also self-regulating. As long as local managers produce a profit and offer the services detailed in the government guidelines, they are free to operate their CICs as they see fit. Running the centers is thus rendered attractive to local entrepreneurs.

This business model of local autonomy underwritten by government support is crucial to the CICs' success. Some villages are so remote (in extreme cases, several days walk from the nearest road) that only locals can understand the market conditions.<sup>34</sup> By international standards, Bhutan's national media (particularly its newspapers) are weak, and rural service users are likely to have higher levels of trust in local business managers. However, central intervention will be necessary to subsidize the high costs of accessing some rural areas, which is crucial if telecommunications are to reach the population at large. The partnership between local and players and government strikes a favorable balance.

The Government of Bhutan plans to provide a hub-and-spoke network, enabling it to overcome the difficulties associated with placing infrastructure in mountainous and remote terrain. It seeks to provide a network of broadband connection through fiber-optic cables from the capital and out to the 20 districts (dzongkhag) and village groups (gewog). The connection from districts to village groups and on to the villages will be provided by wireless technologies such as GSM. These "spokes" lead to the CICs.<sup>35</sup>

### **LESSONS LEARNED**

The enabling factors and lessons surrounding regulation, business models, partnerships, and infrastructure for these initiatives in Nigeria, Turkey, South Africa, and Bhutan are summarized in tables 2.2 and 2.3.

31 Tobgyl (n.d.:3).

32 Tobgyl (n.d.:4).

33 Bhutan Department of Information Technology, "Microsoft Unlimited Potential Baseline Survey on Socio-economic Demographics and Information Needs," (<http://www.dit.gov.bt/content/microsoft-cic>, accessed July 2011).

34 Tobgyl (n.d.:4).

35 Ministry of Information and Communications (Bhutan), "Vision for Information Society" (<http://www.moc.gov.bt/pdf/Vision%20for%20information%20Society.pdf>, accessed July 2011), p. 10.

**TABLE 2.2:** Key Enabling Factors for Innovations in Rural ICT Provision in Nigeria, Turkey, South Africa, and Bhutan

	HELIOS TOWERS, NIGERIA	INFRASTRUCTURE SHARING, TURKEY	DABBA WIRELESS SERVICES, SOUTH AFRICA	COMMUNITY INFORMATION CENTERS, BHUTAN
<b>Regulation</b>	<ul style="list-style-type: none"> <li>• Support from Nigerian ICT regulatory body</li> <li>• Framework to suggest how to share infrastructure to promote fair competition and infrastructure sharing among telecoms' licensees backs Helios business model</li> </ul>	<ul style="list-style-type: none"> <li>• Telecommunications sector recently focused on regulatory reform and promoting a fully competitive market structure</li> <li>• Allows companies like Vodafone and Turkcell to thrive; enables new companies to enter the market</li> </ul>	<ul style="list-style-type: none"> <li>• Changes to VANS licensing opened a formerly restrictive telecommunications market to new players such as Dabba, allowing them to "self-provide" if they did not cause interference to licensed networks and used type-approved equipment</li> </ul>	<ul style="list-style-type: none"> <li>• Government-led and organized, hence effectively self-regulating service</li> <li>• Local entrepreneurs free to act as they feel most appropriate, provided they make a profit and offer the services detailed by government guidelines (within the framework of other laws)</li> </ul>
<b>Business Model</b>	<ul style="list-style-type: none"> <li>• Scalable and long-term recurring revenues, low churn rates, and operating costs: allow NMOs to achieve savings through outsourcing while retaining profit themselves</li> </ul>	<ul style="list-style-type: none"> <li>• Oligopolistic model has led to price competition, giving consumers connectivity at increasingly lower prices</li> <li>• Network managers such as Ericsson must pass more of their own savings on to MNOs</li> </ul>	<ul style="list-style-type: none"> <li>• Low-cost/lower-capabilities model: Offers customers a lower-commitment approach to telecommunications</li> <li>• Free Internetwork calls and pay-as-you-go card for distance and international calls</li> </ul>	<ul style="list-style-type: none"> <li>• Local autonomy underwritten by government support enables the CICs to combat the remote nature of some locations and the lack of inbuilt trust in national communication systems (due to a weak national media)</li> </ul>
<b>Partnerships</b>	<ul style="list-style-type: none"> <li>• Large numbers of corporate clients, rendering Helios dominant network: financial capability to expand throughout Nigeria and become most comprehensive network</li> </ul>	<ul style="list-style-type: none"> <li>• Agreement between major mobile telecommunications operators to share infrastructure costs in the implementation of 3G technology</li> <li>• On-record support for passive infrastructure sharing from multiple players</li> </ul>	<ul style="list-style-type: none"> <li>• Cisco has offered equipment and financial support</li> <li>• Has paid to initiate an entrepreneurship scheme, enabling Dabba to expand into two new townships</li> </ul>	<ul style="list-style-type: none"> <li>• Partnership between government departments and villages (gewog) to provide national service in remote areas</li> <li>• Microsoft involved in planning and development, bringing experience and expertise in systems implementation</li> </ul>
<b>Network and Infrastructure</b>	<ul style="list-style-type: none"> <li>• Helios offer services to the full range of wireless operators: GSM, CDMA, and WiMAX operators using 2G, 3G, and 4G platforms</li> <li>• Willing to build new towers where there are none</li> </ul>	<ul style="list-style-type: none"> <li>• Comprehensive service provided due to network management companies' desire to remain competitive: Variety of entries provided to mobile broadband service</li> </ul>	<ul style="list-style-type: none"> <li>• Lightweight Ubiquiti equipment is low cost and uses solar energy and battery to reduce costs further</li> <li>• Wi-Fi and wireless mesh networks well-suited to provide coverage for small, local groups and townships</li> </ul>	<ul style="list-style-type: none"> <li>• Hub and spoke network, with fiber-optic broadband connection to the districts (dzongkhag) passed on through wireless technologies to the gewog and eventually individual villages. combats problems of wired access in difficult terrain</li> </ul>

Source: Authors.

**TABLE 2.3:** Lessons Learned from Rural ICT Provision in Nigeria, Turkey, South Africa, and Bhutan

HELIOS TOWERS, NIGERIA	INFRASTRUCTURE SHARING, TURKEY	DABBA'S WIRELESS SERVICES, SOUTH AFRICA	COMMUNITY INFORMATION CENTERS, BHUTAN
<ul style="list-style-type: none"> <li>• <b>Outsourcing can lower costs:</b> Economies of scale enabled Helios Towers to make a profit in difficult areas and enabled MNOs to enter previously unserved areas</li> <li>• <b>Service provision is a vital part of product provision:</b> Helios has offered security assurance and 24-hour access, alongside its towers and connectivity, to assuage fears affecting MNOs' own operations (e.g., vandalism)</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Companies must adapt to the existing market structure:</b> Attempts to produce fully competitive markets have stalled in the face of Turkey's dominantly oligopolistic system</li> <li>• <b>Powerful players can lead to consumer savings:</b> Turkey's telecommunications industry is oligopolistic in multiple and vital sectors, forcing all to use economies of scale to provide savings to clients</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Consider regulatory issues:</b> Dabba lost valuable time and equipment investment by working outside of regulatory approval</li> <li>• <b>Employ local expertise:</b> Antitheft brackets produced in the network's area and other locally made equipment has helped keep costs down</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Geography matters:</b> Bhutan may have to accept that nationwide connectivity is not financially feasible in the short to medium term due to the remoteness of some villages and rough terrain</li> <li>• <b>Adapt the service to consumer needs:</b> Studies have shown that the people of Bhutan have found little need for technologies such as fax; implementers should offer technologies in such a way that their consumer added value is immediately apparent</li> </ul>

Source: Authors.



## Topic Note 2.3: MOBILE MONEY MOVES TO RURAL AREAS

### TRENDS AND ISSUES

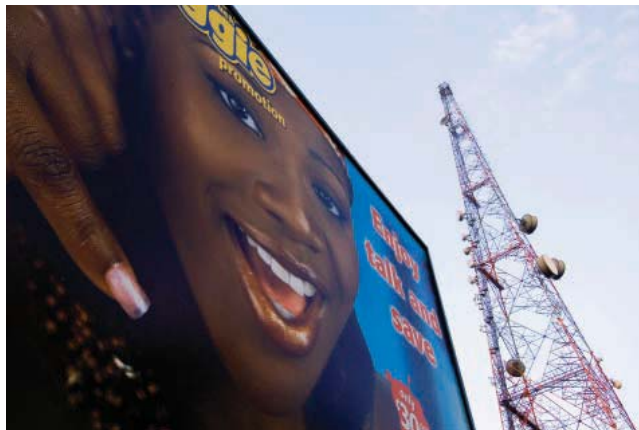
One consequence of improved access to ICT infrastructure, appliances, and services in rural areas may be that rural people will gain better access to financial services and additional sources of income (image 2.2). The telecommunications and microfinance industries have grown rapidly in recent years and are overcoming the traditional challenges of reaching rural and formerly underserved areas. This topic note examines specifically the business models and enabling factors that are making new sources of financing and income accessible in rural areas.

Mobile banking is a logical consequence of the growth of telecommunications and microfinance. In developing economies worldwide, companies have sprung up to deliver financial services outside of conventional bank branches, through mobile phones and nonbank retail agents. A particularly well-known service is M-PESA. Operated by Safaricom in Kenya, M-PESA allows users to transfer money through their mobile phones, without having to register or qualify for a bank account.

M-PESA does not operate in a vacuum: easypaisa in Pakistan, G-Cash in the Philippines, and Bancosol in Bolivia are just a few enterprises that provide some form of mobile financial services to the un- and underbanked poor. One rural bank, Green Bank, has calculated the substantial savings from using mobile technology: By switching from field-based to text-based collection, they reduced their interest rates from 2.5 to 2 percent and their service charges from 3 to 2.5 percent, yet profits rose by US\$ 16 for every US\$ 400 loan (Kumar, McKay, and Rotman 2010).

The rise of mobile income sources is another trend behind the demand for mobile financial services. In recent years conditional cash transfer programs in many countries have provided government payments to economically and socially disadvantaged households, especially the economically active poor, conditional on measurable actions (for example, enrolling girls in school, obtaining consistent prenatal care, or using agricultural inputs). Telecommunications technology is transforming governments' capacity to deliver these additional sources of income quickly, reliably, and at a lower cost. It is also allowing farmers to access commercial banks and critical services including credit, savings accounts, and remote transfers even despite distance and lack of local banking facilities.

**IMAGE 2.2:** Ghana's Telecommunications Infrastructure Expands the Use of Mobile Money



Source: Arne Hoel, World Bank.

Such ventures are united by the goal of enabling the economically active poor to use telecommunications technology to help themselves. Mobile financial and income-generating services such as M-PESA, Zain Zap, easypaisa, and txteagle, discussed in this note, cost little and operate on all handsets, making them advantageous on a large scale, even in more remote rural areas where previous efforts made few inroads. Advances such as smartcards, fingerprint-sensitive ATM machines and market kiosks equipped with electronic point-of-sale devices have also made such programs vastly easier to implement (and more likely to reach the intended beneficiaries).

### INNOVATIVE PRACTICE SUMMARY

#### M-PESA's Pioneering Money Transfer Service

Based on a pilot funded in part by public funds from the UK Department for International Development, Vodafone and Safaricom launched M-PESA in Kenya in February 2007 in partnership with Sagentia.<sup>36</sup> The M-PESA pilot focused on microloans and repayments, but research indicated that consumers primarily would use the service for person-to-person money transfers.

Following the pilot, M-PESA launched with a person-to-person business model in which customers can buy e-money

<sup>36</sup> "M" for "mobile," "pesa" for "money" (Swahili).

from agents throughout Kenya. Any commercial space may become an agent, making this model particularly effective in rural areas. Mobile phones are used to perform financial transactions such as sending money to others, paying bills, and even withdrawing cash from an ATM (without needing a bank account). E-money can be cashed in with agents who receive a commission for the services they provide and for registering customers.

M-PESA's great innovation has been to provide a service accessible to the unbanked populations of emerging economies at a low cost. M-PESA costs users about one-third as much as using a money-transfer company such as Western Union, and it is cheaper still than the banks. Such companies cannot match M-PESA's low rates because their operating costs are higher (Omwansa 2009:6).

M-PESA now has over 10 million customers in Kenya, and services have been introduced in Tanzania and Afghanistan (called M-PAISA in the latter); a number of other deployments are planned across Africa and Asia.<sup>37</sup> Success has so exceeded expectations that M-PESA has faced system capacity and cash flow problems. Cash flow problems have arisen internally (as agents are paid to register customers, who take time to become profitable) and at the point of use (agents run out of both e-money and cash). The problem particularly affects rural areas, where people receive remittances from urban workers and withdraw it as cash. To counteract this problem, larger agents now act as "super-agents," selling e-money and cash to smaller agents.

### **A Flexible Regulatory Environment**

Flexible regulation has been critical to M-PESA's success. Working with the UK Treasury, the Central Bank of Kenya set up special provisions for M-PESA to launch its product with limited risk to the consumer but without being linked directly to a bank and with relatively low levels of regulation. Subsequently the Central Bank provided informal monitoring as opposed to formal regulation. By the time banks and competitors realized M-PESA's potential and began to demand its regulation, the firm was already well established and respected. At the urging of the banks, the Central Bank conducted a thorough audit of M-PESA and found it to be fulfilling all its consumer obligations; the Central Bank has therefore continued enabling this special regulatory environment.

The importance of this flexible "proportional risk" system of regulation is evident in M-PESA's stalled attempts to operate in India, where regulators insisted on a connection with a licensed bank. In Afghanistan, regulations to prevent money laundering have constrained M-PAISA's development as a money transfer service, and it operates predominantly as a microfinance service. The need for identification details detracts from M-PAISA's simplicity and thus its appeal.

### **A Business Model that Sidesteps the Banking Sector**

The M-PESA business model is characterized by low margins and high volumes, whereas banks traditionally need relatively high margins from far fewer people with bank accounts. Independence from the banking sector opened up a huge untapped market for M-PESA: 90 percent of Kenyans did not have a bank account. Although only registered users can initiate transactions, anyone may receive money from M-PESA and withdraw it as cash. This positive nonuser experience was crucial to the user network's growth. This business model has allowed M-PESA to become the dominant and most attractive network. M-PESA's low costs have enabled it to challenge money transfer companies and banks even where they are present. Yet over time many M-PESA users graduated to having bank accounts, and M-PESA is now integrated with the banking system.

### **Partnerships Facilitate Marketing and Technical Operations**

M-PESA's collaborative nature is fundamental to its success. Vodafone, as well as providing the initial funding, holds a coordinating role. Safaricom has provided a brand that many Kenyans trust, and its nationwide airtime reseller distribution network easily transformed into a network of dedicated M-PESA agents, enabling more rapid market penetration. Vodacom undertakes Safaricom's role in Tanzania (and is its sister company); in Afghanistan, Roshan, a large MNO, has been vital in developing the service. Sagentia (IBM as of September 2009) provided key technical expertise. The use of public funds during the development stage is regarded as crucial for maintaining interest in the telecommunications sector during the pilot, which took longer than expected.

### **Networks, Appliances, and Infrastructure**

Registering with M-PESA requires proof of identity, a SIM card, and the submitting of a PIN. In addition to providing security, another key success factor was the added convenience of the customer being able to retain his or her phone

<sup>37</sup> Safaricom statistics, June 2010 (<http://www.safaricom.co.ke/index.php?id=1073>, accessed June 2011).

number. Since applications are on the SIM cards, they do not depend on the functionality of the handsets, a factor crucial for making M-PESA financially accessible: M-PESA works on even the most basic and inexpensive handsets. In Tanzania, M-PESA uses USSD technology, which does not require the SIM card to be replaced and allows transactions to be completed in real time without any application stored on the phone.

M-PESA has a widespread and dense network of agents. Kenya had 7,000 M-PESA agents in April 2009 but only 750 bank branches, allowing M-PESA to reach significantly more people, especially rural people, than competitors.<sup>38</sup> The advantage obtained by being first in the market allowed M-PESA to build the dominant network in its pilot country and become the most attractive network for new customers and businesses (as with companies such as eBay).

### **INNOVATIVE PRACTICE SUMMARY** **Zain Zap Promotes Borderless Mobile Commerce**

Zain Zap is a mobile phone-based banking service.<sup>39</sup> As M-PESA's largest competitor, Zain Zap allows clients to transfer money via mobiles but requires each user to have a bank account. Although registering with Zap is more complicated than registering with M-PESA, Zap offers potential access to a greater number of services. In partnership with banks in Kenya, Tanzania, and Uganda, Zap provides platform access to financial services to people without a nearby bricks-and-mortar bank.

Zain Zap has differentiated itself from M-PESA by innovating along international lines, operating across Kenya, Tanzania, and Uganda without subjecting users to additional fees, administration, or regulation. It forms part of a wider Zain Network, called One Network, which provides international mobile coverage without the expensive rates usually associated with cross-border communication. Before Zap, Celtel (now Zain) introduced a competing product soon after the launch of M-PESA, but the product's very different pricing structure caused it to be withdrawn due to low demand.

38 See "M-PESA power: Leveraging service innovation in emerging economies," M. Barrett, M. H.S.A Kim, and Karl J. Prince (2009). Case study and teaching note, available through [www.ecch.com](http://www.ecch.com).

39 After the 2010 acquisition of Zain Group's African assets by Bharti Airtel, the Zain Zap platform has been rebranded as Airtel Money. Bharti Airtel mobile network operators from Africa maintain their participation in the One Network, alongside Zain mobile network operators in the Middle East.

In 2010, Zap expanded to Niger and Sierra Leone, and it has a pilot scheme in Malawi. Zain claims Zap is now the most comprehensive mobile commerce service in Africa, with over 150 million customers. This claim suggests significant impact in some of the world's most unbanked populations, particularly in rural areas without physical bank facilities. Zain eventually plans to roll out Zap in all 24 countries in Africa and the Middle East where it has mobile networks. If regulation permits this growth, Zain's infrastructure leaves it better placed for such expansion than M-PESA.

### **Thriving within Regulatory Constraints**

Zain's expansion has been checked by regulatory constraints: Zain operates in Lebanon and Zambia without One Network because it has not yet received governmental approval in these countries. However, Zain makes good use of its various partners to ensure that national and international banking regulations are met, and the company seems happy to operate within this framework. Zain works with the National Bank of Malawi and NBS bank in Malawi, Eco-bank in Niger, and Zenith Bank in Sierra Leone. In Kenya, Tanzania, and Uganda, Citibank and Standard Chartered work in partnership with Zain.

### **A Business Model Seeking to Balance Availability and Accessibility**

Zain's business model treads a fine line between widespread availability and accessibility. Its interaction with banks and its provision of mobile banking opportunities to all its dispersed customers allow greater possibilities for the business to grow in rural areas, as small-scale business owners gain access to financial services they previously lacked. Zain's only source of revenue comes from a fixed fee for every transfer made through Zap, however. It does not attempt to make money on deposits or withdrawals but recommends a fee to agents, who are then free to charge as much as they like. This practice could lead to very high prices for customers, especially until other agents appear.

### **Partnerships with Big Banks and Big Clients**

Non-Zain mobile operators can buy a place in the service: In November 2009, Egypt's Mobinil joined, adding 24 million customers to the platform. This practice aids international expansion and allows for the inclusion of local expertise in the business model. As well as partnering with large-scale banks, Zain has also signed deals with large corporate clients such as Coca-Cola and Kenya Airways to allow users to pay for these companies' products through their mobiles.

## Networks and Infrastructure

The primary factor in Zap's successful development is that it belongs to Zain's One Network, the world's first borderless mobile service. According to Zain's corporate website, One Network offers over 90 million of Zain's (and partner mobile operators') customers relatively inexpensive rates, free of high roaming charges for cross-border communications. One Network not only aids rapid expansion by giving Zap a pretargeted customer base, it also offers consumers large incentives to join Zain's network and use its services (over others, such as M-PESA).

### INNOVATIVE PRACTICE SUMMARY Pakistan's Tameer Microfinance Bank for the Economically Active Poor

Tameer Microfinance Bank describes itself as "one of the first nationwide, private sector, non-NGO transformed, commercially sustainable microfinance institutions in Pakistan."<sup>40</sup> A majority share is held by Telenor Pakistan. Tameer has produced an innovative hybrid of M-PESA and Zain Zap's services for the economically active poor in Pakistan.

With its new easypaisa service, Tameer matches M-PESA's ability to reach the unbanked. Currently, easypaisa is available to pay utility bills, but it plans to expand into sending and receiving money within Pakistan and receiving money from abroad. As with M-PESA, customers do not need a bank account and can access the service from a variety of portals, including their mobile phones. Tameer also operates as a bank much as Zain's Zap platform does, although not through partnerships with other banks. Since it became the first bank to gain a branchless bank license in Pakistan (2008), it has been able to offer loans, deposits, overdrafts, insurance, and domestic remittances.

Tameer's innovations are notable for their focus on entrepreneurs and the self-employed. Their aim is to actively generate income in underserved, frequently rural, areas, often by freeing customers from moneylenders and their prohibitive interest rates. Prior to Tameer's penetration of the market, such moneylenders were generally the only option for small-scale businesses in need of cash. Tameer loans have been used to buy new equipment, buy raw materials when they are cheapest, enlarge or purchase new property, and provide insurance against business failure. As such, they represent

a strong opportunity for income generation in underbanked areas. Though Tameer largely operates through bank branches at present (despite its branchless banking license), and thus favors urban areas, the rise of its easypaisa service looks set to counteract this imbalance.

Since its commencement, Tameer has disbursed more than 3.5 billion rupees (Rs), with an active portfolio of Rs 1.4 billion and over 80,000 loan customers. The total customer base of Tameer is over 170,000; it employs 1,100 staff.<sup>41</sup>

## A Business Model Benefits from Microfinance Regulation

As CEO Nadeem Hussain noted, one of the major enabling factors for Tameer was the SBP 2001 Microfinance Ordinance, which regulates the creation of commercial microfinance banks. Tameer argues that unless microfinance is financed through commercial sources, it will remain in the realm of development aid and its growth will be limited.<sup>42</sup> For this reason, the Consultative Group to Assist the Poor has been involved with branchless banking regulation in Pakistan from the beginning. Regulation has allowed the use of retail stores as agents.

Regulation also made it possible for bank and telecom operators to enter into a business model conducive for commercial success. The two partners offer those services that each is best placed to deliver: Telenor acts as a distribution arm for branchless banking, organizes channel management and retail setup, and hosts the technology and operation of a call center that provides customer service and complaint handling. Tameer is responsible for operating accounts, creating ledgers, reconciliation, fund settlement, risk, and compliance and fraud investigations.<sup>43</sup>

## Partnerships

In May 2010, Tameer joined with Pakistan Telecommunication Company Limited (PTCL), Pakistan's largest national telecom solution provider. PTCL will provide network connectivity to all of Tameer's outlets. This provision of centralized connectivity has been one of the key enabling factors in easypaisa's success and, crucially, has allowed them to provide easily accessible, low-cost services.

40 Tameer Microfinance Bank (<http://www.tameerbank.com/about.htm>, accessed April 2010).

41 Easypaisa (<http://www.easypaisa.com.pk/about-tameerbank.php>, accessed April 2010).

42 Easypaisa, (<http://www.tameerbank.com/ceomsg.htm>, accessed April 2010).

43 Mir (2010).

## Networks and Infrastructure

Tameer's large agent network allows customers to access services in a number of ways: via mobile phone, easypaisa authorized shops, Telenor franchises, Telenor sales and service centers, or Tameer Microfinance Bank branches. Like M-PESA, Tameer uses USSD, so customers do not need new SIM cards to store the application. This lowers the cost of signing up to the service even further. Tameer does offer new SIM cards for purchase, however, on which the Tameer application has already been uploaded.

### INNOVATIVE PRACTICE SUMMARY Txteagle Taps a Vast Underused Workforce

A large, global, and reasonably educated workforce remains underused because of poverty and isolation, especially in rural areas. With the rapid penetration of telecommunications in developing economies, Txteagle believes this situation can change, particularly as more economies launch payment platforms like M-PESA. Txteagle is a mobile phone-based SMS server application that takes tasks from corporate clients (such as Nokia and Google), breaks them down into multiple microtasks, and sends them out for completion to registered users. Targeted users are the rural poor in developing economies, who, through their mobile phones, supplement their incomes with these microtasks. Tasks include translation, image sorting, and audio transcription. Txteagle is similar in some respects to Amazon's Mechanical Turk, which also divides up tasks, but differs in that it distributes them by mobile phone, a technology with a higher penetration rate.

Txteagle operates primarily in East Africa, where it relies on technologies such as those developed by M-PESA, but it also sends work to users in Asia and the developing economies of the Americas. In areas not covered by payment platforms such as M-PESA, users are paid in airtime credited to their mobile phones.

Txteagle's impact is unclear because the company is still in its start-up phase. Given the growing number of subscribers to wireless phone technology (more than 1 billion people in the developing world had a mobile phone in 2006),<sup>44</sup> technologies such as txteagle have the potential to enjoy great success. If txteagle can maintain and expand its systems capacity, it has the potential to extend its workforce in Africa,

Asia, and the Americas, as the market for mobile phones expands rapidly in such areas as rural China and India.

## An Outsourcing Model Outside the Regulatory Flow

Txteagle operates fairly unconstrained by regulation because it is classified as a financial creditor, rather than as any form of banking or microfinance institution. This setup gives txteagle a great deal of flexibility in its business model and where it operates, enabling rapid international expansion. As clients become more diverse, this operational flexibility will become a key asset, as txteagle will need workers with different languages and skills sets.

Txteagle's business model enables outsourcing at a lower cost because of savings in office-based costs and its access to a previously isolated workforce. Low costs and a guarantee of quality (clients pay only for adequately completed work) attract corporate clients.

## Adapting to Partners' Needs

Txteagle partners with a number of providers of wireless services, such as Safaricom in Kenya, Telefónica México in Mexico, MTN across Africa and the Middle East, and Viva in the Dominican Republic. As it relies on these partners to provide its service, txteagle is eager to adapt to their needs, from configuring the txteagle platform to operate only during off-peak times, to providing assistance to their customer support teams. This situation has led to worries that txteagle could prove exploitative unless well regulated.

## Network and Infrastructure

A key enabling factor in txteagle's business model is its Accuracy Inference Engine (AIE), which, once tasks have been broken into microtasks, can monitor user performance. The AIE platform is a set of computational routines that can dynamically predict which available workers will be most likely to complete the given task successfully, correctly infer when the job has been satisfactorily completed, and differentially pay workers in proportion to their level of contribution, all to within a 99 percent confidence interval of accuracy.<sup>45</sup> The firm also uses a database that monitors and records user performance. As the system learns more about the capabilities and expertise of its individual users, it updates the algorithms used to assign tasks to make the service as efficient as possible.

44 Tryhorn (2009).

45 Txteagle (<http://txteagle.com/technology/aie>, accessed April 2010).

## LESSONS LEARNED

Mobile phones have the potential to provide low-cost banking wherever there is network coverage, but the use of mobile banking services has been held back because mobile banking services and microfinance institutions often play quite different roles that prevent them from leveraging their full potential. There is a wide variety of mobile services; some do not involve banking licenses and are therefore nonbank implementations, while others may involve banking partners. Mobile banking companies such as M-PESA primarily work with money transfers and payments, using some of the most advanced infrastructure available. By contrast, microfinance institutions tend to focus on credit and savings, and use less advanced technologies. A marriage between the two can produce commercially attractive coverage of the market, as seen with Telenor and Tameer Microfinance Bank, but such partnerships can be difficult to source and sustain. Indeed, in the future, traditional banks may also find themselves trying to deliver these services.

The emergence of competition in the sector (such as between M-PESA and Zain Zap) has begun to erode differences in the roles of mobile banking services and microfinance institutions, however. In May 2010, M-PESA joined with Equity Bank in Kenya to produce its most integrated product yet: a low-cost, low-entry microsavings account called M-Kesho. It hopes to provide its 9.4 million users with accessible bank accounts, which will allow them to hold savings and take out microinsurance and microloans, all managed from their mobile phones.

The competition between Zain Zap and M-PESA in particular highlights interesting considerations for the future. With network-based firms such as eBay and Wikipedia, the more dominant a single network becomes, the more attractive it becomes to new users (because it is the most comprehensive), and it compounds its success. Should either Zain Zap or M-PESA win the battle for dominance in Kenya, the winner could offer a more comprehensive and more widely accessible service. The ensuing lack of competition could raise prices, however, cutting off access to the poorest sectors of the community. The regulation of competition between these networks will determine the shape of the industry—and of commerce in Kenya—in the future.

M-PESA has benefited from relative regulatory freedom to become a comprehensive mobile financial service provider and harness the negotiating power of Equity Bank. If such innovations are to spread, regulators must walk a fine line

between allowing the freedom for such ventures to become commercially attractive and the constraints to ensure that they do not exploit the people they aim to help. Chile's congress has only just approved a law demanding network neutrality, guaranteeing that Internet service providers cannot interfere with content accessed by Internet users. As Chile is among the most progressive of the Latin American and other developing economies in its governance of Internet use, its position demonstrates the great strides regulators must take in this emerging area, if mobile and Internet technologies (such as mobile banking) are to become widely and equitably accessible.

One of the biggest challenges for regulators is to find a balance between delivering the financial services that meet inclusion targets and at the same time combat fraud and terrorism. The temptation is always to overregulate, to err on the side of safety. The World Bank has been working to create guidelines for services such as money transfer to encourage them to operate under tough regulation.

Apart from these regulatory issues, service users have demonstrated the wider applicability of the technologies involved by manipulating them to their own advantage. Bancosol in Bolivia, for example, has implemented a partial use of the technology by providing SMS information services before committing to full mobile banking. The Rural Bankers' Association of the Philippines has made GXI's G-Cash service possible in rural areas by grouping 60 rural banks to act as agents and to use G-Cash to pay their employees. Alone, these banks were too small to be commercially interesting to the mobile service, but through collective action they have become a significant business proposition.

Customers have found moneymaking opportunities in these financial services of which their founders did not dare to dream. M-PESA's users have translated access to secure money transfers into innovative income-generation opportunities, often in rural areas. By transferring primarily to M-PESA-based payments, users enjoy the safety of being able to travel without cash and have reduced service times (customers no longer fumble about with change). The growth of the network of agents has created a large number of jobs, many in the rural areas in which M-PESA, and institutions like it, flourish.

Tables 2.4 and 2.5 summarize the key enablers of the innovative financial service models described here and the lessons derived from their experience.

**TABLE 2.4:** Key Enabling Factors for Innovations in Mobile Financial and Income Services Worldwide

	M-PESA (EAST AFRICA, SOUTH ASIA)	ZAIN ZAP (AFRICA AND MIDDLE EAST)	TAMEER MICROFINANCE (PAKISTAN)	TXTEAGLE (AFRICA, ASIA, LATIN AMERICA)
<b>Regulation</b>	<ul style="list-style-type: none"> <li>Lack of regulation of new technology in Kenya: Establishes self in regulation vacuum</li> <li>Willingness to adapt when regulation necessitates: More closely resembles a microfinance service in Afghanistan</li> </ul>	<ul style="list-style-type: none"> <li>Works with banking partners to ensure international financial regulations are met</li> <li>Seems happy to work within regulatory framework, rather than seek to bypass it as rivals have done</li> </ul>	<ul style="list-style-type: none"> <li>Microfinance Ordinance allowed the creation of commercial microfinance banks: Allows for wider growth</li> <li>Allowed use of retail spaces as agents</li> </ul>	<ul style="list-style-type: none"> <li>It is classified as a financial creditor rather than a banking or microfinance institution, so it can operate fairly free of regulation</li> </ul>
<b>Business Model</b>	<ul style="list-style-type: none"> <li>Initial independence from banking sector and bricks-and-mortar banks allowed provision of a low-cost service</li> <li>Allow nonuser trial: M-PESA becomes dominant network</li> </ul>	<ul style="list-style-type: none"> <li>Users must have a bank account: Potential to provide more diverse services than rivals</li> <li>Users send funds across country boundaries without paying additional fees</li> <li>Fixed fee for transfers; other fees set by agents: Potential for large profits encourages businesses to become Zap agents.</li> </ul>	<ul style="list-style-type: none"> <li>Easypaisa concentrates on paying bills, with expansion into money transfer</li> <li>Clients do not need a bank account, but Tameer offers diverse financial services as it is itself a bank</li> <li>Focus on entrepreneurs and self-employed</li> </ul>	<ul style="list-style-type: none"> <li>Use of mobile technology to reach previously untapped market: Relatively educated rural poor</li> <li>Offers additional source of income to isolated workers and opportunity for corporate clients to save money in their outsourcing</li> </ul>
<b>Partnerships</b>	<ul style="list-style-type: none"> <li>Backed by large MNO: Vodafone</li> <li>Local brand equity and distribution network from Vodafone subsidiary: Safaricom</li> <li>Use of local companies (e.g., Roshan in Afghanistan)</li> </ul>	<ul style="list-style-type: none"> <li>Signed deals with large corporate clients to encourage user growth</li> <li>Non-Zain MNO can buy into One Network, increasing provision</li> </ul>	<ul style="list-style-type: none"> <li>Tameer is itself a bank and so is not reliant on deals and partnerships with other banking institutions</li> <li>Partnership between a bank and a telecom operator: Allows services to be provided and distributed in-house</li> </ul>	<ul style="list-style-type: none"> <li>Works with local wireless services (e.g., Safaricom in Kenya and Viva in the Dominican Republic)</li> <li>Signs up large corporate clients such as Google</li> </ul>
<b>Network and Infrastructure</b>	<ul style="list-style-type: none"> <li>Widespread and dense network of agents: Uses first mover advantage to become dominant network</li> <li>SIM card functionality: Customer can use existing phone (more affordable service)</li> </ul>	<ul style="list-style-type: none"> <li>Use of Zain's One Network: Infrastructure and distribution network already widely available in multiple countries</li> </ul>	<ul style="list-style-type: none"> <li>Large agent network: Customers can access services from their mobile phone, easypaisa authorized shops, Telenor franchises, Telenor sales and service centers, or Tameer Microfinance Bank branches</li> </ul>	<ul style="list-style-type: none"> <li>SIM card functionality: Works on the most basic handsets</li> <li>Accuracy Inference Engine monitors individual performances and assures quality control to corporate clients</li> </ul>

Source: Authors.

**TABLE 2.5:** Lessons Learned from Mobile Financial and Income Services in Rural Areas

M-PESA	ZAIN ZAP	TAMEER MICROFINANCE	TXTEAGLE
<ul style="list-style-type: none"> <li><b>Consider regulatory issues:</b> M-PESA has struggled to take hold in countries where regulation has proved tighter than in Kenya</li> <li><b>Be adaptable:</b> M-PESA changed its business model when money transfer proved more popular than microfinance in the pilot phase</li> <li>The move toward also providing bank accounts is another sign of flexibility and may help solve regulatory problems</li> </ul>	<ul style="list-style-type: none"> <li><b>Strategies need to be implemented to combat first mover advantage:</b> Zain has had to offer more services and work with big name brands to combat M-PESA's dominant network in Kenya</li> <li><b>Customer service is vital:</b> Zap has lost customers to M-PESA due to its more complicated sign-up procedure and the poor service and large fees levied by some agents</li> </ul>	<ul style="list-style-type: none"> <li><b>Entrepreneurs make good clients:</b> Tameer has found a new and loyal market in Pakistan by focusing on this group (previously forced to rely on extortionate moneylenders)</li> <li><b>Rural areas can be profitable:</b> Tameer has rolled out easypaisa to meet the needs of the rural workforce, recognizing that rural areas hold large numbers of the commercially minded self-employed</li> </ul>	<p>Not so much what has been learned, but what it is vital to learn:</p> <ul style="list-style-type: none"> <li><b>The move away from "charity" to helping people help themselves should not be a move toward the exploitation of a still-vulnerable group:</b> Deference to corporate clients and local MNO partners should not mean that workers are paid unfairly for their contributions or abandoned when microtasks such as those provided by txteagle run out</li> </ul>

Source: Authors.

## Topic Note 2.4: DELIVERING CONTENT FOR MOBILE AGRICULTURAL SERVICES

### TRENDS AND ISSUES

The value of knowledge in the world economy has grown with increased technological innovation in distributing information and greater incorporation of information in economic activity. As developed economies become increasingly knowledge and service based, developing economies (agricultural or industrial) must be capable of communicating in and using the language of knowledge if they are to be economically active on a global scale.

The spread of telecommunications technologies over the past decade has outpaced the spread of Internet technologies, which require more costly infrastructure, particularly for rural users. In India, for example, mobile technology has reached over 30 times as many people as the Internet.<sup>46</sup> Because much of India, like many developing economies, remains predominantly agricultural, thought has turned to using mobile technology for the benefit and service of agriculture (image 2.3). Rural economies lose billions of dollars each year because critical information is inaccessible: information on production practices, information on impending extreme weather or epidemics, or information that could enable farmers to transport crops more effectively to markets and sell them at better prices.

Reuters Market Light (RML) offers farmers information on crops, diseases, and market prices, as does the subsidiary group of the Indian Farmer's Fertilizer Cooperative, Kisan Sanchar Limited. This trend toward mobile services for

**IMAGE 2.3:** Girl Uses Phone in Community Meeting in India



Source: Simone D. McCourtie, World Bank.

46 Prakash and Velu (2010).

farmers is seen throughout developing economies. Prominent examples include the Agricultural Market Information Systems in Bangladesh, Farmer's Friend (a Google product) in Uganda, and Ovi Life Tools by Nokia. The latter started off in partnership with RML in India but wanted to offer a wider range of information. It now provides education and entertainment services and has rolled out in Indonesia and China as well as India.

This sourcebook describes a number of efforts to benefit from mobile telecommunications in agriculture. Two of the examples discussed below are also discussed in Module 3 (RML) and Module 6 on AIS (Farmers' Friend), yet they are reviewed here to highlight technical considerations in delivering content and services that rural users value. IFFCO Kisan Sanchar Limited and RML have been implemented through a variety of platforms and business models, with voice and text-based platforms being the primary competing modes of delivery. Farmer's Friend differs from those services by using Google's experience as a search engine to provide an on-demand service and a database that may be searched in the same manner as the Internet.

### INNOVATIVE PRACTICE SUMMARY

#### First Mover Advantage Benefits Reuters Market Light

Reuters Market Light (RML) is a subscription-based SMS service providing Indian farmers with information that helps them increase productivity, maximize revenue, manage risk, and reduce waste. The service, launched in late 2007, provides localized and personalized information on commodity prices, crop cultivation (covering 17 crops), and the weather.<sup>47</sup> Mobile telecommunication was the obvious platform for providing this service, as India has one of the fastest-growing mobile markets in the world, with over 427 million mobile connections. By contrast, there are only 37.5 million landline connections and 13.5 million Internet subscribers.<sup>48</sup>

The predominance of agriculture (which employs slightly more than half of India's 523.5 million strong workforce) gives Reuters a large potential audience. As of February 2010 it had more than 200,000 subscribers in 15,000 villages across 10 states. Supply chain and information failures cause Indian farmers to receive

47 "Reuters Market Light Wins Award for Innovation," Thomson Reuters Press Release, April 6, 2010 ([http://thomsonreuters.com/content/news\\_ideas/articles/financial/RML\\_wins\\_award](http://thomsonreuters.com/content/news_ideas/articles/financial/RML_wins_award), accessed June 2011).

48 Prakash and Velu (2010).



about half of the value of their crops that their Western counterparts do (20–25 percent). If the service helps farmers to resolve these problems, the potential benefits for farmers are large.

### **Regulation: Freedom to Develop Its Business Model**

RML used its first mover advantage in India to become a trusted network—a necessary strategy given that their main competitor, IKSL, is active in rural areas through its links with the IFFCO farmer cooperatives. Active support from the government has given RML relative freedom to develop its business model.

The subscription-based business model allows RML to derive a steady and regular flow of income, allowing for future planning toward expanding the service. The lack of reliable address databases prevents sales staff from locating farmers and consolidating the customer base. Another drawback is that the subscription fee makes RML expensive relative to on-demand services (like those provided by Farmer's Friend in Uganda, discussed later). A survey of 1,000 households in 100 villages by the South Asia Sustainable Development Agriculture department in the World Bank found that only around half of RML users planned to renew their subscription. Of those who had not signed up to the service, 95 percent cited cost factors as the reason (G. Dixie, personal communication).

In response, RML has enabled post offices across the states covered by Reuters to provide the information service to unregistered users. This adjustment in its distribution platform makes the service available to those who do not own a mobile phone as well as those who wish to try the service before they commit. The postal network has been crucial for RML's presence in rural areas and the growth of its user network.

### **Partnerships with Multiple Operators Offer Scalability**

RML's regulatory freedom is complemented by partnerships with multiple operators, which frees the system's content from dependence on any single network and is crucial to the scalability of the business. The links with the post office are a valuable asset for RML's distribution network. RML is discussing a more formal association with the Indian Council of Agricultural Research or Punjab Agricultural University, which contribute some of the service's crop information.

### **Network, Appliances, and Infrastructure**

RML is "network agnostic," meaning that it is not constrained by the limitations of any one MNO, and its service has SIM rather than handset functionality. Information is provided by SMS and therefore can be accessed from the most basic handsets, even those only possessing text capabilities. This delivery format contrasts with that of RML's former partner Nokia, whose Life Tools uses voice recordings instead of text-based

communications and thus requires mobiles to be GPRS enabled (adding to their cost and decreasing their accessibility).

## **INNOVATIVE PRACTICE SUMMARY**

### **Long Experience in Farm Communities Benefits IFFCO Kisan Sanchar Limited**

IFFCO Kisan Sanchar Limited (IKSL), another information service for farmers, is a joint venture between the telecom network operator Airtel and the Indian Farmer's Fertilizer Cooperative Limited (IFFCO, from which the initiative takes part of its name). In addition to crop advice and the weather, IKSL provides advice on animal husbandry, rural health initiatives, and the availability of products such as fertilizer. Unlike RML, IKSL's information arrives via voice rather than text message.

Users access the service through traditional wired technology based at kiosks at rural cooperative societies throughout India. The kiosks are supplemented by mobile technology: Mobile phones are sold bundled with the Airtel mobile network, which essentially converts the phones into personalized communication kiosks. Members of the service receive five free voice messages a day with agricultural information and advice; they also have free access to a dedicated agricultural help line. IFFCO has around 40,000 societies, is present in 98 percent of India's villages, and brings a receptive audience to the enterprise. This extensive coverage and wide farmer base gives IKSL the potential to make a significant impact on agricultural communities.

IFFCO is clearly attuned to making its products and services accessible to rural people. Mobile phones are accompanied by a hand-cranked charger. This innovation is crucial, given the scarcity and cost of power in much of rural India. IKSL's wired information kiosks can be operated through pedal power. These adaptations ensure that the service is not a drain on a highly limited resource and should permit its wider use.

### **Regulation for Quality and Compliance with Standards**

IFFCO is subject to high levels of regulation owing to its dominant presence in the fertilizer trade, which is regulated by the government. To ensure compliance with the standards set for IFFCO as an organization, IFFCO's off-shoots are regulated by an in-house Representative General Body made up of members of the Board of Directors and representatives of the larger member societies in every state/territory.<sup>49</sup> To ensure quality, Kisan Sanchar is assessed by experts from the agricultural universities, and peer reviews are conducted by panels of scientists.<sup>50</sup>

49 See <http://www.iffco.nic.in/ffc/web.nsf>.

50 "Content Management" (<http://www.iffco.nic.in/iksl/ikslweb.nsf/ef05d07df0ecee65652575040037b375/733c79d21f573e15652577a7002b2cd4?OpenDocument>, accessed July 2011).

### **A Business Model to Deliver More Diverse Agricultural Information to an Extensive Rural Base**

IFFCO has branched out from its original business as a fertilizer cooperative into many other areas, and it has a great deal of experience in growing new businesses in rural India. The partnership between IFFCO and another large company, Airtel, has been crucial to success. As one of the largest MNOs in India, Airtel can provide cellular connectivity to areas where it is not financially advantageous (an example is the Aruku Valley in the Visakhapatnam District). Access at cooperative societies, facilitated by IFFCO, is also crucial to the success of IKSL, because new users can try the service before they commit to it, allowing for the growth of the network. This capacity ensures that IKSL achieves maximum coverage and consumer awareness.

In this way IKSL's business model carefully navigates between the steady income of a subscription service and the value added for the consumer by offering flexibility. Users pay Rs 47 to activate the mobile service, which lasts a lifetime, and then 50 paise per minute for calls between IFFCO members (the rate is slightly higher for calls to nonmembers). Membership comes with five free daily messages, as noted.

IKSL's information is more diverse than that available from by RML, although it is still centered on agriculture (for example, farmers can obtain information on fertilizer and farming equipment and limited information on rural healthcare). In offering a more comprehensive service, IKSL may be attempting to combat the first mover advantage of its nearest rival.

### **Network, Appliances, and Infrastructure**

The innovation is SIM rather than handset dependent but does not work on the most basic handsets unless they are updated. IKSL hopes the kiosks will counteract this problem. The prices of the phones used in the pilot—made by Sinocell and sold for about Rs 4,000—would deny the poorer segments of the population access to the technology, but Alcatel, Philips, and Samsung have developed less expensive models that may solve this problem. IKSL also has the potential to develop a suitable phone. The voice recordings are provided in all local languages where the service is provided, a key enabling factor in the challenge to increase access.

## **INNOVATIVE PRACTICE SUMMARY**

### **Farmer's Friend Offers Information on Demand, One Query at a Time**

Farmer's Friend is a Ugandan mobile phone application by Grameen Foundation's AppLab. Working with MTN Uganda as its MNO and using the Google SMS search platform, it provides information on demand for farmers. In addition to weather

forecasts and agricultural advice, Farmer's Friend forms part of a wider initiative that includes health tips, a clinic finder, a Google trading service for agricultural commodities, and other products.

This innovation differs from RML and IKSL in that it is not prepaid; the system is a search engine, and the user pays for each query at the point of purchase. Customers text their query and location and receive a nearly instant reply. The service is currently free from Google, but customers are charged by their network operator for each query. Pilots demonstrate significant uptake of the AppLab's services: the 10 SMS applications that were trialed generated more than 54,000 inquiries among their 8,000 respondents.

Farmer's Friend also generates employment among farmers, some of whom are hired to collate data and pictures of sick plants on local farms. They provide Grameen with more comprehensive information and the potential to offer for better advice.

Farmer's Friend launched at the end of June 2009. Like many efforts initiated recently in rural areas, its impact is not yet apparent. The service has the potential to achieve significant penetration in rural areas because it can leverage MTN's network of over 10,000 village phone and other shared phone operators, as well as all of the privately owned mobiles.

### **Regulation**

Farmer's Friend's regulatory framework is derived from that of its parent organizations. Google adheres to US Safe Harbor Privacy Principles, is registered with the US Department of Commerce's Safe Harbor Program, and works with appropriate local regulatory authorities, primarily local data protection authorities.<sup>51</sup> The service self-regulates through its guidelines and maintains that it is "ready to assist any government that wishes to seriously work to create an enabling environment."<sup>52</sup> The Grameen Foundation has criticized the very loose regulatory framework surrounding Farmer's Friend.

### **A Business Model Designed to Increase Access**

Farmer's Friend's business model is specifically designed to increase access. The service works on the most basic handsets. The organization's membership in a much wider platform (which includes Google Trader and health advice) ensures a broader base of awareness in the community and further opportunities to develop brand loyalty. The pay-on-demand system increases access because the financial commitment is far smaller than with subscription models; RML

51 For details on the Safe Harbor certification program and privacy principles, see [www.google.com/privacy/privacy-policy.html](http://www.google.com/privacy/privacy-policy.html).

52 <http://www.grameenfoundation.org/recommendations-creation-pro-microcredit-regulatory-framework>, p.6.

membership lasts an average of five months (Preethi 2009). Farmer’s Friend users can return to the service at any time.

**An Array of Strong Commercial and Noncommercial Partners**

A key enabling factor of the initiative has been its marriage between strong commercial and nonprofit partners. The nonprofit Grameen Foundation increases access to technologies. As well as using the search expertise of Google and the network coverage of MTN Uganda (Uganda’s largest MNO), Grameen receives agricultural information from the Busoga Rural Open Source Development Initiative, a local NGO that collects local farming expertise from networks of farmers. Weather reports are provided by Uganda’s Department of Meteorology.

**Networks, Appliances, and Infrastructure**

As noted, the services work on the most basic handsets and are not handset specific, but users need to be part of the MTN Uganda network. To widen its distribution network, Grameen is trying to establish Village Phones in rural Uganda. As mentioned in this overview, this service, successfully used by Grameen in Bangladesh, involves public pay phones run by local entrepreneurs. An entrepreneur obtains a loan to

buy the equipment and profits from reselling the services the phone offers. Farmer’s Friends expects to establish 5,000 Village Phone operators over time. Each is expected to serve as many as 2,000 people, greatly enhancing Farmer’s Friend’s prospects for growth. (See IPS “Community Knowledge Worker Initiative in Uganda” in Module 4.)

**LESSONS LEARNED**

Table 2.6 recapitulates the factors enabling farmers to receive agricultural information through the increasingly accessible mobile phone services in rural areas—whether the information arrives through personal or shared phones. The lessons learned so far from the new services are summarized in table 2.7.

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**TABLE 2.6: Key Enabling Factors for Delivering Agricultural Information to Farmers in India and Uganda**

	REUTERS MARKET LIGHT, INDIA	IFFCO KISAN SANCHAR LIMITED, INDIA	FARMER’S FRIEND, UGANDA
<b>Regulation</b>	<ul style="list-style-type: none"> <li>Actively supported by the Indian government: Operates with relative regulatory freedom</li> </ul>	<ul style="list-style-type: none"> <li>IFFCO regulated by Indian government and expert assessment from agricultural universities</li> <li>IFFCO regulates all of its suborganizations to ensure they comply with its own standards</li> </ul>	<ul style="list-style-type: none"> <li>Derives regulatory framework from parent organizations</li> <li>Google works with US Department of Commerce and local regulatory authorities</li> </ul>
<b>Business Model</b>	<ul style="list-style-type: none"> <li>Subscription-based service: Regular local information for farmers, steady income for RML</li> <li>The potential to try the service in post offices before subscribing has been crucial in the growth of the user network</li> <li>Service provided in multiple languages</li> </ul>	<ul style="list-style-type: none"> <li>Voice rather than SMS information provision</li> <li>More diverse information than rival RML: Also provides advice on animal husbandry and products such as fertilizer</li> <li>Wireless technology supplemented by kiosks in cooperatives and commercial areas: Increases distribution and market penetration</li> </ul>	<ul style="list-style-type: none"> <li>On-demand rather than subscription service. Service is free from Google, but users are charged by their MNO</li> <li>Rather than simply receiving advice, users can make queries based on specific needs</li> <li>Supplemented by village phone operators in areas with few mobile phones: Income generation for vendor and wider use</li> </ul>
<b>Partnerships</b>	<ul style="list-style-type: none"> <li>Subsidiary of large, powerful company, Thomson Reuters: strong financial backing in implementation stages</li> <li>Crop advisory tips are derived from trusted sources (e.g., Indian Council of Agricultural Research)</li> </ul>	<ul style="list-style-type: none"> <li>IFFCO uses experience of growing new businesses in rural India</li> <li>Airtel (one of the largest MNOs in India) creates wide coverage by setting up towers at sites provided by IFFCO cooperatives and by providing connectivity in areas where it is not financially advantageous to do so: Combats first mover advantage of RML</li> </ul>	<ul style="list-style-type: none"> <li>Marriage between strong commercial and nonprofit partners: Farmer’s Friend enjoys multiple brand equities and financial backing in implementation stages</li> <li>Partnership with Busoga Rural Open Source Development Initiative uses networks of farmers to provide localized information: Encourages user support</li> </ul>
<b>Network and Infrastructure</b>	<ul style="list-style-type: none"> <li>Network agnostic: allows for maximum coverage, as not restricted to one operator</li> <li>Information is provided by SMS, so it works on the most basic handsets, even those with only text functionality (unlike competitor Nokia’s Life Tools, which requires mobiles to be GPRS enabled to receive voice messages)</li> <li>Single, automated platform for customer services</li> </ul>	<ul style="list-style-type: none"> <li>Free, dedicated help line for service users</li> <li>SIM rather than handset dependent, so has the potential for extensive uptake: SIMs must be updated</li> <li>Widespread cooperative-held kiosks help provide service to poorer customers and allow for trial: Helps grow user network</li> <li>IFFCO has cooperative presence throughout rural India: Strong agent network allows IKSL to become dominant</li> </ul>	<ul style="list-style-type: none"> <li>Part of wider information platform, which includes health tips and a trader function: Diverse capabilities offer greater potential for frequent use and opportunities to develop brand loyalty</li> <li>Queries access information database: Provides Internet-style capabilities where no such platform exists</li> <li>Work on the most basic mobile phones (including SMS only): Greater market penetration potential</li> </ul>

Source: Authors.

**TABLE 2.7: Lessons Learned in Delivering Agricultural Information to Farmers in India and Uganda**

REUTERS MARKET LIGHT, INDIA	IFFCO KISSAN SANCHAR LIMITED, INDIA	FARMER'S FRIEND, UGANDA
<ul style="list-style-type: none"> <li>• <b>Subscription services can be problematic:</b> 64% of users feel RML helps them achieve higher prices, but only around half plan to renew their subscription</li> <li>• <b>Higher costs decrease access:</b> 95% of those who haven't bought into the service state that this is because of its cost. Subscription fees increase costs relative to on-demand services</li> <li>• <b>Database management is crucial:</b> Problems with finding subscribers by their listed addresses and the difficulty of reaching them in their rural locations have negatively affected subscriptions to RML</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Access is a balancing act:</b> The use of voice technology in a variety of local languages combats the problem of illiteracy, but at the same time increases the required capability (and therefore cost) of the handsets providing the service</li> <li>• <b>The use of branded handsets in the trials of the innovation have increased this problem</b></li> <li>• <b>Alternatives must be provided:</b> IKSL has sought to combat access issues through the use of kiosks held by the farmers' cooperatives (offshoots of IFFCO) in villages: Less expensive wired technology supplements the convenience of wireless developments</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Diverse capabilities offer greater potential to develop brand loyalty:</b> Farmer's Friend's position within a wider information service provided by Grameen and Google affords it greater publicity. As customers use one service to positive effect, they become aware of and begin to trust the other, related services</li> <li>• <b>On-demand payment can prove effective:</b> Though providing less stable revenue, the lower cost commitments involved for users allows them to come back to the service at any time</li> <li>• <b>Strong financial backing plays a key role:</b> All three of the initiatives are backed by large-scale commercial and nonprofit organizations, which are able to support the innovators in their rollout phases, provide brand equity, and provide key technical expertise</li> </ul>

Source: Authors.

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## Module 3: **ANYTIME, ANYWHERE: MOBILE DEVICES AND SERVICES AND THEIR IMPACT ON AGRICULTURE AND RURAL DEVELOPMENT**

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### IN THIS MODULE

**Overview.** What has been the impact of mobile phones on agriculture and rural development? This module describes current knowledge, innovative practices, opportunities, and challenges in using mobile phones to benefit agriculture. Based on what has been learned to date, it provides principles for practitioners seeking to use the mobile platform to improve farmers' livelihoods.

**Topic Note 3.1: Key Benefits and Challenges Related to Mobile Phones and Agricultural Livelihoods.** Mobile phones may help to increase income, improve the efficiency of markets, reduce transaction costs, and offer a great opportunity for innovative interventions, especially in service delivery. Yet to realize the full potential of enhanced communication of market information, the use of mobiles must be coupled with additional investments (in roads, education, financial services, and so forth). Mobile services and applications also need to provide compelling value. They must be affordable and have useful content. Finally, mobile phones may not confer their benefits in an equitable fashion or be used in other socially and economically beneficial ways. Context matters. Technology cannot be airdropped into a situation and guarantee positive results.

- **Weather Forecasting Reduces Agricultural Risk in Turkey**
- **Mobiles Are the Center of Esoko's Virtual Marketplace**

**Topic Note 3.2: Two Typologies and General Principles for Using Mobile Phones in Agricultural Projects.** Two frameworks help for understanding and designing initiatives that use mobiles for achieving development goals. One typology focuses on the services that operate through mobile phones to improve aspects of agricultural livelihoods. A second focuses on the various forms that mobile applications might take to develop the agricultural sector. A number of principles improve the chances of sustainable impact: understand users and the technology; engage in participatory, iterative project design; identify partners with the appropriate knowledge, collaborative capacity, and alignment of goals; ensure that the technology is widely accessible; develop a viable business plan to ensure sustainability; and use monitoring and evaluation to develop a better understanding of outcomes, which would help in designing new interventions.

- **Mobile Service Gives Chilean Farmers a Local and Global Information Edge**
- **For Reuters Market Light, the Wider Network of People Matters**
- **Nokia Life Tools Uses Simple Technologies to Deliver New Functionality**

### OVERVIEW

In July 2010, the number of mobile phone subscriptions surpassed the five billion mark (figure 3.1), further establishing mobile phones as the most popular form of global connectivity.<sup>1</sup> In their various designs and capabilities, mobile phones

can be found in the pockets of the wealthy and poor alike. Even in rural areas, mobiles are growing in number and sophistication. Recent figures suggest that although only 81 million Indians (7 percent of the population) regularly use the Internet, price wars mean that 507 million own mobile phones. Calls cost as little as US\$ 0.006 per minute, and Indian operators are said to sign up 20 million new subscribers per month (*The Economist* 2010).

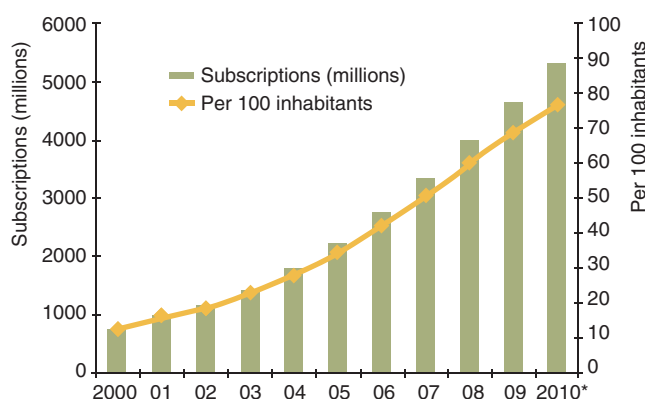
<sup>1</sup> According to <https://www.wirelessintelligence.com/>.

Figures for access to mobiles are higher than ownership figures. A survey in Uganda found that 86 percent of those asked claimed to have access to a mobile phone, although only one-quarter of farmers said they actually owned one (Ferris, Engoru, and Kaganzi 2008).

This module highlights the impact of mobile phones on agriculture and rural development by outlining current knowledge and describing innovative practices. The discussion complements information in Module 2 on technical aspects of increasing mobile phone use in rural areas and agriculture. It also serves as a preface to numerous other descriptions of mobile phone applications throughout this sourcebook.

The rise of the mobile phone has been one of the most stunning changes in the developing world over the past decade. The increasing ubiquity of mobiles in developing countries presents both opportunities and challenges, especially for critical sectors such as agriculture. Like other technologies before it, the mobile phone is likely to be the subject of inflated expectations and hopes. To caution against the hype, this module also explores barriers to using mobile phones to benefit agriculture and provides recommendations for practitioners seeking to use the mobile platform to improve farmers' livelihoods.

**FIGURE 3.1: Global Mobile Cellular Subscriptions, Total and per 100 Inhabitants, 2000–2010**



\*Estimates  
Source: ITU World Telecommunication/ICT Indicators database.

### Why Mobile Phones?

Mobile phones are but one form of ICT. Personal computers, laptops, the Internet, television, radio, and traditional newspapers are all used to promote improved rural development. So why focus on mobile phones?

The most obvious answer is the sheer scale of adoption. In the ten years before 2009, mobile phone penetration

rose from 12 percent of the global population to nearly 76 percent. A series of innovations drove this adoption, especially in developing countries, which had 73 percent of the world's mobile phones in 2010.<sup>2</sup> Like other digital technologies, mobile phones benefit from Moore's law, which states that computational power doubles approximately every two years. The newest smartphones are far more sophisticated than the more affordable models populating poor regions, but those simple phones are still leaps and bounds ahead of devices that were cutting edge a decade ago—and they are entirely relevant to agriculture.

An additional reason for focusing on mobile phones is that regulatory design has improved in recent decades, boosting competition among telecommunications companies. Competition has spurred significant innovation in business models. For example, in most of the developing world, in contrast to practices in some wealthy countries, only the person making the phone call pays. Moreover, mobile phone airtime is available in prepaid bundles, allowing poor customers to avoid lengthy contracts and manage their expenditure in a discrete, granular manner. For those at the bottom of the pyramid, where income is indeterminate and managing finances is very important, this model is a key driver of access and use. (For additional discussion and examples of regulation and business models as key enablers of mobile telecommunications, see Module 2.)

These supply-side improvements have met strong demand from customers around the globe. Like all networked technologies, mobile phones exhibit network effects, making them more valuable as more devices are in use. Also, in contrast to landlines, the mobility and personal nature of this technology have a strong appeal to users. Being connected means being reachable (Ling and Donner 2009). The mobile phone adds a layer of security, allowing someone to reach loved ones or assistance following an accident. It also allows for microcoordination of activities, limiting the need for planning and the cost of changing plans on the fly (Ling 2004). Finally, as anyone who has made a phone call while waiting for the bus or checked his or her BlackBerry during a meeting knows, mobile phones allow for multitasking.

What this proliferation means is that while mobiles may be a substitute or complement for landlines in rich countries, they are more frequently the first form of telephony for many of the world's poor. Through allowing communication at a distance, mobile phones allow users to overcome limits of time and space.

2 See ITU (<http://www.itu.int/ITU-D/ict/statistics/>).

## Why Agriculture?

In many countries, agriculture accounts for the overwhelming majority of rural employment. The manifold benefits that accompany improvements in agricultural productivity are well known: Farmers' incomes rise, food prices fall, and labor is freed for additional employment. In some instances productivity improvements have proven elusive, as climate change and uncertain commodity prices have worsened agrarian conditions for many rural communities. Development practitioners have rightly focused on the difficult situations of many farmers, especially smallholders, who have little room for error and even less protection from social safety nets. Technical innovation, most prominently demonstrated in the Green Revolution, has been key to improving agricultural markets in the developing world. Mobile phones, despite their recent entry into agrarian communities, are already helping those communities improve their agricultural activities.

## THE VIRTUOUS CIRCLE OF MOBILES AND AGRICULTURE

Advances throughout the mobile phone ecosystem tend to act as a positive feedback loop. This "virtuous circle" of innovation enables a number of benefits, even for smallholder farmers:

- **Access.** Mobile wireless networks are expanding as technical and financial innovations widen coverage to more areas.
- **Affordability.** Prepaid connectivity and inexpensive devices, often available second hand, make mobile phones far cheaper than alternatives.
- **Appliances.** Mobile phones are constantly increasing in sophistication and ease of use. Innovations arrive through traditional trickle-down effects from expensive models but have also been directed at the bottom of the pyramid.
- **Applications.** Applications and services using mobile phones range from simple text messaging services to increasingly advanced software applications that provide both livelihood improvements and real-time public services (box 3.1).

Through this expansion process, formerly costly technologies quickly become everyday tools for the bottom of the pyramid. Additional opportunities for more frequent and reliable information sharing will open as technological advances lead to additional convergence between mobile phones and the Internet, GPS, laptops, software, and other ICTs.

## BOX 3.1: What Is a Mobile Application?

A mobile application is a piece of software on a portable device (such as a mobile phone handset, personal digital assistant, or tablet computer) that enables a user to carry out one or more specific tasks that are not directly related to the operation of the device itself. Examples include the ability to access specific information (for instance, via a website); make payments and other transactions; play games; send messages; and so on. The application (app) might come preinstalled but more usually is downloaded (for free or for payment) from a wireless network from an online store and may require a live connection to function effectively. Simple apps may make use of the built-in low-speed data communication facilities of digital mobile phones, such as short message service (SMS) or unstructured supplementary service data (USSD). On many low-cost phones, applications are available through Java software. More complex apps use the Internet protocol-based data communication facilities of higher-speed networks on third- or fourth-generation mobile phone networks. The broad range of applications available includes:

- **Stand-alone software apps downloaded onto a device,** such as an iPhone app. As of April 2010, third-party developers provided 185,000 apps, and more than 4 billion had been downloaded since the iPhone was launched in July 2008, based on Apple's presentation at the iPhone OS 4 media preview event.
- **Applications that require an elaborate ecosystem to support them,** such as Safaricom's M-PESA application for mobile payments in Kenya. M-PESA (which operates in a number of countries) has some 15,000 agents and over 9 million users.
- **Applications built upon a specific platform that is itself an application.** For instance, the MXit instant messaging platform, which began in South Africa, now supports 250 million messages per day. It provides tools for users to develop their own applications running on the platform.

Source: Author.

The topic notes that follow review numerous ways that private industry, government bodies, and nonprofit organizations are using mobile phones in agriculture. Many of these programs are relatively new, and conclusive results are difficult to ascertain. Most show promise, but there are reasons for caution and the barriers to surmount. Topic



Note 3.1 focuses on what is known so far about the benefits, challenges, and enablers related to using mobile phones to improve agriculture and rural welfare. Topic Note 3.2 describes two typologies that can help practitioners understand the various roles and rationales surrounding the use of

mobile phones as agricultural development technologies and help them determine whether and how to incorporate them in the design of new initiatives. The Topic Notes are followed by Innovative Practices Summaries that highlight approaches taken so far.

## Topic Note 3.1: KEY BENEFITS AND CHALLENGES RELATED TO MOBILE PHONES AND AGRICULTURAL LIVELIHOODS

### TRENDS AND ISSUES

The proliferation of mobile phones across the globe has impinged on agriculture in various ways. Mobiles are being used to help raise farmers' incomes, making agricultural marketing more efficient, lowering information costs, reducing transport costs, and providing a platform to deliver services and innovate. Whether the potential of these trends can be realized more widely, especially in rural areas and in an equitable way, is uncertain. Every aspect of the technology is changing rapidly; the public sector, private sector, and private citizens are constantly experimenting with new applications for it; and governments are grappling with any number of strategies to ease the digital divide. This note summarizes what is known so far about the benefits, challenges and enabling factors associated with mobile phones in relation to several aspects of agricultural livelihoods.

### Helping Farmers Raise Their Incomes

In some instances, access to mobile phones has been associated with increased agricultural income. A World Bank study conducted in the Philippines found strong evidence that purchasing a mobile phone is associated with higher growth rates of incomes, in the range of 11–17 percent, as measured through consumption behavior (Labonne and Chase 2009). One reason for this finding is that farmers equipped with information have a stronger bargaining position within existing trade relationships, in addition to being able to seek out other markets. A study of farmers who purchased mobile phones in Morocco found that average income increased by nearly 21 percent (Ilahiane 2007).

Mobile phones seem to influence the commercialization of farm products. Subsistence farming is notoriously tenuous,

but smallholder farmers, lacking a social safety net, are often highly risk averse and therefore not very market oriented. A study from Uganda found that market participation rose with mobile phone access (Muto and Yamano 2009). Although better market access can be a powerful means of alleviating poverty, the study found that market participation still depended on what producers had to sell: Perishable bananas were more likely to be sold commercially than less-perishable maize.

Mobile phones can serve as the backbone for early warning systems to mitigate agricultural risks and safeguard agricultural incomes. In Turkey, local weather forecasts transmitted through SMS provided very timely warnings of impending frosts or conditions that favored pests.

Mobile platforms may also have potential for enabling rural people to find employment. In Uganda, Grameen AppLab partners with government and NGOs to employ farmers to collect information (for more on Grameen, see Module 3). This method, which relies on local people to transmit data to more centrally located research and extension staff, is much less costly and can provide much more timely information than traditional disease surveys.

Txteagle provides employment for relatively educated users (see "Txteagle Taps a Vast Underused Workforce" in Module 2), and even the very poor in rural areas could eventually benefit from access to a mobile job board. Farmers could advertise when they need additional labor for harvesting or other high-intensity tasks via mobile phone, creating a simple advertising portal. Workers could find jobs without wasting time and money traveling. A group called BabaJob is developing such a service in India, where recruiters and workers submit listings by SMS, but it remains in the developmental stage.

### Making Agricultural Marketing More Efficient

At a fundamental level, markets are about distributing information. They do so through prices, which serve as a unifying signal to participants to allow for the coordination of dispersed producers and consumers. Underlying this powerful mechanism, though, is the assumption that everyone knows the market prices for commodities, which is not the case in much of the developing world. Farmers have little information about market prices in urban areas of their own countries, let alone internationally. The result of this information asymmetry is price dispersion—the same goods sell for widely different prices in markets merely a few kilometers apart.

Mobile phones, in addition to other ICTs, can overcome this problem by informing both producers and consumers of the prices offered for agricultural products in various locations. A number of studies have shown that when mobiles are introduced to farming communities that previously lacked any form of connectivity, prices unify as farmers learn where they can sell for a better price. (See Module 9 for more information on marketing through ICTs.)

A striking example comes from the Indian state of Kerala (box 3.2). As mobile networks were rolled out in coastal

regions, fishers who were previously ignorant of daily prices in different markets were able to contact various ports to find the best offer for their catch. The result was demonstrable welfare gains for fishers because fish were sold where they were more highly valued. Waste decreased and prices equalized throughout the regional ports; there were even small gains in consumer welfare (Jensen 2007).

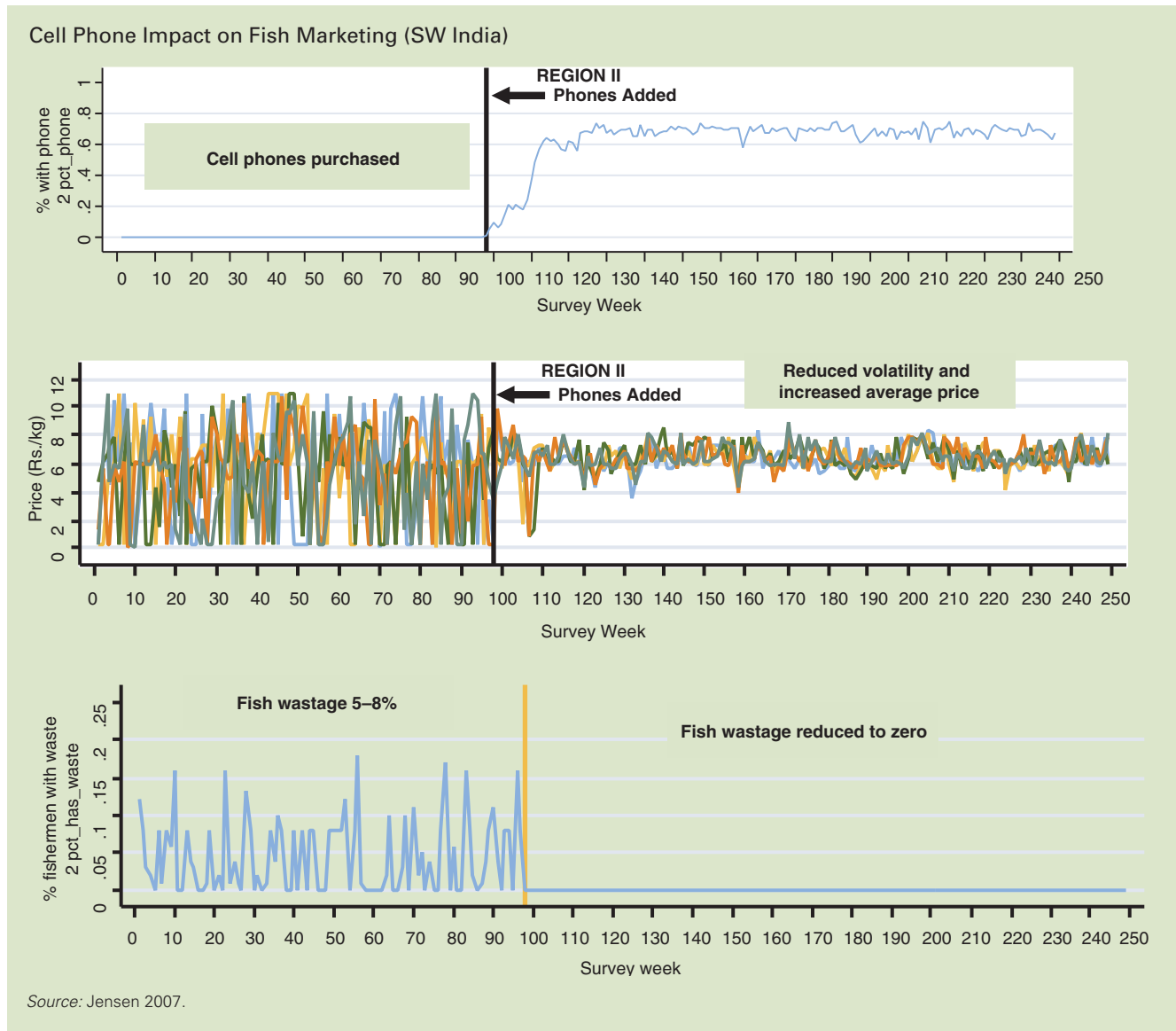
Other studies have confirmed this effect. Despite having the lowest mobile phone penetration in sub-Saharan Africa, Niger has seen important effects on agricultural markets from mobile phone diffusion. As mobile networks have expanded, grain price differences have decreased by 20 percent, traders' search costs have decreased by 50 percent, scarce resources have been better allocated, and consumers paid, on average, 3.5 percent less for grain, which is equivalent to 5–10 days of grain consumption annually (Aker 2010a). A small study in Morocco found that farmers with mobile phones increasingly dealt directly with wholesalers or larger-scale intermediaries than smaller intermediaries (Ilahiane 2007). These studies, in conjunction with a host of anecdotal and theoretical evidence, point to the promise of mobile phones in making markets more efficient.

#### **BOX 3.2: Mobile Phones Enable Kerala Fishers to Identify Better Markets**

As mobile phone coverage increased in Kerala, fishermen bought phones and started phoning along the coast to look for beach auctions where supplies were lower and prices higher than at their home beach. Fishermen rapidly learned to calculate whether the additional fuel costs of sailing to the high-priced auction were justified. The figure below tells a vivid visual story of how phones affected prices (reduced volatility) and wastage (significantly reduced). Price dispersion was dramatically reduced, declining from 60–70 percent to 15 percent or less. There was no net change in fishermen's average catch, but more of the catch was sold because wastage, which previously averaged 5–8 percent of the daily catch, was effectively eliminated. The rapid adoption of mobile phones improved fishermen's profits by 8 percent and was coupled with a 4 percent decline in consumer prices.

By 2001, over 60 percent of fishing boats and most wholesale and retail traders were using mobile phones to coordinate sales. The phones were widely used for fish marketing. Fishermen with phones generally carry lists with numbers of potential buyers. They typically call several buyers in different markets before deciding where to sell their catch. Boats using mobile phones on average increased profits by Rs 184 per day, compared to Rs 97 for nonusers who tended to follow the mobile phone users. Boats with mobile phones gained more (nearly twice as much) in part because they were on average larger boats and thus caught more fish and because they were more likely to be able to profitably exploit the small remaining arbitrage opportunities. Phones appear to be a worthwhile investment: The net increase of Rs 184 per day in profits for phone users would more than cover the costs of the phone in less than two months (assuming that there are 24 days of fishing per month, and given that the handset costs approximately Rs 5,000 and monthly costs are Rs 500). Fishermen are still using phones for marketing purposes to date.

*(continued)*

**BOX 3.2:** *continued***Lowering the Costs of Information**

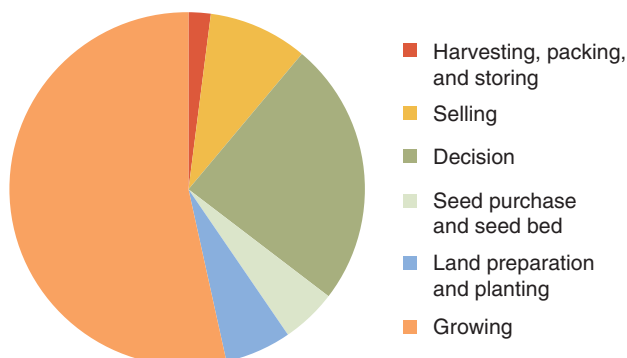
The most obvious and cross-cutting way that mobile phones can improve agriculture is by improving access to information and making it less costly to obtain. In many rural areas, the arrival of mobile coverage is a radical change in the nature of the information ecosystem. Although simply having more information is not sufficient to make advantageous decisions (other resources may be needed to implement them), it is a necessary step toward access to knowledge.

Transaction costs are present throughout agricultural value chains, from initial decisions about whether and what to plant, to all of the operations during the growing cycle, harvesting, postharvest and processing operations, and selling (to intermediaries, consumers, processors, exporters).

These costs can account for a large share of the cost of a farm enterprise.

In a study that compared transaction costs throughout an extended period, 15.2 percent of the total cost of farming was transactional, and of that, 70 percent was informational (as opposed to, say, the cost of transporting crops to market). Undertaken in Sri Lanka, where an inconsistent subsidy on fertilizer introduces considerable uncertainty, the study found that 53 percent of the informational transaction costs were incurred during the growing season, when farmers were attempting to ascertain fertilizer costs. As shown in figure 3.2, another 24 percent were incurred during the initial decision to plant or not, while only 9 percent of the costs related to information were incurred during the selling stage, where studies typically

**FIGURE 3.2: Information Search Cost by Stage of Farming**



Source: Adapted from De Silva and Ratnadiwakara 2008.

focus (De Silva and Ratnadiwakara 2008). It is easy to understand how mobile phones could reduce farmers' informational transaction costs at critical points in the production cycle.

### Reducing Transport Costs

Mobile phones may help users to substitute phone calls for travel. Where safety standards are minimal, roads are in disrepair, and distances are great, substituting phone calls for travel reduces farmers' time and cost burdens. Time savings are important for agricultural households, because many crops have extremely time-sensitive and labor-intensive

production cycles. Farmers who use mobiles can also save on transport costs (Overa 2006)—an effect that is stronger the more rural the area (Muto and Yamano 2009).

Transportation cannot be avoided entirely: Crops need to get to customers. Although mobiles can inform farmers where they should travel to market their crops, evidence suggests that the wealthy maintain an advantage in their ability to make use of this information (Fafchamps and Hill 2004). In combination with improved rural roads, ICT will encourage larger truck-traders to visit harder-to-reach areas, connecting rural and urban regions.

As noted in Module 9, the onion wholesalers known as "Market Queens" increasingly use mobile phones to coordinate supply among themselves and to improve profits by facilitating reductions in their transportation and opportunity costs (Overa 2006). These costs are particularly high in commodity chains that are geographically extensive and organizationally complex, such as the onion trade in Ghana.

### A Platform for Service Delivery and Innovation

The numerous capabilities of mobile phones (box 3.3) provide ample opportunities to deliver traditional and innovative services. Traditional agricultural extension agents are increasingly being outfitted with mobile phones through programs to increase their effectiveness by networking them to

### BOX 3.3: One Device, Many Channels

Mobile phones are multifunctional devices. From smartphones to models available secondhand in rural markets, mobiles do much more than simply place voice calls. In designing a mobile intervention or project, it is important to keep in mind the various channels through which populations can be reached.

In much of the world, voice is still king, owing to widespread illiteracy, but other considerations such as cost, ease of use, and trust influence users' choices. In Africa, the high cost of calls has made 160-character text messages (SMS) very popular.

As networks and devices acquire more capabilities, richer uses of phones are unfolding, and information channels are converging. Camera phones send images, data transfer brings the mobile Internet to the bottom of the pyramid, downloaded software applications provide advanced functionality, and GPS sensors provide mapping functionality. Emerging market consumers are more likely to have their first contact with the Internet through a mobile device, and many are mobile-only users.<sup>a</sup> Cisco estimates that by 2015 there will be 788 million mobile-only Internet users, and though rural areas will lag behind, the highest rates of growth will be in the Middle East, Africa, Latin America, and Eastern and Central Europe.<sup>b</sup> In Kenya, Safaricom recently unveiled a service that converts e-mails to SMS messages and an interactive voice response (IVR) service, in which a computer responds to voice inquiries. Combining mobile phones with other technologies, such as radio or telecenters, can enhance their capabilities.

This potential is important to understand. It shows how adaptable the technology is and how it can be used in areas where smartphones are likely to remain inaccessible to many in the near future.

(continued)

**BOX 3.3: continued**

Each form of mobile communication has its strengths and weaknesses. For example, SMS requires some form of literacy and is limited to 160 characters (although some mobile information interfaces are striving to become more visually intuitive). Data transfer is inexpensive but not available on most phones. The table summarizes types of mobile technologies and their availability.

**Types and Availability of Mobile Technologies**

TECHNOLOGY	DESCRIPTION	AVAILABILITY
Voice	The most basic channel; avoids most literacy or linguistic barriers	Basic phones
Short Message Service (SMS)	Ubiquitous text-based messaging limited to 160 characters	Basic phones
Unstructured Supplementary Service Data (USSD)	A protocol used by Global Service for Mobile Communications (GSM) phones to communicate with the mobile network	Basic phones
Interactive Voice Response (IVR)	Computer programs that respond to the voice input of callers	Basic phones
General Packet Radio Service (GPRS)	Low bandwidth data service	Midrange phones
Software App (e.g., Java or iOS)	Preinstalled or downloaded software of varied sophistication	Midrange, but increased sophistication with smartphones
Mobile Wireless Application Protocol (WAP)	A limited manner of browsing the Internet	Midrange phones
Multimedia Messaging Service (MMS)	SMS-based technology to transmit multimedia (including images and video)	Midrange phones
Camera	For capturing still or moving images	Midrange phones
Bluetooth	Protocol for transmitting data over short distances	Midrange phones
Mobile Web	Full-fledged web access	Smart phones
Global Positioning System (GPS)	Technology allowing for location-based information	Smart phones

Source: <http://www.crisscrossed.net/2009/11/01/the-many-potential-channels-for-mobile-services/>; (a) <http://www.slideshare.net/ondevice/the-mobile-only-Internet-generation>; (b) Cisco (2010).

knowledge banks. Extension can reach more clients through mobile-based learning platforms—textual or richer platforms, such as video—that provide tips to farmers to improve agricultural skills and knowledge. (See the detailed discussion of advisory services and ICTs in Module 6.)

Significantly, mobiles are also a platform for user innovation. Mobile money services, now so prominent in countries such as Kenya and the Philippines, originally began as informal mechanisms between family and friends. Software engineers in developing countries are creating locally appropriate applications to be deployed inexpensively. This form of innovation is possible due to the functionality of mobile phones, but capacity needs to be grown and technological barriers, such as incompatible networks, need to be addressed (see the discussion in Module 2).

Finally, the popularity of mobile phones means that previously excluded populations can have considerably more

political voice, raising the level of interaction between policy makers and their constituents. Mobile phones can be used to direct bottom-up insights towards the appropriate recipients, informing and improving governance (see Module 13).

**LESSONS LEARNED**

As mobile phones come into more widespread use and phone applications for agriculture increase, it is clear that they have the potential to confer significant benefits. To summarize, they may help to increase income, improve the efficiency of markets, reduce waste, and improve welfare. They can reduce agriculture's significant transaction costs, displace costly and time-intensive travel, and facilitate innovative interventions, especially in service delivery.

Yet as many examples in this sourcebook indicate, mobiles and ICTs more generally may serve agricultural development best when accompanied by complementary investments and reforms. For example, shoddy roads—or no roads—limit farmers' ability to sell their grain in prime markets. Poor access to education can prevent many rural people from taking advantage of mobile phone services that depend on being able to read.

A lack of financial services can undermine the new options that mobile phones allow. As discussed, Kerala's fishers saw their welfare increase through the use of mobile phones (image 3.1), but they ran into another financial barrier. Without access to capital, the fishers cannot own their boats. The phones eliminated some intermediaries, but boat owners may still force the fish to be sold in a less-than-optimal port. Small-scale producers and fishers can gain better access to services if they organize (see Module 8), but in many settings, increasing the bargaining power and political clout of small-scale producers remains an issue (Reuben 2007).

**IMAGE 3.1:** Mobile Phones Can Help Fishermen Sell Their Catch



Source: Curt Carnemark, World Bank.

To succeed, mobile services and applications also need to provide compelling value, especially for the poor. Access to devices and networks is insufficient; the technology also must be affordable and have useful applications and content. For example, in Sri Lanka, where researchers found significant potential cost savings from the use of mobile phones, farmers rarely used their phones to obtain market data because they could not obtain accurate and timely information. Instead, farmers made frequent and costly trips to distant markets to determine prices (Ratnadiwakara, De Silva,

and Soysa 2008). But when mobiles were used for timely interventions through SMS, up to 40 percent of wastage could be prevented, a service for which farmers were willing to pay (De Silva and Ratnadiwakara 2008).

Because mobile phones may be purchased as a status symbol, and because their uses are not necessarily economically valuable (entertainment and other social uses are popular), some mobile phone owners may decide to substitute their use for important expenditures such as school fees or food. Given this possibility, it is even more important that development practitioners promote policies and programs that improve livelihoods (Heeks 2008).

An additional caution is that without specific attention to equity issues, mobile phones may reinforce inequitable social structures. Larger traders are more likely to own mobiles than small-scale traders (Overa 2006). Compared to men, women are less likely to have access to mobile phones<sup>3</sup> (box 3.4 provides additional insight into the role of mobiles in relation to gender equity). To avoid exacerbating such inequalities, agricultural programs using mobiles should be designed with equity in mind from the start.

Finally, context matters. Technology cannot be airdropped into a situation and guarantee positive results, and mobile phones may not necessarily be directed at economically useful behavior.

### INNOVATIVE PRACTICE SUMMARY

#### Weather Forecasting Reduces Agricultural Risk in Turkey

A project recently implemented by the Government of Turkey in collaboration with international donors is an exemplary model of local weather forecasting.<sup>4</sup> Rather than focusing on aggregate, national data, this project, implemented by the Agriculture Directorate of Kastamonu Province, focused on the microclimatic conditions essential for monitoring pests and diseases accurately and increasing productivity.

#### The Problem and the Technology

Most producers in Kastamonu maintain orchards, which are extremely susceptible to frost and local pests. Before

<sup>3</sup> See "mWomen" under [http://gsmworld.com/our-work/mobile\\_planet/development\\_fund/index.htm](http://gsmworld.com/our-work/mobile_planet/development_fund/index.htm).

<sup>4</sup> This section draws on World Bank (2010) and personal communication from H. Agah, Senior Rural Development Specialist, World Bank (interview with C. Belden, Agriculture and Rural Development, World Bank, March 22, 2011).

### BOX 3.4: Mobile Phones, Agriculture, and Gender

The larger development community recognizes the importance of emphasizing equitable opportunities and benefits for both genders (for example, see the Gender and Agriculture Sourcebook)—a principle endorsed for the use of ICT in agriculture as well. Access to and use of ICTs are often unequal, with women suffering the consequences. In a number of cases, however, ICT has been used to benefit agriculture while empowering women.

Kenya is a country of 5 million farmers, ranging from the smallest subsistence growers to large industrial agriculturalists. It is also increasingly a hotbed of technological innovations such as M-Farm, a mobile service that aims to improve Kenya's agricultural sector by connecting farmers with one another, because peer-to-peer collaboration can improve market information and enhance learning opportunities.

Based around farmers' traditional needs, such as the need for market price and weather information, M-Farm is a relatively new subscription service that also works with larger institutions, such as NGOs and the government, to connect them with farmers. The idea was generated at IPO48, a weekend-long "boot camp" where technologists and entrepreneurs bring businesses from idea to initial product in only 48 hours. M-Farm, created by AkiraChix (an all-female team of developers who are now pursuing the project full time) won the 2010 IPO48 competition's first-place prize of more than US\$ 10,000. AkiraChix is also the recipient of an infoDev/World Bank grant to facilitate monthly networking events for mobile entrepreneurs and developers in Nairobi.

Both networking and incentives such as IPO48 have proven essential to facilitate the rapid creation of sustainable businesses based on mobile devices and the empowerment of women. Though IPO48 and M-Farm are new and their impacts still limited, they are expected to generate widespread improvements in agricultural marketing, particularly for women.

The Village Phone program of the International Finance Corporation may also benefit rural women. The program provides microloans to rural entrepreneurs who purchase a mobile phone, long-range antenna, solar charger, and airtime. The recipient earns a livelihood by operating a phone kiosk in areas underserved by mobile networks. As is typical in micro-finance, the loan recipients tend to be women. Since the program's inception, nearly 6,000 women have received loans and close to 10,000 have been trained in countries such as Madagascar, Malawi, and Nigeria.

*Source:* Author.

the project commenced, producers had little time to react to weather that might harm their orchards, because national weather forecasts for the next day were broadcast in the evening (both FM radio and broadband Internet were unavailable). Given these constraints, mobile phones with SMS were the most applicable ICT for the project.

National aggregate weather forecasts are not particularly useful for pest management and frost prevention in rural locations. Local, specific conditions vary widely from farm to farm depending on such variables as humidity, precipitation, crop type, and soil fertility. In addition, rural weather is often a few degrees cooler than weather in urban areas where most forecast data are generated.

The provincial directorate established five mini meteorological stations in rural areas throughout the province. The stations collect data on variables such as temperature, precipitation, wind, leaf wetness, and soil moisture, most of which are not collected at the national level. In addition to

these stations, the province maintains 14 reference farms where temperature is measured and pest cycles are monitored. Monitoring the life cycle of pests, along with collecting climate data, allows researchers to predict pest outbreaks more accurately, because pest maturation depends largely on environmental conditions.

With localized weather indicators disseminated daily through SMS, producers can apply pesticides when needed and in appropriate amounts. In the first two years of the project, producers' costs fell dramatically. Pesticide applications dropped by 50 percent in one year, saving farmers around US\$ 2 per tree. Considering the size of the orchards, overall production costs could be reduced by as much as US\$ 1 million each year.

A similar design was used to avert frost damage. Climate change and shifting temperatures have increased spring frosts in Kastamonu Province. If the meteorological stations measure lower-than-normal temperatures, subscribers with personal digital assistants (PDAs) and mobile phones receive

alerts at 4:00 P.M., giving them sufficient time to prepare for the cold snap.

### Anecdotal Evidence of Impact

Though the project has not gone through rigorous assessment, anecdotal evidence clearly points to its success. The means chosen to disseminate information were essential to the project's success, because mobile applications matched the technological capacity of the area. Other dissemination and awareness strategies raised the project's visibility, including the mass media, village leaders, and other forms of human interaction and leadership. It is likely that the weather forecasts had the ripple effect common to other ICT projects, because those who received the service shared the information with family and neighbors who did not. Farmers who participated in the project were successful in planting and protecting their crops. Of 500 farmers reached through this information channel, not one experienced crop losses from frost, although farmers who did not receive the service did.

### Scaling Up and Sustaining the Benefits

The project could be scaled up, but cost is a concern. For the first two years, project costs were fairly low. The five stations, telecoms, software, and system upkeep cost around US\$ 40,000. Costs will climb over time, however, as donor financing ends and climate conditions change (which could make it important, for example, to change the system to include other variables).

Several strategies could reduce the cost to government once external funding ends. For example, the government could partner with the private sector. Firms interested in domestic or export markets for the area's crops may have an incentive to fund some of the technologies or develop the content. Revenue could also be collected through small or tiered subscriber fees (daily forecasts in the Kastamonu Province are currently free).

Scalability is also difficult because of the nature of this particular project. Site-specific climate information is more expensive to obtain than aggregate temperature predictions. Moreover, other areas will produce crops vulnerable to a different spectrum of biological and climate stress, making each target group fairly small. One way to reduce these costs and broaden the scope of a similar program might be to focus first on crops or livestock that represent the most widely pursued or highest-value enterprises.

Transferring this kind of early warning system to Central Asian countries as planned by the World Bank may pose particular

challenges. Turkey's national meteorological system is more advanced than the system of most of its neighbors. High-resolution images and national capacity for weather forecasting are necessary to achieve local efforts. Because global satellites provide basic climate information free of charge, they may fill the technological gap in some countries, but their resolution is low. Alternative strategies like climate modeling have succeeded in Latin America and Africa, but they have not been empirically tested for their effectiveness in forecasting weather.

Anecdotal evidence also shows that technological capacity is not the only factor influencing success. Institutional capacity is equally important. The local government's high level of commitment to the project and consistent implementation were crucial to building client trust and ensuring that the technologies were used appropriately.

## INNOVATIVE PRACTICE SUMMARY

### Mobiles Are the Heart of Esoko's Virtual Marketplace

Esoko (<http://www.esoko.com/>) (which began as TradeNet in 2005) is a market information service that provides price information and a virtual marketplace for buyers and sellers of agricultural commodities to connect through mobile phones and the Internet.<sup>5</sup> Mark Davies, a successful British technology entrepreneur who also manages Ghana's largest ICT center, BusyLab, set up Esoko.<sup>6</sup> Since then, it has become one of Africa's most successful agricultural services using ICTs. Esoko's technology is used in nine African countries and is expanding quickly. Mobiles are at the center of the system.

### Services

Esoko provides four key services:

- **Live market feeds.** Real-time SMS alerts on market prices and offers are delivered automatically to subscribers. Users can submit offers directly into the system using SMS.

<sup>5</sup> Aside from the sources cited in the text, this summary also draws on Gakuru, Winters, and Stepman (2009).

<sup>6</sup> Esoko, which began as a private initiative with encouragement from FAO and the UN, became a partner with USAID's MISTOWA program in West Africa and CIAT's FoodNet program in Uganda, and it was supported with a grant of US\$ 11 million. More recently, IFC (a member of the World Bank Group) and the Soros Economic Development Fund (a nonprofit investment fund that works to alleviate poverty and community deterioration) each invested US\$ 1.25 million of equity into Esoko. The investment will give smallholder African farmers and businesses timely crop information that can be shared via text messaging, enabling farmers to increase their incomes.



- **Direct SMS marketing and extension.** This service targets specific user groups or sends extension messages, which reduces travel and communication costs.
- **Scout polling.** It is possible to set up automatic SMS polling for field activities to track inventories and crop activities (among other things) and monitor and report on crop cycles and yields.
- **Online profiling and marketing.** All users can have a customizable web space to advertise their goods and services. This space can be updated using Esoko's mobile2web content management service.

Participants throughout agricultural value chains can exchange real-time market information. Farmers receive current demands, prices of crops, and the location of seed and fertilizer outlets directly on their mobile phones. Businesses can track how their products are used and market themselves to new customers. Associations and governments can share critical information with thousands using a simple feature for bulk text messaging.

Anyone in the world can visit [esoko.com](http://esoko.com) and register for a free account. There, in addition to 800,000 prices from hundreds of markets, users will find a library of resources and thousands of members offering to buy and sell agricultural products. Prices and transactions are also available via the universal SMS channel, and for slightly more sophisticated phones, a downloadable application offers additional functionality. Users can even receive automated SMS alerts for certain commodities in a given market (box 3.5). Because anyone with a mobile phone may post offers to the website through SMS, smallholder farmers are able to reach a far wider audience than they typically would. Esoko users also are in a better position to negotiate with buyers owing to their enhanced knowledge of prices in other markets.

Esoko offers training and strategy sessions on how to use the platform and can provide customer services for

### **BOX 3.5: An Esoko Transaction**

Here's how it works: A farmer in northern Ghana is selling 20 tonnes of millet. The farmer texts in SELL MILO 20MT to TradeNet's international number, and that information is processed by the software and immediately published on the website. The same details are also redistributed to every other user that has signed up to receive alerts on millet sales in Ghana.

*Source:* Quoted from Bartlett 2008.

farmer groups. The firm also publishes the first commodities indexes in Africa. These powerful tools ensure that farmers are fairly compensated for their crops, as formal commodity exchanges are very rare on the continent. The company is initially publishing two indexes that provide prices for 12 agricultural commodities in 7 markets in Ghana.

### **Impact**

The impact of this information on traders, exporters, transporters, procurers, and others in the agricultural value chain is still to be determined. The service is believed to have the potential to reduce inefficiencies in the value chain. For example, an exporter took 60 days and needed 5 people in the value chain to procure a natural plant product, but with Esoko's technology, the procurement process required 31 days and 3 people, improving both the major traders' and producers' share of the export price. Free field trials for farmers elicited self-reported evidence of a 20–40 percent improvement in revenue. Sixty-eight percent of farmers said that they would pay for the service; every farmer who received information would forward it to an additional 10 farmers.

### **Building and Sustaining a Business Model**

The idea driving the model is that most businesses in the agricultural value chain collect and deliver their own data; Esoko will provide tools and a platform and co-opt businesses to generate content for the platform. Esoko pays on an incentive basis to acquire information, using targets and bonuses. Their revenue-generation model is based on levels of subscriptions (bronze, silver, gold, platinum), each with a different pricing structure and its own mix of content and tools.

For a US\$ 1 per month subscription (beginning in 2011), farmers automatically receive information on commodities, markets, and other topics of interest. In developing a model for selling information to farmers, Esoko encountered a few challenges. Farmers are widely dispersed in the field and hard to reach. It is also difficult to quantify the exact value that the service generates for farmers.

Esoko provides additional functionality for other users, including organizations that would like to customize the technology for their needs. For example, paying subscribers can access Esoko's supply chain tools, which allow harvest activities to be tracked. Mark Davies (quoted in Magada 2009) believes this holistic approach, as opposed to simply providing price

information, is key: “While running TradeNet, we realised that there was a need for a platform to integrate the whole supply chain, not to just provide prices. . . . We’re missing the point if we don’t integrate the whole industry.”

But this scale requires significant investment; whereas Davis started the business with US\$ 600,000 of personal money and US\$ 200,000 from donors, he has suggested that nationwide rollouts require US\$ 1 million in funding. The money goes toward new hardware and for staff to

operate the hardware and work in the commodity markets collecting prices and news. To support this activity, in addition to the tiered subscriptions mentioned above, Esoko pursues public-private partnerships (Donner 2009). Partnerships are key, with governments, donors, and the Esoko Networks, a group of affiliated companies, using and building upon the platform. Esoko demonstrates that finding the right business model is not easy, but donors and government have a role in supporting new interventions.

## Topic Note 3.2: TWO TYPOLOGIES AND GENERAL PRINCIPLES FOR USING MOBILE PHONES IN AGRICULTURAL PROJECTS

### TRENDS AND ISSUES

As governments, donors, NGOs, and private firms attempt to use this popular technology for development goals, researchers are developing frameworks to make sense of these initiatives and help design new ones. The section that follows reviews two such typologies. The first focuses on the services that operate through mobile phones to improve aspects of agricultural livelihoods. The second focuses on the various forms that mobile applications might take to develop the agricultural sector. Both of these approaches may be useful when considering programs to use mobile phones. This note also reviews principles for designing a program to use mobile phones in agriculture, based on what has been learned to date.

### Typology 1: A Focus on Mobile Livelihood Services

Jonathan Donner, a researcher with the Technology for Emerging Markets Group at Microsoft Research India, has developed a framework that examines the various livelihood services available to mobile phone users in the developing world (Donner 2009) (table 3.1). His survey finds six types of “mobile livelihood” services (mediated agricultural extension, market information systems, virtual marketplaces, comprehensive services, financial services, and direct livelihood support) and five possible effects (improving internal activities, adding market information, adding market participants, bypassing middlemen, and starting businesses). Note that

**TABLE 3.1:** The Impact of Mobile-Based Livelihood Services

SERVICE	IMPROVE INTERNAL ACTIVITIES	ADD MARKET INFORMATION	ADD MARKET PARTICIPANTS	BYPASS MIDDLEMAN	START BUSINESSES
Mediated agricultural extension (e.g., Collecting and Exchange of Local Agricultural Content—CELAC, <a href="http://celac.or.ug/">http://celac.or.ug/</a> )	X	X			
Market information systems (e.g., Kenyan Agricultural Commodities Exchange Program—KACE, <a href="http://www.kacekenya.co.ke/">http://www.kacekenya.co.ke/</a> )		X			
Virtual marketplaces (e.g., Google Trader, <a href="http://www.google.co.ug/africa/trader/home">http://www.google.co.ug/africa/trader/home</a> )		X	X	Sometimes	
Comprehensive services (e.g., Manobi or Esoko— <a href="http://www.manobi.net/worldwide/">http://www.manobi.net/worldwide/</a> ; <a href="http://www.esoko.com/">http://www.esoko.com/</a> )	X	X	X	Sometimes	
Financial services (e.g., M-PESA, <a href="http://www.safaricom.co.ke/index.php?id=250">http://www.safaricom.co.ke/index.php?id=250</a> )	X		X		
Direct livelihood support (e.g., txteagle, <a href="http://txteagle.com/">http://txteagle.com/</a> )				X	X

Source: Adapted from Donner 2009.

Note: For more information on M-PESA, see “M-PESA’s Pioneering Money Transfer Service” in Module 2; for txteagle, see “Txteagle Taps a Vast Underused Workforce” in Module 2.

although many livelihood services are bound to have more than one effect—it is perfectly plausible that a service that provides market information will also draw new participants into the market and help farmers bypass intermediaries—table 3.1 emphasizes the main areas of impact.

### Typology 2: A Focus on Mobile Applications for Agriculture

Alternatively, Kerry McNamara has suggested four categories for understanding the forms that mobile applications may take to help the agricultural sector (Hellstrom 2010) (table 3.2). Mobile agricultural applications, in this framework, may (1) educate and raise awareness, (2) distribute price information, (3) collect data, and (4) track pests and diseases.

**TABLE 3.2:** Various Roles for Mobiles in Agriculture

GOAL	METHOD
Education and awareness	Information provided via mobile phones to farmers and extension agents about good practices, improved crop varieties, and pest or disease management.
Commodity prices and market information	Prices in regional markets to inform decision making throughout the entire agricultural process.
Data collection	Applications that collect data from large geographic regions.
Pest and disease outbreak warning and tracking	Send and receive data on outbreaks.

Source: Hellstrom 2010.

### PRINCIPLES FOR DESIGNING A PROGRAM USING MOBILES IN AGRICULTURE

The use of mobile phones in agriculture, though relatively new, has already witnessed failure as well as success. What separates the two outcomes may often be unpredictable and locally nuanced factors, but a survey of what has been learned indicates that a number of principles can improve the chances of sustainable impact.

#### Understand Users and the Technology

Time and again, interventions have failed to gain traction because users' needs and practices were incompletely understood. In technological interventions, this risk is even more of a concern. Practitioners need to think carefully about why mobiles are the technology of choice and consider alternatives, from the cutting edge to the mundane. Farmers

already have information sources and learning opportunities, so it is best to avoid reinventing the wheel if a mobile intervention will not significantly improve upon the experience.

Mobiles are far from unitary, as box 3.3 shows, and an understanding of the platform's strengths and limitations is essential. For example, while it is ubiquitous, SMS is limited to 160 characters. Although mobile Internet is still limited in scale and often confusing to users, it can be sophisticated and is spreading; in fact, some research has even shown more impact from the Internet than mobile phones, so their convergence is an exciting opportunity (Goyal 2010). There is always a risk that new technologies serve to blind the development community to more tried and true methods, so considering how mobile phones fit with needs and existing practices is a key initial step.

#### Engage in Participatory, Iterative Project Design

Understanding local needs is a difficult task that can be made easier by directly involving communities in the design and implementation of interventions. In addition to surveys of global and regional activities (such as this sourcebook), on-the-ground analysis is needed. Partnerships with local organizations, extensive fieldwork, and interactive design sessions offer ways to understand the subtle differences between agricultural subsectors and regions. Trying to “do everything” has doomed projects, while initiatives that start small and focused (such as M-PESA, which began with peer-to-peer money transfers) can evolve into diverse offerings (purchases, credit, and savings). One example of a small, focused program comes from Chile, where a small cooperative receives critical information for production and marketing.

Development practitioners can also learn from software developers who practice the mantra, “release early and often,” meaning that “good enough” prototypes should be piloted and improved in a rapid feedback loop. The risk with this practice is that it may confuse communities that may not understand the process, but if the goal of the project is to reach considerable scale, using small pilot and focus groups to improve earlier versions is a worthy practice.

Bringing communities into the early stages of the project can also foster local ownership, a key component of sustainability. This principle is closely aligned with the need to “go beyond the technology” and focus on people. For example, a lack of cultural awareness almost caused Text to Change, a Dutch NGO working in Uganda, to derail an effort to provide

HIV/AIDS information via SMS. Only on the morning of the program's launch did the NGO realize that the SMS code assigned to them was 666—locally known as “the devil's number”—and had to scramble to receive a new number to avoid upsetting Christian partners and users.<sup>7</sup>

Mobiles, like other technologies, are not silver bullets, but instead are tools that will be shaped by social conditions. Practitioners attempting to integrate mobiles with agricultural communities need to design their programs for equitable access.

### **Identify Partners with the Appropriate Knowledge, Collaborative Capacity, and Alignment of Goals**

As the innovative practice summaries in this module indicate, it is unlikely that any one organization, whether an NGO, ministry, donor, or private firm, will have all of the expertise required to succeed in designing and implementing successful mobile phone interventions in agriculture. Partners should be chosen for their specialized knowledge, willingness to collaborate, and alignment of goals. Special care should be taken at the very beginning of project planning to ensure that the key stakeholders will work together positively.

Projects must seek to leverage trusted intermediaries. One example discussed in this module is Kilimo Salama, which relies on the trusted M-PESA money transfer service and agricultural input suppliers to offer weather insurance to farmers (box 3.6). Another is IFFCO Kisan Sanchar Limited. The partners behind this service (which provides market information and agricultural advisory services) are IFFCO, a well-known farmer's cooperative organization that maintains a presence in 98 percent of India's villages, and Bharti Airtel, a large mobile network operator (MNO) (for details, see IPS “Long Experience in Farm Communities Benefits IFFCO Kisan Sanchar Limited” in Topic Note 2.4).

By their very nature, most agricultural services using mobile phones partner with at least one MNO. For the network operator, the services are a way to boost rural subscribers (an important source of growth) and decrease customer turnover. This objective does not necessarily mean that the network operator has any interest in farmers' livelihoods (although it may), and partners should be cognizant of potentially conflicting motivations. That said, operator buy-in can be a powerful benefit, especially through distribution and marketing. Zain Zap, the mobile international banking service,

### **BOX 3.6: Kilimo Salama Demonstrates the Convergence of Mobile Phones and Sophisticated Mobile Services**

Kilimo Salama (“safe farming” in Kiswahili) is an innovative program operated by Safaricom (Kenya's largest MNO), Syngenta Foundation (the foundation established by the Swiss agribusiness), and UAP Insurance. The initiative delivers crop insurance to smallholder farmers in rural Kenya through the use of mobile phones. Farmers insure their crops with Kilimo Salama when they purchase seed and fertilizer from registered vendors. The vendors are equipped with a camera phone loaded with special software. At the time of sale, the salesperson takes a picture of a special barcode on the products, and an SMS is sent to the farmer's phone confirming the insurance policy. For their work, agents receive a commission. Pricing has changed, with the premium originally subsidized, but in mid-2011, farmers were paying a 10 percent insurance premium.

The Kilimo Salama system relies on weather stations in each agricultural region to measure rainfall and other climate information. When conditions fall below historical benchmarks for farming (indicating that crops will be lost and inputs wasted), the service automatically pays insured customers in that region, using the M-PESA mobile money service.

Kilimo Salama demonstrates the potential for mobile phones and services (such as mobile money) to deliver sophisticated financial products to smallholders, and it underlines the importance of distribution channels and product reliability. Affordability and trust remain obstacles, especially if farmers dispute the payouts from the system.

*Source:* Author, based on IFC Advisory Services 2011.

operates in rural areas where commercial banks have few or no physical branches and benefits from Zain's vast international One Network (see IPS “Zain Zap Promotes Borderless Mobile Commerce,” in Topic Note 2.3). Partnering with private firms, including MNOs and input suppliers, is often required for mobiles-for-agriculture interventions to endure.

### **Ensure That the Technology Is Widely Accessible**

Mobile phones represent a great opportunity for agricultural interventions because they are one of the most accessible

<sup>7</sup> See <<http://failfaire.org/2010/10/15/brilliant-fails-in-m4d/>>.

information platforms available, although barriers do remain. They can take the form of illiteracy or prohibitive cost, or they can be technical or cultural (image 3.2). Given the tenuous nature of smallholders' livelihoods and the lack of social safety nets, many smallholders are particularly risk averse. They are unlikely to participate in a new initiative without significant education, advertising, and local support. Even those who wish to use a mobile intervention may be frustrated if the program is not widely available. Nokia's Life Tools application is intentionally designed to be widely available on its low-cost handsets and fill a gap in low-income communities with a large latent demand for information.

**IMAGE 3.2: Other Challenges, Like Inadequate Transport, Affects Mobile Phone Success**



Source: Mano Strauch, World Bank.

Projects that are exclusive to one MNO or a specific type of phone may face implicit barriers to adoption. Open technological standards and free and open-source software can be used to reach a wider audience and avoid lock-in. They can do much to enable unanticipated user innovation. For example, individuals around the world save money through “beeping” or intentionally missed calls that communicate predetermined messages without using expensive airtime. Elsewhere, users send money through unofficial routes using airtime transfers. Given flexibility and understanding, communities will provide innovative solutions to their needs.

**Sustainability Based on a Viable Business Plan**

Sustainable agricultural projects are key to long-term growth and livelihood improvements, but often projects fail to

continue for an extended term. It is essential to develop a viable business plan from the very conception of a project to use mobiles in agriculture. Such a plan requires a clear understanding of who will pay—the government, end users, cooperatives, or a combination, for example—and how much they are willing to pay for a service. Farmers are willing to pay for timely and contextual information, but different strategies may be needed to encourage poorer farmers to use a service (such as payments per query rather than a long-term subscription). The Reuters Market Light service offers a range of price and service formats to accommodate a wide range of clients.

Innovation in technology is often less important than innovation in the business model; prepaid mobile airtime was arguably more important than low-cost devices in enabling mobile phones to spread. When Google introduced three mobile applications in Uganda for free, they gained significant traction, but when fees were introduced, usage dropped, indicating failure to accurately gauge the appeal of the service and willingness to pay (Kubzansky, Cooper, and Barbary 2011).

Market-based solutions can be more sustainable, but donors and governments often remain important as anchor buyers or subsidizers (see IPS “Mobiles Are the Heart of Esoko’s Virtual Marketplace” in Topic Note 3.1). When interventions are not undertaken for profit, they can benefit from approaches commonly used in the private sector, such as advertising to stimulate demand, rigorous benchmarking, market segmentation, and documenting failures as well as successes for internal and external learning.

**Monitoring and Evaluation**

Although mobile phones have had positive impacts on agriculture, a better understanding of these outcomes would help in designing new interventions. A recent review of ICT-based interventions in agriculture suggests a number of questions to address (Aker 2010b):

- What is the impact of ICT on farmers’ knowledge, agricultural practices, and welfare?
- Are the observed changes due to the ICT or something else?
- What is the causal mechanism behind the effect?
- How does the impact differ between both farmers and type of information provided?

- What are the potential spillovers or unintended consequences for participants and nonparticipants?
- Is the ICT-based approach cost-effective relative to other, more traditional, interventions?
- Do the results transfer to different regions and contexts?

## LESSONS LEARNED

Although mobile phones continue to evolve quite rapidly, the evidence suggests that they can promote improved livelihoods through networking and informing previously unconnected portions of the population. The evidence comes from users' own rapid grasp of the technology's potential (Kerala's fishers using phones to seek optimal markets for their catch) and from planned efforts originating from commercial information providers and development practitioners (as in the market information and insurance programs described in the innovative practice summaries that follow).

Improving agricultural productivity is one of the most pressing issues for developing regions. Although mobile phones are no silver bullet, their widespread availability and flexibility position the technology as a necessary component of sustainable improvements in agriculture. Coupled with corresponding innovation in existing social and institutional arrangements, mobile phones have the potential to make significant contributions. As mobile phones converge with other mobile devices such as netbooks and tablets, the opportunities will proliferate.

For donors, governments, NGOs, and private entities working to promote better agricultural policies, current efforts offer much to learn. Designing programs and initiatives in a careful, flexible manner will enable rural communities to adopt and use new technologies and methods to improve their lives.

### INNOVATIVE PRACTICE SUMMARY

#### Mobile Service Gives Local and Global Edge to Chilean Farmers

In Chile, the Mobile Information Project (MIP) delivers targeted agricultural information from the web directly to farmers, using software to create news channels on

mobile phones.<sup>8</sup> The software, developed by DataDyne (a nonprofit organization based in the United States), organizes searchable content from the Internet into news feeds (RSS) and then transmits that content to farmers via SMS messages. The system was designed to work on the simple mobile phones sell for US\$ 15–20 in Chile and operate effectively even over slow networks with intermittent connectivity.

MIP solved the challenge of sending information from the Internet via SMS messages; the next challenge was to ensure that the content was valuable to the user. Because text messages transmit a maximum of 160 characters, there is no guarantee that messages contain useful information. Even when a system chooses relevant information, the first 160 characters may not accurately convey its meaning.

#### Starting Small: A Pilot with a Small Cooperative

To test the system, a pilot project, DatAgro, was set up in early 2009 between DataDyne and an agricultural cooperative in the Cachapoal Valley, two hours south of the capital, Santiago. The cooperative, Coopeumo, has just under 350 small-scale farmer members, most of whom grow maize and some other crops. Members' coop dues covered the cost of the new SMS system. There was no extra subscription fee and no charge for the text messages (the current cost of US\$ 0.06 is borne by the coop). Training sessions were held at the beginning of the project to teach farmers how to send and receive text messages. Most coop members are men, thus about 90 percent of those receiving training were men.

Coopeumo farmers received weather, news, sports, and other information via SMS. The information came from several sources. Two of the project's partners, UNESCO and Chile's Foundation for Agricultural Innovation (FIA),<sup>9</sup> created messages based on work already done but not yet shared with the community. Two national newspapers sent news to the system. Users could customize the feeds they subscribed to and could rate the messages they found the most helpful.

8 This summary is based on information from Cagley (2010) and personal communication with John Zoltner, DataDyne.org.

9 UNESCO = the United Nations Educational, Scientific, and Cultural Organization; FIA = Fundación para la Innovación Agraria.

### Impact: Local and Global Advantages

In less than a year, the DatAgro service proved popular. One Coopeumo member, Hugo Tobar, reported that his entire crop for 2009 was saved by an SMS message that urged him to delay planting because of impending bad weather. Torrential rain during the next week would have washed his seedlings away.

Ricardo Danessi, executive manager of Coopeumo, said, “Our farmers can now find information about supply prices, product prices, the weather, and what’s going on in international markets. That’s important, because today, everything that goes on outside Chile also affects us. When there’s an excess of production in one place, the prices go down here. Or when there is a sudden disaster or catastrophe somewhere else, the prices improve here. When demand goes up in China or India, the prices here get better. Everything is related in this connected world, and small-scale farmers aren’t left out of that reality” (quoted in Cagley 2010).

### Sustaining the Gains and Scaling Up

Farmers have stressed the importance of the information they receive and the convenience of the MIP platform. Since the close of the pilot project, Coopeumo has assumed responsibility for creating, sending, and paying for the SMS messages. The only ongoing cost to DataDyne is the incremental cost of maintaining and continuing to improve MIP. Developing the MIP platform, testing it in the field, and local implementation cost a little over US\$ 200,000.

Looking to the future, DataDyne plans to expand the use of MIP based on use of the successful mobile data collection tool, EpiSurveyor (<http://www.episurveyor.org>). EpiSurveyor, available via the Internet, can be used free of charge by everyone who wants to collect data, unless they have very heavy needs or require new functions. After a little more than a year, more than 2,500 organizations in more than 140 countries are using EpiSurveyor, 99 percent of them for free. The same model will be used for MIP. If new functions are needed, DataDyne can tailor the system accordingly and charge a fee for doing so, but it will automatically make the new functions available for free to other users. In the case of heavy data requirements, DataDyne will charge a US\$ 5,000 annual license fee. There will also be a charge related to the cost of SMS messages, because

the telecoms companies have to be paid to transmit the messages.

The experience in Chile suggests that disseminating information via simple mobile phones is a good way to reach farmers in areas where Internet facilities are unlikely to be provided in the near future. Refinements to the system should make it easier to provide relevant content to each individual, and a current challenge is to tailor the content automatically; when information is mediated by a human editor, bottlenecks can be introduced.

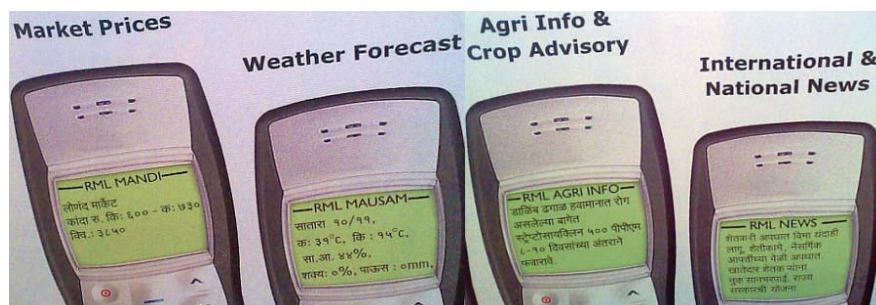
### INNOVATIVE PRACTICE SUMMARY For Reuters Market Light, the Wider Network of People Matters

While on a fellowship at Stanford University, a Reuters employee hit upon the idea of offering highly customizable market information to farmers through the increasingly ubiquitous platform of mobile phones. From this initial idea, the international news giant launched Reuters Market Light (RML) in 2007 to provide market prices, weather, and crop advisory services to farmers in India. This launch was preceded by 18 months of market research, tests, and pilot programs to refine the idea and tailor it to the local context (LIRNEasia 2008).

To subscribe, a farmer calls a toll-free number to activate the service in the local language and specify the crops and markets in which he or she has an interest. Throughout the subscription, farmers receive four to five SMS alerts with relevant information throughout the day. According to RML’s managing director, Amit Mehra, the pilot farmers greatly preferred automated messages instead of having to ask for them. Initial studies show that farmers who receive the service are receiving 5–10 percent more income. (See IPS “Impact of Immediate Market Information in Asia and Africa” in Topic Note 9.3 for additional details on farmers’ gains through RML.)

### Impact

Today, the application is one of India’s largest market information services, serving hundreds of thousands of paying customers in tens of thousands of villages. Via SMS, it delivers highly personalized, professional information to India’s farming community, covering more than 250 crops, 1,000 markets, and 3,000 weather locations

**IMAGE 3.3:** The Reuters Market Light Interface

Source: Medianama.

across 13 Indian states in 8 local languages (Mehra 2010) (image 13.3). The impact is likely even larger than Reuters can count due to the widespread sharing of information that takes place within informal farmer networks. Additionally, RML today has hundreds of employees, many of whom are trained as dedicated price collectors in markets throughout India.

### Continuing Competition for Clients

Reuters Market Light has sought to reach as many customers as possible through a number of strategies. RML has attempted to avoid exclusive partnerships with MNOs, though in some cases it has found that telecommunications firms provide a strong value proposition (notably through sales reach and providing a subscriber catalog that could lessen customer turnover). To make it easy for unregistered users to try the service before committing to a subscription, RML has set up sales offices through the postal network, local shops, input suppliers, and banks. Customers can obtain RML in basic SMS through prepaid scratch cards that give access to the service for a given amount of time—initially only 1 month, but now 3, 6, and 12 months. After much experimentation, pricing has settled at Rs 60, 175, 350 and 650, respectively. (For details of the technology and business model, see IPS “First Mover Advantage Benefits Reuters Market Light” in Topic Note 2.4 in Module 2.)

Although a leading example, RML is hardly a monopoly. It competes with both traditional information services (radio, market intermediaries, newspapers) and other services that use mobile phones. IFFCO Kisan Sanchar Limited (IKSL) offers similar market information for rural farmers but uses

voice messages so that illiterate farmers are able to use the service. Best of all, the service is free and benefits from the partnership of India’s largest MNO (Bharti Airtel), which views the service as a way to attract new customers in rural areas.

According to Mr. Mehra, reaching economies of scale is essential for profitability. Media reports suggest that RML had invested US\$ 2 million by late 2009 and expected to break even within a few more years. In 2009, RML reportedly crossed the US\$ 1 million sales mark. Farmers seem willing to pay for the service—indeed, they are paying for longer periods of service than they were before. Up to 2008, most farmers purchased quarterly installments of the service. Today, the half-year and one-year plans are becoming more popular (Preethi 2009). It also partnered with Nokia as an information supplier for Nokia’s Life Tools application. There are plans to bring the service to Afghanistan and Africa (Reuters Market Light 2009).

### Providing Customized Information Requires Wide Network of People

RML and its competitors suffer from the high expense of collecting market information and maintaining sophisticated technological infrastructure. RML sources information from various content providers and sorts, organizes, and personalizes it for dissemination. A significant portion of this information comes through partnerships with agricultural institutes. These institutes are typically government funded but lack the means to disseminate the information. Students and researchers in these institutes contribute content relevant to RML, which includes it in their package and delivers it to farmers (Preethi 2009).



To process the information, RML employs over 300 office staff in eight states. The teams are organized according to content area and include a news division that scours media sources for agricultural news (pest and disease reports, government programs, weather reports, and local news). The information is finely sorted by geography. Farmers are informed if a particular market in a village is closed or if a pest or disease could affect their specific crops (Preethi 2009).

The importance of customized information is highly evident in RML's operations. As much as technical acumen is important in mobile phone interventions, RML shows that a wide network of people—in this case, price collectors, agricultural institutes, and other information providers—is another essential ingredient.

### INNOVATIVE PRACTICE SUMMARY

#### Nokia Life Tools Uses Simple Technologies to Deliver New Functionality

Nokia is famous for making the low-cost handsets that sit in more pockets than the products of any other manufacturer.<sup>10</sup> More recently, the Finnish mobile phone maker has begun developing mobile applications for its phones, and low-income communities are one of its primary audiences. The most notable of these efforts is Nokia Life Tools, unveiled in mid-2009 for the Indian market and subsequently expanded to other countries (China, Indonesia, and Nigeria) (O'Brien 2010).

Life Tools is aimed at rural, predominantly agricultural communities of the developing world. It is available on a number of Nokia handsets that retail for much less than US\$ 50, and despite the application's rich graphic elements (image 3.4), it uses SMS to communicate, making it affordable and widely accessible. Additionally, because SMS can be delayed, users need not have perpetual network coverage. The application is a prime example of how simple technologies can be tweaked to bring about new functionality.

In India, Nokia has collaborated with multiple partners across the Indian government and private enterprises, including Tata DOCOMO, MSAMB, Syngenta, Pearson, RML, and EnableM

to create a rich ecosystem to deliver the services. Content is divided into:

- **Basic agriculture**, at Rs 30 per month, provides tips on technique and news.
- **Premium agriculture**, at Rs 60 per month, additionally offers market prices and weather updates.
- **Education**, also Rs 30 rupee per month, provides simple English courses and exam preparation services. For an additional Rs 30, the General Knowledge option provides daily world news.
- **Entertainment** at Rs 30 per months provides regional news, astrological predictions, cricket news, and ring-tone downloads.

The agriculture service, available across 18 states, offers two plans. The basic plan, at 30 rupees (Rs) per month, provides daily weather updates and agricultural news, advice, and tips. The premium plan, at Rs 60 per month, provides the closest market prices for three crops chosen by the subscriber, as well as weather information, news, advice, and tips. Nokia Life Tools supports 11 Indian languages: Hindi, Malayalam, Kannada, Tamil, Telugu, Punjabi, Marathi, Bengali, Gujarati, Oriya, and English.

Because most subscribers are prepaid users who do not have a contract, the charges are subtracted weekly. To facilitate this payment, Nokia has partnered with the MNO IDEA Cellular.

Nokia believes that hyperlocalization is key to the success of this service. The Indian application was launched with nine local languages, and future expansions will

**IMAGE 3.4:** The Agriculture Package in Nokia Life Tools



Source: Nokia.

<sup>10</sup> The material for this case study was drawn primarily from Koh (2009).

reformulate Life Tools for the unique conditions of new countries and regions.

The key lesson is that Nokia's mobile application recognizes the multiplicity of human interests: Packaging agricultural information with entertainment can drive adoption (a lesson learned by Mxlt as well). Nokia also has shown that partnerships are a viable alternative to going it alone.

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## Module 4: **EXTENDING THE BENEFITS: GENDER-EQUITABLE, ICT-ENABLED AGRICULTURAL DEVELOPMENT**

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### IN THIS MODULE

**Overview.** Although information communication technology (ICT) provides powerful tools for spreading valuable agricultural information and thus boosting productivity and incomes, it is important for projects that use ICT to carefully consider gender equity during planning and implementation. This module discusses how socioeconomic and cultural factors can affect access to and use of ICTs and offers strategies for the equitable introduction of ICTs.

**Topic Note 4.1: Entry Points for ICT and Gender in Agriculture.** After highlighting key gender differences and inequalities, this topic note discusses ways in which ICTs can help even the playing field in the agricultural sector. ICTs can benefit women directly, through greater access to information and services, or indirectly, by improving the efficiency and transparency of systems already in place, such as government regulatory bodies or supply chains.

- **Community Knowledge Worker Initiative in Uganda**

### OVERVIEW

The resurgence of agriculture on the development agenda has come with the recognition of the need to engage the full range of actors to reduce food insecurity and poverty, from men and women smallholder farmers to multinational food corporations. There is now broad consensus that bolstering the participation and position of smallholder farmers in agriculture is key to economic growth in developing countries. Smallholder farmers are not an undifferentiated group, and the process of their integration must account for the differences in their assets, knowledge, and capabilities if the most gains are to be made. Specifically, investments in smallholder farmers and other stakeholders must account for gender inequalities and the differences between men and women that constrain growth and reduce opportunities for improving the livelihoods and well-being of rural and urban poor populations.

While both men and women contribute to the sector, they do so in different ways as a result of differences in their access to productive resources, their beliefs and perceptions about appropriate work for them, and other factors that limit their full participation. This observation is widely acknowledged and supported by empirical evidence that underscores why addressing gender issues is important for inclusive agricultural development. Empirical evidence includes:

- Asset inequality has been shown to have negative impacts on growth in the agriculture sector (Birdsall, Ross, and Sabot 1995; Deininger and Squire 1998; Sabates-Wheeler 2004.). This includes differences in men's and women's access to land, labor, inputs, and human and financial capital. These inequalities reduce the potential total gains in yields and output by an estimated 20–30 percent and 2.5–4 percent, respectively (FAO 2011).
- Women are important actors at multiple levels of the agricultural value chain as unpaid family workers, wage workers, traders, and entrepreneurs. According to recent estimates, women comprise 43 percent of the agricultural labor force worldwide. This percentage however, masks regional variations and differences across and within countries. For example, in Sub-Saharan Africa and East Asia they make up 60 percent of the agricultural labor force (FAO 2011). Given this high rate of participation, it is clear that harnessing women's full potential would have a significant impact on agricultural growth.
- Abundant evidence shows that increasing women's access to income has beneficial human capital development effects through investments in the health and education of children (Quisumbing 2003; Ranis, Stewart, and Ramires 2000; Smith et al. 2003).

Reducing the barriers that limit women’s access to income and supporting gender equality are therefore important for improving well-being and reducing the nonmonetary dimensions of poverty.

In recent decades, ICT tools have been heralded for their ability to reduce transaction and information costs. Development programs are attracted to the potential ICTs embody for bringing technology solutions to poverty reduction. The objective of this module is to explore the interplay between gender issues and ICT applications in agricultural development. It considers the full range of ICT applications—from well-established technologies, such as radio and television, to more recent innovations in mobile technologies and applications. Given the explicit focus of this module on gender categories, it begins with a short overview of gender issues in agriculture, which is followed by a discussion of how gender inequalities affect the applicability and use of ICTs. The Topic Note explores how ICTs can address some of the key challenges men and women face in agriculture and provides practitioners guidelines and recommendations. The module concludes with an Innovative Practice Summary that describes how the Community Knowledge Worker program in Uganda is attempting to reach both men and women farmers.

### Gender Dimensions of ICTs

The advent of new ICTs and applications creates new opportunities for men and women in agriculture. Nonetheless, challenges remain. ICTs do not inherently reduce inequalities. The “digital divide” exists because men and women within and across developed and developing countries have different opportunities to use and access ICTs. Access and use of ICTs is determined by the availability of the physical infrastructure on which ICTs depend as well as socioeconomic factors such as knowledge and skills, which are often mediated by gender, class, and race. Generally, rural women in developing countries are among those who have the least access to ICTs, a result of constraints (see box 4.1) that affect them with greater intensity than other groups are affected.

The potential for ICTs to be effective in facilitating women’s entry into and

### BOX 4.1: Key Constraints Restricting Women’s Access to ICTs

- Lack of financial resources to secure the use of ICTs
- Higher levels of technological and language illiteracy among women and girls
- Norms that discourage women and girls from using technology
- Lack of control over and ownership of technology

Source: E-Agriculture and GenARDIS 2011.

performance in agricultural development depends on whether they are designed to accommodate men’s and women’s different capabilities and opportunities. Differences in education and literacy between and among men and women will limit the effectiveness of certain ICTs. Although the global literacy rate for adult and young women has increased over the last decade and stands at 79 percent and 87 percent respectively, significant disparities persist at the regional level (image 4.1). In Sub-Saharan Africa and South-Central Asia, the gender gap in adult literacy ranges from 7 to 24 percentage points. Roughly 70 percent of young women and 79 percent of young men are literate in Africa (United Nations 2010, 45–47). With the proliferation of audio- and video-based technologies, there are more alternatives to literacy-dependent content and technology. The Sustainable Tree Crops Program in Ghana delivers training to cocoa

**IMAGE 4.1:** Levels of Literacy Affects Women’s Participation in Agriculture Learning



Source: Ray Litlin, World Bank.

farmers using the Farmer Field School methodology and Video Viewing Clubs. Illiterate and semiliterate women farmers are the primary target for the video clubs. The clubs host facilitated discussions that are complemented by a 10–15 minute video on a range of integrated crop and pest management topics. Thirty-two out of 56 video clubs were women-only clubs, and the remaining were mixed-sex groups (World Cocoa Foundation 2011; Chan 2010, appendix).

Greater integration of ICTs into information dissemination systems has the potential to reduce information costs significantly for both public and private entities. Since men and women are responsible for managing different crops and livestock and undertake different agricultural tasks, the potential for ICTs to address gender issues in value chains can only be achieved if the content is tailored to provide information and services that are relevant to women and men. As an example of why this is critical, extension services have failed to account for women's information needs, focusing heavily on tasks and products dominated by men (FAO, IFAD, and ILO 2010). A better appreciation of the types of information needed is required. In addition, content for applications should be developed in local languages and use a variety of media, including text, audio, and video.

ICT use in value chains must account for norms that limit women's access to, use of, and control over ICTs. Women may not have the same control as men over the radio dial, mobile phones, or the television, which can impede their ability to use these technologies for their own purposes. In Uganda, rural women form listening groups to gather for special radio programs produced by and for women (WB, FAO, and IFAD 2009). Resources to use ICTs can also be a constraint for some women. Recent research on mobile phone use, however, suggests that rural women will divert income away from other uses to pay for phones (GSMA 2010). This indicates that women value the benefits of mobile phones and suggests that using phones as a platform for delivering other extension and services could yield greater results.

ICTs cannot solve all the gender-related disadvantages women and men face in value chain development or in other agricultural activities, but they can alleviate challenges that are intensified by the constraints on women's time and mobility. Women may not be able to frequent public Internet cafés, but mobile phones can provide an alternative means of gathering and exchanging information on market prices. Short message service (SMS) technology allows this information to be sent directly to women with mobile phones without requiring them to travel or interrupt activities.

## KEY CHALLENGES AND ENABLERS

Despite the clear advantages that exist for using ICT to increase and extend agricultural innovation and improve coordination among different stakeholders, two specific challenges reduce the potential for ICT applications to contribute to gender-equitable agriculture development. First, smallholder farmers are often considered an undifferentiated group of beneficiaries, with the same needs and the same opportunities. Second, ICTs are assumed to be gender neutral, that men and women have the same ability to access, use, and control ICTs. Combined, these challenges present a different landscape of the potential opportunities and constraints to using ICTs to enhance agricultural gains; one in which gender plays a central role in determining how men and women participate in agricultural activities, access ICTs, and derive benefits from agricultural growth. Therefore, practitioners must carefully consider how to optimize the benefits of ICT in specific contexts where men and women may have different opportunities and capabilities. The following strategies and enablers focus on overcoming the challenges associated with using ICT in agriculture, with a specific focus on the gender implications involved.

**Conduct a gender analysis to identify opportunities on how ICTs can enhance current practices.** The analysis should describe where and how men and women participate in the specific value chain or agricultural activity. It should capture what information and services men and women farmers need and how they are currently meeting those needs. It should also assess what ICTs are already in use and the type of access men and women have to them (direct or mediated). Sex-disaggregated data on education and income, as well as attitudes toward technology use should also be collected to help identify the most appropriate ICT application.

**Develop appropriate content to meet the needs of women and men farmers.** Women farmers' needs and activities are often overlooked in the design of extension service and delivery. Their on-farm activities can differ from men's by crop and livestock. Women and men take part in different production, processing, and marketing activities even when they are working in the same value chain. As a result, women and men farmers do not always share the same information needs. For ICT applications to improve the productivity of women and men farmers, it is necessary to ensure that appropriate content is developed for them.

**Consider using a range of ICTs.** While the inclination may be to find ways of integrating the most cutting-edge

technology into value chains, practitioners should recognize the infrastructure constraints as well as gender-based constraints that can limit the effectiveness of these technologies. Programs need to identify what ICTs are most appropriate for overcoming specific constraints and must avoid the temptation to design programs around ICTs. Using the radio arguably remains one of the most effective means of reaching farmers in the field because the infrastructure already exists. Reports indicate that combined ICT programming—using radio and mobile phone, might provide new opportunities for women (see IPS “Farm Radio International Involves Men and Women Farmers” in Module 6). Although there can be disputes over control of the radio, programming can be designed to interest both men and women farmers.

***Use ICTs to complement existing information channels.***

Men and women farmers are already exchanging information. Often through word-of-mouth, farmers share farming practices, experiences with different inputs, preparation of different crops for consumption, and so on. Women especially rely on these channels because their time and mobility constraints often limit their exposure to new information providers. ICTs can support and enhance these information channels by providing access to expertise and more up-to-date information. In Uganda, the Women of Uganda Network (<http://www.wougnet.org>) relies on the strength of locally developed information channels to increase the audience for its services. Women’s groups are given a mobile phone and a radio cassette player that are used to listen to local agricultural radio shows, call extension officers, or share information between groups. Information is disseminated in the local language and the groups are encouraged to spread the word to other women farmers through word-of-mouth. The program has been successful in part because it worked within channels that were familiar to women; in this case, the radio and extension officers (GSMA 2010).

***Develop direct relationships with men and women farmers.***

The most recent ICT innovations will fail to bring women into agricultural programs if leaders and practitioners are not intentional about engaging women directly. Buyers, extension agents, input suppliers, and other service providers must reward the appropriate individuals for their participation in the value chain. Because ICTs reduce overall transaction cost for firms, this can allow firms to invest more in developing relationships directly with their suppliers. Firms can contract men and women separately and, more importantly,

ensure that payment is distributed to reward the man or woman responsible for the labor.

***Identify employment opportunities for women with agricultural-related ICT service providers.***

The potential for women to find employment with agricultural-related ICT service providers should not be overlooked. Much of the literature reviewed for this module outlined the benefits of ICT applications for farmers, buyers, or the value chain as a whole. Little research exists that examines the potential for creating new ICT-related employment opportunities for men or women in agriculture. However, the research suggests at least two areas of opportunity for women. First, women can be employed as call center consultants and operators, for example, with M-Kilimo, delivering agricultural information to farmers. This may be a particularly attractive option for women agricultural extension officers who find it challenging to travel to remote districts to meet with farmers. Second, rural women should be recruited and trained at the village-level to act as information intermediaries for other farmers (see IPS “Community Knowledge Worker Initiative in Uganda”).

***Design two-way ICT programs to collect and disseminate information.***

The transmission of information through ICTs must consider not only “pushing out,” but also “pulling in” information. In gathering data on farmers, it is critical to ensure that the data being collected are sex-disaggregated. This includes sex-disaggregated data to fill long-standing gaps in information on land holdings, productivity, and labor force participation. Although increasing the volume of agricultural data is important, a real innovation would be to make sure that the data are collected separately for men and women so that the data could be used to improve our understanding of the gender-based constraints and opportunities in agriculture. Establishing mechanisms for men and women to become cocreators of knowledge products will enhance understanding of innovation occurring at the local level or for capturing men’s and women’s climate adaptation and mitigation strategies.

***Develop gender-equitable national or regional ICT policy.***

The gender dimensions of rural infrastructure and the enabling environment are also important to consider; ICTs can only impact women’s lives if infrastructure reaches them and appropriate policies and programs are in place to address poverty and gender issues in accessing and using ICTs. Box 4.2 provides an example of policy recommendations for equitable rural infrastructure development.

**BOX 4.2: Policy Recommendations for Gender-Aware Universal Access and Rural Development**

- 1. Improve and expand rural infrastructure by focusing on public shared access facilities,** with special focus on wireless technologies and electrical power sources. Policy efforts should make sure infrastructure extends into rural and remote areas.
- 2. Invest in and promote shared access for rural communities.** Community-based approaches can overcome barriers to individual ownership and provide the setting for additional training programs.
- 3. Promote and support the development of local content in local languages.** Local language content will improve the accessibility and inclusiveness of ICT applications. It can also serve as an opportunity to capture and record local practices and knowledge.
- 4. Support adult literacy programs in rural areas.** Although many ICTs make use of audio and video to overcome illiteracy, ongoing support for adult literacy remains an important issue to address.
- 5. Promote and facilitate the establishment of public-private partnerships in the implementation of rural projects.** As the overview module revealed, both public and private actors are integrating a range of ICTs in agricultural value chains (see Module 1). Collaboration between them can reduce costs and help extend the benefits to a greater number of individuals.

Source: Adapted from Association for Progressive Communications 2010.

## Topic Note 4.1: ENTRY POINTS FOR ICT AND GENDER IN AGRICULTURE

### TRENDS AND ISSUES

For actors within the agriculture sector to equitably implement ICT solutions, it is critical that they understand the basic issues surrounding gender-related inequity within the sector. This topic note reviews key gender issues (for a thorough treatment of these issues, see the *Gender in Agriculture Sourcebook*, <http://worldbank.org/genderinag>) and discusses ways in which ICTs can be used to address these issues.

#### Gender Differences and Inequalities in Agriculture

As the following sections illustrate, gender disparities in the agriculture sector are prevalent and often quantifiable. These disparities tend to arise from a combination of socioeconomic and cultural factors.

#### Gender Inequalities in Access to Productive Resources

Relative to men, women generally have less access to land, labor, information, education and training, and inputs. Intra-household dynamics and social and legal institutions affect access to and accumulation of these resources by men and women. Access to land and secure property rights are critical to increasing agricultural productivity. Women's ownership of land lags behind men's around the world, and when they do hold

land it is often of smaller size and lesser quality. Furthermore, access to land facilitates access to other inputs, producer associations, and contract farming opportunities. For example, women's formal participation in contract farming is mixed and is constrained by lack of access to land and financial resources (Schneider and Gugerty 2010). As a result, it varies from one location to another. Research by Masakure and Henson (2005, cited in Schneider and Gugerty 2010) found that in Zimbabwe, 61 percent of contract farmers in vegetables were women. According to Dolan (2001), women made up only 10 percent of farmers in the fresh fruit and vegetable sectors in Kenya.

Even when women have access or user rights to land, their access to labor, inputs, information, and training is less than men's. Women have fewer resources to hire labor compared to men, who have greater financial resources and are able to mobilize the labor of their spouses and other family members. Women are often left out of agricultural extension and training programs because men are the socially recognized farmers even when they are not the principal manager of a farm. Globally, only an estimated 5 percent of agricultural extension resources are directed toward women (FAO 2011). A 2008 study found that women in Vietnam made up 25 percent of an animal husbandry training program and just



10 percent of crop cultivation training (Kabeer 2008, cited in FAO, IFAD, and ILO 2010). In Senegal, a 1998/1999 census revealed that men plot managers received extension services three times more than women plot managers (*ibid.*).

### ***Women's Mobility and Time Constraints***

Social norms that place the responsibility for productive and reproductive activities on women create time and mobility constraints that limit their ability to participate in other activities. The disproportionate distribution of reproductive tasks in particular mean that women have less time to invest in training and capacity building opportunities (image 4.2). Women in India spend 354 minutes a day, compared to 36 minutes by men on household activities including cooking and caring for children (Budlender 2009). In Tanzania, women spend 270 minutes and men 54 minutes on daily tasks (*ibid.*). In comparison to their urban counterparts, rural women spend even more time in activities such as collecting water and fetching firewood because they have less access to basic services. These activities translate into less time to invest in networking, communicating with buyers, and developing market skills to further their productive activities. This also limits time available to learn about and become familiar with ICTs.

### ***Women's Lack of Access to Income***

Women's participation in agricultural supply chains is not always commensurate with the benefits they derive from their labor. Gender norms often set expectations about who controls income and the decision making over how it will

be spent. While women often have control over the small amounts of income they generate through local sale of food and other microenterprises, larger sums of money are often controlled or can be appropriated by men. On smallholder farms, married women and daughters work as unpaid family laborers with the expectation that income derived from the sale of crops will return to the household. For example, a 1993 study of the Kenyan tea sector found that marital conflicts increased when women did not have the access they had expected to the income they earned for the household (Von Bulow and Sorensen 1993 cited in Schneider and Gugerty 2010). Also in Kenya, women supplied 72 percent of the labor inputs in French beans but received only 38 percent of the income (Dolan 2001). This means they have few incentives to participate in agricultural activities. Not receiving their fair share of income impedes their ability to invest in upgrading strategies that would improve their performance in value chains and also reduces their ability to access risk management instruments, through the purchase of insurance or accumulation of assets. Furthermore, unequal bargaining power and control over resources in the household limits the positive impact of integrating smallholder women farmers into value chains.

### **How ICT Can Improve Women's Access to Agriculture Services and Agribusiness**

If approached properly, ICT can improve women's ability to act effectively and productively in agriculture. New applications and cheaper devices have created opportunities for women to engage in agriculture in ways previously unavailable to them. The following section highlights these opportunities.

**IMAGE 4.2:** Women Often Integrate Domestic Roles with Others



Source: John Issac, World Bank.

### ***Facilitating Women's Access to Agricultural Information, Market Prices, and Services***

Whether it is a radio program, a video, a text message, or a phone call, one of the most important contributions of ICTs to agricultural development is the ability to disseminate critical information to farmers through a diversity of channels. Real-time and cost-effective information on weather, market prices, diseases and pests, and services allows farmers, especially women farmers who may not otherwise have access to this type of information, to make more informed decisions about land preparation, planting, harvesting, and marketing. ICTs can help increase women's access to information and

services which can in turn close gender gaps in yields and productivity.

Kenya's largest call center and business processing operator, KenCall, developed the Kenya Farmer Helpline known as "M-Kilimo" (<http://www.m-kilimo.com/>), with support from the Rockefeller Foundation, to improve the transfer of knowledge to farmers. The service provides an interactive alternative to agricultural information services delivery via mobile phones. Instead of receiving messages via SMS, farmers can talk to a real person to get agricultural expertise and information to help them make informed decisions on land preparation, planting, pest management, and marketing. Farmers receive information in English, Swahili, or other local languages. In its first 18 months of operation, the program reached 25,000 farmers. An estimated 43 percent of callers are women farmers (GSMA 2010).

Collaboration between Bharti Airtel and Indian Farmer's Fertiliser Co-operative (IFFCO) led to the development of a similar program in India. The IFFCO Kisan Sanchar Ltd. Agri Helpline aims to provide information, inputs, and services in real time through affordable mobile communication. Farmers can purchase a "Green SIM" card that allows them to receive five free voicemail messages daily on a range of agricultural topics. In addition, the service provides a helpline farmers can call to ask questions. Although women reportedly make up a number of the listeners of the daily messages, they are only 13 percent of direct users (Pshenichnaya 2011). The majority of SIM card holders are men. (See also IPS "Long Experience in Farm Communities Benefits IFFCO Kisan Sanchar Limited" in Module 2.)

Also in India, the Self Employed Women's Association (<http://www.sewaict.org>) provides current and future commodity prices, which allow members to make more informed decisions about when and where to sell their produce. Women with mobile phones can receive SMS messages directly, while women without mobile phones can visit a computer-based village notice board that also posts the prices. To overcome illiteracy constraints, the association is piloting an interactive voice response system that would provide the same information using speech recognition software. Initial results from the pilot indicate that over 20,000 women are using the system (GSMA 2010).

Knowing & Growing, a collaboration between Networked Intelligence for Development and the Jamaica Organic Agriculture Movement, offers training for women producers in the English-speaking Caribbean on how to grow organic vegetables and use ICTs to manage their farms (Tandon

2010). Organic farming requires the intensive management of information about agricultural production to meet certification standards and is therefore well suited for ICT use. The project helps women use ICTs for business management and marketing. It teaches participants how to create an e-mail address, how to access information on markets and prices for their products, how to enter financial and agricultural data about their vegetable production, and how to market their products.

#### ***Improving Coordination Between Women Farmers and Other Actors in the Value Chain***

As the previous examples have made clear, ICTs can facilitate greater communication between farmers and other service providers, like extension agents. They reduce the time and coordination challenges between different actors, allowing farmers to receive better information on product specifications and volumes, coordinate transport, and deliver goods at times when they can secure the best prices. ICTs can also improve the functioning of producer groups, recording financial accounts, registration, and management processes—but women will only benefit from these efficiency gains if they can access the associations and are also trained to use ICTs (see Module 8 on farmers organizations). For women, ICTs that reduce the need to travel to speak with an input supplier, buyer, or transporter helps overcome their time and mobility constraints.

#### ***Enhancing Transparency in Governance, Business Registration, and Land Administration***

A number of different modules in this Sourcebook describe the advantages of integrating ICTs into governance and administrative procedures in the agriculture sector. (See, for example, Module 13 and Module 14.) Improving the timeliness, accuracy, and transparency of these processes are among the key advantages of ICTs. These same benefits can be applied to support gender-equitable objectives. More accurate and transparent record keeping can identify the gender gaps in land administration and provide information to advocacy groups supporting women's land rights. For women traders and entrepreneurs, increasing the efficiency of business registration and customs facilitation can ease time burdens and may also reduce opportunities for corruption.

#### ***Contributing to the Collection of Sex-Disaggregated Agricultural Data***

The lack of sex-disaggregated agricultural data is a frequently cited constraint to understanding women's contributions to and benefits from the agriculture sector. Agricultural census data in many countries are not sex-disaggregated, and donor-funded agricultural development programs have been slow

to recognize the importance of assessing gender-differentiated results. ICT applications alone will not motivate change in the behavior of these institutions, but they can ease the burden of gathering and recording sex-disaggregated data on farmers, suppliers, buyers, and other stakeholders. Whether obtained through the use of AgriManagr software or by registering farmers when they call into M-Kilimo, these data provide more information about the needs, capabilities, productivity, and earnings of farmers, both men and women.

Improving sex-disaggregated data offers additional benefits to farmers. As described in Module 10 on ICT applications for building inclusive supply chains, AgriManagr's records include a history of previous transactions and earnings, which serves as a proxy of the farmer's creditworthiness. This information acts as a type of credit history and collateral that can facilitate access to loans and credit. Establishing a recorded history of women's farming experience and creditworthiness may go a long way in increasing their access to credit and other financial services, especially since they often lack other forms of collateral, such as land.

### *Improving Women's Control Over Income and Access to Financial Services*

Women's lack of access to income is a significant constraint on their participation and productivity in agriculture. Without access to and control over income, women are unable to accumulate lump sums to pay for inputs and services or invest in upgrading activities. Moreover, when women contribute to agricultural activities without seeing the income invested in the household, they lack the incentives to improve their position in agricultural value chains (image 4.3).

#### **IMAGE 4.3:** Women Can Play a Significant Role in Acquiring Family Income



Source: Curt Carnemark, World Bank.

Some of the most impressive innovations are occurring in the mobile money and mobile banking fields. These applications are helping rural and underserved populations obtain financial services that allow them to weather emergencies and risks associated with jobs and harvest loss (Plyler, Haas, and Nagarajan 2010). The most well-known of these services is M-PESA (see IPS "M-PESA Pioneering Money Transfer Service" in Module 2), a mobile phone-based service for sending and storing money offered by Safaricom in Kenya. Other mobile phone service providers, like Zain and MTN, have replicated these services on their networks.

The importance of these technologies for women is quickly becoming clear. The number of women m-Pesa subscribers in Kenya rose from 38 percent of users in 2008 to 44 percent in 2009 (Jack 2010). Women are found among the rural receivers of transfers of regular sums of cash that act as a source of income or lump sums to pay for school fees or inputs (Morawczynski and Pickens 2009). One of the advantages of m-Pesa and other similar services is that they allow women to receive transfers of cash without a bank account, or needing to travel to the bank or the post office. Among the most valued effects of m-Pesa, women report the ability to accumulate cash and keep it secure, presumably from other family members, neighbors, or others.

Opportunity International is adding another layer to improving women's secure access to income. Using smartcards and biometric fingerprint technology, clients in developing countries, globally of whom 84 percent are women, are able to open a bank account without formal identification (Opportunity International 2011). Clients receive a smartcard that is associated with their fingerprint which allows only them to access the banking services. This technology is complemented by an expansion of kiosks, ATMs, vans, and handheld point-of-sale devices that increase the mobility and availability of banking services in rural areas.

### **INNOVATIVE PRACTICE SUMMARY** **Community Knowledge Worker Initiative in Uganda**

It is easy to understate the impact mobile technology has had on our world. Mobile phones and the growth of technology applications associated with them have changed the way we communicate with others, stay informed,

and network with colleagues, friends, and peers. More importantly, their impact has not been limited to users in developed countries. Mobile phones are in the hands of the young and old, men and women, urban activists, and rural farmers in developing and developed countries. The expectation is that the number of subscribers, especially women subscribers, is set to increase. Emerging research is exploring the links between mobile phones and economic growth, and finding some interesting connections (box 4.3) (see also Module 3 for more details on the impacts of mobile phones).

#### **BOX 4.3: Mobile Phones and Economic Growth**

- A 2007 report by Deloitte found a 10% increase in mobile phone penetration is linked to a 1.2% increase in GDP in low- and middle-income countries.
- In India, 3.6 million jobs were created, directly and indirectly, in the mobile phone industry. The industry is expected to continue to add a million jobs annually.
- Mobile phones contributed to a 62% and 59% increase in profits in South Africa and Egypt, respectively.

*Source: GSMA 2010.*

According to research conducted by GSMA (2010), there are 1.25 billion people in low- and middle-income countries that live in areas with mobile network coverage but who do not own mobile phones. Women were found to be less likely to own a mobile phone than a man, with the incidence being higher in Africa (23 percent), the Middle East (24 percent), and South Asia (37 percent). The study found that among women in low- and middle-income countries, 26 percent could benefit from mobile communications but do not, compared to 17 percent of men. This means that an additional 750 million women and 500 million men potential mobile phone subscribers exist. While the market potential for expanding mobile phones in developing countries is there, it is important to understand from a development perspective how closing the mobile phone gap translates into better outcomes for men and women in terms of income generation, poverty reduction, and improved well-being. One such avenue is by using mobile phones to reduce gender gaps in performance in agricultural value chains.

This Innovative Practice Summary focuses on the Community Knowledge Worker initiative (<http://www.grameenfoundation.applab.org/ckw/section/index>) implemented by Grameen Foundation in Uganda. A pilot phase for the project occurred between December 2008 and August 2009, and much of the information in this summary draws on lessons learned from that period.<sup>1</sup> The project was implemented with support from the Bill and Melinda Gates Foundation (BMGF) and in collaboration with MTN-Uganda, the International Institute of Tropical Agriculture (IITA), and Uganda's National Agricultural Research Organization (NARO). A number of other organizations supported technology development, farmer organization, and other components of the project. After the pilot phase, the project received a four-year follow-on grant from BMGF to scale operations to the rest of the country.

#### **Program Objective and Description**

The Community Knowledge Worker initiative aims to build a cross-country network of village-level information intermediaries that deliver agricultural information to smallholder farmers through mobile technology. The program targets smallholder men and women farmers who live on less than US\$ 2 a day. It develops mobile services and applications that Community Knowledge Workers (CKWs) use to provide smallholder farmers with actionable and real-time agricultural information. Farmers can receive agricultural tips and advice, weather forecasts, market prices, an input supplier directory, and detailed farming information on crops and livestock.

The program identifies, recruits, and trains community members to act as trusted information intermediaries for farmers. In the pilot phase, 38 CKWs were recruited and trained. CKWs provided on average 15 services to farmers per week and responded to more than 8,000 queries on organic agricultural techniques for bananas and coffee, market prices, location and contact information for input dealers, and banana disease control. Multiple mobile applications were deployed for accessing and disseminating information to farmers (see IPS "Community Knowledge Workers in Uganda Link Farmers and Experts to Cope with Risk" in Module 11 for complete list).

<sup>1</sup> This section was developed using Grameen Foundation 2011a and Grameen Foundation 2011b.

A second line of action was data collection. CKWs were trained on survey techniques to collect information for the Uganda Commodity Exchange, the World Food Program, IITA, and NARO. Over 6,000 surveys were conducted on topics ranging from smallholder bulking and marketing behavior to banana disease incidence. Demographic and baseline data on farmer households was also collected and weekly customer satisfaction surveys were conducted.

### Gender Approach

The program committed to ensuring that both men and women are represented among the CKWs and farmer beneficiaries. A desire for greater participation by women pushed the designers to aim for one-third of CKW nominees to be women. The criteria for selecting CKWs included experience in community outreach, being a trusted resident of the area, literacy, and fluency in English. The initial recruitment process did not consider differences in men's and women's ability to meet these criteria, although it was acknowledged later that relative to men, women have lower education levels and are less likely to be fluent in English. The project is therefore exploring ways of delivering agricultural information through voice commands and call centers to allow women and men with lower literacy levels to become CKWs. To facilitate women's entry into the network, the project also provided childcare at training sessions to alleviate certain time constraints and household responsibilities.

The follow-on project developed a more thorough gender and social equity plan. This includes conducting a gender and social assessment; a capacity-building plan for staff, CKWs, and farmer beneficiaries; a policy and advocacy plan; and a monitoring framework. The plan aims to equip the Grameen Foundation with the tools necessary to implement a gender equitable project, identify like-minded partners to further these goals, and monitor the progress of its actions on meeting specific gender-related goals and objectives.

### Benefits and Impact

Although the pilot project operated for a short period of time, there are indications that with greater attention to gender issues, the follow-on project could bring significant benefits to both men and women. To achieve this, the project would need to address the barriers women face in

becoming CKWs and tailor the information for women farmers' needs.

Women were found to face higher entry barriers to becoming CKWs than men. First, although relying on partners to identify and recruit potential CKWs was found to be fairly successful, the process was not without its complications. The more decentralized the process, the more political it became, especially with local extension offices. These partners found it more challenging to identify potential women CKWs. Women were also less exposed to the nominating organizations, which suggested the project should think about engaging more women's organizations or other partners that have a greater link to women in the community.

Relative to men, women have lower education and are less likely to be fluent in English, which meant that finding women who met the minimum criteria posed a challenge. Moreover, women's higher labor demands, both in the field and in the household, meant they had less time to dedicate to trainings and to meet with farmers. Although CKWs put in an average of 10 hours of work per week, the pilot found that women CKWs incurred greater costs both in terms of time and money. Women CKWs had to juggle their CKW duties with their household and farm responsibilities, adding extra time to their day, especially when they had to travel to conduct surveys. They also incurred financial costs because they hired labor to manage the household or farm activities in their absence. Some women also hired men to ride the bike they were given to conduct outreach and survey activities while they rode on the back. Finally, some women were found to have less control over the mobile devices than their male counterparts. They had to share the airtime they received from the project with their husbands, who were not CKWs.

Nonetheless, preliminary research reveals that recruiting women CKWs will be important for the program to meet its goal of reaching women farmers. The program is finding that women farmers are more likely to seek advice if the CKW is a woman. Sixty-three percent of women farmers are receiving their information from a woman CKW. Furthermore, women farmers were more likely to return to a woman CKW than a man CKW (Hahn 2010). Finally, despite the greater constraints facing women CKWs, there was no notable difference in the performance of men and women CKWs.

### Lessons Learned and Wider Applicability to Value Chains and Agricultural Extension

The CKW project was not designed to alleviate the constraints of a specific value chain, nor was it introduced by an agroprocessing firm. Nonetheless, it could easily have been designed, for example, to procure passion fruit from smallholders for a processing company. The CKW project's focus on improving access to information relieves a common bottleneck in agricultural value chains—and a pervasive constraint for women farmers. Lessons learned from this experience have wider applicability to using ICTs to address gender issues in a range of agricultural value chains:

**The social and gender contexts matter.** Ensuring that ICTs support inclusive agricultural value chains is as much about identifying appropriate technology uses as it is about understanding the context in which they are going to be applied. As the CKW project discovered, the recruitment process was hampered not only by local power structures but by structural gender inequalities that resulted in fewer women meeting the basic education requirements.

**ICT applications have limits.** Some problems cannot be solved with ICTs (image 4.4). The CKW project identified strategies to overcome the differences in men's and women's literacy by using video and audio, but addressing local power structures must be addressed through other avenues. For this, the CKW project realized it needed to engage women's groups and other organizations that tap into women's networks. A project can increase women's information about fertilizers, for example, but may have to find other solutions to ensure they actually receive them. Recognizing that not all gender inequalities have an ICT solution is important. This is ultimately why gender-based constraints in the value chain need to be identified prior to assessing where and how ICTs can address specific constraints.

**Opportunities for mediated or direct access to ICTs must be identified.** It is not necessary to put mobile

**IMAGE 4.4:** ICT Often Requires Additional Inputs to Be Effective



Source: Ray Witin, World Bank.

phones into the hands of every man and woman farmer for them to benefit from the services the mobiles provide. The CKW project demonstrates how designing a program built on mediated access to ICTs can be effective when it is embedded in the social context. Identifying appropriate leaders to become CKWs can be tricky, but when it is done well, it can overcome several different gender issues. Mediated access to ICTs using community leaders can overcome the financial constraints that limit women's ability to purchase their own mobile phones and create issues around control of technology when women have to share devices with spouses.

**It is important to engage women beyond the farm.** While it is important to ensure that women farmers receive agricultural information that can help close agricultural productivity gaps, it is equally important to identify ways of supporting their participation in other ways. Like many of us who learn on the job, women can use the farm skills they acquire to move into related activities, such as information service providers or software developers. This project set a goal to recruit women CKWs and found that this helped attract more women to request services from the CKWs. Expanding the opportunities for women to participate in the project not only as end-receivers of information but also as service providers led to better outcomes all around.

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## SECTION 2

### Enhancing Productivity on the Farm





## Module 5: **INCREASING CROP, LIVESTOCK, AND FISHERY PRODUCTIVITY THROUGH ICT**

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### IN THIS MODULE

**Overview.** How can farmers and governments use ICTs to increase agricultural productivity? At the local level, farmers can use ICTs to match cropping practices to climatic trends, use inputs and resources environmentally and sustainably, and cope with productivity threats. At the national level, public officials can adjust policies to reflect the data collected with ICTs, predict food supplies, and target social programs or promote yield technologies. Integrating ICT into national programs, creating a policy environment conducive for ICT investment, and designing digital systems that are compatible and common can help improve access for users, but social and financial challenges remain. Powerful yet inexpensive tools (and the financial support and training to use them) are not always available for small-scale producers in most developing countries, although some are being developed and piloted. Conducting impact studies and sharing pilot project information can focus and speed development of such ICTs. The productivity goals and technologies used to meet them must match the IT capacity in the focus location.

**Topic Note 5.1: Achieving Good Farming Practices through Improved Soil, Nutrient, and Land Management.** New ICTs help to characterize field conditions, sometimes at a very fine level of detail, and help farmers improve soil and land productivity. Correcting past damages and ensuring future yields will require farmers, governments, and development partners to mitigate the effects of climate change and environmental degradation. Significant, national progress with some of these technologies will require appropriate legal and regulatory frameworks, monitoring systems, and liability, access, and property rights laws and regulations, such as regulations on carbon limits.

- **Seeing-Is-Believing Project Improves Precision Farming**
- **Improving Nitrogen Fertilization in Mexico**
- **Monitoring Livestock to Prevent Pasture Damage**

**Topic Note 5.2: Preventing Yield Losses through Proper Planning and Early Warning Systems.** ICTs have considerable potential to help even small-scale producers prevent losses after investments have been made by identifying and controlling pests and diseases, receiving timely weather information, and improving resource use. At the same time, ICTs allow governments and development partners to better monitor farm productivity, make more accurate projections, and plan better for the future. ICTs should be used to form two-way communication networks that gather and use local knowledge. Advances in ICT are best suited to helping farmers improve their management of one or two farm components at a time. Development partners and governments need to prioritize which yield technologies or agricultural strategies to introduce. Incentives for partnering with the private sector in large-scale ICT projects may enable the investment to reach smallholders. Taking stock of the technical capacity in rural areas will clarify infrastructure needs.

- **Radio Frequency Identification to Prevent and Treat Cattle Disease in Botswana**
- **Digital Orthophoto Quads Form a Database for the Dominican Republic**
- **Using Landsat to Assess Irrigation Systems in Mali**

## OVERVIEW

Agriculture is a vital sector for the sustained growth of developing countries, especially agriculture-based countries such as those in sub-Saharan Africa. Equally important, a significant portion of the world's population—86 percent of rural inhabitants—still depends on agriculture for employment and sustenance (World Bank 2007). Demand for food is increasing, too (box 5.1). The Food and Agricultural Policy Research Institute (FAPRI) estimates that an additional 6 million hectares of maize and 4 million hectares of wheat plus a 12 percent increase in global maize and wheat yields will be needed to meet demand for cereals alone in the next decade (Edgerton 2009). Demand for meat is expanding as incomes rise, creating competition for land and other resources. Increasingly unstable weather and temperatures require adaptive agronomic techniques to meet the demand.

The average maize yield per hectare in wealthy countries like Canada is three times higher than the average maize yield in low-income countries (FAO 2008). Growth in yields of rice, the primary staple for a significant number of developing

countries, has stagnated in developing countries. Several regions, particularly East Asia, have seen rice yields decline by 10 percent owing to climate change. The factors contributing to low productivity are vast, including the coevolution of pests and pathogens, poor infrastructure, soil loss and degradation, waterlogging and salinity, the impact of climate change, lack of storage facilities, and weak markets. Low investments in agricultural research have reduced the scope for innovative thinking and technological development that could address these contributing factors and improve productivity.

Despite the dim outlook on meeting global food demand in a sustainable manner, successful social, economic, and technological developments have resolved productivity and population issues in the past and may hold some hope for the future. For example, over the past 40 years, annual global cereal production has grown from 420 million to 1.176 billion tons (FAO 2000). In the 20th century, yields in the United States rose from 1.6 tons per hectare to 9.5 tons per hectare (Edgerton 2009). Similarly large increases occurred around the world from the mid-1980s to early 2000s, when cereal yields rose by more than 50 percent (World Bank 2007).

### BOX 5.1: The Food Security Challenge

**The lack of food.** Increasing agricultural productivity and access to food are the primary development goals of the 21st century. Demand for food has reached new heights, and predictions of future demand are discouraging. Although growth in global demand for cereals will slow in the coming 40 years, demand in sub-Saharan Africa will balloon by as much as 2.6 percent per year.<sup>a</sup> The food-insecure population in sub-Saharan Africa is also expected to increase by up to 32 percent by 2020, whereas food insecurity is projected to decline in Latin America and Asia.<sup>b</sup> Overall, the world will need 70–100 percent more food by 2050, when the population increases to 9 billion.<sup>c</sup>

**The lack of nutrients.** The lack of food is not the only problem. Almost one billion people were undernourished in 2010, and the lack of nutritious food has serious, long-term consequences for physical and mental health. More than one in seven of the world's people do not receive enough protein and carbohydrates in their daily diets. These people constitute 16 percent of the developing country population.<sup>d</sup>

**The rising prices.** Even with projected reductions in food insecurity, price spikes could keep staple food out of the reach of poor people. The 2008 price spikes led to starvation in many countries, hitting the net food importers—typically the poorest countries—the hardest. Ethiopia, Malawi, Tanzania, and Uganda experienced maize prices that were twice as high as in the previous year. In Kenya and Mozambique, prices rose by 50–85 percent, according to the United States Department of Agriculture. Sharp and unexpected price spikes can provoke riots and political instability, aggravating an already precarious food situation. FAO recently predicted that the total costs of food imports would reach a near-record level in 2010, roughly US\$ 1 trillion.<sup>e</sup>

**The changing climate.** Climate change has made the challenges of food security and rising prices even more stark. Continued release of greenhouse gases increases the likelihood of unpredictable weather and temperatures. The severe 2010 droughts and fires in Russia, Ukraine, and Kazakhstan raised wheat prices substantially, leading to grain embargos in multiple countries. Russia's wheat exports fell by 13 million metric tons in one year.<sup>e</sup> Pakistan's floods are another warning of the serious climate changes facing developing countries. The loss of soil nutrients that can accompany climatic extremes makes agricultural land less productive and adds to food insecurity. This prospect is ominous, considering the consistent drop in cereal yields over the last decade.<sup>f</sup>

Source: Authors; (a) Rosegrant et al. 2006; (b) Shapouri et al. 2010; (c) World Bank 2007; (d) FAO 2009; (e) FAO 2010a; (f) Raloff 2010.

Agricultural productivity rose around the world because more land was cultivated and more land was cultivated more intensively. Most of the gains were made through intensification. Agricultural land expanded by only 11 percent between 1961 and 2007 (FAO 2009), but between 1960 and 2000, genetic improvement and agronomic practices contributed to 78 percent of the increase in production (Lal 2010).

Bringing more land into production is infeasible, not only because of the growing number of competing uses for land but because of the environmental and social costs involved. The drive for agricultural land has often resulted in deforestation, reduced biodiversity, and provoked other forms of environmental degradation (Balmford, Green, and Scharleman 2005). It has also removed livelihood opportunities for some communities and elevated greenhouse gas emissions (Millennium Ecosystem Assessment 2005).

Given these constraints, development partners and governments alike continually seek ways to raise crop yields without using additional land. Raising yield per unit of land was observed during the Green Revolution of the 1960s and 1970s, when the use of new cultivars (shorter, higher-yielding varieties of wheat and rice) and improved practices (such as the use of fertilizer and irrigation) significantly increased crop yields throughout most of Latin America and Asia. A similar Green Revolution never arrived in sub-Saharan Africa but is sorely needed, given that almost all of the arable land is being cultivated (Govere, Nyoro, and Jayne 1999).

Nonetheless, land can be used more intensively as well as more sustainably than in previous years, under innovative farming practices like precision farming, integrated pest management, agroforestry, and aquaculture (Burney, Davis, and Lobella 2010). Sustainable land intensification, in which yields rise but negative environmental impacts are curbed, provides a potential answer to food security and poverty reduction challenges. The sobering consideration, however, is that this type of intensification cannot occur unless 1.5 billion farmers—85 percent of whom farm less than two hectares—obtain and use these and other new technologies (World Bank 2007).

If the goal is to achieve sustainable increases in the global food supply and economic growth, it is important to ask who is responsible for producing food and commodities. Equally crucial, it is important to ask if they have access to technology, the knowledge to use it, and the purchasing power to acquire it (Pretty et al. 2006). The world as a whole, all regions, and all nations depend on farm households to provide food and by 2050 the world will ask farm households to supply double the current amount of food. Today, the farmers that the globe depends on are primarily smallholders with little access to technology, limited knowledge, and few financial resources. Notably, 43 percent are women (FAO 2011). Box 5.2 expands on why gender is a critical consideration in designing and implementing ICT for agriculture productivity.

Given that the future of food depends to such a great extent on small-scale agriculture, governments and development

### **BOX 5.2: Gender in Agricultural Productivity**

Exploring how gender disparities affect agricultural productivity is at the forefront of the development agenda. Women play significant and essential roles in agriculture in most developing countries. Their knowledge of local agrobiodiversity and conservation practices makes them prime assets in the sustainable intensification of agriculture. Women are also responsible for processing most crop and animal products and are often more involved than their male counterparts in high-value production. In addition, females play the chief role in care-taking, making them essential to household nutrition and children's (especially girls') education. It is widely accepted that women invest more regularly, and to a greater extent than men, in the well-being of future generations. These responsibilities add to a burdensome workload that involves time-consuming activities like fetching water and fuel.

Despite women's key contributions to agriculture and rural development, they face major challenges in accessing inputs like land, improved tools, and financial services. Cultural, social, and political barriers prevent women from using their assets effectively in the field. Women are much less likely than men to purchase fertilizer or machinery. Women also have lower incomes compared to men: They receive smaller salaries in formal positions, earn less from their livestock, and are typically involved in seasonal, part-time work, if any.<sup>a</sup> As a result, their productivity is minimized and below that of male smallholders.

This situation represents a major challenge to increasing yields, because the majority of the world's smallholders are female (75 percent in sub-Saharan Africa). Increasing agricultural productivity requires greater attention to gender differences and women in general. FAO asserts that if women had better access to resources, they could increase yields by 20–30 percent.<sup>a</sup> Development institutions should use ICT to address these issues—and of course make certain that women can access ICTs in the first place.

Source: Authors; (a) FAO 2011.

partners are focusing on how to increase productivity in sustainable ways through new technologies that smallholders can use. Irrigation management, biotechnologies, pest management and eradication, soil assessment, improved nutrient and land management, improved market access, and innovative storage facilities are all strategies for increasing smallholders' agricultural productivity and improving their access to markets, but the challenge lies in ensuring that smallholders can obtain and use them. ICT provides an incredible opportunity to reach farmers with the technical information they require to increase yields.

### Linking Technology for Agricultural Productivity with ICTs

This module discusses two sets of technologies and the links between them:

- **Yield technologies**, like improved seed, crops developed through biotechnology, tractors, pesticide, fertilizer, and irrigation systems.
- **Information and communication technologies**, like geographical information systems (GIS), wireless sensor networks, data mediation software, and short message service (SMS).

Though they often work symbiotically at the farm level, and though both are often required to achieve the kinds of development goals discussed in this module, the differences between them need to be understood. Figure 5.1 helps to clarify them.

When farmers have access to biophysical and other yield-enhancing technologies, frequently they do not know how to use them effectively to address their productivity challenges (for example, they may have fertilizer but not know the optimal amount to apply). ICT can fill this gap in knowledge. Global positioning systems (GPSs), radios, mobile phones, digital soil maps, and other ICTs give farmers information to

use biophysical technologies appropriately (for example, nitrogen sensors can help to determine the correct fertilizer dose).

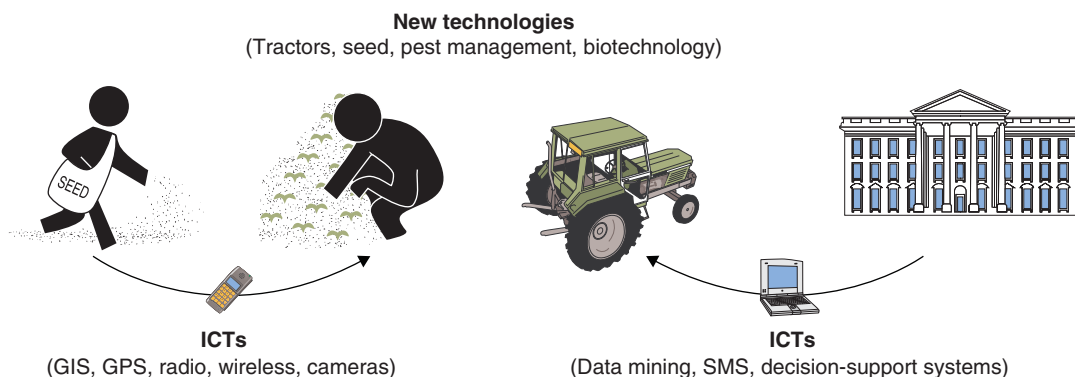
Similarly, governments or development partners may know that farmers are using new yield-enhancing technologies but may not have the capacity to understand their impacts. Data-mining technologies, decision-support systems, and modeling software that can clarify the impacts and outputs of yield-enhancing technologies are among the most promising means of linking productivity and ICTs.

This module describes how farmers and governments can use ICTs in their strategies to increase agricultural productivity. The applications are quite broad: ICT can be used to monitor pest thresholds in integrated pest management, provide relevant and timely information and agricultural services, map agrobiodiversity in multiple-cropping systems, forecast disasters, and predict yields. Crop losses diminish as farmers receive relevant and timely information on pests and climate warnings through SMS technology.

Just as important, information can (and should) go both ways: Farmers can alert local governments or other relevant actors about serious crop developments like disease symptoms. This information makes it possible to avoid disasters more effectively and improves economic management, both of which are crucial for adapting to climate change.

ICT can also lead to more optimal use of inputs. Increasing producers' knowledge of how to use and manage water, equipment, improved seed, fertilizer, and pesticide has improved the intensification of farm practices around the world. In the long run, and after collecting and analyzing multisite, multiyear data, ICT can be used to match cultivars to appropriate environments, increase the understanding of genotype-by-environment interactions, and adapt cropping strategies to the changing climate.

**FIGURE 5.1:** Defining the Relationship Between ICTs and Yield Technologies



Source: Authors.

Each of these applications increases the profitability of agriculture, reduces transaction costs, facilitates climate change adaptation, and improves livelihoods for the rural poor.

Strategies to increase yields (including strategies to avoid yield losses) include initiatives like soil nutrient assessments, weather forecasting, and crop or animal protection. The ICTs used to enhance these strategies are discussed in the topic notes.

Topic Note 5.1, “Achieving Good Farm Practices through Improved Soil, Nutrient, and Land Management,” focuses on soil testing technologies and tools that characterize field conditions, sometimes at a very fine level of detail. These technologies help farmers apply inputs appropriately and encourage the use of sustainable, profitable farming practices.

Topic Note 5.2, “Preventing Yield Losses through Proper Planning and Early Warning Systems,” focuses on how ICTs can be used to identify and control pests and diseases, improve access to timely weather information, and improve the design and management of irrigation systems.

Various examples and innovative practice summaries are included; it should be noted that most of these practice summaries come from pilot programs in Africa, where many studies and projects are currently underway. Discussions of lessons learned (covering cross-cutting themes, challenges, and key enablers) conclude each note. Finally, the broad ICTs discussed in this module fall into three categories. They are briefly defined in the sections that follow.<sup>1</sup>

### Remote Sensing Technologies: Raw Data Collection

The first type of ICT that improves productivity includes tools that collect agricultural data:

- **Geographical information systems (GIS)** collect geographic data through computer hardware and software to capture, store, update, and display all forms of geographically referenced information by matching coordinates and time to other variables. Data sets formed by GIS constitute “layers” of information (for example, on topography, population size, or agricultural household income) that can be merged and analyzed to establish relationships and produce maps or charts that visualize geographical traits (GIS .com n.d.).

- **Global positioning system (GPS)** is a satellite-based positioning and navigation system with three basic components: satellites that orbit the earth, control and monitoring stations on the earth, and the GPS receivers owned by users. GPS receivers pick up signals from the satellites, including precise orbital information (latitude, longitude, and ellipsoidal GPS altitude) of a given object or location, as well as the time. GPSs can function in any weather and are free for public use (GPS.gov n.d.; GARMIN n.d.).
- **Satellite imagery** is an image of Earth taken from satellites in orbit. There are four types of satellite imagery: spatial (size of surface area); spectral (wavelength interval); temporal (amount of time); and radiometric (levels of brightness)—which capture a variety of variables about a given area of varying size. The resolution (in meters) of these images depends on the satellite system used and its distance from Earth; weather can interfere mainly with satellite systems utilizing visible wavelengths of light. The cost of the technology depends on the satellite system used, on whether new or archive imagery is purchased, and on possible georeferencing to a coordinate system.
- **Aerial photography and orthophoto mosaic.** An aerial photo is an image (once a photograph, now a digital image) of the ground taken from an airplane, helicopter, or radio-controlled aircraft at a given altitude. Aerial images are presented as an orthophoto mosaic that is an alternative to a map. These images are higher in resolution (deci-meter) than satellite images, proving useful for those who want more details of the terrain such as crop conditions or land use. In addition, modern digital aerial photography is georeferenced—that is, each point has geographical coordinates, whereas satellite imagery requires georeferencing to be geographically accurate and compatible with other geographical data (for example, in GIS) (T. Jantunen, personal communication).
- **Laser scanning, or light detection and ranging (LiDAR),** is an active airborne sensor using a set of laser beams to measure distance from an aircraft to features on the ground. Airplanes and helicopters can be used for laser scanning. The data from laser scanning are three-dimensional at very high accuracy, and they also allow ground elevation under the tree canopy to be measured. The elevation accuracy of laser scanning data is much better than aerial photography, which makes laser scanning useful for accurate

<sup>1</sup> This is not a comprehensive list of all of technologies discussed in the module; nor is it a comprehensive list of all ICTs used to increase agricultural productivity. The technologies reviewed here are the best known and most applicable to all yield technologies or agricultural strategies.

topographic mapping where elevation is critical. The data can also be used to measure forest attributes such as the height and density of trees and thus the volume (aboveground biomass) of the forest (T. Jantunen, personal communication).

### Information Management Technologies: Making Sense of the Data

The raw data collected above are fairly useless without analytical tools, both human and inanimate:

- **Spatial modeling (among other models).** Closely related to spatial analysis or statistics, models are an attempt to simulate real-world conditions and explore systems using their geographic, geometric, or topological properties. GIS (which can also perform analysis), among other ICTs, has increased opportunities to create models that predict occurrences like yield growth and ecosystem degradation.
- **Data mining** is the extraction of stories or patterns from large amounts of data. Data mining can find four major patterns: clustering (discovering groups), classification (forming a structure), regression (finding a function), and associations (finding relationships). These analyses help to make sense of agricultural data collected by remote sensors (Palace 1996).
- **Data mediation** is the process of taking many different data sets to produce a single, coherent set of information. Data mediation software organizes different types of data (such as hourly versus daily) and synthesizes different approaches to classification (for example, the use of different classification vocabulary), helping to mediate differences between data sources—particularly those on the Internet.

### Dissemination Tools: Getting the Results to the Stakeholders

After analysis, the results must reach those who need to react to the findings, using tools like:

- **SMS.** Text options that allow interaction between fixed-line and mobile phones.
- **Radio.** transmission of information through electromagnetic waves with low frequencies.

- **WiFi.** Wireless local area network that allows various devices to connect to the Internet remotely.
- **Knowledge management system.** Electronic system that provides relevant information as it is requested.

It should be noted that extension agents and advisory programs are essential to disseminate knowledge about the ICTs discussed in this module, but this issue is not discussed in detail here; see Module 6.

### KEY CHALLENGES AND ENABLERS

Increasing smallholder productivity is one the greatest tasks in this century. Although the dimensions of the challenge are huge (growing populations, growing demand for food, rising poverty, economic stagnation, worsening environmental degradation, and climate change), the growing number and sophistication of ICTs offers some hope of raising agricultural productivity, even in smallholders' fields. Variable rate technology, GIS, GPS, satellite imagery, and other data collection technologies have increased the information available about soil health, weather conditions, and disease outbreaks, making very site-specific farming possible. The key to using these technologies to boost productivity is to remember that complementary technologies are needed: Data analysis technologies (such as data mining or mediation software) and information dissemination technologies (such as mobile phones and radio) are essential to reaching smallholders effectively. Dissemination also includes the crucial human component: Extension agents and farmers themselves must transmit and share knowledge.

As noted, productivity can be increased by expanding the land available for agriculture or by making the land already in use more productive. Given current global circumstances, it seems that the second option is more likely to close the productivity gap and meet demand. In conjunction with technologies developed to raise yields, the use of ICTs such as those discussed in this module may do just that. Mainstreaming the use of ICTs in agriculture will also enable them to be used more effectively. Integrating ICT into national programs, creating a policy environment conducive for ICT investment, and designing digital systems that are compatible and common can help improve access for users. Conducting impact studies and sharing pilot project information is also critical to

success with ICTs, as more specific lessons and impacts are learned (IICD 2006).

In closing, it is important to emphasize that the benefits of ICT can be realized on multiple levels. As ICT capacities expand, local farmers and communities as well as nations

and regions need to understand their potential uses to increase agricultural productivity. These stakeholders must learn how to tailor ICT solutions to macroeconomic needs as well as local agricultural bottlenecks, while exploring how current infrastructure can harness relevant and appropriate technologies.

## **Topic Note 5.1: ACHIEVING GOOD FARMING PRACTICES THROUGH IMPROVED SOIL, NUTRIENT, AND LAND MANAGEMENT**

### **TRENDS AND ISSUES**

Residue removal, tillage, overuse of pesticides and fertilizers, lack of crop diversity, overgrazing, overexploitation of natural resources, and deforestation have led to unhealthy soils and yearly reductions in crop output. Greenhouse gases worsen the situation. Changes in atmospheric temperatures (rising in most developing countries) reduce crop performance. Above 30°C, food and fiber crops develop at a faster rate, leaving less time for nutrient assimilation, biomass accumulation, and growth (Qaderi and Reid 2009). With lower yields and continued soil mismanagement, economic growth slows drastically. This outcome is seen most vividly in countries like Rwanda, Tanzania, Mozambique, and Niger, where costs associated with depletion of soil nutrients are estimated to account for 12–25 percent of the agricultural share of GDP (Drechsel et al. 2001).

Good farming practices maximize chances of a good harvest. In the past, conventional farming practices treated entire farms as homogeneous units even though they are often variable in productive potential. This view is changing as technology allows producers to measure soil nutrient status, crop potential, pasture health, and water-use efficiency at specific sites within a field. ICTs like digital soil maps provide extensive soil information that can be stored and accessed online. GPS, satellite imagery, remote sensors, and aerial images help to assess soil and land variations, and mobile applications and the Internet can disseminate the information quickly. With this array of ICTs, precision farming can be employed to optimize crop and livestock management. Until now, however, these techniques have been concentrated in highly mechanized, large-scale agriculture in industrialized countries.

### **ASSESSING SOIL PROPERTIES FOR CLIMATE-RESILIENT AGRICULTURE**

Accurate soil analyses and improved farming practices are needed urgently because productivity gains are highest in healthy soils and where pesticide, fertilizer, tools, and machinery are used properly. Instruments for mapping and analyzing soil properties have proliferated in the last decade, increasing farmers' knowledge about the soils on their farms and the need for climate-resilient agricultural practices. The following section discusses these technologies and their associated challenges in broad terms. Subsections discuss innovative technologies specifically related to nitrogen and carbon, two essential chemical components for successful soil conservation and climate change mitigation.

Digital soil maps are the most promising applications for visualizing soil properties and the gravity of soil nutrient depletion in a particular area.<sup>2</sup> The International Working Group on Digital Soil Mapping (WG-DSM) defines digital soil mapping as “the creation and the population of a geographically referenced soil database generated at a given resolution by using field and laboratory observation methods coupled with environmental data through quantitative relationships” (Rossiter 2004). A variety of technologies, including satellite remote sensors and cameras, can be used to survey soil and collect data to create digital soil maps.

These technologies collect soil information faster than methods that require scientists to take soil samples from

<sup>2</sup> For a diverse set of soil maps and data, see FAO, <http://www.fao.org/climatechange/54273/en/>.

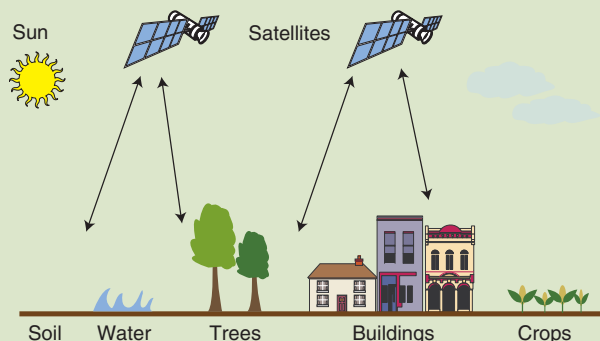


the field. In the latter methods, 80 percent of the work on soil mapping is dedicated to soil identification and boundary mapping, and only 20 percent of the time spent in the field is left to gather data on more complex and equally important topographical features, such as water-holding capacity (Manchanda, Kudrat, and Tiwari 2002). Innovative data collection technologies allow researchers to focus on a variety of soil features (box 5.3).

Practitioners can take the soil data collected from the technologies described in box 5.3 and use statistical methods, GIS, and soil inference systems to form “predictive soil maps.” These maps provide information on a soil’s capacity to provide ecosystem services (such as its capacity to infiltrate water, produce crops, or store carbon), geographical representations of soil constraints (such as aluminum toxicity, carbon deficit, or subsoil restrictions), and a baseline for detecting subsequent changes and assessing their impact (AfSIS 2009).

### **BOX 5.3: Using Remote Sensors and Similar Tools to Measure Soil Properties**

A number of ICTs can be used to measure soil properties for creating digital soil maps. Through near infrared and short-wave infrared sensors, satellites measure spectral reflectance in soils on the ground. Different materials reflect and absorb solar radiation at a variety of wavelengths (see the figure). As a result, remote sensors can measure soil color, texture (sand, silt, and clay), organic matter, moisture, salinity, and absorption processes by detecting and observing the solar radiation reflected (orbit sensing). Reflectance changes depending on the soil’s contents; for example, reflectance is low in areas with low silt content.<sup>a</sup> This technology gives researchers an accurate assessment of soil properties to use in GIS and computer modeling for digital soil maps.



Source: Authors, adapted from <http://www.crisp.nus.edu.sg/~research/tutorial/optical.htm> and Hoffer 1978.

Digital soil maps give practitioners a good picture of soil fertility, vulnerability, and potential. Statistically testing soil maps against other data on human or policy variables (like demographics, land administration, farming practices, and climatic changes) allows researchers and others to explore causes of soil damage and forms of restoration.

At a national or regional level, models created from digital soil maps can be used to improve the selection of crops and varieties (based on which crops and varieties can withstand stressful soil conditions). They can also be used in early warning systems (predicting crop failure, for example), giving policy makers more time to react to shortfalls in domestic and export markets. In addition, fine-resolution soil maps collected from a number of regions could enable climatologists, hydrologists, and crop modelers to more accurately predict the effects of climate change or new technologies on food production and environmental health.

After soil data are collected, analyzed, and reflected in digital soil maps, results need to be shared with policy makers, scientists, and especially farmers, who would otherwise not have such detailed information on soil fertility in their respective farming communities. Recent developments in ICT increase the cost-effectiveness of soil maps: The spread of mobile phones and Internet access can transfer relevant soil information even to remote locations. Collaborating with extension staff, farmers, agrodealers, and others, development institutions can generate integrated soil fertility management schemes that improve a wide range of farming practices. Box 5.4 explains how these results can be applied.

### **Challenges in Soil Mapping**

Although technological developments have improved access to digital soil maps, major technological and economic challenges remain to be addressed in soil science and development institutions. Broadly speaking, the impacts and outcomes of using digital soil maps in smallholders’ fields have not been captured. Soil assessment techniques certainly contribute to the knowledge of production potential, but the transformative effects of this knowledge (such as the adoption of new practices) have not been tested empirically. Another technical challenge is that some digital soil maps cannot be used in quantitative studies or in models of food production or carbon management. Such studies generally require information on the functional properties of soils, such as available water capacity, permeability, and nutrient supply, which many mapping procedures do not capture. Finally, individual soil map units are shown as

#### **BOX 5.4:** Collecting African Soil Data Over Time to Understand Soil Degradation Trends

The African Soil Information System (AfSIS) Project, led by the International Center for Tropical Agriculture (CIAT), collects data that will help address food insecurity and environmental degradation in sub-Saharan Africa. AfSIS takes advantage of recent developments in ICT—digital soil mapping, remote sensing, statistics, and soil fertility management—to analyze alternatives for protecting and rehabilitating soil. The project also tests a variety of farming techniques in an effort to discover the most effective methods to suit a wide range of conditions and situations. The soil map website and mobile networks help to ensure that the data collected can reach the complete spectrum of people involved in farming in Africa.

One objective of the AfSIS research, therefore, is to develop a baseline—an overview against which future results can be compared—using standardized tests and procedures. By applying an agreed process of sampling and analysis, scientists will build a comprehensive picture of soil health and degradation in an area of sub-Saharan Africa covering 42 countries and more than 18 million square kilometers.

It is well known that farmers in Africa typically use little fertilizer compared with farmers in the rest of the world. One important initiative in AfSIS investigates methods farmers can use to improve the fertility of their soils. The trials compare the effectiveness of different fertilizers used on a range of soils, the rate of fertilizer application, and the integration of leguminous crops in rotations.

AfSIS information will also be used in a wider international effort to produce a digital map of the world's soil resources (the Global Digital Soil Properties Map Initiative). Scientists from soil information and agricultural development institutes in Mexico, Canada, and the United States work with the AfSIS team to produce the global map.

*Source:* AfSIS 2009; ICT Update, "Farming From the Ground Up: Scientists Use the Latest Technology to Produce a Digital Soil Map of Africa," April 29, 2010 (<http://ictupdate.cta.int/en/Feature-Articles/Farming-from-the-ground-up>, accessed July 2011).

discrete polygons with definite boundaries. The data used in polygon maps are difficult to integrate with other forms of data, which are grid-based (like satellite images and digital elevation models) (Hartemink et al. 2010)

Social and financial challenges remain as well. Detailed yet inexpensive soil analysis tools are not widely available for

small-scale farming in most developing countries, although they are being developed and piloted. Even where technologies are free to the public (like online satellite images), the resolution is too low to capture soil characteristics on individual plots. Without accurate, affordable soil analysis technologies, resource-poor farmers are unlikely to adopt sustainable and resource-optimizing farming practices. These practices are often more expensive in the short term and are typically more labor intensive. Finally, disseminating knowledge about soil management and farming practices is challenging. Soil science is complex. Soil restoration activities vary based on a diverse set of properties and the agroecological system. Even digital soil maps that create opportunities for soil assessment at the local level will require major dissemination and training efforts by extension staff and other stakeholders.

These challenges are being overcome as technologies advance. For example, GlobalSoilMap.net (along with others) is compiling data on digital soil properties around the world into a comprehensive global map, providing access to a consistent set of soil functional properties that define soil depth, water storage, permeability, fertility, and carbon (information needed for more quantitative studies). Placing maps online helps address some of the challenges related to dissemination and smallholder relevance. GlobalSoilMap.net can be used in a variety of ways to suit a range of purposes: users can view and manipulate the data online (for example, they can compare soil patterns with satellite imagery or land-use maps) or compose and print local maps by combining several sources of online data (soil, climate, terrain, and infrastructure, among others). Development partners, soil scientists, and governments then have a firm basis for formulating policies on land use and can share this information with farmers, so that they can make management decisions such as how much fertilizer to apply.

#### **NITROGEN MANAGEMENT**

In addition to digital soil maps, which are useful over larger areas, *nitrogen-sensor technologies* are used to manage nutrients and prevent the overuse or underuse of fertilizer at the level of a single field and crop. Ineffective use of nitrogen fertilizers can limit crop biomass production and diminish carbon content in the soil. Conversely, optimal nutrient management raises yields, improves soil health (including soil carbon storage capacity), and maximizes the cost-benefit ratio. An especially important consideration for smallholders is that reduced or more accurately timed fertilizer applications can lower the cost of investing in fertilizer (see "Improving Nitrogen Fertilization in Mexico").

A key component of soil management is to maintain appropriate amounts of nitrogen in the soil to optimize crop growth and yields. Under certain weather conditions and farming practices, nitrogen applied as fertilizer, which is highly soluble, can be lost from the soil. Successful nitrogen management delivers enough nitrogen to the crop to optimize yield and profitability while minimizing losses to water and air. The timing, rate, and method of fertilizer application largely determine this optimization (Scharf and Lory 2006). Over the years, agronomists have established how much nitrogen various crops require. Using these measures, along with data collected from digital soil maps and other soil data, farmers can apply the right amount of nitrogen at the optimal time to maximize crop performance.

Farmers in developed countries use technologies that measure nitrogen levels and determine rates of fertilizer application. Evidence shows that sensors like the Yara N-Sensor (<http://www.yara.co.uk/fertilizer/index.aspx>) which measures light reflectance from vegetation and adjusts fertilizer application accordingly, can increase yields by up to 10 percent over standard farm practices while reducing fertilizer costs and minimizing environmental losses (image 5.1). N-tester, a technology

**IMAGE 5.1:** Nitrogen-Sensor Technology



Source: Yara International ASA 2004.

developed by the same company, is another example of sensory technology for nitrogen. This portable device, using no subsidiary equipment, measures the chlorophyll content in the leaves of cereal and potato plants to monitor the need for nitrogen. N-tester is being piloted with high-value, nitrogen-demanding crops in a range of countries throughout northern Europe, southern Africa, and North America.

The tools used for nitrogen-sensor technology have similar challenges to those of digital soil technology. Databases and information support systems have been established to raise awareness and disseminate information to smallholders, but widespread access is limited by the extent of network infrastructure and costs. Increasing the opportunity for communication among various stakeholders involved in farming (such as input dealers and extension agents) could improve the spread of information.

### SOIL CARBON SEQUESTRATION IN AGRICULTURE

The amount of organic carbon present in soil depends on water availability, soil type, and other features. A primary factor affecting the soil's carbon content is agriculture. Soil carbon in forests, crop land, or grazing pastures increases or decreases depending on inputs that are applied, rates of deforestation, and farming practices. In recent decades, producers' poor land management practices have reduced soil carbon content. When soils are tilled, organic matter previously protected from microbial action decomposes rapidly and accelerates erosion and degradation. Improved farming practices like leaving crop residues in the field after harvest and no-till (where seed is planted without plowing) maintain soil carbon at higher levels (Lal et al. 2004),<sup>3</sup> but these practices are not widespread. No-till is practiced on only 5 percent of the globe's cultivated land (Derpsch and Benites 2003). The overwhelming majority of vulnerable regions are those with lower organic carbon pools (figure 5.2).

High levels of soil organic carbon are crucial to agricultural productivity and environmental conservation. Studies found that increasing the pool of soil organic carbon by  $1 \times 10^9$  picograms of carbon per hectare can boost yields 20–70 kilograms per hectare in wheat, 10–50 kilograms per hectare in rice crops, and 10–20 kilograms per hectare in bean crops (Lal 2010). Despite rapid depletion of soil organic carbon, projections show that carbon can be restored to about 60–70 percent of natural levels. A calculation relevant to developing countries and poor producers is that they could grow up to

<sup>3</sup> These practices incur some costs, especially in the short term. More fertilizer may be needed before soil organic carbon increases. Similarly, crop residues that are used for fuel or feed will no longer be available (Lal et al. 2004).



Despite the growth in sensor and information technologies for carbon sequestration and restoration, significant barriers prevent smallholders from being included in efforts to monitor and increase carbon sequestration. They include the poor development of carbon markets to date, especially in agriculture, and the continuing problem of developing methods that smallholders can truly access and afford. See the discussion below.

### **Poor Carbon Market Development, Especially in Agriculture**

Carbon markets were designed to provide incentives for carbon sequestration and good farming practices. Since 2002, developed countries and firms (primarily in Europe) have traded carbon credits (Lal 2004). Trading carbon credits can encourage firms and farmers to increase soil carbon content and switch to more environmentally conservative systems. Despite major strides in carbon market development, serious challenges remain. A variety of economic and scientific factors make it difficult to set prices for carbon credits, and assessing the biological and ecological relationship between carbon storage and climate change is even more daunting (Lal 2010; World Bank 2010a). Even more important, agriculture and livestock are not included routinely in global carbon emissions treaties, which reduce even large firms' incentives to participate in carbon sequestration. The Clean Development Mechanism of the Kyoto Protocol does not include land management, which prohibits carbon in agricultural soils from being traded in the Kyoto compliance market (World Bank 2010a). Current efforts to include agriculture in carbon trade institutions and policies will create financial incentives for governments, firms, and farmers in developing countries to use soil carbon sequestration technologies.

### **Accessibility and Affordability of the Technology for the Poor**

Beyond poorly functioning carbon markets, other technical and social barriers prevent smallholders from adopting practices that increase soil carbon levels. As noted, the ICTs used to monitor, report, plan, and verify the amount of carbon sequestered are not appropriate for small farms. Monitoring sequestration is easiest when the potential is large, or around 100,000 carbon tons (Bajtes 2001). This limitation is a major challenge to carbon sequestration, given that "90 percent of the potential for carbon capture can be found in the developing world, where land managers are largely poor farmers on small plots of land" (Smukler and Palm 2009:1).

Most available ICT not only inhibits smallholders from participating in carbon markets (or their development) but reduces

their ability to participate in simple soil restoration and conservation techniques. Recent World Bank projects have shown that robust, clear, and cost-effective accounting methods that outline how carbon is measured and quantified are essential if projects designed for smallholders are to function well, as is transparency in monitoring to assure farmers' participation (World Bank 2010a). In the future, development institutions can focus attention on reducing costs of ICT for soil carbon (using coarse-to-medium resolution satellite imagery) (Smukler and Palm 2009), improving land rights and enforceability (which will help regulate carbon trade), and determining how financial incentives might be created (for example, through local carbon markets or payment for ecosystem services) to ensure that smallholders can participate (box 5.5) (World Bank 2010a).

### **BOX 5.5: Rewarding Farmers for Carbon Sequestration in Kenya**

The Kenya Agricultural Carbon Project is one of the first examples of a soil carbon project that not only addresses issues like food security and climate change but also provides financial assistance to rural dwellers. Kenya is a prime candidate for carbon sequestration. Agriculture contributes to over 50 percent of gross domestic product and one-third of the country's population lives on ecologically fragile arid land.

Funded by the World Bank and designed by the Swedish Cooperative Center-Vi Agroforestry, the project, located in Western and Nyanza Provinces, addresses most issues faced on arid land. On approximately 45,000 hectares of land, farmers adopt good practices that result in carbon sequestration. These practices are expected to generate 60,000 tons of carbon dioxide each year, increase yields, and allow smallholder farmers to access the carbon market and achieve supplemental income through payment of environmental services. Extension agents disseminate technical knowledge, monitor and account for carbon sequestered, and build capacity in farmers' organizations.

Once carbon is sequestered, the credits will be sold to the World Bank's BioCarbon Fund. Project developers expect that improved practices will result in an additional US\$ 350,000 in 2011 for the communities involved. The project also promotes improved carbon management policies and strategies that improve agriculture productivity and sustainability at the national level.

*Source:* World Bank Ghana Office 2010; World Bank 2010d.

## PERFECTING THE FARM THROUGH PRECISION AGRICULTURE

Site-specific information that allows producers to make management decisions about discrete areas of the field is called precision farming or precision agriculture. Determining soil and crop conditions to improve whole-farm efficiency—while minimizing impacts on wildlife and the environment—is the crux of precision farming. It has been used successfully in many developed countries and has the potential to change agriculture dramatically in this century.

A variety of tools can be used in precision agriculture. GPS, satellites, sensors, and aerial images can help to assess variation in a given field. Farmers can match input applications and agronomic practices with information received from these ICTs. Precision agriculture has been applied to many types of agricultural produce (hay, pasture, fruit, and cereals, for example) and to fisheries under many different climatic conditions. Many of these efforts have been limited to large-scale farming because of the significant investment required, but applications under smallholders' conditions are gaining visibility. Remote sensors, sonar-based technology, and other ICTs can also improve aquaculture and livestock production.

Essentially precision farming provides a framework of information for farmers to make management and production decisions. It can answer questions pertaining to land preparation (including tillage depth and type, residue management and organic matter, and reductions in soil compaction); seed (planting date and rotation, density and planting depth, cultivar selection); fertilizer (nitrogen, phosphorous, potassium, and other nutrients, as well as pH additives, application methods, and seasonal conditions); harvest (dates, moisture content, and crop quality); and animals and fisheries (pasture management, animal tracking, and school identification).

### Precision Farming through Wireless Sensor Networks

Consistent advances in microsensing, smaller devices, and wireless communication (Kabashi et al. 2009) have resulted in new comprehensive technologies that offer even more consistent and reliable systems for smallholders and policy makers alike. Wireless sensor networks (WSNs), which combine many kinds of sensory data in one location, are some of the most innovative technologies available for farming and agricultural planning. With the right components, these networks can form knowledge management systems, research databases, and response systems that can guide local communities and governments in agricultural development.

A WSN is a group of small sensing devices, or nodes, that capture data in a given location. These nodes then send the

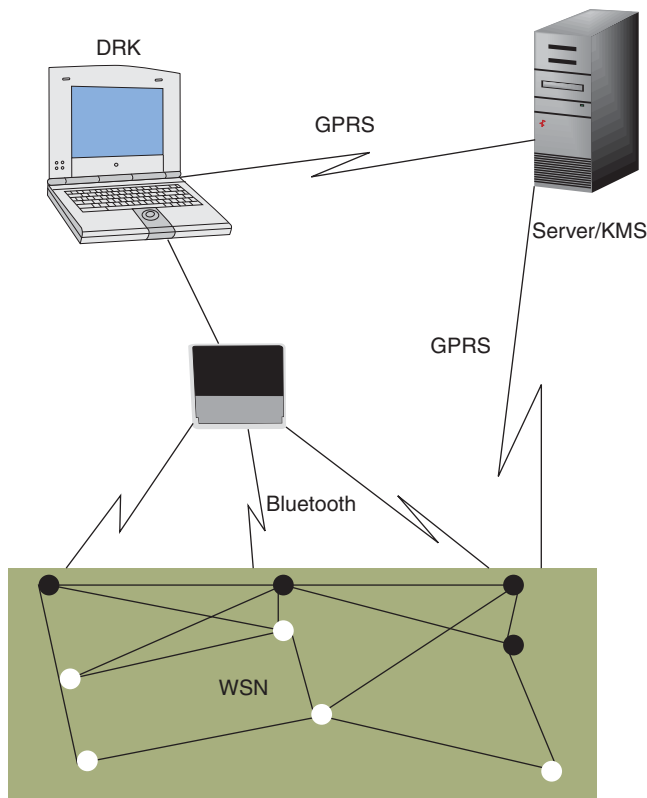
raw data to a base station in the network, which transmits the data to a central computer that performs analysis and extracts meaningful information. The base station acts as a door to the Internet (typically a local area network), providing operators with remote access to the WSN's data (Dargie and Zimmerling 2007). Because the networks can have multiple sensory devices, the data can contain information on soil, climate, chemicals, and other relevant subjects. The wide application of WSNs allows them to be used not only in managing agriculture but in testing water quality, managing disasters, detecting volcanic activity, and conducting environmental evaluations.

These networks have several key features. First, WSNs have both active and passive sensors. Active sensors release a signal to detect a physical phenomenon like seismic activity and radar. Passive sensors, which transform a physical phenomenon into electrical energy, can detect a vast array of phenomena, including temperature, humidity, light, oxygen, and chemicals (Dargie and Zimmerling 2007). Once sensors (for example, temperature and soil moisture) are selected, node locations are needed. Node density in developing countries should be scarce to better guarantee network connectivity for each node, reduce maintenance, and improve the network's reliability (though it will limit field-mapping techniques). In addition, because low-income countries often experience poor network and telecommunications connectivity, nodes will often require a "buffer," where data can be rerouted or stored in another node if connection to the base station fails. If an active node fails to transmit data to the base, the network will "wake up" the closest neighboring buffer node (Kabashi et al. 2009), providing a "multihop transmission" (see figure 5.3 for a basic illustration of the process).

The design and implementation of WSNs requires a number of important features. The nodes should monitor the field(s) continuously and for a significant period—it is best if maintenance is not required for at least one cropping season (or 4–6 months). The nodes should cover a wide area, be small to prevent animal and human interference (like stealing), and tolerate harsh environmental conditions like monsoons and extreme heat. Self-organization is also important: The network should automatically detect removed or newly arrived nodes and adapt the messaging route (Depienne 2007).

WSNs offer extensive benefits to farmers producing plants and animals. Agriculturalists can detect problems at an early stage and use more precise applications of fertilizer, water, and pesticide. Pastoralists can use WSN to monitor grazing land productivity. Placing wireless nodes in pastures allows farmers to move animals according to environmental indicators like soil moisture (see image 5.2 and IPS "Monitoring Livestock to

**FIGURE 5.3:** Wireless Sensor Network (WSN), Distributed Collection Architecture



Source: Kabashi et al. 2009.

Note: DRK = Distributed Resource Kits GPRS = General packet radio service; KMS = Knowledge Management System.

Prevent Pasture Damage” in Topic Note 5.1). WSNs can also be used to manage irrigation and even to measure water quality.

Governments and development partners also benefit financially from WSNs. The technology is fairly cheap; some units cost as little as US\$ 100 (Dargie and Zimmerling 2007). Developing countries often experience power deficiencies, but nodes that operate on batteries and alternative energy sources do not need electricity. Data are collected more easily. Whereas traditional methods of collecting agricultural data for national planning rely on occasional data logging by human operators, WSNs can collect continuous data with minimal human interaction. Even though some ICTs like mobile phones or transceivers can collect information faster in the field, they often have trouble cooperating with other software or Internet servers (Fukatsu et al. 2004). WSNs integrate the Internet into the software, making the data more user friendly and accessible.

Data organization is vital to the output of WSN as well as other remote technologies. If countries want to use WSN data to construct yield models or predict climate shifts, making sense of the data is pertinent to the design. The data

**IMAGE 5.2:** WSN Can Help Monitor the Quality of Pastures



Source: Curt Carnemark, World Bank.

produced can be used to improve crop management strategies and even develop knowledge management systems where best practices, crop disease identification, and planting techniques can be disseminated to smallholders. It is important to note, however, that although battery-operated nodes can function in areas with low power connections, changing batteries in remote areas may prove difficult. Sleep settings and well-designed energy-conserving hardware can help prevent frequent battery changes (Dargie and Zimmerling 2007).

Wireless sensors can also be used in aquaculture. Though concentrated in developed countries, the use of underwater wireless sensors has great major potential for developing countries. Real-time information is crucial to effective and profitable aquaculture. Akvasmart (see <http://www.akvagroup.com>), a Norwegian firm specializing in commercial fish farming, uses a wide variety of ICT tools, including sensors. Sensor systems can monitor oxygen, tidal current, temperature levels, fish behaviors, and water conditions. Interestingly, Doppler pellet sensors with a built-in camera can detect uneaten food in fish cages (figure 5.5). With this information, signals from the sensors can stop the feeding, allowing for more specific care and feed purchase. The sensors can also adapt to the accurate feeding rate of the fish over time.

Wireless sensors in water, just like those on land, can be coupled with other cameras for more precise readings. Akvasmart offers a video image system called the Vicass Biomass Estimator that measures the height and length of the fish in the pond. These figures can be used to estimate the weight of the fish. Other camera systems can be placed at the surface or underwater. Monochrome cameras monitor the feeding process by “looking up” from the bottom. Color cameras can monitor feeding and inspect the pond or cages and surrounding environment. Remote access cameras can tilt, zoom, and

**FIGURE 5.5:** Akvasmart Doppler Pellet Sensor Network

Doppler Pellet Sensor flow chart:

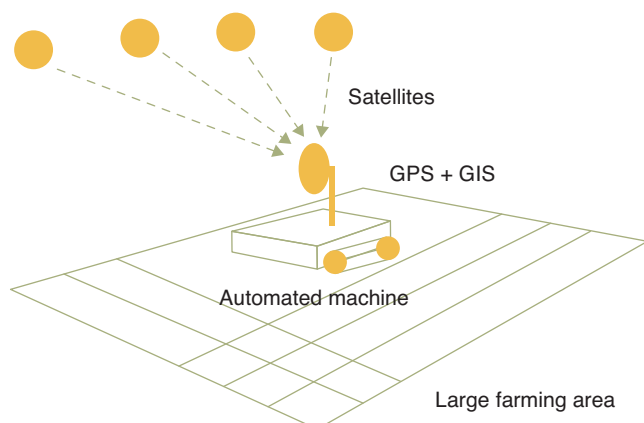


Source: Akvasmart (<http://www.akvasmart.com/index.cfm?id=205626>).  
 Note: CSU = Cage Sensor Unit.

pan according to the interest of the fish farmer. Each of these camera and wireless sensor systems can be accessed from a personal computer and in some cases the Internet, where the data are collected.

### Precision Farming through Satellite Technologies

Precision farming through satellite technology utilizes three technologies: GPS (which can position a tractor within a few feet in the field), GIS (which can capture, manage, and analyze spatial data relating to crop productivity and field inputs), and variable rate technology (which provides site-specific, “on-the-fly” estimates of field inputs for site-specific application). The three ICTs combined provide information that allows producers to apply inputs, such as fertilizer and insecticide, precisely where they are needed (figure 5.6).

**FIGURE 5.6:** Precision Farming through Satellite Technologies

Source: Adapted from GIS Development Net.

Agricultural information is typically captured spatially, making it more convenient to handle on a regional scale. GIS technology is promising because it allows for a more specific focus. Variable rate technology has helped to identify weed infestations and water stress in areas where crop pest levels are high, which improves targeting of chemical applications and reduces waste associated with conventional blanket spraying (Munyua 2007). In addition to the potential productivity gains and cost savings, precision farming through satellite technology enables governments to study how agricultural practices affect the ecosystem and develop better regulations.

Once data are collected through GIS, scientists can interpret the images and analyze the soil and crop conditions to achieve better results. Although satellite imagery cannot detect soil quality directly like sensors can, it can record soil properties like light reflections and color. As crops start growing, precise pictures of the crops are captured more efficiently. The condition of the fully grown plants can then provide a clearer picture of the quality of the crops and what they require for successful harvest.

Based on soil and crop conditions, farmers can estimate the precise amounts of seed, pesticide, and fertilizer they need, organize the distribution of inputs, plan which crops to plant in which areas, and make new investments. Knowing the size and shape of fields can also help rural communities plan for future developments and investments like mechanization. Small, fragmented, or awkwardly shaped fields are difficult to work with a tractor or even animals. Above a certain minimum field size, it becomes cost-effective to use a tractor. Precision farming provided through satellite imagery can determine this threshold before a community invests in new equipment. If an area is suitable for mechanization, the benefits can be extensive. A GPS system that controlled tractor steering in Sudan cut planting time on the farm by 60 percent (Munyua 2007).



Precision farming must also rely on an information dissemination process. Many rural areas in developing countries are isolated from sources of new agricultural information; not surprisingly, farmers in these areas use few modern technologies. ICT is beginning to play an important role in providing advisory services in real time to farmers, which helps them plan and manage production, postharvest activities, and marketing more efficiently (see Module 9). Online information, consultation, and land suitability maps with web-based systems can play an important role in improving and updating knowledge for producer organizations.

Management and information-sharing tools are also necessary for effective precision farming based on satellite technologies. RiceCheck and the online knowledge bank at the International Rice Research Institute (IRRI) (<http://irri.org/knowledge/training/knowledge-bank>) are two of the most advanced knowledge management tools in rice production today. Collecting, analyzing, and sharing information on individual plots has been difficult, but through RiceCheck, farmers can now monitor crops, have an online group meetings (often with agronomists), and compare their yields to regional benchmarks for high yields (for a description of these benefits in Malaysia, see box 5.6) Through IRRI's site, connected farmers can also make a checklist for their daily activities and review plans for the entire growing season.

### LESSONS LEARNED

This Topic Note primarily reviews soil and land productivity, particularly for the planning and preplanting stages of the production cycle. Correcting past damages and ensuring

#### **BOX 5.6: Web-Based GIS for Paddy Precision Farming, Malaysia**

In Malaysia, an interactive, web-based GIS provides information for precision farming and mapping in the Sawah Sempadan rice-growing area in Tanjung Karang, Selangor (Che'Ya et al. 2009). The system allows farmers to access information about rice cultivation in their area. Because it uses open-source software, the system is cost-effective for users. Farmers can print variable rate fertilizer application maps and historical data about yield per paddy lot in previous seasons. This helps farmers analyze and reflect on the best strategy for the coming growing season. Farmers can share information, especially on fertilizer recommendations. A web presence also allows policy makers to access rice information.

future yields, however, will require farmers, governments, and development partners to mitigate the effects of climate change and environmental degradation on soils. With the expanding reach of ICTs, achieving this goal is more likely in both developed and developing countries, but challenges remain in using ICTs to improving soil and land health. They are discussed in the following paragraphs, along with some means of preventing or overcoming them.

To begin with, these technologies are relatively new even in developed countries, and their potential is just being realized in developing countries. National awareness of the importance and benefits of soil fertility takes time to develop. As with carbon sequestration, ICTs to improve and maintain the fertility and productivity of land will require new legislation and policies outlining their use and providing incentives to achieve their benefits. Appropriate legal and regulatory frameworks, monitoring and verification systems, and liability, access, and property rights laws and regulations, such as regulations on carbon limits in some countries, are necessary to make significant, national progress. Though not all technologies require such stringent legal frameworks, government involvement—specifically at the national policy level—often raises the visibility and adoption rates for new ICTs.

Testing methods for soils vary and are still in development. For this reason, results are not always reliable and may be difficult to harmonize. Continued research—particularly in poor countries where research is typically limited—will help to address these challenges. Developing countries also lack the financial footing and human capital to use expensive technologies that require reliable operation and maintenance, even more so in harsh conditions. Strategic and long-term investments are needed to sustain improvements in soil and land productivity, especially if they are used in rural areas, where farmers who may be required to maintain the ICTs have little time to do so.

Farmers may not have a contemporary perspective on the environment because they have received little new information. They may not have access to the country's environmental regulations (for example, prohibiting the burning of charcoal) or export requirements (such as limits on pesticide residues). Extension education and campaigns through ICTs like radio will help farmers to make decisions related to environmental policies and strategies.

Despite the benefits of soil technologies, smallholders have limited access to credit to use them. Even if they have access to soil maps or nitrogen estimates, their adoption or adjustment rates might be low. The inputs required to change practices are often out of reach in poor rural areas. New credit

insurance schemes or financial rewards (like carbon markets) may reduce these monetary concerns.

Soil ICTs are not only new but complex. Farmers will require training and education to learn how to use them. Electronic education (e-learning) is an option, but infrastructure must be considered. In some cases, technologies function well with low bandwidth (WSNs are one example), but in others they do not (the RiceCheck web interface is an example). The productivity goals and the technologies used to meet them must match the IT capacity in the focus location.

Finally, the lack of institutional capacity poses other challenges for increasing soil and land productivity. Governments that want to incorporate the use of carbon markets or digital soil maps into agricultural policy will have to make major adjustments and investments in human resource capacity. Development partners like the World Bank can support some of these efforts.

### INNOVATIVE PRACTICE SUMMARY

#### Seeing-Is-Believing Project Improves Precision Farming

Small-scale farmers in West Africa are experiencing unpredictable changes in their agricultural land. Soils are infertile in many areas, reducing agricultural productivity and spurring fear and uncertainty about future livelihoods among farmers. In the past few years, many West African farmers have abandoned their land, which had been in their families for generations.

It is imperative that smallholders obtain the knowledge about changing soil and crop patterns that can help them manage their farms. The Seeing-is-Believing West Africa (SIBWA) Project has been assisting farmers with accurate satellite information and imagery of their farm fields to help them improve their agricultural practices.

In June 2009, SIBWA started working with six farming communities in this region—three in Mali and one each in Ghana, Burkina Faso, and Niger. SIBWA is funded by the Bill and Melinda Gates Foundation through AGCommons, with supplementary funding from the United States Agency for Internal Development and Germany's Federal Ministry for Economic Cooperation and Development (CODE-WA project).

Led by scientists at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), the SIBWA team provided farmers with very high resolution satellite images (such as those on displayed on Google Earth) of their land. To get a more precise picture of soil fertility, scientists can analyze the images when the crops are at their peak growth

stage. When the ICRISAT team acquires a very high resolution image (VHRI), they use computer software to enhance it, adding extra layers of information, and analyze data that would be useful to farmers, such as variations in soil fertility, land size, and shape. Although a single VHRI image costs US\$ 1,000–1,500, this method of analysis is often still cheaper than visiting every individual farmer's field to collect samples. Partnering with local NGOs and extension officers, the SIBWA team visits the project sites to verify their findings with the farmers. ICRISAT further analyzes the images using feedback from field research to build a database that they can use to develop an accurate map of each farm.

SIBWA partners translate the soil and image information into local languages and take the detailed maps back to individual farmers, who can use them to plan and manage their crops for the coming season (image 5.3). The maps show areas of low or high fertility inside each field. With an overview of soil and crop conditions, farmers can organize the distribution of fertilizer throughout their fields and estimate which crops will produce the highest yields. The SIBWA team works with the farmers to determine the area of each field, making it easier for farmers to calculate the amounts of seed, pesticide, and fertilizer required for each field.

Another advantage of VHRI is that it shows the direction of furrows on the field and areas where farmers can plow along the contour lines of the land. Using this imagery, farmers monitor whether they were following the contour lines accurately and efficiently to reduce soil erosion. SIBWA also involved local NGOs specialized in technology and extension services in each community to help farmers make use of the data.

**IMAGE 5.3:** Farmers Learn to Use Images of Their Farms to Improve Productivity and Resource Management



Source: Work funded by AgCommons a program executed by the CGIAR.

Data from projects like SIBWA can be used to develop growth and yield models by various means. Some rely on computer simulation and include weather-related variables; others are statistical estimation models based on multiple regression equations. While no single model has proven satisfactory in all conditions, both low- and high-resolution imagery have benefits extending beyond the decisions of individual farmers. Low-resolution yield prediction can benefit food importers and exporters as well as international and government agencies concerned with global markets and prices. In this regard, data collected from imagery in localized projects will be useful in years to come. Although it remains too early to analyze the impacts of SIBWA, the team expects that the farmers will use the data when planning for the new growing season (Traoré 2010; ICRISAT 2010).

### INNOVATIVE PRACTICE SUMMARY

#### Improving Nitrogen Fertilization in Mexico

The International Maize and Wheat Improvement Center (CIMMYT) recently piloted a nitrogen sensor on 174 wheat plots in Mexico's Yaqui Valley, in collaboration with the State of Sonora, Oklahoma State University, and Stanford University (image 5.4). A handheld device with an infrared sensor captures light to measure biomass and red wavelengths to measure chlorophyll content. These two measures determine how much nitrogen a plant requires and thus the appropriate amount of fertilizer to apply (CIMMYT 2005).

In Sonora, farmer-advisors purchase the sensors for US\$ 5,000 and charge 7 pesos per hectare to diagnose farmers'

**IMAGE 5.4:** Infrared Sensor Technology Increases the Cost-Efficiency of Nitrogen Fertilizer Applications in Yaqui Valley



Source: Iván Ortiz-Monasterio, CIMMYT.

crops (I. Ortiz-Monasterio, personal communication). Though the cost of the diagnosis is expensive for smallholders, they needed significantly less fertilizer to maintain yields. Farmers who did not use the sensor applied 219 kilograms of nitrogen per hectare for yields of 6.92 tons per hectare; those who used the sensor applied as little as 158 kilograms of nitrogen per hectare for yields of 6.91 tons per hectare. For a 100-hectare farm, these savings add up to approximately US\$ 7,500 per harvest (CIMMYT 2007).

The technology not only reduces costs but reduces environmental damage: Nitrogen that washes into the ocean or local streams can harm ecosystems. CIMMYT is now working on a prototype pocket sensor that costs US\$ 100–200, which would facilitate more affordable nitrogen testing services for farmers in developing countries (I. Ortiz-Monasterio, personal communication).

### INNOVATIVE PRACTICE SUMMARY

#### Monitoring Livestock to Prevent Pasture Damage

Animal production in Australia traditionally required animals to be restrained to a particular location. The cost of installing fences and maintaining them constitutes around 30 percent of the cost of rearing one animal. Controlling animal location implies that farmers need to know about pasture conditions, because overgrazing leads to land erosion and nutrient depletion. With this in mind, researchers implemented a static and mobile node and camera network to remotely monitor the condition of grass throughout a field.<sup>4</sup> Using solar panels, which generate much higher energy outputs compared to what is needed, the team observed soil moisture, greenness level, grass height, and grass coverage.

Consisting of an Atmega 128 microcontroller at 8 MHz, a Nordic NRF903 radio transceiver with a bit rate of 76.8 kilobits per second, a temperature sensor, and a soil moisture sensor, the commercially available static node (ECH20 capacitance-based) takes readings every minute with a  $\pm 2$  percent error rate. Pictures of the pasture, troughs, and gates help to guide herdsmen in cattle movement. Additional mobile nodes connect directly to the cattle (around their necks). These nodes measure the livestock's speed and turning rate, which improves tracking capacity.

With these two technologies, scientists can build generic models of herd movement so that herdsmen can better manage resources in smaller pastures. Though the technology is focused on developed countries, these ICTs hold great potential for developing countries.

4 This section draws on Wark et al. (2007).

## Topic Note 5.2: PREVENTING YIELD LOSSES THROUGH PROPER PLANNING AND EARLY WARNING SYSTEMS

### TRENDS AND ISSUES

ICTs can help to prevent and reduce losses in crops through well-planned investments and disaster warnings or time-sensitive alerts. Water management and disease or pest prevention are crucial to increased productivity. Advances in ICTs such as GPS, GIS, mediation software, mobile phones, and satellite imagery have improved smallholders' ability to adjust farm strategies and reduce risk. At the same time, these advances allow governments and development partners to better monitor farm productivity, make more accurate projections, and plan better for the future.

Water is a primary topic in this thematic note. Although water is scarce and is becoming more so due to climate change, many water resources in developing countries are simply not exploited. In fact, the vulnerability facing agriculturalists in most of Africa is not the result of more variable rainfall but of failure to access the water that is available. Only 2–3 percent of Africa's water is used (Woodhouse 2009). Despite current efforts to tap water resources and adapt to climate change, competition for water for household and industrial use will steer water away from agriculture over the next few years in almost 60 percent of the world's most vulnerable countries (Ruttan 2002). Weather data, along with improved irrigation management and system engineering, are more important than ever.

This note also discusses disease and pest control. Pests and pathogens continually evolve, making it particularly difficult for small-scale farmers to increase productivity. Without inputs like pesticides and the knowledge to use them correctly, pests and diseases reduce global harvests by upwards of 30 percent for maize, rice, and potatoes (Oerke 2006). ICTs like mobile phones and radio frequency identification technology are making it easier for farmers to know which diseases or pests to watch for and how to handle them if they are found. Pest eradication takes national and collective efforts. With ICTs, governments find it easier to reduce crop losses from flies or rodents and livestock losses from disease like bovine spongiform encephalopathy (less formally known as "mad-cow disease").

### PREVENTING DISEASE AND PEST DAMAGE

Plant protection is important to save crops from diseases and pests. Increasingly, ICTs are used to help farmers reduce or

more efficiently use the total amount of pesticides employed in crop protection. Farmers often are unaware of or cannot accurately assess plant diseases, which may reduce agricultural productivity and raise costs if pesticides are overused. Concerns for animal health are similar. Herdsmen and fishermen spend resources and time treating sick animals or identifying disease outbreaks. Using a variety of ICTs, producers can better identify, track, and protect their crops, animals, and livelihoods.

One example involves fishing communities, which face major challenges in both wild and managed fisheries. They can use ICTs to prevent fish diseases and protect local fishing grounds from unwanted visitors. Illegal, unregulated, and unreported fishing poses serious obstacles to sustaining fish production. Tools like GPS and mobile phones help fishers and governments locate poachers and report abuse (image 5.5). The South Pacific Forum Fisheries Agency, for example, now has a vessel monitoring system, which observes fishing grounds throughout the area, identifying and fining illegal fishers. The Sustainable Fisheries Livelihoods Program has helped Guinean fishing communities perform similar policing: local fisherman used hand-held GPSs to calculate the position of poachers and then radio them to the coastguard. Benefits of these technologies improve productivity indirectly by protecting the fish population. In Guinea, for example, incursions by industrial criminal vessels went down from 450 to 81 after just two years (FAO 2007).

Protecting farm animals from disease and other ailments also improves through ICT (see IPS "Radio Frequency Identification

**IMAGE 5.5:** Mobile Applications Help to Monitor and Protect Fishers



Source: Edwin Huffman, World Bank.

to Prevent and Treat Cattle Disease in Botswana” in Topic Note 5.2). Sensors and other remote technologies can be implanted in an animal, providing herdsman with the exact location, health, and situation for livestock like cows, pigs, or sheep. In addition to enabling easier identification and tracking, in the future, some instruments may offer animal response systems.

ICT is now being used in integrated pest management systems to improve farm management in a variety of ways. The Low Frequency Array Project (<http://www.lofar.org>) piloted in the Netherlands uses sensors to monitor and treat potato crops at risk for the fungus *Phytophthora infestans*, which causes late blight. Because the development of late blight depends heavily on climatic conditions (OECD 2009), capturing climatic conditions like humidity and leaf temperature can help farmers prevent onset of the disease by optimizing fungicide applications when climatic conditions warrant it. The project used three instruments: sensor nodes, a server, and a decision support system. One hundred and fifty sensor nodes, called TNodes, send soil information every 10 minutes through a TinyOS operating system to the server where data are stored (Baggio 2004). Users can access this information directly, or receive texts or emails from the linking decision support system (LOFAR n.d.). The decision support system gathers information from the server along with other meteorological data from weather stations to produce maps of the temperature distribution within fields. The system sends alerts to the farmer that identify the patches of land most susceptible to the fungus.

Information technologies are vital for disseminating crop protection advice, but “crowdsourcing,” (using ICTs to leverage widespread collaboration) can prevent diseases from spreading in the first place. If sufficient numbers of farmers can text information on potential crop disease symptoms to researchers and receive appropriate disease control advice, researchers can also track and potentially forestall epidemics. If farmers or cooperatives have access to the Internet, online bulletin boards or mailing lists can spread information on disease incidence quickly. Online decision support systems<sup>5</sup> that link data to possible action, such as the one used in the Low Frequency Array Agro Project, are becoming more popular because clients require minimal software, which reduces management and distribution costs.

Additionally, it is useful to link weather information to pest or disease development over time. The Pacific Northwest Integrated Pest Management website through Oregon State University (<http://oregonstate.edu/dept/nurspest/>) collects temperature and precipitation data from 380 weather stations and links it

### **BOX 5.7: Crowdsourcing Prevents Cassava Losses in Tanzania**

In Tanzania’s Lake Zone, farmers from 10 districts who participate in the Digital Early Warning Network have been trained to recognize symptoms of cassava mosaic disease and cassava brown streak disease. Armed with mobile phones, farmers “crowdsource” or send out monthly text messages to researchers about disease incidence and receive disease control advice in return. When more than 10 percent of the members of a group spot a disease that was not present previously or has increased in prevalence, the project team visits the area to verify the information and advise farmers what to do. Each group of farmers—60 overall—is given a topped-up phone card to text researchers. They meet monthly to discuss observations and send the text messages. The network is part of the Great Lakes Cassava Initiative, which aims to improve the livelihoods of more than a million farmers in six countries of the Great Lakes region by tackling issues that affect cassava yields.

*Source: Ogado 2009.*

to pest phenology models for 22 insects, 2 diseases, and 2 crop species (Bajwa and Kogan n.d.). Pest alerts and control techniques are announced and shared through social media like Twitter and email subscriptions. Similar alerts can be carried out through SMS in developing countries (box 5.7).

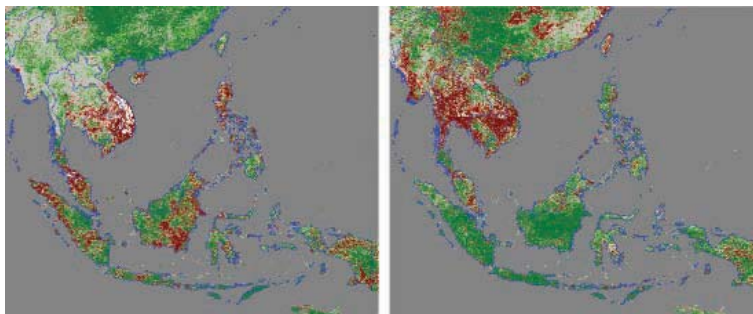
### **WEATHER FORECASTING**

Since 2000, new ICTs have given farmers and partners better opportunities to manage climate risk. WSNs and satellite images capture raw data that can be transformed into information useful for agriculturalists, helping them optimize decisions related to choosing crops (based on water requirements), planting (timing and planting density), buying inputs, and applying fertilizer. Climate information can also improve insurance markets.

Remote sensors are presently the chief source of climate data. FAO’s Global Information and Early Warning System on Food and Agriculture tracks data and trends related to food security, price risks, and natural disasters. FAO analysts monitor climate conditions and changes around the world using four satellites—FAO’s ARTEMIS (Africa Real Time Environmental Monitoring Information System), Europe’s METEOSAT, the United States’ NOAA (National Oceanic and Atmospheric Administration), and Japan’s GMS (Geostationary Meteorological Satellite). Every 10

<sup>5</sup> See <http://www.dssresources.com>.

**IMAGE 5.6:** Satellite Image of Vegetation Changes from 1998 to 2004 (Red Indicates Decreasing Vegetation and Green Indicates an Increase)



Source: FAO (<http://www.fao.org/giews/english/spot4/sea/index.htm>).

days, ARTEMIS and METEOSTAT provide images that help to estimate rainfall for Africa. FAO maintains a database of these images from the past two decades, which provides an opportunity to monitor significant changes in weather over time (image 5.6). GMS produces similar information for Southeast Asia as well as information on crop densities at the subnational level (FAO 2010b). Beyond reflecting past trends and predicting future ones, these satellites and others can provide up-to-date forecasts for farmers. These satellite images and others are free on FAO's website.

This proliferation of weather information has made mediation software extremely relevant to the productivity discussion. For example, MetBroker (<http://www.agmodel.org/projects/metbroker.html>), software that pulls weather data from various sources and "hides" the differences between them, is run on a computer permanently connected to the Internet. From 5,000 stations from 14 databases in 7 countries, MetBroker averages forecasting data and makes it consistent (Laurenson, Otuka, and Ninomiya 2001). This approach has two benefits: Researchers and modelers can access data from various harmonized sources for growth prediction models, and farmers can receive accurate real-time weather information to make farming decisions. Clients—whether farmers or modelers—can request a wide array of climate-related information from MetBroker, including rainfall prediction, air temperature, solar radiation, soil temperature, and leaf wetness (Laurenson, Otuka, and Ninomiya 2001). Some mobile technologies permit farmers to access MetBroker and request information on weather conditions for a certain region, specific stations, and for a restricted period, even with low bandwidth. MetBroker provides an option for summarizing data as well; users can opt to receive daily temperatures instead of hourly ones or receive expert summaries of weather information instead of complete data sets.

Another weather forecasting service, this one in Turkey, relies on simple SMS information to help farmers prevent

losses to frost and pests in their orchards. Prior to the project, producers could not obtain weather information on time to cope with conditions that might harm their orchards. (See the IPS, "Weather Forecasting Reduces Agricultural Risk in Turkey," in Topic Note 3.1.)

#### **BOX 5.8: Modeling India's Groundnut Yield through Climate Information**

In India, rainfed agriculture supports more than 60 percent of the population. In the semiarid Anantapur region, rain typically falls from May to November, yet it varies significantly from week to week, resulting in frequent wet and dry spells. If a dry spell occurs at a critical planting stage, groundnut yields decrease significantly.

Attempting to identify the most promising planting times, researchers used the PnutGro model to simulate groundnut growth and yield. The model included vegetative and reproductive development, carbon balance, nitrogen balance, and water balance. The team collected climate data from the Anantapur Agriculture Research Station, which has maintained records since 1962. Using maximum and minimum temperatures, radiation, and rainfall data over three decades, they found that the period between July 15 and August 10 is associated with very high yields. Even more important, planting in two additional periods was also associated with high productivity, suggesting that missing the earlier planting time does not mean that yields will be low for the entire season.

Like all models, this one is limited: it cannot be used to assess the profits or risks associated with management strategies in times of crisis (like the El Niño weather pattern). Nonetheless, analysis of yields associated with different climatic conditions can help to improve farming strategies for specific seasons and raise red flags for potential weather disasters after investments have been made.

Source: Gadgil, Seshagiri Rao, and Narahari Rao 2002.

Mediation software was also essential for modeling groundnut yields in India (box 5.8). Among other things, the models can help identify the best times to plant to evade drought.

Other forms of electronic weather information have potential to increase productivity, primarily by reducing risk. Many of these systems are being tested in OECD countries. eWarning ([http://www.landbrugsinfo.dk/Planteavl/Sider/pl\\_11\\_543.aspx](http://www.landbrugsinfo.dk/Planteavl/Sider/pl_11_543.aspx)) was created through PlantInfo ([www.planteinfo.dk](http://www.planteinfo.dk)), a Danish initiative supporting decision making in national plant production. eWarning provides farmers with real-time weather information sourced by the AgriMeteorological Information System and Danish Meteorological Institute. In this particular system, weather information, including precipitation and temperature, is divided into 10-square-kilometer plots to provide farmers with specific climatic details on specific plots.

In eWarning and other systems, farmers request information through SMS in two forms. Push-type messages are regular, automatic updates obtained through a user subscription. Pull-type messages are sent only when a user requests them. When the user sends a letter (like “P”) in a message, the eWarning system will respond with information on precipitation for the user’s geographical location. Surveys show that the push-type message is most popular, providing farmers with an hourly forecast up to four times per day (Jensen and Thysen 2003).

A Yakima software firm, in partnership with Washington State University, is customizing a weather website for specific locations to provide weather alerts to farmers in the United States. These alerts include frost warnings, wind speed with recommendations for pesticide spraying, and information on disease outbreaks. After a farmer has registered for the

service online, he or she can request information and specify the method to receive it (via text, email, or recorded voice message). Eventually, the service will offer climatic information in Spanish, making it easier for native Spanish speakers to make interpretations and decisions (Lester 2010). In the future, similar ICTs can be used in rural areas of developing countries.

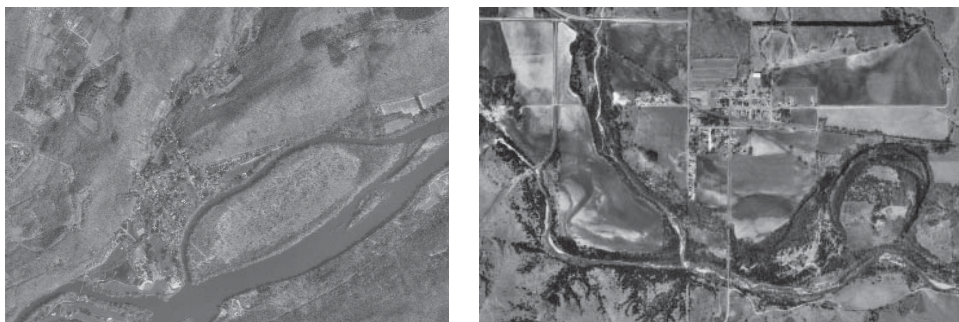
## IRRIGATION MANAGEMENT

Major water resource constraints and climate change make it increasingly important for developing countries to develop sound water-use policies and well-functioning, well-managed irrigation systems. Innovative water management systems and ICTs are helping to improve water use and expand intensive irrigation facilities. Though the number of technologies for irrigation is vast, this section focuses on remote sensors, satellite imagery, and GPS cameras. Each of these technologies helps to connect the farmers to irrigation infrastructure and guide governments in designing and implementing irrigation strategies.

ICTs help address some of the challenges inherent in creating and sustaining irrigation systems in rural areas. The function of water-user associations and their productivity improve through ICTs like mobile phones and personal device applications PDAs), which increase the quality and frequency of producers’ communication and interaction. Sharing information about emergency maintenance problems, entitlement rights, and management schedules is facilitated through ICT, which allows real-time responses even between users from distant communities.

Digital orthophoto quads (DOQs), a feature of GIS, are digital maps that combine the geometric information of a

### IMAGE 5.7: Two Examples of Digital Orthophoto Quads



Source: United States Geological Survey.

regular map with the detail of an aerial photograph (Neale 2003) (image 5.7). DOQs provide spatial illustration of terrain, including elevation and property boundaries, which can help delineate irrigation canals and drainage systems. Given the high and increasing value of rural land, it is worth noting that the resolution and georeferencing possibilities of most satellite remote sensing systems are not yet adequate to demarcate property accurately. Nonetheless, achieving greater accuracy and confidence in property boundaries is essential to limit the land disputes that ensure when new irrigation schemes are designed and built. DOQs can help to achieve this higher level of resolution, but sometimes at higher costs than other high-resolution imagery. (See IPS “Digital Orthophoto Quads Form a Database for the Dominican Republic” in Topic Note 5.2.)

LiDAR (laser scanning) is a new technology for obtaining a highly detailed digital terrain model or, if equipped with an aerial camera, for topographic mapping. A digital terrain model is basically a digital representation of an area’s terrain on a GIS that provides accurate position and elevation coordinates. It is compatible with other digital spatial data, is more accurate, and has a higher resolution than satellite images. Elevations can be accurate within 5 centimeters, but accuracy typically is closer to 10 or 20 centimeters. In comparison, digital aerial cameras only provide only about a 20-centimeter horizontal resolution.

Because of its detailed imagery, a digital terrain model can be used for meticulous engineering designs such as those for roads, drainage, gravity-fed irrigation works, and detention reservoirs. These models can also be used more broadly to manage land and water (for example, in flood control). When combined through GIS with other data such as soil types, these models can help to identify areas with potential slope instability and erosion, which are important for reducing soil degradation and its negative impact on soil fertility. At the field level, digital terrain models can monitor and improve areas affected by waterlogging or flooding. Overall laser scanning has considerable potential for planning irrigation schemes, designing infrastructure, managing irrigation operations, and modeling. Laser scanning is most useful for large areas because the aerial operation is expensive. The cost of laser scanning also depends on the accuracy of the data required, location of the area of interest, and level of the data products (such as GIS layers).

Satellite data can also prove useful in managing irrigation schemes, such as the enormous Office du Niger scheme in

Mali (see IPS “Using Landsat to Assess Irrigation Systems in Mali” in Topic Note 5.2). This irrigation scheme, one of the largest in West Africa, produces 40 percent of Mali’s rice crop and is key to national food security.

An equally intriguing ICT for irrigation management, specifically for monitoring the construction of irrigation systems, is GPS cameras. The cameras are relatively cheap and user friendly; when a project worker photographs infrastructure, the camera records the date, time, longitude, and latitude automatically.

Afghanistan’s national Emergency Irrigation Rehabilitation Project (funded by the World Bank) was delayed owing to increases in conflict in certain regions, but now GPS cameras provide “remote supervision.” As the irrigation project unfolds, water users can photograph the construction process to make contractors more accountable and prevent financial resources from being wasted. Users can report infrastructure problems to the government without needing to travel through potentially dangerous regions.

Project workers have photographed over 650 locations where irrigation construction projects are being implemented. These photos, which are emailed or delivered by hand to ministry offices, serve as the baseline for progress (World Bank 2010b). A crucial point is that the technology also enhances the participatory process, which may improve user associations’ productivity once the irrigation system is complete.

## LESSONS LEARNED

This note has described the many ways that ICTs enable real-time adjustments in agricultural practices to prevent losses after investments have been made. These technologies also have considerable potential to help small-scale producers use scarce resources—water, nutrients, and others. Greater certainty about the weather, access to water, and disease outbreaks can lead to better decisions and higher productivity. These ICTs also face important challenges, however, and a number of considerations are important in improving their effectiveness, especially for smallholders.

Strategies to improve agricultural practices change dramatically over time, just as strategies to manage irrigation have evolved from a nationally operated to user-operated model. ICTs aimed at preventing crop or livestock losses must adapt in line with these strategies so that users



receive current information, communicated in the most cost-effective way.

Local knowledge is critical to improving smallholders' productivity. ICT not only creates opportunities to disseminate information but offers ways of capturing local expertise. Vast differences in ecological and agronomic conditions make farmers' knowledge indispensable. ICTs should be used to form two-way communication networks, ensuring that local knowledge is acquired and utilized.

The collective action problem is quite apparent in relation to the technologies described here. Water management and disease control require hundreds or even thousands of farmers to perform the same tasks in unison. By strengthening information sharing, ICTs like mobile phones will increase the potential for collective action. Self-policing may also be crucial to the technology's success.

ICTs to disseminate information like weather forecasts must match capacity in the focus area. Some phones handle complex messaging; others do not. Local ICTs may need to improve before some preventive technologies can work in developing countries. Taking stock of the technical capacity in rural areas will clarify infrastructure needs.

Gender is an important consideration when using ICTs to prevent crop loss. Women are often already involved in maintaining water resources (for domestic and agricultural use) in their families. Involving them in water management or pest control projects increases their time to attend to other important activities like education and generating income. It also often results in more effective management.

Timing is a major concern in weather, water, disease, or pest ICT. If information is sent too late, farmers may not have time to adjust their farming strategy. If information arrives too early, farmers may make changes that prove unnecessary or even damaging.

Information must be relevant and clear. Too much text or scientific data can conceal the message and cause confusion. Only the most appropriate and contextually-based information (like forecasts) and updates should be provided. By continually interacting with farmers and monitoring their responses to information, project managers can clarify which information needs to be sent and which does not.

Keeping information current is expensive. Collaborating with various agencies and creating common systems and

technologies can help achieve economies of scale to reduce costs (IICD 2006).

Just as they can be overwhelmed with too much new information, farmers can be overwhelmed with new technology and become reluctant to use it. Advances in ICT are best suited to helping farmers improve their management of one or two farm components at a time. Development partners and governments need to prioritize which yield technologies or agricultural strategies they would like to introduce and use ICTs to disseminate them to a broad population.

Limited financial resources are also a potential limitation to using these technologies. Large agricultural firms and smallholders alike need to control agricultural water, diseases, or pests. Incentives for the private sector to partner with government in large-scale ICT projects may enable the investment to reach smallholders as well.

### **INNOVATIVE PRACTICE SUMMARY** **Radio Frequency Identification to Prevent and Treat Cattle Disease in Botswana**

Implemented by Inala Identification Control (IIC) in South Africa, the Livestock Identification Trace-Back System in Botswana is one of the largest and more innovative forms of ICT for animal husbandry, involving over 300 million cattle.<sup>6</sup> The system, which uses radio-frequency identification (RFID), serves many purposes, including meeting beef import requirements for the European Union (EU), the destination for 80–90 percent of Botswana's beef exports. The system also improves veterinary services and livestock health.

A bolus with a unique ID number and a transponder is inserted into each animal's rumen. In the field, 300 fixed readers scan cattle ID numbers and relay information to databases in 46 district offices. The bolus collects information that allows both herdsman and the government to monitor new registrations, look for possible disease outbreaks, identify lost or stolen cattle, track weight gain, and plan for animal treatments. The database also provides the opportunity to monitor trends over time.

Technology like this offers many benefits. The bolus is safe for animals, protected from criminal tampering, and can be recycled, which keeps costs low. The bolus also saves time: Ear-tags, the traditional form of identification, required

<sup>6</sup> This section draws on Burger (2004).

herdsmen or veterinarians to handpick cows through a lengthy process. This system speeds up the identification process. Herdsmen can optimize feeding schedules, select certain bulls for breeding programs, and keep updated health records, which improves productivity directly by reducing susceptibility to disease and planning for yields.

### INNOVATIVE PRACTICE SUMMARY

#### Digital Orthophoto Quads Form a Database for the Dominican Republic

Digital orthophoto quads (DOQs) can do much more than provide digital maps. By tracking the photos, it is possible to create water databases that are crucial to the success of irrigation. The databases can provide real-time information on heavily and sparsely irrigated locations, statistics on water use (and subsequently water users), drainage problems, and even salinity issues.

This kind of database featured in a program to improve users' management of irrigation systems (PROMASIR) in Dominican Republic in partnership with the Inter-American Development Bank and Utah State University.<sup>7</sup> By combining DOQs with other information (such as information on property ownership), the database enables water users to search for other water users, observe property boundaries, review monthly crop and water statistics, or obtain estimates of irrigation water demand in certain areas. Users have access to more accurate information to use when updating their infrastructure as well as more insight into potential maintenance problems (such as a system breakdown upstream). Assigning water rights and water fees are also easier with databases. In areas with greater demand, prices can be expected to rise. Finally, a system like this can also prevent conflicts over water, because all users have access to the same factual information, such as price information and plot size.

An important point, however, is that smallholders who typically use agricultural water to meet their own needs for sustenance may not be accustomed to the kinds of collective action needed to develop and sustain large water management networks. They may maintain an individual farm mentality even when technologies like DOQ databases are available.

<sup>7</sup> This section draws on Neale (2003) and World Bank (2006). PROMASIR is the Programa de Mejoramiento y Administración de Sistemas de Riego por los usuarios.

### INNOVATIVE PRACTICE SUMMARY

#### Using Landsat to Assess Irrigation Systems in Mali

The Office du Niger, a vast irrigation scheme dating to the 1920s in Mali, delivers water from the Niger River to approximately 80,000 hectares of rice fields. The irrigation scheme is divided into five administrative zones, each responsible for its own water management. The scheme's senior staff use data from Landsat (which uses sensors to record reflected and emitted energy from Earth) and other sensory data (including air temperature and humidity) to analyze cropping intensity, assess water productivity, and monitor equity in water distribution.<sup>8</sup> The data are also used to compare the productivity of fields at the head (beginning) of the water source with the productivity of the fields at the tail (the most distant point from the water source).

Landsat has the ability to "see" a variety of colors as well as near-infrared, mid-infrared, and thermal infrared light, which helps to distinguish differences between land plots or water sources. Initial results from Landsat images revealed critical similarities and differences between administrative zones that irrigation managers can use to determine and address the causes of yield variation (for example, low yields in fields near the tail). To gain even greater clarity on why irrigation may succeed or fail in a given location, remote sensing and GIS images such as those used in Mali can be coupled with other statistics like administrative boundaries, crop data, and poverty levels in GIS maps.

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<sup>8</sup> This section draws on World Bank (2010c) and NASA (n.d.).

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## **PERSONAL COMMUNICATION**

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T. Jantunen, March 9, 2011.

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## Module 6: ICTS AS ENABLERS OF AGRICULTURAL INNOVATION SYSTEMS

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### IN THIS MODULE

**Overview.** Research, extension, and advisory services are some of the most knowledge-intensive elements of agricultural innovation systems. They are also among the heaviest users of information communication technologies (ICTs). This module introduces ICT developments in the wider innovation and knowledge systems as well as explores drivers of ICT use in research and extension.

**Topic Note 6.1: ICT in the Agricultural Research Process.** This section spans the entire agricultural research process from engaging partners and stakeholders, through data collection and analysis, collaboration and knowledge access, publishing and dissemination, to feedback and interactions with rural and other end-user communities. In each of these areas, ICTs are making agricultural research more effective.

- **Advances in ICTs Increase the Utility of African Sites for Testing Varieties**
- **KAINet Kenya Knowledge Network Anchored in Partnerships and Collaboration**

**Topic Note 6.2: Using ICT in Extension and Advisory Services.** This note looks at ways ICTs are helping transform extension, including the emergence of public and private innovators and startups with business models built around ICT-enabled advisory services. It examines how traditional and new ICTs are being used to reach rural communities, enable the creation and sharing of rural communities' own knowledge, and support connections of rural communities to markets, institutions, and other sources of information and advice.

- **Farm Radio International Involves Men and Women Farmers**
- **E-Extension in the USA and Philippines**
- **TECA Uganda Exchange Group Offers Practical Advice for Smallholders**
- **Participatory Video and Internet Complement Extension in India**

**Topic Note 6.3: E-learning as a Component of Agricultural Innovation Systems.** Learning through ICTs can provide fresh approaches that are learner-centric, which engages producers and their communities in designing and implementing the learning experience. It can also make it easier to maintain quality by supporting feedback mechanisms and ensuring appropriate accreditation and certification processes. This note also explores some of the adaptations and strategies required for e-learning to succeed in rural areas of developing countries.

- **Lifelong Learning for Farmers in Tamil Nadu**
- **Innovative E-Learning for Farmers through Collaboration and Multi-Modal Outreach**

### OVERVIEW

The traditional approach to fostering innovation in agriculture is often described as linear: Researchers develop an innovation such as a disease-resistant wheat variety, extension services advise farmers through demonstrations and other methods that a more disease-resistant variety is available,

and farmers plant it. The problems with this approach have been widely acknowledged. It can encourage research and extension to act independently of one another and of farmers, to the extent that each group becomes relatively isolated. A linear approach can exclude other stakeholders in the agricultural sector such as universities, agribusiness,

traders, and nongovernmental and civil society organizations. It does not reflect the many well-documented ways that agricultural innovation actually occurs, such as experimentation by individual farmers, informal networking among farm communities, private sector participation, collaboration among extension workers interested in a particular idea, collaboration between researchers and farmers, and the adaptation by all of these actors of knowledge and practices from domains outside agriculture.

A few decades ago, practitioners began to use the concept of innovation systems to explain noteworthy economic performance driven by a strong orientation to innovation in some developed countries.<sup>1</sup> An innovation system can be defined as “a network of organizations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organization into economic use, together with the institutions and policies that affect their behavior and performance” (World Bank 2006). This thinking recognizes that interactions of people and ideas catalyze innovation and that innovation consists of generating, accessing, and putting knowledge into use (Hall 2006). It also recognizes the importance of institutions and policy in fostering innovation.

### ICTs and Agricultural Innovation Systems

ICTs appear ideally suited to the task of enhanced interaction because they can expand communication, cooperation, and ultimately innovation among the growing array of actors in agriculture. ICTs, especially mobile phones, can and do drive participatory communication, including communication from those on the margins of traditional research-extension processes, and they are often the key instruments that organizations use to deliver services to larger numbers of rural people than they could reach before. ICTs are fundamental to the business models of the “infomediaries” and “brokers,” public and private—extension agents, consultants, companies contracting farmers, and others—emerging to broker advice, knowledge, collaboration, and interaction among groups and communities throughout the agricultural sector.

Numerous electronic tools increase interaction among the actors involved in agriculture. On a macro level, e-Science (e-Research) draws on increasingly connected and extensive digital infrastructure to facilitate collaboration and knowledge exchange nationally, regionally, and globally. On a micro level, m-Agriculture, powered by increasingly affordable mobile digital devices such as phones, laptops, and sensors,

connects millions of rural people to sources of information. In both cases, ICTs empower individuals and institutions to create, access, and use knowledge and to communicate in unprecedented ways. In agricultural extension and education, from universities to farmers’ fields, ICTs facilitate learning.

### ICT-Enabled Tools

As ICTs have developed and become more pervasive, they have become more relevant in agricultural innovation systems. The most pertinent developments for research, extension, and e-learning are reviewed briefly below.

First and foremost, the increased pervasiveness of telecommunication networks has enabled ICT to reach rural areas. Technologies that have long been applicable to poor agricultural communities have not been effective simply because they are difficult to get into the hands of rural users. Expanded telecommunications networks have increased the speed, reliability, and accuracy of information exchange—through text, voice, and applications—between farmers and other stakeholders. Low-bandwidth networks have also started to trickle into rural areas in developing countries, creating opportunities for farmers to connect with extension workers, agribusiness, researchers, and each other. For example, telecommunications networks have facilitated e-learning by liberating it from the classroom and from the need for the user to invest in anything other than a mobile phone. Power lines and power sources critical for the regular use of and upkeep of ICTs also continue to expand. (See Module 2 for more information on the growth of this infrastructure.)

Second, cloud computing services have immense potential to improve agricultural innovation systems. The advantage of cloud computing is that it offers pooled and elastic resources on demand over the Internet (Porcari 2009). More specifically, cloud computing has been described as “a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction” (Mell and Grance 2009). Over the past few years, these services have created opportunities for data sharing initiatives that were once prohibitively expensive for most institutions to explore, let alone students conducting master’s or doctoral research. They have also eased the data collection and aggregation process, which is critical for research, extension, and education.

For example, a website such as Amazon Web Services can be used to acquire a Windows or Linux server by specifying

<sup>1</sup> See Freeman (1987) and Lundvall (1992).

how much processor, bandwidth, and storage capacity are needed. The required resource is made available immediately over the Internet, and the cost is based on how long the server is used. Cloud computing's elasticity and variable capacity make it possible to process very large datasets, which can also be shared with anybody with adequate connectivity (box 6.1).

### **BOX 6.1: Datasets on Amazon Web Services**

Public Data Sets are a centralized repository on Amazon Web Services (AWS) for public data that can be seamlessly integrated into AWS cloud-based applications. AWS hosts the datasets at no charge for the community. As for all AWS services, users pay only for the computing and storage they use for their own applications.

Previously, large datasets such as those in the Human Genome Project and United States Census required hours or days to locate, download, customize, and analyze. Now anyone can access these data from their Amazon Elastic Compute Cloud (Amazon EC2) and start their computations within minutes. Users can also leverage the entire AWS ecosystem to collaborate easily with other AWS users. For example, users can produce or use prebuilt server images with tools and applications to analyze the data sets. Users can also discuss best practices and solutions in the dedicated Public Data Sets forum (<http://aws.amazon.com/publicdatasets/>).

*Source: Authors.*

Third, the movement toward open access and public involvement through online or mobile tools also favors agricultural innovation, not only in research institutions but more broadly among all participants in an innovation system. Governments, organizations, and even the private sector are sharing data and reports with the public and one another through ICT. As ICT has alleviated the difficulties inherent in interactions among people in dispersed locations, knowledge sharing and multistakeholder engagement are widely acknowledged to have increased. Research can involve more expert opinion and diversity (box 6.2). Advisory services can tap a much wider range of current expertise and provide advice in a much more targeted way to those who need it. With Internet access, e-learning can occur even in the absence of a formal distance education program, and web platforms such as agropedia, discussed in Topic

### **BOX 6.2: Social Media Support Research Project Review and Reporting**

The System-wide Livestock Program of the Consultative Group for International Agricultural Research uses social tools to capture, record, and share discussions at its project review and planning meetings. A wiki was used to plan and report on meetings. A pre-meeting survey among participants was conducted using SurveyMonkey. Scientists in remote locations were brought in using the "webex" Internet conferencing system. During the meeting, all the resources prepared and shared were published online. The results of the intense "internal" small group discussions were recorded on video and shared on the project website. A key feature is the use of social "reporting" to share information that normally remains internal and closed.

Similarly, the Fodder Adoption Project organized an end-of-project meeting for project participants from Ethiopia, Syria, and Vietnam to draw lessons and share results. The organizers used web tools to document and share all the notes, contributions, and discussions at the meeting. By the end of the meeting, the wiki contained the essence of the workshop report (<http://fodder-adoption-project.wikispaces.com/Final+Workshop>). Video interviews recorded the group discussions (usually this tacit knowledge is lost) and a series of blog posts shared the meeting "live" with wider audiences.

In these cases, web applications directly contribute to research meeting organization, reporting, and dissemination. The tools are free or inexpensive. They require Internet connectivity (at a high speed if video is part of the package), some digital skills among meeting organizers and participants, a willingness among participants to embrace an extended digital toolkit and workflows, and an open attitude to sharing "internal" discussions more broadly.

*Source: Author; see also <http://vslp.org> and <http://fodderadoption.wordpress.com>.*

Note 6.3, make it much easier to develop and transmit content for e-learning programs.

Finally, new forms of knowledge brokering have been made possible through ICT (image 6.1). Knowledge brokering has always been an integral part of agricultural innovation systems (box 6.3). The creation and passing of information



**IMAGE 6.1:** Specialized Knowledge on Farm Practices Can Result in Profitable Enterprise



Source: Dominic Sonsoni, World Bank.

between farmers and extension agents, farmers and researchers, and researchers and extension agencies, among others, is critical to innovation and increased productivity through adoption of better farming practices and technologies. Knowledge brokering is becoming a specialization—sometimes a profitable one.

On a more basic level, as digital literacy and the availability of ICTs increase, farmers, traders, and others in developing countries are offering information services for a small fee. This private activity can widen the availability of information in rural areas and reduce pressure on public extension agents, who are charged with getting timely and locally relevant information to farmers. Private sector involvement in advisory services has almost always been more

successful than the involvement of public services with their very broad mandates, but until recently the high costs of such services limited private advisory initiatives. An issue that policy makers need to examine, however, is how public advisory services and other forms of knowledge brokering will meet the needs of rural people who are not linked into the innovation system through ICT, either because they cannot access it or do not yet know how to use it effectively.

### KEY CHALLENGES AND ENABLERS

The topic notes and innovative practice summaries in this module demonstrate the potential for ICTs to enable agricultural innovation systems to develop and function more effectively, but enormous challenges in pursuing this agenda remain. Two key enablers—policy change and collective action (among research institutions, extension agents, governments, and farmers)—are critical to using ICTs such as mobile phones and the Internet in agriculture and enabling the many relatively small, scattered innovations in the agricultural sector to add up to major impacts. Policy change can spur development of the underlying infrastructure for ICT-enabled information sharing, and collective action, facilitated by digital tools, can push the agricultural agenda forward.

Just as roads are essential for rural development, digital connectivity is becoming essential for research, extension,

### BOX 6.3: Innovation Brokers at the Heart of Networking and Communication in Agricultural Information Systems

Innovation brokers are teams of specialists that combine a strong background in agricultural science with knowledge of business, marketing, and/or the creation of innovation networks. Innovation brokers support linkages among actors in the agricultural innovation system and help farmer organizations and private firms manage projects. They teach courses on the management of innovation, assess the actors' innovation capabilities, propose actions to strengthen them, and may facilitate the implementation of the recommendations. Innovation brokers may also help governments and donors to develop their own innovation capabilities and to explore new instruments to foster innovation. NGOs, specialized service providers, or public organizations (including research or educational institutions) can play this role. Klerkx, Hall, and Leeuwis have concluded that "innovation brokerage roles are likely to become relevant in emerging economies and that public or donor investment in innovation brokerage may be needed to overcome inherent tensions regarding the neutrality and funding of such players in the innovation system."

Source: Adapted from World Bank 2012 and Klerkx, Hall, and Leeuwis 2009.

and e-learning. Connectivity does not depend on national policy alone; it is affected even by the policies prevailing in an institution. Researchers may want to disseminate results more widely and increase their usefulness, for example, but they can be inhibited by institutional information technology (IT) and intellectual property policies that limit opportunities to tap into the open access movement.<sup>2</sup> If national research systems do not digitize their research results and create repositories for them, other organizations are limited in their ability to access and share findings in a wider network. Extension programs, other agricultural services, and producers suffer the consequences. Appropriate institutional policies and general e-readiness are essential to build innovation cultures where ICTs thrive and are put to good use.

Even if all farmers in poor countries own phones, however, this connectivity will not ensure that extension agents and researchers will listen to what farmers have to say and adapt their programs accordingly. Nor will it guarantee that farmers can use any knowledge they may obtain; as Topic Note 6.3 indicates, farmers learn best when the information is carefully targeted to their needs and when multiple stakeholders provide incentives for learning (for example, in the form of a mobile phone for learning any time and any place, and a bank loan to put their new knowledge to use). Investments in agricultural innovation systems give particular attention to building the capacity to innovate (especially the capacity to share and use knowledge) and to the enabling environment that fosters innovation.

ICTs to facilitate communication and engage many stakeholders are fundamental to such an approach. Much stronger farmer representation and influence are also needed in the forums where research and program priorities are determined. Specific reforms and incentives are needed for service providers to become more accountable to clients, and ICTs can make a difference by strengthening

feedback systems and accountability. ICTs can help people to learn the interactive skills (collaborating and negotiating, for example) that have proven critical in effective innovation systems, and they can help them to acquire agricultural and technical skills as well.

Building research networks, data repositories, and expert query systems and engaging in large data collection efforts require effective management and collaboration. In addition to committing resources, the right climate and culture must be created, including at senior management level, for collaborative planning, knowledge sharing, communication, cross-functional teams, and critical review of current information and communication systems.

ICTs are also fundamental to enabling advisory services to fulfill their primary role in an agricultural innovation system, which is to serve as a central node for knowledge sharing and innovation brokering (including brokering new partnerships). The nature of farmer engagement, two-way communication, information requirements, and the complexity of extension networks all make the design of advisory service programs critical to their ultimate success. In designing advisory programs that use ICTs, the basic requirements for developing an ICT service must be considered, including ICT policy, rural connectivity, and user fees; the information and communication needs of potential stakeholders; functional linkages; existing communication channels and knowledge sources; lessons related to previous information dissemination and networking efforts; farm diversity; and demographic, political, and environmental demands (image 6.2).

**IMAGE 6.2:** ICT Must Be Complemented by Other Inputs Like Improved Seedlings



Source: Dominic Sansoni, World Bank.

<sup>2</sup> They may also be limited by inadequate policies on intellectual property. The urge to protect research results can be strong, especially if they represent a potential source of income for impoverished national research programs. Many public organizations, lacking expertise in intellectual property management and protection, opt for the most restrictive policy on information sharing, even though they recognize that it is detrimental to innovation (see World Bank 2012, Modules 6 and 7).

Given that agricultural innovation systems are generally quite complex and diverse, it is often challenging to identify who has been excluded or which targets have been missed. As agricultural innovation systems become more digitally engaged, there are growing opportunities to use ICTs to monitor them, track the interventions of numerous stakeholders in multiple processes, and evaluate innovation system performance more effectively. Good monitoring and evaluation design, effective use of the data collected, and emerging analysis, reporting, and visualization tools yield better insights into what agricultural innovation systems produce, who uses and benefits from the products of innovation systems, and where the challenges are.

Finally, not all of the ICTs available for agricultural information systems will work in rural areas. Analyzing the technical capacity (infrastructure, connectivity, accessibility, affordability,

equipment) as well as staff capabilities (in software development, IT understanding) in line departments, local government offices, or research centers are two critical prerequisites to implementing effective technical services. Public-private partnerships can be forged, particularly for commercially oriented extension or e-learning (see IPS “Lifelong Learning for Farmers in Tamil Nadu” in Topic Note 6.3), to improve telecommunications infrastructure, identify sustainable business models, and aid in capacity building and training. Box 6.4 reviews areas that require attention when using ICT in agricultural innovation systems (AIS).

### ORGANIZATION OF THIS MODULE

This module focuses specifically on how ICT can be used in three major, interrelated components of agricultural innovation systems, especially to build innovation capacity and

#### BOX 6.4: Key Considerations When Using ICT in AIS

**Policies.** Generate or adapt institutional and national strategies and policies to make the introduction of ICT innovations more frequent and more effective.

**Institutions.** Adapt organizational structures at all levels to accommodate changes in ICT systems and information management processes, develop new incentive structures to encourage all innovation actors to contribute novel outputs or to stimulate collaboration, and develop innovative business models, particularly where they relate to mobile devices and telecommunications.

**Individuals.** Develop and diversify the skills and competencies of all stakeholders in applying ICTs for innovation. Invest in the skills of new intermediaries, such as innovation brokers, who specialize in linking actors and resources to foster innovation and often rely on ICTs to do so.

**Content.** Stimulate open access to the increasing volume of outputs of agricultural research so that all can benefit. Develop and comply with coherent standards that continue to improve the interoperability and exchange of data among stakeholders.

**Processes.** Use ICTs to facilitate and open up inclusive multi-actor processes in which knowledge flows and can be put to use by different stakeholders. Facilitation will be needed at various levels to bridge divides and gaps in access to ICTs and in institutional strength.

**Technologies.** Invest in greater connectivity, data and information generation and handling capacity, hardware, software, and improved human-computer interfaces that have been purposefully designed to enable innovation. Ensure that rural ICT infrastructure and connectivity are enhanced. Specific actions are needed to overcome barriers to technology use, such as culture, language, and gender. A recurring challenge is the fast-moving pace of change and development in the technologies.

**Monitoring and evaluation.** Develop new and improved tools and approaches to assess information and knowledge interventions more effectively.

**Capacities.** Invest in the technical and organizational capacities of individuals and institutions so they appreciate and use ICTs as tools to enhance knowledge creation, transformation, and innovation. These capacities are more than just technical; appropriate mindsets and incentives are essential to encourage information and knowledge to flow.

Source: Authors.

foster an environment in which innovation occurs more readily: research and knowledge sharing systems, advisory services, and e-learning. Each of these components is discussed in a topic note.

Topic Note 6.1 focuses on the use of ICTs in research for agricultural development. Investments in infrastructure and digital research collaboration, along with rapid developments in mobile devices and connectivity in rural areas, are changing information and knowledge flows. This note focuses on general research processes rather than specific applications, describing how ICTs are altering research collaboration and data collection, analysis, storage, and dissemination. For example, the note describes efforts by individuals and research organizations to make formal and informal research outputs (peer-reviewed journal articles and unpublished literature) freely and openly available on the Internet using low-cost technologies.

Topic Note 6.2 describes how ICTs are benefiting agricultural extension and advisory services. Many countries are reassessing the organization, mandates, and partnerships of their agricultural advisory services to reach farmers and other clients more effectively. “Extension” is no longer a public

employee traveling among villages to deliver technologies to farmers. This note is organized around broad functions of ICTs in supporting this new notion of advisory services: the need to provide localized, customized, and highly accessible information; the need to archive and provide reference information for a wide array of actors in the sector (from fertilizer application rates to quality standards for food processors and exporters); the need to facilitate networks (local, regional, global) for collaborative, interdisciplinary approaches to problem solving and research diversification through shared knowledge bases, online forums, and collaborative spaces; and the need to empower and “give voice” to rural communities.

Topic Note 6.3 focuses on electronic learning, especially its potential for building capacity in extension providers and in producers. E-learning potentially enables any actor in the innovation system to reach large numbers of producers, involving them as partners and adult learners in designing and implementing the learning experience. The use of ICTs such as mobile phones makes it possible for learning to occur without classrooms or fixed schedules, although face-to-face interaction and incentives for using the new knowledge are important for e-learning to succeed.

## Topic Note 6.1: ICT IN THE AGRICULTURAL RESEARCH PROCESS

### TRENDS AND ISSUES

This note discusses the entry points for ICT to be used in agricultural research for development. Agricultural research is a key part of any innovation system. As with other components of an innovation system, in agricultural research successful innovation depends on a number of variables. Particularly important variables are the partnerships surrounding the research process, the level of accountability shared by the partners, and the purpose, quality, and intensity of the research in which the partners are concerned.

In dramatic and well-documented ways, the effects of ICT have permeated the agricultural research process and the partnerships that define, sustain, and direct it toward development goals. For example, ICTs are making agricultural research more inclusive and at the same time more focused on development goals, because they change how, where, and to whom information flows. Information can flow in many directions; it can be highly dispersed and accessible, and it can be highly targeted, location specific, and location aware (Ballantyne, Maru, and Porcari 2010).

ICTs are becoming integral to the mechanics of the research process. They are also associated with the collaborative context in which the research process unfolds, and they are critical to the communication and accessibility of the data, information, and knowledge that researchers and their partners create.

These technologies offer new potential to developing country institutions, national research centers, and networks to participate in a worldwide digital knowledge economy (Kirsop, Arunchalam, and Chan 2007). Open repositories and Web 2.0 tools create opportunities for the more digitally connected stakeholder groups in research agencies and academia to generate, capture, store, analyze, and share virtually the entire range of research content, such as theses, data, images, researcher profiles, and so on. These technologies have also created more informal ways of communicating research outputs.

### COLLABORATING IN THE RESEARCH PROCESS

The need for collaboration cuts across the entire research process, from the conceptualization of a research program to the application of the results. In agricultural research for

### BOX 6.5: ICTs Engage Stakeholders in Formulating an Ambitious Research Program

In the summer of 2010, four international agricultural research centers in the Consultative Group for International Agricultural Research came together with partners to develop an innovative, inclusive research program on livestock and fish. Before the program could be developed, a very wide range of stakeholders (governments, funders, extension, research, the private sector) participated in extensive consultations, not only in person but online. Their efforts were supported by a wiki to enable documents and other resources to be shared in a transparent, efficient, and cost-effective manner; a blog where assumptions and questions were posed and comments received; and several online surveys developed using the SurveyMonkey tool. The process and documentation were fully open. All documents, presentations, and interviews were publicly available.

Fostering broad and deep engagement among numerous stakeholders to develop a very large research program is not a simple or brief task. For this particular program, the e-consultation began in July 2010 and consisted of eight rounds of questions, each focused on a different aspect of the proposed research. The initial proposal emerged after five rounds of consultation, each including a survey (a series of statements with which participants were invited to agree or disagree) and an opportunity to submit open-ended comments. Three more phases of the e-consultation followed in February 2011. During this time, revisions to the initial proposal based on an external review were shared and tested in public through the e-consultation forum.

Between July 2010 and March 2011, the various e-consultation tools and resources were viewed more than 25,000 times. The organizers received 465 comments and other feedback on questions and surveys. The consultations raised a number of concerns and suggestions that were instrumental in strengthening the proposed program throughout its development.

*Source:* Program proposal (<http://livestockfish.wordpress.com>).

development, for example, priorities are often based on the needs of small-scale farmers with very limited resources. ICTs are making it easier for research organizations to link with these stakeholders and document and understand their needs, thus enhancing the relevance and effectiveness of their research. ICTs also make it possible to consult a much wider and more dispersed network of stakeholders (such as producer groups, technical experts, private sector, research administrators, and policy makers) prior to developing a research program (box 6.5).

An integral part of “who to include in the collaborative research process” is “where to do the research.” The local nature of agriculture, from the environment’s effect on crops and biodiversity or the social and cultural norms that influence the agricultural sector (for example, in one location women are quite active as small-scale farmers and traders; in another, they never work alone in the field and are forbidden from selling produce to strangers), suggests that it is usually necessary to pick locations appropriate to the locale in which the results are to be applied.

Here again, ICTs have proven quite useful making these links. For example, in developing new varieties with specific traits needed by small-scale farmers (such as drought tolerance or resistance to a particular disease), plant breeders have relied for years on ICTs to collect, analyze, and validate data to identify field testing sites that are representative of conditions in

small-scale farmers’ fields (see IPS “Advances in ICTs Increase the Utility of African Sites to Test Varieties” in this topic note). In Tanzania, researchers have added to their capacity to track and monitor the development of cassava mosaic disease and cassava brown streak disease because ICTs offer a means of cooperating with the distant farming communities whose crops represent the front lines in these pandemics (box 6.6).

Communication in agricultural research is traditionally dominated by a focus on the dissemination of “end-results”—by publishing journal articles or otherwise reporting on results. To make research more relevant, open, and accessible, ICTs are used in some organizations to enhance knowledge sharing much earlier in the research process, during program formulation, design, and as part of ongoing planning and review (box 6.7). Increasingly, researchers are using digital social media tools, which are easy to access and use, to extend and open up communication and knowledge sharing throughout the research process.

To disseminate information on such approaches and tools, the Consultative Group for International Agricultural Research (CGIAR) has assembled a Knowledge Sharing Toolkit (<http://www.kstoolkit.org>) in conjunction with FAO, the KM4Dev Community, and UNICEF. The toolkit consists of knowledge sharing tools and methods to promote collaboration through each stage of the research project cycle. Online tools include collaboration platforms, wikis, blogs,

**BOX 6.6: Rural Tanzanians Update Researchers on Spreading Cassava Diseases**

Pandemics of cassava mosaic disease and cassava brown streak disease are reaching East and Central Africa. The costs of sending researchers to monitor disease development are high. Yearly visits have barely kept pace with these spreading diseases, yet early warnings of new outbreaks and greater community involvement in their control would considerably slow their progress through Africa.

The Digital Early Warning Network (DEWN) provided training and mobile phones to farmers in northwestern Tanzania so that they could recognize symptoms of the two diseases and text their findings to researchers. Information obtained from farmers was used to generate maps. One of the most significant findings was that brown streak disease reported by farmers was confirmed by researchers' visits to two districts where it had not previously been reported. This finding allowed project teams to concentrate disease mitigation efforts on these areas.

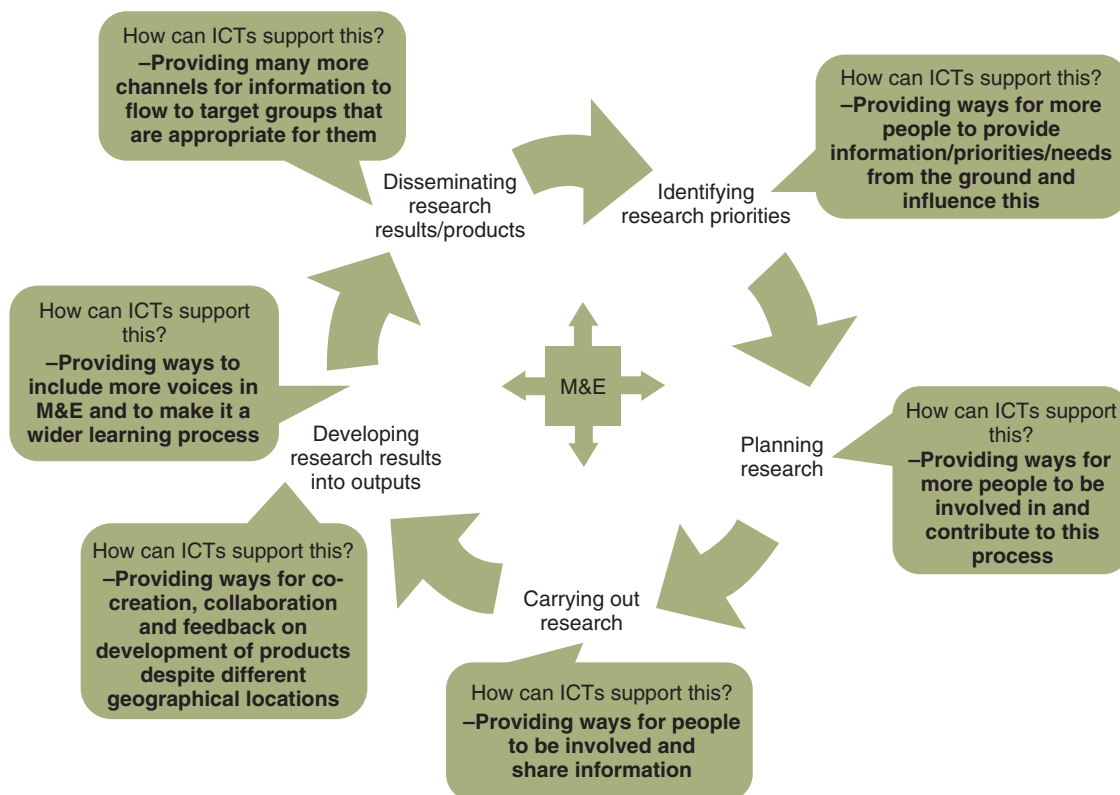
DEWN has provided an innovative, informative, and relatively cheap means of involving communities in monitoring and maintaining the health of their crops. Research has been enriched and cost-effectively extended through greater connectivity with the voices and knowledge of farming communities. DEWN was primarily piloted by the Lake Zone Agricultural Research Institute in Tanzania with the International Institute of Tropical Agriculture.

Source: Adapted from <http://r4dreview.org/2011/04/dewn-a-novel-surveillance-system/>.

photo sharing, podcasting, Google documents, discussion forums, intranets, content management systems and instant messaging. Each tool is described, with links to relevant resources and suggestions for use, on the website. Fig-

ure 6.1 illustrates how the CGIAR ICT-KM Program (<http://ictkm.cgiar.org>) perceives the relationship between the research cycle and different knowledge sharing and collaboration tools highlighted above.

**FIGURE 6.1: Knowledge Sharing and Collaboration Tools in the Research Cycle**



Source: Manning-Thomas 2009.

Note: M&E = monitoring and evaluation.

### BOX 6.7: Web-Based Tools Facilitate Research Collaboration

The last few years have seen the emergence of many web-based collaboration tools and approaches, frequently described as “Web 2.0” or “social media.” The key features of such tools are that they are web-based, free or very low cost, and very easy to use; they encourage interactions between people; and they offer ways to integrate different types of information from different perspectives.

These tools are used by the Nile Basin Development Challenge (<http://www.nilebdc.org>) in Ethiopia. This initiative is funded by the CGIAR Challenge Program on Water and Food to work with numerous national partners and a group of international centers to improve the resilience of rural livelihoods in the Ethiopian highlands. Web-based applications are used in the project to support interaction and sharing among the project team members and to communicate messages to wider audiences and stakeholders:

- The project has a shared wiki space where project members document activities and plans. This space has been used, for example, to share meeting agendas and reports, discuss issues, and share files.
- The project has a private conversation space on Yammer (<https://www.yammer.com/>), a social networking site for corporate purposes, where project members share updates, questions, and announcements.
- The project has a DSpace (<http://www.dspace.org/>) document repository where all public reports and resources from the projects are indexed and made accessible.
- A blog is used as a website with regular stories and updates from the project.
- Updates and news are spread across social networking sites like Facebook and Twitter.
- The project uses social media tools like Flickr to share photos, slideshare to publish presentations and posters online, and Blip.tv to publish video and film.

Such a web-based approach also requires complementary face-to-face, print, and offline tools and approaches to really engage with the rural communities “on the ground.”

Source: Author; see also <http://www.nilebdc.org/>.

### COLLECTING AND ANALYZING RESEARCH DATA

ICT is widely used to collect data, with the choice of technology depending on the kind of data needed. Surveys can be administered electronically. Information from online research collaboration can be recorded and analyzed using a variety of ICT tools. Mobile devices of all kinds record research data—smartphones, mobile phones using short messaging service (SMS) text messages, personal data assistants (PDAs), Global Positioning System (GPS) units, and specially designed equipment to measure indicators of soil nutrient levels, among others. Electromagnetic and photographic data are recorded by sensors in satellites and aircraft and on the ground. Small transmitters are used to collect, store, and send data, including data from radio-frequency identification (RFID) tags (Munyua 2007).

Mobile technology has also created opportunities for crowdsourcing farmers. Rather than perform data collection by hand or through paper surveys, researchers can collect data through SMS. Data on pest outbreaks, for example, can be recorded by asking farmers to text information to a premium number. Scientists and governments are able to monitor farming activities and local problems remotely and to predict regional and national challenges with greater certainty. SMS and other mobile devices have also eased data entry. Paper surveys, which require enormous amounts of labor after the initial data are collected, are being replaced with devices connected to software packages that automatically transfer the data to databases and statistical programs. iFormBuilder is an innovative application that collects rural survey data (<http://www.iformbuilder.com>).

In addition to collecting primary data, researchers often rely on secondary data to complete their analyses. For example, several organizations offer archival geographic information system (GIS) data, including remote sensing data, at increasingly better resolutions and sometimes free of charge.<sup>3</sup> Other organizations (public and private) offer data sequences of crop genomes. In the future, as biotechnology and agriculture increasingly overlap, results of nanotechnology applications in agricultural production and food processing and packaging<sup>4</sup> will increasingly be

3 See Stanford University’s Library and Academic Information Resources (“Websites for Digital GIS Data,” <http://library.stanford.edu/depts/gis/web.html>) and the CGIAR Consortium for Spatial Information (“What is CGIAR-CSI?” [http://csi.cgiar.org/WhtlsCGIAR\\_CSI.asp](http://csi.cgiar.org/WhtlsCGIAR_CSI.asp)).

4 For examples related to nanotechnology, see the National Institute of Food and Agriculture (<http://www.nifa.usda.gov/nanotechnology.cfm>).

collected and shared through the ICT (Interagency Working Group on Manufacturing R&D, Committee on Technology, National Science and Technology Council 2008).

The use of ICT to analyze research data appears virtually universal, although some research systems are limited by the infrastructure and applications available to them. Options range from custom software developed for a particular research project or organization to more generic packages such as GenStat Discovery Edition (<http://www.vsni.co.uk/software/genstat-discovery/>), a version of the widely used GenStat software for statistical analysis that is available free of charge to noncommercial users in developing countries.

One chief impediment to the wider use of analytical software in research for development is the lack of funding. The 13th edition of GenStat costs about US\$ 330, for instance, but other software, especially for sophisticated genomic and proteomic analyses, may be even more costly, especially for public research programs in developing countries. Reducing the costs of ICTs for data analysis is critical in enabling poorer institutions to participate more fully and meaningfully in the innovation system.

Some of the most innovative current uses of ICT in data analysis are in modeling, simulation, visualization, and cloud computing (do Prado, Barreto Luiz, and Chaib Filho 2010; Li and Zhao 2010; Hori, Kawashima, and Yamazaki 2010).<sup>5</sup> For instance, ICTs are vital for developing models of crop performance in environments where yields are reduced by climate stress and increasing climatic variability. Such models offer an important means of evaluating the potential for new cultivars to adapt to climate stress and climate change and to assess food import needs and export potential.

Another example involves researchers at the Medical College of Wisconsin Biotechnology and Bioengineering Center in Milwaukee, who recently developed free tools for analyzing virtual proteomics data (“Cloud Computing Lowers Cost of Protein Research,” 2009). The tools are used in combination with other free software and Amazon’s cloud computing service, giving researchers access to considerably more computing power than they may have at their own institutions. Proteomics—the study of proteins expressed by an organism—has numerous applications in plant breeding research, such as improving the understanding of how plants respond to disease—but until recently few research institutions in developing countries have been able to afford the ICT infrastructure to analyze proteomics data.

<sup>5</sup> For examples related to geospatial, precision, and sensor technologies, see the National Institute of Food and Agriculture (<http://www.nifa.usda.gov/ProgViewRelated.cfm?prnum=16198&lkid=4>).

## MAKING DATA AND INFORMATION ACCESSIBLE

A primary output of the research process is knowledge, typically encapsulated in reports, manuals, articles, maps, data files, and interactive video and audio media. The transition from print to digital information formats is one of the most striking transformations in agricultural research. New storage technology, particularly the availability of storage in the cloud, is making the storage and sharing of data and other information far less expensive.

Organizing and providing access to its information and data resources are among the most useful investments that an agricultural research institution can make. Complete, easy to access, open repositories or archives of research outputs are becoming a standard to which research institutes aspire. The concept is based on the use of free software such as DSpace (<http://www.dspace.org/>) or ePrints (<http://www.eprints.org/>) that allows an organization to set up a repository of its documents and outputs. These repositories allow content to be uploaded and made accessible in full; they also allow the metadata to be harvested and shared using open standards. As the collections grow, they become permanently accessible indices of an institution’s research and nodes in a globally searchable knowledge base for agriculture.

Alongside these repositories, many related specialized systems focus on, for example, theses or academic learning materials, specific subject areas (aquaculture, forestry, and so on), or national aggregations of data from different sources. Parallel systems facilitate the curation, sharing, and sometimes analysis of data in various forms (box 6.8). All of these systems build on basic connectivity and ICT infrastructure, both within institutions and outside them through the adoption of applications that enable global sharing and aggregation, harvesting, and distributed management of data.

### BOX 6.8: Dataverse: An Open Application for Storing and Analyzing Data

Dataverse is an open application to publish, share, reference, extract, and analyze research data. It makes data available to others and allows them to replicate work by other researchers. Developed by the Institute for Quantitative Social Science at Harvard University, the software can be freely downloaded for local use, or data can be hosted by the project. Dataverse is used by the International Food Policy Research Institute to archive and make its data accessible, for example.

*Source:* Authors; see also <http://thedata.org/home> and <http://dvn.iq.harvard.edu/dvn/dv/IFPRI>.



A number of examples of data storage and sharing follow, and many more could be cited. They are similar in several ways. First, they use open standards and common taxonomies that allow metadata to be shared across organizations and systems. Second, they are often based on free or low-cost specialized applications provided by third parties. Third, they depend on the distributed actions of organizations and initiatives that are working toward common objectives and are committed to making information and data widely accessible through the Internet. Fourth, they have chosen to use systems that not only store content but curate and index content in ways that add value to this public good. Finally, they all rely on increasing (remote) storage and connectivity capacities.

Research institutes and other agricultural entities participating in research projects or dissemination projects usually select a single approach to organize their research electronically. These forms of organization include subject, national, regional, institutional, and crowdsourcing approaches or a variety therein. Selecting a manner in which to organize repositories is critical to its user and management friendliness.

### Subject Approaches

Avano (<http://www.ifremer.fr/avano/>) harvests electronic resources related to the marine and aquatic sciences. It provides access to almost 300,000 resources from almost 300 repositories and other archives worldwide. It is operated by a group of information professionals who agreed to use open repositories and standards and to allow their resources to be harvested.

The Global Forest Information System (GFIS, <http://www.gfis.net>) is a collaborative initiative that allows forest-related information to be shared easily through a single gateway. GFIS is an open system to which information providers, using agreed information exchange standards, may contribute content. Similar to Avano, GFIS is organized by the global forest community. It depends on the adoption of open tools and content by its many collaborators. It uses RSS (really simple syndication) as the primary device to aggregate and represent content acquired from different sources.

The System-wide Information Network for Genetic Resources (SINGER, <http://singer.cgiar.org>), developed by the agricultural

research centers of the CGIAR and their partners, is an extensive collection of information about the genetic resources conserved by SINGER members. These collections hold more than half a million samples of the world's major food crops, forage crops, and forest species and are an essential resource for plant breeding and biodiversity conservation worldwide.

### National Approaches, Pioneered and Partnered with Ministries

The Government of India in partnership with the World Bank began funding the National Agricultural Innovation Project (NAIP) in India in 2006 (<http://www.naip.icar.org.in/index.html>). Led by the Indian Council of Agricultural Research, this six-year project aims to quicken the pace of agricultural development by exploring and applying agricultural innovation in collaboration with a variety of public and private stakeholders. NAIP has established over 50 research alliances between public organizations, commercial enterprise, and farmers, focusing applied research initiatives on technological innovation in poor rural areas. The project and its partnerships have led to a wide expansion in stakeholder engagement, more frequent monitoring and evaluation of technological outcomes, and improved knowledge brokering.

The project component most relevant to this module focuses on the management of change and information in the national agricultural research service. This component seeks to strengthen the use of ICT for research and technological innovation, increase public awareness of ICT, experiment

**IMAGE 6.3:** Open Access to Genetic Information Can Improve Yields Worldwide



Source: Edwin Huffman, World Bank.

with e-learning models, and open opportunities for stakeholder collaboration and exchange using electronic tools and web platforms. The project has connected over 300 institutions on the web, working toward building an enormous ICT network for agricultural research and dissemination. The project is also developing a central portal for the network, which will serve as the platform for knowledge building and sharing. This central portal will maintain 42 open-sourced and subscription-based agricultural libraries. Formal links between libraries in the national research system and other agricultural libraries will be forged. This project component also includes virtual classroom development (source: <http://www.naip.icar.org.in/index.html>).

Brazil's national agricultural research system, EMBRAPA (the Brazilian Agricultural Research Corporation), recently contributed 470,000 bibliographic records to WorldCat, "the world's largest library catalog" (<http://www.worldcat.org/>), reflecting the scale and publishing power of this research system. EMBRAPA also maintains substantial repositories of its research outputs in full text: The ALICE repository (<http://www.alice.cnptia.embrapa.br/>) provides full access to formal research outputs in the form of book chapters, articles in indexed journals, articles in proceedings, theses and dissertations, technical notes, and so on. This resource is complemented by the Infoteca-e (<http://www.infoteca.cnptia.embrapa.br/>), which collects and provides access to more practical information on technologies produced by EMBRAPA. This information is intended for farmers, extensionists, agricultural technicians, students and teachers from rural schools, cooperatives, and others concerned relatively directly with agricultural production.

In Jordan, the National Center of Agricultural Research and Extension, the Ministry of Agriculture, and FAO have joined forces to set up a National Agricultural Information System portal (<http://nais-jordan.gov.jo/Pages/Index.aspx?CMSId=8>) that provides updates and news as well as access to full-text reports and publications.

### Regional Approaches

Similar in concept in that it seeks to link local project actors, the International Fund for Agricultural Development (IFAD) in Asia joined with the International Development Research Centre to use ICTs to support learning and networking across a number of IFAD-supported development projects. ENRAP (<http://www.enrap.org/>)<sup>6</sup> was formed to promote knowledge sharing and networking between IFAD projects located in the

Asia-Pacific region.<sup>7</sup> ENRAP worked in the area of knowledge networking and Internet applications at the local, national, and international levels.

The project, which ended in 2010, was designed to bring the benefits of global information resources to IFAD-supported rural development projects in Asia and the Pacific. It aimed to increase effective use of the Internet and electronic communication by project staff and, ultimately, by project communities. The project focused especially on methods and practical solutions to foster participation at the grassroots level. Local electronic newsletters, agricultural market information dissemination, and shared electronic libraries are examples of ENRAP-supported activities.

The first phase of ENRAP began with an emphasis on ICTs, but subsequent phases focused more on the knowledge/content that needed to be shared. Attention was given to building capacities in knowledge production, especially the use of digital video as a supplement and alternative to written documentation of project experiences.

### Institutional Approaches

In Chile, the digital library of the Fundación para la Innovación Agraria (Foundation for Agricultural Innovation) (<http://bibliotecadigital.innovacionagraria.cl/>) incorporates new ICTs to manage and diffuse public information. It assembles information on all the reports and publications, photos, videos, and presentations produced by the foundation.

In 2009, the International Livestock Research Institute (ILRI) set up an open repository of its research outputs (<http://mahider.ilri.org/>). ILRI used free DSpace software to develop the repository, and in the first 18 months, some 4,500 outputs were included in the service. Since the system uses open standards, the contents are harvested across the Internet and can be reused in other services—Google Scholar, the CGIAR Virtual Library, FAO's AGRIS (<http://agris.fao.org/>), and so on. The same platform is being used to develop a shared service across several CGIAR centers and initiatives.

In Uganda, Makerere University has established a "scholarly digital library" (<http://dspace.mak.ac.ug/>) with the full text of reports and theses, including those of its agriculture and veterinary sciences faculties.

A final example comes from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). ICRISAT conducts

<sup>6</sup> Originally Electronic Networking for Rural Asia Pacific.

<sup>7</sup> Similar projects exist in Africa, Latin America, and the Middle East.

genomics research to enhance the efficiency and effectiveness of crop improvement. In the course of this work, it learned that the rate-limiting step in genomics was no longer data generation but the speed at which data were captured, validated, analyzed, and turned into useful knowledge. ICRISAT initiated its Global Theme on Biotechnology, a program that focuses on building and sharing the ICT tools to accelerate these stages of research. The program develops information systems for data capture, storage, retrieval, and dissemination.

The program also develops software based on open-source technologies; this software is all in the public domain (<http://www.icrisat.org/bt-software-downloads.htm>). Applications have been downloaded several hundred times by users from other institutions. For example, a Library Information Management System (LIMS) facilitates molecular genotyping through modules that make it possible to track samples, schedule jobs, generate reports, and perform other tasks. LIMS has been adopted by other research facilities and customized by a private sector partner. Information is shared through ICRISAT's Integrated Crop Resources Information System (ICRIS). Available on the Internet with password-protected access, the database provides genotype, marker, and phenotype information. An integrated decision support system, iMAS, has also been developed to facilitate marker-assisted plant breeding by integrating freely available quality software needed for designing experiments, mapping quantitative trait loci,<sup>8</sup> and providing decision guidelines to help users interpret results.

### Crowdsourcing Approaches

Researchers and others are not just sitting back and waiting for others to provide tools to share data and information. Researchers with access to the Internet are making their own specialized literature bases available online (box 6.9). They are also assembling them into quite sophisticated resources that become new research products in their own right. An example is WikiGenes (<http://www.wikigenes.org>). This collaborative knowledge resource for the life sciences is based on the general wiki idea but employs specifically developed technology to serve as a rigorous scientific tool. The project provides a platform for the scientific community to collect, communicate, and evaluate knowledge about genes, chemicals, diseases, and other biomedical concepts in a bottom-up process.

8 A preliminary step in identifying and sequencing the genes related to variations in physical characteristics of an organism arising from the interactions of multiple genes and/or interactions between genes and the environment in which they are expressed.

Such open collaboration is possible only because of the Internet and the way it allows distributed systems for the aggregation, review, and dissemination of knowledge and, most important, the active support of a large community (Hoffmann 2008). Tools like this one are a form of “expert crowdsourcing” online.

Crowdsourcing through ICT can also be effective in research projects that involve rural inhabitants. Asking farmers to send information via mobile phone can be an effective way of gathering data with reduced costs and labor. In areas where mobile phones are ubiquitous, it also allows for increased participation from a variety of farmers or farmer groups.

### BOX 6.9: Mendeley: ICT to Expand the Literature Base

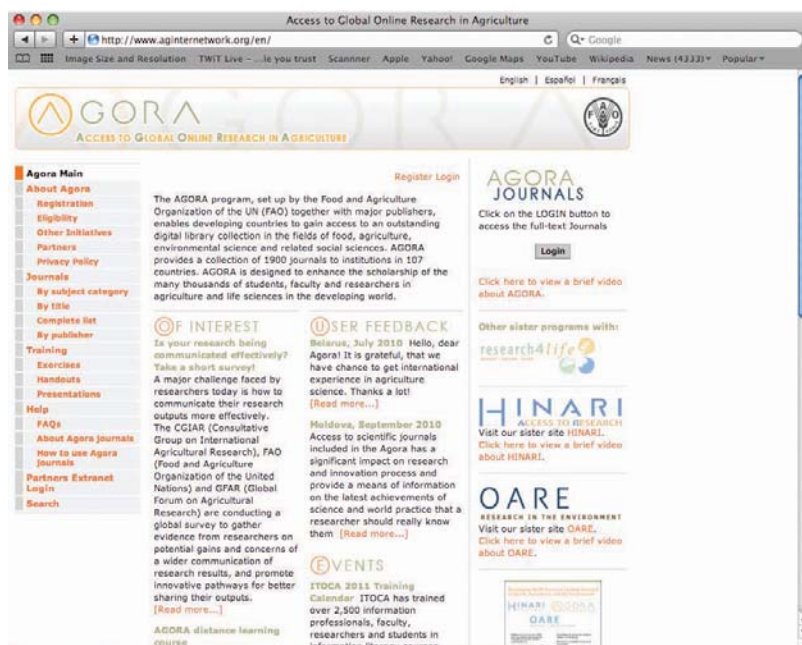
Mendeley is a free online reference manager and academic social network through which researchers organize their research, collaborate with others, and discover the latest research in their areas. With Internet connectivity, scientists can manage their personal research profiles and presence and co-create a literature base on a subject or around an event. For example, researchers at the International Food Policy Research Institute have started to use this service to collate, share, and track research information around specific projects and events, such as the 2011 conference on agriculture, nutrition, and health (<http://2020conference.ifpri.info/knowledge-fair/literature-hub>).

Source: Authors; see also <http://www.mendeley.com/>.

### Preferential Access Schemes for Research in Developing Countries

Despite increases in Internet access and connectivity, developing-country researchers continue to face barriers in gaining access to scientific publications and literature. This is particularly significant for journal articles and other publications published through commercial channels where subscriptions are required.

In recent years, commercial publishers have begun to provide free or inexpensive access to some developing countries through initiatives like AGORA (Access to Global Online Research in Agriculture, <http://www.aginternetnetwork.org/>), which provides free or very low-cost access to 2,400 journals on food, agriculture, and related sciences to institutions in 107 countries (image 6.4); PERI (the Programme for the Enhancement of Research Information, <http://www.inasp.info/peri/>), which supports the efforts of developing-country institutions to get together in

**IMAGE 6.4: AGORA Provides Access to Agricultural Research Literature**

Source: A screenshot of the AGORA homepage.

consortia to pay for heavily discounted subscriptions; and TEEAL (The Essential Electronic Agricultural Library, <http://www.teeal.org/>), which provides a package of content that institutions can run on their own networks.

Although Internet connectivity gives scientists access to the resources provided, evidence shows that significant

investments in information literacy are needed to maximize the use of these tools. Scientists may rely on their traditional information-seeking strategies and remain unaware of new electronic resources. Their parent organizations need to encourage the use of e-resources and provide appropriate bandwidth and training.

**Gaining Access to Private Sector Innovation and Research**

Initiatives like CIARD (box 6.10) are important to make publicly funded research results accessible (see image 6.5). It is quite another challenge to gain access to the results of research financed by private companies, which in total spend more on research than the public sector. Because companies operate for profit and need to recover their R&D investment, they seek intellectual property rights for their innovations, which typically prevent public access and, at times, collaboration.

Some systems permit research results from private firms to be shared. Innovations covered by patent rights allow the patent holder 20 years to exploit the commercial potential of the patented innovation, in exchange for publicly disclosing the innovation in a patent database. This practice is meant to enable other researchers to build on the initial innovation. The largest searchable patent databases include PATENTSCOPE

**BOX 6.10: Driving Developing County Access: The CIARD Initiative**

Public knowledge and research results have limited impact on agricultural and rural development when they are not easily or widely accessible. The Coherence in Information for Agricultural Research for Development (CIARD, <http://www.ciard.net/>) initiative, pioneered by FAO, the Global Forum on Agricultural Research, the CGIAR, and other partner organizations, aims to change this by increasing the awareness of how new ICTs and associated institutional changes expand options to manage and present information differently and economically. CIARD's vision, "to make public domain agricultural research information and knowledge truly accessible to all," reflects the transformational effects of ICT in agricultural development. CIARD partners coordinate their efforts, promote common formats for information sharing and exchange, and adopt open information systems approaches. CIARD projects, like KAINet in Kenya, focus on three priority areas:

- Making content accessible through open content, open systems, and common international standards.
- Empowering individuals with awareness and skills and encouraging institutions to be self-sufficient through ownership of their information.
- Advocating better investments through policies that improve access to information, coordinated approaches, and evidence of benefits.

The explanation and the routes for implementation of the CIARD agenda as a whole are available at the CIARD website and in print.

Source: <http://www.ciard.net/>.

**IMAGE 6.5:** Accessing Private Sector Research Could Have Wide Impacts on Poor Agriculture



Source: Jonathon Ernst, World Bank.

from the World Intellectual Property Organization, with close to 2 million international patent applications (<http://www.wipo.int/pctdb/en/>). The United States Patent Office database (<http://patft.uspto.gov/>) and esp@cenet, the European Patent Office database, offer 60 million patent documents from over 80 countries. For a recent review of patent databases, see <http://patentlibrarian.blogspot.com/2010/02/patent-database-review.html>; for a more general discussion of IP and related issues in agricultural research, see the work of the CGIAR Systemwide Program on Collective Action and Property Rights (CAPRI, <http://www.capri.cgiar.org/>).

Initiatives like the African Agriculture Technology Foundation (<http://www.aatf-africa.org/>), the International Service for the Acquisition of Agri-biotech Applications (<http://www.isaaa.org/>), and Public Intellectual Property Resources for Agriculture enable developing countries to maximize access to promising technologies and innovations developed by the private sector. Such efforts are built on smart access to relevant developments in the private sector, insights into local research interests, and brokering between the various parties.

### LESSONS LEARNED

Increasingly, ICTs such as computers, mobile phones, other devices, and e-mail are standard tools of the trade for individual researchers, scientists, and the people they work with. As part of a personal research toolkit or dashboard, ICTs are

essential to the delivery of today's research. Lessons learned in using these technologies for agricultural research are summarized here; the discussion also highlights the key enablers for designing and implementing ICT-enriched research initiatives.

First, ensure that each researcher has basic levels of e-literacy and ICT access. It is critical to convince managers and funders that ICTs are "basic" to research, not just desirable add-ons. Beyond the level of the individual scientist or researcher, many opportunities for using ICT in research require significant institutional investments to have a real impact on research itself or the targets of research.

The lack of systematic investment in ICTs by research institutions and their funders often holds researchers back from adopting and using ICTs (FARA 2009; Balaji 2009; GCARD

2009; RUFORUM 2009; Karanja 2006; Kashorda and Waema 2009; and UNCTAD 2010). Like funding for agricultural research more generally, investments in ICT for agricultural research are vital to increase and should be at the forefront of the agricultural research discussion. Thinking carefully about how ICT might contribute to research projects is critical to tapping the wide range of opportunities available throughout the research process.

Unfortunately, beyond the use of ICTs for everyday communication and Internet access, research institutions may offer few incentives to undertake ICT-enabled research that deviates from traditional paths and uses newer ICTs, especially if that research involves gaining access to proprietary information and ICT tools (or even paying fees for ICT services). This lack of incentives represents a major challenge to using ICT for agricultural research, especially in rural areas where difficulties like the lack of electricity and weak telecommunications connections abound.

As for open access to research products, low investment in technical infrastructure, in sustaining research capacity, and in research itself have left many countries on the margins of global digital society and innovation, most notably in sub-Saharan Africa (RUFORUM 2009; Karanja 2006; Kashorda and Waema 2009). Their marginalization renders them less aware of and able to adopt the international standards and methodologies required to participate in open digital information sharing. In this context, the efforts made by organizations to

overcome institutional inertia, join together, and develop collective and accessible research information repositories and services are immensely important. Although each institution will have its own priorities and constraints, all can subscribe to common approaches.

An additional major challenge in research is for organizations and individuals to truly grasp the emerging possibilities and be willing to use them. One aspect of this challenge is awareness: Which of all the possible tools and investments will work best, and where? Who has the skills to make them work? What “fallout,” positive and negative, will the organization experience if they are used? What is the best portfolio of ICT-related investments for my particular set of individual, project, or institutional goals and challenges? The use of new ICTs is also a risky and change-making business. Just adopting a new tool can trigger major changes in workflows, procedures, processes, culture, and hierarchy that force a wider assessment of business processes. Legacy IT systems as well as institutional processes and power relations are often threatened.

Finally, moving beyond “ICT-assisted and connected” research to “ICT-enabled and transformed innovation” is a challenge for even the smartest, best-funded scientific institute. A research organization that has been transformed through ICT needs people and leadership with skills to develop a vision for e-research and align ICT investments to research and innovation processes, ensure that staff acquire the necessary skills, redesign institutional processes, adopt open standards and access to knowledge, change staff mindsets, give staff access to ICT toolsets, invest in technological infrastructure and networks, and innovate and experiment—among other needs. Devising and developing the optimal ICT investment portfolio for a national research institute or network is a major challenge.

### **INNOVATIVE PRACTICE SUMMARY** **Advances in ICTs Increase the Utility of African Sites for Testing Varieties**

Widespread use of higher-yielding and stress-resistant varieties throughout Africa has been frustrated by the variability of African growing conditions, the difficulty of selecting appropriate sites to test new cultivars, and the challenges of matching new cultivars to suitable growing environments across the continent. Innovations may be tested, but they are not tested in ways that make it more likely that they will be useful to farmers, so they are not adopted.

Africa Trial Sites (<http://africats.org/>) is a portal that enables national and international research organizations to electronically pool their extensive information on trial sites and provides numerous tools (based on ICT advances in bioinformatics, GIS, and data management) that help farmers, plant breeders, and agronomists to evaluate new varieties more efficiently in the field and gain more useful data from field trials. For some time much of the data from field trials—representing an enormous investment of research resources over several decades—resided on the shelves of research institutions and was difficult to assemble, analyze on a large scale, and put to use.

Users can search the website for trial sites and data by country, design trials to evaluate cultivars, obtain tools to manage trials (from developing a budget to estimating water stress during the growing season), analyze trial data, view results of spatial analyses, examine data on an interactive Google map, and report results online. They can also rank varieties and add comments about their performance at a given site. The website allows the analysis of climate data for any point in Africa as well as climate similarity comparisons between trial sites and other areas of Africa. Finally, the site includes links to resources such as websites of the participating centers, from which anyone can request seed from breeders and genebank curators.

The combination of African trial site data and interactive data analysis tools has made valuable information much more widely available and useful for the agricultural research, development, and extension community. Results for cultivars tested in Africa are rarely available online. Participants’ data will significantly expand knowledge of which cultivars are suited to which environments (especially environments subject to stress from diseases, pests, or environmental factors). International agricultural research centers are beginning to use the trial sites in a climate adaptation research program, drawing in national partners, and they are using Africats.org to standardize their trial site information.

### **INNOVATIVE PRACTICE SUMMARY** **KAINet Kenya Knowledge Network Anchored in Partnerships and Collaboration**

The Kenya Agricultural Information Network (KAINet, <http://www.kainet.or.ke>) project, supported by FAO, encourages and assists Kenyan agricultural organizations to capture and share information in a series of repositories. The network, launched in 2009 and supported by the Ministry of Agriculture,

provides training and support. The network's website allows researchers to query the resources of all member institutions at once. The repositories include around 4,000 full-text digital documents generated by the institutions, with around 40,000 metadata records that conform to international coherence standards to facilitate access and sharing. The network is guided by a national stakeholder forum, a board of trustees, and a network management committee.

Like the thematic services Avano and GFIS mentioned earlier, KAINet relies on distributed action by different organizations, their compliance with standards, and sufficient connectivity for the harvesting and virtual querying of the databases. The collaboration between national institutions and international partners ensured the effective use of national resources and leveraged knowledge of international best practices.

An important aspect of KAINet is that it is integrated into national and institutional policies and strategies. Its outputs and resources, such as the institutional and national repositories of agricultural information, complement national and global initiatives aimed at sharing information. Its training programs support the development of human capacity in information and communication management.

Experiences with KAINet have been carefully documented. Among the lessons and enabling factors that emerged, piloting the network with a limited number of national institutions allowed the partners to learn and devise workable solutions before expanding the network. The management and steering committees played important roles in promoting the network, involving the management of partner institutions in its development, and guiding project activities. Linking the project to the priorities and plans of partner institutions added credibility to KAINet, ensuring that it would enhance existing work and not remain an isolated initiative. The initial planning and partnership-building phase was critical for success, because it provided an understanding of the institutions' information and communication management needs and helped partners develop a basis for collaboration.

The development of adequate capacities in information and communication management (including physical infrastructure) was essential to develop open repositories, and these capacities should preferably be built early in a networking project. Because networking contacts were the basis of collaboration and project operations, telephone and e-mail groups were essential for constant communication among partners.

## Topic Note 6.2: USING ICT IN EXTENSION AND ADVISORY SERVICES

### TRENDS AND ISSUES

Rural people must be able to respond productively to the opportunities and challenges of economic and technological change, including those that can improve agricultural productivity and food security. Innovation is more successful when producers can communicate with and be heard by their peers, local authorities, and institutions. Producers also require relevant knowledge and information, including technical, scientific, economic, social, and cultural information. To be useful, that information must be available to users in appropriate languages and formats. At the same time, it must be current and communicated through appropriate channels.

This topic note outlines key issues involved in using ICTs to convey demands for rural advisory services and deliver those services effectively. Although there is convincing evidence that ICTs can revitalize research-extension interactions in ways that respond to farmers' demands, the use of ICTs is merely one element in the wider transformation of

a traditional, top-down, technology-driven extension system into one that is more pluralistic, decentralized, farmer led, and market driven (and thus more effective within the innovation system). Part of the role of ICTs is to contribute to the many reforms that are urgently needed to empower and support small-scale farmers as developing countries seek to respond successfully to food security, market development, and climate change challenges (Christoplos 2010).

In the context of rural advisory services that support innovation, ICTs have four broad functions. First, they need to deliver or provide access to information. They should address the need for localized and customized information—adapted to rural users in a comprehensible format and appropriate language—to give small-scale producers as well as providers of advisory services adequate, timely access to technical and marketing information, as well as information or support on new technologies and good farming practices (image 6.6). It is not just a matter of getting information out. A key aim is to

**IMAGE 6.6:** Matching ICT to the Diverse Needs of Farmers Is Critical



Source: Neil Palmer, CIAT.

give rural people the facilities and skills to find the information and answers they need.

Second, they need to organize the knowledge base. ICTs should help document and store information for future use. In many cases, information and knowledge on technologies and good practices is available only in hard copy or in people's heads, and data are incomplete, scarce, or inaccurate. Local and indigenous knowledge is often transmitted orally, records are often unavailable, and information is dispersed only to nearby family and friends. As with research, all this knowledge needs to be documented and organized for reuse. The challenge is evident from the scattered nature of the information, its multiple "formats," and the general lack of attention to documentation and learning in this area. While researchers are rewarded for publishing, extension workers, advisors, and farmers are motivated to deliver "practical" results; documentation is only a potential by-product.

Third, ICTs need to connect people and networks. ICTs can facilitate networking—locally, regionally, and globally—thus leading to collaborative and interdisciplinary approaches to problem solving and research based on shared knowledge and collaboration (Nyirenda-Jere 2010). Many NGOs, research organizations, and national ministries have used

ICTs to improve access to technologies and knowledge in their rural advisory services, by means of rural telecenters, community knowledge workers, online networks, and various types of forums. They also need to focus on ways to empower rural communities to connect with one another, not just to the outside world. Facilitating linkages between market actors, extension, and smallholders along value chains is also essential.

Fourth, ICTs need to empower rural communities. ICTs should help farming communities "gain a voice" so that they can convey their needs and demands, negotiate better deals with other actors in value chains, and generally get practical benefits from the services intended for them (and otherwise avoid being exploited). A key element is to use ICTs to give rural people the skills and tools to tell their own stories, in their own words and languages, in ways that reach and influence others (see Module 8 on farmer organizations for additional information on ICT and collective action).

Throughout the developing world, ICTs are being integrated into classic rural advisory services, through radio, SMS, television, video, Internet, libraries, the media, and mobile services. Advice and information provided via ICTs is becoming more varied, covering specific technologies and practices; climate change mitigation and adaptation; disaster management; early warning of drought, floods, and diseases; price information; political empowerment; natural resource management; production efficiency; and market access. It is not a one-way flow: ICTs open up new channels for farmers to document and share experiences with each other and with experts (IICD 2006).

Some of the likely trends in the use of ICTs for rural advisory services over the coming years include (Ballantyne 2009)

- Many advisory services will be privatized as the agricultural sector becomes more commercial, as other actors step into this arena, and as clients are willing to pay.<sup>9</sup>

9 As discussed in Module 3 of the *Agricultural Innovation Systems Investment Sourcebook* (World Bank 2012): "The private sector increasingly finances extension services for specific objectives and/or value chains. Contracting public extension workers for specific tasks is a common practice among NGOs as well as specific commodity development programs, such as the program for cashew production in Mozambique. Some export commodity chains finance extension services through a government-instituted export levy, as in Mozambique and Tanzania. The private sector also finances extension services directly, as is the case with large tobacco companies in Malawi and Mozambique. Many of these arrangements are in transition to become systems of cost-sharing with farmers, first by assuring effective demand for relatively costly services and eventually by having farmers fully finance extension services, as a complement to services they already provide one another (F2F extension)."



Some services—for small-scale producers and natural resource management, for example, which excite less interest from commercial providers—will continue as public services.

- ICTs, including devices and software, will become more available, much cheaper, and more affordable or even cost-free (open-source software is one example), even in rural areas.
- Connectivity will become more pervasive and more mobile. More devices will be “smart” and capable of performing multiple operations.
- Farmers and rural communities will be regarded as much less “passive” consumers of advice and information; through ICTs as well as other developments, they are becoming active participants in formal rural knowledge and innovation systems.
- Traditional public advisory services will be challenged and bypassed by the emergence of new actors with alternative ICT-based business models. Increasingly, these new actors rely on ICTs to provide their comparative advantage. To be relevant and competitive in such situations, public extension services need to reinvent or transform themselves, with strategic use of ICTs as part of the change process.
- There will be much experimentation and innovation by governments, NGOs, the private sector, and new intermediaries to develop and test ICT-based services and business models to better reach or engage with rural communities. The challenge will be to scale these out to reach specific target groups or broad groups of marginal communities.

The more complex and dynamic interactions characteristic of innovation systems, including the interactions fostered through ICT, will require new skills, both technical and entrepreneurial, to be acquired by farmers as well as advisory service providers (Swanson and Rajalahti 2010). In some instances, ICTs themselves can enable farmers and service providers to attain these skills; in others, special capacity-building efforts will be needed. This discussion is beyond the scope of this topic note, but helpful information is available (see World Bank 2012, especially Module 4).

In the remainder of this note, the discussion of ICTs in advisory services contains examples and innovative practice summaries that illustrate

practical strategies for integrating farmers’ demands into advisory services and give an idea of their relative strengths and weaknesses. The examples and practice summaries also illustrate some of the social and economic outcomes that can arise when ICTs support the wider webs of communication that characterize effective innovation systems.

### ICTS FOR EXTENSION AND ADVISORY SERVICES

ICT has great potential to transform the way public extension is organized and delivered—including interactions with farmers. It is also an entry point for nontraditional actors who see advisory services as an area of intervention and for giving greater emphasis to subjects traditionally deficient in extension services. ICT can also increase women’s access to advisory services.

Some developing countries have moved quickly to enable farmers to interact in real time (or close to it) with advisory services through ICT. Until ICTs offered farmers a channel for communicating directly with distant technicians and experts, many farmers could wait months or years for an extension worker to provide technical advice, and often that advice did not address their immediate concerns (image 6.7). The following examples highlight some of the ICT applications that advisory services have used to improve their interactions and technical knowledge sharing with farmers in developing countries. These applications include web services like “ask the expert,” mobile messaging for advice, radio programs to disseminate technical information, and video. Many of these endeavors are fairly new, limiting practitioners’ ability to analyze their effectiveness.

**IMAGE 6.7:** Timely Advisory Services Improve the Effectiveness of Other Technologies



Source: Thomas Sennett, World Bank.

### Informing the Extension Agent

Two recent projects improve extension agents' ability to respond to farmers' needs by improving the quality and relevance of information available to both groups. The first was launched in Egypt and the second in Uganda.

Egypt launched a Virtual Extension and Research Communication Network (VERCON) in 2000 to develop and strengthen links among the research and extension components of the national agricultural knowledge and information system. By improving research-extension linkages, the initiative aimed to improve advisory services for Egyptian farmers, especially resource-poor farmers (see [http://www.fao.org/sd/2001/KN1007\\_en.htm](http://www.fao.org/sd/2001/KN1007_en.htm)).

VERCON-Egypt introduced and tested several innovative communication tools. One of the most useful tools is the Farmers' Problems Database, created explicitly to address farmer's problems. The web interface enables extension agents to pose questions on behalf of farmers seeking solutions to agricultural problems; they can also examine answers to questions already posed to researchers. Content is classified into four main categories of problems: production, administration, environment, and marketing.

The online database and tracking system enable farmers' questions to flow from provincial extension centers to the national extension directorate and research system. Farmers approach extension centers with problems, and if they cannot be solved using online resources such as extension bulletins or agricultural expert systems, the extension agent develops a full description of the problem and his/her proposed solution, which is forwarded to a specialized researcher who provides advice to address it (Beltagy et al. 2009). The problems and solutions are added to the online database to assist other users of the network who face similar problems.

Aside from addressing farmers' problems, the system provides valuable information to track farmers' problems, including their incidence and significance. The system makes farmers' problems more visible and quantifiable for research planners, and chronic problems can be addressed in research projects. Since 2006, over 10,000 problems and their solutions accumulated in the interactive database, and over 26,000 farmers benefited from the system (FAO 2008).

In Uganda, the Grameen Foundation's Community Knowledge Worker Initiative established a distributed network of intermediaries, called Community Knowledge Workers (CKWs), who used mobile devices to collect and

disseminate information to improve the livelihoods of small-holder farmers. The idea was to extend the reach of centralized expertise and transmit farmers' concerns more clearly. Via mobile phones, CKWs provide information on three-day weather forecasts, seasonal forecasts, good farming and husbandry practices, input supplies, and markets. The subject matter for each of these topics comes from expert partner institutions like the Uganda National Agro-Inputs Dealers' Association and Uganda's National Agricultural Research Organisation.

Early findings indicate that women and poorer farmers are frequent users of the service and that farmers generally act on the information they receive. Even so, CKWs require intensive training in mobile technologies, agricultural information, survey techniques, and business skills to be effective.<sup>10</sup> (For more detailed information on this initiative, see IPS "Community Knowledge Worker Initiative in Uganda" in Module 4 and "Community Knowledge Workers in Uganda Link Farmers and Experts to Cope with Risk" in Module 11.)

### Using Radio and Video to Reach Rural Farmers

Among the various communications media available, even the most novel and technically sophisticated alternatives, radio remains the most pervasive, inexpensive, popular, and socioculturally appropriate means of communication in many parts of the developing world. Radio is still the only medium for disseminating information rapidly to large and remote audiences, including critical information about markets, weather, crops, livestock production, and natural resource protection. Video has also made substantial impact in convincing farmers to try new technologies; its images and demonstrations make information easier to understand and apply.

Rural radio is distinctive from urban radio and most national radio networks in that it is directed specifically to a rural audience and its distinctive information needs, often including authentic stories and experiences from communities and successful farmers. Rural radio can motivate farmers, promote the exchange of views, and draw their attention to new agricultural production ideas and techniques. Communities actively plan the production of broadcasts, making them an expression of community life and concerns rather than treating communities as passive listeners. (For examples, see box 6.11 and IPS "Farm Radio International" in this topic note.)

<sup>10</sup> See <http://www.grameenfoundation.applab.org/applab-blog/2010/05/20/community-knowledge-worker-pilot-report-and-program-launch/>.

**BOX 6.11: Rural Radio Lets Listeners Speak**

A villager's story, recorded in a rural radio program about bushfires:

*My uncle once told me how a bushfire burnt his field: "That bushfire was angry—it charged like a herd of elephants, destroying everything! Even came near to our home!"*

*I said, "Don't be scared. With the right words, a good hunter can stop a herd of charging elephants. We too can stop bushfires with the right words."*

*"What words?"*

*"Let's unite."*

*"Let's unite?"*

*"If the entire village gets organized to fight bushfires, you'll never be afraid of bushfires again!"*

Rural radio programs serve a variety of purposes, such as promoting an anti-bushfire campaign in Chad. Whether produced at the local, regional, or national level, such radio programs are most effective when made with audience participation, in local languages, and taking into account cultural traditions. Rural radio programming, besides spreading agricultural information, can fulfill other important functions: It can stimulate a regular discussion and debate among the people involved in agricultural development, provide a forum where rural communities can express their views, and can even be a powerful means of investigation for decision-makers, helping them to approach local agricultural development in appropriate ways.

Source: FAO n.d.

Rural radio producers must know the rudiments of agriculture, be familiar with farmers' agricultural problems, and have a good general understanding of rural life to ensure that their programming is relevant to their audience. Production teams are taught to work with farmers and, to the extent possible, organize broadcasts directly from the field in open-air gatherings in which entire villages or communities participate.

Program content is generated through participatory discussions with community representatives and presented in languages and formats to which the audience relates socially and culturally. For every rural radio project, the starting point

should be a participatory needs assessment to evaluate not only the material needs of communities that will benefit from the project but the perceptions, expectations, and commitments that community members can bring to the initiative.

Radio overcomes some of the most challenging issues related to using ICT in advisory services:

- **Accessibility.** Radios are relatively cheap to produce and distribute and do not need electricity or special skills to operate. They can also be shared by groups of listeners. It should be mentioned, however, that a key challenge to reaching female farmers through radio is ownership. Often men own the radio and choose the programs to listen to, which may not be relevant for women farmers. Radio programs should target women (although ensuring women's access to radios in the household may not be so easy).
- **Literacy and language barriers.** Radio requires no reading and speaks the language of the community it intends to reach.
- **Geographic coverage.** Radio can easily and simultaneously reach large numbers of isolated communities over vast geographic areas.
- **Local focus.** Radio can focus on local issues in local languages. The United Nations Development Programme notes that in Latin America, for example, most radio programs are locally or nationally produced, whereas only 30 percent of television programming comes from the region.

New ICT has benefited radio by offering better and cheaper means of recording, mixing, editing, and transmitting (for example, the digital audio recorder, audio editing on computers, and the electronic transmittal of sound programs as attachments) (image 6.8). Development practitioners increasingly recognize the potential for combining radio with new Internet-based ICTs, given that the new ICTs are still limited in some areas by the lack of telecommunications infrastructure and reach only a small number of people in developing countries.

Like radio, video has the advantage of attracting people's curiosity, and it appears to be an especially convincing medium when it captures familiar people or situations (as does local participation in radio broadcasts). Advances in ICT have made video much easier and less costly to produce and disseminate. Like radio, video does not demand literacy, and it suits the narrative culture that prevails in most developing countries. Images can make it easier for viewers with little education to understand complex topics. An additional benefit is that video can foster social cohesion in agricultural

**IMAGE 6.8:** New Technologies Have Allowed for More Innovative Radio Programs



Source: Farm Radio International.

communities by featuring the actions and voices of marginalized groups (Lie and Mandler 2009).

Through videos developed in collaboration with farmers, the Africa Rice Center (<http://www.africarice.org/>) has widely disseminated information about rice productivity and marketing opportunities (van Mele, Wanvoeke, and Zossou 2010). The Africa Rice videos stimulate learning and experimentation in rice production from field to market. A series of 11 videos in more than 30 African languages on producing, processing, and marketing rice were produced and widely shared with local radio stations and farmer organizations across Africa. These videos have reached more than 500 organizations and probably hundreds of thousands of farmers; it is likely that they continue to be copied and distributed more widely, but this spontaneous diffusion and any resulting innovation are difficult to monitor and evaluate.

The videos appear to have had a tangible impact on the livelihoods of rural women. Because the videos featured women, they reached more women, who were more likely to apply what they learned (Africa Rice Center 2009). For example, women who saw the video on parboiling rice improved their parboiling techniques and marketed their rice through new outlets. Others developed a better relationship with the NGO that showed the video, formed producer groups, and gained assistance from the NGO in obtaining credit to purchase inputs for improving rice production. The NGO, in turn, recognized the effectiveness

of the video format and began to use more visual aids in its work with women. The fact that the videos showcased women's expertise and innovation convinced some male researchers that they should work more with women farmers. Giving a voice to women and other marginalized groups in this manner and involving them in the development and dissemination of agricultural technology may be an effective means of promoting greater social inclusion. To see the rice videos, visit Africa Rice Center (<http://www.warda.org/warda/guide-video.asp>).

**Making Information Accessible through Mobile Phones and Internet**

Colombia's Ministry of Agriculture and Rural Development, in collaboration with partners, facilitates AGRONET, the National Agricultural Information and Communication Network of Colombia ([www.agronet.gov.co](http://www.agronet.gov.co)). AGRONET

is a network of agricultural information providers that have adopted a common platform to standardize and integrate resources to offer value-added information and communication services for the agricultural sector using modern and traditional ICTs.

To send relevant information to producers, AGRONET develops user profiles based on a needs assessment and users' particular productive activities. AGRONET introduces new methods and improved workflows to provide content systemically and takes advantage of mobile technologies to reach a growing number of rural users. Through SMS, producers receive updates on AGRONET's platform, including changes in its databases and other news and events pertinent to agriculture. The ministry plans to expand the service to reach 160,000 producers in 2011 with context-specific information on agricultural markets, inputs and supplies, weather alerts, and other subjects. Over the medium term, AGRONET plans to provide a greater wealth of content and information services to producers by adding capacity in digital television.

The government's efforts to reduce the digital divide through public-private partnerships and growing broadband penetration in rural municipalities catalyzed the development of AGRONET's innovative, value-added information services. An assessment by Colombia's e-Government Program ranked the ministry first in online information provision.

In Uganda, ARENET (Agricultural Research Extension Network) is a web portal (<http://www.arenet.or.ug/index.php>) created to strengthen the links between the National Agricultural Research System and the National Agricultural Advisory Services program and its related extension service providers. The portal provides access to practical and technical agricultural information from national and international sources. Users can post questions and problems through the system to experts at research institutes and in local government, and ARENET makes it possible for farming communities, researchers, extension agents, and the private sector to communicate among themselves and to share their knowledge and experience. The site uses English but may include other local languages in the future.

The question-and-answer module of the website is divided into categories such as livestock, agricultural engineering, and forestry, and it lists the most viewed and recently posted questions. There is also a page from which various technical publications can be downloaded. Questioners are advised that their query should receive an answer within three days. The discussion forum section is not yet operational. Like many Internet information sites at present, this site will be more valuable for large-scale farmers than for smallholders.

Plans are well advanced for an ambitious ICT platform to improve Uganda's research capabilities and the way it delivers extension services. The National Agricultural Advisory Services and the National Agricultural Research Organisation will be supported by this program, which, among other things, will allow feedback from farmer organizations and other users of the services. One important aim is to change the culture of the research organizations to one of accountability, transparency, and competence. This transformation should have obvious benefits to the clients.

### ICTS THAT PRESERVE FARMERS' KNOWLEDGE

ICTs—some of which, like radio, have been available for some time, and others, such as digital video, which are relatively new to rural areas—bring farmers' views and voices into agricultural advisory and research services. ICTs are invaluable for eliciting and preserving local knowledge, such as knowledge of the medicinal traits of plants or traditional erosion control practices. The following sections illustrate how rural people in a range of settings have benefited from and enriched advisory services through greater participation and knowledge sharing mediated by ICTs.

### Using ICT to Share and Elicit Local Knowledge

Many organizations and governments see ICTs as tools that bring information and modernity to rural areas. They help get messages "out." Undoubtedly they extend the reach of extension and advisory services, but they can become one-way pipelines, pushing information to uninterested communities. A more inclusive approach uses ICTs to empower rural people to document their own knowledge so it can be shared with other communities and with extension. This empowering approach is more challenging as it depends on the capacities of the communities and their willingness to share their knowledge. For their part, proponents of the approach must be willing to use ICTs to enable changes that cannot be defined before the work is underway. The approach will involve some loss of control and very probably unexpected impacts.

People will use a system for sharing information, including agricultural information, if the content is adapted to local needs, sourced appropriately, and presented suitably. In Costa Rica, a national team conducted a participatory rural communication appraisal in selected regions to engage farmer organizations in sharing their knowledge. In the Brunca region, for example, livestock production dominates agriculture, and farmers identified livestock diseases as an important concern. One participant, a woman farmer, was famous for her knowledge of how to cure sick cows. The organization decided that the best way to document her knowledge was to film her. The videos could be shown at the local livestock auction and remain available digitally on the national PLATICAR ("talk") web platform.<sup>11</sup>

In other regions where the participatory method was used, it elicited information and knowledge on other themes. Farmer organizations producing tuber crops decided to prepare radio programs that were broadcast and then archived in PLATICAR. For rice producers, information sheets were developed on each of many rice varieties in Costa Rica.

The participatory approach that led to the choice of the most knowledgeable person was the innovation that enabled farmers to recognize that their own local and traditional knowledge was most appropriate for their needs. The innovative decision was to select the best medium for sharing this knowledge, as well as the place and time where it would be shared most effectively. The fact that the information is digitally preserved

11 Plataforma de Tecnología, Información y Comunicación Agropecuaria y Rural (Platform for Agricultural and Rural Information and Communication).

means that it can be archived and available through PLATICAR. The team that led the participatory process was the key enabler, because it built trust among stakeholders and brokered the sharing of personal knowledge that could benefit the whole group.

### Documenting and Mobilizing Indigenous Knowledge

A related information-sharing effort documents indigenous knowledge (image 6.9). As experienced farmers migrate to urban areas, as the local farming population ages, or as climate change and social upheavals uproot agricultural communities, much knowledge can be lost. This knowledge is worth preserving simply for its cultural value, but it is also instrumental in aiding researchers and extension workers to develop and adapt technology and practices for local conditions (and could help communities recover from natural disasters and conflicts).

In Bolivia, the CARENAS project started in 2003 in the Department of Santa Cruz to strengthen rural communication for sustainable natural resource management and rural development. Representatives of municipalities, farmer associations, and NGOs participated in intensive training for one month in communication methods and techniques, the use of ICTs, and the production and use of multimedia materials in the field. The 21 people who passed the course became local audiovisual specialists, who engaged in a participatory process with advisory service workers and farm communities to elicit farmers' traditional knowledge and integrate it with technical knowledge. Based on this interaction, the audiovisual specialists produced draft videos, which were validated through focus group discussions, interviews, and farmer-extension meetings. The videos were then shown to the communities and, after participatory evaluation, final versions were produced. They were distributed to 25 communities in 11 municipalities (see [http://www.fao.org/tc/tcdm/italy/op\\_bol034\\_en.asp?lang=en](http://www.fao.org/tc/tcdm/italy/op_bol034_en.asp?lang=en)). The videos, which demonstrated such techniques as repairing drainage ditches using nets and vegetative cover, recycling organic waste, and building compost latrines, eventually formed part of a training package consisting of printed guides for trainers and booklets for farmers.

In South Asia, in an effort to increase their impact, organizations working with rural communities in Bangladesh and India embarked on a process of Farmer Led Documentation

**IMAGE 6.9:** Farmer-Led Documentation Processes Can Use Digital Tools in Place of Paper



Source: Charlotte Kesi, World Bank.

and Knowledge Sharing.<sup>12</sup> Farmer-led documentation is defined as an empowering process in which local communities take the lead role in the documentation process. The results are used by community members for learning within the community (internal learning) and exchange between communities (horizontal sharing) and communities, development agents, and policymakers (vertical sharing).<sup>13</sup> This process of engaging with farmers to document their knowledge and experiences showed that a “people-led development process does not only help increase yields or conserve the local biodiversity; it can also help farmers to get access to the resources they need and can contribute to strengthening local organizations, networks, and alliances. Most important of all, it leads to empowerment.”

### ICTS TO MONITOR AND EVALUATE AGRICULTURAL INTERVENTIONS

Monitoring and evaluating outcomes of research results (such as new varieties and management practices), the construction of agricultural infrastructure (often involving contractors), or the impacts from extension programs or new technologies in a decentralized rural setting can greatly benefit from

<sup>12</sup> See [http://www.misereor.org/fileadmin/redaktion/MISEREOR\\_Strengthening\\_people-led\\_development.pdf](http://www.misereor.org/fileadmin/redaktion/MISEREOR_Strengthening_people-led_development.pdf).

<sup>13</sup> The farmer-led documentation approach was promoted by Participatory Ecological Land Use Management (PELUM), Promoting Local Innovations (PROLINNOVA), and OXFAM Novib. See [www.prolinnova.net/fld.php](http://www.prolinnova.net/fld.php).

ICT. ICT can transform monitoring and evaluation, which are often afterthoughts in agricultural interventions because of the difficulties associated with analyzing impact. Monitoring and evaluation are expensive (entailing the costs of traveling, producing materials, hiring experts, analyzing data), especially for poorly resourced public agencies. It is often a challenge to measure impact accurately because so many variables cannot be controlled (including unanticipated changes in weather, conflict, natural disasters, or community or farmer health). ICT can address some of these challenges by reducing the paper trail, increasing farmers' responses (and the diversity of respondents), improving remote observation, and expanding data accuracy. (See also Module 13 on governance.)

### Monitoring and Evaluating Agricultural Interventions and Research

India has pioneered the use of ICT in many agricultural interventions and is often at the forefront of technological innovation for smallholder farming. To track research being conducted in India, the Indian Agricultural Statistics Research Institute developed the Project Information and Management System for the Indian Council of Agricultural Research. The data management system was created to prevent duplication between research projects, monitor research initiatives and their progress more effectively, evaluate research outcomes, and contribute to smoother management processes. By generating online software, the Indian Council of Agricultural Research has the ability to monitor and evaluate research projects at national and state levels simultaneously. Users involved in research projects can upload information on new projects and update information as the project moves forward. Users can also browse through projects, which helps to spur innovation and creative thinking while preventing overlap. Research directors and managers can then manage and monitor agricultural interventions and research remotely and with fewer costs. In addition, the management system can hold research data and final reports. For more information on how the system works, visit the tutorial at <http://pimsicar.iasri.res.in/>.

In another project, which monitored drought vulnerability, local participants played key roles in validating and evaluating the effectiveness of the information provided. The Virtual Academy for the Semi Arid Tropics (VASAT) (<http://www.icrisat.org/vasat>) uses components such as PC-equipped rural information centers, community radio, and mobile telephony in conjunction with human-centered efforts to anticipate and monitor the effect of drought at the micro level. Since 2005–06, activities under this initiative have taken

place in Niger and in India. In both locations, rural organizations established community-based information centers with international support. The focus was on helping rural communities anticipate drought and to help them develop and arrive at decisions that can mitigate the impact of drought when it occurs.

In the VASAT initiative, a blend of remote sensing and agrometeorology techniques was used to develop highly localized, village-by-village forecasts of drought vulnerability. These forecasts were presented as simple color-coded maps of the locality (a cluster of adjoining villages). Red/amber indicated severe vulnerability to drought (including drinking water scarcity), whereas green indicated that business as usual could continue. Yellow indicated that the village needed to give attention to altering their cropping pattern and pay attention to fodder supplies. Developed for the coming season from global and regional rainfall forecasts, these maps and a set of recommended actions are shared with rural communities through the information centers. Every village has at least one individual who is trained in reading the vulnerability maps.

Analyses of the effects of this intervention reveal that after two seasons, a large number of individuals started to use the color-coded maps as reliable information resources. In 2009 in India, a particularly serious drought was forecast at the micro level although not at the aggregate level. Rural families prepared for the anticipated drought by storing fodder and not sowing water-intensive crops such as rice. Through these actions, they mitigated the effects of the ensuing drought, which was serious, lasting more than halfway into the season. Using ICT to monitor weather patterns as well as farmers' responses helps VASAT determine the correlation between the two. In this intervention, it was significant that women were key actors in absorbing and relaying information about vulnerability to drought. They were also meticulous data providers for experts to refine or correct the vulnerability forecasts.

Pajat (<http://www.pajatman.com/>), a company founded in 2009 and financed by the Finnish Funding Agency for Technology and Innovation among others, has also pioneered ICT for monitoring and evaluation. The POIMapper, using GPS-enabled mobile phones, can collect data and photos with digitized links to location. Numeric or text data can be uploaded to a central database through cellular or bandwidth networks. Data collected for a particular intervention can be mapped on a computer; multiple datasets can be layered to create more informative maps. This tool can be used to monitor a variety of projects, including projects to develop infrastructure such as

wells or to manage forests (see the forestry module). It may also be used to monitor the effects of agricultural interventions by mapping data on increases or declines in crop yields or frequencies of livestock disease. (See IPS “PoiMapper in Kenya” for more information in Module 15.)

In Africa, organizations have used mobile phones to collect information from farmers about how they can improve their programs, as illustrated in box 6.12.

### **BOX 6.12: Mobile Phones as Tools for Farmer Surveys and Feedback**

Voice of the Farmer (VoF) is a pilot project testing a structured approach to obtain broad-based, low-cost, and frequent feedback from farmers in Kenya, Tanzania, and Uganda, using mobile phone technology. The pilot was conducted between January 2010 and March 2011 by Synovate Panafrica, with funding from the Bill and Melinda Gates Foundation.

The approach was designed to help organizations collect a steady supply of empirical, actionable data more rapidly and cost-effectively. Feedback from target constituencies enables organizations to assess whether they need to change their activities and approach to better meet their constituents’ needs. In the shortest possible time, findings can be available to participating organizations through an online portal.

How has VoF been used? Some organizations used VoF data to monitor progress in implementing projects. Others used the surveys to help guide the content of products they planned to develop. One organization used VoF to get a better idea of how to focus its monitoring and evaluation surveys. Another used VoF primarily for quick marketing surveys to receive timely feedback on new products and services. Experience with the pilot project indicates that VoF has potential as an efficient, low-cost solution meeting a number of needs in private, public, and civil society organizations.

*Source:* Authors; see also <http://www.synovate.com/contact/africa/>.

### **LESSONS LEARNED**

Despite the benefits of using ICT in agricultural advisory and extension services, many challenges remain. Lessons from the examples herein and Innovative Practice Summaries are relevant to many projects that use ICT to improve advisory

services. These lessons and their potential solutions are discussed below.

Because advisory services are one of the most direct lines to poor farmers, it is critical to determine the main objective of services and the most appropriate ways to use ICT to meet them. If the primary aim is to get information to farmers, then multiple channels and media should be used to reach many groups. The quality and relevance of the content/advice to be provided is also important, as is the level of community “connectivity” to the providers’ messages. Conversely, if the aim is to maximize farmer-to-farmer documentation and sharing, then the emphasis is likely to be much more on capacity building and issues of culture, language, and various forms of literacy.

The technological component of an ICT for advisory services should be developed locally, in collaboration with users, and drawing on local, national, and international content as appropriate. Attention should be focused on what the technology needs to deliver, not its capabilities.

During implementation, the roles and responsibilities of the various actors need to be defined. Accountability improves when participants are aware of what is expected from them in terms of their roles and their commitments of human and financial resources and time. This clarity is especially important for national advisory services, where stakeholders are diverse and systems are decentralized. Regular face-to-face meetings are also crucial to capitalize on information exchange and stimulate new ways of working together and sharing lessons learned.

Any technology used for advisory services must be user-friendly, accessible, and serve farmers’ needs quickly and sufficiently. Trust, useful information and knowledge, and appropriate support are critical to user sustainability. Part of ensuring sustainability is engaging in proper prior analysis and involvement of end users. These steps will help providers determine whether the users can pay for the service and, if so, how much; understand the culture surrounding the use of technology in a given location; identify social and political challenges that may arise during implementation; and determine what kinds of applications will serve users best based on their agrarian activities.

Special efforts have to be made to guarantee that both men and women participate in and benefit from information and communications for advisory services. The opportunities offered by information technologies can significantly enhance



information provision to rural women in developing countries. Without equal access to information, women are at a disadvantage in making informed choices about what to produce and when to sell their products. While ICT certainly improves these circumstances, availability of an ICT device does not necessarily imply equitable access. More often than not, ICT devices (radios, phones) remain under the control of men, preventing women from tapping knowledge and information relevant to their needs. Gender-disaggregated data, monitoring, evaluation, and better targeting will improve these outcomes.

### INNOVATIVE PRACTICE SUMMARY

#### Farm Radio International Involves Men and Women Farmers

Radio is used to spread knowledge of improved farming and land management practices, but farmers do not necessarily adopt them. Farm Radio International, a Canadian NGO funded by the Bill and Melinda Gates Foundation, has created a new model of radio broadcasting that seeks to overcome some of these challenges to adoption.

Farm Radio International partners with 360 radio stations in 39 African countries and reaches more than 200 million smallholders in more than 100 African languages. It offers a number of services but primarily develops Participatory Radio Campaigns, theme-based radio programs that continue for four to six months. Themes range from livestock husbandry to farmer innovation, soil conservation, and issues specific to rural women (such as maternal health, farm implements designed for women, and women's land rights).<sup>14</sup>

The most innovative aspect of the Participatory Radio Campaigns is the broad base of farmer participation. First, men and women farmers help to develop the scripts, and a number of communities are invited to participate during implementation and evaluation (image 6.10). Second, programs are broadcast on a consistent schedule to keep farmers engaged. Third, Participatory Radio Campaigns feature voice response systems and call-in options that have proven remarkably successful in retaining listeners. The information elicited in this way helps extension staff and local NGOs identify the challenges, understand the perspectives, and gain the knowledge associated with a given community or area. Finally, women farmers are regularly

**IMAGE 6.10:** Women Can More Easily Participate in Rural Radio Interviews



Source: Farm Radio International.

included in the broadcasts and participatory aspects of the programs, improving their visibility and importance in the local agricultural supply chain.

Empirical evidence of impact, which is currently lacking for many applications of ICTs in agriculture, is available for the Participatory Radio Campaigns. In 90 communities across five countries, about 4,500 farm households (1,988 women and 2,452 men in total) were randomly selected and surveyed through questionnaires. Key informant interviews and site observations were also used to assess overall impact. The communities were split into three categories: (1) communities that participated actively in broadcasts and program design, (2) communities that listened to broadcasts without active participation, and (3) control communities (or those that did not have network radio signals to listen to the programs).

Thirty-six percent of active listening communities adopted improved farming practices, and 21 percent of passive listening communities adopted. Women from active listening communities were much more likely to adopt the practices covered in the radio programs (almost as likely as male listeners) than women in passive listening communities. These adoption rates are higher than those from many other radio programs, demonstrating that participatory radio is more effective than programs that do not engage farmers directly. More men than women listen to and have access to radio programs (table 6.1), although when women have no radio in the household, they access radio elsewhere.

14 See <http://farmradio.org/english/radio-scripts/gender.asp>.

**TABLE 6.1: Radio Access and Frequency of Listening in the Household (%)**

	MEN	WOMEN
Radios in the household	84	68
Access to radio (both inside and outside of the home)	96	89
Frequency of listening (at least once/week)	95	86

Source: Farm Radio International Participatory Radio Campaign Evaluation Report 2011 (unpublished).

Participatory Radio Campaigns take approximately 12–18 months to design, distribute, and evaluate. For themed packages, costs range from US\$ 25,000–50,000. For the whole process, including training and assessment, costs can range from US\$ 80,000 to US\$ 200,000, depending on the country and other factors. To put these figures into perspective, it is useful to know that if a campaign reaches 1 million farm families, the cost lies somewhere between US\$ 0.08 and US\$ 0.20 per listening family. Given the adoption rates cited earlier, costs per adopter range from US\$ 0.20 to US\$ 1.00. These costs are relatively small in light of the relatively high adoption rates and resulting productivity increases.

### INNOVATIVE PRACTICE SUMMARY

#### E-Extension in the USA and Philippines

This summary looks at how electronic advisory services are being implemented in the United States and the Philippines. Both programs use ICTs to increase the expertise available in the national advisory service and transmit that expertise to a much larger audience—while learning from that audience in the process.

#### United States: ICTs to Co-Create and Deliver Extension and Educational Knowledge

In 2001, the United States government decided to transform the way its Cooperative Extension System fulfilled its mission through technology. The program that became known as “eXtension” was approved as a national initiative in 2004 and fully launched in 2007. By definition, eXtension is the product of new and emerging technologies. The program aims to become a national, Internet-based information and education network; provide accurate, up-to-date information for use anytime, anywhere; use technology and new organizational processes such as communities of practice; enhance the accessibility, quality, breadth, and depth of information provided to the public; foster collaboration within the Cooperative Extension System; and reduce duplication. It is an integral part of the Cooperative

Extension System and complements and reinforces other extension activities.

Through the Internet, eXtension provides 24/7 access to objective, science-based information from land-grant universities and partners. One of eXtension’s most notable features is “Ask an Expert,” which puts people in touch with experts in universities across the country. In addition to those resources, eXtension’s communities of practice connect extension professionals throughout the country to collaborate in developing new content and web services. eXtension has transformed extension’s traditional teaching role by offering a wide range of virtual learning and skill-development activities and events on its website. Through social networks and media (including blogs), the communities of practice expand the reach of extension and engage with new users.

The eXtension websites are a useful resource for those seeking to develop similar programs in other countries. They offer a wealth of information on the approach and the tools used (<http://www.extension.org> and <http://about.extension.org>).

#### Philippines: ICTs Power Advisory Service for Agriculture, Fisheries, and Natural Resources

The Philippines launched its e-Extension Program in December 2007. The lead organization—the Agricultural Training Institute—relies on collaboration with various organizational units within the Department of Agriculture. The goal of e-Extension is to integrate and harmonize ICT-based delivery of advisory services for agriculture, fisheries, and natural resources and to use its network of institutions to provide a more efficient alternative to a traditional extension system. e-Extension can be thought of as an electronic, interactive bridge where farmers, fishers, and other stakeholders meet and interact to enhance the productivity, profitability, and global competitiveness of the agricultural sector. The benefits of the approach are expected to include empowered stakeholders, who have alternative means of acquiring new knowledge and skills related to farming and fishing technologies; reduced costs of education and training; more optimal use of resources; enhanced delivery of programs and services; and an organized repository of information, harmonized across related initiatives.

The main program components are e-Learning and e-Farming; an e-Trading component is available as well. e-Learning courses are available online and can also be delivered to small groups. Blended courses offer computer-based instruction backstopped with field activities and face-to-face interaction between

learners and experts. Learners also have the opportunity to interact through online discussion forums. Online they also have access to a wide array of free digital resources to increase the knowledge gained through coursework and obtain additional information to make decisions about their agricultural enterprises. Media for school radio programs are available as well. The e-Learning courses are designed to be highly interactive. Photos, video, games, and puzzles also help to sustain interest.

e-Farming uses ICTs to deliver farm and business advisory services. It provides technical assistance to farmers to increase the profitability of their enterprises and facilitates the exchange of information among traders and investors in agriculture and fisheries. Its Farmers' Contact Center caters to farmers' concerns through voice, text, e-mail, and other online communication formats such as instant messaging and online forums.

e-Trading is a service for online trading and for information on market trends, investments, market prices, inventories of producers and suppliers, and other information, initially available through the PhilAgribiz Centers of the Department of Agriculture. For more information, see <http://e-extension.gov.ph/> and <http://www.ati.da.gov.ph/>.

### INNOVATIVE PRACTICE SUMMARY

#### TECA Uganda Exchange Group Offers Practical Advice for Smallholders

The TECA web platform (<http://www.fao.org/teca/>) includes online resources, discussion forums, and query/response services that offer practical information on technologies and practices that will help small-scale producers. The platform, which is a medium for FAO technical units, partners, and projects to document and share successful technologies and good practices, is also a tool that supports further development, testing, adaptation, sharing, and adoption of technologies for small-scale farmers.

The central TECA platform on the FAO server permits information sharing at the global level in English, French, and Spanish. A local version on the partner organization's server contains modules provided by FAO for information sharing and exchange within a national agricultural innovation system; the modules can be adapted to local languages and specific information needs. For example, the TECA Uganda Exchange Group, piloted in 2010, currently has more than 300 members from public and private advisory services, NGOs,

research, the private sector, farmer groups, government, and universities (including some student members).

Since its establishment, the group has had very positive feedback. Members have shared their experiences and created their own informal networks. An active group facilitator, fully dedicated to the group, has been central to its success. The facilitator must increase awareness of the platform among potential users, bring individuals together and identify their common interests, initiate discussions, motivate members to contribute, identify experts, and provide technical assistance. The facilitator needs support from IT as well as contacts who can gain visibility for the platform. Although TECA is designed as an online forum, personal gatherings proved essential to establish a vibrant online community (the kind of interaction will require funding for meetings, phone calls, transport, and other items that facilitate personal interaction). Another major lesson is that students are a very important and active group of participants; introducing them to the idea of knowledge management, is a key asset for their future work in agriculture.

### INNOVATIVE PRACTICE SUMMARY

#### Participatory Video and Internet Complement Extension in India

Digital Green (<http://www.digitalgreen.org/>) started with the support of Microsoft Research in India. It disseminates targeted agricultural information to small-scale and marginal farmers in India through digital video. The system includes a database of digital videos produced by farmers and experts. The topics vary, and they are sequenced in ways that enable farmers progressively to become better farmers. Unlike some systems that expect ICT alone to deliver useful knowledge to marginal farmers, Digital Green works with existing, people-based extension systems to amplify their effectiveness. The videos provide a point of focus, but it is people and social dynamics that ultimately make Digital Green work. Local social networks are tapped to connect farmers with experts; the thrill of appearing "on TV" motivates farmers. Although Digital Green requires the support of a grassroots-level extension system and other partners, it is effective because its content is relevant and it maintains a local presence. This local presence makes it possible to connect with farmers on a sustained basis. Key aspects of the model include the following:

- **Digital video.** Digital Green relies on recent advances in digital videography, including low-cost camcorders and

PC solutions for editing digital video, which have greatly reduced the costs of developing local video content.

- **Mediation.** Videotaped demonstrations are not a complete extension solution. They lack the interactivity that is the hallmark of good extension. Digital Green relies on a local facilitator, whose role is to pause or repeat video to engage the audience in discussion and capture farmers' feedback.
- **Partnerships.** Digital Green emphasizes the development and delivery of digital content to improve the cost-effectiveness of organizations involved in agricultural research and/or extension. As noted, the goal is to strengthen existing institutions and groups, not to create new ones.
- **Community-based content.** Content must be relevant to local conditions (crops, climates, soils, farming practices, and so on). The use of video provides opportunities to customize materials. When videos feature farmers' fellow villagers, farmers often instantly connect with the message. Digital Green has an open model to disseminate content, so it is freely available to everyone to use.
- **Beyond connectivity.** To be successful and sustainable, Digital Green operates in environments with

limited infrastructure and financial resources. High-bandwidth Internet connections are not necessary, since one option for receiving the video content is DVD.

- **Feedback.** By enabling anyone to be a content producer and consumer, Digital Green gives even isolated communities a voice. Other types of audio- and video-based mechanisms are used to support reporting and to build trust among virtual communities of participants.

The Digital Green approach is underpinned by various technological innovations (<http://www.digitalgreen.org/tech>). For example, its COCO (Connect Online, Connect Offline) software supports data tracking for organizations with sizable field operations, even where Internet service is intermittent and/or poor. COCO, a standalone application in the Internet browser, requires no additional desktop software installation or maintenance. It has an open-source, customizable framework and can be used without support from professional IT or engineering staff. Digital Green's Analytics System provides day-to-day business intelligence on field operations, performance targets, and basic measures of returns on investment relevant to an organization (see <http://analytics.digitalgreen.org>).

## Topic Note 6.3: E-LEARNING AS A COMPONENT OF AGRICULTURAL INNOVATION SYSTEMS

### TRENDS AND ISSUES

Learning—formal and informal—is central to all innovation systems, including those for agriculture, and in sustaining the capacity to innovate over the long term. Formal learning consists of specific courses of study of varied length and complexity in the educational system. This system develops the skilled experts who contribute to agricultural innovation (the varied research disciplines and areas of technical expertise, innovation brokers, as well as developers of food processing systems and standards, financial and risk management instruments, rural infrastructure, IT systems—the list is as extensive as the agricultural innovation system is comprehensive). Outside of this context, informal learning occurs through the varied interactions in an agricultural innovation system and is particularly important in agricultural extension (FAO 2003). The role of agricultural education and training in an innovation system is discussed in detail in Module 2 of World Bank (2012). This topic note focuses on the role of e-learning, particularly in extension interactions.

With the advent of radio, ICTs opened new channels for learning that proliferated rapidly as the range of ICTs expanded to include computers, the Internet and their applications (CD-ROMs, e-mail, websites, multimedia, and so forth). Learning delivered through the newer ICTs was termed “e-learning,” and its potential to facilitate “distance learning” and “distance education” (instruction and learning outside the traditional classroom setting) was recognized immediately (image 6.11).

The World Bank defines e-learning as “the use of electronic technologies to deliver, facilitate, and enhance both formal and informal learning and knowledge sharing at any time, any place, and at any pace.”<sup>15</sup> E-learning can widen the inclusiveness of the agricultural innovation system by bringing elements of traditional learning and mentoring to a wider

15 See <http://go.worldbank.org/3IVXTNIW20>.

**IMAGE 6.11: E-learning Creates Opportunities for Rural Participation**

Source: Curt Carnemark, World Bank.

audience and further empowering people through learning communities.

In theory, e-learning enables governments, agricultural advisory services, NGOs, farmer organizations, private companies—in fact, any actor in the innovation system—to reach large numbers of producers. Content can be updated quickly and accommodate rapidly changing needs. E-learning can also provide fresh approaches that are learner-centric, engaging producers and their communities as partners and adult learners in designing and implementing the learning experience. In addition, e-learning can make it easier to maintain quality by supporting feedback mechanisms and ensuring appropriate accreditation and certification processes.

These qualities make e-learning especially attractive to extension, especially for expanding extension workers' and farmers' knowledge and skills. Efforts in extension education have long been challenged by the use of a formal didactic framework that expects students to fit with the established courses (Kroma 2003). Public sector extension has suffered from declining investments, the high proportion of farmers in relation to trained extension workers, and the need to incorporate adult learning strategies and indigenous knowledge into their activities (World Bank 2012).

ICTs (and e-learning) may make it possible to surmount some of these barriers to effective extension training and outreach in developing countries, but significant adaptations will be

needed. E-learning originated in a postindustrial setting among a relatively well-educated population with reasonably good infrastructure for accessing digital services. Investments in digital content for e-learning were an agreed priority that resulted in the development of a host of advanced platforms and applications for learners and facilitators/teachers.

The innovative practice summaries in this topic note indicate some of the adaptations and strategies required for e-learning to succeed in rural areas of developing countries, especially communities with limited literacy (digital and otherwise) and access to digital resources. Both examples come from India. The first summary describes an e-learning initiative in which farmers use mobile phones to gain specific skills that enable them to benefit more substantially from services such as commercial banking and extension advice. The second describes the

development of a web-based platform called agropedia for storing and sharing agricultural information in a range of formats and languages. The platform, which incorporates Web 2.0 elements such as wikis, blogs, and commentary spaces, provides much-needed content for e-learning for farmers and extension workers. Through these features and multiple access points (including mobile phones and landlines), the platform connects researchers, extension personnel, and farmers in various information-sharing and e-learning activities.

### LESSONS LEARNED

The experiences summarized here offer important social and technical perspectives on e-learning for rural people and extension workers in developing countries. ICTs can facilitate a learner-centric process if they are adapted carefully to the particular social, economic, and political context (including constraints on learners' time and travel). A multistakeholder partnership is essential for promoting learning among the farming community through ICTs, and agricultural institutions need to produce more extension-oriented digital content. Content for e-learning must be highly granular for rapid uptake and must be linked to specific learning outcomes. E-learning does not require the complex online workflows associated with standard learning management systems, but a priority in promoting e-learning in agricultural innovation systems is to build ICT capacity in personnel at all levels of agricultural education, training, and extension.

Finally, ICTs and virtual interactions are not sufficient to form cohesive learning communities. Peer-to-peer contact significantly improves learning, and mobile phones can provide useful support. In the lifelong learning for farmers initiative, for example, mobilization, social capital, and social networking played a major role. The use of ICTs for learning influenced development outcomes because the learning experience was tailored to women's cognitive social capital and reinforced by links with commercial banks.

### INNOVATIVE PRACTICE SUMMARY

#### Lifelong Learning for Farmers in Tamil Nadu

Lifelong Learning for Farmers (L3F) (<http://www.col.org/progServ/programmes/livelihoods/L3farmers/Pages/default.aspx>) is an application of Open and Distance Learning for Development by Commonwealth of Learning (COL) in Commonwealth countries (Balasubramanian and Daniel 2010). Banks, universities, and marketing agencies are the partners in the L3F initiative. Using open and distance learning and ICT, the initiative aims to strengthen the self-directed learning process among men and women in the farming community and create linkages between various stakeholders. The objective is to facilitate the enhancement of skills and knowledge of farmers in partnership with financial institutions and research institutions. L3F is based on the following premises:

- Unexploitative, mutually reinforcing contractual relationships between rural producers and the formal public and private sector will promote rural entrepreneurship.
- Learning and extension can be a self-sustaining process in which secondary stakeholders support L3F within a win-win framework. For instance, by blending rural credit with appropriate capacity building, rural credit will perform much better in terms of productivity, returns, and nonperforming asset levels. Such gains will lead financial institutions to support L3F.
- Capacity building will also enlarge the market for bank credit among small-scale and marginal farmers and among other marginalized groups of the rural poor, particularly women. Modern ICTs can play a major role in supporting capacity building, which in turn would enhance the market for such technologies.

The rural poor stand to gain in this process, along with the participating financial institutions, research institutions, and

ICT companies. In addition to using ICTs to build capacity, financial institutions can use them to reduce the transaction costs of lending. Integrating these functions can improve the likelihood that the L3F process will be replicable and sustainable.

#### Integrating Mobile Phone-Based Learning and Credit for Women Livestock Producers

VIDIYAL, an Indian NGO, uses L3F to promote community banking among 5,000 women organized into self-help groups (SHGs). During 2008, nearly 300 women from the SHGs became partners and decided to build their capacity through open and distance learning related to various aspects of sheep and goat production. As poor laborers, most of the women felt that attending classes or watching multimedia materials restricted their ability to work and attend to household chores. They asked VIDIYAL and COL to explore the use of mobile phone as a learning tool, because they would not need to be confined to any particular place or time during the learning process.

Through face-to-face and computer-based learning, COL and VIDIYAL encouraged the women to develop a business proposal for rearing sheep and goats. They developed a business proposal in which each member would obtain credit for buying nine female goats, one buck, and one mobile phone. The local bank agreed to the proposal and sanctioned a loan of US\$ 270,000. The credit and the legal ownership of the assets are in the names of the participating women.

The 300 women bought simple mobile phones, and VIDIYAL entered an agreement with IKSL, one of India's major mobile network operators, to send audio messages to the women's phones free of charge and enable free calls among group members. The company felt that this strategy would enhance its mobile service in the long run.

VIDIYAL and some of the participating women were trained in developing audio content for mobile phone-based learning (image 6.12). Learning materials are prepared within the broad principles of open and distance learning to meet learners' time and geographical constraints. VIDIYAL developed the materials in consultation with the Tamil Nadu Veterinary and Animal Sciences University and contextualized them to the local culture and dialects.

The learning materials convey information in granular fashion—in short, concise messages. Three to five audio messages are sent to participating women every day. Each message runs for 60 seconds.

**IMAGE 6.12:** Women Use Mobile Phones to Learn Better Goat Production Techniques



Source: Commonwealth of Learning.

Women preferred to receive the messages in the mornings while going to work or performing their household tasks—for example, while grazing the livestock. The women reported that they learned and practiced the messages and recorded them in their diaries. Illiterate women sought the help of literate family members to record the messages. Most of the respondents' families supported their learning objective, which benefited the entire family by expanding their knowledge base in relation to small livestock production.

Other multimedia learning materials were shown during SHG meetings and telecast through local satellite channels run by the SHGs. Once a week, SHG members met and shared experiences. The horizontal and vertical transfer of knowledge has encouraged self-directed learning among the members (Balasubramanian, Umar, and Kanwar 2010).

### Preliminary Impacts

An important contribution of L3F is that it establishes links between research and education institutions, extension organizations, and the primary stakeholders. The participatory preparation of learning materials fosters intensive interaction

between all of these groups. A consortium of agricultural and veterinary universities supports the farmers' and women's groups in developing business plans and providing learning materials on seed, animals, and other subjects. The women's association assesses the problems in a particular area, aggregates the queries, and sends them through video e-mails to the universities. Designated professors in the universities provide answers through video e-mails that are stored in a digital library for farmers and others to access easily. Similarly, the FAQ system used in mobile phone-based learning is linked to the universities, research institutions, and extension organizations.

In this learning process, information flows both ways as farmers contribute their informal learning and tacit knowledge to the other partners. Through mobile phones and computers, the students and researchers interact with SHG members (farmers and women) to understand their indigenous knowledge. SHG members participate in university research by managing research plots, providing data, and in analyzing results. Undergraduate and graduate students undergo field training under the supervision of the women farmers. Universities use the distance learning materials developed by women's groups and farmer groups as reference materials for diploma courses in agriculture and horticulture.

The social capital and capacity building accumulated through L3F and the interaction it induces have led to some interesting results. Around 5,000 women and men are involved in structured learning courses through mobile phone. During 2009–11, commercial banks extended approximately US\$ 1 million in credit to 2,000 L3F participants. Over the same period, the total turnover of the supported enterprises was US\$ 3.14 million. The higher rate of credit repayment among L3F participants encourages support from the banks (COL 2010). Studies by COL indicate that the quality of the sheep and goat enterprises operated by L3F participants is significantly better than those of nonparticipants in the same region (Balasubramanian and Daniel 2010).

### Learning through Interactive Voice Educational System

Recognizing the potential of mobile phone-based learning, COL asked the University of British Columbia to develop an audio-based Learning Management System and Learning Content Management System. The university created a prototype called Learning through Interactive Voice Educational System, which not only enables audio-based learning materials to be automated but helps process the tests, feedback, and responses through appropriate

databases (Vuong et al. 2010). This system should improve quality assessment and certification in an informal learning environment.

### **INNOVATIVE PRACTICE SUMMARY** **Innovative E-Learning for Farmers through Collaboration and Multi-Modal Outreach**

The apparent limited availability of digital content relating to agricultural extension reduces the opportunity to build sustainable, digitally mediated services that bring new benefits to farmers and increase the reach of extension personnel (for example, see Balaji 2009). This gap could be overcome by developing a content aggregation system that receives and provides information in multiple modes, especially through the Internet and voice/text messaging on mobile phones.

Such information could be generated using standard validation procedures in research and education or captured from transactions (such as query response services involving farmers and experts). The same arrangement could provide additional training support to field-based stakeholders in agriculture, especially farmers. The core principle here is multi-modality in access to information and training/learning support services.

#### **The Consortium for Agricultural Knowledge Management: Resources for E-Learning**

A key initiative under the World Bank-funded National Agricultural Innovation Project in India is the Consortium for Agricultural Knowledge Management, which has been active since 2008. The initiative is built around an advanced online content aggregation system called agropedia (<http://agropedia.net>), which delivers and exchanges information through a web portal and mobile phone networks accessible to phones with limited or no data capability. Agropedia also provides a subsidiary platform to support online learning for agricultural extension (<http://www.agrilore.org>).

Agropedia was designed to overcome the paucity of useful agricultural extension information in the web space. Online discussions can be set up to support queries or validation. The platform incorporates Web 2.0 elements such as wikis, blogs, and commentary spaces and receives material in digital formats including text, still images, audio, and video. A highly targeted search engine allows users to search for content in multiple Indian languages,

overcoming a serious challenge in using ICTs for development. Agropedia is already linked to the principal website of the Indian Council of Agricultural Research (<http://www.icar.org.in>).

Agricultural extension workers can use the agropedia platform to create their own groups of contact farmers or peers, facilitating e-learning. These groups can be sent timed SMS/text messages and voice messages, enabling specific interest groups to receive specific messages and not broadcasts. A farmer or a practitioner in the field can raise a query via voice or text. A virtual call center built into agropedia receives the query and passes it to appropriate extension workers and experts. In this way, trust and/or interest-based messaging networks can be formed and sustained.

Agropedia is an example of how a highly integrated platform can use multiple approaches to connect a spectrum of stakeholders, including research experts validating information, extension personnel in farm research stations and in the field, and farmers. Field-based producers do not need computers to connect to experts and extension personnel. Farmers with advanced practical knowledge and skills are in a position to share their tips and messages with a much wider community and can participate in discussions related to validation of particular pieces of information.

Agropedia has the equivalent of about 10,000 pages of material on 10 important crops in four languages and has close to 2,000 registered expert users. During two cultivation seasons in 2009–10, the consortium organized mobile phone contacts with about 27,000 farmers in four language regions and conducted 2.2 million SMS/voice transactions through 687 specific messages. Analysis revealed that farmers in general prefer voice as the transaction medium and that the preferred length of voice messages is about 36 seconds maximum.

The consortium is continuing into its second phase. An analysis of costs and efforts in the first phase (January 2009 to September 2010) revealed that university-based extension personnel could participate in the second phase without requiring additional staff. Since mobile phone and platform-hosting costs are low in India compared to the rest of the world, the analysis concluded that the effort can be mainstreamed as a regular activity in a typical agricultural university. The serious challenge is to strengthen ICT capacity among specialists and personnel at all levels, ranging from researchers to field-level extension workers.



### Adapting the E-Learning Approach for Farmers

An important activity for the consortium is to use e-learning methods to help farmers adapt their crop management practices to cope with drought. This activity was pursued by the Adarsha Mahila Samaikhya (AMS), a community-based, all-women federation of microcredit groups (south central India) and ICRISAT, which led the agropedia consortium in 2008–10. The AMS has a membership of about 7,400 women (June 2011); almost 70 percent come from households that are below the official poverty line.

ICRISAT helped the AMS set up the basic infrastructure connecting the AMS rural operations hub to the Internet, using a low-cost landline. A number of AMS activists were trained in IT. ICRISAT research scholars functioned as trainers and remotely supported extension-related queries from farmers. The scholars escalated queries to senior scientists of ICRISAT if needed. Several AMS women activists were trained in the basics of reporting problems related to crop cultivation, using a blend of online/e-learning and direct contact.

ICRISAT scientists and scholars realized that the e-learning methods were originally designed for the classroom milieu and needed to be adapted to new learners with limited or no classroom experience. Based on advice from COL, ICRISAT developed modules based on granules of instruction (see the previous practice summary; the modules can be viewed in English at <http://www.icrisat.org/vasat>).

Twenty minutes was set as the maximum amount of time that a farmer would have to attain a learning outcome. Learning outcomes were defined accordingly (for example, a learning outcome in this context would be to recognize a visible symptom of a plant disease). Women farmers were trained in facilitation to help other farmers state their field problems with greater clarity. Together, these skills were developed in a group of 30 farmers using internet chat first, bolstered by regular contact sessions. Eight hours of instruction were required over four weeks on average.

### Preliminary Results

The results were encouraging. With an untrained interlocutor, a farm problem received a solution from a subject matter specialist in an average of 26 hours, since the specialist needed to keep going back to the farmer for more information. With a trained interlocutor, the average time taken to identify a solution dropped to less than two hours, because the interlocutor was able to elicit important supplementary information (on rainfall, fertilizer and irrigation applications,

crop variety, and so forth). With the same number of extension personnel, more problems could be resolved in the field owing to the improved skills that women interlocutors mastered through e-learning. Key granules with photos were translated by the activists into the local language (Telugu) and issued as pamphlets for distribution among the interested farmers. Over a period of two years, 15 of 30 trained activists received higher-level recognition in the form of certificates from the Indian National Virtual Academy for Rural Prosperity.

Taking this experience into account, agropedia designers developed a repository of agricultural learning objects for use in extension (<http://www.agriore.org>). Three open and distance learning institutions—Indira Gandhi National Open University, Maharashtra State Open University, and the Open and Distance Learning Directorate of Tamil Nadu Agricultural University are populating this repository with about 500 granules relating to horticulture. They use this information to deliver certificate-oriented learning services to 5,000 farmers in three linguistic regions. This effort is also supported by the World Bank-financed National Agricultural Innovation Project as a separate activity.

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## Module 7: BROADENING SMALLHOLDERS' ACCESS TO FINANCIAL SERVICES THROUGH ICT

HENRY BAGAZONZYA (World Bank), ZAID SAFDAR (World Bank), and SOHAM SEN (World Bank)

**Overview.** Four kinds of financial services help farmers to achieve their economic goals: credit savings, transfer and payment facilities, and insurance. The major prerequisites for using information communication technologies (ICTs) to deliver these services in rural areas are robust national financial systems (for example, with national payment systems, credit bureaus, ATM switches, central platforms for microfinance) and the infrastructure that allows electronic financial transactions between institutions and individuals. Factors that are critical for ICTs to expand financial services in rural areas are a supportive economic policy and regulatory framework; appropriate financial and nonfinancial products; and mechanisms, processes, and technology applications that can deliver products and services, improve transparency and accountability, reduce costs, and become self-sustaining.

**Topic Note 7.1: The Use of ICT-enabled Financial Services in the Rural Sector.** New channels for delivering financial services (facilitated by ICTs), new players, and greater competition enable service providers to offer a larger suite of financial products and services and acquire better financial information, some of which is useful to government regulation and policy development. A number of nonbank institutions have developed innovative approaches to financing agriculture, enabled by or integrated with ICTs, including mobile financial services, branchless banking, ATMs, and smartcards.

- **Linking Conditional Cash Transfers and Rural Finance in Brazil**
- **RFID Facilitates Insurance and Credit for India's Livestock Producers**

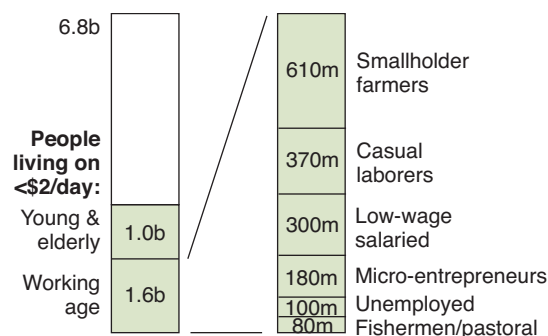
**Topic Note 7.2: Policy Strategies and Regulatory Issues for ICT-enabled Rural Financial Services.** Often governments lag in introducing the policies and regulations needed to extend cost-effective financial services throughout the economy, including underserved rural areas. To design supportive policies, provide the necessary infrastructure, and provide appropriate, affordable financial products meeting local needs, governments must explore partnerships with the private sector and rural communities. In turn, governments can devise and implement policies that give rural communities and private enterprises incentives to participate in the rural financial sector.

- **Kenya's DrumNet Links Farmers, Markets, and Financial Service Providers**
- **A Common Platform Delivers Financial Services to Rural India**

### OVERVIEW

Smallholder farmers are the world's largest group of working-age poor (figure 7.1). Much of the world's food supply will continue to depend on their efforts, yet a lack of financial services often stymies their attempts to make productivity-enhancing investments and to smooth their consumption between periods of plenty and scarcity. Capital-constrained farmers minimize risk instead of maximizing returns (for example, by investing in high-quality seed and fertilizer or growing what is most profitable) (Trivelli and Venero 2007). Box 7.1 summarizes the four kinds of financial services that farmers need to achieve their economic goals.

**FIGURE 7.1:** Smallholder Farmers Are the Largest Group of Working-Age Poor



Source: Mas 2010b.

### BOX 7.1: Farmers Require Four Kinds of Financial Services

- **Credit**, in the form of loans, personal loans, salary loans, overdraft facilities, or credit lines, is often used as working capital at the beginning of the growing season to purchase inputs and prepare land. They also need capital to invest in equipment such as tractors or drip irrigation and to harvest, process, market, and transport their produce. It is important to distinguish between short-term loans, which microfinance institutions usually provide, and the long-term financial services required for agricultural and livestock enterprises.
- **Savings** may be in the form of current accounts, savings accounts, or fixed or time deposits. Farmers have a significant need for savings, because their income is seasonally tied to the harvest, and for much of the year they rely on savings to smooth consumption.
- **Transfer and payment facilities** allow for local and international money transfers, remittances, government transfers, and check clearing.
- **Insurance** may cover crops and livestock as well as human life and health.

*Source:* Author, based on CGAP and IFAD 2006:6 and Nair and Fissaha 2010.

ICTs have now created the potential to deliver a greater diversity of financial products to greater numbers of rural clients than conventional financial service providers have been able to reach. ICTs can also enhance the government's capacity to monitor and evaluate financial services provided to rural clients and design effective financial policies and regulations for the rural sector.

A number of agents in rural areas—such as government departments, commercial banks, microfinance institutions, traders, telecommunications companies, community-based organizations, families, and friends—provide financial services, which can include credit, savings, insurance, transfers, and payments. Even so, tailoring and providing financial services for small-scale farmers remains challenging. Rural clients differ from the typical clients of financial service providers. They are located in remote and often sparsely populated areas, and they rarely possess the sorts of physical or financial assets that financial institutions customarily accept as collateral. Typical rural assets, such as livestock,

pose challenges of inventory assessment and management, and collateral substitutes based on warehouse receipts or returns from future crops are unavailable in many countries. Farmers also have a special need for financial products with a time horizon extending over multiple crop cycles.

This module explores how innovative mechanisms and technologies are used in specific situations in different countries to help rural dwellers—mainly farmers, whose businesses do not readily receive financial support—obtain the financial services listed above from commercial banks and other providers. Some of these technologies are already used in microfinance institutions in urban and peri-urban areas. Important to note, the ICTs discussed in this module are gender neutral; they are enablers and should be used in contexts where both men and women can participate.

Major prerequisites for using ICTs in financial services for agriculture are robust national financial systems and the infrastructure that allows electronic financial transactions between institutions and individuals. Two types of infrastructure and related services facilitate electronic transactions and are vital for extending financial services to rural areas.

The first is ICT infrastructure, such as high-speed Internet and mobile phones, available at affordable prices. This infrastructure is the backbone of electronic financial transactions. The second is financial infrastructure, which includes national payment systems, credit bureaus, ATM switches, or central platforms for microfinance institutions. Financial infrastructure enables financial service and technology service providers, as well as other providers vital for the integrity and stability of the financial system, to connect and perform transactions in real time.

For example, financial infrastructure makes it possible for customers of one bank to use the ATM of a different bank or conduct a transaction (such as writing checks or wiring money) with customers of a different bank. It also channels financial information (such as the creditworthiness of a new customer) to financial institutions.

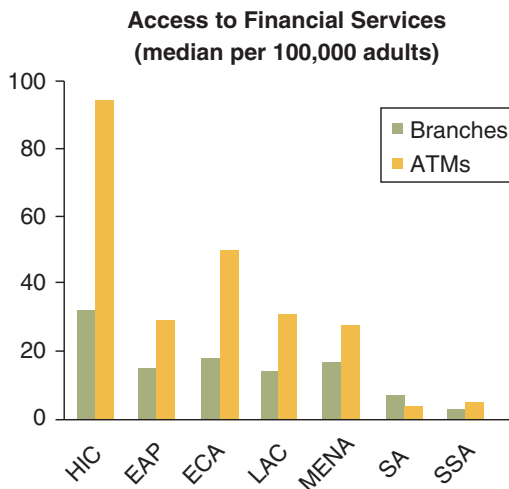
These services and infrastructure do not benefit merely one operator or financial service provider; they cater to the entire rural and financial sector. For this reason, their provision is often initially regarded as a task for government, although in reality they can be (and often should be) provided by the private sector alone or in partnership with government.

### CURRENT ACCESS TO FINANCIAL SERVICES IN RURAL AREAS

Across developing countries, in urban and rural areas, access to and use of formal finance remains very low in general. The financial access data in figures 7.2 and 7.3 are not specific to farmers, but they serve as a good proxy, showing that rural reach is a smaller proportion of total reach. Agriculture in particular has been underserved; for example, commercial lending to agriculture is 1 percent of all lending in Africa (Campaigne and Rausch 2010). Often, as a result of poor access to formal sources of finance, farmers are left to borrow at very expensive rates from informal money lenders.

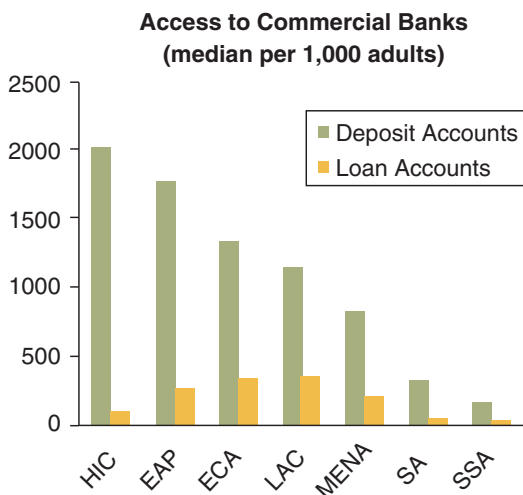
Commercial banks remain the dominant formal institutions providing finance to farmers (figures 7.5 and 7.6). Commercial

**FIGURE 7.2:** Low Access to Financial Institutions



Source: CGAP and World Bank 2010.

**FIGURE 7.3:** Low Utilization of Financial Services

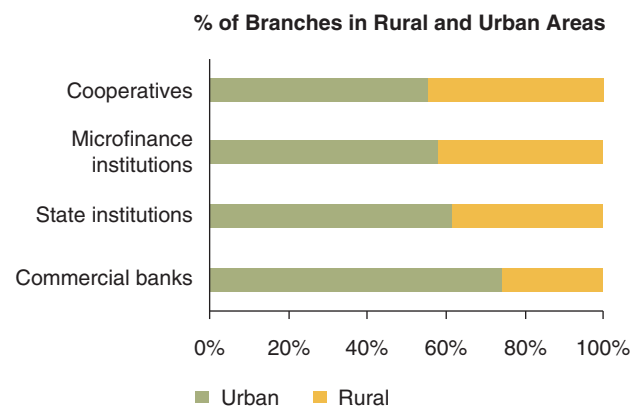


Source: CGAP and World Bank 2010.

banks constitute more than 75 percent of all rural branches of financial institutions worldwide; in comparison, microfinance institutions account for less than 3 percent. Microfinance institutions and cooperatives may situate a larger share of their branches in rural areas—41 percent and 43 percent, respectively (figure 7.4)—but their absolute total country reach is limited (figure 7.2).

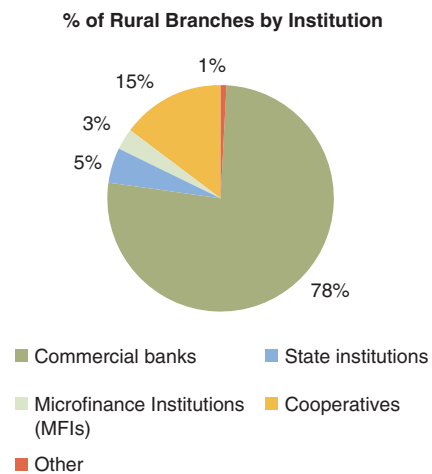
The supply of financial products and services in rural areas will remain a challenge until financial institutions can reduce the high operating costs associated with catering to rural clients; however, as this module indicates, ICT applications have demonstrated considerable promise in doing so. The next section briefly describes the factors that have proven critical to using ICTs successfully to expand the range of financial services in rural areas. The topic notes that follow provide

**FIGURE 7.4:** Access Is Worse for Farmers



Source: CGAP and World Bank 2010.

**FIGURE 7.5:** Commercial Banks Are Main Players



Source: CGAP and World Bank 2010.

greater detail on ICT-enabled interventions in rural finance (Topic Note 7.1) and explore policy and regulatory issues that either positively or negatively influence the expansion of the frontier for rural finance (Topic Note 7.2).

Both topic notes contain summaries of innovative practices that demonstrate how ICT is being used in specific settings to expand financial services while reducing transaction costs and information asymmetries. These approaches are certainly not conclusive (because the ICT is extremely dynamic and constantly changing), yet they provide an indication of alternatives that practitioners can consider when designing projects to improve rural access to financial services in a variety of situations, given the right policy and legal environment.

### KEY CHALLENGES AND ENABLERS

Expanding access to rural finance is challenging, and needs to be looked at as a process that includes a combination of factors, including a supportive economic policy and regulatory framework; appropriate financial and nonfinancial products; and mechanisms, processes, and technology applications that can deliver products and services, improve transparency and accountability, and reduce costs. Any proposed technology solution should be self-sustaining, with a clear plan for generating revenue and financing, or it will eventually prove impossible to sustain and replicate elsewhere. The technological applications described in the topic notes meet these criteria. This section reviews the lessons from implementing those applications as well as the enablers that different players can take to ensure that using ICT to help farmers access to finance is achievable in the long-term.

#### Federal Economic Policy

Financial markets resemble other markets in that direct government involvement can crowd out private participation. This problem has been perennial in developing countries' rural credit markets, where government agricultural banks offering subsidized credit were almost ubiquitous. Their presence created a "chicken-and-egg" problem: Governments were reluctant to withdraw from these markets because there was no private sector presence, but the private sector was reluctant to enter when, in addition to other obstacles to rural lending, government competition was a constant threat. In recognition of this problem, a new generation of government agencies was designed to coexist with—or even "crowd in"—the private sector by filling niches or resolving market failures by operating on a more commercial basis than their predecessors.

Agricultural policies may act to suppress private sector development, including the development of private financial services. Governments often use state-owned enterprises to intervene in agricultural product pricing to reduce price fluctuations and provide a floor price, for example. Such interventions can be very costly, are often ineffective, and preempt development of both insurance and storage markets. Farmers will not hedge their production if there is a floor price. Since producers have little incentive to store crops if they do not expect prices to rise over time, the market for storage facilities (and therefore the emergence of a warehouse receipt system and other mechanisms for managing risk) will be suppressed if these price movements are prevented by government intervention.

In sum, the policy environment that enables markets for financial services to develop is one in which minimal government interventions are carried out on a commercial basis, which allows markets to function freely. This restraint will, in turn, provide an opportunity for financiers to provide cost-effective and appropriate financial services without being encumbered by the government. It will also allow the provision of increased risk management services and ultimately lead to greater availability of financial services.

#### Legal and Regulatory Environments: Enforcing Contractual Obligations

The largest risk to sustainable financing for agriculture is often attributed to inherent business risks or the inability of financial institutions to design profitable financial products for the rural population. Yet interventionist government policies, such as subsidized interest rates, forgiveness of debt, and failure to enforce appropriate rules and regulations can immensely limit the effectiveness of an ICT-enabled product that could have made finance accessible to a large number of people. Conversely, an enabling environment and legal framework, enforcement of regulations, and supportive rural infrastructure eventually lead to lower but sustainable interest rates by reducing transaction costs and risks and increasing competition. All of these outcomes go a long way toward making a sustainable access to finance a reality.

#### Infrastructure Costs and Shared Platforms

Technology solutions require an investment that can be costly and difficult to justify when implementation is risky, as is typically the case with technology. Investments in technology can be leveraged by financial intermediaries and others within a community to provide additional services on

the same platform, however. Sharing infrastructure such as power, telecommunication, data networks, hosting, application support, or data management drives down the cost of technology, making it affordable to deliver financial products and services to rural areas (see IPS “Passive Infrastructure-sharing in Nigeria” in Module 3).

This idea of leveraging infrastructure can also be considered in the development of warehouses for collateral-based systems, weather stations for the development of index-based rainfall insurance, and physical infrastructure to facilitate improved functioning of the supply chain. Investments in infrastructure that can be leveraged but require a high initial investment require the participation of both the public and the private sector to ensure ownership on both sides.

### Technical Assistance and Capacity Building

Building the capacity to use and adapt ICTs to facilitate financial services is important not only for the staff of banks and financial service providers but for borrowers and, in some cases, for governments. Capacity building for staff increases the chances of innovation and success in extending financing. Capacity building is also important for borrowers. In a number of cases reviewed in the topic notes, particularly the cases involving institutions or agencies other than banks, technical assistance was one of the core components of success. Likewise, capacity building that focused on maximizing the impact of credit through improvements in product quality was essential to successful management of supply chain financing in Kenya (see IPS “Kenya’s DrumNet Links Farmers, Markets, and Financial Service Providers” in Topic Note 7.2).

Borrowers will need to be educated about new, ICT-enabled instruments for risk management and insurance. There are many ways that organizations and producers can manage risk, and they should learn to select the correct tool or combination of tools that most efficiently and cost effectively match their risk.

Finally, governments will, in some cases, require assistance in capacity building or creating an appropriate legal or regulatory framework. Such assistance may include, for example, support in drafting appropriate legislation and regulations. Variations in the regulation of ICT infrastructure for making cash transfers and providing other financial services have had a considerable impact on the kinds of services eventually provided in rural areas (see “Topic Note 2.3: Mobile Money Moves to Rural Areas”).

### Organizational Culture

A dynamic organizational culture allows staff to innovate—by using new technology, for example—and ensures the sustainability of financial innovation. For example, Bolsa Familia (see IPS “Linking Conditional Cash Transfers and Rural Finance in Brazil”) involves organizations that train staff well, provide innovative tools for the job, and create dynamic environments with appropriate incentives to motivate staff to work closely with clients. Management’s participation is crucial, particularly for the development and implementation of an ICT-for-finance program. Other case studies (such as DrumNet) underscore the benefits of empowerment. People with a stake in a business expend many efforts to make the business work.

## Topic Note 7.1: THE USE OF ICT-ENABLED FINANCIAL SERVICES IN THE RURAL SECTOR

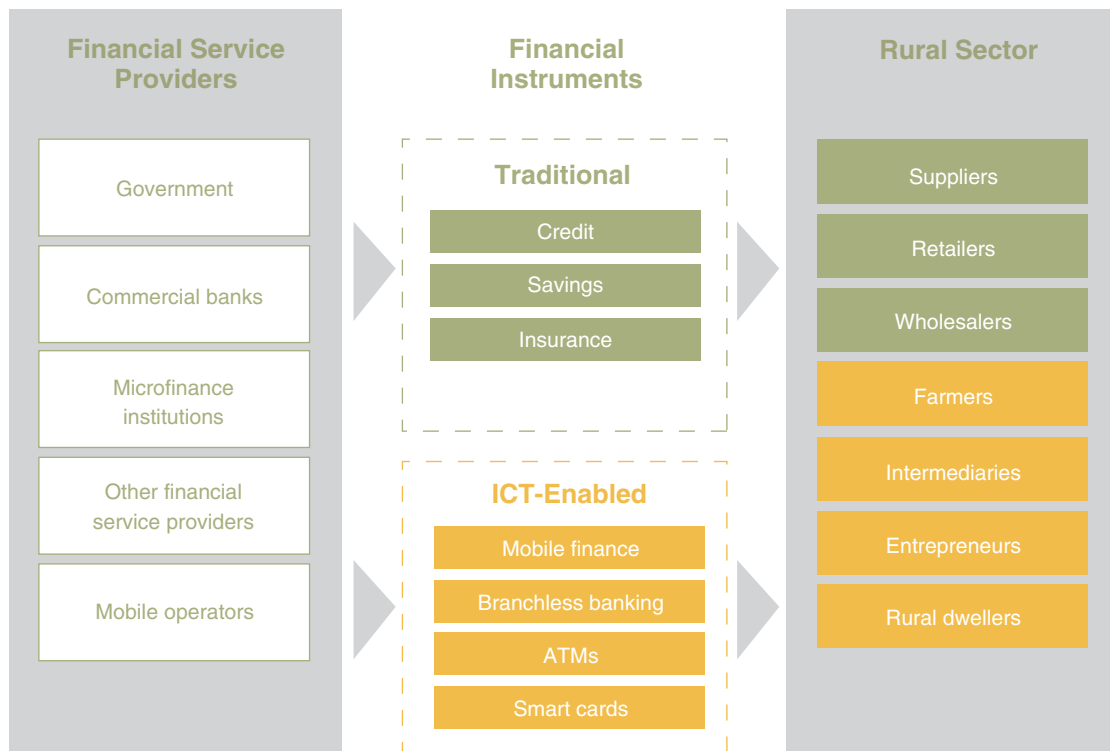
### TRENDS AND ISSUES

ICT introduces new channels for delivering financial products and services to the rural sector, and it has the potential to reach farmers, intermediaries, entrepreneurs, and rural dwellers more directly than traditional brick-and-mortar bank branches or microfinance offices. These new channels enable financial service providers to offer a larger suite of financial products and services and acquire better financial information, some of which is useful to governments as they oversee, regulate, and develop policy for the agricultural and rural sectors. Figure 7.6 illustrates how ICT expands the

traditional relationships and service capacities in the rural finance ecosystem. (As noted, Topic Note 2.3 looks at how ICT infrastructure enables this expansion.)

Interventions using ICT can introduce new players and lead to greater competition in the rural financial sector. Institutions or agencies that are not banks (nonbanks) may start providing rural financial services. Since the early 2000s, a number of nonbank institutions have developed innovative approaches to financing agriculture. They have sometimes adapted microfinance concepts to provide agricultural



**FIGURE 7.6:** ICT and the Rural Finance Ecosystem

Source: Author.

finance, used good banking practices, and above all, drawn on knowledge of agriculture and ICT to enter and succeed in this market. Many of these new approaches show great promise, but no single approach will work for all situations. Rather, organizations have the most success when they are not dogmatic, apply innovative and comprehensive risk-management strategies and tools, and retain the ability to perform credit analyses of their intended rural clients without political interference.

Nonbanks and banks can provide these ICT-enabled financial services for the rural sector:

- **Mobile financial services.** Given the pervasiveness of mobile phones in developing countries, financial service providers can use them to reach clients in rural areas and provide a broad array of financial products and services, including credit, insurance, payments, and deposits. Financial service providers can tailor financial products offered through mobile phones to rural needs.
- **Branchless banking.** Field agents, equipped with mobile phones or point-of-sale devices, can serve as mobile branches. Agents can provide financial services to smallholders, take deposits, provide financial

information, and keep records of clients' creditworthiness. In this way, branchless banking deepens financial inclusion throughout rural areas.

- **ATMs.** Though ATMs are often associated with debit cards or smartcards, ATMs can serve as cash-dispensing machines in tandem with branchless banking, mobile financial services, and other ICT-enabled financial products. The availability of ATMs in rural areas can place cash-exchange points within reach.
- **Smartcards.** Though not entirely in the category of ICT, smartcards (or stored-value cards) are an alternate means of providing services when mobile financial services are not readily available. Pre-paid cards, debit cards, or credit cards provide payment and credit facilities to rural clients. Stored-value cards have historically assumed some level of literacy (in particular, the ability to sign for a transaction), but the advent of smartcards that use biometric devices eliminates the challenges associated with literacy barriers.

As discussed, financial services rely on the availability of underlying financial and ICT infrastructure, such as payment systems, credit bureaus, central ATM switches, central financial platforms, mobile telephony, mobile data

services, and Internet in rural areas. Governments have to work with the private sector to ensure that the underlying infrastructure is in place and extended to rural areas. (For a discussion of how various governments have done so, see Module 2.)

### EXAMPLES AND LESSONS LEARNED

The following examples highlight successful ICT-enabled interventions selected from a wide range of similar interventions implemented in developing countries. They demonstrate that rural and agricultural finance can be profitable without high government subsidies and discuss the lessons learned in the course of implementing the interventions.

#### Availability and Transparency of Financial Services

ICT can make financial services more readily available in rural areas through mobile phones, Internet, point-of-sale devices, and field agents (box 7.2). Electronic banking makes it possible to provide financial services in places that rural clients visit routinely, such as markets and post offices. Electronic conditional cash transfers also make it easier for rural poverty reduction programs to reach specific beneficiaries (see IPS “Linking Conditional Cash Transfers and Rural Finance in Brazil”). Because transactions are conducted electronically using ICT, they promote transparency, accountability, and financial discipline among all account holders, whether they are in farming, business, or government.

#### BOX 7.2: ICT Increases the Availability of Rural Finance in South Africa

Through its A-Card, South Africa’s uBank (previously Teba Bank) (<http://www.tebabank.co.za/index.php>) offers affordable and accessible financial services to communities, especially in rural areas, that were previously denied access. The card is used with a point-of-sale device that enables customers to access a transactional banking account. The primary banking products and services include standard savings and credit accounts and a facility by which state social grants are deposited directly into a customer’s bank account. The United Kingdom’s Department for International Development, ShopRite, and Checkers partner with uBank in this project.

Source: Cracknell 2004.

#### Cost and Operational Efficiency

Financial service providers have reduced transaction costs using electronic payment systems, branchless banking, and other ICT-enabled services. Because these services are available to farmers via handheld devices or loan officers based in the field, they obviate the need to visit a bank branch to conduct basic transactions (box 7.3).

Aside from reducing operating costs, the use of ICT within financial institutions or government can also improve operational efficiency, create public platforms for smaller organizations to use, and develop management capacity.

#### BOX 7.3: In Rural Kenya and South Africa, ICT Applications Reduce the Cost of Financial Services

**Kenya: M-PESA.** The leader in mobile payments is Safaricom’s M-PESA, a short messaging service (SMS)-based money transfer system that allows individuals to deposit, send, and withdraw funds using cell phones. M-PESA has grown rapidly to reach approximately 38 percent of Kenya’s adult population. The M-PESA model has been copied with little modification worldwide.<sup>a</sup> Kenyans use M-PESA to deposit money with a registered agent or phone vendor. The agent then credits the phone account. Users can send between 100 Kenyan shillings (US\$ 1.5) and 35,000 K Sh (US\$ 530) via text message to a recipient. The recipient obtains the cash from a Safaricom agent by entering a password and showing personal identification.

**South Africa: Wizzit.** In South Africa, First National Bank partnered with a mobile phone provider, Mobile Telephone Networks (MTN), to provide services to clients who had no bank accounts but wanted to send and receive money via cell phone. The service, called Wizzit (<http://www.wizzit.co.za/>), has enabled 500,000 South Africans to send and receive money from relatives, pay for goods and services, check balances, and settle utility bills. Previously South Africans often paid couriers the equivalent of US\$ 30–50 to deliver cash to relatives. Now such transactions cost only US\$ 0.50 through mobile bank networks. The greatest impact is in rural areas, where 80 percent of farmers still lack bank accounts. Wizzit accounts, unlike regular bank accounts, do not expire if customers do not use them regularly, which is critical for seasonal activities like agriculture.<sup>b</sup>

Source: Author; (a) Jack and Suri 2009:6; (b) Kimani 2008.

The need for ICT-based government services becomes more important as the financial sector expands and the sophistication and complexity of financial products grows (box 7.4). The availability of a common information technology (IT) platform enables government at all levels (municipal, state, federal) to obtain accurate information about the availability and affordability of financial services in rural areas, financial well-being of financial service providers, indebtedness of citizens, and related information. This information enables policy makers and regulators to make appropriate decisions with respect to the rural financial sector. ICT can make information gathering and monitoring and evaluation possible on a real-time basis.

Governments require information systems for their own management and operations with respect to making policy and regulating the rural financial sector. Such information systems can be linked with financial infrastructure (such as payment systems) and applications that can reach most rural clients.

#### **BOX 7.4: Increased Operational Efficiency in Africa through ICT**

**IBM and CARE: The Africa Financial Grid.** IBM and CARE are designing the Africa Financial Grid, a shared financial service and infrastructure model that will, for example, help microfinance providers reduce their operating costs, streamline lending processes, scale up, and integrate their services with other resources such as credit bureaus, financial institutions, and international payment networks. The Africa Financial Grid will eventually link with telecommunications providers to enable customers to repay loans or carry out money transfers via mobile phones or other devices.

**Ghana: E-Zwich payment system.** The Bank of Ghana has rolled out a national payment and settlement system in the form of an electronic clearinghouse for all banking and financial institutions called e-Zwich (<http://www.ghipss.net/e-zwich>). The Bank of Ghana also issued a biometric smartcard, which is a very secure way of paying for goods and services.

*Source:* IBM 2007; B&FT 2010.

#### **Improved Risk Management**

Through ICT, financial institutions and intermediaries can better manage the risk involved in increased lending, especially in lending to lower-income and rural clients (box 7.5). Credit bureaus and collateral registries can equip financial service providers with better financial information about

#### **BOX 7.5: Financial Service Providers in the United States and Mozambique Use ICT to Improve Risk Management**

**United States.** In the United States, Sevak Solutions and Financial Ideas are piloting technology that allows credit decisions for microfinance clients to be made electronically, increasing transparency between lenders and lenders. Initial tests will be carried out with United States military personnel and their families, some of whom experience financial distress caused by limited financial literacy and predatory “pay-day” lenders (<http://www.sevakolutions.org/prototypes/finideas.html>). A similar idea could be useful in developing countries, particularly as farmers and rural citizens gain further access to loans and credit.

**Mozambique.** The Banco Oportunidade (a microfinance bank) introduced its Client Relationship Management (CRM) system, a web- and cloud-based system that assists with processing and monitoring loans and is accessible to loan officers, managers, and country and regional teams. The CRM uses data from land mapping and farmer and crop profiling conducted with agricultural clients to process loan applications electronically, taking into account the standard data and farmer, crop, and national limits. After a loan is approved, the CRM sends the data to the bank’s accounting system and assists in loan disbursement, monitoring, and recovery, providing real-time information. The CRM has a personal dashboard, specific to each bank team member, which allows inputting and monitoring related to the team member’s specific line management and process control responsibilities.

*Source:* Sevak Solutions 2008; Management Reports for Banco Oportunidade in Mozambique.

the market and clients and improve their ability to expand lending. (See IPS “RFID Facilitates Insurance and Credit for India’s Livestock Producers” for more detail on the importance of ICT in managing lending risks.)

#### **Authentication**

Using a variety of technologies, ICT can help financial service providers and government authenticate individuals, inventories, and assets in rural areas (box 7.6). For example, biometric technology captures and stores information that is unique to every person, such as fingerprints, retina scans, or facial images. Its increasing availability and decreasing cost

has made it useful in developing countries, where it limits identity theft and facilitates the development of credit markets. The ability to track individuals in a credible way over time provides incentives to individuals to repay loans and reduces the risks faced by lenders. Financial service providers can use biometric tools to provide services to individuals who may not have a national identity card or never learned to sign their names. (See IPS “Using Biometrics to Provide Rural Services” in Module 13.) Similarly, radio frequency identification (RFID) can count and track livestock, harvests, and inputs, among other things. Global positioning system (GPS), satellite data, and weather-based electronic sensors can collect data necessary to create and price crop insurance policies, particularly index insurance programs.

**BOX 7.6: Using ICT to Identify Financial Service Clients in Africa and South Asia**

**Malawi: Biometric technology in rural credit markets.** In 2009, 3,200 smallholder paprika farmers in Malawi who had applied for loans to purchase agricultural inputs were randomly assigned to a control and treatment group. The treatment group was electronically fingerprinted and told that their fingerprints would be stored and used to validate their eligibility for future loans. Repayment rates rose by 40 percent in the treatment group. The increased rate of repayment and the resulting savings from avoiding default could justify the costs of deploying an IT system to collect fingerprints for all loan applicants.

**Kenya: Kilimo Salama.** The Kilimo Salama index insurance scheme uses weather indicators as a proxy for loss of inputs. The insurer collects premiums and distributes payouts via mobile phone, which reduces assessment and administrative costs. Kilimo Salama also employs a “pay-as-you-plant” sales model, in which insurance policies are sold for each input purchased.

**India: Biometric ATMs.** ICICI and the Government of India launched an initiative in 2004 to offer banking services to people who earned less than US\$ 40 per month (<http://www.icicibank.com/>). The service relied on biometric ATMs (based on fingerprint scans) and biometric smartcards that do not require personal identification numbers, which can be forgotten or stolen. The ATMs cost 5 percent of what these wage-earners have been accustomed to pay at kiosks offering similar services.

*Source:* Giné 2010 for Malawi; Ogodo 2010 for Kenya; ICICI Bank 2001 for India.

**Disseminating Information**

ICTs are perhaps best known for their capacity to disseminate information. Online videos, television, and community radio can improve farmers’ financial literacy by informing them about the benefits and risks of credit and various banking transactions. At basic rural Internet kiosks, farmers can acquire accurate financial information, such as market prices, to improve productivity and sales.

**Conclusion**

These brief examples provide some idea of innovative, on-the-ground initiatives that have brought financial services to rural areas. All of these initiatives hold promise but face challenges which, in the end, may not enable them to be scaled up or replicated. Even so, they demonstrate that it is possible to provide financing for agriculture on a sustainable basis and at a reasonable cost. Many of these initiatives are based on the premise that the policy environment will allow such innovations to flourish.

The next sections of this topic note explore two innovative practices in greater detail. The first one, Brazil’s Bolsa Familia, uses an IT platform to extend financial services to people who have been excluded from using them. The second one, a livestock insurance and credit scheme in India, uses RFID technology to reduce the risk inherent in providing these services to poor producers.

**INNOVATIVE PRACTICE SUMMARY**  
**Linking Conditional Cash Transfers and Rural Finance in Brazil**

A 2009 study found that governments worldwide transfer cash to more than 170 million poor people through social protection programs providing cash allowances, health benefits, and pensions (Pickens, Porteous, and Rotman 2009). The number would be much higher if government wage payments were included. In comparison, an estimated 99 million people access microfinance loans, but few of these payments advance the goal of rural financial inclusion. Three-quarters of government-to-person (G2P) payments are delivered in ways that do not allow people to store the payments until they need the money, transfer the money to others, or access them easily (from the perspective of cost and distance).

ICT creates a significant opportunity to exploit the synergy between G2P payments and financial inclusion. The reasoning is that if the government were to facilitate development

of the required infrastructure, institutional capacity, and literacy to deliver government payments into basic savings accounts that poor recipients could access easily, those accounts might also be used to channel a wider array of financial services to the same segment—a segment that currently has little or no access to such services.

While three-quarters of G2P payments have not yet exploited this opportunity, some governments are using ICTs to reduce the transaction and administrative costs of implementing government transfer program that also serve as vehicles for financial inclusion. Examples include Brazil's Bolsa Familia ("family allowance") program, implemented through Caixa Economica ([http://www.caixa.gov.br/Voce/Social/Transferencia/bolsa\\_familia/index.asp](http://www.caixa.gov.br/Voce/Social/Transferencia/bolsa_familia/index.asp)); Colombia's ACCION Social (<http://www.accionsocial.gov.co/portal/default.aspx>); Kenya's Hunger Safety Net Program, through Bankable Frontier Associates ([http://www.hsnp.or.ke/index.php?option=com\\_content&view=article&id=81:ending-hunger&catid=38:fp-items](http://www.hsnp.or.ke/index.php?option=com_content&view=article&id=81:ending-hunger&catid=38:fp-items)); Mexico's Oportunidades program, implemented through McKinsey and BANEFSI (<http://www.oportunidades.gob.mx/Portal/>); Peru's Juntos ("together") program (<http://www.juntos.gob.pe/>); and South Africa's Department of Social Development (<http://www.dsd.gov.za/>) (Rotman 2010b). The Government of India has used the Financial Inclusion Network and Operations platform to deliver social transfers as well (see IPS "RFID Facilitates Insurance and Credit for India's Livestock Producers").

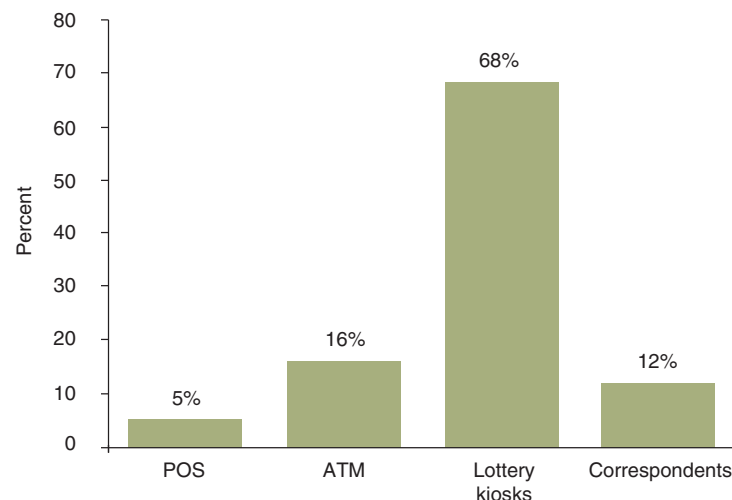
### Bolsa Familia: The Applications and Their Impact

Of the programs just mentioned, Brazil's Bolsa Familia program is exceptional in its scale and impact. Created in 2004, the program consists of monthly cash transfers to poor households with children or pregnant women as well as unconditional transfers to extremely poor households (Anna Fruttero, World Bank, personal communication). In 2007, the program reached 12.4 million households—one-quarter of the country's population.

Of the 13 million Bolsa Familia family recipients, 3.84 percent withdraw benefits using their electronic benefit card at one of 13,000 lottery kiosks, correspondents, or point-of-sale terminals belonging to merchants acting as agents of Caixa Economica, the bank that holds the grant delivery contract (figure 7.7). In 2004, when cards were first issued to Bolsa Familia recipients, only 24 percent of customers said that using the card was "easy" or "very easy," but one year later, the number has risen to 96 percent (Pickens, Porteous and Rotman 2009; Anna Fruttero, World Bank, personal communication).

The electronic benefit cards did not quite constitute financial inclusion because the value of the cards had to be used within three months or it would expire. Nor was the value on the card easily transferable. In response, Caixa Economica decided to migrate the Bolsa Familia recipients from the electronic benefit card to a Conta Caixa Facile ("easy account"), a financially inclusive account that includes a Visa-branded

**FIGURE 7.7:** Channels for Financial Inclusion for Bolsa Familia Beneficiaries



Source: Pickens, Porteous, and Rotman 2009.  
Note: POS = point of sale.

debit card. As of October 2009, the bank had converted 2 million recipients to the Conta Caixa Facile. Caixa also has experimented with offering insurance to Conta Caixa Facile holders, is considering microloans, and has developed a financial literacy program for new account holders.

### Two Key Enablers, One Key Lesson

Though G2P recipients often have limited schooling and little exposure to banking, these limitations have not prevented them from using electronic infrastructure as long as the services match their needs. In Brazil, two key enablers fostered success with electronic transfers through Bolsa Familia. First, the value of the Conta Caixa Facile is significantly enhanced by a wide national network of over 20,000 contact points formed by Brazil's preexisting financial infrastructure of ATMs, bank branches, and point-of-sale-equipped merchants who handle deposits and withdrawals. Second, government policy favoring cash transfer programs such as Bolsa Familia drives the growth of the Conta Caixa Facile. The key lesson is that a government transfer program can indeed be a vehicle or instrument for financial inclusion.

### INNOVATIVE PRACTICE SUMMARY

#### RFID Facilitates Insurance and Credit for India's Livestock Producers

Worldwide, 60 percent of rural households are estimated to own livestock (including cattle, goats, pigs, sheep, poultry, honeybees, and even silkworms) and to earn 10 percent of their income from products such as meat, milk, cheese, eggs, honey, raw silk, wool, hides, and skins (FAO 2009:34). Livestock perform numerous vital functions. They are a savings mechanism, a form of insurance, collateral for loans, a source of food security, an aid to farm operations, a means of recycling waste products, and form of controlling insects and weeds, and a powerful source of opportunities for women to earn income (which promotes gender equality) (FAO 2009:33).

For this reason, livestock constitute some of the most important assets of rural households. Their loss through theft, disease, or drought can push households into poverty or deepen the distress of already impoverished households. Insurance products piloted in Mongolia, Kenya, and India seek to mitigate the risk of such losses.

Monitoring the whereabouts and health of livestock poses a significant challenge for both farmers and financial institutions. Insurance companies must be able to validate reports of livestock losses to avoid the moral hazard problems (the false claims) that plague insurance delivery and drive up the cost of insurance for all farmers. Most livestock move around to graze and are therefore susceptible to injury, theft, starvation (when drought reduces foliage and pastures), and drowning in floods. Monitoring animal health is even more important when animals are concentrated in intensive production facilities where the risk of disease is high.

Traditional livestock monitoring is cumbersome and expensive. Farmers must hire or use family labor to herd, pasture, or otherwise keep track of animals to keep them safe. Banks and insurance companies need to spend time and money to find and identify individual animals to verify reported losses or take possession if owners have defaulted on loans.

The use of RFID technology has reduced the cost of monitoring livestock. RFID uses electromagnetic waves to exchange data between a terminal and an electronic tag attached to an object that enables identification and tracking (image 7.1). At a minimum, most RFID tags have an antenna for receiving and transmitting the signal and an integrated circuit for performing specialized functions such as monitoring animals' location, heart rates, or temperatures and storing and processing information on animal weights, feeding histories, and immunizations. The tags can be read by terminals or readers

**IMAGE 7.1:** RFID Can Be Used to Track Cattle and Manage Herds



Source: Curt Carnemark, World Bank.

from several meters away and beyond the line of sight of the reader. The readers can be used to access the stored information or place additional information on the chip.

The technology allows farmers to better manage their herds and enables farmers, banks, or insurers to locate animals. RFID tags have become 99.9 percent reliable and have dropped in price. Prices vary by location, but a basic RFID chip costs approximately US\$ 0.15, whereas readers can range from one hundred to several thousand dollars, depending on their sophistication (RFID Journal 2010).

### **A Business Model for Delivering Cattle Insurance in India**

India is the world's largest milk producer, but only 7 percent of India's cattle are estimated to be insured (*Economic Times* 2009). Insurance would not only protect producers from losses but improve their ability to obtain loans to increase their herds, because commercial banks are more willing to lend toward the purchase of insured cattle.

In September 2009, several institutions in India teamed up to offer cattle insurance to farmers in two districts of the southern state of Tamil Nadu. The Institute for Financial Management and Research (IFMR) Trust, a private trust that has pioneered financial inclusion efforts, joined HDFC Ergo, a commercial bank that provides insurance, and Dairy Network Enterprise (DNE), a supply chain and logistics organization, to design and deliver the new insurance product, which has several unique features.

First, the insurance is cheaper than other insurance offerings, with a premium of 2.9 percent of the insured value—typically 10,000–20,000 Rupees (Rs) or US\$ 200–400, compared to the typical premium of about 4.5 percent. Second, the time needed to issue a policy or indemnity payment is only 72 hours, compared to the norm of 15 days or more. Third, the insurance policy provides access to preventative veterinary services and medicine through DNE to maintain the health of insured animals. Finally, insured animals are tracked using RFID chips in ear tags. The tags cost Rs 60 (US\$ 1.20) (standard metal tags cost US\$ 0.30).

Policies are sold through the Pudhuaaru Kshetriya Gramin Financial Services (PKGFS), which has 25 branches serving 135 villages in the two remote districts where the new product is being piloted. Each branch has three agents who serve approximately 2,000 households. Policies can be issued rapidly because the PKGFS customer management system is connected in real time and integrated with HDFC Ergo's

policy issuance system. PKGFS and DNE, which manages the RFID technology and health services, must verify that the producer does indeed own the animals he or she wishes to insure and that the animals are healthy. Once this information is verified, PKGFS collects the premium (PKGFS can issue a loan for the premium if necessary) and the producer's information and transmits it to HDFC Ergo, which activates the policy, usually in less than three days (IFMR Trust 2008).

Once a policy is issued, DNE registers the insured animals at the farm, tags them, and records their vital information in a computer database. Then DNE begins regular check-ups to ensure that insured animals remain in good health. Veterinarians update the computer database every time they perform a checkup. In entering this information, they must scan the RFID tag of each animal to collect the unique ID number which must be entered into the database along with the latest health update. This procedure prevents veterinarians from avoiding farm visits and entering false data into the system.<sup>1</sup> If an animal should die, DNE agents verify the death and notify PKGFS, which connects to HDFC Ergo to ensure payout.

### **Key Enablers**

One key enabler was leadership in coordinating important stakeholders. The partnership between the bank/insurer (HDFC Ergo), a logistics organization (DNE), a rural financial institution (PKGFS), and a coordinating group (IFMR Trust) was critical for ICT-enabled insurance to promote financial inclusion.<sup>2</sup> The leadership demonstrated by IFMR Trust in assuming a coordinating role cannot be overstated. Elsewhere, such a role might also be performed by government or a public financial institution.

A second key enabler was the Internet and communications infrastructure. The PKGFS customer management system connected to HDFC Ergo requires Internet and communications infrastructure. Such infrastructure is increasingly accessible in India. According to the World Bank's World Development Indicators, teledensity—a measure of telephone access—is 60 percent (though 100 percent in urban areas and 20 percent in rural areas), and 670 million people in the country subscribe to a mobile phone service. India has 4.5 Internet users per 100 people, double the number for the average least-developed country (though less than one-third of the average for low-and middle-income countries).

1 If services other than routine preventive care are required, the producer must pay for them on top of the insurance cost.

2 This arrangement resembles the arrangements in another successful program, DrumNet in Kenya.

### Growth and Lessons

Since its launch in 2009 in Tamil Nadu, the program has expanded to the states of Uttarakhand and Orissa. The mortality rate of cows has improved with the provision of preventive care, especially deworming drugs and vaccinations.

Despite this initial success, two issues remain to be resolved: moral hazard issues and low adoption. With regard to moral hazard, it appears that RFID tags can be removed far too easily from animals' ears, and without a national or even regional animal tracking system, it is possible to have duplicate tags. Australia's National Livestock Identification System tracks all animals, each of which has two RFID chips (one in the ear, one in the digestive system). The point is that RFID technology alone may not resolve moral hazard problems. Using two tags may help, but the key lesson is that an institutional framework in the form of

a national or regional identification system is probably necessary for commercial banks to become sufficiently confident to extend financial services to the poor to buy livestock.

Several factors appear to limit adoption. Given insurance companies' propensity to renege on contracts, producers lack confidence that indemnities will actually be paid. Producers also seem to be confused by the livestock insurance product compared to a cheaper personal accident insurance product offered by PKGFS. Where efforts have been made to explain the difference, a higher rate of adoption has been observed (Gupta 2010). The key lesson is that technology cannot substitute for human capacity. In determining whether insurance products—even efficient, ICT-enabled products—will succeed in a given area, practitioners must consider the prevailing basic literacy and financial literacy rates.

## Topic Note 7.2: POLICY STRATEGIES AND REGULATORY ISSUES FOR ICT-ENABLED RURAL FINANCIAL SERVICES

### TRENDS AND ISSUES

As noted, a diverse group of stakeholders is involved in providing financial services to rural dwellers. To design supportive policies, provide the necessary infrastructure, and provide appropriate, affordable financial products based on assessments of local needs, governments must explore partnerships with the private sector and rural communities. In turn, governments can devise and implement policies that give rural communities and private enterprises incentives to participate in the rural financial sector.

For example, the Government of India promoted rural digital services by partnering with the private sector to set up village kiosks with IT infrastructure. The kiosks offered a single window for providing government services electronically at the village level (for example, issuing land records to farmers). The kiosks improved citizens' experience in dealing with government, because they reduced the time needed for officials to respond to citizens' requests. They also created a village database that could be used to reach more citizens. Financial service providers could potentially use this infrastructure to follow up on clients from the village.

Another example of effective public-private partnerships between government and ICT providers and community

organizations is in Sri Lanka, which has 600 distance learning centers and e-libraries that penetrate deeply into rural and remote areas, cover 22 of 24 districts in all nine provinces, and link more than 70,000 underserved users to markets and information essential to their livelihoods.<sup>3</sup> At the telecenter in Bakalacia, users include farmers checking market prices, entrepreneurs marketing their businesses, community leaders searching for information on how to improve community livelihoods, mothers seeking first aid and connecting to hospitals and doctors in the capital city, children and students interested in learning, and citizens communicating online, requesting government services, or doing word-processing, printing, and copying. Surveys indicate a user satisfaction rate of 96 percent. An estimated 48 percent of users are women; 82 percent are youths up to 25 years of age. These telecenters can also be used for financial services, like point-of-sale terminals.

### LESSONS LEARNED

Financing smallholder agriculture is a complex undertaking, easily thwarted by regulatory impediments to the development of new products or service delivery channels. For

<sup>3</sup> This section draws on unpublished information from World Bank Implementation support missions.



example, some potential financial service delivery channels, such as agency arrangements that operate outside physical branch offices, are not yet allowed in most countries in Africa and in most of Asia. Regulatory support for such arrangements may be needed to alleviate the perception of risk associated with financing agriculture and livestock production. Agents can be based closer to rural communities at a fraction of the cost of brick-and-mortar banks. From this vantage point, they can assess the risk associated with lending to farmers better than banks or microfinance institutions. Agents can address the scale issues associated with providing financial services in rural areas, such as the small size of most transactions.

The lack of an appropriate regulatory framework also hampers the development of warehouse receipts as an electronic financial instrument.<sup>4</sup> Many countries do not recognize warehouse receipts as a transferrable financing instrument, even though this product can facilitate smallholders' access to finance and, at the same time, improve the quality of produce, which is often dictated by warehouse managers. Policies and enabling legislation would provide for the establishment of a central registry for warehouse receipts as a title document used by banks to grant loans. Warehouse receipts held by banks would be included as liquid assets under the definition of the national banking act. A fund would be established to collect access from warehouses to indemnify receipt holders in the event of a loss. Coherent industry standards and certification regulations would be introduced.

Many ICT-enabled applications described in this module (and sourcebook) require an enabling legal and regulatory environment. In many countries, point-of-sale devices, m-banking, and other innovative applications have yet to be introduced because the corresponding regulations have not been introduced, despite evidence that they can extend cost-effective

<sup>4</sup> Warehouse receipts are not covered in depth by this module because of the limited ICT used. Nonetheless, the basics for establishing warehouse receipts as a financing mechanism are not normally addressed, and as a result, some interventions do not succeed. In addition to proper legal frameworks that protect all parties, there must also be a critical mass of farmers' organizations that can bring produce to the warehouse. The commercial banks and other service providers must be brought into the design from the very beginning, and there must be interest from the private sector to participate in the operations of the scheme. Warehouse receipt mechanisms also often lack the long-term objective of linking the scheme to the overall commodity exchange system, which would then encourage small-scale farmers to participate. Warehouse receipts can be useful with the proper frameworks and implementation, however. The Uganda Commodity Exchange warehouse receipt mechanisms, for example, is working well for smallholders.

financial services throughout the economy, including underserved rural areas.

The two innovative practice summaries that follow demonstrate the importance of public policy and regulatory frameworks in stimulating the use of ICTs to improve rural financial systems and services. The first summary describes how ICT minimizes information asymmetries and links farmers directly to markets and to finance. It demonstrates how risk can be managed at the three operational levels of the financial service provider, market operator, and farmer. The second summary offers another example of the benefits that accrue from a common ICT platform to support rural banking in India.

### **INNOVATIVE PRACTICE SUMMARY** **Kenya's DrumNet Links Farmers, Markets,** **and Financial Service Providers**

Small-scale farmers struggle to obtain agricultural loans even where they have good access to commercial banks. Commercial banks are reluctant to lend to them, recognizing the severe barriers and risks these farmers face in successfully producing a crop, marketing it, and repaying loans. Smallholders face risks in transporting produce to markets, finding buyers there, and earning the value they expected at planting. This risk not only introduces uncertainty in their income stream but, as noted, inhibits their ability to obtain the credit to make the productivity and quality improvements that will break the cycle of poverty.

Much of the risk in accessing markets can be mitigated, and farmers' access to credit can be improved, if farmers can forge better links with agribusiness buyers such as domestic supermarkets, agroprocessors, or (further along the supply chain) exporters. When such links are weak, buyers also face problems in sourcing sufficient produce of the quality demanded by supermarkets or food processors. Farmers often do not know that the market is willing to pay a high price for certain products that meet certain quality standards; even if they do know, they lack the financing to switch to a new and more profitable crop or the knowledge to achieve the desired level of quality.

Better links between farmers and buyers would help to overcome these obstacles, but they are difficult to form. Mistrust between farmers and buyers runs deep. Buyers fail to honor purchasing agreements or do not pay the agreed price at harvest. Farmers abandon purchasing agreements and sell their produce to another buyer or on the spot market if they can get a more favorable price. Aside from these

problems, the practical aspects of working with large numbers of small-scale farmers—organizing them, negotiating prices, sharing information, and managing their agronomic activities—are daunting for agribusinesses. Even if they were easy to resolve, agribusinesses still lack the core capabilities and often the resources to extend financing to all of those farmers.

The less risk exposure a client presents, however, the more banks are willing to lend. If farmers can demonstrate that an agribusiness is willing to purchase what they will produce, a bank will be much more amenable to financing the purchase of inputs and labor for production. The challenge for the bank is then limited to the transaction costs of disbursing funds, ensuring the loans are used for their stated purpose, collecting payments, and bearing the exposure to weather risks (unless there is crop insurance).

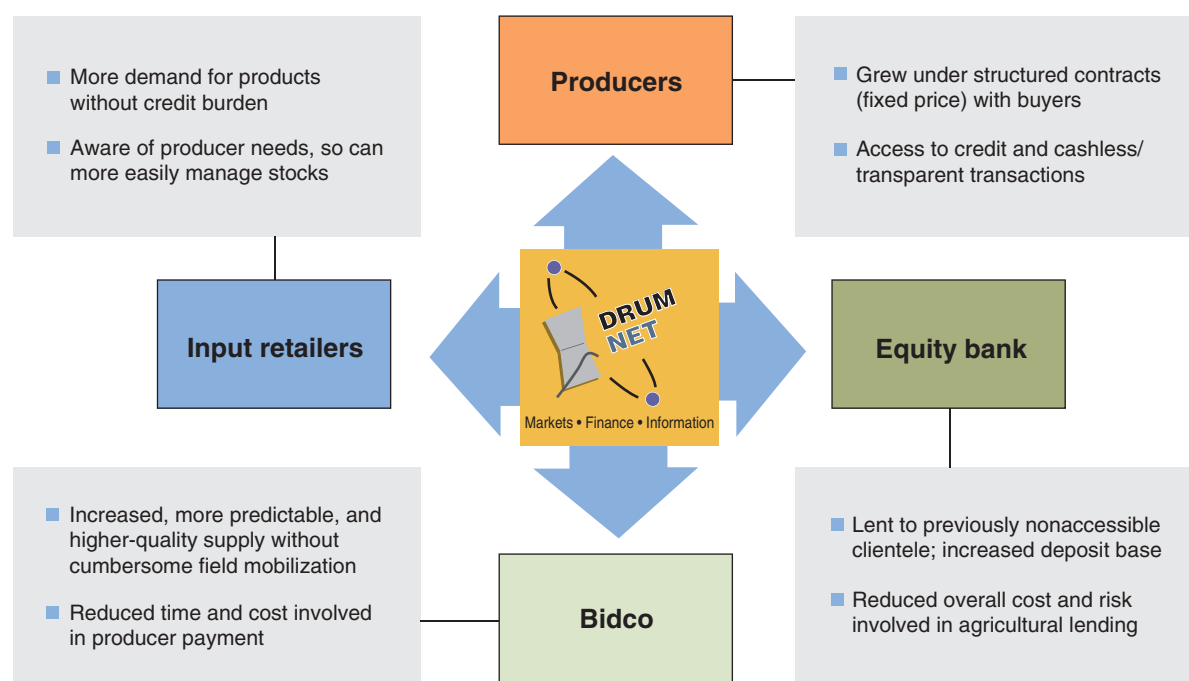
DrumNet is a project of PRIDE AFRICA, a nonprofit that has promoted the spread of microfinance across the continent since 1988. Created in Kenya in 2002, DrumNet was designed to provide market, information, and financial services to smallholders, and it has evolved a sophisticated technology platform to deliver these services. The project illustrates that it is possible for a third party to coordinate and link farmers, buyers, financial intermediaries, and operations managers to deliver financing to small farmers, and that ICTs

have a vital role in doing so. ICTs such as mobile phones, smartcards, and management information systems facilitate communication between the parties and help to manage the administrative challenges of tracking large numbers of smallholders, delivering loans cost-effectively, ensuring that funds are properly used, and collecting payments.

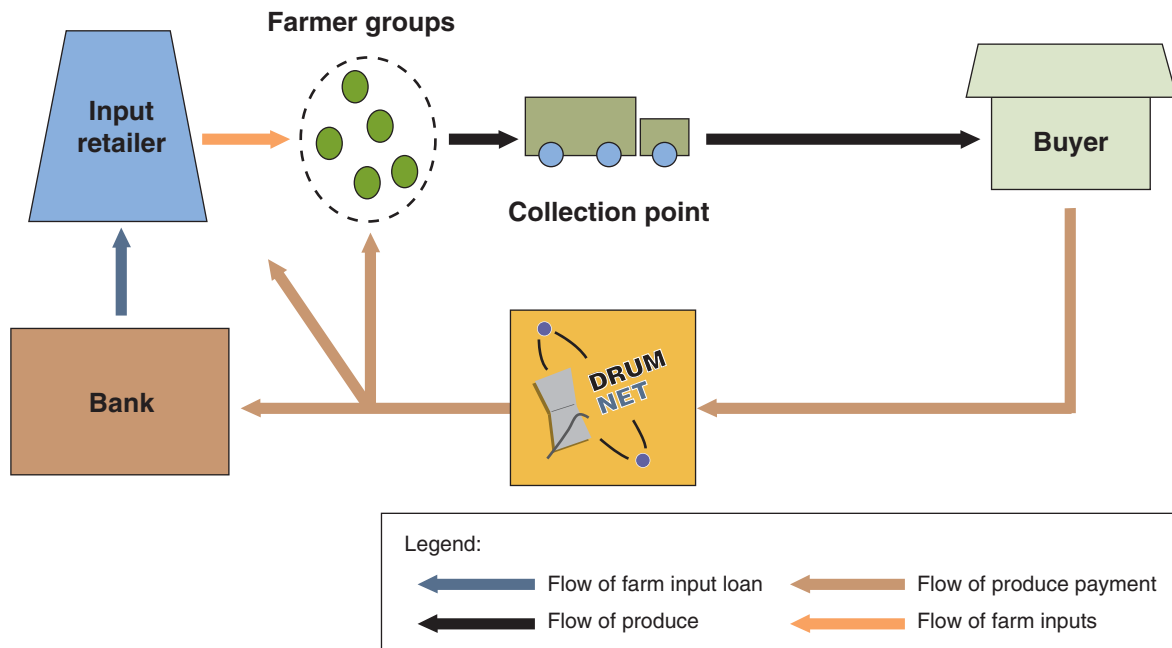
### Links with Key Players

DrumNet recognized that it could not improve financing for farmers without linkages with financial intermediaries and buyers (DrumNet 2007). In 2008, DrumNet began a pilot program in the sunflower subsector to facilitate partnerships that would give smallholders access to finance and improve efficiency throughout the supply chain. The agribusiness buyer, Bidco, was the largest manufacturer of vegetable oils, fats, margarines, and protein concentrates in East Africa and needed a steady supply of sunflower seed. The financial institution was Equity Bank (also involved with M-PESA, discussed earlier). Farmers were recruited to grow sunflower instead of their typical crop. Two additional players proved important to the partnership. Input suppliers had to agree to sell products to farmers on credit and receive payment from Equity Bank instead of cash directly from farmers. AgriTrade recruited farmers and managed sunflower production, harvest, and collection. The benefits foreseen from their collaboration are depicted in figure 7.8.

**FIGURE 7.8:** Benefits to Stakeholders in DrumNet’s Sunflower Supply Chain Partnerships



Source: Adapted from PRIDE AFRICA n.d.

**FIGURE 7.9:** Flow of Goods, Information, and Money in DrumNet's Sunflower Supply Chain Partnerships

Source: Adapted from PRIDE AFRICA n.d.

### Services and Revenues

DrumNet negotiated the contracts that brought these parties together and managed the flow of information and financial transactions among them (figure 7.9). Through this arrangement, farmers received credit for inputs from Equity Bank upon signing a fixed-price contract with Bidco. To ensure that the loans would be used for their stated purpose, farmers received no cash from Equity Bank. Instead, through another agreement facilitated by DrumNet, Equity pays input retailers directly for materials purchased by farmers on credit. When the produce is delivered to Bidco, Bidco pays farmers through DrumNet, which first deducts the cost of the loan and transfers it to Equity Bank. The remainder is sent to the farmer's account with Equity Bank (Campaigne and Rausch 2010). DrumNet earns revenue for this service.

Farmer groups (typically consisting of 20–100 farmers in the same area) open an account with Equity Bank through which all payments are made. Individual farmers can be paid in cash, but cash is withdrawn from the bank at the group level to reduce transaction costs. Each member is required to contribute to a Transaction Insurance Fund, which is

25 percent of the value of the input loans and acts as security for them (DrumNet 2009).

### ICT Applications

DrumNet provides the ICT platform through which all financial transactions and communications take place. The platform includes mobile phones, SMS, and email to enable the parties to do business. All payments from buyers pass through DrumNet accounts at the bank.

Information is transmitted up and down the supply chain during the crop cycle primarily via SMS. Bidco is informed about the area planted to estimate production and plans accordingly. The processor monitors crop progress and passes on important crop management information to farmers. Input retailers are updated on which products to stock at what time, and producers learn about collection dates and locations long before harvest.

The input retailers, trained in basic record keeping for DrumNet, submit virtual receipts to DrumNet via mobile phone and receive payments into their bank accounts in

two-week cycles through the DrumNet system. Equity Bank is shielded from these many small transactions, as it simply opens a single line of credit in DrumNet's Master Account, receiving regular principal and interest payments from DrumNet from this revolving account. DrumNet's management information system provides the internal controls to track and report on compliance throughout the process. It also retains data to establish user and credit ratings.

### Key Enablers

A key enabler is the partnerships between Equity Bank, Bidco, input suppliers, and farmers that enabled the system to work. ICT plays a significant role in sustaining the trust and confidence that make these relationships work. It provides the visibility, communication, and speedy transactions that bind partners together for their common benefit. The DrumNet system allows the various partners to be in touch constantly, reducing the potential for misunderstanding and unilateral decision making. Each partner can view the actions of the other partners. If there is no rainfall, Bidco knows to downgrade production plans, Equity Bank knows and can begin to work with farmers to make refinancing arrangements, and so on. Collaboration replaces confrontation. The speed of payment permitted through DrumNet is also central to maintaining sound relationships. Farmers note that they get paid in days rather than months, as was customary. The same can be said for the retailer and bank or the buyer and bank.

As the previous paragraph implies, a second key enabler was infrastructure. DrumNet's ICT platform relies on mobile phones and Internet. Based on the World Bank's World Development Indicators, it appears that Kenya's infrastructure for both technologies is above average compared to that of other developing countries in sub-Saharan Africa. Kenya has wireless coverage across 77 percent of its territory (the average for developing countries in sub-Saharan Africa is 75 percent) and 42.1 mobile subscriptions per 100 people (compared to 33.3 in developing countries in sub-Saharan Africa). Similarly, Kenya has 8.7 Internet users per 100 people compared to 6.5 for sub-Saharan Africa.

### Outcomes and Lessons

More than 2,000 smallholders participate in the sunflower pilot. Several lessons have become apparent since the first

harvest was completed. The complex arrangement between farmers, buyers, banks, and retailers certainly allows farmers to obtain credit, reduces defaults, and increases trust. Yet the relationship remains extremely fragile. It is still susceptible to mistrust. Side-selling by farmers, scams from input retailers, buyers reneging on agreements, and hidden fees from the bank all erode trust and undermine the relationships. Such problems occur more often at the beginning of the process. As the partners come to understand each other's operations and develop trust, the problems should lessen. As noted, efficiency in service delivery is one way to mitigate some of these risks.

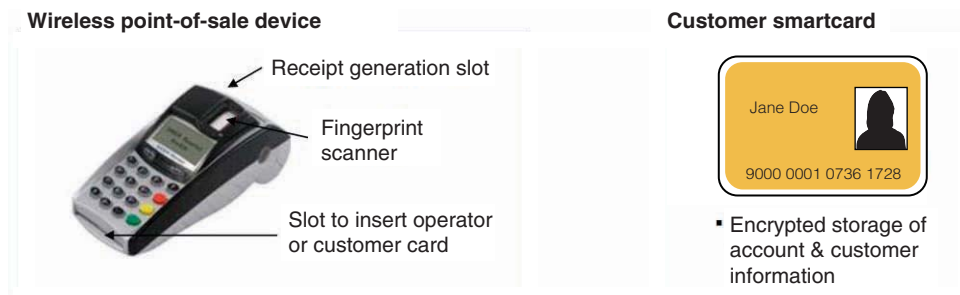
The partnership is also susceptible to problems arising from typical production risks such as drought or floods. After the first year, when one region of sunflower growers was affected by drought (McCormack 2009), the issue of loan repayment became contentious. Would Equity Bank allow an additional year to repay? Should DrumNet require a higher security deposit from farmers? Failure to reach agreement on such flashpoints before a partnership is implemented can unravel hard-won cooperation.

### INNOVATIVE PRACTICE SUMMARY A Common Platform Delivers Financial Services to Rural India

In India, the Financial Inclusion Network and Operations (FINO), an Indian technology company, and ICICI Bank have used ICT to facilitate remote bank transactions and dramatically reduce the costs of serving rural areas. Using smartcards and point-of-sale devices connected to a centralized ICT platform, FINO has overcome the traditional problems of low volumes and values of transactions in rural areas.

### ICT Application and Business Model

In partnership with IBM and i-Flex (now Oracle), FINO developed a remote transaction system that uses a small biometric point-of-sale device, in combination with a biometric smartcard, to authenticate users and conduct transactions (figure 7.10). Transaction data are sent over the Internet to a core banking system that houses the data and allows for analysis. Besides the obvious benefit of allowing remote transactions, the service provides the ability to uniquely identify customers and record their

**FIGURE 7.10:** Other ICTs Used by the Financial Inclusion Network and Operations

Source: FINO and author.

transactions over time. The transaction history for each customer can be used to provide credit bureau services to mainstream banks and allow them to lend to qualified borrowers in whom they have confidence (*Business Line* 2006).

### **An Extended Agent Network**

FINO employs over 10,000 agents, 95 percent of whom are based in rural areas. The agents, called *bandhus* (“friend” in Hindi), form a network of human ATMs. Each agent is trained and equipped with the handheld biometric transaction device which allows clients with smartcards to access banking services. Balance transfers, deposits, and withdrawals can all be done through the smartcard system, even where the Internet is not accessible, since the smartcard retains the user’s account information (India Knowledge@Wharton 2010). New transactions are stored on the transaction device until Internet is available, at which point the data are synchronized with the core banking system.

### **Products and Services**

Through its human and electronic network, FINO delivers microfinance transactions for various banks as well as its own banking services. Originally meant as a conduit for other financial institutions, FINO decided to offer its own financial services—savings, credit, insurance, and remittances—primarily because banks and businesses remained reluctant to pursue the rural market (India Knowledge@Wharton 2010).

FINO is also testing new initiatives. For instance, the company opened bank accounts for dairy farmers that supply milk to the National Dairy Development Board in Gujarat. Along with a savings bank account, farmers can receive bank

loans and cattle insurance combined in a single product (India Knowledge@Wharton 2010).

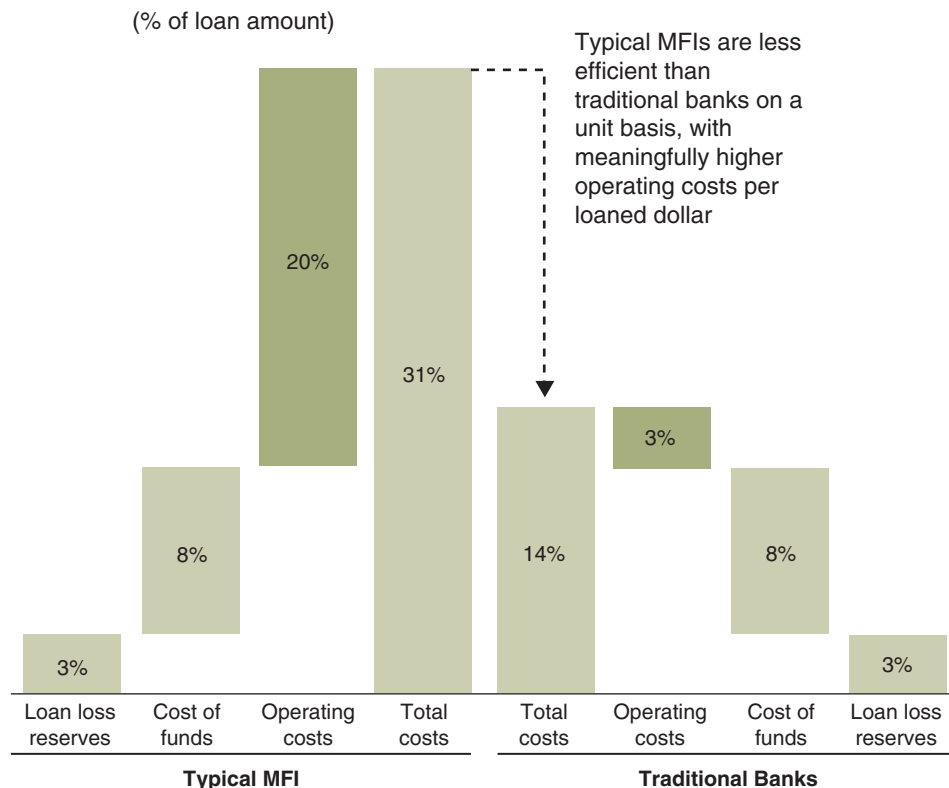
### **Profit Margin and Cost Structure**

FINO earns approximately US\$ 0.10 for each transaction. A similar transaction costs US\$ 1.00 at a bank and about US\$ 0.40 cents at an ATM (Rotman 2010a). The company had turnover of US\$ 22.5 million in 2009–10 (India Knowledge@Wharton 2010). FINO aims to keep interest rates below 20 percent. The company has a similar cost structure as other microfinance institutions (figure 7.11), but it claims to have operational costs of 4–6 percent, nearly on par with traditional banks, because its rural agents cost less than urban agents, technology reduces administrative paperwork, and FINO shares the cost of maintaining the agent network with other banks that use FINO to conduct transactions (India Knowledge@Wharton 2010).

### **Scale and Sustainability**

FINO has grown spectacularly since it was launched in July 2006. The company reached 2 million customers by 2008 (FINO 2008) and 5.5 million by 2009 (findBiometrics 2009), within an estimated market of 500 million rural people. By September of 2010, “there were 21 million customers, 22 banks, 10 MFIs, 4 insurance companies and 12 government entities covering 22 states, 266 districts and 5,884 gram panchayats [village councils].” The ambitious goal is to reach 100 million customers by July 2011 and have revenue turnover of US\$ 52 million (India Knowledge@Wharton 2010).

The financial viability of the agent network is questionable, however. At about US\$ 23, the average monthly profit for

**FIGURE 7.11: Cost Structure of Microfinance Institutions (MFIs) in India**

Source: CGAP and IBM.

a FINO agent is less than 20 percent of the profit made by an M-PESA agent in Kenya or an agent in Brazil, both of whom make around US\$ 130. FINO agents surely need additional income to supplement that from FINO, but being an agent for FINO takes up an enormous amount of time, leaving little for another job unless there are synergies between the travel required for FINO and the other job (Rotman 2010a).

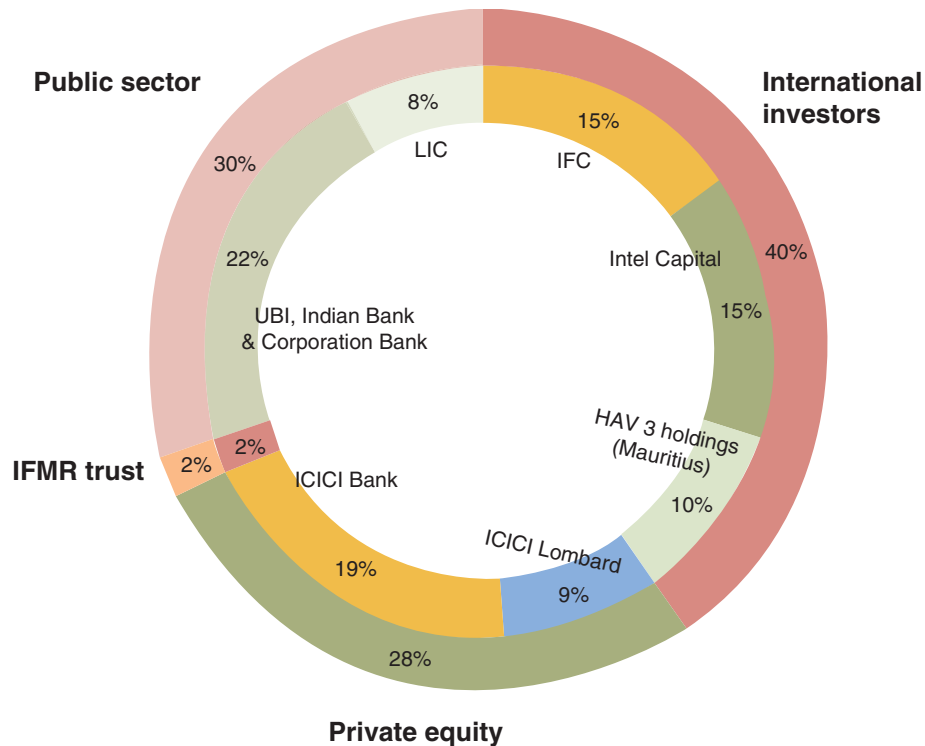
### Key Enablers

An operation on such a large scale requires strong support from major institutions, policy initiatives, and infrastructure. FINO has benefited from all of these key enablers. A major advantage was that ICICI Bank, India's largest private financial institution with assets of US\$ 81 billion, incubated FINO. It transferred critical technical and administrative capacity to the company in addition to financial support.

Early on, ICICI Bank recognized the challenge of reaching rural customers. The bank, founded in 1955 by the

Government of India, industry, and the World Bank, has consistently innovated in service delivery. In 2004, the bank launched the Kisan ("farmer") Credit Card in Andhra Pradesh to facilitate delivery of cash loans and credit to tobacco farmers (ICICI Bank 2001). In the same year, ICICI unveiled biometric ATMs in peri-urban areas. The ATMs cost 5 percent of typical ATMs.

These steps led ICICI to envision a technology platform that could allow banking transactions in rural areas, and ICICI began incubating FINO to achieve this goal. The effort was guided by leaders of other companies that ICICI had incubated: Crisil, a ratings agency, and Ncdex, a commodities exchange (*Business Standard* 2006). FINO spun off in 2006, with ICICI retaining a 19 percent stake. Intel Capital and the International Finance Corporation (IFC) each have a 15 percent stake, the Life Insurance Corporation of India has 8 percent, and various other public banks have the remaining 22 percent (figure 7.12) (India Knowledge@Wharton 2010).

**FIGURE 7.12:** Financiers of the Financial Inclusion Network and Operations

Source: fino.co.in.

Government policies and regulatory incentives have also been instrumental in helping FINO to grow and maintain its momentum. First, FINO earns most of its revenue from delivering government transfer payments for the Social Security Pension system, the Health Insurance initiative, and the National Rural Employment Guarantee Act (India Knowledge@Wharton 2010). Second, FINO facilitates transactions that commercial and state banks are legally obligated to perform. Since the 1960s, the Reserve Bank of India has required commercial banks to direct some portion (more than 40 percent) of their lending to priority sectors, which include rural industries and agriculture. Finally, a centralized ICT platform such as FINO's relies heavily on telecommunications infrastructure, which is already quite good in India.

### Lessons

As indicated in the discussion of FINO's operations, significant financial, management, and political support from ICICI Bank and the International Finance Corporation were critical

to the development and implementation of a rural transactions system as ambitious as FINO. Another important lesson is that government can be an important customer. It can drive the transaction volumes necessary to make rural financial transactions viable.

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## Module 8: FARMER ORGANIZATIONS WORK BETTER WITH ICT

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### IN THIS MODULE

**Overview.** Farmer organizations can function more efficiently by using information communication technologies (ICTs) to attract and retain a wider membership, generate more funds, and provide better services to their members. Documented benefits of ICTs include improved connections to members, better accounting and administration, and stronger collective voice. Given the lack of basic infrastructure in much of the developing world, the most successful ICTs are robust and relatively simple. Governments, donors, and nongovernmental organizations (NGOs) generally initiate the development and testing of ICT solutions for farmer organizations, but in many instances partnerships with the private sector are essential. Two important challenges are to sustain the use of ICTs over the long term and ensure inclusiveness.

**Topic Note 8.1: Finding Better Marketing and Sharing Technical Information Using ICTs.** Mobile phone systems appear to be the most flexible technology for improving connections within farmer organizations and providing a wider range services. Technologies that do not depend on literacy (digital photography and video clips) are extremely effective for sharing information within and between farmer organizations.

- **Zambia’s National Farmer Organization Develops SMS-Based Service**
- **Burkina Faso Farmers Use ICTs to Share New Production, Processing, and Marketing Skills**
- **The SOUNONG Search Engine for Farmer Organizations in China**

**Topic Note 8.2: Dairy Cooperatives Lead the Way with Computerized Systems to Improve Accounting, Administration, and Governance.** Computerized record-keeping has transformed efficiency in farmer cooperatives; approaches include commercial systems and systems using open-source software. Supportive government policy and willingness on the part of government organizations to join partnerships are important enablers.

- **IT Tools for India’s Dairy Industry**
- **CoopWorks Dairy and Coffee, Open-Source Software Launched in Kenya**
- **ICTs Improve Marketing and Governance for Malian Coop**

**Topic Note 8.3: Giving Farmers a Voice and Sharing Information.** Farmers’ collective voice is stronger and reaches wider audiences with the help of radio and television. Interactivity is possible and even more promising through phone-in programs and text messaging. Radio and television are also effective tools for agricultural extension. Interactivity through websites is becoming more important for farmer organizations, but less so for individual smallholders.

- **Community Listeners’ Clubs Empower Social Networks in Rural Niger**
- **Through Radio and Television, Thai Bank Gives Rural Voices a Wider Audience**

### OVERVIEW

Farmer organizations play an important role in tackling the systemic causes of poverty, because they give farmers—men and women—a legitimate voice in shaping pro-poor rural policies. By articulating farmers’ interests to public and private institutions, farmer organizations encourage those institutions to tailor their strategies, products, and services

to farmers’ needs.<sup>1</sup> Given a supportive policy framework, farmer organizations are well able to drive balanced social and economic development (AgriCord 2010).

<sup>1</sup> Many smallholder farmers have little or no disposable income and would be considered poor by any standards, but it should be remembered that there are others—landless laborers, for instance—who would not have the assets required to join such a group.

As well as forging institutional links and giving farmers a collective voice, farmer organizations provide services to their members. Smallholders can generate more income in a number of ways—such as by using better cultivation techniques and improved seed, reducing postharvest losses, and having better access to markets—yet as individual entrepreneurs, they may lack the knowledge or capital to change the way they operate. The collective strength of an organization can help its individual members become more efficient, if the organization’s services match its members’ needs. ICTs are integral to fulfilling both the lobbying and service functions of farmer organizations, speaking both for and to the farmer.

Farmer organizations also have a third, commercial function, as seen in agricultural cooperatives and producer groups. Commercial activities become more efficient and transparent when supported by ICTs.

“ICT” is a catch-all term for an increasing number of technologies, each offering corresponding opportunities for innovation. This module looks at a range of technologies, from the well-established and familiar technologies like radio and mobile phones to the more specialized technologies, such as computerized record-keeping systems and global positioning system (GPS). The discussion emphasizes technologies that can (or that have the potential to) reach large numbers of beneficiaries and perform reliably in the challenging context of the developing world. Different technologies offer different benefits, achieve different objectives, and have different limitations, so each is considered on its own terms.

### Benefits Offered Through ICTs

When considering the value of ICTs to farmer organizations and cooperatives, it is worth bearing in mind that in remote rural areas of many developing countries, particularly in Africa, these organizations often are the only ones operating. Local government offices may be found in district headquarters, but often there is little else apart from frontline extension officers and schools.

As a hub for business information, transportation, and storage, as well as a place where people share new systems and processes, farmer organizations have enormous potential—which should not be underestimated—for networking and bringing people together with the help of ICTs.

The benefits offered by ICTs to producer organizations and agricultural cooperatives fall into three broad categories. Practical examples of ICTs in use sometimes cut across these arbitrary categories, and particular technologies may

bring unexpected benefits, but the examples in this module are presented in three sections to reflect this categorization:

- **Enhanced connections to members.** Through the organization, farmers share market information and technical know-how, and they remain informed about the organization’s activities. For instance, topics discussed and decisions taken at board or executive committee meetings can be shared with members who, for reasons of distance or cost (direct and opportunity) cannot attend. Decision-making processes become more transparent, increasing trust between members, the board, and executive managers, and the overall functioning of the organization is improved.
- **Improved accounting and administration.** Farmer organizations are often responsible for handling very large amounts of money that may represent the cash income of thousands of farm families. Efficient record keeping allows an organization to serve its members better, and the transparency offered by computerization and other technologies enhances trust. Cooperatives that have invested in modern management and member information systems can improve their image to attract high-quality staff and gain members’ confidence.
- **Stronger collective voice,** including improved political voice. “Interactivity” as understood in developed countries with good infrastructure is still rare in many parts of the world. But individual farmers nevertheless “have their say” by phoning and texting their participation in agricultural radio broadcasts. They give feedback (and complain when necessary) about the services offered by their farmer organization and local government. Comments are likely to have more influence expressed over the airwaves than expressed in a less public forum.

Despite the potential benefits of ICTs, farmer organizations are rarely the first to adopt them, given that they usually work in difficult environments with low margins to generate income for their members. Neither managers nor members are preoccupied with the latest iPad. Where particular ICT solutions are available and necessary to guarantee better performance and benefits to members, farmer organizations can be expected to be late adopters of such technology without external support.

In general, it is governments, donors, and NGOs that have the funds to develop and test ICT solutions that may benefit farmer organizations. Most if not all of the cases illustrated in this module are public-private initiatives to “include the excluded” by promoting ICTs in remote rural areas. Successful cases provide good examples for scaling up and replicating in other countries and regions.

## Promising Approaches

Table 8.1 summarizes the types of ICT covered in this module, arranged by topic note. All of them have proved useful in addressing one or more challenges faced by farmer organizations.

It is important to remember that ICTs—whether mobile phones, computers, telecenters for Internet access, or radio broadcasts—are not ends in themselves; they are simply the means by which information can be recorded,

**TABLE 8.1:** Specific ICTs Discussed in This Module

TYPE OF ICT APPLICATION	CHALLENGE FACED BY FARMERS AND THEIR ORGANIZATIONS					
	LACK OF MARKET INFORMATION—PRICES, POTENTIAL BUYERS, AND SO ON	LENGTHY MANUAL BUREAUCRATIC PROCEDURES, POOR TRANSPARENCY, INCLUDING WITH THE FO	LACK OF KNOWLEDGE OF MARKET STANDARDS BY FARMER, OR LACK OF CONSUMER CONFIDENCE	LACK OF ACCESS TO EXTENSION SERVICES AND LATEST RESEARCH, AND INABILITY TO SHAPE RESEARCH	EXAMPLES IN THIS MODULE	
Enhanced connections to members	Mobile phones (voice or short messaging system (SMS)) to access price information, purchasing options, and other market intelligence; also to access information in broader sense.	Fairer relationship between farmer and trader	If GPS an option, can make it easier to verify the source of crops—e.g., for organic or other certification	Informed farmer can sort and offer produce according to required standards	Voice and text increasingly used to contact interactive radio broadcasts to solve problems	–ZNFU (Zambia) –Coopeumo (Chile) –FrontlineSMS –SOUNONG (China)
	Digital multimedia (cameras, video recorders, computerized presentation) to share new techniques and effective practices; ICT-based information on grades and standards.			Can demonstrate standards in effective, visual way. Can help in reaching export market	FO can document best practice and share from farmer to farmer; pictures are more effective than words	–FEPPASI and Songtaaba Yalgré Association (Burkina Faso) –Coprokazan (Mali)
	GPS technology for plotting source of produce.		Speeds recording process	Consumers know source of produce and trust claims about organic status and similar characteristics		–Songtaaba Yalgré Association (Burkina Faso)
	Rural telecenters connected to Internet.	Easier to find prices and buyers	FO can share information for better transparency	Information available	Information available, interactivity possible	–Several
Improved accounting and administration	Member transaction systems; software for financial management.		Reduces need for clerks, speeds transactions, improves transparency	Graphic presentation of financial info makes statistics easier for coop members to understand		–Dairy and coffee coops (India, Kenya) –Coprokazan (Mali)
	Automated milk measurement systems.	Fairer relationship between farmer and coop	Reduces waiting time for farmers and amount of milk spoiled; farmers trust the automated system			–Dairy and coffee coops (India, Kenya)
Stronger collective voice	Local radio stations providing market and technical info and phone-in virtual markets. Could also share information about FO.	Farmer better informed about prices and possible markets	Together with mobile phones, can increase connections with FO members and increase transparency	Farmers better informed on standards	Possible to broadcast info on latest techniques; phone-in programs allow farmers to discuss problems	–Farm Radio International –RIU (Zambia) –Listeners' clubs (Niger, Zambia)
	TV programs specially tailored to share farming information—technical, market, problem-solving, and other.	Market info broadcast	As above for radio	As above for radio	Interactive problem-solving seminars on agricultural issues; picture more effective than words	–Doordarshan Broadcasting Co. (India) –BAAC (Thailand)
	Websites set up by FO and producer groups; online discussion forums.	Can reach wider markets	FO could put financial and other info online to increase transparency	Inform members of standards required	Information can be accessed online	–Several

Source: Authors.

Note: BAAC = Bank for Agriculture and Agricultural Cooperatives (Thailand); FEPPASI = Fédération Provinciale des Professionnels Agricoles de la Sissili; FO = farmer organization; RIU = Research Into Use; and ZNFU = Zambia National Farmers Union.

summarized, displayed, and passed on more quickly. It is the information itself that is important. Since information (on market intelligence and agricultural techniques, for instance) changes, the task of collecting it and choosing the most relevant sources is critical. Farmer organizations might have to be helped to create partnerships that will provide information that is of most use and relevance to members and management. Any intervention dealing with ICTs must therefore consider this point.

### KEY CHALLENGES AND ENABLERS

With regard to farmer organizations, ICTs currently offer guaranteed improvements in enhanced connections to members and improved accounting and administration. Already, working examples offer lessons for future development of ICT interventions. The third topic discussed in this module—stronger collective voice—has fewer working examples, but it may benefit more from ICT interventions in the future.

Farmer organizations can function more efficiently by using ICTs to attract a wider membership and thus generate more funds and provide better services in a virtuous spiral of development. To speed the uptake of ICTs, it may be appropriate for public agencies to provide funds that can overcome the inertia typical of organizations struggling on a shoestring budget. Supporting a pilot project to demonstrate benefits can be effective. Indeed, many examples in this module are relatively small-scale interventions that succeeded in changing the way farmer organizations operate.

The challenge in most cases, however, is to sustain the use of ICTs after the period of support. Costs are associated with change, not only equipment costs but also the costs of maintenance, training, and continuing development. New technology must either generate enough extra income for an organization to cover ongoing costs, or individual users must see enough tangible benefits in order to pay for the technology. In the developing world, and particularly in agriculture, subject as it is to the external shocks of unpredictable weather and global market forces, the benefits of ICTs must be very firmly established for farmer organizations to sustain their costs.

One way of looking at the sustainability issue is to regard well-functioning farmer organizations as a public good that merits support from public funds, at least initially. Given the vital role of such organizations in helping impoverished farmers improve their living standards in areas that may be poorly reached by other interventions, this argument is powerful.

Public-private partnerships are also important, as developments in ICT come largely from the private sector. Dealing with such partnerships will be a critical issue. Private companies need to make a profit for their goods and services, but safeguards need to be built into partnership arrangements so that the farmer organizations (and ultimately their members) see long-term benefits.

Where support is offered to farmer organizations that have not yet reached a level of financial maturity that would allow them to adopt ICTs independently, it is important to design interventions that give due consideration to the issue of gender. Women need to be involved at the planning stage as well as in the management of a project to ensure their proper representation (box 8.1 lists obstacles to increasing women's use of ICTs). Somewhat paradoxically, women, despite having lower social visibility and literacy than men, have more to gain from ICTs. Women may not be able to free themselves from their traditional time-consuming commitments to household and children, but armed with only a cheap mobile phone they can find the best prices for their crops without abandoning their domestic tasks (image 8.1). Women who might already be involved in the accounting

#### BOX 8.1: Factors that Can Hamper Women's Uptake of ICTs

- Cultural attitudes discriminate against women's access to technology and technology education: What would a woman farmer want with a computer?
- Compared to men, rural women are less likely to own communication assets, such as a radio or mobile phone.
- Rural women are less likely to allocate their income to use in public communications facilities, except when they need to communicate with family or to arrange for income transfers.
- Rural women are often reluctant to visit cyber cafés or public Internet centers, which are often owned by men and visited by men. The café culture often excludes girls and women.
- Rural women's multiple roles and heavy domestic responsibilities limit the time they can allocate to learning and using ICTs, until and unless they realize the potential information benefits (and time-saving elements) of using these technologies.

Source: World Bank 2008.

function of a farmer cooperative should have the opportunity to learn computer skills when these functions become computerized. Such skills will become more valuable as computerization becomes more common, giving women more employment choices.

Consideration should also be given to age asymmetries in access to ICTs, which younger people tend to adopt more readily. This asymmetry has the potential to cause friction in traditional societies where elders are respected and turned to for guidance. On the other hand, young people's readiness to adopt new technology can be turned to advantage and used as a learning tool within communities.

Of course, there are also the persistent challenges common to developing countries: poor infrastructure, poverty, illiteracy, and the draw exerted by urban centers. Mains electricity is rare outside major towns (although solar recharging devices and kiosks are starting to appear). Mobile phones are widely used in some rural areas, but others still lack network coverage. Maintaining computer systems can be a challenge in remote rural areas. Technical staff trained to use computers tend to migrate to towns, where salaries are higher. Farmers themselves may not see the importance of spending money on ICT (bringing Internet connectivity, say) when a reliable water supply would bring more immediate and tangible benefits.

A more subtle challenge is the danger of widening the digital divide, because better-educated groups are more likely to accept and use new technology, which further distances them from poorer organizations. The coops that are likely to be successful are the ones that already have competent, educated managers and already function well as businesses (see the discussion of dairy cooperatives in Topic Note 8.2). Smaller, less well organized groups will always present more of a challenge; they require more intensive training and support services over a longer period. They might also need a significant period to become aware of the benefits of computerization before any intervention is possible.

Given these challenges, it is not surprising that the most effective technologies are relatively cheap and simple. Mobile phone ownership is increasing rapidly, and far more people own phones than have computers. Market information in the form of text messages to mobile phones can therefore reach large numbers of farmers and give them a stronger negotiating position with traders. Phones that connect users directly to the web unleash an even wider range of possibilities. India

**IMAGE 8.1:** Indian Woman Text Messages on Phone in India



Source: Simone D. McCourtie, World Bank.

is poised to take this step, and one might predict that African countries will follow suit (*The Economist* 2010).

Using text messages or the web requires a certain level of literacy, however, and not everyone owns a phone, so radio broadcasts have proved even more effective, especially when they are carefully considered. Popular and informative programs transmitted at appropriate times of day—such as early evening, when outdoor chores have been completed and women can listen, too—can bring about real improvements over a wide geographical area.

It is also worth noting that ICTs can be beneficial in indirect ways, by reaching farmers who are not themselves online or using any new technology through farmer-to-farmer information sharing, at which farmer organizations have already proved adept. Some have used digital multimedia equipment to produce teaching materials showing better farming or production practices. Slide shows or video footage of actual farmers demonstrating new methods, particularly if the farmers are from the local area, appear to be much more effective in getting a message across than dry information presented

by an “expert” from outside. In such cases, even though the actual users of technology are few, the benefits are enjoyed by a much wider group.

The same can be said of the combination of community radio with text or voice contributions via mobile phones, where the audience as a whole is much larger than the number of participants. Regular, facilitated programs covering local issues, agricultural extension messages, and specific problems raised by farmers that can be answered by experts command a wide and receptive audience. The approach is inclusive as well, and with the interactivity made possible by SMS and phone calls, the audience can influence program content.

Taking the idea a step further, the workings of farmer organizations could be made more transparent with regular programs covering recent activities and financial information. Farmer organization leaders could take questions from listeners and viewers, improving both awareness and trust.

A final point is that even proven technology can take time to be adopted fully, and adoption rates will differ according to complex factors in the underlying development and business environment. The rate of adoption also depends on the route chosen, and so far it is not possible to say which will be more successful in the longer term. For instance, dairy cooperatives in India are already benefiting from computerization based on commercial software systems, whereas similar coops in

Kenya are at an earlier stage, pursuing a different approach with open-source software developed specially for that context.

Topic Note 8.1 discusses how farmer organizations have used ICTs to help their members find better markets and share technical information, using examples from Zambia, Burkina Faso, China, and other countries.

Topic Note 8.2 looks at computerized accounting systems used by cooperatives; examples from India and Kenya show contrasting routes to developing such systems. The topic note also highlights the unexpected benefits of ICTs, using an example from a cooperative in Mali.

Topic Note 8.3 examines how ICTs can give farmer organizations and their members a stronger voice. The lack of infrastructure—electricity, mobile signal, and Internet connectivity—in rural areas has severely limited the means by which farmer organizations can receive communications from their members, but many organizations now have websites and use e-mail and online discussion forums to interact with similar organizations and the wider world. Other alternatives to communicate farmers’ views, locally and nationally, are rural radio and telecenters. The advocacy role of farmer organization can also be pursued by federations of farmer organizations linked by ICTs. The note provides examples of how farmer groups have used all of these strategies and innovative practice summaries from Niger and Thailand.

## **Topic Note 8.1: FINDING BETTER MARKETING AND SHARING TECHNICAL INFORMATION USING ICTS**

### **TRENDS AND ISSUES**

The concept of farmer organizations is based on the notion of strength in numbers, of giving small-scale farmers the chance to punch above their weight and become entrepreneurs in their own right. The challenge, though, is to reach isolated farmers with the information they need to sell their produce at the best price and to grow more and better crops. Although an organization’s headquarters can offer a business hub for members, many members live too far away to make frequent visits. Others are effectively barred from using the facilities because they speak a minority language or cannot read or write.

New communication technologies are vital for overcoming these barriers. They include technologies that help farmer organizations to maintain and expand ties with grassroots

members, telecenters for mastering digital technology and using it to meet the goals of farmer organizations, mobile phone technology to provide services, and ICTs to facilitate certification and access to international markets. A persistent issue is how farmers and farmer organizations will pay for obtaining and providing technical and market information.

### **Technology to Maintain Close Ties with Grassroots Members**

Smallholder farmers are some of the poorest people in the world, and they cannot afford to join a group that does not offer tangible benefits. Creating better links between farmer organizations and their members is crucial if the organizations themselves are to flourish. Reliable flows of information

between headquarters and the grassroots should boost trust and membership.

The challenge of improving links between farmer organizations and their grassroots members can be tackled using ICTs, but in the poorest areas of developing countries where infrastructure is lacking and many farmers are illiterate, the technology must be simple and cheap. Most farmer organizations cannot afford to introduce new technologies, even when they can see the potential benefits, so they rely on public-sector support.

Despite the digital poverty in rural areas, evidence suggests that farmers, both men and women, are well able to learn to use relevant technology if they are taught in the local language and can see clear benefits from new ways of doing things. For instance, some of the nearly 2,000 women who work with a shea butter association in Burkina Faso (discussed later) have become financially independent by learning to use ICTs, including GPS and the Internet, to reach a developed-country market for certified organic shea butter. Another promising idea is for a farmer organization to communicate with members to create a database on crops and productivity. Backed by reliable historic production figures and sound projections of possible future yields, the organization would be in a better position to access credit for its members—a valuable service.

Many small-scale producers struggle to access up-to-date technical information, but the experience in Burkina Faso and elsewhere shows that farmer organizations can use new ICTs to provide advice and services tailored to members' needs (see IPS "Burkina Faso Farmers Use ICTs to Share New Production, Processing, and Marketing Skills"). Using local languages and photos or moving images are effective ways of reaching poorly educated farmers. ICTs have revolutionized the means of disseminating information to such an audience, although a facilitator is often needed as part of the process.

### Telecenters to Strengthen Farmer Organizations' Skills and Efficiency

Some farmer organizations have set up telecenters to help their members learn about ICTs and access market information, among other objectives; see box 8.2. The centers require investments in equipment and training, which may be too high for organizations to bear without initial and continuing support. However, experience such as that of the Coprokazan cooperative in Mali suggests that telecenter services may be attractive to nonmembers as well. If they are prepared to pay to use the Internet or to print a document, for example, the facility may become self-sustaining (image 8.1).

**IMAGE 8.2:** Telecenters Can Attract a Wide Range of People



Source: Jonathan Ernst, World Bank.

### BOX 8.2: Telecenters Build Skills, Directly and Indirectly, in Members of Farmer Organizations

In its most basic incarnation, a telecenter is simply an individual, often a woman, sitting under an umbrella with a telephone that people can use for a small fee. More complicated solar-powered booths have been developed, such as the Cooperative Internet Booth (Coop-e-Booth) in Kenya, which has computer terminals, a terminal managed by an administrator, and wireless Internet connectivity. The booths were launched in July 2010, and the Cooperative Alliance of Kenya hopes that they will allow interested individuals and organizations to generate income and create employment.

The benefits of telecenters operated by farmer organizations—access to technical and market information from the Internet, for instance—do not have to be limited to literate farmers who live close by. The benefits can be amplified if telecenters are used to develop training materials for illiterate or far-flung members of the organization.

Source: Authors.



In Uganda, the 3,800 members of the Busia District Farmers Association have a telecenter with various facilities, including seven Internet-ready computers, a printer, a fax machine, and a generator for when the mains electricity fails (Nabwowe 2010). It was set up in 2008, with the Uganda Communications Commission contributing 80 percent of the costs and the members 20 percent. Farmers are trained to use the Internet to identify markets and liaise with them directly, and they say they can find better prices and sell their produce in bulk. They pay a small fee to use the center.

Another example of the telecenter model is the case of the arid Huaral Valley in Peru, where farmers cannot operate without access to water for irrigation.<sup>2</sup> The water comes from lakes in neighboring highlands, and there is a long history of social organization to ensure that water is distributed fairly.

The Peruvian Center for Social Studies developed a project to establish a network of local telecenters with the help of local farmer organizations. An important aim is to provide information hubs for farmers so they can improve their practices and become more resilient to periodic water shortages that have followed diminishing rainfall. It is also important to distribute irrigation water fairly, so water use has been monitored and recorded in the information system and administered by the local board of irrigation users. Water use is now more transparent, and it is easier to monitor contributions toward maintaining and administering the irrigation systems.

A small minority of farmers can access information directly online, but the new knowledge is said to be shared with a much wider circle. Changes in the community appear to be beneficial, and a community radio station has been set up to broadcast on farming and environmental issues. Effects on long-term food security have not yet been seen, but the fact that farmers with low levels of formal education have proved able and willing to embrace new technology to solve agricultural challenges in this difficult environment is a positive outcome.

The telecenter concept shows that literate farmers readily learn to use ICTs to access technical information and market prices. The farmers benefit from being able to contact other farmer groups and link with buyers. To ensure that women benefit as much as men, however, the differences in their socioeconomic contexts need to be considered (box 8.3 shows what happens when they are not). A telecenter must be attractive to women (not perceived as a men's club) and sited in a place women find safe and convenient to visit while carrying out other chores.

### **BOX 8.3: Unintended Consequences of *Not* Including Women**

Warana lies in the sugarcane belt of one of the most prosperous regions in Maharashtra, India. Kiosks were set up in 70 villages and equipped with a computer and printer, which were networked to a central administration building via wireless telephony. Looking back, project staff pinpointed the project's weaknesses to the exclusion of women. Warana neither assessed the information needs of the community nor promoted local ownership and participation. Because Warana did not give particular attention to ICT access among women and poor people, these groups were marginalized. Women were not encouraged to become information kiosk operators, and the resulting increase in men's digital literacy exacerbated the male-female digital divide. The poorest, landless laborers, and tribal groups did not use the kiosks, even though these groups would benefit the most from information about employment and educational opportunities.

*Source:* World Bank 2008.

As noted in box 8.2, the benefits of a telecenter can also reach the wider group of less literate farmers and those who live too far away to use it often. This was the case in Burkina Faso, where the training courses created by the FEPPASI telecenters have benefited thousands of members even though only a few hundred farmers were trained to use ICTs.

Despite various examples of telecenters in use, there seems to be some doubt as to whether they can be self-sustaining and whether they are being used optimally. One research example reported that a PC-based system was replaced successfully by a mobile phone-based system. Using text messages instead of computers, it was possible to transfer small but relevant amounts of data to farmers. The project (Warana Unwired) worked with a sugarcane cooperative in rural Maharashtra. In an eight-month trial involving seven villages, the mobile phone-based system replicated all of the PC-based functionality and was found to be less expensive, more convenient, and more popular with farmers than the previous system (Veeraraghavan, Yasodhar, and Toyama 2009).

### **Mobile Phone Technology Delivers Market Information and Other Services to Members**

A major service provided by farmer organizations is to improve members' access to market information, and the advent of mobile phones and SMS has exponentially increased their capacity to do so. Module 9, which focuses on the use of ICTs

<sup>2</sup> See <http://www.bcoalliance.org/node/459> and Bossio (2007).

in marketing, discusses many aspects of these issues; this topic note concentrates on how farmer organizations have used ICTs to gain an advantage in marketing and information sharing.

Among farmer organizations, SMS systems are proving their worth by enabling farmers to compare prices in different markets and to take a stronger negotiating position when selling their produce. Some farmer organizations opt to join an established trading platform such as Esoko. Others have set up their own services. Large organizations such as the Zambia National Farmers Union (ZNFU) have developed message systems using commercial routes (see IPS “Zambia’s National Farmer Organization Develops SMS-based Service”). Smaller farmer groups have used free open-source software such as Mobile Information Platform or Frontline SMS, which provide options for sending bulk messages. For an example from Chile, see box 8.4 (and for more detail, see Module 3).

FrontlineSMS (Banks 2009) is software that effectively turns a computer and mobile phone into a two-way, group text

messaging hub that does not need Internet connectivity. Devised to enable information flow for election monitors, news agencies, and humanitarian NGOs, the system is proving adaptable to the needs of farmer groups.

In El Salvador, for instance, where farmers in general do not have access to computer-based information services but where there are more than 50 mobile phones for every 100 inhabitants, the Agricultural Technology Innovation Foundation is promoting the use of mobile phones to encourage farmers to exchange information and strengthen market links. With 600 subscribers who pay only for the information they receive, the pilot project is currently supported by the cost of calls.

In Aceh, Indonesia, FrontlineSMS is used to send information to small-scale producers. A team gathers a range of information, and the data are entered into a computer running the program. Latest prices, costs of inputs, and weather forecasts are then sent to groups of producers and others in the agricultural sector. Farmers say they like to have a base

#### **BOX 8.4: Chile’s Coopeumo and the Mobile Information Project**

Coopeumo, a Chilean farming cooperative with fewer than 400 members, uses text messages to help small-scale farmers increase productivity. This area of Chile, south of Santiago, has good soils and climate, but smallholders are at a disadvantage compared to larger enterprises because it is not easy for them to access specific market, technology, and weather information that could boost production. Smallholders are aware of computers and would like access to the Internet, but with low population densities and low incomes in the areas where they farm, it will be difficult for private service providers to offer connectivity. This “digital poverty” has been noted in Chile, where the government is keen to promote social equity, and agricultural exports are an important part of the country’s economy.

Through the Mobile Information Project (MIP), farmers now receive research findings and news (including market prices and weather forecasts) directly from the Internet on their mobile phones. Weather updates are particularly useful to farmers at critical points such as planting and harvest. The MIP software works on the cheap phones (US\$ 15–20) that farmers tend to use and is effective over slow networks.

Several organizations implement MIP:

- **The Foundation for Agrarian Innovation** (FIA, Fundación para la Innovación Agraria), is a Chilean governmental agency that works closely with agrarian communities to understand their information needs and to locate, edit, and/or create appropriate content to meet those needs (resulting in the creation of micro weather stations, for example). FIA is therefore a key partner responsible for sending a content stream of locally relevant information.
- **The United Nations Educational, Scientific, and Cultural Organization** (UNESCO) is responsible for financial support and provides educational content.
- **Coopeumo**, a cooperative based in the town of Peumo, is responsible for local implementation of the project among cooperative members.
- **Entel PCS**, a Chilean telecommunications company, is helping support the project with the technological platform, telephony equipment, and competitive pricing for mass SMS messaging.
- **The national Chilean newspapers** *El Mostrador* and *El Mercurio* supply news feeds, among which users can choose preferred news streams.

Sources: Authors; Cagley 2010; Datadyne (<http://datadyne.org/programs/mip/datagro>).

price on which to start negotiations with buyers. They also report that as they learn the range of price fluctuations for each product, they are better able to choose which crops to grow.

An even more low-tech approach is used in the First Mile Project in Tanzania. The project supports a group of “market spies” to gather market intelligence and share it with farmers (“Bahati Tweve: The Honest ‘Middleman’ Brokering Deals,” *New Agriculturalist* 2008). This intervention is based simply on phone conversations, SMS messages, face-to-face meetings, and village notice boards, but it has helped build market chains and put farmers in a stronger position when selling their produce. After support from project funding comes to an end, the spies aim to cover their costs by charging a commission to link buyers with producers. Other possible ways to generate revenue might be to charge a small fee for advertising on information boards and for storing produce.

Mobile market information has a number of benefits. At the very least, a smallholder armed with information on current prices has a better chance of negotiating a good deal for his or her produce with passing traders. Smallholders also value and use information on the price of inputs from different sources and on the whereabouts of the nearest buying center. Although household responsibilities keep many women close to home, if they can discover the best markets for their produce via SMS, they can maximize their income.

Services for sending and receiving cash via mobile phone, such as M-PESA, which has more than 13 million users in Kenya (“Not Just Talk,” *The Economist*, 2011), make it easier for farmer organizations to provide other services such as selling inputs and arranging more convenient payments for produce. For example, Zambia is testing an “e-voucher” project (Sibanda 2010) in which farmers who register with the scheme receive prepaid mobile phone vouchers worth about US\$ 50 to purchase inputs from agrodealers<sup>3</sup> (see Module 9). Farmer organizations may be able to develop similar arrangements with input suppliers.

### Technology for International Certification and Markets

Farmer organizations are using ICTs not only to provide local and national market information to members but to increase their international reach. The lure of lucrative international markets, such as those for organic or Fair Trade products, can be a strong motivation for farmer organizations to master ICTs in the first place (image 8.3). Anecdotal evidence from

**IMAGE 8.3:** Women’s Cooperative Processing Shea Butter in Ghana



Source: Jonathan Ernst, World Bank.

some organizations shows that they can reach this ambitious goal even if their members have little formal schooling.

Many women belonging to the Songtaaba Yalgré Association, a shea butter trading group in Burkina Faso, never attended school but confidently use ICTs and the Internet (Soré n.d.). The group has had a French-language website since 2004 (<http://www.songtaaba.net>) and handles 90 percent of its sales through the Internet, sending shea butter products to Europe, Canada, and the United States.

The website describes the background of the producer group and lists the various products formulated using shea butter as well as the chemical ingredients of those products. Largely through their website, the women have strengthened their position in the marketplace. As Noëlie Ndembe, the head of MIPROKA (the national shea information and promotion center),<sup>4</sup> has said, “To be on the Net is to be seen everywhere in the world” (quoted in Soré 2008).

A particular selling point for this particular shea butter (a sought-after ingredient for beauty products) is its certification under Bio-Ecocert and Bio-NOP, which guarantee that a product is 100 percent natural and has been manufactured under conditions that respect human and environmental health. GPS technology has been essential for recording the source of the shea fruit and thus assuring distant customers that the certification is genuine.

Website development and related training in the technology were done in partnership with MIPROKA. Two village telecenters were set up, each with several computers linked to the Internet, a scanner, photocopier, and telephone. Technical

<sup>3</sup> The scheme is a joint venture between the Zambian government and FAO, funded by various donors.

<sup>4</sup> Maison d’Information et de Promotion du Karité.

training had two elements: (1) how to produce shea butter to the exacting purity and cleanliness standards demanded of an export product and (2) how to use ICTs, including GPS and computers. Other facets of the training included better ways of marketing the product, as well as environmental and energy awareness.

Moré, the local language, has been used throughout, and the trade group produces an in-house bulletin that also appears in Moré. The bulletin gives information on the group's activities and on the production of organic shea butter.

Despite some literacy barriers, many women have learned how to use GPS equipment to map their fields and record each tree from which they harvest shea fruit. A small group was initially taught by an expert from Europe, but they can now train other village women in GPS skills. Mapped information is vital for certification. As an incentive to capture all relevant items each time, the women earn a small bonus if they do it without mistakes. Careful record keeping and good production techniques allow the women to sell their "bio" shea butter at more than twice the price of uncertified shea butter. Even the raw shea fruit is worth more if it is certified as coming from approved fields.

## LESSONS LEARNED

Although ICTs can certainly improve connections between farmer organizations and their members, farmer organizations are unlikely to be early adopters of this technology. Organizations of small-scale producers in particular are likely to need support to try new systems and learn how to make them cost-effective. It is worth remembering that farmers can be reached by channels other than ICTs; prices can be published in newspapers, broadcast on the radio, or simply chalked up on boards in markets or farm supply shops.

Messaging systems and telecenters can require a level of literacy that is often rare in remote rural areas, and the limit of 160 characters per text message can make it a challenge to provide certain kinds of content. Newer versions of software such as FrontlineSMS hope to incorporate multimedia information in audiovisual formats. Other software and hardware designers are also developing products that are more intuitive to use and employ audio and video. One benefit of using a common, open-source platform like FrontlineSMS is that users can easily share experiences, which in turn should lead to improvements.

Studies of a range of agricultural market information systems in sub-Saharan Africa suggest that disseminating information by mobile phone creates interactivity between the system

and its users.<sup>5</sup> Where users choose the information of interest to them, a wider range of information can be offered without inundating users with valueless data.

A persistent issue is that it is not clear how information systems that rely on mobile phones will pay for themselves over the long term. Experience to date offers conflicting evidence about farmers' readiness or ability to pay for information text messages.

Before looking at specific examples of formal services, it is worth bearing in mind that mobile phone communication by itself is an effective way of sharing market prices. Several studies suggest that simply providing mobile phone coverage can affect market efficiency (see Module 9). This outcome should be noted when considering whether to support more formal SMS services (USAID 2010).

In India, early results from research attempting to quantify the impact on farm profitability of a subscriber-based, local-language information service suggest that farmers cannot afford it.<sup>6</sup> They say this despite claiming to have negotiated better prices for their crops, spent less on inputs, and enjoyed overall better income. The package costs about US\$ 1.50 per month, for which the subscriber gets 75–100 SMS messages. Each subscriber shared the information with about seven other people. Only about half of the subscribers planned to renew their package. Almost all of those who had not bought the service said that cost was the reason.

In contrast, the phone company Nokia has found that farmers in India are prepared to pay US\$ 1.35 per month to subscribe to their service, Life Tools (O'Brien 2010). Nokia reports that more than 6 million people have signed up to pay for commodity data in India, China, and Indonesia and that Life Tools is about to expand to Nigeria.

In Zambia, the ZNFU admits that although there is huge demand for its SMS-based market information system (see IPS "Zambia's National Farmer Organization Develops SMS-based Service"), the system does not yet pay for itself and cannot yet be expanded. One possible revenue-raising mechanism for ZNFU and similar schemes might involve transport companies. Recognizing that running trucks empty after making a delivery is inefficient, truck owners might be willing to pay for information to find return loads. Other revenue-raising possibilities might include charging for arbitrage or brokerage services.

5 "Agricultural Market Information Systems in Africa: Renewal and Impact." Unpublished summary of workshop held March 29–31, 2010, Montpellier, CIRAD—UMR MOISA.

6 Grahame Dixie, World Bank, personal communication.

The experience in Chile (box 8.4) suggests that disseminating information via simple mobile phones is a good way to reach farmers in areas where Internet facilities are unlikely to be provided in the near future. Since the pilot project closed, Coopeumo has taken on the responsibility and costs of creating and sending the SMS messages. Farmers do not pay directly—the charges are included in the membership fees they pay to the cooperative. Refinements to the system should make it easier to provide relevant content to each individual. The goal is to tailor the content automatically (a human editor would slow the service).

A concluding lesson is that farmer organizations and their partners may find it challenging to use ICTs in the absence of a supportive regulatory framework for the technology. Mobile phone networks are subject to varying degrees of bureaucracy, taxation, and government regulation in different countries, and any proposal to set up a messaging service using mobile phones must comply with prevailing rules. When ZNFU was setting up its market information system,

the fact that Zambia had not finalized its ICT policy was regarded as slowing development of the ICT industry.<sup>7</sup>

In many African countries, providers of new mobile services must use intermediaries to get a short code for customers to dial, and many governments see phone companies as sources of easy tax revenue. Competition and the development of new infrastructure are often limited by restricting licenses to new operators (see Module 3). Mobile communications are thus more expensive in Africa than they need to be (“Not Just Talk,” *The Economist* 2011).

Kenya is a notable exception. Its good regulatory environment has led to competition and reduced the cost of mobile phone tariffs (World Bank 2010). See box 8.5 for additional considerations for designing effective ICT interventions for farmers’ organizations.

<sup>7</sup> Unpublished summary of the meeting of the Agricultural Thematic Group (part of the e-Brain Forum of Zambia), “e-Agricultural Marketing—What Are the Issues?” on October 27, 2006 in Lusaka.

### **BOX 8.5: A Checklist of Considerations for Designing an Effective, Sustainable ICT-Based Project to Support Farmer Organizations**

- What are the levels of literacy, mobile phone ownership, and willingness of farmer organization members to embrace new technology? Many smallholders cannot afford phones, do not know about SMS or voicemail, or cannot punch a message into a phone keypad.
- How well can farmers understand market information and use it to their advantage?
- What is the role of smallholder farmers’ organizations in this context? What capacity is required for them to be effective?
- How will the most vulnerable members of the organization be included? Some people might be too poor to pay for information or might live outside the range of mobile phone coverage. Women may be less likely to have access to a phone.
- What information is best disseminated by different media (SMS, ICT-enhanced training workshops, telecenters)?
- Do different categories of farmers need different information? Large-scale farmers have different interests than smallholders, but both may be members of the same organization.
- Are there transport links to the different markets? Information is of no use unless farmers can get their crops to the market of their choice.
- Can farmers store crops safely and without spoilage after harvest? Otherwise they are in no position to delay selling until prices are optimal. Market price information has little value here, so improved drying and storage facilities might need to go hand in hand with a market information system.
- What are the sources of information needed by farmers? They are likely to include research bodies, government extension services, news media, the Internet itself, other farmers, other farmer organizations, and private seed or input supply companies.
- How should information be sorted to be most useful for the recipient? SMS messages have 160-character limit, so it is a challenge to prioritize messages.
- Who will be responsible for selecting and sorting information, and how can quality control be maintained?
- How will the costs of the service be covered?
- What is the level of cooperation offered by mobile phone companies? How well might rival companies work together?
- What is the appropriate software? Is free open-source software such as FrontlineSMS the way forward?

Source: Authors.

### **INNOVATIVE PRACTICE SUMMARY** **Zambia's National Farmer Organization Develops SMS-Based Service**

ZNFU's messaging system is an easy-to-use service that announces prices via SMS to mobile phones and the web.<sup>8</sup> ZNFU introduced the system with support from the main mobile phone network provider in Zambia, several other local organizations, many farming cooperatives, the agribusiness chamber, and buyers and sellers. The mobile phone network provider organized the bulk messaging process to deliver the information to as many mobile phones as possible, and it offered several hundred half-price mobile phones to farmers. The Smallholder Enterprise and Marketing Program gave additional funding and technical support.

Starting with details of just 6 commodities in 2006, the system now deals with 14 commodities and sends 1,000 messages each month. Pamela Mulozi, the market/trade information administrator at ZNFU's head office in Lusaka, reported "a significant change in how farmers and traders are dealing with each other" and observed that traders "are now taking the farmers much more seriously as trading partners" (Goudappel 2009).

More than 200 buyers use the system, giving farmers a better choice as to where to sell their produce. Another measure of success is the fact that food processing businesses, government ministries, and banks regularly use the system to provide broader support to the country's agricultural sector.

Each commodity, trader, and district has a code. ZNFU supplies everyone using the system with a small information card with instructions and relevant codes and trains them how to use the system. Farmers wanting to know the price of a particular product simply type the code into a text message and send it to the specified number. The system sends back another text with the latest prices and the codes for the traders offering those prices. The farmer chooses a trader and sends the code in a second SMS to the system, which replies with the trader's full name, phone number, business address, and directions. The farmer can then contact the trader directly.

To make the information available to farmers without mobile phones and in areas lacking network coverage, ZNFU trains at least one farmer in every district to act as a contact farmer. Contact farmers, based in district offices, publish the commodity price and trader information that they get either via SMS or from the website and give it to extension officers. Every

week the extension officers display the prices and details of interested traders on posters in local information centers.

So far the system seems successful and popular with farmers. For instance, Grace, a farmer involved with the scheme, said, "The SMS system makes everything so much easier. You can check the market on your phone to find the 10 best prices in the district or even in another district if that works out better for the transport cost" (Goudappel 2009). Farmers coordinate their delivery times and organize a single location for traders to pick up goods in bulk, saving many individual farmers from traveling to the Lusaka market.

This arrangement saves money and gives farmers more time to work on the farm. Grace said, "Although we still pay for the costs of the SMS messages, we end up spending only 5,000 kwacha," (just over US\$ 1), adding, "It's a big saving but it also reduces a lot of the risk involved with travelling to the city every time" (Goudappel 2009).

Despite this initial success, which means that ZNFU would like to extend the trading system to more farmers, any immediate expansion is limited by the lack of funding. Hamusimbi Coillard of ZNFU observed, "We still have to work out how the system will pay for itself. . . . If we can use the SMS system to link up farmers and other small traders to the trucking companies, then both sides would benefit and we would gain more subscribers to the scheme" (Goudappel 2009). If another network operator, MTN, joins the scheme, coverage will reach more communities.

### **INNOVATIVE PRACTICE SUMMARY** **Burkina Faso Farmers Use ICTs to Share New Production, Processing, and Marketing Skills**

The Federation of Agricultural Producers of Sissili Province (FEPPASI)<sup>9</sup> (<http://www.feppasi.org/>) in south-central Burkina Faso was founded in 1998 and has about 12,000 members, a quarter of them women.<sup>10</sup> It began a project in 2003 called Sissili Vala Kori ("Sissili farmers' voice"), which focused on rural information and communication. Since 2005, FEPPASI, supported by the International Institute for Communication and Development (IICD), has been testing the potential of ICTs to train farmers.

FEPPASI now uses multimedia tools, such as digital photo and video cameras, to document the results of field trials and to create training materials. The FEPPASI headquarters in Léo and

8 This summary is based on Goudappel (2009) and personal communication with Pamela Mulozi, market/trade information administrator, ZNFU.

9 Fédération Provinciale des Professionnels Agricoles de la Sissili.  
10 This summary is based on information from Lenoir (2009), IICD (2010), and personal communication with Miep Lenoir, IICD.

one of its regional offices are connected to the Internet. Both locations function as information centers where members can use the computers. GPS is used to map farms, and a family farm database has been set up. Information and documents are stored on the Synology server (<http://www.synology.com>).

FEPPASI initially trained a group of 20 farmers to advise other farmers in their districts, where they were trusted more than advisors from the capital city. This initial group was also trained in basic ICT skills and how to use them to create training materials that are more persuasive. Korotimi Douamba, a former evaluation officer at FEPPASI, observed:

*Previously, people fell asleep during our training sessions. With the digital camera, we can show images of the development in the agricultural test fields. In our meetings with producers, these images allow us to make visual comparisons. We beam the images and discuss the causes of the successes and failures of the different fields. We also make videos of the farming techniques and show them during the training sessions.*

Translated by author from IICD 2010

Douamba added that it was difficult to convince farmers about crop varieties simply by telling them that their neighbors in the other village produced more per hectare, but now people can actually see the improvements. Images make it easier to explain certain topics to audiences, 80 percent of whom may be illiterate. FEPPASI's advisors have used videos, photos, and digital presentations to train about 2,500 farmers in new production and food processing methods, marketing skills, organic fertilizers, and sustainable management of natural resources.

Workshops are shorter but more effective, and farmers surveyed through anonymous questionnaires in 2006, 2007, and 2008 mentioned many benefits: "I have found contacts online to sell almonds and shea," said one; "I manage the production techniques to produce yellow and white maize," said another. A farmer who now processes yams into flour, couscous, and cake increased his income through marketing: "The products are better presented through the use of labels, and I sell more."<sup>11</sup> An impact study carried out by INERA,<sup>12</sup> the national agricultural research institute, revealed that, on average, agricultural production increased from 0.5 tons per hectare in 2003 to 4.5 tons in 2007.

Sissili farmers also use the Internet to develop techniques to select and improve seed from their best varieties. Producer Moumouni Niébié searched online and found a specialist

organization in Benin that taught him to produce seed yam from fragmenting yam roots. FEPPASI advisors also act as intermediaries between farmers and INERA, notifying them with digital photos of disease outbreaks.

In 2009, the dial-up connections were replaced by more expensive very small aperture terminal (VSAT) connections.<sup>13</sup> Costs are recovered by sharing the connection with other organizations nearby for a fee (20,000 CFA francs per month). This step, which has turned FEPPASI into an Internet provider, could move the organization away from its core objectives. FEPPASI has also expanded the telecenter at headquarters.

Several lessons can be drawn from this experience. Farmer-to-farmer approaches have proved successful in many parts of the world (AgriCord 2010). Farmers often are more prepared to trust information imparted by another smallholder than by an anonymous "expert," and ICTs offer a means to extend this principle. FEPPASI needed time to incorporate the technology, build skills, and discover how ICT tools could best suit members' interests. Networking with local ICT training partners and other organizations was also crucial, enabling FEPPASI to get technical advice and share ideas.

Although the farmer-trainers devised specific audiovisual content (based on local research and adapted to local conditions), they have no central storage system for these materials. It would be beneficial for these materials to be centrally available to colleagues within the organization or a wider audience online.

Success was not purely a result of technology. It sprang from the organization's clear aims and understanding of how ICTs might facilitate them, taking into account the importance of local trainers, locally developed content, local support, and the freedom to change objectives according to new insights. Financial support was only one part of the support IICD provided (the project cost € 101,000): The long-term partnership between IICD and FEPPASI, which gradually explored how ICTs could best strengthen the activities of the organization, was a more important factor. The program is sustainable in the sense that ICT is now integrated in the organization, the added value is clear, and the organization will continue to invest in ICT.

### **INNOVATIVE PRACTICE SUMMARY** **The SOUNONG Search Engine for Farmer Organizations in China**

A good example of how ICT enhances farmer organizations' access to knowledge comes from a project in China (the

11 Quoted material translated by author from IICD (2010).

12 Institut de l'Environnement et de Recherches Agricoles.

13 Very small aperture terminals, which are two-way satellite ground terminals offering better connectivity.

Construction and Popularization of Agriculture Info-Service System), where a priority is to make modern ICTs accessible and useful for farmers. The project, introduced in Anhui Province, has three main features: an Internet portal, information assistants, and information dissemination models. It targets specialized farmers' cooperatives, a primary force for agricultural development in China. The project is funded by the World Bank and implemented by the Hefei Institute of Physical Sciences of the Chinese Academy of Sciences.<sup>14</sup>

The Institute of Intelligent Machines developed an Internet search engine called SOUNONG to aggregate information from the Internet and provide it to farmers' cooperatives in a meaningful manner (figure 8.1). SOUNONG coordinates with China's governmental agricultural websites, which maintain high user rates and have more authority to promote information. This multilateral collaboration has helped raise the visibility of SOUNONG and its activities and also prevents overlap.

SOUNONG monitors over 7,000 websites per day, including nearly all of China's agricultural data. These sites contain information on prices of wholesale farm products, prices in 9,000+ markets, and prices for 20,000 types of agricultural products. Information is also retrieved from a number of databases, including those on climate, crop species, and pest and disease

diagnostics. Electronically generating a short list of agricultural information from this array of websites reduces the time spent collecting it manually. In 2009, 1,276 households were using the site—by 2010, that figure had almost doubled.

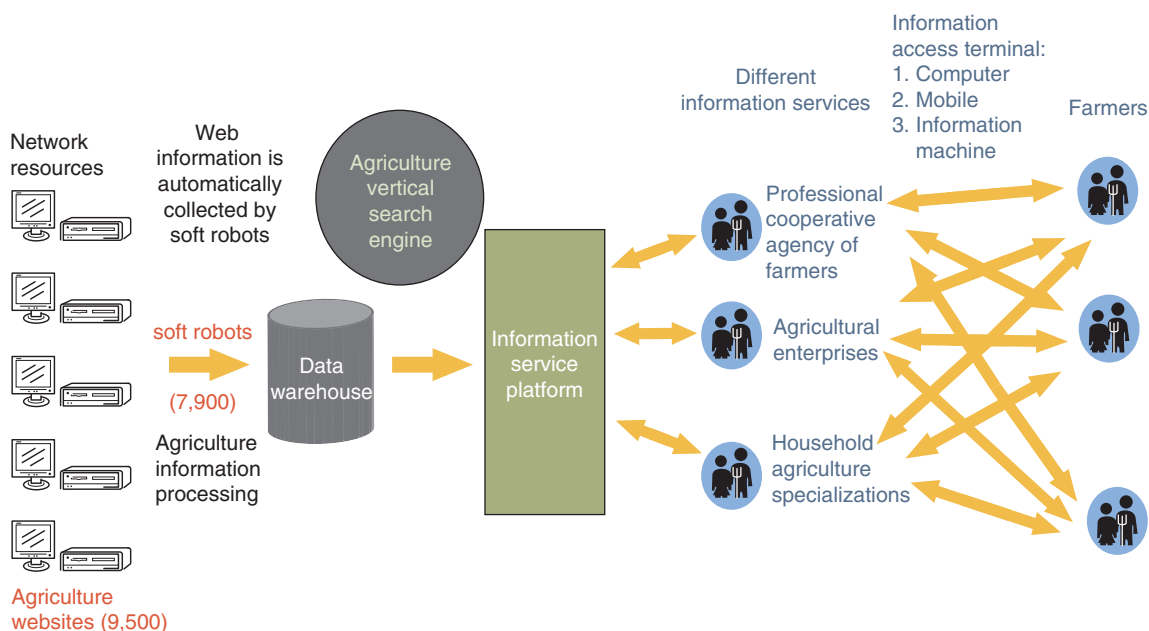
Once the website was launched, project leaders selected 38 farmer organizations to act as partners. The organizations were well established and had good management, which suggests that it may be critical for farmer groups to meet certain criteria to become involved in ICT for agricultural development.

A total of 76 information assistants, who are responsible for collecting information and disseminating it, as well as 541 farmer households, were trained to use computers to search, browse, download, and disseminate information through the Internet. As the project grew, over 1,000 members of cooperatives received ICT training.

Members of farmer organizations can access information from the SOUNONG site through computers, mobile phones, personal digital assistants (PDAs), and PDAs plus mobile phones. Depending on network connections, regional characteristics, and farm conditions, farmers can select the appropriate option for their local network capacities and skill level. All provide low-cost, easy access to the SOUNONG site. For members who may not have access to computers, mobile phones, or PDAs, cooperatives can also print information and recommended actions.

14 Information gathered from SOUNONG 2010, Institute of Intelligent Medicines.

**FIGURE 8.1:** Conceptual Technological Framework for the SOUNONG Search Engine



Source: Adapted from SOUNONG 2010, Institute of Intelligent Machines.



Surveys found the mobile phone option to be popular because of its timeliness and convenience. The mobile phone option is consumer friendly—farmers had both “push” and “pull” options. The computer option was also popular because users could browse for and select specific information. Network coverage is not a problem in rural Anhui Province, but the Internet remains more expensive than mobile phones and requires users to become adept at identifying irrelevant or misleading information.

Success stories are common. In 2010, farmers in Taihi Jinqiao Cooperative recognized that a number of their pigs had high fevers. The information assistant released the information onto SOUNONG. Veterinary experts diagnosed fatal swine high fever syndrome and provided control methods that prevented potential losses of 1,000,000 yuan (Y) for the farmer group.

Taihi Jinqiao extended sales of their local chicken breeds to poultry markets like Nanchang and Wuhan by using the SOUNONG website. Smaller cooperatives producing pork have used SOUNONG to reach major markets like Shanghai.

SOUNONG attracted additional cooperatives, entrepreneurs, and farmer households and led to the development of more specialized services for farmer organizations. Websites were developed to provide information for specific producer organizations; for example, the Agriculture Committee in Anhui Province formed an Anhui Farmers’ Specified Cooperative website (<http://www.ahhzs.com>). The Taihi County Government gave Y 24,000 to the Jinqiao

**IMAGE 8.4:** ICT Programs Like SOUNONG Helps Cooperatives Identify Livestock Disease



Source: Steve Harris, World Bank.

Cooperative to generate an online platform enabling more discussion and real-time information sharing between members.

The Anhui Fengyuan Agriculture Science and Technology Co. Ltd. was selected to monitor and evaluate the project and its development over time. The company continuously examines the practicality, effectiveness, degree of user satisfaction, and public welfare (the four main indicators) of the Construction and Popularization of Agriculture Info-Service System. A key lesson is that farmers require training to use the information they access appropriately. Those involved in the project note the challenges associated with introducing ideas and technologies that have major learning curves for users.

## **Topic Note 8.2: DAIRY COOPERATIVES LEAD THE WAY WITH COMPUTERIZED SYSTEMS TO IMPROVE ACCOUNTING, ADMINISTRATION, AND GOVERNANCE**

### **TRENDS AND ISSUES**

Computer systems have the potential to vastly improve the efficiency, governance, and accountability of farmer organizations (image 8.4). Dairy coops are considered the type of organization most likely to see clear benefits from computerized accounting systems, simply because of their numerous members and large volume of daily transactions. Even smaller coops benefit from computerizing their accounts, which leads to greater efficiency and transparency. Having financial and membership information always at hand helps management make better decisions, and using software to present financial information in graphical or diagrammatic form can make the information easier to understand.

Throughout the world, accounting in small companies is generally regarded as a “backroom” function that attracts little management interest or company investment. Management counts the cash in the till and requires no other financial information. Accounting is done only because the government requires accounts for taxation. Yet when “other people’s money” is involved in a business (like a cooperative), accounting becomes the only means to explain what happened with the money, to prove that transactions with members and clients are straightforward, and to create the trust that enables a cooperative to function.

Farmer organizations and cooperatives in the developing world are turning to computerized management systems, despite their cost and the challenges posed by infrastructure, for some or all of the following reasons:

- Better accounting and management increase efficiency, save time, and reduce mistakes. The more logical approach demanded by computerization means that procedures have to be improved, which leads to better overall administration.
- Information for control and management decisions is available instantly. Inventory control improves, and real-time information becomes available.
- Relations between members and management can be improved. Better services to members flow from more efficient administration. New and improved services to members mean that they are prepared to invest more in the society.
- The cooperative has more options for communication and information sharing. There may be opportunities to communicate beyond the organization, using e-mail, newsletters, websites, and information networks.
- Data are available to guide policy decisions.

Capacity is built within the organization as staff members learn new skills. The general lessons from these efforts are discussed next, followed by three innovative practice summaries. Two summaries describe contrasting approaches to the development of computerized accounting systems for cooperatives in India (dairy) and Kenya (dairy and coffee). The third shows how computers brought in for other purposes improved administrative efficiency in a women's shea butter cooperative in Mali.

### LESSONS LEARNED

The evidence to date suggests that computer systems can be adopted successfully to improve accounting, administration, and governance in cooperatives for staple commodities such as milk as well as export commodities such as coffee and shea butter, in peri-urban as well as remote rural areas. People with very low levels of literacy can benefit from and learn to use the systems, if they are designed with care and deliver tangible benefits (image 8.5).

Even so, the danger of widening the digital divide persists. The best potential clients for computerization are successful and relatively rich organizations with business-minded management, situated near a big city. Poor coops find it challenging to purchase computers, and distant ones do not have electricity.

Computerization has clear potential to make the governance of cooperatives more efficient, transparent, and fair. Even if

they do not necessarily understand the technology, cooperative members can see that the new systems work well. In dairy cooperatives, for example, computerized systems facilitate timely payments to farmers for their milk, together with clear records of all transactions (milk supplied and inputs bought). Where there is an automated milk collection system, it is operated by dairy coop personnel who are generally also farmers and members of the society. Milk is always weighed and tested, with few errors, and the data are displayed clearly on the testing equipment. The operation is quick and transparent. Farmers no longer worry that figures might be adjusted by unscrupulous staff.

Benefits to the cooperative societies are many, largely because computerized accounting is faster and more reliable. Computerized accounts are much quicker to audit and may even be displayed online for greater transparency. Coops need to employ fewer clerks, and daily accounts are available immediately at each milk collection center. Profit and loss calculations are easily done and the balance sheet is automatically updated. The various options for graphic display—using colored charts, for instance—make it easier for management and coop members to understand financial information.

In dairy systems, daily payment slips are printed for farmers and can be modified to include other pertinent information, such as reminders to inoculate cattle. When detailed milk

**IMAGE 8.5:** Many Enablers Are Needed to Ensure Coop Function



Source: Ray Wiltin, World Bank.

records are kept for each farmer, patterns in production can be discerned. Seasonal variations in quantity and fat content can be predicted, which is useful for the dairy, veterinary services, and cattle feed companies alike.

The quality of infrastructure and the resources available to maintain it are an issue with all ICTs. Computers need an electricity supply, with backup generators and uninterrupted power supply equipment to cope with failures if they are common (generators will add to the overall cost of installing a computer system). Power can be provided by solar panels where the climate is suitable.

The choice of technology also depends on whether a range of computer and training experts can be found within a reasonable distance of the coop offices and are able and willing to travel to the site. If a solar-powered computer system is set up in a remote area, for example, initial training and routine maintenance will almost certainly be done by staff from elsewhere. Coop administrative personnel must be confident that any subsequent problems will be dealt with speedily. This kind of response is unlikely if support services are sparse, do not exist, or the surrounding road network is poor.

Although there are real benefits for a farmer organization to have a simple computerized member and management information system, the organization can achieve far more if it also has Internet connectivity. Dialup connections are possible where telephone land lines are available. Mobile phone coverage is expanding, and another alternative is to use a small plug-in wireless adapter to connect to the Internet. Neither of these options is as fast as a broadband connection, and both are subject to lapses in service.

Supportive government policy and willingness on the part of government organizations to join partnerships are important enablers. For example, India's National Cooperative Development Corporation supports computer projects in the cooperative sector, including hardware, site preparation, system and application software, and training.<sup>15</sup> It has encouraged cooperatives from the primary level to the state and national levels to install computers and evolve effective management information systems. Lower-level (district and primary) coops must have a threshold turnover of Rupees (Rs) 1 crore (roughly US\$ 225,000) to qualify for assistance and must be financially sound and viable. This stipulation raises the issue touched on before—that only the more organized coops qualify for assistance, thereby widening the digital divide.

15 See [http://www.ncdc.in/Activities\\_files/Computerisation.htm](http://www.ncdc.in/Activities_files/Computerisation.htm).

Indirect government support can come from the educational system, because without skilled young people no one will be able to develop and maintain computer systems. For example, among Kenya's roughly 30,000 university graduates in 2008, only about 5,000 were considered suitable for employment in the ICT industry (World Bank 2010). This situation makes it all the more important for Kenya's Cooperative College to move forward with plans to train students in the CoopWorks software.

The independent nature of open-source software allows users to tailor it to their needs, and it can be a form of insurance against power issues—no single individual or group can control it, and users may be encouraged to cooperate. But this advantage is theoretical in the many cases where farmer organizations do not yet have the capacity to develop software themselves.

For long-term sustainability, the private sector probably should be involved in computerization projects. Success may thus depend to an extent on the willingness of entrepreneurs to risk capital. In India, the inventors of milk-testing equipment were prepared to lend it out for free so that dairy cooperatives could see the benefits. They also had the foresight to predict that illiterate farmers would accept the system and use it confidently. Success might also depend on creating a critical mass of users so that a business "ecosystem" can develop. This effort would include software development, support, marketing, and other network effects.

Finally, aside from modernizing their management information tools, cooperatives need to attract good management staff if they are to compete in the marketplace. A coop must decide how much it is prepared to spend on managerial capacity. Box 8.6 lists practical guidelines to help farmer organizations use computerized administration and management systems.

### **INNOVATIVE PRACTICE SUMMARY** **IT Tools for India's Dairy Industry**

With demand for milk in developing countries projected to double in the next 20 years, dairy cooperatives are crossing the digital divide. The need for computerized administrative systems is especially urgent in India, the world's largest milk producer.

Dairy cooperatives typically have thousands of members. The recording system at the collection point has to cope with the huge volume of members' daily transactions. Milk is highly perishable, especially in hot climates, and any delay in collection quickly leads to significant waste. Members often

**BOX 8.6: Considerations for Effectively, Sustainably Computerizing Farmer Organizations and Cooperatives**

- The organization's management and members will want a system that works, can be maintained, and is affordable. In small, cash-strapped cooperatives, it may be hard to persuade farmers that it is worth making the investment, because initial costs are high and benefits are not immediately apparent. It is broadly true that the bigger the institution, the more likely it is to afford the costs of computerization.
- How willing are management and members to invest money and time and to take a long view? In the early stages, manual and computerized systems must operate in parallel to make sure that data are not lost, and this procedure increases costs in the short term.
- Can coops make independent investment decisions and buy a computer system from a local provider on a commercial basis? Management might lack the skill to do this, and it might be hard to get loans for the investment.
- Which approach to software development—commercially licensed or free open-source software—is best? In practice, the cost of the software is likely to be only a small part of the overall cost of computerization, so this issue might be less important than others, such as technical support (see the next point).
- Is backup technical support available? Aside from requiring initial installation of the software and training in its use, the contract should require fully functioning accounting output. All operations, not just the machinery, must work and be reliable for a long time.
- Consider how the process will be funded and develop plans for sustainability.
- Training is very important. Enough trained operators must be on hand locally. This issue is particularly important, because those with computer skills tend to migrate to towns to work for companies at higher pay.
- Training should not focus simply on narrow technical issues; it needs to provide an insight into the wide-ranging possibilities of a fully functioning computerized system. Without this overview, coops may not use a system to its full capacity.
- Consider the possibility of offering on-the-job training. Internships might be offered by coops already using computer systems to staff from other coops. Perhaps such internships could be linked with formal technical education at the tertiary level.

Source: Authors.

buy inputs on credit from the cooperative. These purchases have to be reconciled before members can be paid for their milk. Each member needs a statement at the time of each monthly or twice-monthly payment to show (correctly) how it has been calculated. Payments must be timely and regular, because coop members depend on receiving their money on time. In manual accounting systems, a mountain of paperwork is done before issuing each payment. Computer accounting can produce up-to-date payment calculations and member statements at the click of a mouse.

The most advanced examples of computerization are to be found in the Indian dairy industry, where cooperative societies have a long history. India has more than 10 million dairy farmers, most of whom run small, marginal operations (Sharma and Yadav 2003). Although milk yields had quadrupled in the 40 years ending in 2001, time-consuming manual recording systems had changed little. Producers waited for hours before they could deliver their milk, much of which soured in the heat.

**Early Innovation**

A significant change occurred in 1996, when a small, private company (Akashganga–Shree Kamdhenu Electronics Private Ltd.) developed IT-based tools to automate milk collection at local dairy cooperatives and computerize the accounting system.<sup>16</sup> The company introduced simple technology to weigh milk, check its quality (fat content), and pay producers promptly. The basic model was an electronic weighing system, a milk analyzer, personal computer, and accounting and management software.<sup>17</sup>

16 This summary is based on information from the Akashganga website (<http://akashganga.in/WhatWeDo.htm> and <http://www.akashganga.in>), a presentation on the Amul Dairy Project by Vipul Vyas (<http://www.scribd.com/doc/16808474/Amul-Dairy-Project-by-Vipul-Vyas>), the UN-Habitat Best Practices Database (2006), and personal communication with Anil Epur.

17 Akashganga's current high-end system, selling for about US\$ 3,300, incorporates an electronic weighing system, a milk analyzer to test milk quality, a personal computer, and accounting and management software.

The new technology found a ready market, once initial mistrust was dispelled by active marketing by the company, which offered equipment to some coops free of charge. The free installations showed neighboring cooperatives the utility of automated collection centers. Intensive training was provided, and IT systems were maintained by motorcycle-borne service engineers who could quickly attend to any faults. Only when the coop was convinced of the system's worth did it have to pay. The application, initially built around a microprocessor but now usually involving computers, took a decade to diffuse on a large scale, but many Indian dairy cooperatives have now adopted computerized systems.

Developers of the Akashganga system claim that there is a viable market for companies that can design products suited to the needs of cooperatives in developing countries. The design of the equipment was carefully considered, not only to ensure that it was easy to use but to make the weighing equipment sufficiently robust to cope with the heat and dust of rural India. Price was an issue, as coops have to justify expenditures to members. The equipment to measure fat content was developed in India for less than one-quarter the cost of European designs.

### Subsequent Innovation

Village cooperatives have installed more than 3,000 computers to support automated milk collection.<sup>18</sup> Distributors are keen to computerize their operations, too, and to get e-mail connectivity for better communication with sales offices.

Currently no standard ICT solution is used throughout the industry. Software may be tailored by local vendors to a particular enterprise (the Mulkanoor Women's Dairy Cooperative has taken this route), or dairies may choose to use packages developed by software companies such as Tata Consultancy Services.<sup>19</sup> Member records can include not only information on milk delivered and inputs bought but information on veterinary care (dates for vaccination or artificial insemination, for instance) so that farmers can be prompted to take action.

Some dairies are now upgrading to enterprise resource planning (ERP), which encompasses the range of activities from the farmer or collection point to consumer sales (box 8.7).<sup>20</sup> One

### BOX 8.7: What Is ERP?

There are many different systems in a large company's "back office," including planning, manufacturing, distribution, shipping, and accounting. Enterprise resource planning (ERP) integrates these functions into a single system designed to serve the needs of each department within the enterprise. ERP is more of a methodology than a piece of software, although it does incorporate several software applications under a single, integrated interface.

Source: Sererra (<http://www.sererra.com/ERP>).

of these is the Gujarat Cooperative Milk Marketing Federation Ltd. (whose brand name is Amul). The federation collects over 10 million liters of milk every day and is co-owned by some 2.8 million milk producers. All zonal, regional, and member dairies are connected through VSATs to make information-sharing easier. Amul is in the process of web-enabling the entire supply chain so it can capture key information at the source.

The experience in India suggests that the private sector plays an important role in bringing computers to rural communities and that such activities can profit private enterprise and benefit users. Complementary support from the public sector was also valuable, including support from the National Cooperative Development Corporation (discussed earlier) and National Informatics Center. The National Informatics Center developed Lypsaa and openLypsaa software, a complete solution for dairy cooperative societies, used by more than 50 societies in Kerala. The center also developed a Linux-based portal for communication between the cooperative department and the cooperative societies.<sup>21</sup>

The key lesson is that change does not come quickly, even where all factors are conducive to development. Despite aggressive marketing by the inventors, clear benefits to users, and a supportive policy environment, it has taken a decade to automate dairy cooperatives on a large scale.

### INNOVATIVE PRACTICE SUMMARY

#### CoopWorks Dairy and Coffee, Open-Source Software Launched in Kenya

Kenya, one of the largest milk producers in Africa, sources more than 80 percent of its milk from roughly 800,000 small-scale dairy farmers (Seré 2010). These producers "represent

18 See the presentation on the Amul Dairy Project by Vipul Vyas, <http://www.scribd.com/doc/16808474/Amul-Dairy-Project-by-Vipul-Vyas>.

19 Anil Epur, personal communication.

20 A widely used, comprehensive ICT solution (based on the Microsoft DYNAMIX ERP package) currently costs around Rs 3.5 million. It can handle all activities for a daily throughput of up to 10,000 liters of milk (Anil Epur, personal communication).

21 See <http://news.kerala.nic.in/imgmulti.aspx?Id=E1328>; <http://in.linkedin.com/in/douglasdsilva>; <http://www.kerala.nic.in/Brochures/opensource.pdf>; <http://informatics.nic.in/archive/july2007.pdf>.

an emerging market opportunity for local and international agribusiness alike” (Seré 2010).

Despite this potential, the process of computerizing agricultural cooperatives and producer organizations is at an earlier stage in Kenya than in India. The impetus for computerization in Kenya has come not from private enterprise with government support, as in India, but as a joint push from FAO and donors (Kenya National Federation of Agricultural Producers 2008).<sup>22</sup>

Under a donor contract, the private sector developed a prototype management and member information system to improve the business efficiency and competitiveness of producer organizations and cooperatives in national, regional, and global markets. The system, known as CoopWorks, is open-source software available free of charge from <http://sourceforge.net/projects/coopworks/>.<sup>23</sup>

The software replicates all the accounting functions that would formerly have been done on paper, and it consists of a dozen or so modules (including member management, inventory, payroll, and others). It conforms to Kenyan government regulations and the stipulations of the International Systems Audit and Control Association, and the prototype was followed by improved versions (the latest being CoopWorks 5).

### The Dairy Experience

CoopWorks was first trialed at the Tulaga dairy coop in 2006. The system kept member records, including the amount of milk delivered and any purchases made by the member. Clerical officers found they could operate more efficiently, without duplicating work, and the task of preparing members’ monthly payments was much easier. Fewer errors in this important task meant that members’ confidence in the society improved.

At the start of the trial, Tulaga had 800 active members, which increased to 1,800. Daily milk intake more than tripled,

from 3,000 to 10,000 kilograms per day, and the average price paid to members increased from K Sh 10 per kilogram to K Sh 17. Coop sales also tripled in eight months. The milk customer base increased from two processors to five after many private buyers emerged.

After various revisions, CoopWorks Dairy version 2 was tested at Oloolaiser and Wamunyu dairies, where it was also well received. By 2010 at Tulaga, coop membership had reached 3,000, and milk production was 18,000 kilograms per day. Since the introduction of CoopWorks Dairy, Tulaga has used its own funds to increase the number of computers from 4 to 15 and uses all the capabilities (modules) of CoopWorks in its operations.

A group of donors and international organizations, together with the Cooperative College, the Cooperative Bank, and the Kenyan Ministry of Cooperatives, all see a need to computerize Kenya’s dairy coops on a larger scale and believe that it can be done. Electricity is available in most places, dairy coops are big enough to need quick accounting methods, and investors are ready to help. CoopAfrica has a project to involve all stakeholders, including the Cooperative Bank (providing loans) and the Cooperative College (training local service providers).

### The Coffee Experience

Given the applicability of the software to other products as well as milk, a Finnish-funded AgriCord-Agriterra project developed a version of CoopWorks for coffee (Kiplagat 2010). Smallholder coffee farmers were dissatisfied with the record keeping in coffee factories, where they suspected that unscrupulous clerks easily abused the paper-based system. The Kenya Coffee Producers Association (KCPA), which implements the project, was attracted by the lower cost of free open-source software.

The new system has two components, one to keep records within the society and one to provide information via a website and SMS. The system tracks all the steps from coffee collection to processing to sales. A member management feature holds data on individual members, and the accounting module has cash book registers, ledgers, and a payroll system. Other features include asset registration, loan management, inventory for the cooperative store, and report publication.

With the old manual data entry system, the cooperatives did not know how much coffee the milling factory would produce from their beans and could not predict the financial

22 Specifically, an FAO project funded by the Government of Finland in collaboration with Agriterra (the Netherlands) and Kenya National Federation of Agricultural Producers.

23 This summary is based on information from the Kenya National Federation of Agricultural Producers (2008); personal communication with Marcel Werner (Flametree Systems/Innovation Africa) in Kenya; the draft report of the Agriterra CoopWorks evaluation mission to Kenya (January 2011); “How Open Source Software Makes Money for Coffee Grower Cooperatives” (<http://www.selectstartcafe.com/2010/08/how-open-source-software-makes-money-for-coffee-grower-cooperatives-in-kenya-and-around-the-world-by-fighting-back-against-the-ghost-kilograms/>); and “Kenya Coffee Eyes a New Golden Era” (2011)).

return. The new system, however, can convert the weight of beans into an estimated value once it goes into the mill.

The software also monitors coffee deliveries based on each cooperative's tracking number. Once the coffee is sold, the payment is received into the system and credited to the appropriate cooperative's account. CoopWorks already produces a member statement of inputs bought on credit and the proceeds of deliveries sold to millers, which helps farmers better understand their costs and profits. KCPA is delivering coffee and input prices to members on their mobile phones via SMS and will soon link to mobile banking as well. The association has also promoted CoopWorks Coffee throughout the country (covering about 600,000 producers).

A weighing scale may be added to the system, although this option is relatively expensive (€ 1,000). Farmers are said to value automated scales, as they believe there is less scope for dishonesty behind the scenes, but their high cost has prevented most cooperatives from adopting them.<sup>24</sup>

### Preliminary Conclusions from the Open-Source Experience

The experience in Kenya suggests a different route to computerization. Free open-source software can be developed, customized, and upgraded, preventing the software provider from becoming too powerful within an organization.

Using free open-source software does not mean there are no costs to computerization, however. The software is available as a free download, but a cooperative still has to buy appropriate computing hardware and find resources to train staff to use the system.<sup>25</sup> The low costs and high adoptability of open-source software are insufficient to create critical mass and network effects if other related costs are too high.

A survey in late 2009 of 27 agricultural coops in Kenya suggested that many are aware of the potential benefits and would be keen to computerize if the process were less expensive (Flametree Systems Engineering Ltd. 2010). The two coops involved in the pilot project certainly felt the system to be a success (Nissila, Puhakainen, and Tanhua 2009).

A recent review found differences in the extent to which coops use CoopWorks' capabilities. Even when only some modules

were used, the effects of computerization were considerable, not least in creating a stronger bond between the coop and its members. The main challenge is to make users aware of the true scope of the software and the significant benefits that will accrue on top of the improvements in efficiency and transparency already experienced. Good ICT support at the local level is vital. Trainers or advisers must be proactive in demonstrating the "big picture" of what CoopWorks can do, rather than dealing only with narrow technical instruction or responding to queries from coop staff.<sup>26</sup>

Apart from highlighting capacity issues specific to CoopWorks, the experience has shown that further capacity building in modern information systems is required. To address this issue, Kenya's Cooperative College is adopting a proactive, innovative approach by planning to cover CoopWorks software in its curriculum. Even though the short timeframe of the pilot project was insufficient to develop capacity, it could be argued that without such support for development, dairy coops in Kenya might be even slower to computerize.

### INNOVATIVE PRACTICE SUMMARY ICTs Improve Marketing and Governance for Malian Coop

In some cases, the decision to use computers is not driven by a perceived need for better governance and administration, but better governance may be a welcome byproduct of the process. Women in southern Mali traditionally gather fruit from the shea tree (*Butyrospermum parkii*) to extract the seed for processing into cooking oil and a "butter" that is an effective skin moisturizer. In 1999, by forming a cooperative society, Coprokazan (<http://www.coprokazan.org>),<sup>27</sup> producers were able to get better prices for their products. All management and accounting procedures were done manually, and the society had only a few hundred members.

The move toward computerization came from a desire to produce effective training materials for coop members, raise the profile of the society, and enable its products to reach a wider market (Laureys, Marcilly, and Zongo 2010).<sup>28</sup> Working with the Malian Association for the Promotion of Youth and the IICD, Coprokazan assessed what sort of technology would be most useful. Zantiébougou, the town where the society was based, had no mains electricity, so all equipment

24 Draft report of Agriterra CoopWorks evaluation mission to Kenya, January 2011.

25 Successful free, open-source software (FOSS) initiatives are driven by large developer communities, including programmers, trainers, and advisors with commercial interests. The software will be free but related services may not be.

26 Draft report of Agriterra CoopWorks evaluation mission to Kenya, January 2011.

27 Coopérative des Productrices de beurre de Karité de Zantiébougou (Zantiébougou Shea Butter Producers' Cooperative).

28 See also <http://www.iicd.org/projects/mali-shea-butter-and-ict>.

had to be solar powered. This requirement limited the society to three computers, together with a printer, a projector, a small video camera, and some digital photo cameras.

With these, the coop planned to create visual training materials that would give clear information to all members, including those who could not read. Photographs showing the quality of nut suitable for processing would prevent women from harvesting and transporting poor-quality produce to the collection point only to have it rejected. Filmed demonstrations of new, more efficient processing methods would improve the quality as well as the quantity of shea butter.

These benefits materialized, and Coprokazan now has its own website showcasing its products. An unplanned benefit of computerization was that it enabled Coprokazan to improve governance and administration. Coop office personnel began using the computers for routine administration, and member records are now kept electronically. Staff members also learned to use PowerPoint to produce a visual overview of yearly accounts and activities to show at the Annual General Meeting, which has increased transparency and boosted members' confidence in the workings of the coop. This experience indicates the extent to which it can be challenging to neatly apportion the benefits of ICTs.

In the four years since ICTs were introduced, the coop's shea butter production and income have almost tripled. With its improved administrative capacity, the coop can now deal

with more members. From a base of fewer than 400 in 2006, the coop expected to have more than 1,100 members by the end of 2010. The coop plans to invest in GPS equipment as a step toward traceability and possible organic certification.

Among the more general lessons from Coprokazan's experience was the lesson that local languages make technology more accessible. Many poorer farmers, especially women, have poor reading and writing skills, even in their own language. It is unrealistic to expect them to master ICTs in a foreign language. Computer keyboards were adapted to make it easier for Coprokazan women to type in the local language.

Multimedia tools, on the other hand, often do not require high literacy levels. Women who could barely read or write learned to use digital cameras and create image-oriented narratives that could be used for training coop members.

Another unforeseen effect of bringing solar-powered computer equipment to a small town without electricity was that the coop offices became a magnet for nonmembers. Some people reportedly traveled more than 30 kilometers to type, print, and copy documents. The training room was used by other organizations for training sessions, and local schoolchildren were attracted to the premises to do their homework, as the building is one of very few in the area to have electric light. As mentioned in Topic Note 8.1 with regard to telecenters, it may be possible to levy a small charge for nonmembers and direct this revenue toward operating costs.

### **Topic Note 8.3: GIVING FARMERS A VOICE AND SHARING INFORMATION**

#### **TRENDS AND ISSUES**

In an increasingly interactive world, the idea of "having your say" is easier to put into practice. Internet-based discussion forums, blogs, and phone-in radio programs are part of the information exchange landscape. For farmers in the developing world, opportunities to be heard are few, but the situation is changing, largely as a result of the simple combination of local radio and mobile phones. (See Module 13 for more on citizen participation, exchange, and knowledge sharing.)

Farmer organizations have higher visibility than individual farmers. Many have a website and Internet connectivity to communicate with similar organizations or in regional forums. If farmers can raise issues with their local organizations, there is a chance that their concerns will be noted and

passed to higher levels, which suggests an important role for ICTs. Answers to technical problems raised by members need to reach farmers even in remote areas, which is currently best achieved by using broadcast media.

Given the lack of infrastructure typical of remote rural areas, it is a challenge for farmer groups to use ICTs for interactive communication. Radio and, to a lesser extent, television broadcasts reach wide audiences and can be understood by all, even those who cannot read or write, so they are currently the best ways of transferring information to individual farmers. When the makers of radio and television programs base their output on real issues raised by farmers themselves, farmers readily act on the information to improve their production methods. Farmer organizations thus have a



role in seeking the views of their members on which topics should be featured in the broadcast media.

The following sections highlight the effectiveness of radio and television in reaching a broad audience, including women. They show that the interactivity enabled by phone-in and SMS contributions brings true relevance and usefulness to farmers.

### **ICTs Make Radio Programming Less Expensive, More Inclusive**

Research in Uganda found that more than 90 percent of farmers interviewed owned a radio, but only 25 percent owned a mobile phone; none claimed access to a computer (Ferris, Engoru, and Kaganzi 2006). Radio is a popular medium that can draw a wide audience and operate in local languages. Like mobile phones and other ICTs, however, radio has issues related to access, such as who owns the radio, who chooses which programs to hear (men, women, elders), or whether programs are broadcast when listeners can actually listen. The innovation in radio is that programming is becoming more interactive, with phone-ins, live community forums, and radio diaries all finding a place in the schedules. SMS messages allow listeners to contribute cheaply and easily.

Radio is also becoming cheaper in the sense that the cost of setting up a radio station has fallen dramatically in recent years (AFRRI and FRI 2008). Recording equipment that only a decade ago would have cost thousands of dollars can now be bought for about US\$ 100 or less, and computers, the Internet, and mobile phones have brought down the cost of obtaining and storing information for broadcast. Research in 2008 reported that a microstation with a broadcast range of 2.5 kilometers had been set up in Mali for just US\$ 650.

The hope is that as radio becomes cheaper and more interactive, its programming can become much more locally relevant and inclusive. Efforts in this direction include Farm Radio International. This NGO partners with more than 350 radio broadcasters in almost 40 African countries to develop programming to help small-scale farmers improve their food security. Participatory Radio Campaigns, carefully planned broadcasts focusing on one farmer-selected issue at a time, feature farmers' participation and appear to make measurable differences to farmers' livelihoods (AFRRI and FRI 2009). (For more detail, see Module 6.)

In Kenya, the popular weekly program *Mali Shambani* ("wealth on the farm") (Mbogo 2008) offers advice on various technical and financial issues. Listeners are invited to call or text the program with specific questions. Surveys suggest that 80 percent

of listeners claim to have learned something new from the program, and half said they had put advice into practice. A typical hour-long program can attract up to 200 SMS messages, including contributions from neighboring Uganda and Tanzania.

Local radio stations are particularly well placed to develop programming to suit their audiences. When radio operates as a source of reliable information that works at the local level, it gives farmers an alternative to limited public agricultural extension services. In Kenya, Radio Mbaitu FM prioritizes content on fruit farming and horticulture and uses the Kikamba language to reach the farmers in its listening area. Radio Coro FM, broadcasting in Kikuyu, covers dairy farming, which is widespread in central Kenya. Radio Salaam uses Kiswahili to broadcast information on fisheries and fruit farming to coastal farmers, while Kass FM, a Kalenjin station, focuses on dairy and maize production.

In Zambia, the Research Into Use (RIU) program uses community radio as a way of promoting conservation agriculture. Programs follow different formats—prerecorded factual programs, drama programs, and phone-in or interactive programs—and are broadcast in either English or the local language.<sup>29</sup> Listeners particularly enjoy the vernacular, drama, and interactive output.

RIU Zambia has set up radio listeners' clubs that have trained over 1,000 people in recording skills and club coordination. Local farmers can now record their discussions, questions, and development concerns and send the recordings to their local radio station. A producer then edits the material and includes feedback from experts before the program is aired. These programs are also interactive at the point of broadcast; farmers phone in with further contributions.

Some of the radio stations are private, such as Sky FM in Monze District. The RIU program supports them to broadcast this content, and six radio dramas were sponsored by a local seed company. This suggests a route toward sustainability when RIU support comes to an end. Another possibility is shown by Namwianga Radio in Kalomo District, which is supported by the church. Community church services have apparently proved to be useful forums for smallholders to share experience with conservation agriculture.

### **Television Support to Agricultural Extension in India**

In 2005, the Doordarshan Broadcasting Corporation of India began a project to televise live, interactive, problem-solving

<sup>29</sup> Research Into Use (2011).

crop seminars as well as to set up various other initiatives to spread agricultural information.<sup>30</sup> Agricultural seminars are set up in a village, with farmers invited to bring diseased or pest-infested crop samples or other field problems to be discussed by a panel of experts. Possible solutions are then suggested.

Each seminar is filmed and broadcast live by Doordarshan through its provincial network (55 stations, using the appropriate local language) to share the information with farmers who live too far to attend in person. Daily bulletins on the latest market prices and weather forecasts also appear on television.

The broadcaster also offers a weekly live phone-in program to give experts' "instant solutions" to farmers' problems. In some areas of India, this televised exchange occurs twice a week. Information about the programs is shared on the Internet—television producers upload program details onto the portal. The website also features contact details to facilitate interaction between farmers and appropriate subject matter specialists, as well as opportunities for farmers to give feedback and offer suggestions.

### **A Voice in the National Debate on Agriculture in Mali**

An ambitious project in Sikasso Province aims to bring farmers, through their organizations, into the national agricultural policy debate. With the descriptive title "Let's Talk under the Palaver Tree," the project was set up by the Regional Committee for the Coordination of Rural People.<sup>31</sup> This regional committee was set up by a group of farmer cooperatives that hoped to represent the interests of Sikasso's farmers at the national and perhaps international level, within the West African rural network ROPPA.<sup>32</sup> Its aim, apart from offering market and technical training, is to act as a lobby group and to strengthen its members by encouraging information sharing. The regional committee now has a website with information about the project, lists of members, and news about events.

The project has a simple structure: Seven telecenters in towns and villages throughout the province form information hubs for a communication system based on Internet and local

radio. The system brings together 215 organizations with a total membership of more than a million people, of whom just over half are women. Local Committees for Coordination of Farmers' Organizations are the "anchor points" for each of the seven telecenters.

The Internet is used for e-mail, sharing documents, and searching for specific information useful to farmers. Ten local radio stations have signed contracts to broadcast agricultural information, and local radio also advertises activities relevant to farmers, such as workshops and meetings. There is also a regular radio broadcast on legal issues related to agriculture. Legal issues are also covered on the website, but the forum section is not yet operational.

So far all the telecenters are said to function well, apart from poor Internet connectivity in three of the hubs. Eighty farmers were trained in basic ICT skills, with a further 10–20 trained at each center. Direct project users are relatively few—the heads of the local farmer organizations and some individual producers—but they in turn share information with members. Farmers themselves are encouraged to raise issues for discussion at higher levels.

### **Farmers "Cluster" in the Caribbean**

The Caribbean Farmers Network (CaFAN) (<http://www.caribbeanfarmers.org/>) has found that farmers in the Caribbean region benefit from working in clusters that are created either geographically or thematically (Greene 2010). Farmers working in close proximity, or those who simply share an interest, set up a cluster to share technical information and experiences, plan for new market demands, and maximize their lobbying and bargaining power.

CaFAN encompasses 30 member organizations that together represent half a million farmers in 12 countries. Clusters cut across membership boundaries. Farmers use Skype, e-mail, and the CaFAN website to keep in touch. Text messages are also widely used to communicate directly with farmers, and it is hoped that production information will soon be sent by SMS.

CaFAN claims that fostering connections, sharing information, and training farmers puts farmers in a stronger position to respond to the perennial problems of the agricultural sector. They say that collective action can give better access to important resources (agricultural inputs, credit, transport, information) and can reduce financial risk. Pooling resources and collective marketing reduces the high transaction costs incurred by farmers acting alone: Operating as part of a group is simply more efficient.

30 "Mass Media Support to Agricultural Extension," ICT for Development, <http://www.comminit.com/en/node/133865/307>, accessed May 2011.

31 See <http://www.iicd.org/projects/mali-jefako-gelekan>.

32 Réseau des Organisations Paysannes et des Producteurs Agricoles de l'Afrique de l'Ouest (Network of Farmers' and Agricultural Producers' Organisations of West Africa).

### The ZNFU Discussion Forum

ZNFU reports more than 10,000 hits a month to its website (<http://www.znfu.org.zm/>). New topics are introduced to the discussion forum as a means of encouraging farmers to participate and share their experience related to particular issues. Current threads include the state of feeder roads in rural areas, price expectations for the maize crop, and tariffs charged by Zesco (the national electricity supplier). Members are invited to make suggestions to be included in ZNFU's submission of proposals relevant to agriculture in the national budget. The "How Do I" section for technical questions is divided by subject and includes farm and land, equipment, livestock, and employment.

Despite its welcome and advanced features, this online forum still has low participation, because most farmers do not have computers, Internet access, typing skills, or great proficiency in English. There are only a few posts and comments on the forum—some discussion categories are empty, and several of the other posts are more than six months old. At this stage, the ZNFU website appears much more useful to large-scale farmers than to the smallholders who form the majority of those working in agriculture in Zambia.

### LESSONS LEARNED

There is much to gain but much to be done in giving farmers a voice. Rural areas lag behind towns and cities in the infrastructure needed for online connectivity and access to blogs or Internet discussion forums. Many farmer organizations are situated within reach of electricity and the Internet, however, so they are able to set up websites to raise their profile and market possibilities. Their online forums offer a space for those few farmers with Internet access to share information or raise concerns to be aired more widely.

Considering the current state of infrastructure in much of the developing world, it is realistic to expect the uptake of ICTs to give farmers a stronger voice at the organizational rather than individual level. Giving smallholder farmers a stronger political voice, for example, can be done by encouraging them to join an organization or cooperative. If individual farmers can reach their representative organizations better, these organizations can effectively represent farmers at the local, regional, national, and international levels. The best way for individual farmers to be heard at present is via local radio stations.

The visual nature of television makes it particularly valuable for practical demonstrations of good agricultural practice. Overall, though, radio seems more useful than television as a

discussion forum, given the ubiquity of radio ownership and access. Radio producers are now skilled in presenting information in memorable ways, and radio programs are more interactive, owing to contributions made through mobile phones. Listeners' clubs in Zambia and Niger show that oral communication is very popular.

Technological developments can be seen simply as extensions of a very human need. These developments indicate that there is an argument for recommending that governments and donors should strengthen the capability of farmer organizations to contribute to radio programming. The credibility and transparency of farmer organizations would improve if problems and achievements were discussed openly on local radio, with members' comments being welcomed on air. Any issue related to the organization could be raised.

### IMAGE 8.6: Women Speak About the Livelihood Challenges They Face on the Radio



Source: Ami Vitale, World Bank.

Independent community radio is relatively new in most African countries, however. Even a decade ago, the only programs offered were from publicly funded state radio. A study of the effectiveness of the Participatory Radio Campaigns tentatively concluded that participatory farm radio by itself, without any other intervention, has a strong impact and is a highly cost-effective strategy for helping farmers learn about and adopt new approaches to farming (AFFRI and FRI 2009).

A recent study into the economics of rural radio, a hitherto unexplored subject, points out that the costs of programming depend on the level of interactivity of the program format, the accessibility of additional resources to produce specialized programs, and the type of station involved (AFFRI and FRI 2009). Community stations tended to invest more resources in interactive programming with community involvement and

less on in-studio formats. The cost of a reporter in the field (a common format for agriculture reporting) was about US\$ 300 per program for a commercial station in Uganda and just over US\$ 100 per program for a community station in Malawi.

Educational farm radio must compete for airtime with less expensive and popular items such as music and evangelism, but interactive programs with farmers—phone-in shows, field interviews, listening groups, and talk shows with local experts—can be popular enough to compete. Among the radio stations examined, the average cost of rural production ranged from just over US\$ 100 for a phone-in show to US\$ 300 to record and air a village debate. An investment of US\$ 500 per week (US\$ 26,000 per year) would therefore finance the production and broadcast of 3–6 hours per week of interactive farm radio programming. Radio broadcasting requires an enabling policy framework under which local radio stations can flourish without excessive regulation. Many African countries lacked such a framework until recently, so commercial and community radio stations are still relatively new. Many countries have issues related to freedom of expression. For instance, proposed amendments to the Zambian constitution included scrapping an article on freedom of speech in favor of one providing penalties for false statements. This amendment is of major concern to the many privately sponsored and civil society–sponsored local radio stations. Another example is Ethiopia, where community radio (whether run by the private sector or civil society) is not fully liberalized.

Effective radio programs depended heavily on partnerships, both with radio broadcasters, individual farmers, and agriculture experts. For example, close cooperation with the Indian Department of Agriculture has been necessary to support the Doordarshan Broadcasting Corporation’s live crop seminars. Villages are chosen in consultation with the department, and the experts who deal with the farmers’ questions come from the agriculture department of the nearest university. Where possible, the Department of Agriculture sets up an exhibition in tandem with each broadcast to offer farmers additional information about crop varieties and new technology.

For farmer organizations wishing to set up a website, with or without a discussion forum, the question of design can be fraught with difficulties. Since bandwidth is expensive—expressed as a percentage of average annual income, the cost of an Internet connection in 2003 was more than 100 percent in much of Africa and was from 10 to 50 percent in much of Asia and Latin America—it is unlikely to be increased quickly. Given that the biggest factor in user satisfaction is the speed of response, it makes sense to design websites

### **BOX 8.8: Considerations for Effectively, Sustainably Enabling Farmers to Share Information and Gain a Greater Voice in the Agricultural Sector**

- How many members of the farmer organization can realistically benefit, given local infrastructure? This question favors radio broadcasts over Internet discussion forums and similar technologies.
- What resources are available to the farmer organization, including basic infrastructure and financial and human resources?
- Will radio broadcasts be done in the form of “community” radio, or will they be part of a commercial local radio station?
- What is the best way to support the process to ensure that it can become self-sustaining? Consider whether radio broadcasts should be regarded as a significant public good that justifies long-term public support.
- When setting up a website, determine how complex it will be. The level of complexity will depend on its intended purpose. Is it simply intended to raise the profile of an organization and provide contact details, or does it need to be used interactively by buyers or those seeking information?

*Source: Authors.*

for prevailing conditions. See box 8.8 for additional considerations in designing and implementing ICT interventions to increase farmers’ voice.

### **INNOVATIVE PRACTICE SUMMARY** **Community Listeners’ Clubs Empower Social Networks in Rural Niger**

Since July 2009, 300 community listeners’ clubs (200 all-women, 89 all-men, and 11 mixed clubs) have been established in villages of southern Niger.<sup>33</sup> Involving more than 6,000 women and men, together with nine community radio stations, the Listeners’ Clubs Project breaks the isolation of rural populations, especially women. It does this by offering access to information and communication and by encouraging people to join discussions on development issues. The project is led by FAO, via the Dimitra Project, and cofinanced with

<sup>33</sup> This section is based on information from FAO’s *Dimitra Newsletter*, issues 17, 18, and 19, available at <http://www.fao.org/dimitra/dimitra-publications/newsletter/en/>.

UN agencies and the Canadian Development Corporation. It is implemented by an NGO.

The community listeners' clubs are groups of villagers who have been trained and organized through literacy training centers to identify and discuss their information needs and development priorities. Whenever a group finds a topic that they feel deserves attention, they contact a community radio to record club members' views on the subject. These views are then broadcast, prompting immediate responses, opinions, and suggestions sent by mobile phone from other listeners. The clubs have already discussed a wide range of topics, including food security, agricultural inputs, plant and animal health, and policy issues such as land access and decentralization. Debating and listening to radio programs gives the participants knowledge, allows them to share their experience, and reinforces self-confidence.

The project has also improved rural populations' knowledge of new technologies. At the outset each club was given a solar-and-crank-powered radio and mobile phones fitted with solar chargers, but the project was so popular that clubs were soon given extra mobile phones. These phones were linked up in a network known as a "fleet," which enables cost-free communication at any time between the clubs and radio stations.

These mobile phones are now also used to pass wide-ranging information between villages—such as forthcoming social events or the price of agricultural produce and livestock—or to offer products for sale. The telephones in the fleet also serve as public telephones, allowing private calls to be made for a small charge. For women, the telephones have helped create a social network, enabling them to communicate with other women they have never met and to exchange information beyond the topics covered by the clubs.

The enthusiasm for the listeners' clubs has exceeded all expectations. Preliminary data indicate that women have gained self-confidence, good practices have been shared, and even sensitive subjects such as HIV-AIDS have been discussed. Club members have realized that their knowledge and opinions have a value and that their voices matter.

### **INNOVATIVE PRACTICE SUMMARY** **Through Radio and Television, Thai Bank Gives Rural Voices a Wider Audience**

The Bank for Agriculture and Agricultural Cooperatives (BAAC) is a large government institution with 14,000 staff covering

800 branches and field offices throughout Thailand.<sup>34</sup> It sees public interest in promoting agriculture, and its radio and television programs link farmers with the outside world. Farmer organizations discuss issues relevant to their members.

As well as radio programs produced from its provincial offices, BAAC broadcasts various television programs that focus on agriculture. For instance, "The Villagers' Stage" is broadcast free every week. Aimed at farmers, farmer organizations, agricultural cooperatives, and the general public, it shows the rural way of life and presents the voice of village dwellers to the wider community. A reality program called "My Little Farm Project" appears on cable television daily. Particularly "hot" issues are covered on the "Thai Agricultural Heart Program" on free television every weekday. That program presents Thai agricultural students as they learn about farming processes, project management, and financial issues.

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## SECTION 3

### Assessing Markets and Value Chains





## Module 9: **STRENGTHENING AGRICULTURAL MARKETING WITH ICT**

*GRAHAME DIXIE (World Bank) and NITHYA JAYARAMAN (Consultant)*

### IN THIS MODULE

**Overview.** A growing body of evidence suggests that market information services, especially those based on mobile phones, reduce asymmetries of information between traders and producers, reduce transaction costs, enable farmers to purchase inputs, and enhance farmers' ability to fine-tune production strategies to match the accelerating rates of change in consumer demand and marketing channels. The latent utility of the technology is still being discovered, and the scale of its impact is still being understood. It is difficult to anticipate the eventual balance between privately run agricultural information services and government services, but it is very likely that the optimum configuration could involve some kind of public-private arrangement.

**Topic Note 9.1: Mobile Phones as a Marketing Tool.** Farmers use mobile phones to build a network of contacts and draw on this wider experience and expertise to obtain critical information more rapidly. Essentially the mobile phone, its special applications, and the Internet (although to a lesser extent currently) are becoming management tools for farmers, specifically in relation to marketing. Greater access to information seems to help farmers make better decisions around transportation and logistics, price and location, supply and demand, diversification of their product base, and access to inputs.

**Topic Note 9.2: ICTs Improve Logistics, Lower Transaction Costs.** Information communication technologies (ICTs) improve logistics and reduce transaction costs by improving supply-chain management. The benefits largely reside with traders, so the key question for development practitioners is how to design ICT interventions that enable producers to improve their returns and/or help urban consumers to buy food at lower prices. Combined investments in roads, telephone communications, and electricity have a greater aggregate benefit compared to separate investments.

- **In South Asia, Mobile Phones Amplify Investments in Extension and Infrastructure to Bring Farmers to Markets**
- **Across Africa, Mobiles Ease Market Logistics**

**Topic Note 9.3: ICTs Facilitate Market Research.** Market information strengthens farmers' position in their day-to-day trading and, over time, market intelligence enables them to focus on satisfying consumers' and buyers' demands and on developing relationships with stakeholders in the next stage of the value chain. The key development challenge lies in assembling and disseminating this information in a timely manner, not just to traders or larger-scale farmers but also to smallholders.

- **Evidence of the Impact of Immediate Market Information in Asia and Africa**
- **Web Portals Offer the Big Picture on Markets in Africa, Europe, and Asia**

**Topic Note 9.4: ICTs Facilitate Access to and Delivery of Inputs.** ICTs can enable farmers to make more informed decisions about which inputs are better or cheaper to buy, when and where to best obtain them, and how to use them. ICTs can also ensure that subsidized inputs are sold to the intended beneficiaries.

- **Agribusiness Advises India's Farmers through e-Choupal Kiosks**
- **Zambian Farmers Buy Subsidized Inputs via Mobile Phone**

## OVERVIEW

One of the best definitions of marketing is that “marketing involves finding out what your customer wants and supplying it at a profit.” Probed more deeply, this deceptively simple sentence manages to encompass most facets of marketing. It is also a convenient structure around which to explain the expanding role of ICT in strengthening agricultural marketing.

The phrase “finding out what your customer wants” emphasizes the role of communications in agricultural marketing. It encompasses two kinds of information: (1) the immediate information required on the market’s demand for specific volumes and quality of agricultural products and (2) the longer-term information on market trends (referred to here as “market intelligence”) required to make future plans for the farm. ICTs, especially mobile phones, facilitate the provision of both types of information. ICTs are used for real-time market research to obtain current information and help users gradually accumulate market knowledge and insight.

“Supply” emphasizes the critical role of transport and logistics in moving products efficiently and effectively from rural production areas to consumption points, which increasingly are located in distant urban markets. The management of supply chains—the aggregation of product, organization of transport, and consolidation of loads—is increasingly improving through the use of ICTs.

The phrase “at a profit” has as a subtext the multiple issues surrounding the reduction of costs and improvement of prices. Reducing costs can involve, for example, reducing transaction costs, reducing losses following the harvest, gaining better access to cheaper inputs, and increasing productivity for an overall reduction in the unit costs of production. Improving prices can involve, for example, gaining a stronger negotiating position, exploring alternative markets, or making better decisions on where and when to sell product.

This module begins with an overview of the need for and impact of ICTs in agricultural marketing, especially from the perspectives of producers, consumers, and traders. The overview concludes by reviewing lessons and envisaging future developments in ICTs for agricultural marketing, suggesting potential policy changes and active interventions to improve their utility. (Note that although mobile phones feature significantly in the discussion, the emphasis is on their contribution to agricultural marketing. For a comprehensive discussion of mobile phones in agriculture, see Module 3.)

The second major part of this module consists of four topic notes that drill deeper into the role of ICTs in agricultural

marketing, focusing on lessons from the field. The main themes include: mobile phones as a marketing tool (Topic Note 9.1); evidence that ICT is changing logistics and transaction costs (Topic Note 9.2); the use of ICTs for market research (both for acquiring immediate market information and acquiring market intelligence over time) (Topic Note 9.3); and the use of ICTs to make input supply and use more effective (Topic Note 9.4).

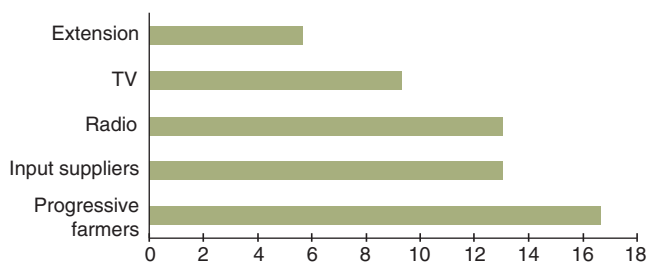
## Farmers’ Changing Information Needs and Sources

Studies of farmers’ information needs paint a mixed picture. Information needs differ significantly between countries and within countries for farmers producing different products. Farmers differ in their perceptions of the information they require (as revealed by market research) and in their priorities when they come to access information. The primary message underlying these disparities appears to be that farmers require a package of information and that their needs and priorities change throughout the production cycle.

Farmers’ information sources outside their immediate network have not always been reliable, but the situation is changing (box 9.1). Very often farmers’ primary source of information continues to be progressive farmers (figure 9.1 presents an example from India). Farmers give more credibility to information provided by other farmers considered to have a similar status and cultural profile.

According to market research by a private company in India, farmers’ information priorities include accurate local weather forecasts, technical information sequenced according to the stage in the crop cycle, data on the costs of production, and market supply and price information. These priorities shift during the production cycle—for example, market information is of little interest until the start of the harvest. In practice, when a subscription-based agricultural information service was rolled out, farmers claimed that the market news service was the most valuable.

**FIGURE 9.1: Percentage of Farmers Relying on a Given Information Source, India**



Source: Mittal, Gandhi, and Tripathi 2010.

**BOX 9.1: Changing Sources of Information for Farmers**

A number of initiatives by governments aim to provide market price services, driven by the view that greater price transparency is a public good. Price has been disseminated in many ways—chalked on notice boards, broadcast by local radio stations, published in newspapers, and (more recently) posted on websites. The information on these websites is confined mainly to product standards and specifications as well as market studies—particularly of external markets but increasingly of local value chains—including databases of contacts such as buyers, traders, agricultural processors, and input suppliers. To the extent that these sites become more accessible, their usefulness could increase, but at present they are out of reach for most rural people.

Government-run market information services have been criticized because their poor accuracy and lack of timeliness have resulted in little immediate economic impact. Public market information systems collect, analyze, and disseminate information. They are generally considered to carry out the price analysis satisfactorily. There are weaknesses in price gathering, as there are few incentives for accuracy or for working outside office hours. The major criticism has been that the information does not reach farmers on time, if at all.

Mobile phone applications are changing farmers' sources of market information. Agricultural applications support logistics with graphical presentations of available supplies and methods for traders to upload price and supply information directly. They facilitate marketing by linking buyers and sellers.

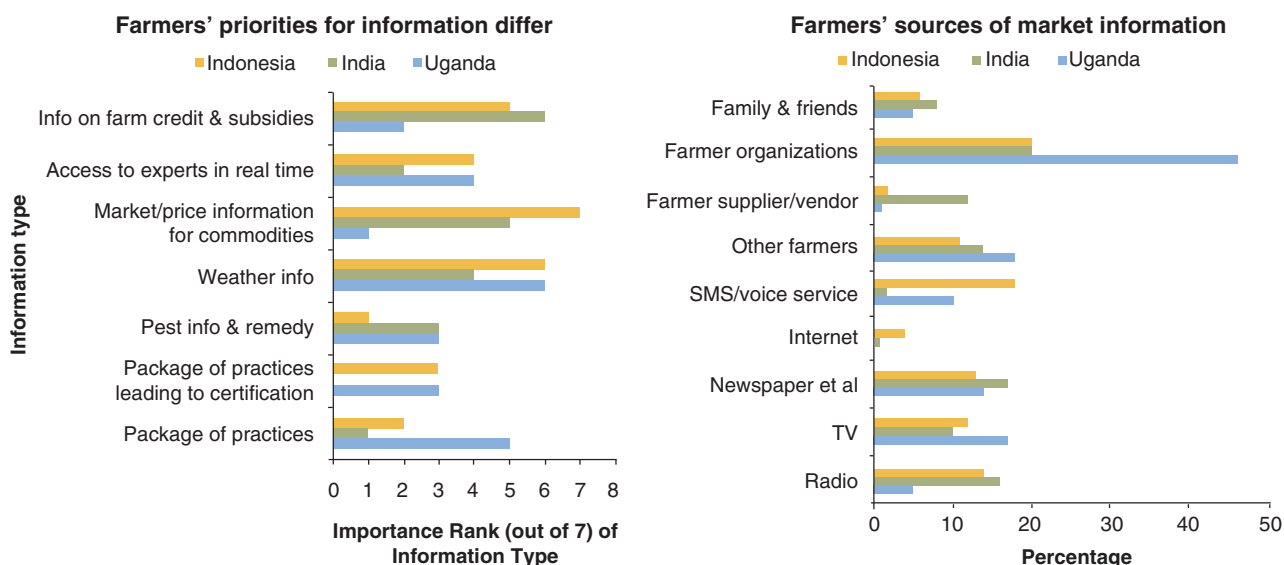
Private companies have started to either sell subscription-based information services or to use price information as a means of promoting other products to farmers—most notably to sell mobile phone services (rural markets being among the few unsaturated markets for mobile phone services) or inputs (particularly fertilizer). These services generally rely on local-language text messages to farmers' phones. In the main, the information has been well received by farming clients, with good reports on its quality, accuracy, and timeliness and positive evaluations of its impact.

Source: Authors.

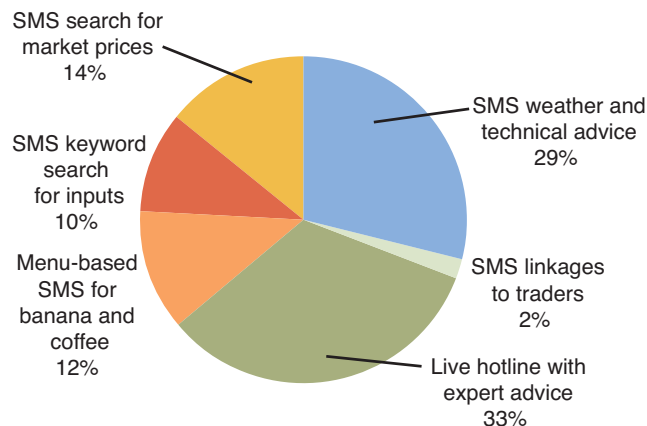
Through examples from India, Indonesia, and Uganda, figure 9.2 illustrates how farmers' information priorities and sources of information can differ. It is worth bearing in mind that Ugandan farmers mainly supply commodities

like coffee, whereas the Indian farmers are specialized apple producers from Kashmir. For market information, these farmers rely very little on the Internet but turn to multiple other sources, including farmer organizations,

**FIGURE 9.2: Farmers' Differing Information Priorities and Sources of Market Information in Indonesia, India, and Uganda**



Source: Kumar n.d.

**FIGURE 9.3:** Ugandan Farmers' Use of Voice- and SMS-Based Agricultural Information Services

Source: Kumar n.d.

other farmers, newspapers, radio, TV, and short messaging service (SMS) and voice services.

Some sense of farmers' actual demand for information services can be gained from figure 9.3, which compares farmers' use of voice and SMS delivery mechanisms in Uganda. Technical advice was the most popular agricultural information service, provided via phone-in hotlines, followed by SMS-based technical and weather advice, with SMS-based market price services coming third.

### LESSONS AND FUTURE DEVELOPMENTS

Quantitative evidence is increasingly available on how market information affects prices paid to farmers (table 9.1). The results are generally positive in terms of farmers' income and prices. There is some evidence that consumer prices can be lowered; it is also clear that traders who have access to ICT and mobile phones can raise their margins.

**TABLE 9.1:** Summary of ICT's Impact on Farmers' Prices and Incomes, Traders' Margins, and Prices to Consumers

LOCATION, PRODUCT, MEDIUM (STUDY AUTHORS)	FARMER	TRADER	CONSUMER	COMMENTS
Uganda, maize, radio (Svensson and Yanagizawa 2009)	+ 15%			Increase in price paid to farmers considered to be due to farmers' improved bargaining power
Peru, range of enterprises, public phones (Chong, Galdo, and Torero 2005)	+ 13%			Increases in farm income, but higher for nonfarm enterprises
India (West Bengal), potatoes, SMS (M. Torero, IFPRI, pers. comm.)	+ 19%			Yet to be published, but showed information to be important both in the form of SMS and as a price ticker board in markets
Philippines, range of crops, mobile phones (Labonne and Chase 2009)	+ 11–17%			Effect on income among commercial as opposed to subsistence farmers, plus perceived increase in producers' trust of traders
India (Madhya Pradesh), soybeans, web-based e-Choupal (Goyal 2008)	+ 1–5% (average: 1.6%)			Transfer of margin from traders to farmers, effect seen shortly after e-Choupal established
Sri Lanka, vegetables, SMS (Lokanathan and de Silva, pers. comm.)	+ 23.4%			Appreciable price advantage over control over time, plus benefits such as increased interaction with traders and exploring alternative crop options
India (Maharashtra), range of products, SMS (Fafchamps and Minten n.d.)	No significant effect			In this one-year study, quantitative analysis did not show any overall price benefit, but this finding is thought to be due to sales in state by auction; price benefits of 9% were observed with farm-gate sales and younger farmers
Morocco, range of crops, mobile phone (Ilahiane 2007)	+ 21%			Small sample showed usual behavioral changes; higher-value enterprises took a more pro-active approach to marketing via mobile phone
India (Kerala), fisheries, mobile phones (Jensen 2007)	+ 8%		–4%	Outlier in the sense that fish catches are highly variable and fishermen have their own boat transport
Uganda, range of crops, SMS and radio (Ferris, Engoru, and Kaganzi 2008)	Bananas + 36% Beans + 16.5% Maize + 17% Coffee + 19%			Awareness of market conditions and prices offers more active farmers opportunities for economic gain
Niger, grains, mobile phones (Aker 2008)		+ 29%	–3 to –4.5%	Traders increased margin by securing higher prices through greater capacity to search out better opportunities
Ghana, traders, mobile phones (Egyir, Al-Hassan, and Abakah 2010)		+ 36		Traders using mobile phones tended to sell at higher prices but also tended to be larger-scale traders than nonusers
Kenya wholesale traders, mobile phones (Okello 2010)		+ 57%		Improved trader margin through combination of cheaper buying prices and higher sale price

Source: Authors.

The scale of the effect on farmers' prices appears to depend on a number of factors, including:

- **The effectiveness** of the informal market information networks that already exist.
- **The stability** of the price structure—for example, whether the government controls prices for a staple crop or whether fixed contract pricing is widely used.
- **How the product is sold**—for example, ICTs may have a greater effect where negotiation is part of the sales process and a lesser effect when sales are by auction.
- **The type of product being marketed.** Circumstantial evidence suggests that market information systems have a greater effect on prices of higher-value, less-perishable products such as onions, potatoes, and pulses and a lesser effect on prices of extremely perishable products such as leaf salad. (For an exception, see “Remote farmers with perishable crops” in this module.)

By all indications, the phone—especially the mobile phone—is the most powerful marketing tool available to farmers and traders. The latent utility of the technology is still being discovered, and the scale of its impact is still being understood. Even so, the studies reviewed throughout this module indicate the phone's potential for reducing asymmetries of information between traders and producers, lowering transaction costs, and enhancing farmers' ability to fine-tune their production strategies to match the accelerating rates of change in consumer demand and marketing channels.

It remains unclear whether market information services can be delivered on a financially sustainable basis by the private sector or whether they can ever be delivered efficiently and effectively by the public sector, given its history of gathering inaccurate data and disseminating it badly. The private sector is finding it difficult to develop a working business model to charge farmers for agricultural information and market services delivered through ICTs. Some governments are interested in purchasing SMS-based agricultural information services, either to empower their field extension officers or to provide holistic agricultural information services directly to farmers. The content can consist of technical, marketing, weather, costing, pest, and disease alerts as well as information on government schemes. SMS-based services are likely to cost considerably less than sending out mobile extension officers and be more accessible than Internet-based services (box 9.2).

In the long run it is difficult to anticipate the eventual balance between privately run agricultural information services and government services. It is very likely that the optimum configuration could involve some kind of public-private arrangement.

For example, the collection and analysis of information could be outsourced to the private sector, which could use such a platform to create additional value-added services for the network of businesses and institutions that support the farming sector. Another option is for the agricultural department to create a database of farming clients and negotiate lower SMS costs. This platform can be used to deliver a fast, targeted, and holistic package of information services consisting of public-good information and also private-sector messages to the farming community. Such a service has the potential of creating a cadre of smaller-scale commercial farmers, who will be better adapted to changing agricultural markets, trained in the use of modern information systems, and able to access services and receive advice via their mobile phones.

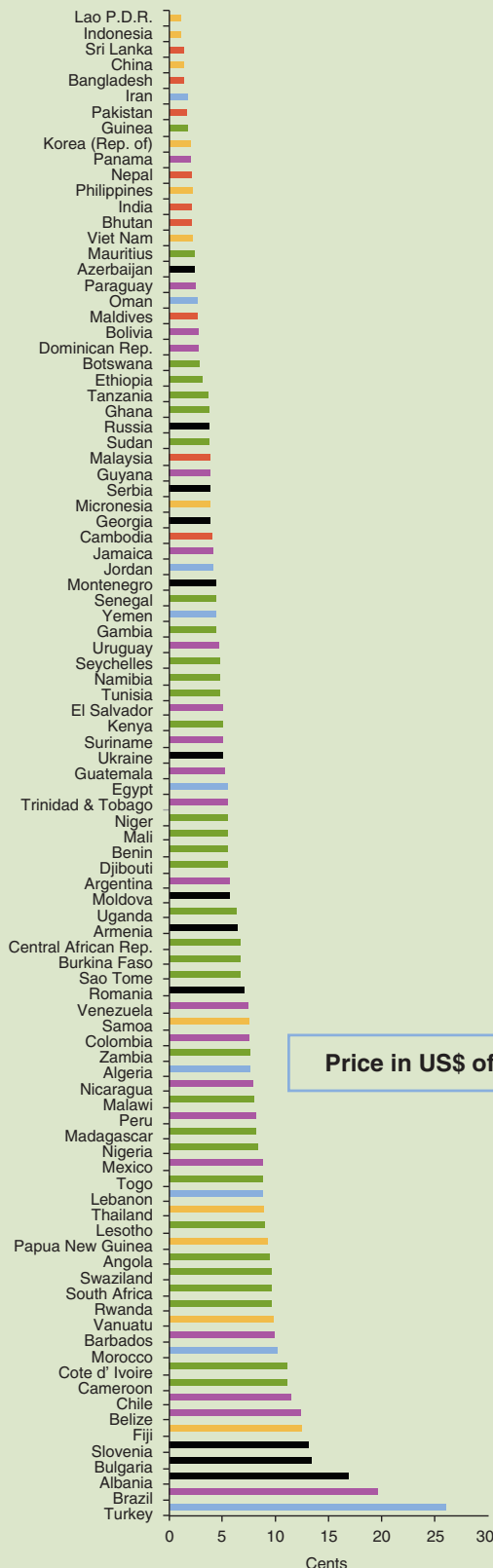
For the development practitioner, the key messages of this module relate to the benefits of accelerating the dissemination of mobile phone technology (Topic Note 9.1), especially to areas where its signal, and therefore its impact, have not yet reached. In many countries, profits generated by mobile phone use in urban areas are set aside specifically for extending the mobile phone network further into rural areas. Typically these funds are underused. This module provides a broad swathe of empirical evidence of the benefits of phone technology for improving rural income and, potentially at least, for reducing transaction costs and thus consumer prices. In occasional instances, technologies such as mobile phone amplifiers and transmitters, focused on marketplaces, will extend the distance over which wireless signals can travel and encourage additional agricultural trade to emerge. Many of these ICT infrastructure issues are discussed in Module 9.2.

Although ICTs appear to reduce transaction costs (see Topic Note 9.2), most of these cost savings presently accrue to traders who have invested in mobile phones. To date, disappointingly little analytical work has been done to provide empirical evidence of these effects. These kinds of studies need to be done. They are likely to be important for informing better investment decisions on infrastructure, particularly at the nexus between investments in roads, markets, and communications technology. Given accelerating urbanization and the increasing emphasis on food security, the development sector needs a better understanding of how to ensure that the reductions in transaction costs that are possible along the agricultural marketing chain especially benefit those at both ends of the supply chain—the rural producers and urban consumers.

As discussed in Topic Note 9.3, market intelligence and market education are increasingly important to farmers' survival in increasingly competitive markets. Given the projected acceleration of change in consumer demand, the emergence of new

**BOX 9.2: The Spread of SMS-Based Services and Prospects for Reducing Their Costs**

Unit Costs of SMS Messaging in Selected Developing Countries



Source: Authors (figure source is authors' calculations, based on InfoDev cross-country data).

In the future SMS will increasingly enable the two-way flow of information. The emergence of open-source software is facilitating the dissemination of targeted SMS messages on a large scale (see the discussion of FrontlineSMS in Module 8). Agricultural line departments and projects are using this technology to better control and improve their agricultural information dissemination. In particular, this new technology should help eliminate the recognized weaknesses in dissemination by government-run market information services.

The prices charged for sending SMS messages differ hugely from country to country and region to region. They tend to be significantly lower in South Asia than in Africa (see figure). For a mobile phone company, the actual costs of SMS transmittal is a fraction of the price charged. Informed opinion often puts the costs at between US 0.01 and 0.02 cents each. The margins that SMS messages generate for mobile phone companies are particularly high. In the minds of mobile phone company executives, their challenge is to balance the high margins generated by SMS messaging with the potential of those messages to generate additional revenue from voice services. This equation is not fully understood. Even so, there is considerable scope for a regulator to insist that SMS rates be significantly reduced for the transmission of public-good information.

For example, in South Asia the total cost for a private company to deliver a single agricultural text message is believed to be around 2 US cents. This cost is divided into one-third (that is, about US 0.6 cents) for broadcasting the SMS, one-third for sales and marketing, and the remainder for the whole operation of collecting and analyzing information and operating the business. Even at this relatively low cost, farmers still resist paying for this information. Where the public sector wants to use SMS technology to disseminate information to government staff and farmers, the affordability of the technology is highly relevant. A World Bank project coordination office in India recently negotiated to broadcast 100,000 SMS messages at US 0.4 cents each.

**TABLE 9.2: Current and Future Roles of ICT in Agricultural Marketing**

FUNCTION DELIVERED BY ICT	ENABLING OR DELIBERATE?	TECHNOLOGY	FUTURE
Real-time market research	Enabling infrastructure	Fixed-line and mobile phones	Extending range of mobile phones and ICT, facilitated by infrastructure investment and policies
Coordination of logistics	Enabling infrastructure	Fixed-line and mobile phones	Specialist applications, training/producer organizations
Market information (price and supply)	Deliberate: Public and private sector	Web-based and SMS	Applications and public–private sector partnership, plus training and organization
Market intelligence	Deliberate	Web-based	Applications and development of market intelligence services, plus training and organizations
Inputs	Enabling infrastructure	Fixed-line and mobile phone	Targets SMS messaged by private sector, e-vouchers for subsidies

Source: Authors.

marketing channels, and the evolution of modern variations within traditional marketing channels, better information will help farmers align production more closely with changing demands.

It can be argued that if the situation were left to resolve itself, the bulk of the benefits generated by these new market opportunities would go to the larger-scale and better-off farmers and to the trading sector. To redress that imbalance, there may well be a role for extension—particularly the public extension services—to alert farmers to new market opportunities, provide training on changing market conditions (especially experiential training), and transmit important market intelligence, especially through the Internet.

Not only do farmers have difficulty identifying the best markets for their produce; they often have difficulty discovering

where and when they can purchase inputs, especially if private input suppliers have been crowded out by government distribution of subsidized inputs. ICTs can provide this information (see Topic Note 9.4).

Input-supply companies can use text messages to promote their products and provide technical advice to farmers. Electronic voucher schemes offer potential for implementing subsidy programs that “crowd in” the private sector and enable more precise targeting of input supply programs to the poor.

Table 9.2 summarizes the role of ICT in agricultural marketing, based on whether the ICT consists of enabling infrastructure such as telephones or deliberate applications. It also suggests what the future is likely to hold.

## Topic Note 9.1: MOBILE PHONES AS A MARKETING TOOL

### TRENDS AND ISSUES

Although the mobile phone’s main purpose among the public is for social interaction, it is proving to be a powerful marketing tool. Around 60–70 percent of calls are made to family and friends; business calls typically constitute 5–10 percent of calls. Learning to exploit the economic benefits of the mobile phone is a skill that takes some time to develop (see the evidence from Malaysia later in this section). Younger users are typically better able to exploit the mobile phone’s business advantages.

A building body of knowledge, summarized in the section that follows, indicates that phones, especially mobile phones, have a positive impact on agricultural incomes. The evidence suggests that farmers use mobile phones to tap into a wider range of knowledge and information than they could access previously. Farmers build up a network

of contacts and draw on this wider experience and expertise to obtain critical information more rapidly. Essentially the mobile phone, its special applications, and the Internet (although to a lesser extent currently) are becoming management tools for farmers, specifically in relation to marketing.

Research data are emerging on just how much farmers are starting to use mobile phones to assist in marketing their production. For example, work in Bangladesh, China, India, and Vietnam showed that now about 80 percent of farmers own mobile phones (Minten, Reardon, and Chen n.d.). They use them to speak to multiple traders to establish prices and market demand. More than half concluded selling arrangements and prices on the phone (the exception was rice farmers in China). This work illustrates just how much phone access is driving change in marketing systems.



Greater access to information and buyers steadily adds to farmers' market knowledge and gives them greater confidence to diversify into higher-value (often perishable) products. The additional knowledge translates into a more accurate understanding of demand and an enhanced ability to control production and manage supply chains. Farmers' behavior is changing, and their farming is becoming more commercial. Trends emerging around the use of mobile phones include: (1) farmers deal directly with wholesalers or larger-scale intermediaries rather than small-scale intermediaries; (2) farmers conduct market searches over a wider number of markets; and (3) farmers develop a broader network of contacts than their peers who do not own mobile phones.

Greater access to information seems to help farmers make better decisions around:

- **Transportation and logistics.** Farmers begin to leverage economies of scale. They can organize and coordinate among themselves and (larger-scale) truckers to consolidate volume. Greater coordination also occurs around the timing of aggregation, collection, and volumes. Larger volumes can lower costs and enable farmers to realize higher prices.
- **Price and location.** An ability to compare prices increases farmers' power to negotiate with traders. It also enhances farmers' ability to change the time and place of marketing to capture a better price.
- **Supply and demand.** Farmers gain greater control over their production and product sales by finding new sources of demand, improve their ability to adjust supply and quality to market conditions, and learn about quality, grades, and product presentation.
- **Diversification of their product base.** Over the longer term, a better understanding of market demand and consumer trends helps farmers diversify into higher-value crops and capture greater value.
- **Access to inputs.** Farmers can make more informed decisions about which inputs are better or cheaper to buy and when and where to best obtain them.

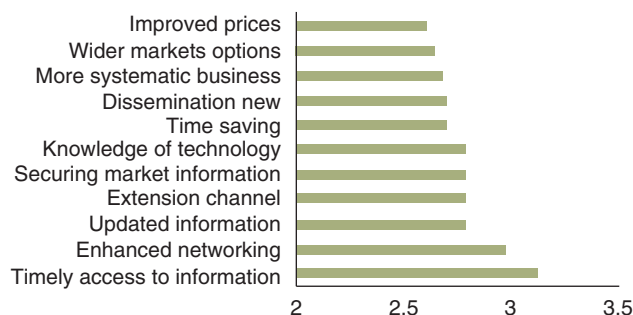
### EVIDENCE OF THE IMPACT OF PHONES ON MARKETING

The evidence to date indicates that farmers (as well as other stakeholders in the supply chain) increasingly use ICT, particularly mobile phones, to reduce their costs, increase the prices they receive, and eventually acquire market knowledge that improves supply-chain efficiencies and adjusts supply more closely to changing demand. There is also an

intriguing suggestion that farmers' use of the phone creates a greater sense of trust with trading partners, presumably because information asymmetries are reduced.

- **Peru: Rural access to telephones raises incomes from farms and other rural businesses.** When Peru privatized its telecommunications industry in the 1990s, the government required the telecommunications company to install public telephones in 1,526 small rural towns across the nation. Some years later, a study of 1,000 rural households distributed across towns with and without public telephones found positive links between public telephone use and incomes. Telephone use resulted in a 13 percent increase in per capita farm income and a 32 percent lift in nonfarm income (Chong, Galdo, and Torero 2005).
- **Filipino farmers used mobile phones to improve income and build trust with trading partners.** In the Philippines, Labonne and Chase (2009) compared the impact of mobile phones on subsistence farmers and commercial farmers who generate a marketable surplus. The study found little benefit for the subsistence farmers, but commercial farmers benefited significantly, as measured by improvements in their consumption of 11–17 percent. A particularly interesting finding was that farmers reported improved relationships with trading partners following the acquisition of mobile phones. They may believe that the relationship is more fair, since they now can negotiate better terms.
- **In Malaysia, mobile phone use was linked to increased profits among younger owner/managers of farms and smaller agribusinesses, especially with growing experience in using the technology.** When 134 younger agricultural-based entrepreneurs were interviewed about their perceptions of the impact of mobile phones on their businesses, they reported two overarching benefits: They could draw upon a wider network of people for information (a "wisdom of crowds" effect), and they could obtain information at a greatly increased speed (Shaffril et al. 2009). Other benefits, such as market information, time savings, and technology, were of a lower order (figure 9.4). The overall impact was an increase in businesses profits, especially after the entrepreneurs had used their mobile phones for more than two years.
- **Mobile phones in Niger bring better price integration, improve profits for traders, and reduce consumer prices.** In Niger, Aker (2008) found that

**FIGURE 9.4:** Commercial Farmers and Small Agribusinesses Rate the Relative Importance of Using Mobile Phones on a Scale of 1 to 4 (Very Useful), Malaysia



Source: Shaffril et al. 2009.

mobile phones reduced search costs by 50 percent compared with personal travel and that mobile phone use increased both traders' and consumers' welfare. Traders' profits increased by 29 percent—not because they traded more product but because they obtained better prices through real-time market research conducted via mobile phone. Mobile phones were also associated with a 3.5 percent reduction in average consumer grain prices. Aker also found that the use of communications technology had several benefits. Search costs were significantly reduced, coordination among market participants improved, and market efficiency increased as traders became engaged in the search process themselves rather than being on the receiving end of a one-way communications system. Traders were able to expand their reach of searchable markets, sell in more markets, and increase their network of contacts. An average trip to a market located 65 kilometers away in rural Niger can take two to four hours round trip, compared to a two-minute call.

*"[With a mobile phone], in record time, I have all sorts of information from markets near and far." —Grain trader from Magaria.*

*"[Now] I know the price for two dollars, rather than traveling [to the market], which costs twenty." —Grain trader from Zinder.*

- In Morocco, mobile phones changed farmers' cropping mix and marketing methods.** A survey of a small sample of farmers in Morocco found that mobile phone use resulted in a 21 percent increase in income (Ilahiane 2007). An even more relevant finding was that the technology changed farmers' behavior:

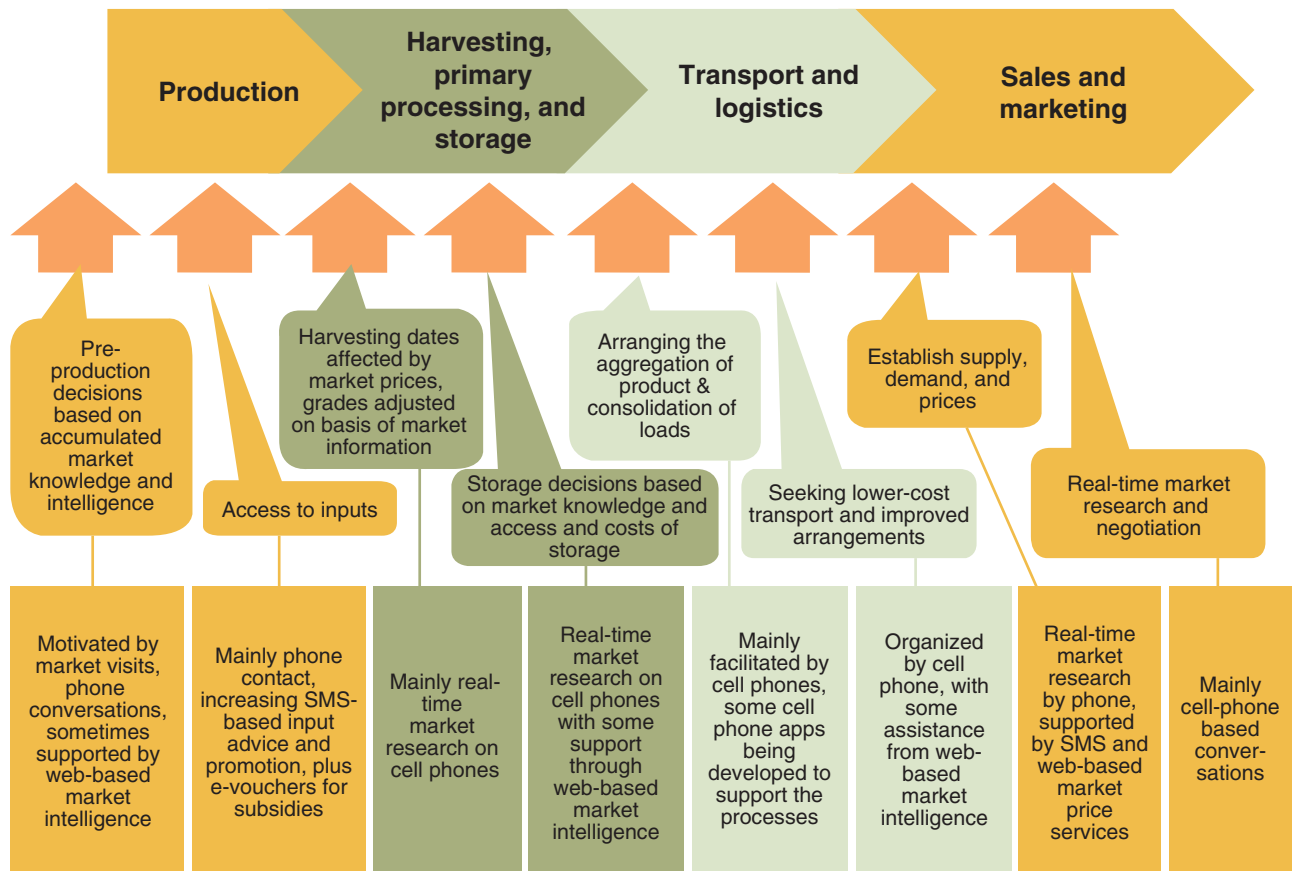
Increasingly, they spoke directly with wholesalers or larger-scale middlemen rather than smaller intermediaries. Farmers changed where they marketed their crops, switching markets to capture better prices and often resorting to larger and more distant markets. They coordinated with local truckers to improve product transport and identify where to deliver their products. Some farmers developed a two-way trade, bringing products back from the market to sell in their own rural communities. A particularly important change was that they used their new market knowledge to become more market oriented in their production, move away from producing low-value crops, and diversify into higher-value enterprises. The knowledge gained from using the mobile phone reduced the perceived levels of risk and helped them target their production to specific, identified market opportunities.

Figure 9.5 illustrates where the impacts of ICTs on agricultural marketing occur along the links in value chains, thus indicating the information required and the technology involved. The diagram has two key messages. First, ICT potentially has an impact on the management of every step in the production marketing chain, from planning to sales. Second, almost all of these functions are likely to be carried out by mobile phone. Other potential services, such as market price information, market intelligence, and specific cell-phone-based applications, largely perform support and secondary functions that make farmers' mobile phones more useful.

## LESSONS LEARNED

The experiences in using ICTs to improve access to market information reveal that ICTs contribute to:

- Reduced logistics and transportation costs.** Farmers obtain the latest information with a phone call instead of making a long trip to a market. They can coordinate with other local farmers to use one large truck rather than several smaller ones to deliver their products.
- Improved negotiation power.** Farmers' increase their power to negotiate, particularly with traders, based on their ability to understand pricing in multiple markets, to cut out intermediaries, and to sell directly to larger-scale buyers.
- More sophisticated marketing plans based on price information.** For example, farmers can modify the date of marketing, product permitting, or switch to alternate markets, transport and regulation permitting.

**FIGURE 9.5:** ICT Inputs to Marketing Along the Agricultural Value Chain

Source: Authors.

- Broader and deeper networks.** Farmers communicate by phone with traders and farmers outside of their immediate geography as opposed to making a physical trip. The ability to communicate more easily and to triangulate information creates deeper trust in key trading relationships.
- Innovative partnerships.** For example, partnerships are facilitated and built among groups of producers, or by virtue of direct communication with corporations and traders, or through the ability to supply product based on just-in-time and/or quality needs.
- Informed use of inputs.** Farmers improve their capacity to raise yields through better use of inputs and/or use of better inputs. They can identify sources of inputs, obtain them more cheaply, and are better able to buy and apply them at the optimal times.
- Improved farm business management.** Farmers can become better managers through better information about which inputs to use, new knowledge about grades and standards for produce, and increased interaction with corporations, traders, and other farmers.

## Topic Note 9.2: ICTS IMPROVE LOGISTICS, LOWER TRANSACTION COSTS

### TRENDS AND ISSUES

The higher the transaction costs, the smaller the geographical area in which it is feasible to market any product. Without market access, productivity is low (Kunaka 2010), and options for the farming enterprise are limited.

Driving down transaction costs in the supply chain delivers very clear public goods. It can create benefits, especially for poorer urban consumers, by lowering the costs of food. Lower transaction costs also offer the prospects of higher net returns for producers.

As noted in the overview, field observations show that in many places ICTs, particularly mobile phones, are transforming how rural logistics function. The resulting improvement in logistics can be seen through lower transaction costs, improved potential profits, and less wastage. By giving people the ability to replace distance with “space-shrinking technology,” mobile phones enable market agents to better coordinate product supply and demand, strengthen existing trade networks, facilitate the assembly of products to reach a critical mass, and enable products to be delivered cost-effectively to new markets. Despite these positive impacts, other factors can still limit increased supply-chain efficiency, such as geographic position, limited access to transportation and credit, and poor access to inputs.

An ICT-enabled logistics system can help in:

- **Collection**—by setting out well-organized collection routes.
- **Aggregation**—by assembling markets with sufficient critical mass to attract large-scale traders. Traders use the quantity and variety of products and the mobile phone network to conduct real-time research and identify arbitrage and market opportunities for the products they buy directly in rural areas.
- **Delivery**—by coordinating directly with other farmers or truckers to organize times, dates, volumes, and so forth.

Currently, ICTs mainly benefit those who can afford the technology—mostly the traders. The logistics system will not be fully transformed and smallholders will not fully benefit from the ICTs described here until the technology is ubiquitous and market information is less asymmetrical. At that point, prices and the returns realized by farmers are likely

to improve, as well as the downstream positive effects on consumer food prices.

A typical rural agricultural value chain has several steps. Production takes place on small plots of land. Very small volumes of the produce are then sold to a local aggregator, who perhaps collects it on a bicycle or bullock cart. This intermediary then sells the aggregated (but still small) volume to another intermediary, perhaps one with a tractor.

In such a manner, product cascades through the hands of several intermediaries, who increase the load size at every step, before it reaches the end market. Small aggregate loads generally incur high unit transport costs. In addition, each small-scale trader has to charge a relatively high margin per kilogram to make a living wage. The aggregate margins are relatively high. The resulting multiple handlings also cause significant wastage through loss or spoilage, further impacting the price that the smallholder receives and the consumer pays.

Table 9.3 and figures 9.6 and 9.7 serve to overlay this description of a rural value chain with some sense of scale and numbers. Most farmers need transport to move small loads (units under 80 kilograms) over relatively short distances (of 1–10 kilometers). Rarely are motorized transport services available, affordable, or even necessary to meet this demand, particularly in sub-Saharan Africa.

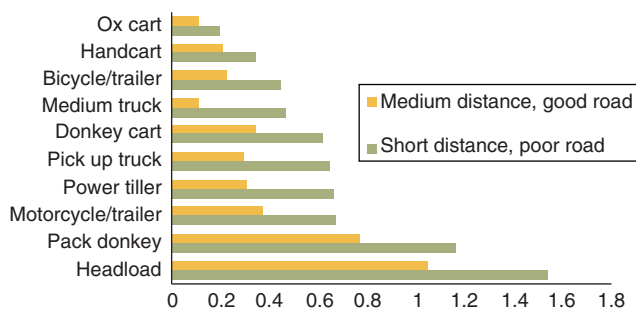
Figure 9.6 provides an indication of how unit costs for transporting produce change depending on distance, road quality, and transport mode. The key take-aways are: (1) the high cost of head loads and pack animals; (2) the low unit costs, particularly for short distances on bad roads, of intermediate modes of transport such as ox carts, hand-carts, and bicycles/trailers; and (3) the greater cost efficiencies of mechanized transport, especially medium-sized trucks, when the distances and the quality of the roads are reasonable.

Figure 9.7 demonstrates the importance of critical mass in lowering transport costs. A vicious circle is often observed in the field: Even with a new road, truckers will not invest in additional vehicles until they see a substantial increase in the volume of agricultural produce that needs to be transported; at the same time, farmers are wary of expanding production without evidence that the necessary transport services

**TABLE 9.3:** Size of Loads and Distance Covered in Moving Rural Goods Produced by Small-Scale Farmers, Various Countries

	KENYA	MALAYSIA	INDIA	BANGLADESH	WESTERN SAMOA	REPUBLIC OF KOREA
Typical distance of transport	90% of trips < 7 km	75% of trips < 7 km	90% of trips < 5 km	Most trips < 12 km	Most trips < 5 km	Most trips < 10 km
Average off-farm distance		10 km	8.3 km			
Loads transported	70% of trips < 25kg			Most trips < 50 kg	Most trips < 80 kg	30–80 kg

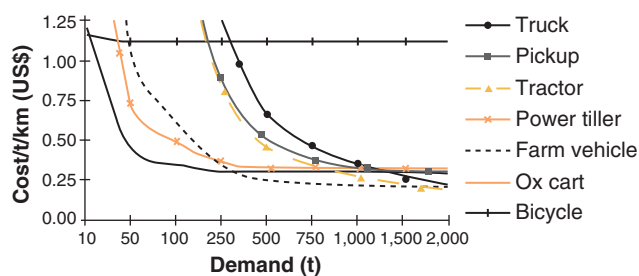
Source: Banjo, Gordon, and Riverson 2010.

**FIGURE 9.6:** Transport Costs for Different Vehicles in Developing Countries (US\$ per Ton-Kilometer)

Source: Sieber 1999.

will be in place to deliver their surplus to external markets. One solution to this conundrum is to aggregate product into sensible critical masses at particular times and places. For example, a 10-ton (medium) load would need to be made up of product from 150 to 200 smaller-scale farmers, a process that is being greatly facilitated by the use of ICT, especially mobile phones.

Additionally, there is little transparency around the availability of facilities for transportation, warehousing, storage, processing, and so on. One particular feature of rural transport internationally is the high costs in Africa, which are often four times the cost in South Asia of transporting larger loads over longer distances. Some of this difference in cost is ascribed to the cost of vehicles and poor quality of roads in Africa, but a significant proportion is believed to be the consequence of cartels. (In contrast, in Pakistan, for example, transport brokers regularly operate to consolidate loads and improve transport efficiency with backhauls.) This lack of information results in high transaction costs at each stage in the value chain and offers little opportunity to leverage economies of scale or move swiftly to alleviate blocks in the supply chain.

**FIGURE 9.7:** Transport Costs in Relation to Demand, by Mode

Source: Sieber 2009.

The literature on ICTs' impact on rural logistics largely focuses on data obtained from user surveys and case studies. Little research has been done to assess the direct impact of mobile phones on reducing transaction costs related to agriculture. The lack of information is not surprising, given that logistics is generally regarded as an infrastructural issue and that its synergies with ICT have not been considered.

### LESSONS LEARNED

Findings on how mobile telephony enhances marketing by improving supply-chain management include:

- **More efficient use** of existing storage, packaging, transport, and processing facilities.
- **Increased monitoring and coordination** of freight transport operations, including product collection, delivery, and security.
- **Quick response to any disruptions** in the supply chain (for example, disruptions such as vehicle breakdowns clear up more rapidly).
- **Reduced travel time and expense** through the ability to call markets to obtain information instead of having to travel there.

- **Disintermediation and improved transport efficiency** as mobile phones facilitate the assembly of product, which enables larger trucker/traders to buy sensible-sized loads directly in rural areas. Suppliers can use mobile phones to conduct real-time market research, and entire truckloads can be bought and sold while still on the road.
- **Synergies between investments**, so that combined investments in roads, telephone communications, and electricity have a greater aggregate benefit than separate investments ever could have. (If a single investment were to be made, however, the most cost-effective investment would probably be telephones.)

### PRINCIPLES AND GUIDELINES FOR POTENTIAL INTERVENTIONS

Information technology is stimulating a quiet communications revolution in traditional agricultural marketing channels in many developing countries. The benefits largely reside with traders, who use the technology to maximize profits by lowering search and transaction costs. The key question from development practitioners is how to design ICT interventions that enable producers to improve their returns and/or help urban consumers to buy food at lower prices. Little empirical evidence is available on the scale of these effects or on the practices and investments that could enhance them.

A combination of economic intuition, observation, and research indicates that important synergies can be created from a confluence of investments.

- **Address policy issues around increasing access to the poorest.** Despite phenomenal growth in telephone lines and mobile phone networks, access is still highly inadequate and unequal. Today, the main beneficiaries of ICTs are those who have the technology, enabling them to increase their profits. Not only are the poor and those living in rural areas at a disadvantage, but full utilization of the technology is impossible, even for those with access, until universal access is achieved. In other words, a full transformation of the logistics system will not happen until the technology becomes ubiquitous, intensifying competition and carrying the potential long-term benefits of reducing transaction costs.
- **Look for possibilities to create an integrated rural infrastructure investment program.** Investments that help to remove intermediaries are believed to have

good potential for improving marketing efficiencies and lowering transaction costs. Studies in South America have demonstrated synergies between investments in roads, telephones, and electricity, although individually telephones consistently show the highest return (Jansen, Morley, and Torero 2007). Integrated rural infrastructure investments could include, for example, investments that improve agricultural productivity, rural roads, and rural markets (specifically assembly or primary wholesale markets) and extend rural mobile phone coverage. For example, in areas where phone signals are weak, a mobile phone amplifier, located at a market, would facilitate conversations and flows of information around market opportunities and needs, logistics, and prices. Markets themselves could be built in selected hubs in rural areas where local farmers can convene and sell produce. Experience indicates that such markets must be located correctly. Normally these investments are made in existing and expanding marketplaces, often with public investment linked to improvements in market management. For example, a market committee is formed of stakeholders to actively promote the market, oversee its operation and management, and become empowered to act on its further development.

- **Create capacity in farmer organizations and groups.** Coordinated activities by farmer groups offer potential for improving opportunities and farmer incomes through many channels—in operating the market, in actively being empowered to seek out competing transport options, and in organizing (through mobile phones) sensible collection routes that ease logistics, create the necessary critical mass of products, and attract larger-scale and more efficient buyers and traders. As this topic note emphasizes, ICT will increasingly provide avenues to link producer organizations, cooperatives, smaller transporters, and others. (See the discussion in Module 8.)

### INNOVATIVE PRACTICE SUMMARY In South Asia, Mobile Phones Amplify Investments in Extension and Infrastructure to Bring Farmers to Markets

The following examples from Bangladesh, India, and Sri Lanka describe how poultry farmers and vegetable producers managed to market their produce more efficiently. The situations of these producers may be quite different, but the

catalyst in each instance was the advent of mobile phones. The example from India shows how benefits are magnified through complementary investments in infrastructure (in this case, roads and phone networks)

### **Bangladesh: Market Extension and Mobile Phones Give Women Chicken Farmers New Leverage with Traders**

As part of a Swiss-funded livelihoods project in Bangladesh, community organizations, particularly women's groups, were provided with a six-step, experiential training program in marketing. The program covered the selection of key products to market (step 1); basic economics (step 2); market research (step 3); review of findings (step 4); presentation of action plans and agreement by the community (step 5); and implementation of the chosen action plan (step 6).

One women's group (image 9.1) traditionally sold backyard chickens to a visiting trader. When they visited the nearby market town, they were shocked to discover that chickens were selling for nearly twice the price they were receiving. They agreed that they would be prepared to consolidate their chickens and transport them for sale directly into the market town. Before committing to this action, however, they wanted to confront the trader with their increased market knowledge.

When they challenged the trader about the price disparity, his reply stunned them. He explained that he could not afford to pay them more because he had to cover all his transport

#### **IMAGE 9.1: The Bangladeshi Community Who Solved Their Chicken Marketing Problems Through Mobile Phones**



Source: Authors.

costs with the few (normally 8–10) chickens they had available for sale. The women asked, "How many chickens will you need to be able to pay us sensible prices?" "Around 50," was the trader's reply.

When it was established that the traveling trader had his own mobile phone, an arrangement was reached that the community would phone him whenever they collectively had 50 chickens for sale. The arrangement worked. The price has increased by 60 percent, enabling the women to aggregate chickens from a far wider group of nearby villagers and encouraging increased production, as backyard chickens are now considered a profitable enterprise.<sup>1</sup>

### **Primary Rural Wholesale Markets Capitalize on New Roads, Increased Vegetable Production, and Mobile Phone Coverage in Assam**

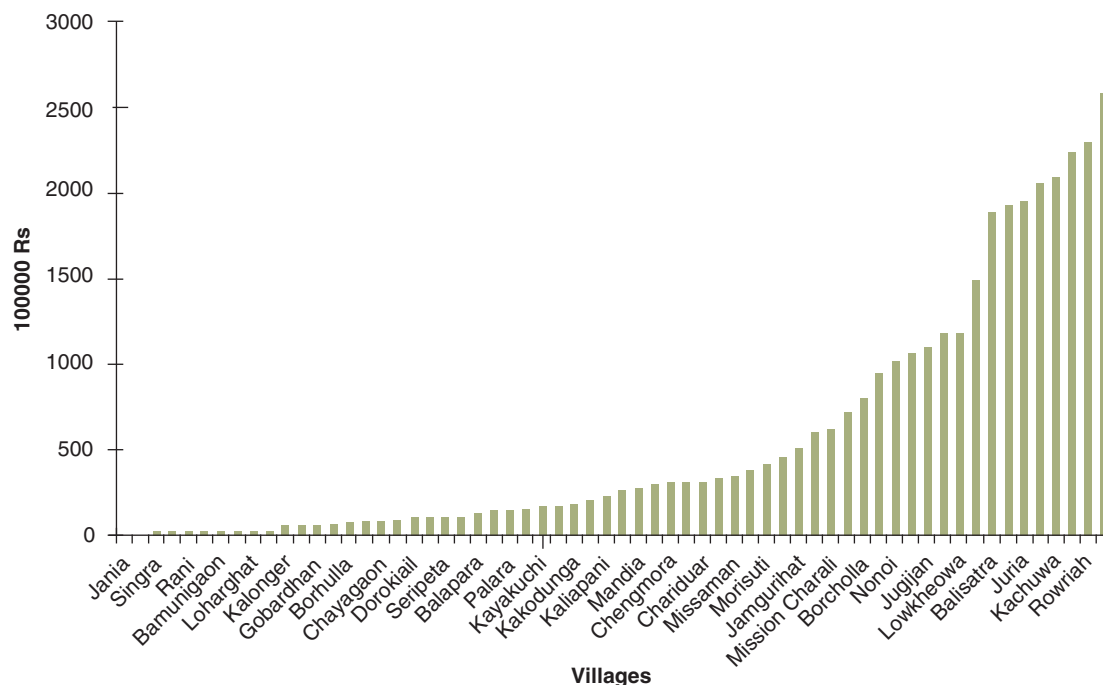
Planning studies for an agricultural competitiveness project in Assam, Northeast India, showed flat or declining turnover in traditional wholesale markets but rapidly rising lease incomes for weekly consumer markets (*haats*). Deeper investigation revealed that only a small proportion of the *haats* were booming (about 13 percent). They had developed into daily wholesale markets selling tens of thousands of tons of product (figure 9.8, image 9.2).

When these markets were visited and stakeholders interviewed, an explanation emerged. The markets were booming owing to investments in new rural roads, expanded vegetable production following increased investment in irrigation, and the arrival of larger-scale truckers (with 10-ton vehicles) to buy product.

The trucker/traders described the benefits of these larger markets: They offered sufficient product for sale to provide choice, they offered a variety of products, and the turnaround times were quick, but the critical change was the extension of the mobile phone network. The network enabled trucker/traders to carry out real-time market research with their customers to meet their produce requirements and prices.

Instead of product passing through the hands of multiple small traders, resulting in high unit transport cost, significant postharvest losses, and a high overall aggregate margin, the transaction costs were reduced. The Assam Agricultural Competitiveness Project is investing in these successful

<sup>1</sup> For more information, see Dixie (2007).

**FIGURE 9.8:** The Emergence of Primary Rural Wholesale Markets at Well-Located Weekly (Haat) Markets in Assam

Source: Project documentation for the Assam Agricultural Competitiveness Project (<http://web.worldbank.org/external/projects/main?pagePK=64283627&piPK=73230&theSitePK=40941&menuPK=228424&Projectid=P084792>).

**IMAGE 9.2:** Produce for Sale at an Assamese “Super-haat.”

Source: Authors.

“super-haats” to provide them with the facilities required for the growing volumes of business they transact.<sup>2</sup>

#### Sri Lanka’s Smallholders Could Reduce Cost of Market Information by Using Mobile Phones

Ratnadiwakara, de Silva, and Soysa (2008) calculated the information-related transaction costs of smallholder farmers who sell their vegetables at one of Sri Lanka’s largest wholesale agricultural markets (Dambulla). The four vegetables that were most heavily traded (by volume) were considered in the study: tomatoes, onions, eggplant, and chilies.

Information-related costs formed 70 percent of the transaction costs incurred by farmers growing those crops. On average, a farmer made 24 visits to the wholesale market during the crop cycle at an average cost of US\$ 2 per visit, which included travel, food, and related costs. The total search cost

<sup>2</sup> For more information, see the documentation for the Assam Agricultural Competitiveness Project (<http://web.worldbank.org/external/projects/main?pagePK=64283627&piPK=73230&theSitePK=40941&menuPK=228424&Projectid=P084792>).



for a farmer averaged US\$ 52, of which over 80 percent was the cost of travel.

If half of a farmer's market visits could be replaced with phone calls (assuming a phone call costs US\$ 0.37), the total search cost would be reduced by 33 percent, without even accounting for time saved.

### INNOVATIVE PRACTICE SUMMARY Across Africa, Mobiles Ease Market Logistics

The examples that follow, from West and East Africa, describe how farmers and entrepreneurs use mobile phones to ease the traditional barriers to moving and marketing produce. Some rely on sophisticated applications; others rely on a series of phone calls.

#### With Mobile Phones, Ghana's "Market Queens" Transform the Onion Trade

The onion wholesalers known as "Market Queens" increasingly use mobile phones to coordinate supply among themselves and to improve profits by facilitating reductions in their transportation and opportunity costs (Overa 2006). These costs are particularly high in commodity chains that are geographically extensive and organizationally complex, such as the onion trade in Ghana.

Mobile phones allow traders to save on time and transportation costs because they are able to coordinate trucking and conduct their business in multiple locations or on the road (table 9.4). The phone also gives wholesalers greater access to their customers, which helps them to build trust and a good reputation. In turn, these qualities encourage more transactions at less cost and risk.

#### Remote Farmers with Perishable Crops Reach More Ugandan Markets when Mobile Phone Coverage Expands

Uganda's mobile phone network expanded from covering 46 percent of the population in 2003 to 70 percent in 2005. Using panel data from 856 households in 94 communities across the country, Muto and Yamano (2009) estimated the impact of mobile phones on farmers' market participation.

Improved access to price information appeared to reduce marketing costs and increase farm-gate prices. Mobile phone coverage was associated with a 20 percent increase in sales of bananas, although the same was not true for maize. This difference suggests that expanding mobile phone coverage has been more useful for perishable crops and that farmers have gained particularly from being able to arrange transportation more efficiently.

Farmers' price gains are greater in areas close to the district center than in more remote areas, but the farther a farmer is located from the district center, the greater the impact of mobile phone coverage on market participation. The expanded mobile phone network favored banana farmers in remote areas, who tend to have lower production costs, compared to banana farmers near district centers, where production costs were higher. The results also suggested that even households without mobile phones benefited from the network, possibly because traders used mobile phones to reduce transportation costs.

#### With Mobile Phones and Training, Ugandan Farmers Supply Fast-Food Chain

The Nyabyumba Farmers' Group reached an agreement to supply Nandos, a multinational fast-food restaurant

**TABLE 9.4:** Average Time and Cost Savings Occurring When Ghanaian Onion Traders Substitute Phone Communication for Travel

LOCATION	DISTANCE FROM CENTRAL ACCRA (KM)	AVERAGE COST OF 5-MIN TALK (US\$)	AVERAGE COST SAVINGS (US\$) <sup>a</sup>	AVERAGE TIME SAVINGS (H) <sup>b</sup>
Adenta	16	0.20	0.08	2
Prampram	50	0.80	1.66	3
Kumasi	289	0.80	11.66	9
Tamale	654	0.80	13.50	21
Bawku	899	0.80	22.00	30

Source: Overa 2006, as adapted from Table 5.2 in Segbefia 2000; Overa field data 2003.

<sup>a</sup> Cost of a 5-minute telephone call from a communication center, subtracted from the average cost of transportation.

<sup>b</sup> Includes average time spent waiting for minibus and traveling to Central Accra and back.

in Kampala, with graded ware potatoes<sup>3</sup> at a fixed price throughout the year. Supplying these outlets offered farmers higher incomes and more stable demand but required farmers to make significant improvements in product quality, quantity, and business management (Kaganzi et al. 2008).

To meet these conditions and engage with this higher-value market over the long term, farmers needed to become more organized and strengthen their partnerships with service providers. A purchase agreement specified the following conditions: Nandos would receive 50 bags of 100 kilograms each every two weeks throughout the year; potatoes would not be washed; bags would contain only one variety; each potato would be approximately 80 grams, oval, with few eyes; and a fixed price of US\$ 170 per ton would be offered throughout the year, payable by check on the 15th of each month after delivery.

The key challenges were to ensure that farmers could consistently produce potatoes to these standards and communicate directly with their client. Farmers' lack of grading knowledge and initial inability to produce potatoes that met Nandos' quality standards caused 80 percent of their production to be rejected. Training reduced the rejection level to less than 10 percent in less than a year.

To ensure direct communication, the chairman of the Nyabyumba Farmers' Group purchased a mobile phone to maintain regular contact with Nandos as well as other members of the cooperative. The phone facilitated collection, delivery, and the fine-tuning of harvesting and dispatch to match demand in Kampala.

### Mobile Maps Optimize Logistics for Senegalese Producers and Exporters

Manobi (<http://www.manobi.net/worldwide/>), a private ICT provider in West Africa, has developed a number of applications to facilitate agricultural marketing. For example, Karaya

**IMAGE 9.3:** Inventories of Karaya Gum Mapped and Displayed Through a Mobile Phone Application



Source: Annerose 2010.

gum producers have a contract to supply local exporters, but exporters claim that they do not know how much stock is available and so cannot carry enough cash to pay farmers at the sale point. Producers often are obliged to sell to local middlemen instead at a lower price.

Manobi reports that its new mobile phone application gives gum growers a dedicated system for recording their inventory, which is displayed on the exporter's mobile on a map (image 9.3). Exporters can optimize their collection logistics, more accurately estimate cash requirements, and save money on transport. Gum growers sell at higher prices directly to exporters and are paid cash on delivery. Manobi claims that as a result gum producers have increased their sales income by 40–50 percent (Annerose 2010).

<sup>3</sup> Ware potatoes are potatoes grown for human consumption rather than for planting.

## Topic Note 9.3: ICTS FACILITATE MARKET RESEARCH

### TRENDS AND ISSUES

Multiple and complex dynamics operate around market demand. Consumer demand changes constantly. Demand for specific products fluctuates daily and weekly; longer-term trends in consumer demand vary as well. Marketing channels continuously evolve. The rate of change in consumer demand and marketing channels is accelerating. Ultimately, the farming community will be better off if it can align production more closely to market changes and opportunities.

To become adept at pairing production with opportunities, farmers and others along the value chain need to become better at acquiring market information that is immediately useful and at acquiring longer-term knowledge related to markets. This topic note is organized around these two needs.

### Market Information, Intelligence, and Knowledge

Immediate market information is used largely to sell existing crop and livestock products in ways that maximize their profitability, mainly by creating a better understanding of short-term fluctuations in pricing and demand. Most often, short-term information improves price negotiation, but it can also influence the timing of sales and the selection of the market. This kind of information tends to change rapidly, and its timeliness and accuracy is of great importance.

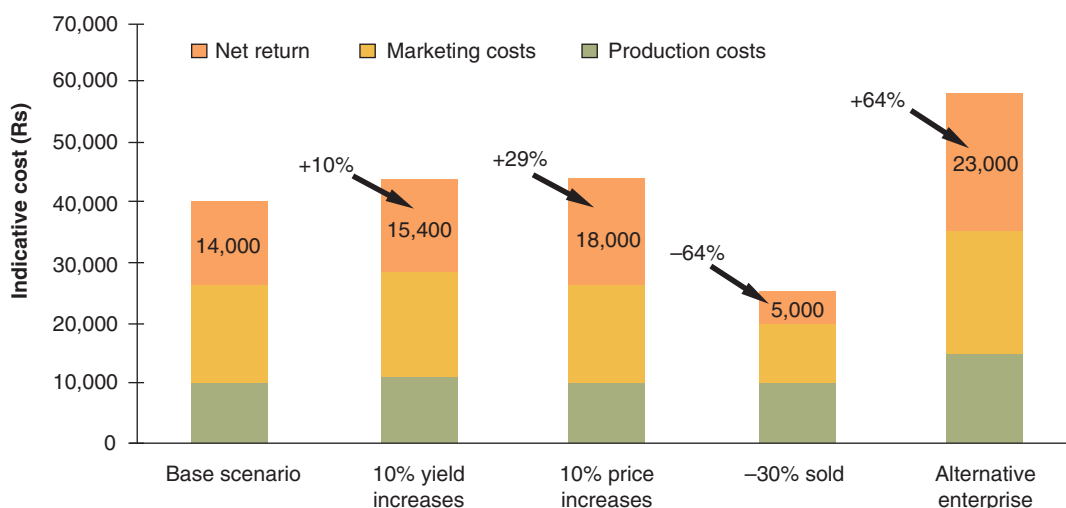
It is longer-term market information, referred to here as “market intelligence,” that affects farmers’ longer-term decisions.

Examples of these decisions include the choice of product to produce, the choice of marketing channel to use, and other strategic decisions aimed at maximizing profits. To be made well, these kinds of decisions require an understanding of competing suppliers, buyers’ needs, product specifications, market trends, and other key issues for specific products. Generally these decisions also build on the aggregate knowledge created through the acquisition of short-term market information over a period of time. The key development challenge lies in assembling and disseminating this information in a timely manner, not just to traders or larger-scale farmers but also to smallholders so that they can make more sensible management decisions and increase their profitability.

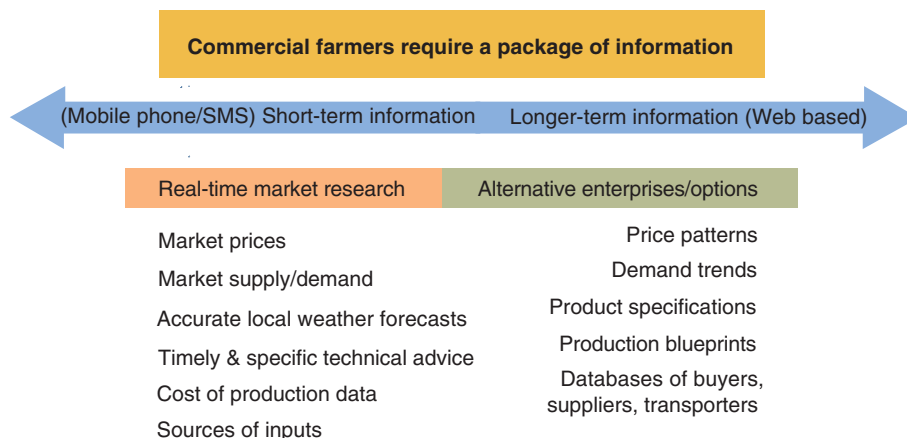
Figure 9.9 shows how market information can significantly affect farming profits. Profitability is highly affected by prices, largely because any change in price has little or no effect on costs, so the effect impacts directly on the bottom line. An inability to find buyers for products also has a profound effect on profits. By accumulating market knowledge, however—from a combination of market information and market intelligence—producers gain an opportunity to identify and diversify into alternative and more profitable products.

The main goal of increasing access to market information is to empower farmers to take greater control of marketing their production and orienting their production to identified market opportunities. A deeper understanding of short-term and long-term market dynamics should, on balance,

**FIGURE 9.9:** Farmers’ Incomes Are Highly Sensitive to Market Issues: Prices, Volume, and Enterprise Diversification



Source: Authors.

**FIGURE 9.10:** Commercial Farmers' Information Needs and Sources

Source: Authors.

enable farmers to become more commercially savvy and profitable.

In essence, the ability to conduct market research—to gather both short- and longer-term information—will increasingly become part of the mix of farming skills. In most situations, market information is fragmented, anecdotal, outdated, inconsistent, and incomplete, although the situation differs by product. For example, markets for staple cereals, which are often subject to price controls, move relatively slowly. Information about these markets is more widely known. However, for products that are more perishable or for which consumer demand is shifting, the market situation is far more opaque.

The primary role of government in promoting the acquisition of immediate information through ICTs is to focus on the overarching importance of maximizing mobile phone coverage while improving access to the technology for the rural poor. An equally important role for government is to support producers in using the technology to become more commercially astute and better attuned to changing markets for agricultural products. The overall aim is to strengthen farmers' position in their day-to-day trading and, over time, enable them to focus production on satisfying consumers' and buyers' demands and to develop skills in market servicing (the capacity to develop relationships with stakeholders in the next stage of the value chain).

### Producers' Market Information Needs and Research Strategies

Figure 9.10 provides a sense of the package of information that farmers need with respect to immediate information

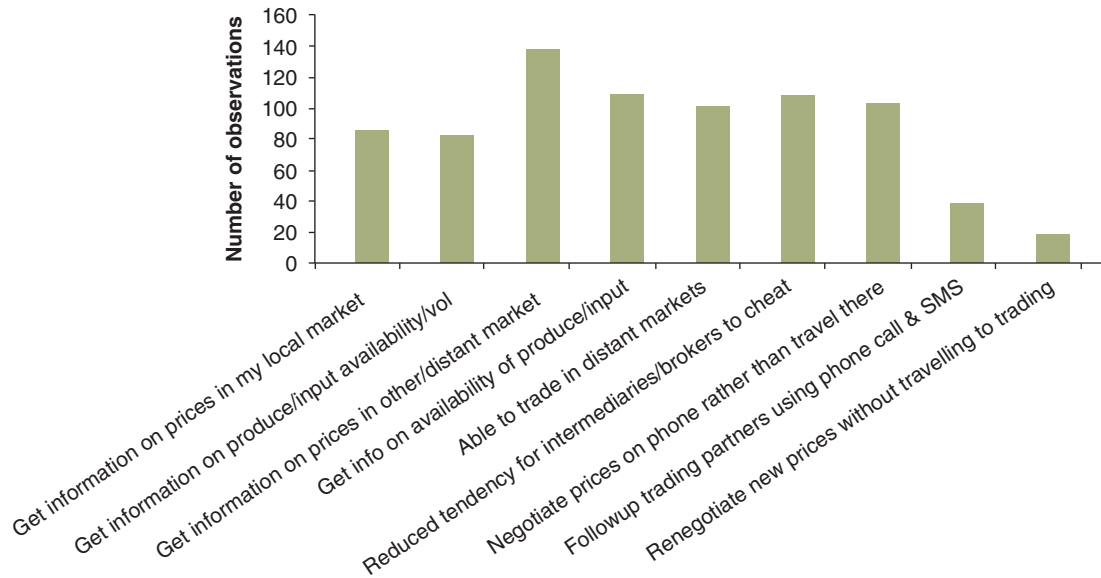
and long-term market intelligence. It also displays the likely sources of that information.

In the day-to-day marketing of their products, farmers are mainly at a considerable disadvantage. Their market information will come from a neighboring farmer who may have visited a market on the previous day. A trader's core skill is to read the market, assess supply and demand, and compute how these factors might affect price. Increasingly traders will triangulate their information with information from others. Given the opportunity, traders will exploit farmers' relative ignorance to buy low and, ideally, sell high. The power balance in these negotiations is altogether different when the trader senses that the farmer-interlocutor also appreciates the real market situation and can access different markets, buyers, and outlets.

Field observations show that traders use their mobile phones extensively for finding information (such as local and more distant prices and product availability), negotiating prices, and conducting entire transactions on the phone. These observations increasingly are supported by empirical evidence; figures 9.11 and 9.12 present examples from Kenya and Ghana.

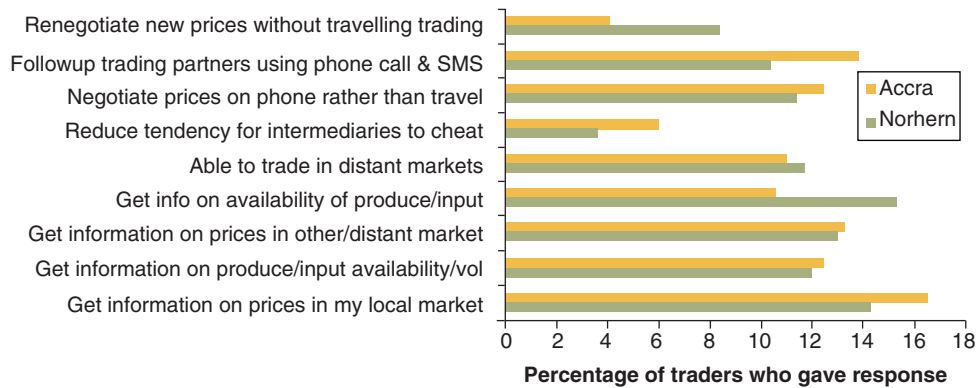
Research on negotiation approaches indicates that it is important to obtain as much information as possible prior to a negotiation. This information should include the trading patterns, goals, and preferences of those that one is negotiating with. Groups provided with more information in advance achieved more effective *and* efficient outcomes as well as higher levels of satisfaction with the negotiation. These findings reaffirm the findings from the Philippines discussed earlier in this module, where farmers reported feeling increased trust in their trading partners after farmers had gained access to mobile phones.

**FIGURE 9.11:** Traders’ Perceived Benefits of Using Mobile Phones, Kenya



Source: Okello 2010.

**FIGURE 9.12:** Traders’ Perception of the Benefits of Using Mobile Phones, Ghana



Source: Egyir, Al-Hassan, and Abakah 2010.

Research on tomato farmers’ negotiations with rural traders in Ethiopia showed that on average farmers’ initial asking price was about three times higher than the final price they obtained from buyers (Jaleta and Gardebroek 2007). Yet when farmers had market price information—typically obtained by a mobile phone call to acquaintances close to the central market—the difference between their initial asking price and the final price was reduced by 16.5 percent. In other words, market information increased farmers’ bargaining power by one-sixth.

Still other evidence indicates that farmers increasingly use mobile phones for real-time market research. In Bangladesh, for example, about 80 percent of farmers now have mobile phones; of these, two-thirds have owned mobile phones for

three to five years (Minten, Reardon, and Chen n.d.). About 70 percent of rice growers and 30 percent of potato growers contact multiple traders by phone to explore selling opportunities and prices, and about 60 percent will agree on the details of the trading deal over the phone. These findings explain and lend further weight to the findings presented earlier (for example, from Morocco, Malaysia, and the Philippines) on how the use of phones appears to increase farmers’ incomes and profits. An example from Georgia (box 9.3) provides additional evidence.

One of the most famous studies of the impact of mobile phones was carried out by Jensen (2007), who tracked impacts on the fisheries subsector as mobile phone coverage was extended along the coast of Kerala, South India (see Module 3

**BOX 9.3: Winter Salad Grower in Georgia Improves His Negotiating Position with Itinerant Traders by Mobile Phone**

Georgia has traditionally been the major supplier of winter greens to Russia, primarily to the Moscow wholesale market. The salad crops are purchased directly at the farm gate by a 5-ton trucker/trader, who delivers the bundled leaves to the Moscow wholesale market. To negotiate from a position of strength, the farmer would phone a colleague in the Moscow market to establish wholesale prices and make some estimates of supply. From experience, the farmer had good estimates of transport costs from Georgia to Moscow and of the typical margin the trader achieves. Using these figures, the farmer arrived at a sensible estimate of the price he was likely to receive, and he used this information as the basis of his opening offer.

*Source: Authors.*

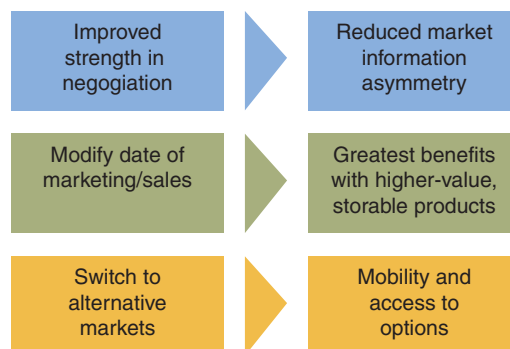
for details). The results were dramatic. Because farmers could identify the best markets for selling their catch, price volatility was reduced, wastage was significantly lower, fishermen achieved higher average prices, and consumer prices fell.

The marketing of caught fish differs from the marketing of most agricultural products, however. Fish typically swim in shoals, making for a “feast or famine” supply, whereas consumer demand is relatively stable. Fishermen, unlike most farmers, have their own transport, but they may not have information about where it is best for them to transport their fish for sale. By using their mobile phones, they can seek out nearby undersupplied beach auctions and deliver their fish directly to markets where supply is low and prices correspondingly high.

**ACCESSING IMMEDIATE MARKET INFORMATION: LESSONS LEARNED**

Short-term (immediate) market information refers to the constant (daily or weekly) changing picture of supply and demand requirements or a product in terms of quality, taste, grading, delivery, size, color, and alternative market opportunities. Figure 9.13 sets out the three ways that producers are likely to use this information. As shown in the previous discussion, farmers in Georgia used market information to strengthen their negotiating position, whereas in Kerala fishermen used market information to switch to alternative

**FIGURE 9.13: How Farmers Use Market Information to Improve Prices and Profits**



*Source: Authors.*

markets. Producers also use market information to decide when to harvest produce or, if possible, where to store it until they can sell it at higher prices.

The enlightened debate among practitioners centers on the relevance of the public sector’s role in market information services compared with that of the private sector, and on whether the best way forward is a partnership between the two sectors. Some take the view that if telephone infrastructure is provided, stakeholders will find a way to use the technology for gathering the price and market information that they need.

How is this debate playing out? The public sector in different countries has invested in its own market information systems. As explained in the overview, this role consists of three functions: (1) enumeration (collecting price data); (2) data analysis; and (3) dissemination. Their performance has generally been poor over the last decade.

Government employees have few incentives to attend wholesale markets out of normal office hours to collect real-time data. Analysis of price data sets frequently reveals disturbing gaps or suspicious similarities in prices from day to day. Field surveys often reveal little confidence in the information by farmers and traders. The information is rarely used except to give a general sense of the broad changes in product prices, and often it arrives so late that it services only for retrospective analysis by academics. In addition, government market information has been mainly posted on Internet sites to which small-scale farmers have almost no access (box 9.4).

Even if farmers can obtain the information from the Internet, the information is of limited use for changing the balance of power in negotiations between farmers and traders. Despite these

#### **BOX 9.4: Government-Provided Information on Market Prices: A South Asian Example**

A South Asian government took the view that the existence and dissemination of complete and accurate marketing information was the key to achieving both operational and pricing efficiency. Not only did farmers need agricultural market information to plan production and marketing, but market participants needed the information to arrive at optimal trading decisions.

The government's market information system was established in 2000 as an Internet portal with the aim of providing easy access to daily prices and arrivals by commodity. The operating budget is some US\$ 900,000 per year (which does not include enumerators' salaries but does cover the US\$ 11 monthly bonus if 20 daily reports are submitted). The system reports on 1,700 markets. The Internet site receives some 1.75 million hits per year at a public cost of US\$ 0.5 each.

The users are not farmers. They are graduates in the 35–44 age group, who are mainly academics or work for agriculture-based companies. It is claimed that outreach to farmers has not happened because of inadequate infrastructure (computers and networking), coupled with a lack of manpower and trained personnel in rural areas. Though still useful for broader economic growth, the ICT scheme has not yet reached those targeted in the outset of the intervention.

*Source:* Authors.

challenges, there is major potential for government-provided ICT services to improve as resources become available, infrastructure expands, and technological learning becomes more widespread. (See Module 13, where key lessons in building more effective IT-driven public services are discussed). In the future, smartphones might make Internet-based dissemination more effective, especially for interventions that seek to expand market intelligence (see the innovative practice summaries).

As discussed in the overview, however, open-source software that can be downloaded onto a laptop computer to send targeted SMS messages to a database of mobile phone owners may have a far greater impact. This technology offers the prospect of delivering market price information directly to farmers' mobile phones and thus empowering farmers to understand the value of their products and immediately firm up their negotiation positions. If governments do venture into this territory, a key issue will be the unit price of each SMS message (as discussed in the overview).

The private companies that have emerged more recently (typically in the last four to eight years) to deliver market information take a pro-active approach to understanding potential customers' information needs, and they build feedback loops to learn how their services can be better attuned to demand and more responsive to complaints. They use their own enumerators, whose employment depends on the accuracy of their price reporting. Generally their customers—mostly younger, more literate, and larger-scale farmers—have reacted positively. In the service operated by Reuters Market Light, evidence indicates that the information is further distributed by recipients to 5–12 others. In this process, the status of the primary recipient is elevated in their rural community. As emphasized in the overview, the early lesson is that it is not at all easy to manage and operate financially viable businesses selling information to farmers.

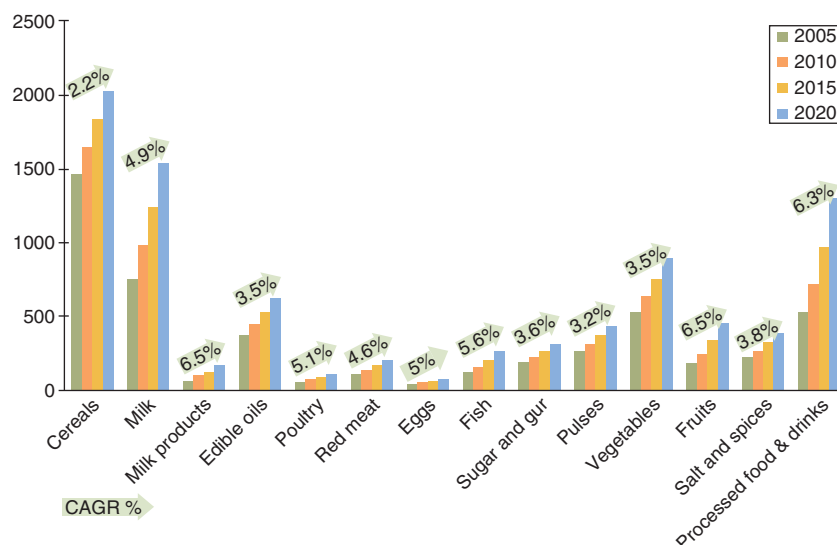
A third (and seemingly the most effective) option for providing market information is some kind of public-private partnership. Partnership with the private sector helps to overcome some of the public sector's challenges in gathering and disseminating accurate market data. Under outsourcing arrangements, for example, governments may purchase SMS-based agricultural information for extension agents to distribute or for direct distribution to farmers.

Another option is for the government line department to take responsibility for disseminating information itself. To do so, the department must build its own producer database, including information on producers' locations, key enterprises, farm sizes, and so forth, and negotiate with mobile phone companies to obtain SMS prices that more accurately reflect the actual cost of sending SMS messages. The government covers the costs of this service as well as the costs of running an incentivized market price reporting service by selling the SMS service to others—input suppliers, banks, and other companies—who wish to target messages/information to the farming community. Using the platform created to generate income by selling targeted messaging is a role that can be outsourced. If and how this sort of arrangement will play out in practice remains to be seen.

#### **ACCESSING MARKET INTELLIGENCE: LESSONS LEARNED**

Aside from increasing their profits and competitiveness through immediately useful information related to prices, markets, and logistics, farmers require information about market changes that may influence their production and marketing choices over the longer term. The purpose of market

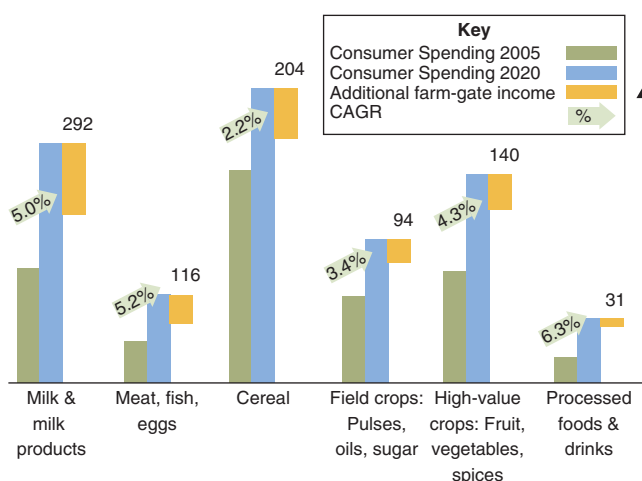
**FIGURE 9.14:** Aggregate Consumer Demand by Agricultural Product from 2005 to 2020 at a 5.5% Yearly Growth in GDP, India (Rs Billion)



Source: CESS 2007.

Note: CAGR = compound average growth rate.

**FIGURE 9.15:** Projected Consumer Expenditures in India from 2005 to 2020 and Additional Farm-Gate Income (Rs Billion)



Source: CESS 2007.

Note: CAGR = compound average growth rate.

intelligence is to improve farmers' understanding of changes in agricultural marketing and demand so that they can adjust their plans and production more closely to changing circumstances and generate the highest value.

Figures 9.14 and 9.15 illustrate why it is vital to understand the implications of changing patterns in consumer demand for agricultural products. The figures show projected increases

in consumer expenditure on food over the longer term in India. They are based on a combination of income elasticities for various food categories, the impact of urbanization, population increases, and a projected annual growth rate of 5.5 percent in GDP. Per capita cereal consumption is projected to be flat, and growth in demand for cereals is forecast to be broadly in line with population growth. Strong growth in consumption is expected for animal proteins (surpassing 5 percent), processed products (over 6 percent for milk and other processed foods and beverages), and high-value crops (over 4 percent). Demand for fish is projected to grow at more than 5 percent. Given that about half of India's fish is sourced from the sea, meeting this demand will require fish supplies from freshwater sources such as lakes, rivers, ponds, and fish farms to grow by about 10 percent per year. In business language, freshwater fish demand constitutes a "booming market." The single agricultural subsector that will deliver the greatest increase in farm-gate income is milk.

Patterns of consumption will change elsewhere as well. Huge increases in Africa's urban population (approximately 4.3 percent per annum) over the next decade will place strong additional demands on agriculture to supply a different mix of products. Changes in marketing systems will occur at the same time. Agribusiness will increasingly look to source raw material directly from producers. New, alternative marketing channels are emerging in many countries to deliver higher-quality products to supermarkets, hotels, exporters, and other buyers.



To facilitate diversification, farming communities are thought to require product-based information, which typically includes:

- **A general overview of the market.** What is the market's size, value, and growth rate? What are the divisions between sectors? Who are the competing suppliers?
- **Product specifications.** What are the prevailing grading and packing standards and consumer and market preferences (taste, color, size, season)?
- **Marketing issues.** What are the typical prices and seasonal price patterns, quality premiums, and marketing channels? What is the prognosis on future prices and changes occurring in the supply chains for the market?
- **Key contacts.** What are the names, addresses, and telephone numbers for key contacts, particularly buyers, agribusinesses, and traders but also specialist input suppliers and transport operators?

Development practitioners often underappreciate the value of names and addresses. Publishers in the agricultural sector understand the value that stakeholders place on contact databases, as they can be the key information required to open a new market opportunity, enable producers to deliver product a step further up the supply chain, or discover an alternative way of doing things. Field experience has repeatedly shown that larger-scale traders and agribusinesses are interested in making more direct purchases in the field, provided producers can collectively aggregate a critical mass of product.

Information that can be categorized as “market intelligence” changes slowly and is used occasionally (rather than every day). It is most naturally housed on a website from which individual farmers, farmer organizations, traders, and extension personnel can download and print it out for reference. The information is generally considered to be a public good (and thus unlikely to be delivered on a financially sustainable basis). For this reason, the information is mostly funded publicly, although the preparation of market intelligence is often outsourced.

## PRINCIPLES AND GUIDELINES FOR POTENTIAL INTERVENTIONS

Based on the accumulating evidence, experience, and lessons learned, a number of principles and guidelines are important to consider in developing market intelligence:

- **Market intelligence is one of the building blocks for stronger knowledge of the changing market for agricultural products.** The provision of market intelligence is primarily seen as a public-sector activity that should enable more disadvantaged farmers to explore

and discover market opportunities for themselves.

Because the information is relatively slow to change, is required only occasionally, and mostly needs to be downloaded and printed for later reflection, it can be conveniently housed on an Internet site.

- **Market information on prices, supplies, and demand can positively affect prices paid to farmers, but only if it is done well.** Farmers need a package of information that changes as their priorities change throughout the agricultural season. This information package can encompass weather forecasts, technical advice, market prices, pest and disease alerts, and messages about schemes and support from the appropriate line departments. Market information on its own is not enough to make farmers both more productive and more profitable, however. An integrated approach to information generation and delivery is required.
- **Both the private sector and government are having difficulty in delivering ICT-based information in a sustainable, effective way.** One approach is to outsource the supply of agricultural and market information to the private sector. This approach would help to underwrite their finance, enable them to use the financial security to build a platform for a range of value-added services, and enable them to look for alternative income sources from other private companies delivering products and services to the farming community.
- **An alternative arrangement is a public-private partnership, in which the public sector plays a dominant role.** New open-source technology is making it possible for government institutions to provide far more targeted information, primarily by sending local-language SMS messages or voice messages directly to farmers' phones and by allowing feedback from the field. The technology helps overcome the major criticism that government information systems do not reach their clients. Open-source systems can become the foundation of an ICT-mediated extension service that alerts clients to pest and disease problems, other information vital for production, and opportunities to participate in new government schemes. The potential for generating income to cover operating costs would be significantly increased if the government would use its resources to build an accurate and useful database of its farming clients, with their mobile phone numbers and farming characteristics, and leverage a very substantial reduction in the cost of SMS messages (see the next point). The extension service will have the very real possibility of selling SMS broadcasting services to clients supporting the

farming sector, such as banking institutions (to send messages, technical and price information, and loan repayment reminders to borrowers) or input suppliers (to promote products, remind farmers to buy inputs, and respond to pest, disease, and plant/animal nutrition issues). Sales of such services, along with the collection of price data, may best be done by the private sector or suitably incentivized individuals.

- **Lower the cost of SMS.** Clearly there are important opportunities for enhancing the range, scale, and impact of information dissemination by working with the regulator to reduce prices for bulk messaging to producers. Development institutions need to be able to benchmark costs to strengthen negotiations when proposing the development of public good, SMS-based information services.
- **Invest in farmer education and extension training.** Helping smallholders to understand needs for grading, organization, coordination, and market opportunities is critical to success. Marketing education, especially experiential marketing training, can be an important element in leveraging the benefits that ICT can bring to farmers' prices and returns.

### INNOVATIVE PRACTICE SUMMARY

#### Evidence of the Impact of Immediate Market Information in Asia and Africa

The summaries that follow describe how various strategies for disseminating short-term market information have

affected (or are anticipated to affect) farmers' profits. The delivery methods vary considerably, ranging from immediate access through SMS and radio to the physical circulation of information sent via SMS to extension agents.

#### Better Incomes for Farmers with Better Market Information in Madhya Pradesh

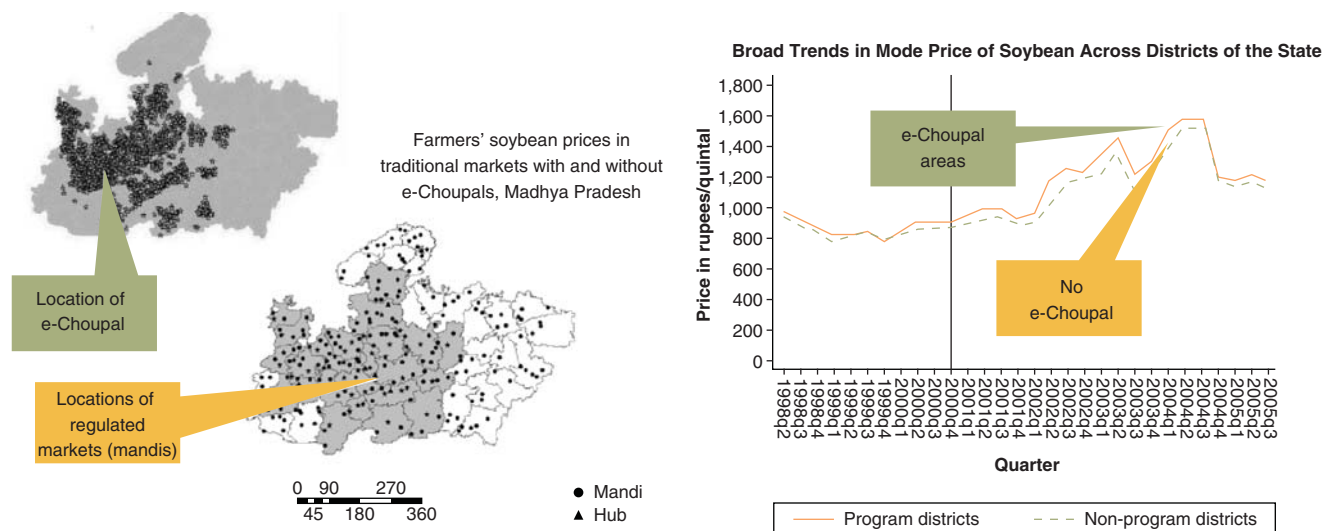
Goyal (2008) compared farmer prices in the regulated market (mandi) for soybeans in two areas of Madhya Pradesh. In some areas, 1,600 Internet kiosks (e-Choupals) (<http://www.itcportal.com/sustainability/lets-put-india-first/home.aspx>) operated by ITC disseminated price information, whereas the other areas relied only on the mandi for such information (figure 9.16).

Goyal found that farmers obtained better prices when they had access to a wider range of market information. Farmers' price increases ranged from 1 percent to 5 percent, with an average of 1.6 percent. The additional farm income from soybeans in Madhya Pradesh was estimated at about US\$ 10–20 million per year. This income was almost certainly a transfer from traders to producers as a result of producers' greater market knowledge and improved strength in negotiation.

#### In India, Reuters Provides SMS-Based Market Information to Farmers

In 2007, Thompson Reuters introduced the Reuters Market Light (RML) service in India, a mobile information service sending customized message to farmers in their local language (for details, see Module 3. A survey of the 243 farmers

**FIGURE 9.16:** Prices Paid to Soybean Farmers in Areas with and without Market Information from e-Choupals (Internet Kiosks)



Source: Goyal 2008.

that received the Reuters Market Light package (onion, wheat, pomegranate, soybean, and tomato farmers) found that around 60 percent believed that they obtained improved prices and often changed the time and location of sales. The information was passed on to 5–12 others.

The analysis did not demonstrate any overall impact on prices paid to farmers. This finding needs to be seen in context, however. Produce prices are rising rapidly in Maharashtra, and the vast majority of produce is sold by public auction, where knowledge of earlier prices has little or no impact on the price that farmers receive. The research was carried out only for one year when this new information technology was provided to a number of randomly selected farmers, but farmers will need time to learn to exploit this marketing tool.

The data did show that RML users were able to achieve 8–9 percent increase in prices for the relatively small volume of produce sold directly to visiting traders, and that the service appeared to have a greater effect on younger users, who may be on the front end of a learning curve. Younger users tended to receive higher prices (6 percent) than nonusers of the same age and to increase the proportion of produce that was graded.

### **Government Program to Equip Extension Workers with Timely Agricultural Information and Improve Farm-Gate Prices in Maharashtra**

The annual cost for an extension officer to operate in India is around US\$ 5,000–7,000 per year. These officers are generally isolated. They are rarely trained or provided with up-to-date technical data and market information to disseminate to farmers.

Under a new Agricultural Competitiveness Project to improve the market orientation of production, 20,000 extension officers (plus other farmer decision influencers) who own mobile phones will receive annual subscriptions to SMS-based information services.<sup>4</sup> The services (in the local language) will be tailored to suit local agricultural specialization and consist of technical information, local weather forecasts, price information, overviews of the market, and information related to the competitiveness project, such as training opportunities, government agricultural schemes, and so on.

The cost will be around US\$ 10–15 per year (constituting about 0.2 percent of the operating cost for an extension officer). Each officer will receive around 1,000 messages per year. Extension

officers will be specifically tasked with disseminating the information to smaller-scale and more disadvantaged farmers.

The annual cost of the SMS program will be about US\$ 500,000. Annual crop sales in wholesale markets in the state are valued at about US\$ 8 billion per year. If the SMS market information service for 20,000 extension officers in Maharashtra has an effect similar to that of the 1,600 Internet kiosks in Madhya Pradesh (where the e-Choupal scheme raised prices paid to farmers by 1.6 percent), it could generate an increase in farm-gate income of some US\$ 120 million.

### **Radio Raises Farmers' Maize Prices in Uganda**

Svensson and Yanagizawa (2009) assessed how prices paid to farmers were influenced by market information collected by the Market Information Service Project and disseminated through local FM radio. The information was broadcast through daily bulletins of 2–4 minutes and a longer weekly program that provided district market prices.

Having access to a radio was associated with a 15 percent higher farm-gate price. Where market information was not disseminated through the radio, there was no effect. The results suggest that reducing the information asymmetries between farmers and other intermediaries increased farmers' bargaining power.

### **Market Price and Supply Information for Farmers in Senegal**

Manobi's Time2Market (T2M) application provides real-time information on prices and arrival status of products in markets (Annerose 2010). Manobi independently collects the information, which it uploads onto a central database using mobile phones that dial in to the server via WAP (wireless application protocol, which is specifically designed for handheld wireless devices to browse Internet content). It offers access to the data for producers, exporters, and public agencies through the web, WAP, SMS, and voice.

Farmers can check prices before they set off to sell their produce and discover where they are likely to find the best offers. Farmers have secured, on average, about 15 percent higher profits after having paid net costs, including the price of Manobi's service.

### **Esoko Develops a B2B Market Information Exchange to Increase Market Efficiencies in Ghana**

Esoko's (<http://www.esoko.com/>) business model is to become a market information exchange that aggregates and delivers

4 Information in this section is based on the Project Appraisal Document for the Maharashtra Agricultural Competitiveness Project (<http://web.worldbank.org/external/projects/main?Projectid=P120836&theSitePK=40941&piPK=73230&pagePK=64283627&menuPK=228424>).

market information and intelligence.<sup>5</sup> The idea driving the model is that most businesses in the agricultural value chain collect and deliver their own data; Esoko will provide tools and a platform and co-opt businesses to generate content for the platform.

Esoko pays on an incentive basis to acquire information, using targets and bonuses. Their revenue-generation model is based on levels of subscriptions (bronze, silver, gold, platinum), each with a different pricing structure and its own mix of content and tools.

The impact of this information on traders, exporters, transporters, procurers, and others in the agricultural value chain is still to be determined. The service is believed to have the potential to reduce inefficiencies in the value chain. For example, an exporter took 60 days and needed 5 people in the value chain to procure a natural plant product, but with Esoko's technology, the procurement process required 31 days and 3 people, improving both the major traders' and producers' share of the export price.

Esoko offers options for farmers as well. Anyone with a mobile phone can request data for the cost of an SMS, without a subscription. For a subscription of US\$ 1 per month, farmers can automatically receive information on commodities, markets, and other topics of interest.

In developing a model for selling information to farmers, Esoko encountered a few challenges. Farmers are widely dispersed in the field and hard to reach. It is also difficult to quantify the exact value that the service generates for farmers. Free field trials for farmers elicited self-reported evidence of a 20–40

percent improvement in revenue. Sixty-eight percent of farmers said that they would pay for the service; every farmer who received information would forward it to a further 10 farmers. (For additional details on Esoko, see IPS in Module 3.)

### INNOVATIVE PRACTICE SUMMARY

#### Web Portals Offer the Big Picture on Markets in Africa, Europe, and Asia

The summaries that follow describe web portals that offer market intelligence in three quite different settings: South Africa, Moldova, and India. The information spans a wide range, including long-term price trends, quality standards, options for marketing export crops, market advice specifically developed for smallholders, and overviews of value chains for individual products. This kind of information can shorten the time that producers need to acquire a sound knowledge base to develop production and marketing strategies.

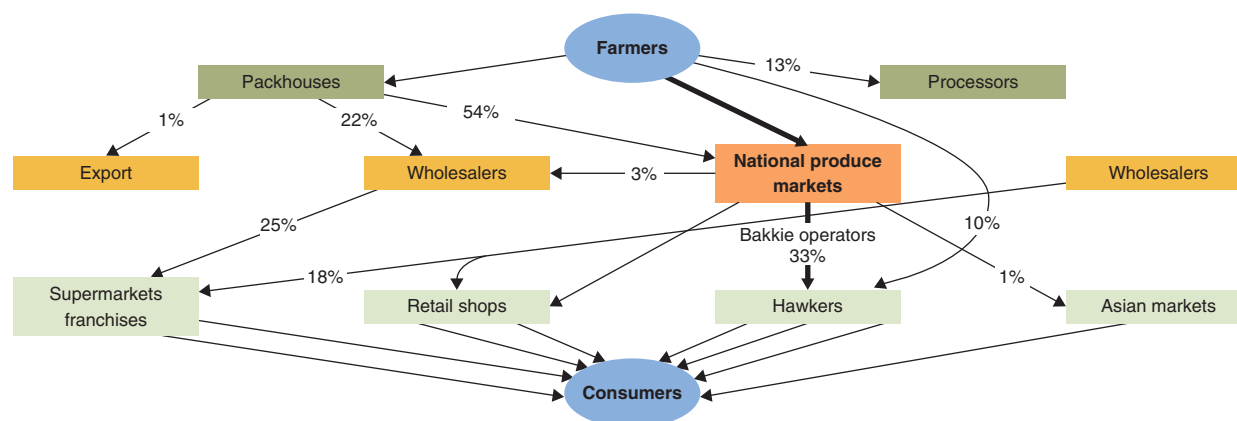
#### Market Intelligence from Price to Advice in South Africa

Market intelligence is included as part of a marketing extension program developed by FAO and the Republic of South Africa. Overviews of the markets for different products are posted on the program's website. They are downloaded by farmers as well as extension officers providing marketing extension training, particularly to South Africa's emerging cadre of black farmers.

The reports cover horticultural crops, livestock, dairy, wool and mohair, and broilers and eggs, and aside from the information on markets, they include price histories, grading standards (fat codes for beef animals, for example), and advice on market options for smaller-scale farmers. Figures 9.17 and 9.18 reproduce examples of marketing information for

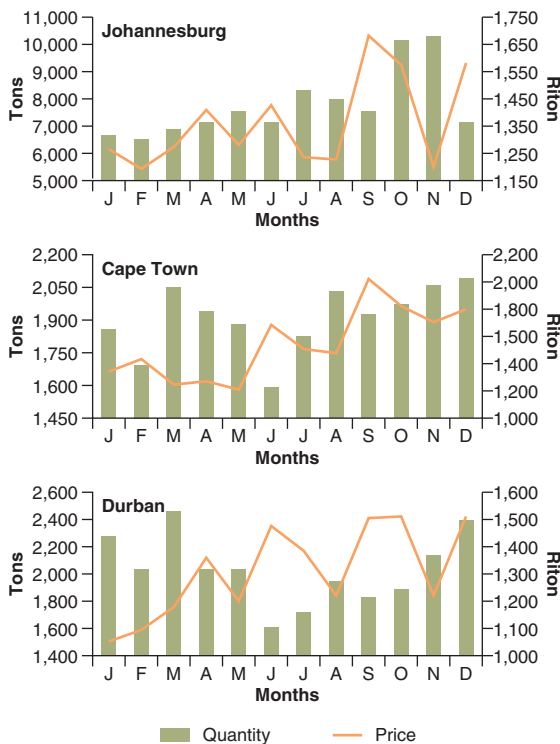
5 Information in this case study is based on personal communication with Esoko staff.

**FIGURE 9.17:** Vegetable Marketing Channels, Republic of South Africa



Source: Ministry of Agriculture, The South Africa Horticulture Market 2000.  
Note: A "bakkie" is a pickup truck.

**FIGURE 9.18: Average Tomato Sales for Three Fresh Produce Markets, South Africa**



Source: NDAA 2000.

horticultural crops and fresh produce in South Africa (<http://www.nda.agric.za/docs/GenPub/marketEx.htm>).

As an adjunct to this information, the Department of Agriculture website (<http://www.daff.gov.za/>) lists over 40 value chains, providing an overview of the market for a range of products, including field crops, livestock, and horticultural products. The Agrimark website ([http://www.agrimark.co.za/about\\_frame.htm](http://www.agrimark.co.za/about_frame.htm)) posts weekly reports on key commodities such as sugar, maize, and livestock, which build up a picture of the market for these products over the medium term. This is a good example of how government can provide a comprehensive market intelligence service aimed at building farmers' understanding of the market. Interestingly the main criticism of the information has been the urgent need to update it, especially the contact details of key organizations.

### “Export Moldova” Portfolio Provides Detailed Export Market Assistance

Another example of ICT used to provide market intelligence comes from Moldova, where the USAID/CNFA website, “Export Moldova” (<http://www.acsa.md/category.php?l=ro&idc=178>), has been incorporated into the larger

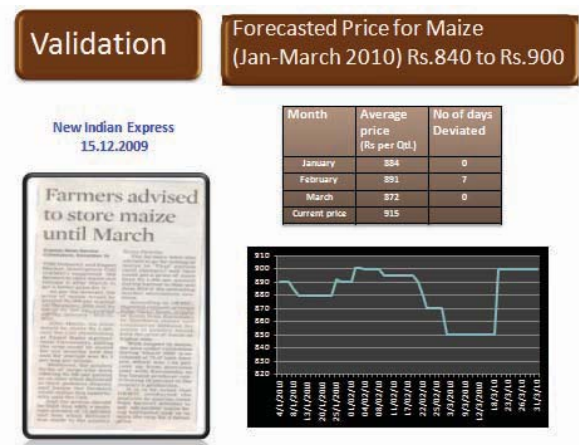
national extension service website. Export Moldova provides a portfolio of important information to traders and producers to facilitate their access to export markets. The information covers 13 products and drills down to detailed market information on export markets, varieties, packaging, and postharvest handling and processes, as well as EU quality standards, the standards endorsed by Global G.A.P., and similar information.<sup>6</sup>

### Detailed Market Price Projections from India’s AGMARK Service

In India, under the World Bank-funded National Agricultural Innovation Project (NAIP), a consortium headed by the Tamil Nadu Agricultural University has developed a largely web-based market intelligence service (although SMS and print media are also used). The service, AGMARK (<http://www.tnagmark.tn.nic.in>), carries out a number of functions aimed at improving farmers' prices and their understanding of the bigger marketing picture for selected products.

Like the Moldova portal, the NAIP portal offers information on grading standards, export processes, and postharvest technology, but its innovative element is a projection of future prices based on rigorous surveys of the trade, international information, and an understanding of Indian and global production data (figure 9.19). With this information, the service generates future price estimates to enable growers to improve their decisions to sell or store products.

**FIGURE 9.19: India’s Farmers See the Bigger Picture: AGMARK’s Market Price Projections**



Source: Tamil Nadu Agricultural University.

6 CNFA is the Citizens Network for Foreign Affairs.

## Topic Note 9.4: ICTS FACILITATE ACCESS TO AND DELIVERY OF INPUTS

### TRENDS AND ISSUES

Farmers' yields deviate from potential yields for a variety of reasons: poor climate or weather may play a part, along with other factors such as socioeconomic status, physical infrastructure, institutional and government policies, or poor access to farming technology or finance. The benefits of narrowing the yield gap include increased productivity and profits. These issues—covered elsewhere in this sourcebook—remain a central challenge in improving farming efficiency. Why don't farmers use inputs and intensify their production more? The response to this question often is limited to farmers' lack of knowledge about technology, its affordability, and farmers' access to working capital.

Yet farmers may also lack information on how to get inputs. Farmers can be unsure when inputs are available, particularly when the government distributes subsidized inputs. Farmers' buying habits may also be suboptimal; a little "nudging" at the right time could help them purchase inputs at the correct time. This note examines how much of the yield gap is related to problems in accessing inputs and how ICT can be used to facilitate access. To date, research on this subject has been limited; it might be important to prioritize for further research.

### ICTS AND IMPROVED ACCESS TO INPUTS: LESSONS LEARNED

Farmers' need accurate information on agricultural techniques, including input use, and they also need to source good-quality inputs in a timely way for production. In a study of mobile phone use in India, six of the focus groups interviewed highlighted difficulties in sourcing inputs such as fertilizer, seed, and agrochemicals for plant protection. They highlighted this problem twice as frequently as the next key problem, which was their lack of irrigation. Several groups noted that they lacked information for distinguishing genuine products from the counterfeits flooding the market, which remain a significant productivity drain. Their concern over accessing inputs was echoed in surveys of how Indian farmers used their mobile phones. The search for inputs—particularly seed, fertilizer, and plant protection chemicals—was listed high among farmers' reasons for using mobile phones.

Even if they know where to buy inputs, farmers do not or cannot always buy them at the right time. Duflo, Kremer, and

Robinson (2009) argue that a tendency to procrastinate may explain why so few African farmers use fertilizer, despite knowing that it raises yields and profits. Only 9 percent of farmers interviewed believed that fertilizer would *not* increase their profits, yet only 29 percent had used any fertilizer in either of the two preceding seasons. When asked why, almost four-fifths of the respondents said that they did not have enough money to buy fertilizer, although fertilizer was readily available, and even poor farmers earned enough to buy fertilizer for a portion of their fields. Better intentions made little difference. Virtually all farmers said they planned to use fertilizer the following season, but only 37 percent actually did so.

Duflo and colleagues contend that the reason for this gap between thought and action is that many farmers are biased toward the present and procrastinate repeatedly. Right after the harvest, when farmers are cash-rich, most can afford to buy fertilizer. But they don't. They postpone the purchase, believing they will make it later. It seems that a small discount, and little "nudging," could improve the intensity of input use.

The question is whether ICT, with targeted messages, could be effective for helping farmers to become more rational and better-organized buyers of inputs. In other circumstances, having access to such information through ICT seems to provide clear benefits (table 9.5):

- In India, farmers with access to ICT services reported 10–40 percent yield increases, primarily through gaining better access to hybrid seed and being encouraged to introduce new farming practices (Vodafone India 2009). All farmers claimed that their mobile phones had led to increased yields, with some also citing price and revenue improvement. These increases are a result of better information flows through the use of mobile phones and other ICT services such as the e-Choupal.
- A national survey of Indian farmers found that only 40 percent of farm households accessed information about modern agricultural techniques and inputs.<sup>7</sup> The

<sup>7</sup> Situation assessment survey of farmers conducted by the National Sample Survey Organization (June 2005), Government of India, quoted in Mittal, Gandhi, and Tripathi (2010).

**TABLE 9.5: Information Priorities of Farmers Using Mobile Phones in India (Ranked)**

INFORMATION PROVIDED VIA:		
NSS 59TH ROUND OF PHONE USAGE	VODAPHONE	REUTERS MARKET LIGHT
Seed	Seed	Accurate local weather forecasts
Fertilizer application	Prices	Technical information
Plant protection	Plant protection	Input sources and/or production costs
Harvesting and marketing	Fertilizer application	Market information
Farm machinery	Harvesting and marketing	
	Farm machinery	

Source: Authors.

survey also found that almost all small-scale farmers reported some increase in convenience and cost savings from using their mobile phones to seek information such as input availability.<sup>8</sup>

- In a survey of farmers who received the RML service, 50 percent said they reduced expenditures on agricultural inputs because of SMS information services. The service is also changing farmers' behavior: 44 percent said that it changed their fertilizer applications and 43 percent said that it changed the timing of spraying.<sup>9</sup>

A reason commonly cited for the difficulty in obtaining inputs is that the government will often distribute subsidized inputs, often through schemes that last only a few years. These policies restrict the potential for the private sector to supply inputs, and when government programs end, no company can sustainably deliver inputs to the farming community.

### PRINCIPLES AND GUIDELINES FOR POTENTIAL INTERVENTIONS

Given the multidimensional challenges of designing an effective intervention to supply inputs, a successful design will take a multipronged approach:

- **Find innovative ways to form private-sector partnerships.** Better involvement and organization of stakeholders can improve farmers' access to information about inputs. Agribusinesses and input suppliers have an incentive to invest in ICT services

that provide input information because of the potential benefits that can be realized from increasing input sales. Moreover, input suppliers and dealers can come together to create partnerships to facilitate access to inputs. They can do so by combining their data and communicating via SMS. It is certainly envisaged that SMS systems can and will be used by input supply companies to alert farmers to the arrival of inputs, remind them to purchase inputs, and provide timely advice on proper input use, especially for treating emerging pest and disease problems.

- **Identify ways to use ICT to improve governance of subsidy programs.** ICT offers a means of delivering subsidies to the intended beneficiaries. It enables community procurement of inputs and input delivery through the private sector. The embedded e-payment system guarantees timely payment from the government and encourages the emergence of a private network of input suppliers.
- **Education and information dissemination are key components of supplying inputs through ICT.** It is critical for farmers to have a rooted understanding of the potential long-term implications on productivity and profits of using better inputs in a timely manner. On a more practical level, farmers need information about how to source inputs and identify counterfeit supplies, which remain a significant productivity drain.<sup>10</sup> Examples are emerging in Nigeria of e-systems for verifying the provenance of specific agricultural inputs. Similar systems might be applied elsewhere.

8 Mittal, Gandhi, and Tripathi (2010).

9 The World Bank and Reuters are funding a project commissioned by Oxford University's Economics Department and International Food Policy Research Institute (IFPRI) to quantify the impact of the RML service on farm profitability.

10 Mittal, Gandhi, and Tripathi (2010).

The innovative practice summaries highlight two experiences in supplying inputs based on the use of ICT, one from India and one from Zambia. These innovations seek to overcome some of the limitations encountered in input supply programs, such as the challenges of transmitting information on input use to widely dispersed farmers or of ensuring that government-subsidized inputs reach the intended beneficiaries.

### INNOVATIVE PRACTICE SUMMARY

#### Agribusiness Advises India's Farmers through e-Choupal Kiosks

ITC is an agribusiness that provides information services to India's farmers through 6,500 e-Choupal (Internet) kiosks (<http://www.itcportal.com/sustainability/lets-put-india-first/home.aspx>). Started in 2000, the kiosks presently operate in 40,000 Indian villages to reach approximately 4 million farmers. These kiosks are hubs where farmers can obtain price information, seek options for selling their produce, buy inputs, and obtain advice on farming practices related to input use. Services are offered free of charge; ITC earns

its revenues from commodity transactions at the kiosks and from using the kiosks to market other goods such as agricultural inputs.<sup>11</sup> In addition to the kiosks, ITC will also offer information services to farmers over mobile phone, thus deepening its relationship with the farmer (Kumar n.d.).

Table 9.6 shows the impact of e-Choupal service on farmers' yields and costs. Ultimately ITC expects half of its revenue to come from input sales.

### INNOVATIVE PRACTICE SUMMARY

#### Zambian Farmers Buy Subsidized Inputs via Mobile Phone

In Zambia, an electronic voucher (e-voucher) system is being piloted by the United Nations World Food Program (WFP), CARE, and the local Conservation Farming Unit (CFU). With

11 "ITC's Rural Development Philosophy at Work" ITC, [http://www.itcportal.com/ruraldevp\\_philosophy/echoupal.htm](http://www.itcportal.com/ruraldevp_philosophy/echoupal.htm), accessed July 2011.

**TABLE 9.6:** Agricultural Interventions Made through e-Choupal Kiosks and Their Impacts

TYPE OF AGRICULTURAL TECHNOLOGY OR PRACTICE	BEFORE E-CHOUPAL: 2000	E-CHOUPAL INTERVENTION	IMPACT
Seed use per unit area	For soybeans, farmers used a high planting density (45–50 kg seed/acre)	Farmers advised to use a lower planting density (30–35 kg seed/acre)	Savings: 10 kg seed/acre (Rs 200/acre)
Seed of verified quality	Farmers' limited awareness of benefits of certified and foundation seed led to limited use of such seed	The e-Choupal demonstrated the benefits of foundation and certified seed through its agricultural extension program (Choupal Pradarshan Khet)	Yield increase and self-sufficiency in seed (for self-fertilizing, nonhybrid crops)
Seed treatment	Low awareness of benefits of seed treatment	The e-Choupal spread awareness about benefits of seed treatment and provided treated seed to some farmers	Germination percentage and yields increased significantly
New varieties and improved timing of planting	Farmers used varieties inappropriate for local conditions (climate, pest, and disease incidence and timing of rainfall)	The e-Choupal suggested new varieties suitable for adverse conditions and advised farmers how to better align planting with rainfall	Most suitable variety planted on time, leading to higher yields
Weed and other pest management	Farmers controlled weeds by hand; for pest control, they were largely guided by local input dealers	The e-Choupal suggested use of herbicides and/or pesticides in specific circumstances	Effective weed and pest control leading to low loss of yield
Soil testing	No awareness of soil testing and consequent benefits	The e-Choupal propagated the practice of replenishing soil nutrients based on soil testing reports	Reduced fertilizer costs and more appropriate nutrients applied
Storage practices and market linkages	Low awareness of hygienic practices for stored crops; limited opportunities to sell products	The e-Choupal advised storage of grain based on moisture content to avoid loss and contamination; it offered farmers alternate opportunities to sell their products	Reduced losses from poor storage practices as well as better earnings from the sale of output

Source: ITC Ltd 2010.



the help of Mobile Transactions (a company specializing in low-cost payment and financial transaction services) (<http://www.mtzi.net/>), the e-voucher system empowers smallholders to obtain subsidized inputs from private firms (giving the firms, in turn, an incentive to expand and improve their business).<sup>12</sup>

An e-voucher is redeemed in the following steps:<sup>13</sup>

1. On receipt of the e-voucher, which resembles a prepaid mobile phone card, the farmer goes to a registered agrodealer. He/she buys inputs using the voucher and the amount of top-up cash required to complete the purchase.
2. He/she scratches the first foil to reveal a PIN. The agrodealer uses the PIN to validate the authenticity of the farmer's voucher and certify receipt of the top-up payment. Upon validation, the redeemable cash value of the scratch card is automatically credited to the supplier's transaction account from the master "subsidy account."
3. Upon delivery (which is either immediate in the case of an agrodealer or later if the buyer purchases from an agent), the farmer scratches the second PIN to confirm delivery and complete the final authorization, which allows the agrodealer or agent to receive final payment from the master subsidy account.

Under the government's Fertiliser Support Programme (FSP), small-scale farmers had difficulty accessing inputs owing to delays in input distribution and poor monitoring of the program's fertilizer distribution.<sup>14</sup> The mobile transaction system enables electronic monitoring of the e-voucher system, documenting which vouchers have been redeemed, where, and for which products, thereby improving the efficiency and effectiveness of the input subsidies.<sup>15</sup> Because farmers are registered with the system, they can be identified more

effectively for specific training programs with input- and productivity-enhancing components. Moreover, the e-voucher system supports private agribusinesses by making them the direct source for inputs; as more private input dealers choose to participate, competition may increase.

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13 Based on testimony to the Parliamentary Committees on Agriculture and Lands on Performance of the Fertiliser Support Programme in Zambia.

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## Module 10: ICT APPLICATIONS FOR SMALLHOLDER INCLUSION IN AGRIBUSINESS SUPPLY CHAINS

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**Overview.** Smallholders can raise their incomes by participating in commercial supply chains, but including smallholders entails significant challenges for agribusinesses and smallholders. For agribusinesses, interacting with a large group of smallholders implies high transaction and monitoring costs to ensure quality, safety, and timely delivery. For smallholders, participation can be risky, requiring access to inputs and training to satisfy stringent quality requirements. Information communication technologies (ICTs) facilitate exchanges and flows of information between parties all along the supply chain and can be used to manage transactions, arrange logistics, and ensure that quality specifications are clearly understood. Under the right circumstances agribusinesses have the incentives, capacity, and resources to create and apply technologies that support inclusion. Public organizations play an important role by implementing supportive policies, fostering public-private collaboration to develop ICT applications, and by developing and using their own ICT applications.

**Topic Note 10.1: Private-sector Efforts to Integrate Smallholders in Commercial Supply Chains through ICT Applications.** Many companies have taken innovative, instructive steps to include smallholders in supply chains. These efforts are useful to understand because agribusinesses have the motivation, capacity, and resources to create and apply ICTs that help to overcome the problems involved. Private-sector demand for technological solutions appropriate for developing contexts has created a market for ICT applications and spurred innovation in private companies in developing economies, most vividly in India and Kenya.

- **EID Parry's Indiagriline Services Improve Sugarcane Production and Sourcing**
- **Virtual City's AgriManagr Builds Better Supply-Chain Links with Farmers**

**Topic Note 10.2: Public-sector Efforts to Integrate Smallholders in Commercial Supply Chains through ICT Applications.** The public sector does indeed lead collaborations with other partners, including the private sector, to produce useful applications for a given development context. The public sector can bring together stakeholders that might otherwise be competitors or unable to collaborate effectively. These partnerships require careful structuring, however, and prior agreements regarding revenue sharing and intellectual property rights. Although donor-funded projects present unique challenges to scale and sustainability, they can be overcome.

- **ACDI/VOCA's ICT Solutions Help Private Companies Source from Smallholders in India**
- **TIPCEE's ICT Applications Bring Ghanaian Smallholders into Export Supply Chains**

### OVERVIEW

The global food industry has undergone significant structural changes in recent years that have created opportunities for smallholder farmers in developing nations. The inclusion of these smallholders in agribusiness supply chains offers significant opportunities as well as challenges. ICTs can aid smallholders in taking advantage of opportunities and mitigating some of the challenges, as discussed in this module.

### Smallholders in the Global Food Industry: A Complex Relationship

The global food industry, with over US\$ 4 trillion in annual retail sales (Gelhar 2009), comprises agribusinesses of varying sizes. The largest are multinational corporations that operate internationally. In this module, "agribusiness" refers to a wide range of private companies:

- Retailers such as supermarkets or convenience stores (Walmart, Carrefour, ITC Choupal Fresh)

- Food processors and manufacturers (Nestlé, Kraft, Unilever)
- Input suppliers who produce fertilizer, seed, pesticide, irrigation equipment, and farm machinery (Bayer, Syngenta, Monsanto).
- Producers that may be smallholder farmers, cooperatives, or corporate farming entities.
- Wholesalers, traders, and other intermediaries in a supply chain that connect retailers or processors to producers (ADM, Bungee, Cargill, Olam).

In recent years, following deregulation of the food industry in many developing nations (Reardon et al. 2009:5) and the lowering of trade barriers in developed ones (World Bank 2008), private, market-driven agribusinesses have replaced state-supported entities. On the demand side, an increasingly urban population worldwide requires food to be delivered farther and farther from the farm; with rising incomes and changing preferences, this population also demands higher levels of food safety, quality, and traceability.

Changes in the informal supply environment have accompanied changes in the broader industry. The entry of large, private, often international agribusinesses from the formal economy has caused fragmented, informal suppliers to consolidate and formalize. To meet supply requirements arising from changing demands, agribusinesses often prefer to source through lead farmers or farmer cooperatives or directly from individual farmers. The alternative—purchasing from wholesale markets—can pose difficulties, be inefficient, and most important, cost more. When sourcing from wholesale markets, agribusinesses have little quality control, face uncertainties in supply and price, and lose the ability to trace products (which consumers increasingly demand).

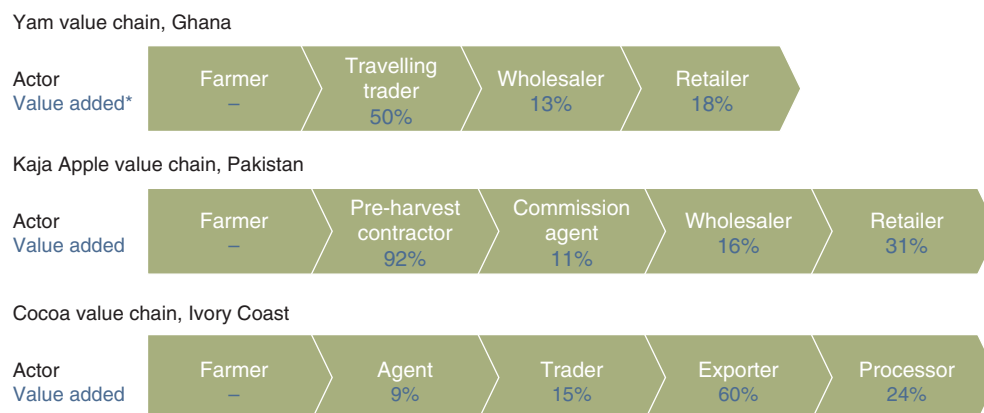
When farmers are insulated by layers of intermediaries, it is difficult to communicate to farmers what items or quality levels the market demands. Reducing the number of intermediaries (“disintermediation”) allows companies to reduce, deploy their market power more directly to garner lower prices, and improve quality control.

Direct procurement and improvements in production, transport, and supply-chain technologies make it possible to source competitively from vast numbers of suppliers and increase the relative importance of factor costs such as labor and raw materials. Companies looking to economize move production to places where factor costs are lower, which presents an enormous opportunity for farmers in developing countries (World Economic Forum 2009).

“Commercial supply chain” refers to a supply chain in which a private agribusiness is sourcing agricultural produce from farmers or selling products to farmers in accordance with a profit-seeking business model. “Supply chain” typically refers to the set of buy-sell interactions as goods flow from raw materials through production to the final retailer where consumers can buy them. “Value chain” generally refers to the whole ecosystem of players involved moving from the retailer backward to the producer. These terms are often used interchangeably, and a special distinction is not made in this module. Such chains can be of various types (see figure 10.1).

Although participation in commercial supply chains presents an opportunity for smallholders to attain higher incomes (between 10 and 100 percent; see World Bank 2008:127) and reduce poverty, these outcomes are not certain unless other important factors are addressed. For example, actual income changes depend on the crop, the time needed for farmers to learn to produce the crop more efficiently, and

**FIGURE 10.1:** Examples of Value Chains, Their Participants, and the Value Added Along the Chain



\* Value added = price received by actor – price paid by actor.  
Source: World Economic Forum 2009.

**TABLE 10.1: The Business Case for and Against Procuring from Small-Scale Producers**

FOR	AGAINST
<ul style="list-style-type: none"> <li>• Smallholders' comparative advantages (premium quality, access to land, and so on)</li> <li>• Risk management: Securing supply in volatile markets, spreading portfolio geographically, reducing risk of undersupply and localized pest and disease problems</li> <li>• Flexibility in production: Capacity to ramp up or ramp down production without incurring fixed costs (contract farming)</li> <li>• Access to donor assistance</li> </ul>	<p>Costs and risks in organizing supply from dispersed producers:</p> <ul style="list-style-type: none"> <li>• Quantity</li> <li>• Quality</li> <li>• Consistency</li> <li>• Safety</li> <li>• Traceability</li> <li>• Compliance with rising standards</li> <li>• Packaging</li> <li>• Loyalty and fulfillment of commitments by farmers</li> <li>• Negotiation time and costs</li> </ul>

Source: K. Kumar, personal communication.

the quality and other standards required. Changes in income may not be sustainable unless accompanied by improved practices such as postharvest handling or risk management.

Market forces do not in and of themselves guarantee smallholders' inclusion in modern supply chains. When possible, companies might seek to source from larger producers, who can deliver economies of scale, often are better educated, and typically also have better access to finance. Including smallholders can present significant challenges for both the agribusiness and smallholder, but a strong business case can be made for both sides to work together (table 10.1 summarizes the advantages and challenges).

For agribusiness:

- Smallholders can have distinct competitive advantages in certain situations. Compared to smallholders, large suppliers have greater market reach and multiple options to sell produce, so it can be riskier to source from them. It may also be less risky to source from numerous producers distributed across a wider geographic area, which can reduce systemic vulnerability to floods, droughts, and pests. Uncertainty about prices and quantities is reduced in the short term.
- Smallholders might simply have access to better land or other resources, and they are often more likely to follow the labor-intensive management practices required for higher-quality outputs.
- With smallholders under contract farming, production can adapt more rapidly to market demand.
- Government or donors may offer incentives to include smallholders.

On their side, smallholders can earn higher incomes. Participation also reduces their uncertainty as to who will buy at harvest and how much they will pay. Linking to a modern supply chain might be an important mechanism to address

smallholders' lack of credit, inputs, extension services, and marketing resources (Reardon et al. 2009).

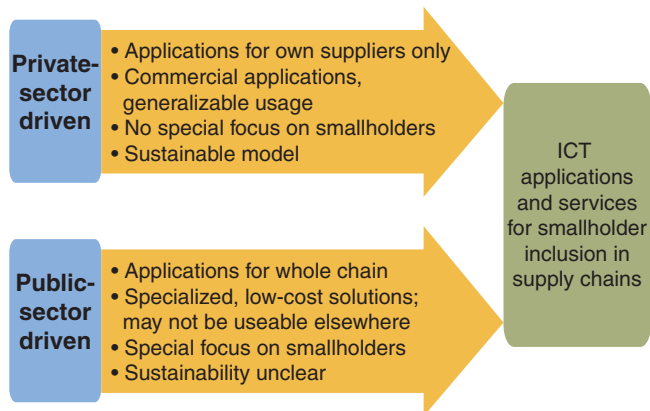
Smallholder inclusion is challenging for agribusiness because interacting with a large group of small suppliers implies high administrative and transaction costs (for example, in controlling quality, maintaining traceability, or ensuring adherence to certification standards). The agribusiness may have to supply physical assets (land, machinery, inputs) and information (on management practices and postharvest practices) for smallholders to produce the quantities and qualities required. Farmers may have to learn how to grow new crops or obtain more costly inputs. Farmers may not honor standing agreements with agribusiness at harvest, especially if the spot market offers higher prices than the company; the agribusiness may not honor its commitment to purchase from farmers.

In short, a supply-chain relationship between agribusinesses and smallholders is a complicated partnership with difficult requirements on both sides. Procurers need an agreement that will provide them with the right product mix, items that meet safety standards and are traceable, items of the right quality, timely delivery, and a cost-effective arrangement. Farmers require market information, extension services, risk-management capacity, financial services, and supporting physical infrastructure services (such as roads, storage, power, and telecommunications).

### **ICTs and Smallholder Inclusion in Commercial Supply Chains**

Modern ICTs and their applications significantly affect smallholders' inclusion in commercial supply chains. ICT applications (hardware and software), guided by business logic, can foster smallholders' inclusion by making the following interventions in the supply chain: reducing costs of coordination (collection of production, distribution of inputs, and so

**FIGURE 10.2:** Drivers of ICT Applications for Including Smallholders in Supply Chains



Source: Authors.

on); increasing transparency in decision making between partners; reducing transaction costs; disseminating market demand and price information; disseminating weather, pest, and risk-management information; disseminating best practices to meet quality and certification standards; collecting management data from the field; and ensuring traceability.

Such interventions have been driven by the private and public sector. Their slightly different focus and resource base influence the kinds and the sustainability of ICT applications they propound (figure 10.2).

The private sector views its supply-chain relationships as a competitive advantage. The ICT applications it develops to engage with the supply chain and provide information services are typically exclusive to its suppliers. Larger agribusinesses are also likely to have the scale and resources to deploy more expensive, commercially available ICT solutions within their supply chain. These interventions, if supported by a viable business model, are likely to be sustainable, but agribusiness-driven interventions may not necessarily focus on smallholders.

The public sector, donors, and civil society typically see the inclusion of smallholders as a public good. Their intervention in the supply chain is therefore focused on inclusion. The applications they create and develop are less likely to be exclusive. Because they have usually been designed to be specific to particular projects and used only once, public-sector interventions are unlikely to be easily generalizable to other contexts. Sustainability of donor-supported efforts has therefore been more uncertain, though future designs are expected to incorporate learning from previous experiences to enhance sustainability.

### ICT for Supply-Chain Management

*In conditions of poor information flows supply chains are highly fragmented. Otherwise information technology driven innovations make it easier to acquire, manage, and process information and allow closer integration between adjacent steps in the value chain. There is therefore greater integration of supply chains based on information availability.*

*Kunaka (2010:24)*

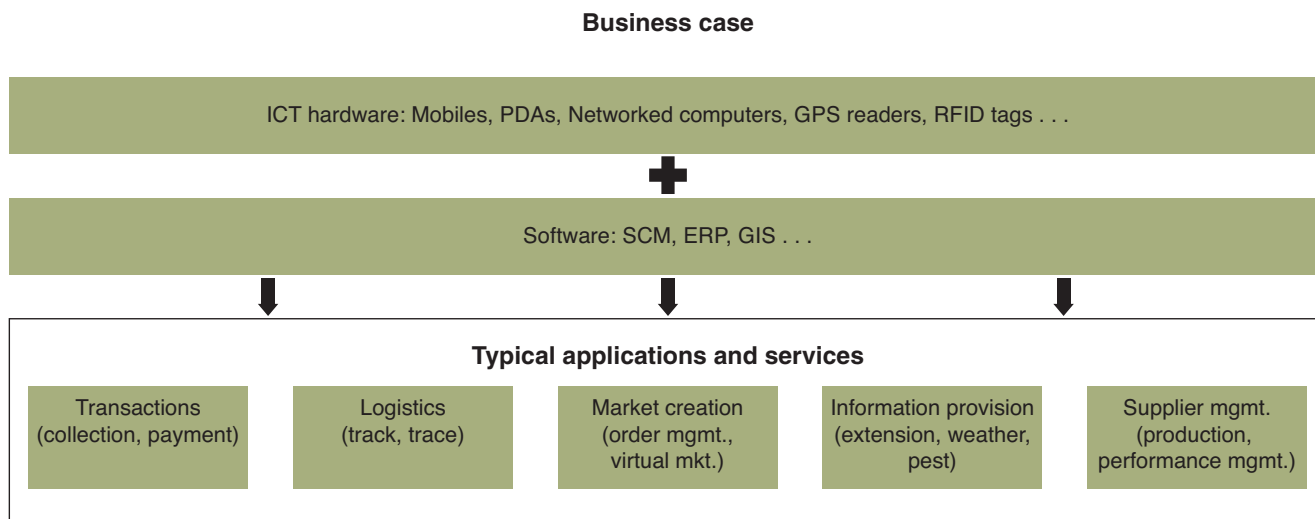
Organizations have understood for some time that logistics and supply-chain management (SCM) applications could reduce the transaction costs of procuring from smallholders. Indeed, any sizeable company in the developed world uses SCM systems to handle procurement and other tasks (box 10.1).

### BOX 10.1: Functions of Supply-Chain Management Systems

Supply-chain management (SCM) software running on networked computers and handheld devices typically performs some or all of the following functions:

- **Stores information about suppliers.** In the context of sourcing agricultural products from smallholders, this function would allow a food-processing company to know which farmers grow what, as well as other information, such as farmers' names, locations, previous transactions, and previous performance. Such a database makes it much easier to deal with a large base of smallholders.
- **Enables the company to transmit an order to farmers.** The order would specify what is required, when it will be collected, and how much will be paid for it.
- **Ideally, allows production to be monitored,** making it possible to manage quality and incentivize high-performing suppliers or support poorer performers. The software could provide answers to questions such as which farmers are on schedule, which are behind, and how much product has already been collected from each farmer. If connected to the bank accounts or mobile transaction accounts of the procurer and supplier, such software might also transfer payments when orders are fulfilled.
- Finally, SCM software might **track the transport of goods** from the farm gate to the warehouse or retailer.

Source: Authors.

**FIGURE 10.3:** Typical ICT Applications and Service

Source: Authors.

The lack of context-appropriate software, the prohibitive cost of hardware, and the lack of supporting infrastructure once made it quite difficult to use SCM systems in developing countries. The diffusion of ICT devices (especially mobile phones) and infrastructure has eased these constraints by making it possible to aggregate smallholders virtually. A secondary-source survey of ongoing or recent efforts toward smallholder inclusion using ICTs and their applications suggests that these technologies can solve many supply-chain problems associated with transactions (ordering, invoicing, payment); logistics (collection, storage, transport), quality assurance (safety, traceability); process management (production oversight, input distribution, extension support); and product differentiation (specialization in organic, fair trade, or regional labels) (figure 10.3).

The development of ICT applications for SCM can be driven by a wide variety of agents in the private and public sector, but collaborative partnerships appear to yield more effective applications. For example, agribusiness companies, mobile network operators, third-party service providers, and software firms as well as development institutions and research institutes may participate. It is rare for applications to be developed independently by any one party; collaborative partnerships focused on smallholder inclusion or value-chain competitiveness are much more common.

No single ICT application is ideally suited for all procurement contexts or types of producers and actors along the chain. Organizations vary in size, budget, and operations. Some source perishables; others source staple grains. Supply chains encompass larger and smaller ranges of regions and

producers (whose languages and education levels also vary). Not surprisingly, the varying degree of sophistication in ICT applications reflects this diversity. Bigger firms can extend their SCM solutions; other, smaller firms, turn to the off-the-shelf software or applications for mobile phones that are increasingly available; still others rely on spreadsheets. Some applications handle everything from transactions to logistics and quality control. Others focus on a smaller subset of areas. They rely on different combinations of software and hardware, but a combination of mobile phones, PDAs, networked computers, and centralized databases figure prominently in the architecture of most applications. (Module 2 discusses how the accessibility and affordability of ICT devices and infrastructure influence their use.)

Finally, the applications differ in their commercial approach. Some are public goods that do not have a revenue-generating model, while others adopt a one-time turnkey installation fee. Still others take a fee-per-transaction approach, while many follow an embedded service model in which revenues are generated from commercial trading (buying-selling) transactions and a fee for ICT services is not charged to farmers.<sup>1</sup>

There is a sense that ICT applications can be the glue that holds together complex supply-chain partnerships. The rapid flow of information between buyers and producers that such applications allow minimizes misunderstandings, allows for risk management, provides higher levels of transparency, and ultimately fosters trust.

<sup>1</sup> A discussion about value-chain business models is outside the scope of this module, but readers can turn to World Economic Forum (2009) or Barrett et al. (2010) as a starting point.



A particular area of concern on both sides is the possibility that one side or another will not uphold the preexisting agreement. As mentioned, when prices are high, farmers have an incentive to sell to the spot market (side-sell) instead of to agribusinesses. Similarly when market demand for certain products changes or is lower than expected, procurers have an incentive to buy less than promised or at a lower price (finding produce to be of insufficient quality is a common tactic). Better communication between farmers and procurers, and systems that allow farmers to be paid faster, can reduce such myopic behavior and help relationships endure. If farmers know that side-selling this season will have repercussions in the next because the company keeps electronic records, they might be less likely to engage in this behavior. On the other hand, automated processes in the collection center make it more difficult for buyers to reject products arbitrarily or pay less.

ICTs will not sustain linkages that are fundamentally flawed, however. If the supply chain is not competitive or the business environment or trade laws prove restrictive, software to manage sourcing will not reverse the situation. If market price fluctuations are sufficiently severe, ICT applications may not prevent farmers from side-selling or procurers from renegeing.

Finally, the impact of these ICT applications on smallholders' inclusion in commercial value chains is not yet known. There is a general consensus that participation has a positive effect, but to what extent ICTs enhance or dilute that effect is unknown and requires research. The application of ICTs can be expensive from the perspective of software development or purchase, implementation, training, and so forth. The costs may not be justified in all cases. Better information on potential impact can help to make this determination.

### KEY CHALLENGES AND ENABLERS

ICTs may create opportunities to incorporate smallholders more effectively into supply chains, but their impact will be limited without the requisite supporting infrastructure, policy, and culture of collaboration. This section describes the challenges and enabling factors associated with using ICT to manage supply chains and integrate smallholders.

Infrastructure is particularly critical for ICTs, which often require reliable electrical power and telecommunications networks. The presence of complementary infrastructure also has much to do with the success of ICT interventions for smallholder inclusion (roads, storage facilities, transportation, and financial infrastructure, among other types).

Commercial value chains prosper in an enabling business environment; policies that support such an environment are indirectly quite important to the effectiveness of ICT applications in supply chains. Policies can also discourage or encourage smallholder inclusion. In India, for example, limits on the size of landholdings make it difficult for agribusinesses to avoid smallholders in favor of larger producers. Until quite recently, policy barriers made it difficult to source directly from farmers at all.

Public-private partnerships have proven critical in developing ICT applications targeted toward smallholder inclusion. Public organizations lack the technical capacity, agribusinesses alone may not have sufficient incentive to reach out to smallholders, and technology companies are reluctant to absorb the risk of producing products unless they are assured of markets. Public institutions can lead such collaborative efforts if they are willing to share rights to outputs of the joint activities.

Public intervention in the private sector's use of ICTs in supply chains should focus specifically on improvements in the policy environment and the competitiveness of smallholders. An important role of the public sector might be to incentivize smallholder inclusion and provide guidance on technologies that can be used to do so. The public sector might also work to organize farmers into groups and spread financial literacy (ICTs can help here, too; see Module 8).

Finally, the public sector should rigorously evaluate current ICT applications to determine their impact on smallholder inclusion and incomes. Quantitative and qualitative evaluation can include a variety of indicators to document outcomes. Key quantifiable indicators that are relevant to smallholders and can measure impact throughout the chain can include production volumes; product quality; net income; distribution of income among smallholders, within households, and along the supply chain; and the distribution of costs associated with risk mitigation and management.

These indicators can be complemented by additional quantitative measures that assess the overall viability of the supply chain, such as market position and penetration, profitability as compared to similar chains, and trends in volume and prices. Wherever possible, disaggregate data by gender.

Key qualitative or skills-based indicators that have an impact on farmers' incomes can include key skills related to: (1) the nature and quality of the relationship between farmers and trading intermediaries; (2) improvement in bargaining power; and (3) the governance functions of the chain

itself. For chains linked to high-value markets, pay additional attention to issues related to product and process upgrading and collective innovation as the chain adapts to increasingly demanding market conditions. While this process does not occur fully at the farmer level, the existence of this skill set is critical for the entire system's continuing competitiveness. Unlocking innovation and opportunities for smallholders is a critical element of impact, because it leads to benefits that help drive farmers' incentives for inclusion (K. Kumar, personal communication).

When beginning an intervention, ascertain whether the barriers to smallholder inclusion are best addressed by an ICT application. Care should be taken to ensure the presence of key enablers—special attention is required to include women and other vulnerable groups. It is also important to consider the full cost of ownership beyond any one-time software and hardware fees. Installation charges, maintenance, upgrades, and the cost of training users must also be included.

After diligent consideration, if an ICT application is deemed appropriate, consider existing commercial products before attempting to develop new products. If the development of

a new product cannot be avoided, sustainability should be made a priority, and local partners must be included. A focus on developing standards for ICT applications and systems will allow interoperability between technologies and make it easier to develop new applications when necessary.

Finally, human capacity is critical for the development and uptake of ICTs in supply chains. Farmers or farmer associations may find ICT tools challenging to use (illiteracy, a lack of training, or simply a lack of comfort with modern ICTs are typical barriers). Nor can ICTs be developed or deployed well if a technical talent pool with an entrepreneurial spirit is lacking.

This module continues with two topic notes. Drawing on actual cases (figure 10.4), the notes highlight trends and issues and identify lessons that might prove instructive to others.<sup>2</sup> Topic Note 10.1 focuses on efforts led by the private sector to apply ICTs to the various problems associated with including smallholders in commercial supply chains. Topic Note 10.2 reviews efforts led by the public sector or in collaboration between public and private organizations.

<sup>2</sup> Payne (2010) provided an immensely helpful starting point for many of the examples and cases in this module.

**FIGURE 10.4:** Cases and Examples Discussed in Topic Notes and Innovative Practice Summaries

Typical applications and services					
	Supply-chain management	Logistics	Transactions	Market creation	Information provision
Private >	Suguna Poultry, Godrej Agrovet, OLAM—standard commercial SCM				
		EJAP Bangladesh—spreadsheets			
		Virtual City AgriManagr—mobile-based application			
	Muddy Boots, Sourcetrade, FarmERP—off-the-shelf SCM specifically for developing contexts				
			ICT e-Choupal, EID Parry Indiagriline, among others—collection center-based information providers		
Public >	ACDI/VocafreshConnect—SCM developed for developing context in India				
			Mobile Transactions Zambia—mobile-based payments		
	SAPA Mobile for Agribusiness—mobile-based SCM				
		TIPCEE—GIS and barcodes for mapping and traceability			
			Fruiléma Mali—web-based platform connecting buyers and sellers		

Source: Authors.

## Topic Note 10.1: PRIVATE-SECTOR EFFORTS TO INTEGRATE SMALLHOLDERS IN COMMERCIAL SUPPLY CHAINS THROUGH ICT APPLICATIONS

### TRENDS AND ISSUES

Private efforts to use ICTs to include smallholders in supply chains are useful to understand because agribusinesses have the motivation, capacity, and resources to create and apply ICTs that help to overcome the problems involved. Many companies have taken innovative, instructive steps to do so. Private-sector demand for technological solutions appropriate for developing contexts has created a market for ICT applications and spurred innovation in private companies in developing economies, most vividly in India and Kenya.

The specific context is critical in determining if and why any agribusiness will source from smallholders. Private companies often source from smallholders out of competitive necessity, even if doing so can be difficult (Barrett et al. 2010). Quality and certification demands by consumers and export markets also force agribusinesses to assert more control and link backward to the producers in the supply chain. Often there is no choice but to source from numerous smallholders, because they dominate production of certain goods. Corporate social responsibility initiatives may encourage procurement from smallholders; the political context may require it—the ramifications of ignoring smallholders may be significant.

Agribusinesses, especially larger domestic ones and certainly international corporations, already use technology to manage their organizations. When linking backward to smallholders, these companies reflexively turn to technology. It can simply become an exercise in extending their current technologies through the “last mile” to smallholders or deploying more context-appropriate ICTs. Typically, such corporations are more capable than nongovernmental organizations (NGOs) or governments in marshaling the human and financial resources to develop new technologies or extend existing ones. Finally, when these technology needs cannot be met with current systems or commercial software, companies demand solutions that are better suited to the specific context, language, or region, fueling development for innovative new solutions.

At the end of this topic note, two innovative practice summaries illustrate the different ways that the private sector is taking the lead to include smallholders in their supply chains. The first focuses on EID Parry, a company that provides

information and technology services directly to farmers in southern India and purchases their produce (sugarcane) at its rural collection centers. The second describes Virtual City, a Kenyan company that produces software to automate and standardize the process of sourcing from a smallholder through rural collection centers such as EID Parry’s in India.

### ICT AND SUPPLY-CHAIN MANAGEMENT THROUGH PRIVATE INITIATIVES

As noted, food processors and retailers, especially in India and Latin America, are turning to procurement models that bypass traditional wholesale markets to engage directly with farmers. Through SCM software on networked computers and mobile phones, ICTs facilitate this process in headquarters, field offices, collection centers, farmer cooperative offices, and in the hands of farmers and extension workers. The sophistication and source of the technology, as well as the extent of its reach to smallholders, vary.

Many large organizations simply extend the use of their current ERP software to manage their smallholder suppliers (box 10.2). Such software is used by large organizations to centrally store organizational data and manage data transmission and use between departments within the organization and external partners, such as suppliers. A 2002 report found that typical costs of ownership for an SCM system average about US\$ 15 million and can range from US\$ 500,000 to US\$ 300 million (Sysoptima 2005). These costs represent fees for software, consultants required for installation, and hardware.

For smaller operations, world-class SCM systems may be neither necessary nor cost-effective. These players develop modest systems in-house to manage sourcing challenges. In Bangladesh, EJAB (<http://www.ejabgroup.com/>) relies on Microsoft Excel and printed forms to track and manage relationships with its potato farmers (USAID 2011).

A market for cheaper ICT solutions has developed owing to the growing trend toward direct sourcing as well as the large number of procurers that cannot afford SCM systems but can no longer get by with simple spreadsheets. The market has especially grown because of the need for applications that

**BOX 10.2: Companies Use Enterprise Resource Planning Software to Manage Smallholder Suppliers**

In India, Suguna Poultry (<http://www.sugunapoultry.com/>), with annual revenues of US\$ 700 million, operates in 11 states. The company sources poultry products from over 10,000 farmers from 270 locations. In 2006, the International Finance Corporation invested US\$ 30 million in Suguna to expand production capacity. In the same year, Suguna deployed Oracle's SCM system across its organization, though it had information systems before implementing Oracle's product. Agents in field offices interact with the system using computers connected to the Internet to track information and manage the operations of Suguna's contract farmers.

Suguna is not the only agribusiness in India to move toward world-class SCM software. Godrej Agrovet (<http://www.godrej.com/godrej/GodrejAgrovet/index.aspx?id=2>), with US\$ 300 million in annual revenue from oil palm, animal feed, poultry, and agrochemicals, implemented SAP software in 2010 to manage information and interactions with oil-palm farmers.

These companies follow in the footsteps of their international counterparts. Singapore-based Olam (<http://www.olamonline.com/home/home.asp>), with revenues of around US\$ 8 billion and sourcing operations in over 60 countries, supplies cashews, coffee, and rice. The company uses SAP to manage its interactions with farmers and to support production activities.

Large farmer organizations that source directly from members (some of whom are very small-scale producers) also use ERP software. Module 8 describes the use of ERP software in an Indian dairy cooperative.

*Source:* Authors, based on IFC 2006, Oracle 2006, and "Godrej Agrovet Empowers Rural India With SAP," *The Financial Express* 2010.

perform specific supply-chain functions that are common for procurers working with smallholders, such as tracking data about producers and their performance over time; communicating orders to farmers; managing production; speeding collection and payment at harvest; and tracing materials along the chain to comply with certification requirements.

Also in demand are applications that can run on mobile phones or other lower-cost ICT devices such as personal digital assistants (PDAs). Supply-chain solutions relying on such devices are better suited for use in developing contexts

where computers and Internet connectivity are generally less accessible than mobile phones and wireless service. Several private firms have produced such solutions, and others have been created in joint efforts by private and public organizations (see Topic Note 10.2).

Virtual City (<http://www.virtualcity.co.ke/>), a ten-year-old company in Kenya, sells several pieces of software that address challenges in supply chains. AgriManagr automates the collection of produce from smallholders at rural centers. The system consists of handheld PDAs running the AgriManagr software and smartcards belonging to individual farmers. AgriManagr reduces the time required to collect materials from the farmers and pays them electronically. Information is recorded with fewer errors, and farmers receive a receipt with their previous transactions, which they can use as collateral to borrow. The system strengthens the link between smallholders and procurers by reducing the cost and time associated with the transaction for the latter and by increasing transparency and trust through faster payments for the former.

Collecting information accurately is quite important for firms to manage their operations optimally. Muddy Boots (<http://en.muddyboots.com/>), a private British software company founded in 1996, has developed a product (called Greenlight) for large aggregators and exporters who are sourcing from many smallholder farmers. This product allows users to track information relevant to standards compliance along the entire value chain. It mostly runs on networked computers, but agents use it on mobile phones at the field level to collect data on production and compliance (Muddy Boots 2007). American firm SourceTrace (<http://www.sourcetrace.com/>) offers software with similar features, which has been used in Latin America and India (SourceTrace 2011). Indian software maker Shivarai produces a similar product called FarmERP (<http://www.farmerp.com/>). Developed in 2003, the product has gone through several iterations and has been available as an Internet-based service since 2007 (FarmERP n.d.).

ICT applications can improve linkages between procurers and smallholders in indirect ways as well. A phenomenon not limited to India, but highly prevalent there, is agrodealers' practice of running retail distribution and collection centers in rural areas. These centers (sometimes simple kiosks; see image 10.1) offer ICT-based access to information and extension services to attract farmers to the centers. Farmers are consumers of household items and agricultural inputs sold in these places, but they are also suppliers of agricultural produce. In some instances, farmers have the option of visiting multiple centers nearby, but in other cases, a company that

**IMAGE 10.1: ICT-Enabled Kiosks in Rural India Can Help to Inform Rice Farmers**

Source: International Rice Research Institute.

procures the major crop grown in a place might have the sole collection center in the area.

By offering access to information and other services through their rural centers, companies build farmers' trust and loyalty. Come harvest time, farmers familiar with the center are likely to sell their produce at the distribution center, which reduces the company's cost of procuring raw material. In exchange, farmers have access to information that improves the productivity and quality of their crops.

The example cited most often is that of ITC's e-Choupal service, an extensive network of kiosks—6,500, in 40,000 villages reaching approximately 4 million farmers—where farmers access an extensive array of information (prices, weather, expert advice) for free. ITC's revenues come from its commodity transactions and input sales at the kiosks.<sup>3</sup> ITC plans to deepen its relationship with farmers by offering information services via mobile phone (Kumar n.d.).

Many other retailers have followed ITC's lead. They include Indian Farmer's Fertilizer Co-Operative Limited (IFFCO) Kisan Sanchar Limited (IKSL), DSCL—Haryali Kisan Bazar ([http://www.dscl.com/Business\\_Agree\\_HarKisBzr.aspx](http://www.dscl.com/Business_Agree_HarKisBzr.aspx)), Tata Kisan Sanchar (<http://www.tatakisansansar.com/>), Gojred Adhar, Bharti FieldFresh (<http://www.fieldfreshfoods.in/>), and Reliance Fresh.

The most hopeful possibility in the near future is the potential for technology development and transfer from major food

3 "ITC's Rural Development Philosophy at Work" ITC, [http://www.itcportal.com/ruraldevp\\_philosophy/echoupal.htm](http://www.itcportal.com/ruraldevp_philosophy/echoupal.htm), accessed July 2011.

corporations. Many of these corporations have dedicated corporate social responsibility programs that emphasize smallholder inclusion. A second likelihood is the amalgamation of the mobile-based information services that exist in many countries (one of many examples is Nokia's Life Tools. Instead of recreating similar services, retailers are likely to simply offer such services to their farmer-suppliers.

**LESSONS LEARNED**

The private sector can be effective in developing and deploying ICT tools to procure directly from farmers and has demonstrated an interest in doing so. It is less clear

whether they are developing tools that will allow them to source from smallholders specifically.

Providing services (information, advice, inputs, finance, and other resources) to farmers can be an effective incentive for them to participate in commercial value chains. Farmers often join value chains to solve market failures in insurance, financial, input, and information markets (Barrett et. al. 2010:13). The numerous instances of rural collection centers creating links with farmers by providing access to weather, extension, or other services through Internet-connected computers appear to be effective.

The wide array of private information services available for agribusiness to communicate with or manage their interactions with farmers is still growing. Care must be taken to identify the actual problems that prohibit farmers from participating prior to the implementation of an ICT solution. Knowledgeable experts can provide guidance here.

ICT interventions are not one-time efforts. Technologies and business needs continually change, and the deployment of ICTs must continue to evolve as well.

### **INNOVATIVE PRACTICE SUMMARY** **EID Parry's Indiagriline Services Improve Sugarcane Production and Sourcing**

EID Parry is a large, publicly traded Indian company that sells sugar and fertilizer.<sup>4</sup> It is innovative because it uses a

4 This section draws on information from Annamalai and Rao (2003) unless otherwise noted.

franchise model to create a network of service and collection kiosks. The kiosks distribute information and other services for smallholders to improve sugarcane production; in turn, they make it easy for farmers to sell their sugarcane to EID Parry. Partnerships play a critical role in the information content provided; the state research and veterinary services are key contributors. While rural distribution centers are not a new concept in India, elsewhere they are less common.

EID Parry depends on smallholders to remain competitive. It sources sugarcane from 80,000–100,000 farmers for nine sugar-processing plants it operates in three states of southern India (M.C. Gopinathan, personal communication) and earned over US\$ 280 million in revenue in 2010 (EID Parry 2010). When India began to remove import restrictions in response to pressure from the World Trade Organization in 1997, agribusinesses like EID Parry had to optimize their production to reduce costs and stay competitive. EID Parry was already cost efficient in production, but there was scope to reduce the cost of sourcing sugar. The company had a clear incentive to work with its large farmer base to increase productivity and improve quality.

### The Rural Kiosk Network and Indiagriline

In response to the need for larger quantities and higher quality, the company developed Indiagriline (<http://www.indiagriline.com/>) in their Research and Development Department. Indiagriline is a web-based portal that provides farmers with information to improve productivity and quality, such as market prices, weather alerts, and advisory and extension assistance as well as supply-chain information (image 10.2).

Supply-chain information comes to farmers through EID Parry's Cane Management Software, which enables farmers to forecast demand, access records of their previous transactions with the company, register their sugarcane area, submit payment information, and monitor demand, among other services. Most of the content consists of the extension information provided by state universities or independent foundations in partnership with the company.

In the pilot launched in 2001, 16 kiosks, called "Parry's Corners," were deployed with the Indiagriline system in 16 villages near the largest sugar factories. These kiosks were connected to a main Internet server in the factory by a cheap, easy-to-maintain wireless access technology called "corDECT" (FAO 2005).

### Franchise Business Model

Instead of paying for and operating the kiosks, the company opted for a franchise model. Independent local entrepreneurs

**IMAGE 10.2:** Indiagriline Logon Screen



Source: A screenshot of the Indiagriline homepage.

became franchisees by investing US\$ 1,000 for space, computers, and standard equipment such as a printer, power backup, telephone, and furniture. They also pay for operational costs such as Internet and power. The company offers financing through local banks if necessary.

In exchange for the franchise arrangement, EID Parry provided training and assistance to the franchisees and the right to use the brand, sell products, and source sugar on behalf of the company. Over the first years of project, EID Parry spent US\$ 500,000.

Operators can expect to earn US\$ 16–40 per month. The franchisees earn their revenue from additional services offered at the kiosks along with Indiagriline. The information service acts to attract customers and create effective demand for the other services. The most important of these is the procurement of sugarcane from farmers. Incentivized by prompt payment and fair weighing, sorting, and transaction records, farmers sell to EID Parry instead of the local market. The kiosk also acts as a rural retail outlet, selling agricultural products such as fertilizer and seed alongside household items such as oil or processed sugar. Finally, the kiosks also allow farmers to access educational programs, farm extension services, banking and insurance services, and communications over phone and Internet.

Besides Indiagriline, some of these other services also rely on ICTs, especially remote agricultural extension. Farmers use email and digital cameras to reach agricultural experts remotely for crop diagnostics.

### Impact, Scalability, and Sustainability

As FAO (2005) notes, the information system obviously removes critical barriers that have kept farmers from participating in the commercial sugar supply chain. Farmers receive relevant and timely information regarding sugarcane production, the company effectively communicates demand and quality requirements, and farmers can demand a fair price and be assured of a market. Further, agricultural yields, access to finance, agricultural extension services, and time required to transact with EID Parry all have reportedly improved.

These improvements have not been quantified, however (FAO 2005). The Indiagriline project was started in 2001 with a stated goal of “increasing farmers’ incomes three times in five years,” but no systematic evaluation has determined the precise impact on sugarcane farmers’ incomes. It is also not clear whether more farmers are participating in the supply chain because of Indiagriline.

Eventually the ubiquity of cheap mobile phones (even among smallholders) and reliable Internet connections did away with the need for farmers to come to a kiosk for information. Urbanization fed a critical labor shortage for production operations and harvest. The company realized that labor shortages made the mechanization of production and harvesting operations essential.

The Parry’s Corner kiosks have been transformed and renamed Parry Mayams,<sup>5</sup> and 82 of these rural centers cover all of the areas that EID Parry sources from, acting as rural retail outlets to sell inputs, equipment, and other services. The centers, like the kiosks that preceded them, continue to run on the entrepreneurial model that supported the kiosks. They also provide complete farm management services to landowners who no longer wish to manage their land themselves—the company calls this “business process outsourcing for farmers.”

ICTs in various forms are integral to delivering these services. Mobile phones and SMS deliver weather, price, market demand, and operational information to farmers from a centralized IT operation of EID Parry. Much of this information was previously provided through Indiagriline, but farmers no longer need to come to the kiosk and log on to the system. Currently, 60 percent of EID Parry’s farmers receive mobile phone messages, and the company is planning to include

all farmers. Extension workers have access to Internet-connected netbooks to provide better information to farmers for optimal cane growth.

As of April 2011, the company was also piloting a call center at one factory to field farmers’ questions. After a few months, the center was receiving 80–90 calls per day. If the pilot proves successful, the service will be extended to the other factories.

EID Parry considered partnering with commercial information service providers instead of creating their own capacity, but they concluded that existing services restricted their farmers’ choices. For instance, Nokia Life Tools requires the use of Nokia phones. Netbooks were chosen over handheld Palm devices to access the Internet and move data through wireless mobile networks.

### INNOVATIVE PRACTICE SUMMARY

#### Virtual City’s AgriManagr Builds Better Supply-Chain Links with Farmers

Virtual City is a private Kenyan technology startup founded by entrepreneur John Waibochi in 2000.<sup>6</sup> The company had its beginnings in e-commerce but shifted its focus to developing software applications that manage supply chains, knowledge, and customer relationships. In response to a perceived market opportunity, Virtual City developed its AgriManagr software.

#### AgriManagr Builds Trust Among Supply-Chain Partners

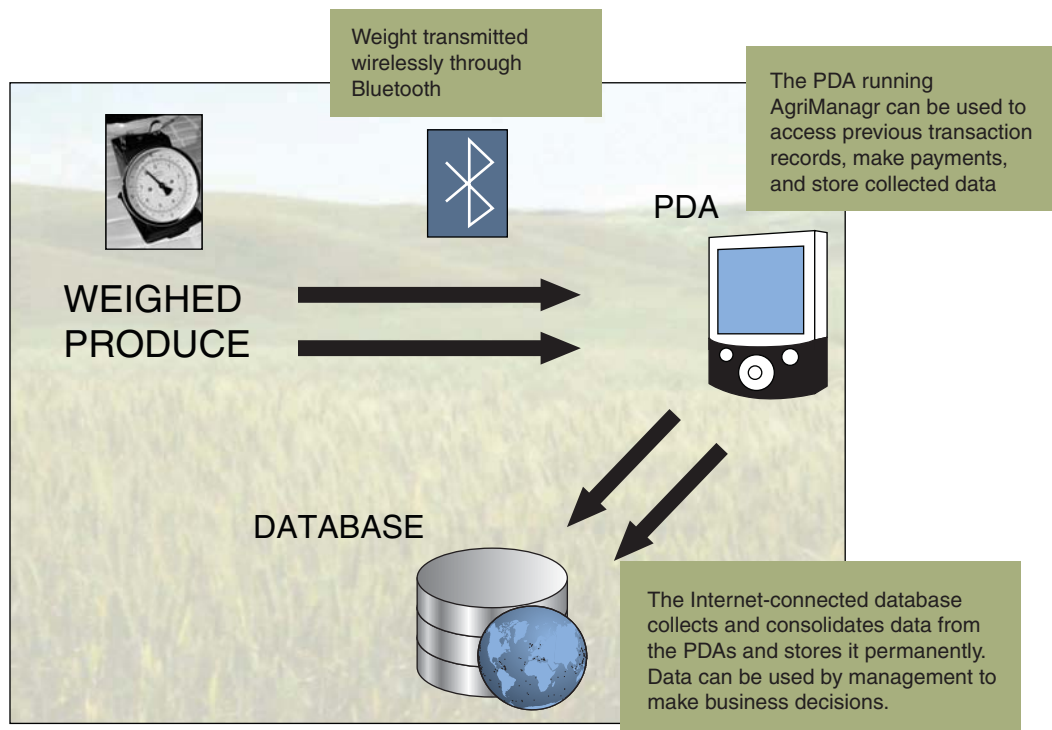
The AgriManagr software is used by collection centers to manage the process of buying agricultural produce from farmers (figure 10.5). The application runs on mobile phones or PDAs.

When a farmer brings his or her produce to the collection center, it is weighed using an electronic scale that sends data via Bluetooth wireless technology to a handheld device. The data are appended to the farmer’s transaction record. The farmer (who is uniquely identified through information on his or her smartcard) is paid without cash through a mobile payment system and given a printed receipt (the scale is wirelessly connected to a printer) noting the current transaction.

The receipt also contains a record of the farmer’s previous transactions at the collection center. It serves as a proxy for the farmer’s creditworthiness, just as a credit history does in

5 The section draws on information from an interview from an EID Parry executive (Gopinathan 2011).

6 This and the next section draw on information from Virtual City (2009).

**FIGURE 10.5:** The AgriManagr System

Source: Adapted from Virtual City 2009.

developed nations. The farmer can use a record of consistent earnings at harvest as collateral for credit.

Data from the collection center are held in the PDA until they can be uploaded or wirelessly transmitted to a main server in the field office, where all the data from various collection centers are gathered and consolidated. Data from various field offices are sent over the Internet to headquarters, where they are consolidated. In this way, field offices and the headquarters are immediately aware of how much of what has been collected, from where, and when.

In the meantime, the collected products are sent to warehouses where entire truck payloads can be weighed. The weight is recorded and sent to headquarters, where it can be cross-referenced with the data from collection centers and field offices to ensure no product was lost on the way to the warehouse.

### Impact, Scalability, and Sustainability

AgriManagr has been deployed by at least a handful of customers across several sectors, all in Kenya (M. Kagochi, personal communication). They include the Kenya Tea Development Authority, which controls about 60 tea

factories, and Brookside, Kenya's leading milk processor. Technoserve reportedly uses the product for coffee-sector interventions, and a Virtual City executive also noted use in the cotton sector. The company won a grant of US\$ 750,000 from the Africa Enterprise Challenge Fund to automate the dairy supply chain using AgriManagr (AECF 2009).

AgriManagr has several benefits for both the procurer and the farmer. It eliminates the manual transcription that inevitably results in record-keeping errors or fraud. It speeds procurement and sharpens management's view of the process, thus increasing its ability to respond rapidly to bottlenecks or opportunities. Farmers, the company claims, receives an average weight that is 9 percent higher than weights recorded using manual scales. Farmer presumably benefit from rapid cashless payment and from being able to use their transaction records to obtain credit.

Evaluations that could answer two fundamental questions are still lacking, however. Are farmers in the value chain earning more owing to the implementation of this technology? Can more farmers participate in the value chain than previously? Both questions need formal consideration.



## Topic Note 10.2: PUBLIC-SECTOR EFFORTS TO INTEGRATE SMALLHOLDERS IN COMMERCIAL SUPPLY CHAINS THROUGH ICT APPLICATIONS

### TRENDS AND ISSUES

The public sector can help smallholders participate in commercial supply chains by helping them to develop relationships with agribusinesses and to grow products that the market demands. Public organizations have facilitated the creation and deployment of various ICT applications to reduce transaction costs associated with the interaction between producers and procurers, better monitor the production process, and improve traceability. As these technologies and their applications become more appropriate to local contexts and needs over time, they are likely to become indispensable for smallholder inclusion.

A special focus on efforts led by the public sector is warranted for a number of reasons. First, public organizations have a unique role to play in enhancing competition, facilitating smallholders' participation in commercial supply chains, and ensuring higher earnings for those that do participate. The growing processed-foods market and urban consumers' preference for supermarkets do not necessarily translate to higher competition among procurers or automatically imply the inclusion of smallholders (World Bank 2008).

Second, public organizations can push for policy changes and make systematic interventions. They can coordinate partnerships between parties in the supply chain that create value but would be difficult for any single player to facilitate. For example, they can invest in both ICT and non-ICT infrastructure.

Third, public organizations can deploy technology and other resources to support and maintain such partnerships and help farmers become more productive, produce the right mix and quality demanded by the market, and meet the certification requirements for participating in high-value supply chains. To source from smallholders, at times it may be beneficial for a private organization to invest in public goods such as roads, extension services, access to finance, and market information, but often this is not the case. The public sector generally provides such public goods.

Two innovative practice summaries follow this topic note. In India, Agricultural Cooperative Development International/Volunteers in Overseas Cooperative Assistance (ACDI/VOCA) is an excellent example of how a public organization can coordinate other supply-chain players, both private and public, to

include smallholders. In Ghana, USAID's TIPCEE project aims to link fruit and vegetable exporters to the international agriculture and trade value chain. An interesting feature is the use of barcodes and GIS to trace exports back to their place of origin.

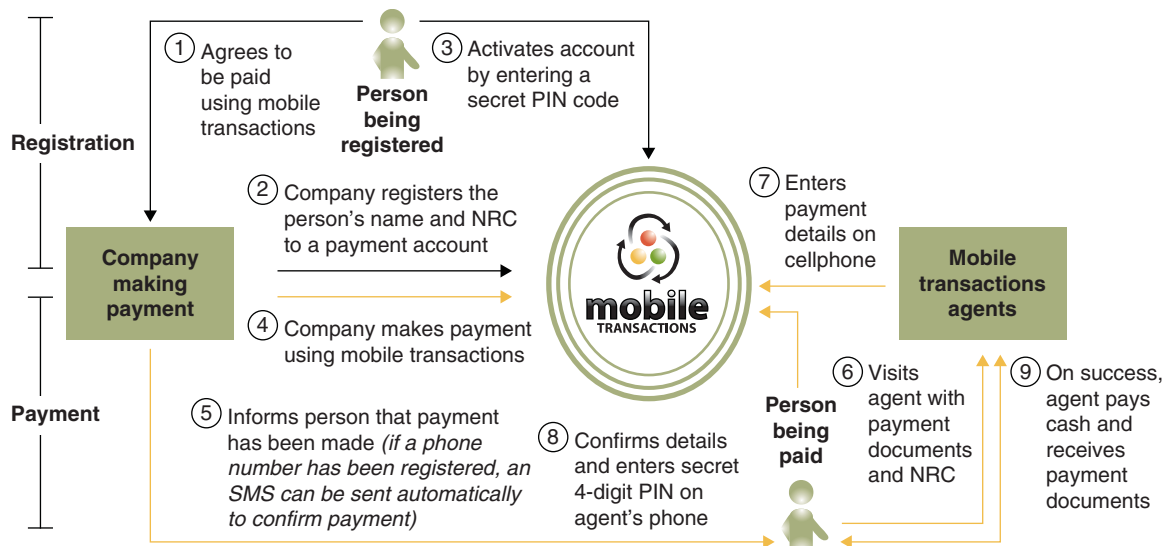
### PUBLICLY SUPPORTED ICT FOR SUPPLY-CHAIN MANAGEMENT

The unique role of public organizations is reflected in the way they use ICTs and ICT applications to foster smallholder participation. Public efforts have focused on creating nonproprietary software and platforms that can be used by multiple procurers and suppliers within supply chains or that can be applied to supply chains for different products altogether.

The spread of telecommunications infrastructure and devices such as mobile phones, PDAs, radio-frequency identification (RFID), and global positioning system (GPS) have made it possible, cost-effective, and useful for public agencies to work with private partners to develop context-specific software for SCM. Many of these applications seek to enhance the competitiveness of entire agricultural supply chains and foster the inclusion of smallholders.

Aside from the examples detailed in the innovative practice summaries, in Indonesia, the Institut Teknologi Bandung incubated the development of SCM software in partnership with Nokia, the Korean International Cooperation Agency, various Indonesian government ministries, and local corporations. Like many similar applications, SAPA Mobile for Agribusiness (<http://akucintaindonesia.com/>), runs on mobile phones and networked computers. Now a private venture, SAPA links over 5,000 small-scale organic rice producers into commercial export supply chains. Smallholders in Sukabumi, West Java, Serdang Bedagai, and North Sumatera regions participate; further expansion is planned (Kumar n.d.:35–36).

While not all efforts are so comprehensive, some have unique features, such as the incorporation of mobile payments, which nevertheless serve to establish links between farmers and agribusiness. In Zambia, the USAID-funded PROFIT (Profit, Finance, and Improved Technologies) project helped establish a partnership between the cotton-producing company Dunavant Zambia Ltd. and Mobile Transactions, a mobile payment provider (Chemonics 2010).

**FIGURE 10.6:** The Process by Which Dunavant and MTZL Collaborate to Pay Farmers

Source: MTZL.

Note: NRC = National Registration Card.

Dunavant (<http://www.dunavant.com/>) found it difficult to pay its contract farmers on time. The prospect of slow payment from Dunavant caused cash-strapped farmers to sell to local dealers, even though farmers could earn more from selling to the company (Zachary 2007). By partnering with Mobile Transactions, Dunavant can pay farmers instantly using mobile phones and Mobile Transactions' network of agents (figure 10.6). Facilitating payments as well as access to finance is a powerful mechanism to link farmers to supply chains (see IPS "Kenya's DrumNet Links Farmers, Markets, and Financial Service Providers" in Module 7).

Some public efforts have used ICTs to include farmers in commercial supply chains by improving the traceability of produce. For example, Fruiléma (a Malian fruit and vegetable exporter) assisted mango small-scale producers to comply with GlobalG.A.P. standards, helping them reach high-value export markets (see Module 12 for details). Another example, TIPCEE, is discussed later in this module.

## LESSONS LEARNED

The public sector does indeed lead collaborations with other partners, including the private sector, to produce useful applications for a given development context. The public sector can bring together stakeholders that might otherwise be competitors or unable to collaborate effectively. These partnerships require careful structuring, however, and prior agreements regarding revenue sharing and intellectual

property rights. ICTs developed by the public sector provide the visibility, communication, and speedy transactions that keep partners together for mutual benefit.

Not surprisingly, the public sector focuses more on small-holder inclusion than the private sector does, so it tends to develop ICT solutions focused on this objective. The resulting products differ from those developed by the private sector, especially with regard to exclusivity: SCM solutions from the public sector are usually not for the exclusive use of one buyer. They are generally platforms that multiple buyers, public or private, can plug into.

A general drawback of buyer-driven models for producers is the frequent demand for exclusivity. From a processor's or retailer's perspective, a supply chain is a source of competitive advantage, and these actors will seek to exclude competitors and prevent suppliers from side-selling. Because a buyer has invested in the supply network, and because the buyer needs to be able to fulfill contractual obligations for specific volumes to its customers, the buyer will demand exclusivity from its smallholder suppliers (K. Kumar, personal communication).

Donor-funded projects present unique challenges to scale and sustainability. Low-cost, context-specific software, for example, can have difficulties supporting higher volumes, and in such cases success can lead to collapse. In other cases, the products are too specialized and cannot be applied to other projects. ICT applications are not one-time interventions. Hardware and software must be maintained

and upgraded. The funds and human capacity to do so might be in short supply after a project is completed, unless special care is taken to ensure sustainability.

Strong local partners who can support a product are critical, but products and services should ideally be designed to become commercially viable and self-sustaining. The substantial learning from deploying ICTs provides good reason to think that future donor-funded projects might overcome many of these challenges to scalability and sustainability (see, for example, Ducker and Payne 2010).

### INNOVATIVE PRACTICE SUMMARY

#### ACDI/VOCA's ICT Solutions Help Private Companies Source from Smallholders in India

ACDI/VOCA innovated by working with Infosys to develop SCM software that reduces the barriers private organizations face in sourcing from India's smallholders. Beyond developing the software, ACDI/VOCA developed the business case for its use by several large food logistics firms. The case demonstrates significant and successful collaboration but also shows the challenges for ICT applications to become sustainable and achieve scale.

ACDI/VOCA is an American nonprofit with annual revenue of US\$ 124 million. It was founded in 1963 and has conducted economic development projects in more than 145 countries. Success with a project to integrate small-scale Indian producers of fresh fruits and vegetables into commercial supply chains (the India Growth-Oriented Microenterprise Development Program, GMED) (ACDI/VOCA 2011) led to a grant from USAID in 2006 to develop "ICT-enabled applications to improve the efficiency of private sector extension services and fresh produce supply-chain management in India" (McCarthy, Kumar, and Pavlovic 2009).

Based on the GMED experience, ACDI/VOCA had learned several lessons about the difficulty of sourcing fruits and vegetables directly from smallholders. They quickly realized that the "only means of guaranteeing a reliable supply and remaining competitive is to establish ongoing, mutually beneficial partnerships with organized groups of farmers." (ACDI/VOCA 2011)

Such partnerships would have to overcome several problems. Farmers lacked access to production and postharvest skills and the knowledge and technology to produce the right mix, quality, and quantity of produce. Farmers also needed market information systems to learn about prices and demand trends. Monitoring and traceability were increasingly required to sell to domestic and export markets, and interactions between a

large base of farmers and the procurer needed to be coordinated and managed effectively and efficiently.

### Collaborative Development Process

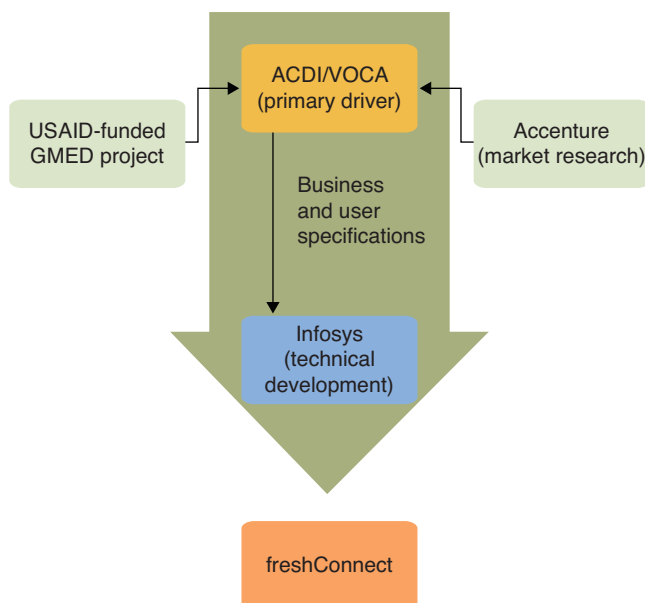
In response to these needs, which ACDI/VOCA realized could be addressed at least partially through the use of ICT, the organization set about developing an appropriate application. They decided it would be based on wireless mobile networks to leverage India's high-growth telecommunications market, low wireless service rates, and the need for real-time information in managing a supply chain for perishable fruits and vegetables.

To augment their own learning, ACDI/VOCA hired Accenture Development Partnerships to analyze the need for an ICT solution and determine which capabilities would add the most value. In a competitive bidding process, they selected Indian software giant Infosys to develop a product that would be commercially viable and obviate the need for donors to support future development and maintenance. A critical piece of the agreement was ACDI/VOCA's willingness to allow Infosys intellectual property rights over the software (McCarthy, Kumar, and Pavlovic 2009).

### ICT Application

By 2008, this extensive collaboration had resulted in freshConnect, a software application that could be accessed by networked computers, mobile phones, and PDAs using wireless technologies. Figure 10.7 depicts the partners' contributions.

**FIGURE 10.7:** Partnerships Involved in Developing freshConnect



Source: Authors, based on ACDI/VOCA 2011.

The software has three main modules. The first module (Order Placement) allows procurers to place an order, which field agents then divide among suppliers. The application continuously monitors prices at wholesale markets to determine minimum and maximum prices that the procurer will pay when placing an order. The quality required can also be specified when the order is placed. The second module (Order Fulfillment) allows field agents to collect information on the quality and quantity produced at harvest. The third module (Order Shipment) allows field agents, farmers, and procurers to track the produce and trucks in transport.

### Business Model

After a pilot phase, the software became commercially available through Infosys, which charges a setup cost and a transaction cost based on the volume of produce supplied. Two major Indian food retailers, HyperCity (<http://www.hypercityindia.com/index.asp>) and Radhakrishna Foodland (RF) (<http://www.rkfoodland.com/>), became the first agribusinesses to use the software commercially to source directly from a cooperative of more than 300 farmers.

### Impact, Scalability, and Sustainability

Farmers and procurers have benefited from the use of freshConnect. Farmers have unfiltered access to market demands and can plan their production knowing that their product will be bought. They know the price they will receive as well as the technical information to produce it at the required quality. Procurers are able to specify quantity, quality, timing, and price information in placing an order, which reduces uncertainty and wastage.

Farmers report earning 15–20 percent more through freshConnect. HyperCity and RF report a 10–15 percent reduction in postharvest wastage. An independent evaluation has yet to be conducted to verify these claims.

An additional 200 farmers had joined the chain to supply HyperCity and RF by 2009, and the freshConnect software has the capacity to scale with additional hardware. The pilot ran into a number of problems that have inhibited wider application, however.

The financial crisis of 2008 ultimately caused RF to go out of business. At the same time, other commercially developed information services such as RML entered the space. Additional customers have not signed on to use freshConnect because the product is more expensive compared to those of new market entrants. Finally, Infosys has not succeeded in tailoring the licensing terms and marketing

efforts to retail grocery chains (Pavlovich and Cech, personal communication).

Nonetheless, freshConnect remains under the ownership of Infosys, where it continues to be developed and marketed. Several lessons with regard to sustainability were offered by the project manager from ACDI/VOCA:

- Information services alone will not lead to smallholder inclusion. Additional services, especially extension, are required, but delivering extension services only by phone is quite challenging. Farmers often prefer face-to-face interaction with extension agents.
- Understanding farmers' requirements and willingness to pay for a product is critical for sustainability. This understanding is difficult for software developers or project designers to attain if they are not intimately familiar with farmers' environment. For instance, various mobile information services provide price information. These services typically update prices daily when, in fact, intraday price fluctuations can be significant for farmers.
- ICTs should be localized. "Localized" does not just mean that an ICT application is available in the local language. Instead of displacing existing relationships and processes at the local level, ICTs should fit into existing relationships to augment their capacity.

### INNOVATIVE PRACTICE SUMMARY

#### TIPCEE's ICT Applications Bring Ghanaian Smallholders into Export Supply Chains

USAID's Trade and Investment Program for Competitive Export Economy (TIPCEE) in Ghana was innovative in its use of ICTs to enable fruit and vegetable exporters to become sufficiently competitive to link with international value chains. The project used barcodes, GPS, and geographical information system (GIS) to ensure that produce could be traced to the smallholders who grew it—a major requirement to participate in the target export markets.

A five-year (2005–09), US\$ 30 million project, TIPCEE focused on the maize, pineapple, tomato, citrus, and onion supply chains. Its goal was to increase export sales to European and United States markets by US\$ 75 million over the life of the project and to affect the lives of at least 15,000 farming households (this number was revised to 100,000 after a successful first year). This large project covered 58 percent of Ghana's districts (CARE 2008).

The project's two main initiatives were to: (1) include smallholders in supply chains by systematically improving product

quality and reducing costs and bottlenecks in each supply chain and (2) implement broad policy reforms to improve the enabling environment around the supply chains and make them more competitive (Chemonics International 2006).

As discussed, produce exported to international markets must typically meet stringent certification standards, which often require traceability. The consumer needs to know the origin of each individual product in a supermarket.

### ICT Application

The TIPCEE project used GIS and barcode applications with GPS readers, barcode scanners, a wireless mobile network, and networked computers to address the traceability problem. GPS readers communicate with global positioning satellites to indicate the exact location of a place on the earth's surface through latitude and longitude coordinates. These coordinates can be collected from the boundaries of a particular farm and fed into a GIS application on a computer, which can map the location of the farm, often with great precision.

Once a farm is mapped electronically, a product from that farm can be traced back easily to the source if the product is marked with the coordinate information, which can be done

with barcodes but is typically done by physically marking the items. The advantage of barcodes is that, once assigned, they can be scanned at points along the supply chain to track not only the origin but the path of goods from the farm to the end consumer. In this way, GIS maps can, in conjunction with barcodes, ensure traceability.

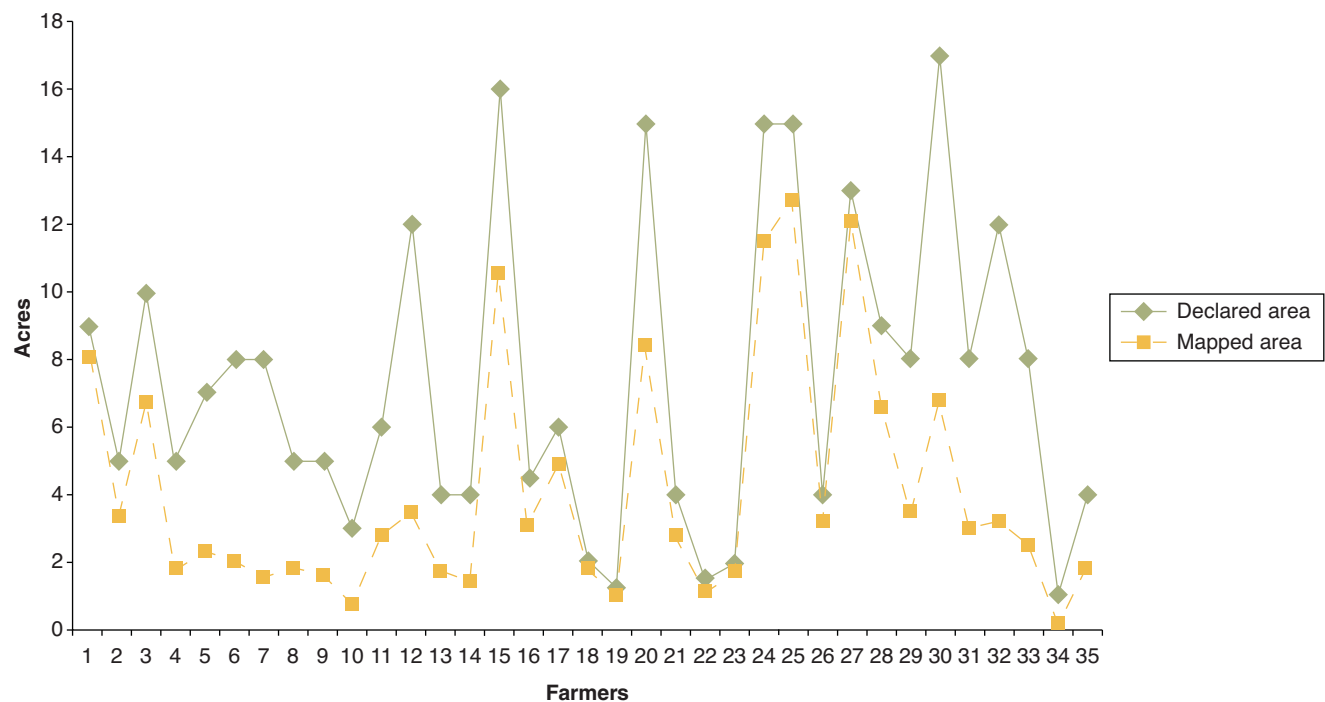
### Business Model

There is no business model in this particular case because TIPCEE as well as the GIS component is supported by the donor. A business case for such an investment is not difficult to make, however. For example, if traceability allows products to enter a high-value international market, the gain in revenue should easily pay for the equipment and labor required to maintain a GIS.

### Impact, Scalability, and Sustainability

The use of precise electronic maps can lead to superior production planning (actual area is often below declared area; see figure 10.8) and yield forecasting. Knowing the location and size of farms makes it easier for procurers to monitor production and improve the targeting of assistance and inputs. Ideally, traceability makes smallholders more attractive

**FIGURE 10.8:** Declared and Actual Area Can Differ Significantly (Citrus farms)



Source: Adapted from USAID 2009.

suppliers to exporters. It is unclear whether GIS mapping affected TIPCEE farmers' incomes or inclusion in a particular supply chain, however. What is known is that by 2009, 12,000 farms on more than 20,000 acres had been mapped for all types of crops (USAID 2009). The use of GIS mapping is replicable elsewhere if funding and training are available.

The initial mapping was a result of the project, which is now completed. To increase the likelihood of sustainability, TIPCEE implementers trained the staff of three firms specializing in horticultural exports, two NGOs, and over 250 farmers, staff members of private firms, and agents of the Ministry of Food and Agriculture to use GPS devices and GIS software. The training covered creating, maintaining, and updating electronic maps. TIPCEE also facilitated discussions with international research institutes (such as IFPRI) and the University of Ghana to create standard practices and formats for platforms and data storage so that current maps will remain compatible with future maps.

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## Module 11: ICT APPLICATIONS FOR AGRICULTURAL RISK MANAGEMENT

SOHAM SEN (World Bank) and VIKAS CHOUDHARY (World Bank)

### IN THIS MODULE

**Overview.** Risk and uncertainty are ubiquitous and varied in agriculture. They stem from uncertain weather, pests and diseases, volatile market conditions and commodity prices. Managing agricultural risk is particularly important for smallholders because they lack resources to mitigate, transfer, and cope with risk. Risk also inhibits external parties from investing in agriculture. Timely information is essential to managing risk. Information communication technologies (ICTs) have proven highly cost effective instruments for collecting, storing, processing, and disseminating information about risk.

**Topic Note 11.1: ICT Applications for Mitigating Agricultural Risk.** ICTs have reduced the costs of gathering, processing, and disseminating information that helps farmers mitigate risk. Information services using mobile phones and radios can direct early warnings of inclement weather, market movements, and pest and disease outbreaks to farmers. With an early warning, steps can be taken to limit potential losses. Farmers can also access advisory services remotely to support their decisions related to risk-mitigating activities or to choose the most appropriate action in response to an early warning. These decision support systems are critical for transforming information into risk-mitigating action.

- **Through mKRISHI, Farmers Translate Information into Action to Mitigate Risk**

**Topic Note 11.2: ICT Applications to Transfer Agricultural Risk.** Applications of ICTs to transfer agricultural risk through instruments such as insurance and futures contracts are still quite limited. The widespread use of these instruments seems to be hampered by low levels of institutional development, high costs, inability to customize products to meet smallholders' requirements, and poor financial literacy rather than by the information constraints that ICTs can address. In a few instances, ICT applications are facilitating the design and delivery of index insurance. Although ICTs have made it easier for smallholders to access and participate in spot commodity exchanges, their use of ICT to participate in futures contracts to hedge price risks remains a distant dream.

- **ICTs Enable Innovative Index-based Livestock Insurance in Kenya**
- **Kilimo Salama Delivers Index-based Input Insurance in Kenya through ICTs**

**Topic Note 11.3: ICT Applications for Coping with Agricultural Risk.** While there have been few applications of ICTs to cope with agricultural shocks, those that exist are proving important and potentially transformative. Mobile phones enable ground personnel or affected persons to report more easily to whoever is coordinating a response to the shock. This communication leads to better-targeted relief efforts. In the event of a shock, ICTs facilitate transfers and remittances to farmers from state and relief agencies as well as from farmers' extended social networks. Finally, disaster management is using more sophisticated applications to collect and synthesize information from the field. In the future, these disaster management applications might be applied to respond to agricultural shocks.

- **Electronic Vouchers Are a Targeted, Traceable Lifeline for Zambian Farmers**
- **Community Knowledge Workers in Uganda Link Farmers and Experts to Cope with Risk**



## OVERVIEW

Risk and uncertainty are ubiquitous in agriculture and have numerous sources: the vagaries of weather, the unpredictable nature of biological processes, the pronounced seasonality of production and market cycles, the geographical separation of producers and end users of agricultural products, and the unique and uncertain political economy of food and agriculture within and among nations. Managing agricultural risk is particularly important for smallholder farmers, who are usually already vulnerable to poverty and lack the resources to absorb shocks. Typical shocks such as drought (image 11.1) or a pronounced drop in market prices prevent poor households from acquiring assets or making the most of the assets they have (Cole et al. 2008). They push families into poverty and cause extreme hardship for those already in poverty.

Exposure to risk prevents farmers from easily planning ahead and making investments. In turn, risk inhibits external parties' willingness to invest in agriculture because of the uncertainty about the expected returns. Improved management of agricultural risk has significant potential to increase productivity-enhancing investments in agriculture (World Bank 2005).

This module discusses experiences with emerging ICT applications that channel critical information for mitigating agricultural risk in developing countries, reduce the costs of delivering insurance to remote rural users, and deliver vouchers to farm households affected by droughts and floods. Although unproven, such applications offer glimpses of how ICT is likely to be used to manage agricultural risk.

### IMAGE 11.1: Unexpected Changes in Climate Contribute to Risk



Source: World Bank.

The module begins by distinguishing among the kinds of risks that affect agriculture and then describes three major strategies for managing risk: risk mitigation, transfer, and coping. The crucial role played by information and ICTs in each major risk management strategy is described, along with lessons from the experience to date. Topic notes and innovative practice summaries detail specific applications, their lessons, and principles for success.

### Defining and Describing Risk

The terms “risk” and “uncertainty” indicate exposure to events that can result in losses. Although the terms are often used interchangeably, they have slightly different meanings. Risk can be defined as imperfect knowledge where the probabilities are known; uncertainty exists when these probabilities are not known. Many of the losses expected from the risks inherent in modern agrifood systems are in fact related to uncertain events for which there are no known probabilities, although subjective probabilities can be conjured by expert opinion (Jaffee, Siegel, and Andrews 2010).

The “traditional” risks to agriculture in developing countries include inclement weather of all kinds (floods, droughts, hail, snow, windstorms, hurricanes, cyclones), pest and disease outbreaks, fire, theft, violent conflict, and hardships of the sort that farmers have always feared. “Newer,” less familiar risks have appeared with the commercialization and global integration of commodity chains, including commodity price volatility, input price volatility, sanitary and phytosanitary risks, the risk of social compliance, and so forth. Regardless of whether these risks are old or new, their sudden occurrence and the inability to manage them can push millions of farmers into poverty traps and undermine the economies of countries that depend heavily on agriculture.

Risk in agriculture can be further classified according to whether it predominantly affects the immediate production environment, markets, or the broad institutional context in which commodities are produced and supplied:

- **Production risks** include bad weather, pests and diseases, fire, soil erosion, other kinds of environmental degradation, illness and loss of labor in the farm family, and other events that negatively affect the production of agricultural

commodities. These risks have a direct, immediate impact on local agricultural production, but it is essential to understand that their effects are transmitted from the farm all along the supply chain.

- **Market risks** can include volatile prices of agricultural commodities, inputs (fertilizer, pesticide, seed, and so on), and exchange rates, as well as counterparty risks, theft, risk of failure to comply with quality or sanitary standards, or risks imposed by logistics. These risks usually emanate from market actors (such as traders and exporters), and their effects are transmitted back to the farm.
- **Enabling environment risks** can include political risks, the risk that regulations will suddenly be applied, risks of armed conflict, institutional collapse, and other major risks that lead to financial losses for stakeholders all along agricultural supply chains.

Risks can be idiosyncratic—affecting only individual farms or firms (for example, illness of the owner or laborers, acidic soil, particular plant and animal pests and diseases) or covariate—affecting many farms and firms simultaneously (major droughts or floods, fluctuating market prices). The high propensity for covariate risk in rural areas is a major reason that informal risk management arrangements break down and that formal financial institutions hesitate to provide commercial loans for agriculture (Jaffee, Siegel, and Andrews 2010).

### Risk Management Strategies

Agrarian communities have traditionally employed various formal and informal strategies to manage agricultural risk, either before or after the effects of risk are felt. Ex ante strategies (adopted before a risky event occurs) can reduce risk (by eradicating pests, for example) or limit exposure to risk (a farmer can grow pest-resistant varieties or diversify into crops unaffected by those pests). Risk can also be mitigated ex ante by buying insurance or through other responses to expected losses such as self-insurance (precautionary savings) or reliance on social networks (for access to community savings, for example).

Ex post strategies (adopted to cope with losses from risks that have already occurred) include selling assets, seeking temporary employment, and migrating. Governments sometime forgive debts or provide formal safety nets such as subsidies, rural public works programs, and food aid to help farms and firms (and their laborers) cope with negative impacts of risky events.

Although ex ante measures allow farms and firms to eliminate or reduce risks, reduce their exposure to risk, and/or mitigate losses associated with risky events, they present real and/or opportunity costs before a risky event actually occurs. In contrast, ex post risk management measures respond only to losses that actually occur, but they can have very high real and opportunity costs when that happens. Farmers make decisions based on their evaluation of risks and the resources at their disposal.

Each strategy for managing risk can be carried out through a variety of instruments, each with different private and public costs and benefits, which might either increase or decrease the vulnerability of individual participants and the supply chain. When selecting a mix of risk responses, it is essential to consider the many links between risk management strategies and instruments (Jaffee, Siegel, and Andrews 2010).

To sum up, agricultural risk management strategies can be classified into three broad categories:

- **Risk mitigation.** These actions prevent events from occurring, limit their occurrence, or reduce the severity of the resulting losses. Examples include pest and disease management strategies, crop diversification, and extension advice.
- **Risk transfer.** These actions transfer risk to a willing third party, at a cost. Financial transfer mechanisms trigger compensation or reduce losses generated by a given risk, and they can include insurance, reinsurance, and financial hedging tools.
- **Risk coping.** These actions help the victims of a risky event (a shock such as a drought, flood, or pest epidemic) cope with the losses it causes, and they can include government assistance to farmers, debt restructuring, and remittances. Government and other public institutions, through their social safety net programs, play a big role in helping farmers cope with risk.

There is a distinct role for both public and private institutions in helping smallholders to manage agricultural risk. Private interventions include individual actions and private arrangements among individuals (either informal arrangements or formal, contractual arrangements). Governments have a supporting role to play here, which may include providing infrastructure, information, and a suitable framework for private institutions. As noted, governments and civil society also have a role as providers of safety nets.

### Central Role of Information and ICTs in Risk Management

All of the above-mentioned strategies—risk mitigation, transfer, and coping—have limitations, and farmers often deploy a combination of strategies to manage their risks. The mix of strategies often depends on factors like the availability and understanding of different risk management instruments, institutional and physical infrastructure, a farmer's capabilities and resource endowment, and a farmer's social network. Information about what needs to be done, when, how, and why is fundamental for smallholders and other stakeholders in the agricultural sector to implement actions to mitigate risk, transfer risk before it occurs, and determine how to cope once those events have occurred.

Farmers' information needs and sources are varied and change throughout the agricultural production cycle (table 11.1), but all farmers require a comprehensive package of information to make decisions related to risk.

Farmers typically have been poorly informed. As the founder of a market information service noted:

*Most [farmers] have long relied on a patchy network of local middlemen, a handful of progressive farmers, and local shop owners to receive decision-critical information, whose reliability, accuracy, and timeliness can have a critical impact on their decision making and therefore livelihood. These are fundamental decisions, such as what price to sell the crop, where to sell (given the numerous fragmented markets), when to harvest, and when to spray pesticides to save the crop.*

Mehra 2010

Research in Sri Lanka found that the cost of information, from the time the farmer decides what to plant until produce is sold at the wholesale market, can be up to 11 percent of production costs. The study also found that information asymmetry is an important contributor to overall transaction costs (De Silva 2008). ICTs such as the Internet, networked computers, mobile phones, and smart phones are the latest

in a long line of technologies (the newspaper, telegraph, telephone, radio, and television) that support risk management practices by collecting, processing, distributing, and exchanging information (World Bank 2007).

A survey of current applications of ICTs to manage agricultural risk suggests that they are valuable for two primary reasons. First, ICTs channel information, advice, and finance to farmers who are difficult to reach using conventional channels. Second, ICTs reduce the costs for organizations to provide risk management services, because they can greatly reduce the costs of collecting, storing, processing, and disseminating information.

These cost reductions have produced two effects that encourage private investment in ICTs to manage agricultural risk. First, previously unprofitable activities have become profitable. Second, reductions in operating costs can reduce prices for the end user. Products and services that were once too expensive for the poor have come within reach, opening a new market segment for risk management products.

The use of ICTs to manage agricultural risk is at such an early stage that it is difficult to discern trends, but interesting developments are underway. Increasingly, the private and public sectors are collaborating to invest in ICTs that can deliver timely information to farmers. With continuing improvements in technology, software, and infrastructure, the quality and richness of that information are improving over time to address specific needs for individual farmers.

Information services will allow farmers ever more interactive, two-way communication with agricultural experts and others in the agricultural innovation system (see Module 6). With the incorporation of ICTs, supply chains are becoming far more transparent and capable of including smallholders (see Module 10). The technology seems to help farmers avoid default risks and produce to consistent quality specifications, which is an important step towards participating in more lucrative commodity markets.

As observed earlier, the encouraging trend in risk transfer products is the use of ICTs to design insurance contracts,

**TABLE 11.1: Farmers' Information Needs in Relation to the Crop Cycle and Market**

BEFORE PLANTING	BEFORE HARVEST	AFTER HARVEST	MARKET INFORMATION
<ul style="list-style-type: none"> <li>• Information on agricultural inputs such as seed, fertilizer, pesticide</li> <li>• Credit</li> <li>• Weather</li> <li>• Soil testing</li> </ul>	<ul style="list-style-type: none"> <li>• Good agricultural practices</li> <li>• Pest management</li> <li>• Harvesting time and techniques</li> <li>• Packaging</li> </ul>	<ul style="list-style-type: none"> <li>• Postharvest management</li> <li>• Storage</li> <li>• Grading and standardization</li> <li>• Logistics</li> <li>• Market information</li> </ul>	<ul style="list-style-type: none"> <li>• Alternative market channels</li> <li>• Commodity prices</li> <li>• Wholesale market price information</li> <li>• Consumer behavior</li> </ul>

Source: Adapted from Narula and Sharma 2008.

deliver insurance policies, assess crop damage, and deliver indemnity payments. Although the agricultural insurance markets in developing countries are very small, ICTs clearly have features that should help broaden those markets.

With regard to risk coping, technologies that allow real-time visualization and assessment of damage are beginning to be applied to agricultural shocks such as floods. Two other technologies—mobile money and electronic voucher systems—are expected to be more regularly incorporated into the operations of multilaterals and governments that must transfer funds to beneficiaries without access to financial institutions (see Module 7).

### KEY CHALLENGES AND ENABLERS

If it is difficult to ascertain trends from nascent activities such as those described in the topic notes, it is even more challenging to assess outcomes and draw lessons. Many of these activities should be evaluated rigorously to determine their impacts and critique their approaches to using ICT in managing agricultural risk. Despite these caveats, several preliminary insights, cross-cutting challenges, and key enablers for risk mitigation, risk transfer, and risk coping should be noted.

First, in some instances, farmers will pay for risk management services, particularly information services, customized to their needs. However, before adequate customization occurs, most risk management services need public or private funding to support farmers' initial access. Thus partnerships are central to assembling the combination of knowledge, skills, and resources required to manage risk through the use of ICTs.

Successful efforts display cooperation between software developers, hardware manufacturers, agricultural experts, financial intermediaries, state governments and institutions, donors, nongovernmental organizations (NGOs), mobile operators, and others in the private sector. These partners might have different incentives for participation that may not always be compatible, and different stakeholders may have different time horizons. To hold such partnerships together, an appropriate balance must be struck between stakeholders' competing interests and short- and long-term gains.

Because partnerships, particularly with the participation of the private sector, are so vital in risk management, an enabling policy environment and institutional framework supporting business and entrepreneurship is also critical to incentivizing private investment to cope with or transfer risk. Additional fundamental elements are adequate

physical and telecommunications infrastructure for the cost-effective deployment of ICTs. Where costs are sufficiently low because mobile infrastructure is already available, more profitable opportunities may exist. Successful ventures will offer insight into ways of ensuring sustainability and use on a wide scale.

Farmer capacity is also challenging. Rural areas, where risk management services are so desperately needed, also lack education services, financial services, and even agricultural services. Many aspects of human capacity—such as financial literacy, knowledge of best agricultural practices, and familiarity with technology—are prerequisites for using risk management tools successfully.

Highly developed software programming skills and technical expertise are also critical for deploying ICTs. Many risk management services were able to leverage the significant human resources of larger organizations such as Reuters and Tata Consulting Services to develop their software (see Topic Note 11.1). This capacity is not universally available. In addition, providers must be able to assess and thoroughly understand the needs of their clients; experience shows that most technology-driven projects that do not connect with and address users' needs have higher rates of failure.

Women and other vulnerable groups do not have equal access to risk management tools. Traditional cultural norms in many societies restrict women's mobility, education, assertiveness, and awareness, all of which affect their ability to acquire information or advisory services to help manage agricultural risks. The underlying structural gender constraints make them passive recipients rather than active seekers of information. Even when women proactively seek information, their access to information and ability to use it are hampered by gender norms and stereotypes (ILO 2001:6).

Theoretically, the impersonal nature of ICTs overcomes some of the traditional barriers and gender asymmetries that women face in accessing information. A mobile phone, for example, does not differentiate between a female farmer and a male farmer, but a male extension worker might. It is often difficult for women farmers to travel long distances to ascertain market prices, but a short messaging service (SMS) might deliver that information without breaking any traditional stereotypes and gender norms. Very little data, disaggregated by the gender of beneficiaries, is available on the impact of ICT applications in agricultural risk management. Increasing gender-disaggregated data and analyzing the effects of risk management instruments on

women's agricultural experience over the long term could provide useful guidance for improving women's access to such instruments.

Trust in information and trust in transfer products are also critical issues in risk management. The information delivery mechanism seems to influence farmers' confidence and trust in the information as well as how they use it. Farmers are more likely to act upon information received directly from an expert than on information provided by an automated database. Farmers are also more likely to trust and act on information they receive from a person standing in front of them than from somebody on the phone or an automated phone message.

Because most initiatives discussed in this module have yet to be studied rigorously, it is difficult to draw quantitatively sound causal relationships between ICT for risk management interventions and gains in risk reduction. Support is needed for research to establish the impact of ICT in risk mitigation, transfer, and coping systems. Such evidence would not only improve the interventions but garner support to scale up effective innovations.

In nearly every instance in which investments in ICT have helped agricultural stakeholders to manage risk, external support has been critical for providing complementary public goods, including:

- **Infrastructure**, especially electricity delivery and mobile network coverage.
- **Institutional and regulatory reform**, especially with regard to commodity markets that raise barriers to the adoption of ICTs for risk management.
- **Business climate reforms** to encourage continued participation and innovation from the private sector. Donors can also encourage and foster cooperation among public and private sector actors.
- **Technological, agricultural, and financial literacy among smallholder farmers**. Low literacy represents a significant barrier to smallholders' effective use of ICTs to manage risk.

Donors such as the World Bank can also monitor innovative applications in risk management, evaluate their impact on small-scale farmers and the agricultural sector, and provide research and technical support where necessary.

## Topic Note 11.1: ICT APPLICATIONS FOR MITIGATING AGRICULTURAL RISK

### TRENDS AND ISSUES

While agriculture will continue to be risky, many risks can be mitigated by timely action and through the application of best practices. Typical risk mitigation actions might be spraying crops with the appropriate pesticides in response to an early warning of a nearby pest outbreak or optimally altering cropping patterns in response to news from commodity futures markets.

Information is the most critical requirement for effective risk mitigation, and farmers need a variety of information to make choices to manage risk. Two types of information are most important for risk mitigation:

- **Early warnings** about the likely occurrence of inclement weather, pest and disease outbreaks, and market price volatility.
- **Advisory information** to help farmers decide upon a course of action to manage production risks optimally or to respond to early warnings.

The connection between agricultural advisory services and risk mitigation is an important one, because information

alone is often not sufficient to manage risk. In Uganda, for example, the Grameen Foundation found that even if a farmer knew that a banana disease was spreading nearby, he or she required help in choosing the right action to prevent infection of the plants they owned (Grameen Foundation 2010a).

In many cases, the early warning or decision support information already exists. State meteorological services generally collect weather information and create forecasts. Similarly, agricultural institutes, research universities, or extension services are typically well aware of best practices in crop selection, production techniques, input use, pest management, global commodity trends, and other topics critical to smallholder farmers. International organizations also generate early warning and decision support information. USAID's Famine Early Warning System (<http://www.fews.net>) provides information for governments to manage food security risk, for example. A similar system at FAO helps to manage food security risk—the Global Information and Early Warning System (<http://www.fao.org/gIEWS/english/index.htm>).

One difficulty has been to collect and process this information so that it is relevant to individual farmers. Another has been to transmit the information to rural populations in poorly connected areas in cost-effective ways. ICT applications have made it easier and cheaper to achieve these objectives.

There is some doubt about whether an early warning alone can help farmers mitigate risk. Many of these causal links have not been tested empirically. Latent demand for advice in addition to warnings appears to exist, but it is not clear whether farmers are willing to pay for such advice delivered using ICTs or whether the private sector can deliver such information sustainably. Public-sector and development institutions should remain active in this space and keep a close eye on pilots in countries such as India, Uganda, and Kenya.

### RECENT ICT APPLICATIONS FOR RISK MITIGATION

Farmers in many countries receive news of impending bad weather and catastrophic events, pest and disease outbreaks, and price volatility in commodity markets. The use of ICTs has reduced the cost and increased the profitability of providing this information, which has attracted private-sector participation in a space traditionally dominated by state extension services or agricultural institutes. The private sector originally developed services to provide market price information, but most of these services have evolved to deliver news about impending catastrophic and inclement weather.

#### Risk-Mitigating Information

The quintessential example of applying ICTs to agriculture is the Indian agribusiness giant ITC and its e-Choupal service (<http://www.itcportal.com/rural-development/echoupal.htm>), detailed in Module 9. This extensive network provides approximately 4 million farmers with information on market prices, the weather, pest and disease outbreaks, and expert advice. The service is free; ITC profits by using its information service kiosks to procure commodities and market agricultural inputs to farmers (ITC 2010).

Reuters Market Light (<http://www.marketlight.org/>) detailed in Module 3, modifies the information delivery model of e-Choupal by eliminating the kiosks and reaching out directly to farmers (box 11.1). Developed by the Thompson Reuters information company, the service provides highly personalized, professional information to India's farming community. It covers over 250 crops, 1,000 markets, and 3,000 weather locations across

#### BOX 11.1: Reuters Market Light Disseminates Early Warnings to Mitigate Risk

The main task of Reuters Market Light (RML) is to give farmers price information to increase their bargaining power in markets, but it also provides early warning information that can be used to mitigate risk. Two pieces of the service are particularly relevant here:

- **Farmers receive daily SMS messages** containing weather information for their particular locations. This information includes predictions for rainfall, humidity, and inclement weather.
- **Farmers receive three types of news** for crops specified when they subscribe to the Reuters service: (1) news regarding outbreaks of pests or diseases, (2) news and analysis from global markets, and (3) government policy information regarding, for example, farmer support programs, schemes, and subsidies.

That timely weather forecasts might help mitigate risk is not difficult to ascertain, as this anecdote from Reuters indicates. A farmer is quoted as saying, "I got message on relative humidity going up to 70 percent. As a precaution, I put a spray of US\$ 10. My friend did not know this. He lost nearly US\$ 8,000 of his crop that day."

*Source:* Authors, drawing on Reuters 2007, Preethi 2009, and Mehra 2010.

13 Indian states in 8 local languages (Mehra 2010). The information is delivered directly to farmers' mobile phones through SMS. RML subscription cards can be purchased from local shops, input suppliers, banks, and post offices.

Rigorous, empirical evaluations have yet to be carried out to determine the quantitative relationship between information availability and the implications for risk mitigation. A preliminary study in Sri Lanka concluded that 40 percent of post-production losses could be mitigated with timely information (Mittal, Gandhi, and Tripathi 2010). From an internal study, Thompson Reuters claims that through information sharing, an estimated 1 million farmers in over 15,000 villages have used the service and received high returns on their investment, amounting to over US\$ 4,000 from additional profits and US\$ 8,000 on saved costs, far exceeding the service fee (International Chamber of Commerce 2010).

Through the ESOKO platform (<http://www.esoko.com/>) described in Module 3, West African farmers and traders

receive targeted, scheduled text messages on commodity prices or offers from buyers. The focus is on creating a transparent, stable market and reducing transaction costs. Similarly, the Kenya Agricultural Commodity Exchange (<http://www.kacekenya.co.ke/>) makes prices on the exchange available by text message (KACE 2010). These services improve farmers' ability to negotiate prices and serve to partially mitigate price risk. Even so, they cannot mitigate the more significant price volatility that originates in global markets.

Research institutes are also innovating in the delivery of information services. MTT Agrifood Research Finland is piloting the EVISENSE project ([https://portal.mtt.fi/portal/page/portal/mtt\\_en/ruralenterprise/tomorrowsfarm/envisenseforecast](https://portal.mtt.fi/portal/page/portal/mtt_en/ruralenterprise/tomorrowsfarm/envisenseforecast)) to provide 24-hour disease forecasts to Finnish farmers using a combination of technologies such as weather sensors, databases, mobile phone SMS, GPS, and online management systems. Sensor networks across the country feed weather data to a centralized server. This centralized database contains farmer-specific cropping information provided by the farmer. Computer models use the site-specific data along with the weather data to predict pest outbreaks. If an outbreak is predicted, farmers receive messages on their mobile phones and can then log onto the Internet to download additional information from a farm management information system. The online system recommends which spray agents to use and when to combat the impending attack.

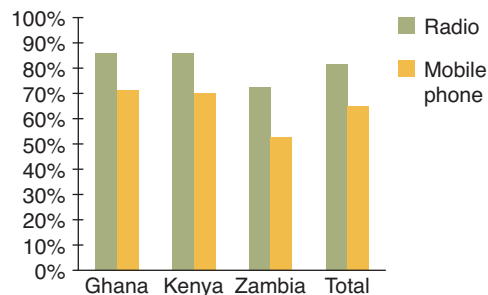
Through EVISENSE, farmers can mitigate the risk of disease by spraying their crops with the appropriate pesticide ahead of an outbreak. The spraying plan can be sent to the computer on the tractor's sprayer to carry out the spraying. Once it is entered into the tractor's system, the plan can be fine-tuned using GPS systems on the tractor and location-specific data on moisture, wind, and predicted rainfall from MTT's SoilWeather system. For example, if rain is predicted within three hours of spraying, the spraying will be discontinued. This information prevents expensive inputs from being washed away and damaging the environment (MTT 2009).

Mobile phones are not the only way to deliver early warning information. Radio remains very important: More farmers are likely to receive information from the radio than from any other source. Recent data show that in sub-Saharan Africa, even among more developed nations, the penetration of radio still exceeds that of the mobile phone (figure 11.1).

### Decision Support Systems

Besides fostering the delivery of timely and accurate information to mitigate risk, ICT applications also act as decision support systems. These systems help stakeholders choose the

**FIGURE 11.1:** Ownership of Radios and Mobile Phones in Ghana, Kenya, and Zambia, 2010



Source: InterMedia AudienceScapes Surveys 2010.

best course of action to manage risks in production or respond appropriately to early warnings. For instance, weather information and advisory services are in place in many countries to help stakeholders make optimal decisions from crop planning to crop sale to manage risks. Again it is important to emphasize that such advisory services are important for risk mitigation because they help farmers translate good information into practical actions that reduce their exposure to risk.

Such services enable farmers to interact in various ways (such as voice interaction or SMS queries using mobile phones) with an automated database containing best practices and recommendations to handle most routine queries. Common queries might include ideal planting times, optimal input applications, or suggestions on which crops to plant based on market trends. In unique cases, queries are referred to agricultural experts. In other cases, the farmer is able to speak directly with extension personnel.

The mKRISHI service recently piloted by Tata Consulting Services in India is a prototypical example of remote extension services that allow two-way interactions. ("Krishi" is "farming" in Hindi.) A farmer uses the platform to access best practices and query agricultural experts through low-cost mobile phones, mostly using SMS (Banerjee 2010).

MKRISHI is not the only program of its kind to offer remote extension services heavily reliant on ICTs. Other countries have experimented with slightly different ways of linking the farmer to extension information. The Kenya Farmers Helpline ("Huduma Kwa Wakulima") ([http://www.kencall.com/index.php/site/kenya\\_farmers\\_helpline/](http://www.kencall.com/index.php/site/kenya_farmers_helpline/)) was launched in 2009 by KenCall, a Kenyan business process outsourcing company, with support from the Rockefeller Foundation. Instead of using SMS, farmers call the Helpline and speak to an agricultural expert in English or Swahili (Lukorito 2010). Kisan Call Centre (India) and Jigyasha 7676 (Bangladesh) are similar operations that provide customized expert advice to farmers.

Radio (a traditional source of extension advice) is becoming a more interactive source of advice with the advent of mobile phones and call-in (or text-in) programs. The African Farm Radio Research Initiative (<http://www.farmradio.org/english/partners/afri/>) of Farm Radio International (<http://www.farmradio.org/>) creates content that can be broadly described as agricultural extension information, including weather forecasts, price news, and early warnings about pests and diseases. (For details, see Topic Note 6.2.)

### Supply Chain Integration and Traceability

ICT applications are also helping supply chains become more vertically integrated. Better cooperation between farmers and buyers along the supply chain mitigates default risk. Amul in India has installed Automatic Milk Collection Unit Systems in village dairy cooperatives. These systems enhance the transparency of transactions between the farmer and the cooperative and have lowered processing times and costs. The application uses computers connected to the Internet at the milk collection centers to document supply chain data such as fat content, milk volumes procured, and amount payable to the member (Bowonder, Raghu Prasad, and Kotla 2005) (for considerably more detail, see IPS “IT Tools for India’s Dairy Industry” in Module 8).

Dairy Information Services Kiosks at collection centers describe best practices in animal care to enhance milk yield and quality and assists dairy cooperatives to effectively schedule and organize veterinary, artificial insemination, cattle feed, and related services (Rama Rao 2001). Delivery of such comprehensive information helps to improve integration of the supply chain, thus reducing default risk. The early detection of production volatility makes it possible to take preemptive measures to address the underlying risk.

ICT applications, particularly GIS and RFID technologies, have had an impact in mitigating two additional forms of risk in the supply chain: sanitary and phytosanitary (SPS) risk and default risk. Larger aggregators and traders use software systems to collect and track information about who is growing what and whether farmers are adhering to the food safety and quality standards imposed in Europe and North America, especially for perishable foods. Traceability technologies and software to increase integration in supply chains, such as Muddy Boots (<http://en.muddyboots.com/>) (see Module 10), help to mitigate default risk when suppliers rely on large numbers of small-scale farmers. Fruiléma (<http://www.fruilema.com/>), an association of fruit and vegetable producers and exporters in Mali, launched a web platform for potential buyers to track the entire mango production chain and enables Fruiléma to comply with Global G.A.P. standards (see IPS “Mango Traceability System Links Malian Smallholders and Exporters to Global Consumers” in Module 12).

### LESSONS LEARNED

A number of insights emerge from recent experiences in using ICTs to mitigate agricultural risk. One important insight is that the missing link in providing risk-mitigating information to farmers was not the information itself but the challenge of aggregating, personalizing, and disseminating it in a timely and cost-effective way. The content that farmers need is already produced by universities and government institutes.

Any use of ICT applications to mitigate agricultural risk must ensure that the fundamental requirements described above are present or can be developed easily. For example, farmers’ familiarity with ICTs should be assessed before initiating an intervention. Similarly, there should be a baseline understanding of whether farmers have the capacity to make good use of the information. Do farmers have access to rural finance, markets, transport, technology, inputs, and so on? If not, consider awareness and education programs regarding risk-mitigating strategies or appropriate responses to early warnings.

One difficulty in providing early warning or advisory services to farmers was not that the information was lacking, but that it could not be delivered effectively. ICTs make it easier to collect information from the universities and institutes that produce it and then to personalize it and provide it directly to farmers. The medium matters, however. A radio announcement is different from a phone call, which is again different from a text message.

Collaboration between the private and public sector is increasing. The public sector generates early warnings and provides expert advice, while the private sector has found that it can leverage ICTs (particularly mobile phones and back-end data collection and processing systems) to deliver this content to farmers quickly. Profitability remains a challenge. In many instances, the upfront investment and capital costs (such as the cost of investing in weather and ICT infrastructure) as well as the operational costs are high. A longer-term horizon and significant economies of scales are required to break even.

The ability to deliver highly personalized information is another key to earning revenue. Farmers naturally want information relevant to themselves—their crops, their plant and livestock disease, their markets—in the language they speak. It is difficult to elicit direct payment for services from farmers, but if farmers see a value proposition, they are often willing to pay for a service.

As a result, private participation in delivering information should be encouraged where possible, but the commercial sustainability of such initiatives should be analyzed rigorously. Information service providers should be encouraged to partner with the public sector to source content. It is difficult



to imagine that the private sector would find it profitable to invest in generating content as well as delivering it (unless delivering it to farmers they contract). State-funded institutions have been critical partners in sharing their knowledge and resources without cost. Cooperation and connectivity are critical between information distributors (mobile application developers) and information creators (universities, news organizations, meteorological services, government data services).

**IMAGE 11.2:** The mKRISHI Interface



Source: TATA Consulting Services.

Technology considerations are also critical. Even though farmers can get weather information from the radio, those reports come only at a certain time and are easily missed, because farmers are often in transit or working in the field away from the radio. Text messages, which can be stored and accessed at any time, are preferred because they ensure that farmers receive the critical early warning. Mobile infrastructure is vital for most services that transmit risk-mitigating information to farmers (except for services relying on radio).

New capacities in technology may lead to even better risk mitigation strategies. The growing sophistication of mobile phones and falling costs of weather sensors make it likely that farmers will soon have access to a richer variety of information that is even more tailored to their location, crop choice, and general information needs. Java-enabled phones, for instance, are cheaper and allow farmers to access information using menus instead of simply sending SMS queries back and forth. Two-way interaction between farmers and advisors, in which farmers can ask and receive answers to specific questions, are likely to increase but also to command a premium. A direct connection overcomes literacy and language barriers, though these barriers should also ease as voice recognition technology improves.

### INNOVATIVE PRACTICE SUMMARY

**Through mKRISHI, Farmers Translate Information into Action to Mitigate Risk**

MKRISHI is innovative because it enables farmers to transform information into risk-mitigating actions (“TCS’ mKRISHI on Pilot Run in Maharashtra,” *The Financial Express*, 2009). The mKRISHI platform, developed by Tata Consultancy Services in 2007, enables farmers to access best-practice information and agricultural experts through low-cost mobile phones using SMS (Banerjee 2010) (image 11.2). The connection between agricultural advisory services and risk mitigation is an important one, because information alone is often not sufficient to manage risk.

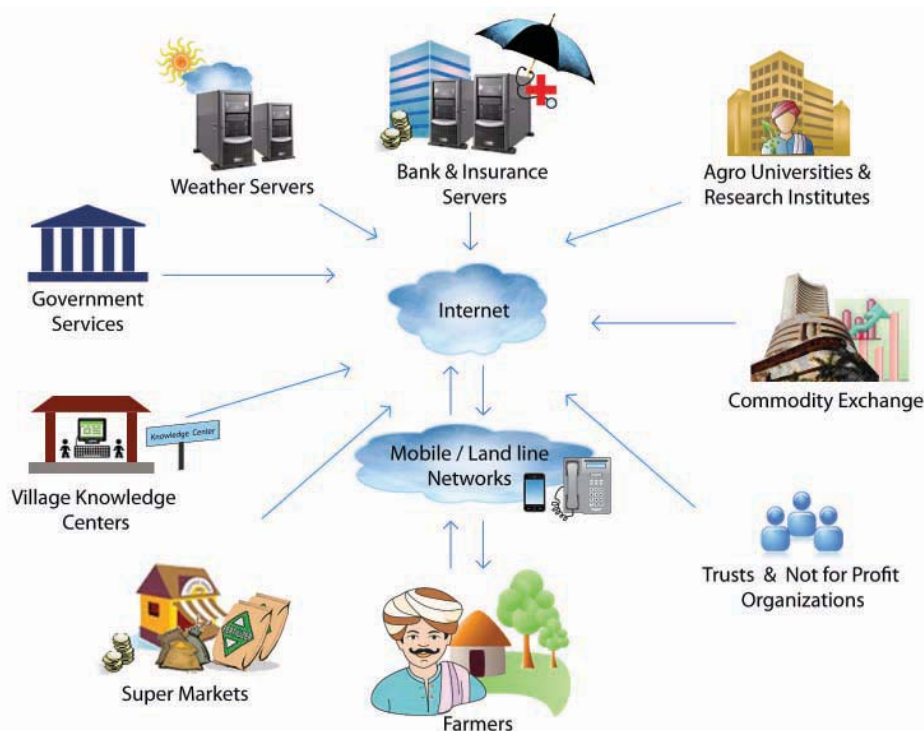
Through the advisory service, farmers might inquire how much fertilizer or pesticide to use, so they can optimize their use of these costly inputs. Similarly, farmers might inquire about when to harvest to avoid inclement weather. Farmers with cameras in their phones can submit photographs to supplement their messages. While responding to farmers’ queries, experts are able to incorporate soil information by accessing the soil sensor nearest to the caller’s location (Pande et al. 2009). Farmers can also request a voice- or SMS-based expert response.

### Growth and Development

MKRISHI was conceived and developed at the innovation lab of Tata Consulting Services (TCS). The first pilot was deployed in 2010 to an estimated 500 farmers in Uttar Pradesh and Punjab, who pay US\$ 1–2 per month to use the service. The service is being provided at a subsidized cost, as farmers were unwilling to pay the unspecified higher cost at which the service was initially offered (Pande 2010). However, mKRISHI has found that farmers may be more willing to pay if information on market linkages and the facilitation of credit is offered along with the advisory services.

Like RML, mKRISHI disseminates a wide range of personalized information; the critical difference is that experts can respond to farmers’ queries. To provide the early warning and news information, the system relies on a web-based mobile platform that ties into many information sources. Data are gathered from commodity exchanges, agricultural research institutions (often state supported, such as Punjab Agricultural University), banks, weather servers, local markets, and solar-powered weather and soil sensors distributed throughout the areas where the service is offered (figure 11.2) (Pande et al. 2009).

To respond to farmers’ queries, mKRISHI relies on an automated database of frequently asked questions. The database

**FIGURE 11.2:** The mKRISHI Infrastructure

Source: TATA Consulting Services.

Note: CDMA = Code Division Multiple Access, a standard used by mobile phone companies.

can handle most questions, which are usually generic, but more specific or sophisticated questions are forwarded to 10 experts with Internet access. These experts interact with a system that resembles email; they are able to see attached photos and soil sensor information with each message and their response is sent back to the farmer by SMS.

### Impact, Scale, and Sustainability

Farmers reportedly use mKRISHI to choose planting strategies, optimize fertilizer use, and time the harvest to avoid bad weather. Such choices surely contribute to risk mitigation, and some early data from the pilot studies and interactions with farmers show promise in this regard.

If productivity increases can be partially attributed to superior risk mitigation, then indirect quantitative research suggests that an agricultural advisory service such as mKRISHI improves risk mitigation. Much evidence supports the idea that effective delivery of traditional extension services to farmers improves productivity. Returns to extension services vary by crop and by geography, but studies show them to be quite high: “75–90 percent in Paraguay, 13–500+ percent in Brazil, and 34–80+ percent in a group of countries in Asia, Africa, and Latin America” (Birkhaeuser, Evenson, and Feder

1991:643). Again, however, the implication of delivering such services remotely is still to be tested.

As noted, mKRISHI was made available to 500 farmers in two Indian states as of 2010, and there are plans to offer the service across India. There are also discussions about launching similar services in the Philippines and Ghana (Banerjee 2010).

The sustainability of the mKRISHI platform is still questionable. The complexity of the platform and the numerous pieces that are tied together, from people to technologies to automatic sensors, imply a difficult and expensive challenge to sustainability. Another challenge is posed by the inability to collect the full marginal cost of the service from farmers (Pande 2010).

The independent development and implementation of the project by a large private company suggests, however, that the program might be able to sustain itself until it can resolve operational challenges to profitability which seems to be occurring. Much of the basic information comes from public sources, and mKRISHI has been able to organize and personalize it through a large consortium of partners. The ready availability of the basic information (a public good) thus becomes one of the prerequisites for building and sustaining such operations.

## Topic Note 11.2: ICT APPLICATIONS TO TRANSFER AGRICULTURAL RISK

### TRENDS AND ISSUES

Farmers face many important risks that they can do little to mitigate through better agronomic practices or the use of early warning information, as described in Topic Note 11.1. Among these risks, price volatility and bad weather risk can be particularly devastating. Low prices at harvest can significantly reduce a farmer's income, while weather risk in the form of floods or droughts can reduce yields or destroy crops.

Farmers (or farmer groups) in developed nations can use specific instruments to transfer their risk to a third party in exchange for a fee. The third party can be a public or private insurance company in the case of weather risk or a commodity futures exchange in the case of price risk. In developing countries, the availability of such instruments is limited, although pilot projects are starting to introduce them.

ICTs are playing a critical role in these pilot studies on risk transfer. Advances in mobile phone applications for money transfers, improvements in the resolution and cost of satellite imagery, and the pyramiding of multiple ICTs (mobile phone, GIS, remote sensing data) to create newer applications are all promising trends that could be leveraged to transfer agricultural risks.

The heightened volatility of international commodity prices and the threat of climate change have increased developing-country stakeholders' interest in risk transfer instruments. Now the bigger challenge is to make risk transfer instruments such as insurance and price hedging more relevant and affordable for smallholders. The ability of ICTs to reduce transaction costs, deliver information and financial transactions, provide real-time data about hazards, and perform remote damage assessment can also help in piloting and scaling up risk transfer instruments.

### Instruments to Transfer Risk

Transferring risk through insurance has several important benefits. Insurance stabilizes asset accumulation by reducing the negative impact of weather shocks. Insurance also fosters investment, because it reduces the uncertainty of returns (Mude et al. 2009) (box 11.2).

Insurance contracts are complex, however, and profitable insurance operations face numerous challenges. These challenges include the difficulty of designing contracts to avoid

### BOX 11.2: How Does Insurance Work?

Insurance allows risk to be transferred to a third party for a fee. In exchange for that fee (premium), a farmer receives an policy or insurance contract that is likely to have the following features, among others: (1) a specified time period during which the risk is partially or wholly borne by the third party; (2) the events that are covered (a single peril such as hail, for example, or multiple perils such as drought, hail, fire, and theft); and (3) the payout in the event that the risk event occurs (indemnity), and possibly some gradation of the payout depending on the severity of the loss.

The insurance company profits by pooling risk across large numbers of clients and charging a premium that exceeds the likelihood of the peril occurring, multiplied by the losses that will accrue as a result. For a peril to be insurable, the resulting loss has to be definite, accidental, large, calculable or able to be estimated, and the total payout must be limited in the event of a catastrophe.

*Source: Greene 2010.*

problems of moral hazard and adverse selection; insufficient data; high administrative costs in delivering the product, assessing damages, collecting premiums, and making payments; and weak institutional and policy environments (Wenner and Arias 2003). Low trust and financial literacy have also limited the effective demand for insurance and limited the willingness to pay for policies (Giné, Townsend, and Vickery 2008). In recent years, a modified form of insurance, weather-based index insurance, has been piloted in several parts of the world to address the moral hazard and adverse selection challenges and to lower the costs of damage assessments (box 11.3).

Farmers can use other means of transferring risk to avoid the problems caused by large fluctuations in the prices of the commodities they produce. By transferring risk through futures contracts traded on commodity futures exchanges, farmers gain a means of managing the price volatility of agriculture commodities, which lends greater certainty to their production planning and farm investment decisions (UNCTAD 2009:17–18) (box 11.4).

**BOX 11.3: What Is Index Insurance?**

The unique feature of index insurance is that it reduces the cost of assessing damage by substituting individual loss assessments with an indicator that is easy to measure as a proxy for the loss. Weather events or visible vegetation have served as typical indicators. Besides reducing transaction costs, another advantage of index-based insurance is that it reduces problems of adverse selection, because the insured cannot influence the index or the loss assessment.

The disadvantage is basis risk: the imperfect relationship between the policy holder's potential loss and the index behavior. It is not always possible to perfectly match one farmer's loss from drought to that of all others. Undoubtedly, some farmers will lose more and some less.

Source: Mude et al. 2009.

**BOX 11.4: Commodity Futures Markets**

A recent report by the United Nations Conference on Trade and Development describes a commodity exchange as:

*. . . a market in which multiple buyers and sellers trade commodity-linked contracts on the basis of rules and procedures laid down by the exchange. Such exchanges typically act as a platform for trade in futures contracts, or for standardized contracts for future delivery. Often, in the developing world, a commodity exchange may act in a broader range of ways, in order to stimulate trade in the commodity sector. This may be through the use of instruments other than futures, such as the cash or 'spot' trade for immediate delivery, forward contracts on the basis of warehouse receipts, or the trade of farmers' repurchase agreements for financing.*

Source: UNCTAD 2009:17.

Like insurance, commodity futures exchanges have significant requirements, particularly with regard to policies, regulation, and financial literacy. Exchanges must be governed by clear rules, operated transparently, and regulated properly to ensure the level of confidence that traders demand. Such institutional capacity is often limited in developing nations. The trading of futures contracts also requires specialized

knowledge that most farmers or farmer cooperatives do not have. Even in the United States, less than 10 percent of farmers interact directly with commodity futures exchanges. They do make use of futures prices to make planting and production decisions, however (Cole et al. 2008). Efforts are underway in China (UNCTAD 2009:13) and India to teach farmers how to make use of futures markets, but ICTs do not play a central role (Cole et al. 2008).

**ICTs and Risk Transfer Instruments**

Although ICT applications have made it easier for farmers to access information from commodity futures markets, such applications have not served to facilitate greater interaction with the futures markets to transfer price risk.

With respect to insurance, however, ICTs seem to be easing constraints arising from the lack of data and high administrative costs. Data requirements can be intensive; for example, weather insurance contracts require time-series data on weather and associated losses for farmers. High-resolution satellite imagery has made data available to design insurance contracts that once would have been impossible to develop given the lack of data in many countries. Advances in ICT can help overcome gaps in weather data by creating synthetic data based on satellite information. Together, new data and lower costs have facilitated the development of innovative index insurance products that are currently in various stages of testing.

For example, AGROASEMEX (<http://www.agroasemex.gob.mx/>), a Mexican national insurance institution focused on the rural sector, was a pioneer of indexed weather insurance (and now offers catastrophic risk insurance). In 2007, the institution began to offer an insurance product for pasture land based on an analysis of vegetation detected by satellite (called Normalized Difference Vegetation Index or NDVI) (IFAD and WFP 2010:65–73). Satellite data also allowed the International Livestock Research Institute (ILRI) and its partners to overcome data limitations and create an index-based livestock insurance program in which damage is assessed through remote sensing (see IPS "ICTs Enable Innovative Index-based Livestock Insurance in Kenya," later in this note).

In Nicaragua and Honduras, synthetic data were created through a public-private partnership in collaboration with the local meteorological agency. Three insurance companies (Equidad in Honduras and LAFISE and INISER in Nicaragua) currently use these data to design index insurance contracts for farmers.

Another novel insurance scheme, Kenya's Kilimo Salama (<http://kilimosalama.wordpress.com/>), is described in the

innovative practice summary at the end of this note. It uses weather indicators as a proxy for input losses.

## LESSONS LEARNED

Compared to the range of applications for risk mitigation, ICT applications to transfer weather and price risk to third parties are limited. Risk transfer instruments such as insurance and futures contracts have fared poorly in developing countries in general. Such instruments often require well-developed institutions and high levels of financial literacy, which are often lacking in rural areas of developing countries.

The critical message here is that ICT applications reduce the cost of delivering insurance and improve the dissemination of prices from international futures markets, but by themselves they are unlikely to foster widespread use of risk transfer instruments. Before ICTs can be used to transfer risk, the environment must be conducive. Appropriate infrastructure, institutional structures, and policies for developing and delivering such instruments must be in place. Farmers must exhibit sufficient demand for the instruments. High levels of financial literacy and technical skills are also required. Technical expertise is absolutely vital for accessing and interpreting satellite data and designing actuarially sound policies.

Unique partnerships are essential to incorporate ICTs into risk transfer products such as index insurance. The array of partners must have the vital technical skills just described and must be able to access distribution channels, provide financial support, and assist with implementation. There is a role for the public sector to develop and disseminate basic information about risk, because such information in the public domain facilitates the creation of risk markets. Governments can also have a role in planning emergency response to infrequent but catastrophic risks, while allowing private markets to handle insurance. Partners must also be willing to collect data and make it available for insurance companies to price policies correctly or, in the case of index insurance, to create the index that links weather events to specific losses.

An enabling regulatory and policy environment is fundamental for risk transfer tools to work and is characterized by such traits as the rule of law, contract enforcement, and private property rights. For commodity markets, a rules- or principles-based approach to regulation and governance, instead of a discretionary approach, is essential for success (UNCTAD 2009). In the case of insurance, the insurance

providers need to be regulated to ensure that they can deliver on payouts.

The application of ICTs to risk transfer products has yet to mature, and interventions should be undertaken with extreme caution. This topic note describes promising examples, but any attempt to replicate them should take the local context into account. Furthermore, the current pilot programs should be subject to impact analysis to quantify their value. In the meantime, efforts can focus on improving the coverage and quality of ICT infrastructure, improving the institutional framework required to support risk transfer products, and improving the awareness of transfer products and their proper use among farmers and cooperatives.

## INNOVATIVE PRACTICE SUMMARY

### ICTs Enable Innovative Index-based Livestock Insurance in Kenya

ICTs have enabled International Livestock Research Institute (ILRI) and its partners to overcome data limitations and prohibitive administrative costs to create an index-based livestock insurance product. Damage is assessed by remote sensing, and the insurance is distributed through wirelessly connected point of sale systems deployed across the country.

ILRI, part of the Consultative Group on International Agricultural Research (CGIAR) ([www.cgiar.org](http://www.cgiar.org)), developed its Index-based Livestock Insurance product (<http://www.ilri.org/ibli/>) in 2009 in collaboration with a wide array of partners, including private and government players (ILRI 2009). Initiated in 2010, the pilot program provides farmers with livestock insurance for 6–8 animals per year for a premium of US\$ 50–100 (Waruru 2009).

Index-based livestock insurance seeks to interrupt the downward spiral of vulnerability, drought, and poverty in northern Kenya—a process that is exacerbated by climate change. Northern Kenya is home to 3 million pastoralist households and is prone to severe drought (Mude et al. 2009). Pastoralists earn a livelihood by grazing cattle (also sheep, pigs, and poultry) on semiarid to arid land and by selling meat, milk, and eggs (image 11.3). Livestock account for 95 percent of family income in an area where the incidence of poverty is 65 percent, the highest in the country (FAO–AGAL 2005:3). If drought occurs, the vegetation that the cattle graze upon is lost. Cattle starve, depriving vulnerable pastoral families of their sole source of income.

Livestock insurance allows farmers to pay a premium to transfer the risk of livestock dying in a drought to an insurance company. If a drought occurs, the policy indemnifies the pastoralists' loss. Previous insurance programs were not sustainable. The administrative costs of assessing the losses of remote pastoral communities, collecting premiums, and paying out indemnities were prohibitive.

It is unclear whether the advent of ICTs will make such programs more sustainable, because other factors affect sustainability, such as creating effective demand or minimizing basis risk. Programs such as index-based livestock insurance are being attempted, however, because ICTs greatly reduce the administrative costs that crippled previous programs. As noted, ILRI's index-based program was designed using satellite data; damages are assessed by satellite; and delivery, premium collection, and indemnity payments are all done through wireless point of sale systems.

### Growth and Development

Much of the technical work on the insurance product was done by Cornell University and the University of Wisconsin BASIS program in collaboration with Syracuse University and the Index Insurance and Innovation Initiative. As with the design of any index insurance, the challenge was to find sufficient data on both the peril as well as the indicator. Both kinds of data are necessary; data on the indicator are used to statistically predict the peril and price the insurance correctly.

The innovation in this case was to use vegetation as the indicator, because vegetation can be measured objectively by satellite to indicate the level of drought. Fortunately, the United States' National Oceanic and Atmospheric Administration has collected the high-quality imagery necessary to construct a Normalized Difference Vegetation Index since 1981, and the imagery is available free of charge.

**IMAGE 11.3:** Pastoralism in Africa Is a Critical Means to Rural Livelihoods



Source: Curt Carnemark, World Bank.

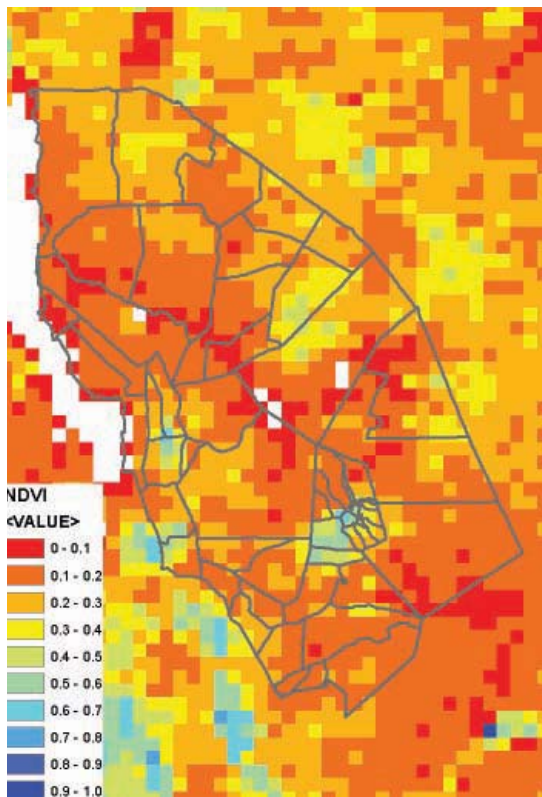
Statisticians used data on livestock losses for Marsabit District, the pilot region, to create an index to predict livestock mortality based on the remotely collected vegetation data (image 11.4). This procedure allowed for actuarially fair pricing of the index insurance (Mude et al. 2009).

The project is being implemented with Equity Insurance Agency, UAP Insurance Limited, Financial Sector Deepening Kenya, and three government departments: Kenya Meteorological Department, Ministry of Development of Northern Kenya and other Arid Lands, and the Ministry of Livestock (ILRI 2009).

Two significant operational challenges arose: creating effective demand and delivering the insurance cost-effectively. Education by way of experimental games proved critical to generate effective demand. Before a farmer would pay for an insurance program, he or she would need to understand what value the product added and how it would work. The challenge was exacerbated by low literacy (Mude et al. 2009).

In a vast region with so few market channels, cost-effective delivery of the insurance product was also a significant challenge. Policies were sold through Equity Bank's point of sale system based on handheld mobile devices, which have been rolled out to 150 areas across northern Kenya. This channel was primarily developed for another program (DFID's Hunger Safety Net Program).

**IMAGE 11.4:** Normalized Difference Vegetation Index, Marsabit District, Kenya, February 2010



Source: ILRI.

### Impact, Scalability, and Sustainability

It is too early in the pilot stage to assess the program's actual effectiveness in managing risk and ultimately reducing poverty. An evaluation is to be conducted by the University of Wisconsin at the end of the pilot. The results will help design any modifications in the insurance program and influence decisions on scaling up the pilot to other areas. The plan is to expand the program throughout the country if it proves successful in Marsabit District (Mude et al. 2009). Meanwhile, an ex ante assessment of the insurance found that:

*"... household initial herd size—i.e., ex ante wealth—is the key determinant of IBLI [index-based livestock insurance] performance, more so than household risk preferences or basis risk exposure. IBLI works least well for the poorest, whose meager endowments effectively condemn them to herd collapse given prevailing herd dynamics. By contrast, IBLI is most valuable for the vulnerable nonpoor, for whom insurance can stem collapses onto a trajectory of herd decumulation following predictable shocks.*

*"District-level aggregate demand appears highly price elastic with potentially limited demand for contracts with*

*commercially viable premium loadings. Because willingness to pay is especially price sensitive among the most vulnerable pastoralists (i.e., those not currently caught in a poverty trap, but on the verge of falling into one) for whom the product is potentially most beneficial, subsidization of asset insurance as a safety net intervention may prove worthwhile. Simple simulations find that relatively inexpensive, partial subsidization targeted to households with herd sizes in specific ranges can significantly increase average wealth and decrease poverty, at a rate of just \$ 20 per capita per one percent reduction in the poverty headcount rate."*

Chantarat et al. 2009

This last point has implications for sustainability, which faces substantial financial hurdles if the product cannot be commercially viable. The development and pilot of the program were funded by Financial Sector Deepening Trust in Kenya, the UK Department for International Development (DFID), and USAID (Waruru 2009), but plans to expand nationally would require substantial private investment.

There are also questions of dependency on other programs. The satellite data, for example, are critical. If they are lost, there would be sustainability concerns. Similarly, the point of sale system used to deliver the insurance is funded by a separate program; any changes to that program might threaten the insurance program.

### INNOVATIVE PRACTICE SUMMARY

#### Kilimo Salama Delivers Index-based Input Insurance in Kenya through ICTs

The Kenyan insurance scheme Kilimo Salama (<http://kilimosalama.wordpress.com/>) (its name means "safe farming" in Swahili) innovates by using mobile phones to collect premiums and distribute payouts, thereby reducing assessment and administrative costs. Weather indicators are used as a proxy for the loss of inputs. Under Kilimo Salama's "pay-as-you-plant" model, agrodealers sell insurance policies according to the quantity of inputs purchased.

Kilimo Salama was developed by the Syngenta Foundation for Sustainable Agriculture in partnership with Safaricom, UAP Insurance, MEA Fertilizers, and Syngenta East Africa Limited. The program specifically insures the cost of inputs in case of poor weather over the planting season. Plans are in place to offer a crop loss product in addition to the input loss insurance.

The premium amount is 10 percent of the input cost, which is shared equally by farmers and the input companies

(50 percent each). The farmer thus pays a premium of 11 cents on a bag of higher-yielding maize seed that costs US\$ 2.20 or 31 cents on a 10-kilogram bag of fertilizer that sells for US\$ 6.20 (Kilimo Salama n.d.)

When the products are sold, the seller activates the insurance policy using the Kilimo Salama application on the seller's handset by (1) scanning a product-specific bar code with the camera phone, (2) entering the farmer's mobile number, and (3) linking the farmer to the local weather station (image 11.5). The buyer receives an SMS confirming the insurance policy ("First Micro-Insurance Plan Uses Mobile Phones and Weather Stations to Shield Kenya's Farmers," *Science Daily*, 2010).

ICTs are used in every part of the operation. Thirty solar-powered weather stations automatically monitor the weather; paperless channels are used to sell product; the Safaricom 3G network is used to cheaply and quickly transmit monitoring, sales, and payout data; and M-PESA (owned by Safaricom) is the platform used to make indemnity payments electronically. The Kenya Meteorological Department provided the supporting weather data to create the index and correlate it to crop losses and therefore to input-investment losses (Ogodo 2010).

Each insurance policy sold requires the farmer to be registered to the nearest weather station (Ogodo 2010). If there is excess rain or insufficient rain, as measured by the weather reporting stations, the index correlating rainfall and crop growth defines the payout due. Then the payment is made straight to the farmer's handset using M-PESA (see IPS "M-PESA's Pioneering Money Transfer Service," in Module 2).

The insurance program was piloted to 200 farmers linked to two weather stations in Laikipia District. There was a drought in both areas, and 80 percent of the input investment was returned to farmers linked to one weather station, whereas the other station reported a less severe drought and the payout was 30 percent of the investment ("First

Micro-Insurance Plan Uses Mobile Phones and Weather Stations to Shield Kenya's Farmers," *Science Daily*, 2010).

The value of the insurance generally is not disputed, but Kilimo Salama has just finished the pilot program and impact has yet to be rigorously assessed. Even so, the business model, privately cofinanced by input sellers, seems to be growing on its own. In 2010, 12,000 farmers had registered for the insurance, and there are plans to make the product available to 50,000 farmers in Kenya by 2011 (Ogodo 2010).

**IMAGE 11.5:** Weather Station in Kenya



Source: Syngenta Foundation.

## Topic Note 11.3: ICT APPLICATIONS FOR COPING WITH AGRICULTURAL RISK

### TRENDS AND ISSUES

Regardless of the best efforts to mitigate or transfer risk, agricultural production is inevitably susceptible to risks of floods, drought, and disease, among others. Such risks, when they materialize, can force farmers to deviate from their agricultural

activities, disrupt them, or in the worst case, shut them down (Jaffee, Siegel, and Andrews 2010:21). Coping involves responding to a shock in ways that immediately curtail further losses in the short term, protect remaining life and assets in the medium term, and enable recovery in the long term.



Left to their own devices to cope with unmitigated risks, farmers typically employ strategies that are expensive in the long run. They may quickly sell productive land and other assets at below-market prices to generate cash; deplete personal savings, if they have any; pull children out of school; or borrow at high interest rates (Cole et al. 2008). Farmers also turn to their social networks for support, but this strategy does not work when entire villages are affected. When a farmer loses crops to floods, he or she may not be able to rely on family members in the same village who have suffered the same fate.

To prevent people from resorting to expensive coping strategies, governments and relief organizations attempt to quickly identify and assist those affected by shocks. Timely assistance can stem further losses and begin the recovery process. Assistance might be provided in the form of food vouchers, low-interest loans, technical assistance to resume productive activity, subsidized fertilizers, or loan cancellations.

### RECENT APPLICATIONS

A few ICT applications are used to cope with agricultural shocks such as droughts, floods, and disease outbreaks, but they are proving important and potentially transformative. First, ICTs such as mobile phones (particularly those equipped with GIS and cameras) can be used to collect information after a shock about the extent of the damage, numbers of individuals affected, and who needs relief. These field data have proven vital to relief efforts, especially for better targeting and coordinating an effective response. Second, ICTs (particularly mobile phones) have been used to address the problem of disbursing remittances or aid vouchers to individuals affected by agricultural shocks. Farmers are difficult to reach and lack access to financial institutions, but increasingly they have mobile phones.

The use of ICT applications to assess the nature and extent of risks and improve the coordination and targeting of coping strategies has been particularly noteworthy for disease outbreaks. Rapid assessment and response are critical to controlling disease outbreaks. Only after a farmer has recognized the symptoms and identified the disease can he or she adopt the appropriate control methods.

Mobile technologies are being used to collect information from the field to assess damage or monitor outbreaks. For example, to monitor the threat of bird flu, the Animal Husbandry and Veterinary Services of the Government of

India created an SMS-based reporting service to track animal health. Fieldworkers collected information about the health of animals and reported it to the directorate for analysis via text message (E-Agriculture 2008). MKRISHI helps farmers cope with similar shocks. If an outbreak occurs, farmers can submit photos or describe the outbreak through SMS to receive assistance in identifying the disease or pest and recommendations for managing the outbreak.

The Community-level Crop Disease Surveillance Project (CLCDS), discussed in an innovative practice summary following this note, takes this activity a step further. Piloted in Uganda by the Grameen Foundation, the project employs community knowledge workers to help identify diseases and advise on control methods.

Another significant challenge in coping with shocks is the need to disburse transfers and remittances rapidly to affected farmers, many of whom have limited access to formal financial services. The advent of mobile money has dramatically eased this constraint, making it faster for farmers to receive remittances from their social networks or receive transfers from governments and relief agencies.

The leader in this space is Safaricom's M-PESA (<http://www.safaricom.co.ke/index.php?id=745>) a money transfer system that allows individuals to deposit, send, and withdraw funds using SMS. M-PESA has grown rapidly, currently reaching approximately 38 percent of Kenya's adult population. The M-PESA model has been copied with little modification worldwide (Jack and Suri 2009:6), but it has yet to be applied specifically to agricultural risk. (See IPS "M-PESA's Pioneering Money Transfer Service," in Module 2, for an overview.)

A Zambian company, Mobile Transactions (<http://www.mtzi.net/>), delivers electronic payments, vouchers, and loan disbursements using mobile phones, scratch cards, and a countrywide agent network (see the innovative practice summary following this topic note). The voucher system primarily targets organizations that regularly make transfers to a large number of beneficiaries, such as the World Food Programme.

Another promising approach is the combined application of remote sensing, GIS applications, and crowdsourcing technologies to allow real-time damage assessment. Aside from improving the identification of affected areas, real-time assessments reduce the time lag between the shock and the delivery of assistance. These tools have not yet been used in response to agricultural shocks, but their use in response

**IMAGE 11.6:** Map of Flood Reports, Pakistan

Source: A screenshot of the Pak Relief homepage.

to catastrophic floods in Pakistan suggests that agricultural applications are worth examining.

Crowdsourcing has become more sophisticated through platforms such as Ushahidi (<http://www.ushahidi.com/>), which have the capacity to aggregate, synthesize, and visualize data on a map. The software allows anyone with access to the Internet or mobile technologies to submit reports of damage or requests for assistance. These reports are verified manually or automatically using computer programs. The data are then synthesized onto a GIS map, which relief and recovery agencies use to target and coordinate their response. Ushahidi is open-source software and has been quickly set up following catastrophic events such as earthquakes in Haiti and Chile and the floods in Pakistan (IRIN 2010) (image 11.6).

## LESSONS LEARNED

There is much to learn regarding the robustness or effectiveness of applying ICTs to cope with risk. Based on the limited experience to date, early preparation and deployment seem to be the keys to success. Damage assessment tools, electronic voucher systems, or disease response advisory services cannot be deployed quickly after a shock occurs; they must be in place beforehand as a part of a robust disaster response plan.

The combination of trained personnel and information services delivered through various ICT channels might be the most effective way to help farmers cope with disease outbreaks that require a rapid response. The ICTs serve to reduce the training required, which in turn reduces the administrative costs of such programs. Reducing the required qualifications also expands the supply of people eligible for the job.

Public institutions, governments, and NGOs often play a big role in helping farmers cope with risks. ICT applications can equip these institutions with better tools to manage their social safety net programs. Mobile money and electronic vouchers seem to have matured sufficiently to be replicated in other contexts and incorporated into plans to transfer funds to farmers affected by drought or flooding. Similarly, information services

that empower people without formal education in agriculture to serve as agricultural extension workers might also be a replicable approach, provided that the infrastructure and human capacity are present. Their effectiveness, however, should be determined first. Finally, because ICT applications for risk coping are still maturing, their incorporation into a risk coping strategy should ensure that alternative coping mechanisms can be used in the event that the technology fails.

## INNOVATIVE PRACTICE SUMMARY

### Electronic Vouchers Are a Targeted, Traceable Lifeline for Zambian Farmers

Mobile Transactions (<http://www.mtzl.net/>) is a private Zambian company that began operating in January of 2010. Through mobile phones (image 11.7), scratch cards, and a national network of agents, the company provides access to banking services for rural Zambians. It has also designed a voucher system for organizations that regularly make transfers to a large number of beneficiaries, such as food vouchers that help rural people cope with shocks such as droughts and floods.

The vouchers are quickly delivered through the Mobile Transactions system in a targeted, transparent, and traceable

**IMAGE 11.7:** Transactions Using Mobile Phones

Source: Mobile Transactions Zambia.

way. Between January and August of 2006, the World Food Programme used the system to deliver food subsidies worth US\$ 500,000 to 32,000 Zambian recipients. FAO used Mobile Transactions to subsidize the purchase of agricultural implements worth US\$ 600,000 for 6,000 recipients (Hesse 2010).

### How the Voucher System Works

Operationally, there are two key aspects to the mobile voucher system: (1) setup and voucher distribution and (2) voucher redemption. Farmers themselves do not need phones, nor is continuous mobile coverage necessary (McGrath 2010).

Mobile Transactions clients sign a contract and an account is set up for them to deposit the funds they wish to disburse. They are also given access to an Internet-based system that indicates the level of funds disbursed, when, and to whom (WFP 2010).

Vouchers can be redeemed only for subsidized items (food, farm implements, and so forth) at previously authorized retail locations. The participating retailers are given a phone and a Mobile Transactions account and are trained to use the system. Retailers are also familiarized with the paper vouchers. Once the client and retailers are set up, the client deposits funds into the Mobile Transactions account at a regular bank. This money is credited to the client's account within the Mobile Transactions system.

The remaining step is to register beneficiaries, who are identified by their national identification cards and assigned a unique number. The unique reference number on each voucher card can be linked to any registered beneficiary number. This linkage is made using a mobile phone when the beneficiary collects the voucher by presenting his or her national identification card.

Redemption of the voucher requires the following steps: (1) the farmer takes the scratch card to an authorized retail agent; (2) the Mobile Transactions system validates the card against the farmer's beneficiary pin number on the voucher, which is revealed by scratching; and (3) if the system responds with a national identification number that matches the identification card the farmer presents, the retailer provides the subsidized product. The retailer, in turn, (4) receives an electronic payment into his or her account in the Mobile Transactions system. Finally (5), this transaction becomes visible to the client immediately through the Internet-based system.

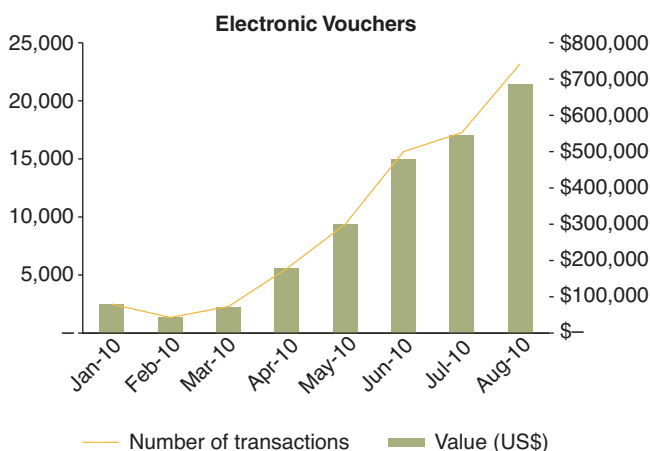
The electronic money service is simpler than paper vouchers. Agents throughout the country who have gone through the setup process are able to accept money from individual payers and transmit the payment to the recipient using the mobile phone and a unique code. The recipient can use that unique code to redeem his payment from a nearby agent for cash.

### Impact, Scalability, and Sustainability

The World Food Programme has not yet used the Mobile Transactions system to help people cope after a shock. The infrastructure is there, however, in the event that food rations need to be increased to allow farmers to cope with threats to food security. Most such threats in Zambia are agricultural: flood, drought, and cattle disease (WFP 2010).

No rigorous impact evaluation of this electronic voucher system has been conducted. Though quite different in some regards, the impact of mobile money might be used to approximate the impact of the Mobile Transactions

**FIGURE 11.3:** Value and Quantity of Electronic Voucher Transactions in Zambia, 2010



Source: McGrath 2010.

system. Studies of Kenya's M-PESA indicate there are significant impacts. Those relevant to risk are: (1) more efficient risk sharing through the expanded geographic reach of social networks and the (2) facilitation of timely transfers of small amounts of money, which enable support networks to keep shocks manageable (Jack and Suri 2009:11).

Mobile Transactions has grown rapidly over its brief existence, from 2,500 voucher transactions worth US\$ 60,000 in January 2010 to about 23,000 transactions worth US\$ 700,000 in August 2010 (figure 11.3). The company is working to replicate the model internationally through partners in Zimbabwe.

Mobile Transactions earns revenue from fees charged, which are approximately 5,000 kwacha (ZMK) or about US\$ 1.08 per transaction. The company is searching for additional capital to supplement the financing they have already received from venture capital firms and grants. It also hopes to begin transferring payments on behalf of the Government of Zambia.

### INNOVATIVE PRACTICE SUMMARY

#### Community Knowledge Workers in Uganda Link Farmers and Experts to Cope with Risk

Community knowledge workers are also discussed in detail in Module 4, which discusses gender implications; as well as in Module 2, which focuses on regulatory

issues. This summary is concerned largely with their role in helping communities cope with risk.

The Community-level Crop Disease Surveillance Project (CLCDS) provides Ugandan farmers with real-time advice for coping with pest and disease outbreaks. CLCDS was piloted in Bushenyi and Mbale Districts between December 2008 and August 2009 as part of the Grameen Foundation's larger Community Knowledge Workers project (<http://www.grameenfoundation.applab.org/section/community-knowledge-worker-project>).

Primary funding for the pilot came from the Bill and Melinda Gates Foundation. Community knowledge workers in the pilot districts used mobile phones equipped with extension information to identify diseases and offer advice about control methods (image 11.8). The workers were also trained to collect disease outbreak data and transmit it to experts. With the data, experts can recommend appropriate responses. If this can be done quickly, individual outbreaks can be contained before they become epidemics (Grameen Foundation 2010a:66).

### Development and Growth

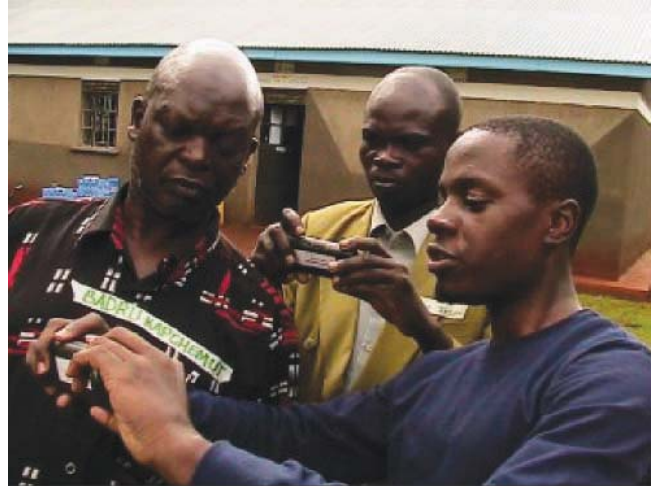
CLCDS responds to the gap between scientific recommendations and on-farm practices in controlling crop diseases. The difficulty of collecting timely data on spreading diseases and the limited effectiveness of on-farm control methods aggravate disease epidemics, which reduce crop yields, quality, and income at the household, community, and national level (Grameen Foundation 2010a:58). In Uganda, three diseases threaten banana production. Of these, banana bacterial wilt alone is responsible for losses of US\$ 70–200 million in Uganda (Grameen Foundation 2010a:59).

For CLCDS, Grameen Foundation partnered with the International Institute of Tropical Agriculture (IITA), the National Agricultural Research Organisation (NARO), and MTN-Uganda (a mobile network operator) to develop and test a disease surveillance system. They used several ICTs to bridge the gap between agricultural experts and farmers: mobile phone applications, a centralized database of disease information, and GIS. The community knowledge workers tie all of these people and pieces together.

To respond comprehensively to farmers' queries, knowledge workers had access to seven information services

**IMAGE 11.8:** Community Knowledge Workers

Source: Grameen Foundation.



(Gantt and Cantor 2010), several of which offer the kinds of information needed to mitigate or cope with risk. See box 11.5 for details.

### Impact, Scalability, and Sustainability

The CLCDS team recruited and trained 38 community knowledge workers, who completed over 6,000 surveys (2,991 related to banana disease) and had more than

14,000 interactions with smallholder farmers (Gantt and Cantor 2010). The initial group of 38 CKWs has now grown to 98 operating in eastern Uganda (Grameen Foundation 2010b).

By the end of the pilot, knowledge workers had trained over 3,000 farmers in the appropriate methods for banana disease identification, preventive measures, and control procedures. The CKWs were estimated to have reached 500–1,000 farm

### BOX 11.5: Information Services Used by Community Knowledge Workers in Uganda

- **Google SMS Farmer's Friend.** A database of locally relevant, organic tips and advice, plus a three-day and seasonal weather forecast. The knowledge worker searches the database through codes sent via SMS. (See IPS "Farmer's Friend Offers Information on Demand, One Query at a Time," in Module 2.)
- **Google SMS Trader.** A user-generated trading bulletin that provides farmers with the contact details of traders and vice versa through SMS posting and notifications. Developed in partnership with MTN-Uganda and Google.
- **AppLab Question Box.** Community knowledge workers phone this service to speak to an operator with access to an Internet database and expert agricultural advice from NARO. This tool was developed in partnership with the NGO Open Mind and NARO.
- **CKW Search.** A series of forms, presented in Java, guides community knowledge workers through a menu to search for agronomic techniques for banana and coffee production. Content was provided by NARO, the Uganda Coffee Development Authority, and IITA.

*(continued)*

**BOX 11.5:** *continued*

- **Input Supplier Directory.** An SMS-based keyword search service gives the location and contact details of shops offering specific agricultural inputs such as seed, pesticide, and fertilizer. Content was provided by the Uganda National Input Dealer Association.
- **Banana Disease Control Tips.** Pre-loaded HTML pages show control measures for specific banana diseases. Content was provided by IITA.
- **Market Prices.** An SMS-based keyword search service gives retail and wholesale prices for 46 commodities in 20 markets. Information provided by FIT Uganda, a local market price provider.

The AppLap Question Box and CKW Search draw from a database that the project team has built and continues to expand and refine. This database of actionable agricultural information is populated by agricultural research organizations and other experts and reviewed by an Expert Review Board for further dissemination to farmers through knowledge workers.

*Source:* Author and Grameen Foundation 2010b.

households in their communities (Grameen Foundation 2010b). Farmers reported increased revenue and decreased losses upon using the helpline information to treat livestock and plant diseases (Gantt and Cantor 2010).

CLCDS also showed how a mobile survey system could enhance scientists' ability to monitor disease outbreaks in real time and deliver information to farmers in remote areas through the knowledge workers, particularly to areas where extension officers and agricultural researchers do not regularly visit (Grameen Foundation 2010a:66). Once CKWs submitted their survey results, scientists could access and view the data directly from the web and download the results for analysis. The surveys provided data showing the spatial distribution of banana disease in the communities. The team of scientists viewed thousands of digital photos of disease symptoms, which knowledge workers submitted with their surveys (Gantt and Cantor 2010).

With this information, scientists could map disease incidence. Over time, they began to better understand the spread of diseases, the adoption of control techniques in different areas, and how these and many other factors intersect to impact farmers' livelihoods. This information is used to prioritize actions and communicate recommendations to farmers via the knowledge workers (Grameen Foundation 2010a:67).

Having up-to-date information that included details of the exact locations of a disease, agricultural experts could

develop a plan of preventive measures and allow the rapid dispersal of information that would decrease the spread of the disease. The GIS data could then help scientists to pinpoint sites to collect plant samples of new or suspicious disease reports for subsequent diagnosis in the laboratory (Gantt and Cantor 2010).

Given the pilot's success, CLCDS will be scaled up with additional support from the Bill and Melinda Gates Foundation over four years to provide the service to 200,000 farmers across Uganda (Grameen Foundation 2010a). The bottleneck is the limited number of knowledge workers. Grameen Foundation is training new ones and attempting to partner with existing extension services (Grameen Foundation 2010b). Farmers are not currently charged for the service (they are compensated for participating in surveys, however), and it is not yet clear how the program will continue when external funding ends.

The operational success of the CLCDS to date has depended on the ability to: (1) recruit excellent knowledge workers; (2) make information accessible to them through mobile phone applications; (3) train them in disease identification and control; (4) train them in the use of ICT tools for data collection and effective dissemination of information; and (5) maintain partnerships with experts to verify and analyze information to provide actionable advice to support the knowledge workers.

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## Module 12: GLOBAL MARKETS, GLOBAL CHALLENGES: IMPROVING FOOD SAFETY AND TRACEABILITY WHILE EMPOWERING SMALLHOLDERS THROUGH ICT

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### IN THIS MODULE

**Overview.** The market for safe and traceable food can exclude small-scale producers who lack the resources to comply with strict standards. Wider access to information communication technologies (ICTs) may lift some of these barriers. The proliferation of mobile devices, advances in communications, and greater affordability of nanotechnology offer potential for small-scale producers to implement traceability systems and connect to global markets. This module examines the effects of food traceability requirements and describes traceability systems implemented in the developing world. For small-scale producers, group systems development and certification may ease some of the constraints in implementing traceability systems, along with capacity strengthening in selecting appropriate technologies for traceability. Networks and partnerships with public, private, or nonprofit organizations can help finance and build traceability systems. Traceability technologies implemented for high-value crops may also expand smallholders' ability to reach key markets.

**Topic Note 12.1: The Importance of Standard Setting and Compliance.** Traceability is becoming an increasingly common element of public (both regulatory and voluntary) interventions and of private systems for monitoring compliance with quality, environmental, and other standards. Stringent food safety and traceability requirements trigger new transaction costs for small-scale producers without adequate capital investment and public infrastructure. This note provides an overview of the wide and growing array of public and private standards, domestic and international standards, and data standards, with special attention to issues that impinge on developing countries' capacity to comply with them.

- **Mango Traceability System Links Malian Smallholders and Exporters to Global Consumers**

**Topic Note 12.2: Traceability Technologies, Solutions, and Applications.** Smallholders face serious challenges in complying with standards, particularly with tracking requirements. The mobile wireless and nanotechnology revolution offers the potential to change all that as remote producers and smallholders gain access to ICTs. Mobile phones, radio frequency identification (RFID) systems, wireless sensor networks, and global positioning systems (GPS) are some technologies that enable compliance with food safety and traceability standards. They also make it possible to monitor environmental and location-based variables and communicate them to databases for analysis.

- **ShellCatch in Chile Guarantees Origin of the Catch from Artisanal Fishers and Divers**

### OVERVIEW

Food production and distribution systems are becoming more interdependent, integrated, and globalized. At the same time, escalating and heavily publicized outbreaks of foodborne diseases have raised awareness of the need to ensure food quality and safety. This need drives much of the technological innovation to trace food consistently and efficiently from the point of origin to the point of consumption.

Traceability is an increasingly common element of public<sup>1</sup> and private systems for monitoring compliance with quality, environmental, and other product and/or process attributes related to food. Small-scale farmers may lack the resources to comply with increasingly strict food safety standards, particularly traceability requirements. Given the role of

<sup>1</sup> Both regulatory (mandatory) and nonregulatory (voluntary).

traceability in protecting consumers, ensuring food safety, and managing reputational risks and liability, it is vital to integrate and empower small-scale agricultural producers in the food supply chain through ICTs.

### Defining Traceability

“Traceability” is a concept developed in industrial engineering and was originally seen as a tool to ensure the quality of production and products (Wall 1994). Economic literature from supply-chain management defines traceability as the information system necessary to provide the history of a product or a process from origin to point of final sale (Wilson and Clarke 1998, Jack, Pardoe, and Ritchie 1998, Timon and O’Reilly 1998).

Traceability (or product tracing) systems differentiate products for a number of reasons. Food traceability systems allow supply chain actors and regulatory authorities to identify the source of a food safety or quality problem and initiate procedures to remedy it. While traceability in the food sector has focused increasingly on food safety (Smyth and Phillips 2002), agrifood and nonfood sectors such as forestry and textiles (particularly cotton) have instituted traceability requirements for product identification, differentiation, and historical monitoring. Specific standards for food traceability have been mandated internationally; by law in the European Union (EU), Japan, and more recently the United States; and by private firms and associations.

In the context of agricultural policy, traceability refers to full traceability along the supply chain, with the identification of products and historical monitoring, and not just the separation of products under specific criteria at one or more stages of the chain. The Codex Alimentarius Commission<sup>2</sup> (CAC 2006) defines traceability as:

*the ability to follow the movement of a food through specified stage(s) of production, processing and distribution. . . . The traceability/product tracing tool should be able to identify at any specified stage of the food chain (from production to distribution) from where the food came (one step back) and to where the food went (one step forward), as appropriate to the objectives of the food inspection and certification system.*

2 Established in 1963 by the Food and Agriculture Organization of the United Nations and the World Health Organization, the Codex Alimentarius (Latin for “food code” or “food book”) is a collection of internationally recognized standards, codes of practice, guidelines, and recommendations on food, food production, and food safety.

The International Organization for Standardization (ISO) ISO/DIS 22005 (November 20, 2006, N36Rev1) has largely adopted this definition; however it is a bit broader in scope as traceability is viewed not only as a tool for meeting food safety objectives but for achieving a number of other objectives in other sectors—for instance, in forestry for chain of custody traceability, sustainable certifications, geographical indicators, or animal health.

The EU General Food Law, Article 18 Regulation (EC) No 178/2002, defines traceability as “the ability to track food, feed, food-producing animal or substance intended to be, or expected to be used for these products at all of the stages of production, processing, and distribution.”<sup>3</sup> In comparison to some international and commercial standards for traceability, the EU does not require internal traceability<sup>4</sup> (that is, it does not require all inputs to match all outputs) (Campden BRI 2009).

For food products that are genetically modified, many countries use identity preservation schemes, but only the EU requires traceability. The EU (Directive 2001/18/EC) additionally defines traceability in relation to genetically modified organisms (GMOs) and products as:

*. . . the ability to trace GMOs and products produced from GMOs at all stages of the placing on the market throughout the production and distribution chains facilitating quality control and also the possibility to withdraw products. Importantly, effective traceability provides a “safety net” should any unforeseen adverse effects be established.*

As noted in CAC (2006), traceability can also help identify a product at any specified stage of the supply chain: where the food came from (one step back) and where the food went (one step forward). Simply knowing where a food product can be found in the supply chain does not improve food safety, but when traceability systems are combined with safety and quality management systems, they can make associated food safety measures more effective and efficient (CAC 2006).

By providing information on suppliers or customers involved in potential food safety issues, traceability can enable targeted product recalls or withdrawals. Similarly, the implementation of food safety management systems can support

3 “Food Safety,” Europa (official EU website), [http://europa.eu/pol/food/index\\_en.htm](http://europa.eu/pol/food/index_en.htm), accessed July 2010.

4 See “Objectives of Food Traceability Systems” in the next section for a definition of internal traceability.

efficient, consistent traceability. For example, prerequisite programs such as good agricultural and management practices and the Hazard Analysis and Critical Control Point (HACCP) system include requirements for record keeping that can support requirements for traceability. The areas of animal identification, disease prevention and control, nutrient management, production safety, and certification for export all include practices that contribute to the efficacy of traceability systems. In summary, traceability can:

- **Improve the management of hazards** related to food safety and animal health.
- **Guarantee product authenticity** and provide reliable information to customers.
- **Enhance supply-side management** and improve product quality.

The benefits of traceability for consumers, government authorities, and business operators are widely recognized. Yet for small-scale farmers in developing countries, especially farmers producing horticultural and other fresh food products, traceability requirements can represent barriers to trade. The market for safe and traceable food can exclude small-scale agricultural producers who lack the resources to comply with increasingly strict standards, particularly requirements for tracking and monitoring environmental and supply chain variables through sophisticated technologies.

Wider access to ICTs may lift some of these barriers. The proliferation of mobile devices, advances in communications, and greater affordability of nanotechnology offer potential for small-scale producers to implement traceability systems and connect to global markets. Mobile phones, radio frequency identification (RFID) systems, wireless sensor networks, and global positioning systems (GPS) make it possible to monitor environmental and location-based variables, communicate them to databases for analysis, and comply with food safety and traceability standards. In the context of food safety and smallholders' participation in global markets, this module explores incentives for investing in traceability systems and the prospects for traceability to empower small-scale producers in the value chain. It includes detailed information on standards, technical solutions, and innovative practices.

### **Food Safety: A Challenge of Global Proportions**

Foodborne disease outbreaks and incidents, including those arising from natural, accidental, and deliberate contamination of food, have been identified by the World Health Organization (WHO) as major global public health threats of the 21st century (WHO 2007b). WHO estimates that

2.2 million people die from diarrheal diseases largely attributed to contaminated food and water (WHO (2007a). The global burden of foodborne illness caused by bacteria, viruses, parasitic microorganisms, pesticides, contaminants (including toxins), and other food safety problems is unknown but thought to be considerable (Kuchenmüller et al. 2009).

Food safety issues have human, economic, and political costs. These costs are exacerbated by animal husbandry practices that increase the numbers of human pathogens, antibiotic-resistant bacteria, and zoonotic pathogens in meat and dairy products; unsafe agricultural practices involving the use of manure, chemical fertilizer, pesticide, and contaminated water on fresh fruits and vegetables; the progressive influence of time and temperature on globally traded products such as seafood, meat, and fresh produce; the contamination of processed food by bacteria, yeast, mold, viruses, parasites, and mycotoxins; the presence of foreign objects causing injury to the consumer such as glass, metal, stones, insects, and rodents; and the threat of bioterrorism (Safe Food International 2005).

Cases recorded in WHO's epidemiological records, medical journals, and other record systems over several decades demonstrate the extent of the problem (table 12.1). The Centers for Disease Control and Prevention (CDC) estimated that 48 million cases of foodborne illness occur each year in the United States, including 128,000 hospitalizations and 3,000 deaths.<sup>5</sup> The three primary avenues of contamination are production, processing, and shipping and handling. In light of global food safety concerns, the WHO Global Strategy for Food Safety, endorsed in January 2002 by the WHO Executive Board, outlined a preventive approach to food safety, with increased surveillance and more rapid response to foodborne outbreaks and contamination incidents (WHO 2002). This approach substantially expands the ability to protect food supplies from natural and accidental threats and provides a framework for addressing terrorist threats to food (WHO 2008).

### **Components of Food Traceability Systems**

Not only foodborne illnesses but globalization, consumer demand, and terrorism threats have impelled the diffusion and growth of traceability systems in supply chains for food and agriculture. Food is a complex product (Golan, Krissof, and Kuchler 2004), and modern food production,

5 "Estimates of Foodborne Illness in the United States," CDC, <http://www.cdc.gov/foodborneburden/2011-foodborne-estimates.html>, accessed February 2011.

**TABLE 12.1: Examples of Food Safety Outbreaks (1971–2008)**

YEAR	CASE
2008	• 294,000 children affected by adulterated formula tainted with melamine. More than 50,000 were hospitalized and 6 died. (China) <sup>a</sup>
2004–2005	• Aflatoxin contamination of maize caused more than 150 deaths. (Kenya)
2001	• Cases of variant Creutzfeldt-Jakob disease (vCJD), which is caused by the same agent as bovine spongiform encephalopathy (BSE), stood at 117 worldwide. A number of animal studies suggest a theoretical vCJD risk from human blood donors in countries associated with the use of BSE-contaminated meat and bone meal and recycling of animals into the animal feed chain. <sup>b</sup> The BSE (“mad cow”) outbreak was highly publicized by the media. It remains etched in consumer consciousness as an example of an acute breakdown in food safety and quality in the developed world. • <i>E. coli</i> O157:H7, various animal foods, 20,000 cases, 177 deaths in Jiangsu and Anhui provinces. (China)
2000s	• Contaminated olive oil. (Spain) • <i>Staphylococcus</i> in milk. (Japan) • <i>E. coli</i> in spinach, carrot juice. (US) • <i>Listeria</i> in ready-to-eat meat. (Canada) • <i>Salmonella</i> in peanut butter. (US)
2000	• WHO noted the presence of antimicrobial-resistant <i>Salmonella</i> bacteria in food animals in Europe, Asia, and North America, which have caused diarrhea, sepsis, and death in humans, as well as <i>Enterococci</i> infections, which present severe treatment problems in immunocompromised patients. <sup>c</sup>
1990s	• <i>E. coli</i> in hamburgers. (US) • BSE. (UK) • <i>Cyclospora</i> in raspberries. (US/Canada) • Avian influenza. (Southeast Asia) • Dioxin in animal feed. (Belgium)
1999	• <i>Salmonella typhimurium</i> , more than 1,000 cases, meat products, Ningxia. (China)
1998	• Statistics from the Ministry of Health showed a marked increase in food poisoning attributed to <i>Vibrio parahaemolyticus</i> , from 292 incidents (5,241 cases) in 1996 to 850 incidents (12,346 cases) in 1998. One large outbreak of 691 cases was caused by boiled crabs in 1996; another involved 1,167 cases traced to catered meals in 1998 (Japan). Outbreaks were also documented in Bangladesh, India, Thailand, and the United States. <sup>d</sup>
1980s	• Beef hormones. (EU) • <i>Salmonella</i> in eggs and chicken. (UK) • Alar in apples. (US) • Hepatitis A in raw oysters, 300,000 cases, Shanghai. (China)
1971–82	• Safe Food International, a global consumer organization, cited cases of foodborne illness arising from accidental or intentional adulteration: “During the winter of 1971–1972, wheat seeds intended for crop planting and treated with methylmercury were accidentally distributed in rural areas of Iraq. An estimated 50,000 people were exposed to the contaminated bread, of which 6,530 were hospitalized and 459 died. In Spain in 1981–1982, contaminated rapeseed oil killed more than 2,000 people and caused disabling injuries to another 20,000 many permanently.” <sup>e</sup>

Source: Compiled by Tina George Karippacheril and Luz Diaz Rios; data on specific cases from (a) Ingelfinger 2008, (b) WHO 2001, (c) WHO 2000, (d) WHO 1999, and (e) Safe Food International (2005).

processing, and distribution systems may integrate and commingle food from multiple sources, farms, regions, and countries (Cannavan n.d.). Food products covered by traceability standards include fresh produce such as mangoes, avocados, and asparagus; bulk foods such as milk, soybeans, specialty coffee, and olive oil; fish and seafood; and livestock for meat and dairy. This module also touches on the role of ICTs in animal identification, a prerequisite for implementing livestock traceability in the meat and dairy sectors.

Food products may be differentiated through systems of (1) identity-preserved production and marketing (IPPM), (2) segregation, and (3) traceability. IPPM systems are important for providing information to consumers about the provenance of a product when the attributes may not be visible or

detectable in the product. They are also useful for capturing product premiums. Segregation systems are used to prevent the mixing of novel varieties in the handling of like varieties or to discourage the mixing of a segregated product with like products if potential food safety concerns exist. Traceability systems, on the other hand, allow sources of contamination in the supply chain to be identified (Smyth and Phillips 2002), which enables a transparent chain of custody, raises credibility, and makes it possible to transfer information on the steps taken to alleviate food safety concerns (McKean 2001). Unsafe food can be recalled because information on all possible sources and supplies of contaminated food can be traced one step forward, one step back, or end to end.

Traceability systems can be classified according their capacity for (1) internal traceability and (2) chain traceability. “Internal

traceability” refers to data recorded within an organization or geographic location, whereas “chain traceability” involves recording and transferring data through a supply chain between various organizations and locations involved in the provenance of food. Food contamination may occur at the farm, during processing or distribution, in transit, at retail or food service establishments, or at home. Fundamentally, traceability systems involve the unique identification of food products and the documentation of their transformation through the chain of custody to facilitate supply chain tracking, management, and detection of possible sources of failure in food safety or quality.

The smallest traceable unit will vary by food product and industry. Some of the data elements may include the physical location that last handled the product, as well as the type of supply chain partner (producer, processor, or broker, for example); incoming lot numbers of product received; amount of product produced or shipped; physical location where cases were shipped; lot number of the product shipped to each location; date/time when the product was received or shipped; date/time each lot was produced or harvested; ingredients used in the production of the product, along with corresponding lot numbers; and immediate source of ingredients and when they were received.

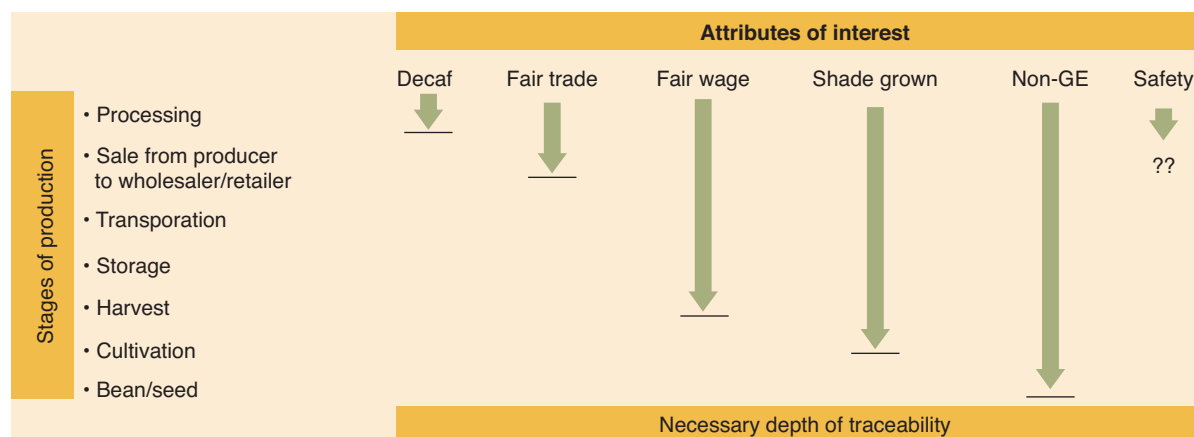
Good practices in traceability entail making the lot number and name of the production facility visible on each case of product and recording the lot number, quantity, and shipping location on invoices and bills of lading. Traceability requires each facility to record data when a product is moved between premises, transformed/further processed, or when data capture is necessary to trace the product. Such instances are

called critical tracking events. Data captured in critical tracking events are vital to linking products, both simple and complex, within a facility and across the supply chain (IFT 2009).

Traceability data can be static or dynamic, mandatory or optional. Static data do not change, whereas dynamic data can change over time and through the chain of custody (Folinas, Manikas, and Manos 2006). “Trace back” implies that a system can identify production/processing steps that resulted in the creation of the product. “Trace forward” implies that a system can identify all derivatives of the product used as an ingredient in numerous other products. Food traceability systems and definitions in standards, laws, and regulations are broadly conceptualized to permit producers to determine the breadth, depth, and precision of systems based on specific objectives (Golan et al. 2004). (For definitions and standards, see Topic Note 12.1.) “Breadth” denotes the amount of information a traceability system captures, “depth” refers to how far backward or forward the system tracks an item, and “precision” shows the degree to which the system can pinpoint food characteristics and movement. Figure 12.1 illustrates these concepts for the attributes of interest in the stages of coffee production.

Traceability data are recorded through media including but not limited to pen/paper, barcodes, RFIDs, wireless sensor networks, mobile devices and applications, enterprise resource planning (ERP) applications, and Internet-based applications. Information related to product tracing may be recorded and transmitted through management information systems or, in the case of smaller operations, paperwork such as invoices, purchase orders, and bills of lading. Traceability data may also

**FIGURE 12.1:** Coffee: Attributes of Interest and Depth of Traceability



Source: Golan et al. 2004.

Note: GE = genetically engineered.

be captured directly from products such as fresh produce, seafood, and livestock. Products may be tagged with barcodes or RFIDs, which store product and associated data. Wireless sensors may transmit data on temperature, spoilage, or location to RFIDs tagged to products. Topic Note 12.2 provides detailed information on traceability technologies and systems.

### Implementing Food Traceability Systems in Developing Countries

Nearly 500 million people reside on small farms in developing countries (Hazell et al. 2006). Their participation in markets typically is constrained by inadequate farm-level resources, farm-to-market logistical bottlenecks, and more general transaction costs in matching and aggregating dispersed supplies to meet buyer and consumer demand. These “traditional” constraints have been amplified and in some cases surpassed by “new” challenges related to complying with product and process standards, including strict traceability requirements, set and enforced by governments and private supply chain leaders (Jaffee, Henson, and Diaz Rios, forthcoming).

The implementation of traceability systems and assurance standards is controversial (Schulze et al. 2008), but it can be especially so in the context of small-scale producers. Weinberger and Lumpkin (2009) have expressed concern that traceability requirements and sanitary and phytosanitary issues will increasingly constrict exports of food products from developing countries, where poor regulation of chemical use, pollutants, and a steep learning curve in traceability capacity restrict growers’ and processors’ participation.

Many developing countries lag in developing and implementing food safety and traceability standards, but some have selectively met demands in high-income export markets thanks to regulatory, technical, and administrative investments. From 1997 to 2003, more than half of the List 1 countries recognized by the EU as having equivalent standards of hygiene in the capture, processing, transportation, and storage of fish and fish products were low- or middle-income countries.

Jaffee and Henson (2004b) suggest that some countries use improved food quality and safety standards as a catalyst to reposition themselves in the global market; the key for developing countries is to “exploit their strengths and overcome their weaknesses such that they are overall gainers rather than losers in the emerging commercial and regulatory context.” As an example, the value of Kenya’s fresh vegetable exports increased from US\$ 23 million to US\$ 140 million between 1991 and 2003 after stricter food safety and quality

standards led producers to reorient their operations (Jaffee and Henson 2004b).

Any application of product traceability systems must take into account the specific capabilities of developing countries. If an importing country has objectives or outcomes of its food inspection and certification system that cannot be met by an exporting country, the importing country should consider providing assistance to the exporting country, especially if it is a developing country. Assistance may include longer time frames for implementation, flexibility of design, and technical assistance (CAC 2006). In recent years, a variety of traceability systems have been implemented in the developing world, including systems for fresh fruit, vegetables, grain, oilseeds, bulk foods, seafood, fish, and livestock (table 12.2). Aside from the examples in the table, Korea has implemented systems for agricultural product tracing, and Jordan has established a framework for product tracing and uses a national digital database to track and investigate product and disease movement (Hashemite Kingdom of Jordan 2004).

**TABLE 12.2: Traceability Systems Adopted in Developing Countries**

CATEGORY	TRACEABILITY SYSTEM	COUNTRY
<b>Fresh produce</b>		
	Mangoes	Mali
	Avocados	Chile
<b>Bulk foods</b>		
	Specialty coffee	Colombia
	Green soybeans	Thailand
	Olive oil	Morocco
	Olive oil	Palestine
<b>Seafood</b>		
	Seafood	Chile
	Seafood	Vietnam
	Shrimp	Thailand
<b>Livestock</b>		
	Dairy	India
	Meat	Botswana
	Meat	China
	Meat	Korea
	Meat	Malaysia
	Meat	Namibia
	Meat	South Africa

Source: Tina George Karippacheril.

Note: These examples from the agrifood sector include but are not limited to issues of food safety.

Support for traceability projects designed to connect small-scale producers to global markets comes from a variety of sources: (1) nonprofit organizations and development agencies (such as IICD for Fresh Food Trace in Mali and IFC for olive oil tracking in Palestine); (2) governments (Botswana and Korea for livestock tracking; Thailand and Vietnam for seafood); and (3) the private sector (ShellCatch for seafood tracking in Chile). The sections that follow provide examples of how food traceability systems have been implemented, particularly in low-income economies.

In addition to support systems for developing countries, mobile technology provides new opportunities for smallholders to connect with export markets. Mobile technologies have not only alleviated asymmetries in the flow of information from the market to smallholders (Muto and Yamano 2009), but hold great potential for enabling the counterflow of information from small-scale producers to markets to meet traceability requirements (figure 12.2). For example, farmers may use a mobile device to input information on the variety grown, planting and harvest dates, and use of farming inputs. Data captured by smallholders can be integrated with information systems and centralized databases to provide greater transparency to supply chain partners and consumers on the farming process, inputs, and output. The integration of wireless sensor networks, RFIDs, and mobile technology could yield sophisticated means to capture data during farming and minimize the need for manual data input through mobile devices.

By fostering more linkages, socialization, and networks between small-scale producers, the diffusion of mobile technology can address issues of geographic dispersion

and linkages to traders, other farmers, or market groups for quality assurance, marketing, and sales. Empowering Smallholder Farmers in Markets,<sup>6</sup> a research project, found that international trader-led linkages can empower smallholders to supply high-quality, traceable produce and gain from quality-linked awards funded by the trader. For example, Italian coffee roaster Illycaffè increased its procurement of superior Brazilian green coffee from smallholders by investing significantly in quality assurance training and market information for smallholders. The company has won competitions and awards for best growers and for commanding above-market prices for the product (Onumah et al. 2007).

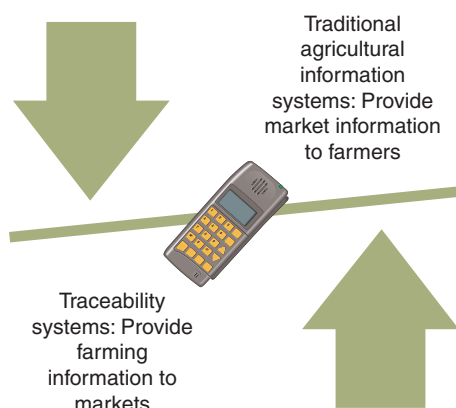
### *Fresh Produce Traceability for Quality Control*

Fresh produce must move quickly through the supply chain to avoid spoilage. After harvest, fresh produce is handled and packed by a shipper or by a grower-shipper and exported or sold directly or through wholesalers and brokers to consumers, retailers, and food service establishments. Traceability systems track fresh produce along the supply chain to identify sources of contamination, monitor cold chain logistics, and enhance quality assurance.

A good example is the use of RFID technology by an avocado producer in Rio Blanco, Chile, for temperature and cold chain monitoring. RFID tags called “paltags” (*palta* is the Chilean word for “avocado”) are attached to the fruit on the tree, and after harvest, the fruit and tags are sorted, washed, waxed, and transported in pallets. Pallets are tagged to monitor temperature during transport, and should the temperature rise above standard levels, pallets are put back into cold storage by quality inspectors at the harbor. Once the pallets arrive at the port in California, the temperature is read by handheld readers to ascertain whether the temperature has risen above acceptable levels, thus checking quality and safety before shipping the avocados to marketers (Swedborg 2010; “Awards Honor RFID Innovators,” *RFID Update*, 2007).

Fresh produce exporters may also be offered centralized cooling and shipping services. The Fresh Produce Terminal in South Africa tracks fruit into the warehouse and onto shipping vessels, deploying 250 vehicle-mounted computers and 100 mobile computers from Symbol Technologies (Parikh, Patel, and Schwartzman 2009).

**FIGURE 12.2:** Mobile Technology as a Key Enabler of Information Counterflow from Farmers to Markets



Source: Tina George Karippacheril.

6 This research project is implemented through the International Federation of Agricultural Producers, European Consortium for Agricultural Research, and International Fund for Agricultural Development (IFAD).



### Bulk Produce Traceability for Product Authenticity

Bulk produce is more challenging to trace than fresh produce. Products such as grain, coffee, olive oil, rice, and milk from multiple farms are combined in silos and storage tanks, making it difficult to trace them back to their sources (IFT 2009).

Yet traceability systems for bulk products have been implemented in developing countries, even among smallholders. For example, the National Federation of Coffee Growers in Colombia, a nonprofit organization for 500,000 small farmers, identifies and markets high-quality Colombian coffee from unique regions or with exceptional characteristics ("Finalists Unveiled for the Fourth Annual RFID Journal Awards," *RFID Journal*, 2010). The federation commands a 200 percent premium transferred entirely to its growers. Its subsidiary, Almacafe, which handles warehousing, quality control, and logistics, implemented a traceability system using RFID tags in 2007 for specialty coffee for its internal supply chain, from farms to warehouses and during processing, bagging, roasting, and trading for export. Although barcodes were considered first, RFID tags were eventually used because barcodes require line of sight and clear labels to be read, which might have been a problem, considering that coffee sacks weigh more than 40 kilograms and tend to be thrown around.

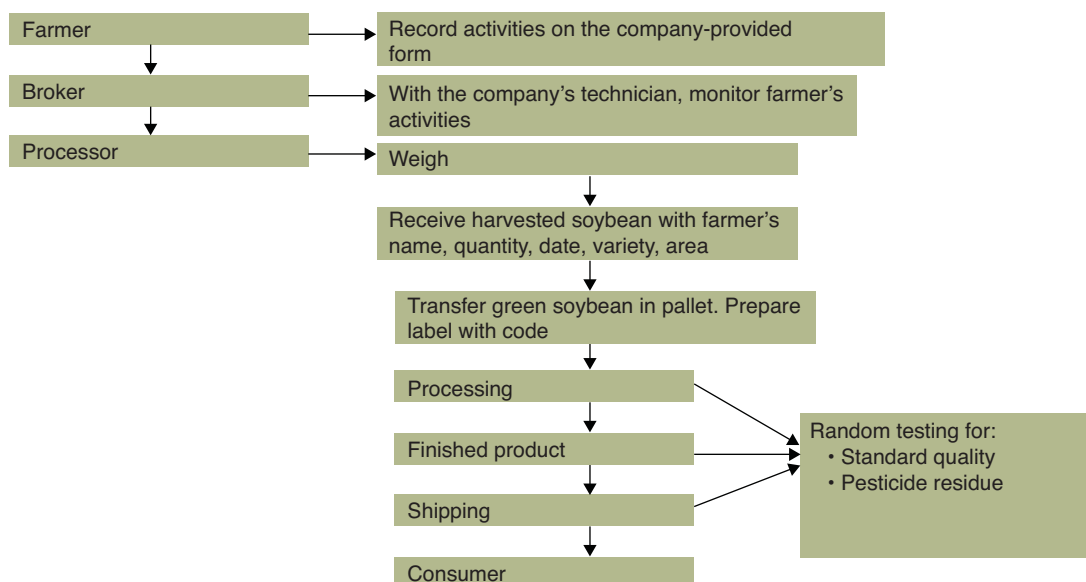
The RFID tags each cost about US\$ 0.25 (paid by the federation), are encased in a wear-resistant capsule, and are

distributed to farmers with a farm identification number and a specialty coffee program code. The coffee is sold to one of 35 cooperatives and transported to one of 15 warehouses, where tags are read by two RFID antennas on either side of a conveyor belt with 99.9 percent accuracy for data and delivery time. Tags are read at each step of the process, and if the coffee does not meet quality standards, it is rejected and the database is updated. In 2008, the federation extended its program with a pilot to help adapt its traceability model to the Tanzanian coffee supply chain.

Consumers may demand systems to trace fertilizer and pesticide in bulk products. In Thailand, for example, exporters require farmers to provide product information regarding the farm, crop varieties, planting, irrigation, fertilizer application, insect or disease emergence, pesticides or chemicals used, harvest date, costs incurred, problems, and selling price (Manarungsan, Naewbanij, and Rerngjakrabhet 2005). Figure 12.3 shows traceability activities carried out along the supply chain for green soybeans, from farmer to broker to processor.

Traceability systems for bulk goods are also implemented for chain of custody monitoring and quality assurance based on consumer demand. Olive oil, a high-value food, is sometimes blended and sold by distributors and marketers, and traceability helps identify the source, method, variety, and farm where the crop was harvested, so it becomes easier for consumers to determine if the olive oil they are buying

**FIGURE 12.3:** Soybean Traceability System in Thailand



Source: Manarungsan, Naewbanij, and Rerngjakrabhet 2005.

is genuine. In North Africa, a combination of GPS, mobile devices, electronic security bolts, and sensors are used for end-to-end, real-time monitoring of perishable olive oil shipments from Spain and Morocco by Transmed Foods, Inc., the United States distribution arm of Crespo Foods, and Savi Technologies (Savi Technology 2009). In another example, an IFC project to improve the competitiveness and export prospects for West Bank olive oil assists small and medium-size enterprises in implementing a basic traceability program to maintain quality, including managing data related to the sources of oil, pressing, handling, storage, and packing operations.

### ***Seafood Traceability for Safety and Sustainability***

Seafood traceability enhances the value of suppliers' brands and consumers' confidence in those brands. For traceability, monitoring, and control, data about the farm of origin, processing plant, current location, and temperature are collected and made available to participants in the supply chain, including wholesalers, shippers, and retailers. If a problem arises, this information enables a targeted market recall and limits the impact on consumers. Seafood traceability is implemented to comply with the EU's zero tolerance of residues of banned antibiotics (chloramphenicol and nitrofurans). Thailand, one of the world's largest shrimp exporters, saw exports drop steeply to US\$ 1.72 billion in 2002 from average annual revenue of US\$ 2.3 billion between 1998 and 2001 (Manarungsan, Naewbanij, and Rerngjakrabhet 2005). The decline caused the Thai private and public sectors to tighten sanitary measures on chemical antibiotic residues in shrimp and adopt probiotic farming techniques, disease-resistant shrimp, and laboratory diagnostics and testing. Farmers and cooperatives must register to facilitate traceability, and quality management systems have been implemented to isolate quality and safety issues along the value chain. The Department of Fisheries has been working with farmers to introduce GAP (Good Agricultural Practice), a code of conduct for sustainable shrimp aquaculture, and HACCP standards and to improve product documentation and traceability.

The department requires farmers to fill out a "shrimp catching form," which includes the catch date, total shrimp weight, name of the farmer, and ID number. Some central markets also require suppliers and buyers to complete this form to enhance traceability. Registering for traceability gives cooperative members access to laboratory test services, training, and information and experience sharing through networking. They also receive funding of US\$ 1,160 and kits to perform their own diagnostic tests. Marine Stewardship

Council certification<sup>7</sup> requires shrimp farmers to notify the Department of Fisheries five days before harvesting, to facilitate tracing shrimp back to their origin (Manarungsan, Naewbanij, and Rerngjakrabhet 2005).

The Vietnamese State Agency for Technological Innovation has collaborated with the Vietnamese Association of Seafood Exporters and Producers and private firms (IBM and FXA Group) to implement a seafood traceability system. The system is based on RFID technology ("Vietnamese Agency Seeks Seafood Traceability," *RFID News*, 2009).

### ***Livestock Traceability for Disease Control and Product Safety***

Unlike other food industries, the livestock industry has a long history of implementing animal identification and traceability systems to control disease and ensure the safety of meat and dairy products. Lessons from livestock traceability systems may apply to other areas of food safety.

Namibia was an early adopter of such systems in 2004. Botswana maintains one of the world's largest livestock identification systems and had tagged 3 million cattle by 2008. Botswana's livestock identification and trace-back system uses RFID technology to uniquely identify livestock throughout the country. The system enables access to lucrative markets in the European Union, where traceability is a requirement for beef from birth to slaughter. A bolus inserted into the animal's rumen contains a passive RFID (it has no battery or moving parts) microchip with a very hard ceramic coating, which does not interact with stomach enzymes or acids. Fixed readers placed at 300 locations scan the bolus of every animal in the herd to obtain identification numbers, information on new registrations, and the status of disease treatments in the herd. The information is relayed to a central database and on to 46 district offices. Aside from traceability, the tagging system enables weight and feed to be monitored, yield to be managed, breeding history tracked, and animals selected for breeding (Burger 2003).

Animal identification and traceability systems have numerous applications, such as tracking animal movement, monitoring health, controlling disease, and managing nutrition and yield. RFID tagging systems for livestock contain unique identification data and information on the animal's location, sex, name of breeder, origin of livestock, and dates of movement. Handheld readers are used to register vaccination information and dates; the data are relayed to a central database.

<sup>7</sup> The Marine Stewardship Council develops standards for sustainable fishing and seafood traceability.

The Malaysian Ministry of Agriculture’s Veterinary Department has introduced a government-run system to control disease outbreaks among 80,000 cattle. The system was implemented to increase the competitiveness of Malaysia’s livestock industry by meeting international import standards and domestic halal market standards (“Malaysia Begins RFID-enabled Livestock Tracking Program,” *RFID News*, 2009). China has a pilot RFID program for 1,000 pigs in Sichuan Chunyung to track epidemics and enable traceability from birth to slaughter for consumers (“China Fixes RFID Tags on Pigs to Track Epidemics,” *ICT Update* 2003). In South Africa, the Klein Karoo Cooperative tagged 100,000 ostriches to comply with traceability requirements for meat exports to the EU (“Project Klein Karoo Cooperative in South Africa,” *ICT Update* 2003).

Korea was another early adopter of animal identification techniques and technologies, using general ear tags from 1978 to 1994, barcodes in 1995, and RFID since 2004. Korea introduced a full beef traceability system in 2008, in the wake of the BSE scare, to promptly identify food safety problems and ensure end-to-end traceability. Korea also uses DNA markers to trace components of carcasses. Markers recommended by the International Society for Animal Genetics are used for verification (Bowling et al. 2008).

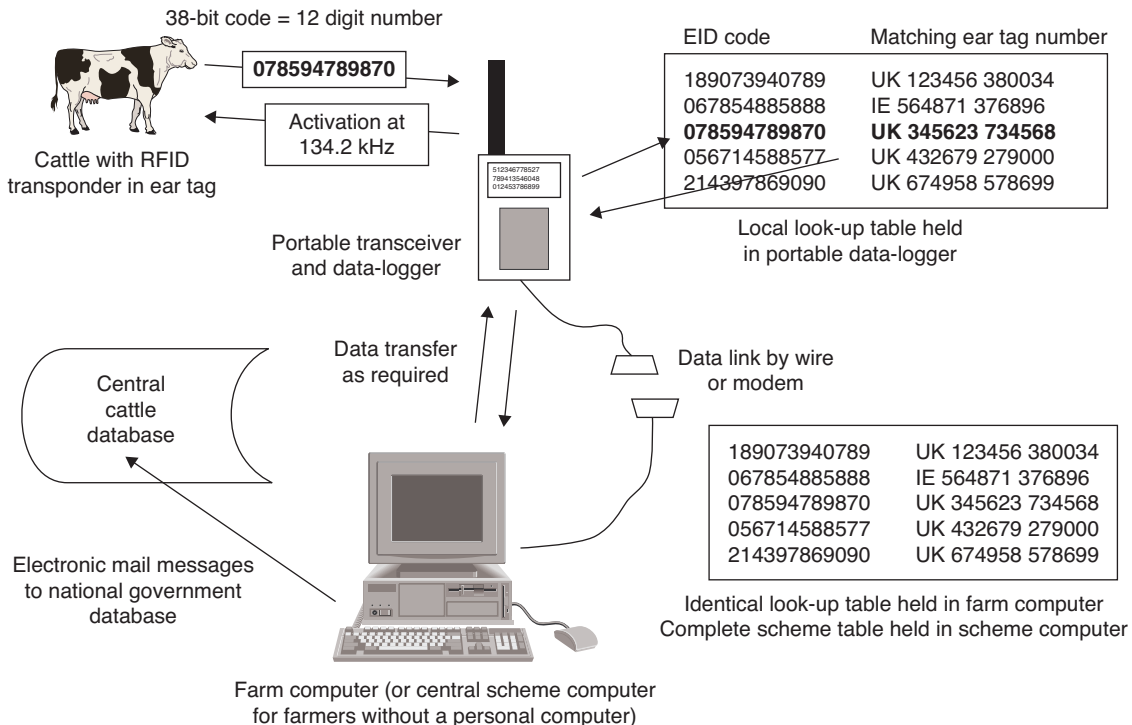
Figure 12.4 illustrates the 2001 Scottish Borders full traceability system for cattle. The systems uses RFID ear tags for unique identification and a portable transceiver and data logger that transfers data to a farm computer or a central computer for farmers who do not have a personal computer.

In dairy farming, RFID technology enables unique identification and monitoring of cattle, their feeding habits, health issues, and breeding history to improve yield management. The technology is integrated with feeding machines to determine the correct amount of nutrition for individual animals. The RFID chip sends data about the animal’s feeding habits, dietary needs, and other information to a sensor on the farm. The data are stored in central databases and analyzed by farm managers and supervisors to monitor the animals’ health and nutritional mix.

India has introduced cattle tagging for dairy farming in the states of Tamil Nadu and Maharashtra. The BG Chitale Dairy in Maharashtra has tagged 7,000 cows and buffalo and plans to extend tagging to about 50,000 animals (“Milk Tastes Better with RFID,” *RFID News*, 2010). (See IPS “RFID Facilitates Insurance Credit for India’s Livestock Producers” in Module 7.)

Traceability systems may be implemented to improve the global competitiveness of livestock and meat exports, the

**FIGURE 12.4:** Scottish Borders TAG Cattle Tracing System



Source: From Pettitt 2001, *World Organisation for Animal Health (OIE) Scientific and Technical Review*.  
 Note: EID = electronic identification; RFID = radio-frequency identification device.

quality of meat, and chain of custody traceability. Beef is placed in refrigerated trucks and containers and sealed with a sensor bolt and a tag for identification. Shipments are tracked to ensure that they do not remain in one place for too long. At key points in the supply chain, such as when the beef is unloaded after it has been shipped from the port, the tag is read with a mobile reader to check for evidence of tampering prior to unloading, and tag data are stored in supply chain databases.

Namibia, which started tracking beef in 2004, was one of the earliest emerging market adopters of advanced technologies to ensure quality and traceability (Collins 2004). A pilot program executed through a public-private partnership with Savi Technology involved the application of RFIDs and sensor bolts to containers of chilled and frozen beef shipped from Namibia to the UK as part of the Smart and Secure Tradelanes initiative extended to African ports. In March 2009, Namibia issued new animal identification regulations, which required livestock producers to identify cattle with one visual ear tag and one RFID ear tag. Cattle must be individually registered in the Namibian Livestock Identification and Traceability System. Namibia has also set up a veterinary fence to avoid contamination: Cattle from northern Namibia cannot be exported and must be consumed locally, and cattle from southern Namibia are protected from diseases and exported to Europe. Namibia also sources non-genetically modified (GM) maize from South Africa at a premium to ensure that beef sold in Europe is considered non-GM.

Basic technologies for animal identification and traceability have applications other than food safety and food security. Cattle rustling threatens human security in East Africa, a region characterized by nomadic movements of people with livestock over vast and hostile terrain. The Mifugo Project (*mifugo* is Swahili for “livestock”), ratified by Ethiopia, Kenya, Sudan, Tanzania, and Uganda, seeks to prevent, combat, and eradicate cattle rustling in East Africa (Siror et al. 2009). Traditional methods of identifying cattle are harmonized with technologically advanced approaches for unique identification, tracking, and recovery of stolen animals. Livestock tags may be queried remotely using the Internet, SMS, and wireless communication through mobile phones to track and monitor animals.

### KEY CHALLENGES AND ENABLERS

Implementing traceability technologies for food safety and other purposes does not come without its challenges. Broadly speaking, the main challenges lie in data collection, processes, technological solutions, business models, costs, and learning. Some of these challenges will be discussed in more depth in the Topic Notes.

In traditional societies, traceability is inherent, because production and consumption occur in the same place, but complying with modern traceability requirements for faraway global markets poses a challenge for small-scale producers with few resources. For example, complying with record-keeping arrangements associated with food safety assurance through HACCP-based systems, with their detailed traceability systems, requires widespread education and cooperation throughout the supply chain (Unnevehr and Jensen 1999). To understand traceability applications for fresh produce and horticultural products, bulk produce, seafood, and livestock, small-scale producers will need to master a considerable range of skills and information.

Although traceability capacity might have some positive effects on domestic markets in developing countries, by and large traceability systems are unidirectional—they track the chain of custody of food exported from developing countries to developed countries. Developing-country farmers who are unable to meet traceability requirements run the risk of being marginalized. Jaffee and Masakure (2005) found that produce export markets in Kenya relied on the exporters’ own farms for products that required traceability; products demanding less traceability came from small-scale outgrowers.

Some evidence indicates that the global movement toward stricter food safety and traceability requirements has translated into stricter demands in domestic markets in developing countries. For example, the rise of supermarkets in Latin America, with their quality and safety procurement standards and associated record-keeping requirements, had a negative impact on smallholder participation, although some cases of success were noted where there was public or private technical assistance (Reardon and Berdegúe 2002).

The costs associated with implementing traceability systems include investments in capital and infrastructure, record keeping, and improvements in harvesting and processing. Unlike small-scale producers, large-scale producers and industry associations are better equipped to upgrade their operations in compliance with traceability standards; the added cost of record keeping is small compared with the potential financial damages of a product recall (Spencer 2010). The questions that remain, then, are who pays for the cost of implementing food traceability systems, particularly in the case of smallholders, and how sustainable those systems can be in the long run.

With respect to business processes, an important challenge involves the poor integration of organizations in the value chain. Proprietary tracking systems allow tracing one step forward or back, but they rarely allow traceability through the full life cycle of a product. Organizations in a value chain may

be reluctant to share proprietary commercial data about a product, with the exception of requirements for recalls.

Studies from the industrial sector, where traceability systems and techniques originated, emphasize that the main difficulties lie in the design of an internal traceability system for a given, complex production process (Moe 1998; Wall 1994). A study on traceability in the United States, undertaken by the International Institute of Food Technologies (IFT), found that challenges are related to both external and internal traceability. External traceability requires accurate recording and storage of information on products and ingredients coming into a facility and information on products leaving a facility. This requirement frequently proves problematic, because industry partners in a food supply chain may not consistently record and store the lot number of the incoming product or case. For internal traceability, data on ingredients and products that may undergo transformation within a facility must be tracked. In some cases, there may be confusion in the assignment of new lot numbers for products that do not match the incoming lot number for products that enter a facility and undergo transformation. Industry practices on data capture, recording, storage, and sharing also vary widely. Paperwork is often inconsistent or incomplete, individual products or lots may not be labeled with unique identifiers, and standardized definitions for data elements may be lacking (IFT 2009).

For small-scale producers, group systems development and certification may ease some of the constraints in implementing traceability systems. The GlobalG.A.P. standard ([www.globalgap.org](http://www.globalgap.org)), for example, allows group certification for smallholders to facilitate their access to markets. Small-scale farmers and producers may also benefit from capacity strengthening in assessing and selecting appropriate technologies for traceability; building networks and partnerships with public, private, or nonprofit organizations that can help finance and build traceability systems; and traceability schemes facilitated through smallholder cooperatives or the public or private sector. Finally, traceability technologies implemented specifically for high-value crops may also expand smallholders' ability to reach key markets.

Golan, Krisoff, and Kuchler (2004) have argued that mandatory traceability requirements that allow for variations in traceability or target specific traceability gaps may be more efficient than systemwide requirements. They may be better suited to varying levels of breadth, depth, and precision of traceability in different firms. Developed countries' experiences with traceability may in some cases be useful for building similar capacity in other countries. Japanese farms, unlike those

in most developed countries, are small but advanced with respect to traceability, a situation that could lend itself well to sharing experiences with small-scale farmers in developing countries (Setboonsarng, Sakai, and Vancura 2009). It could provide insights into the most effective ways to implement traceability systems and the internal and external capacities and resources needed for smallholders to upgrade successfully and comply with safety and traceability requirements.

Incentives to invest in traceability systems also act as key enablers for their development and use. Investments are often driven by regulation and access to markets, the long-term costs associated with public product recalls, the proliferation of certification systems and standards (Heyder, Hollmann-Hespos, and Theuvsen 2009), and pressure from influential external stakeholders such as retailers, consumers, lenders, and NGOs.

Yet investments in traceability systems offer viable benefits and incentives for actors in the supply chain, including swift and precise recalls of unsafe food; premium pricing for safe, sustainable, and traceable food; cost savings and business process efficiencies; and greater consumer confidence, among others (figure 12.5). It is worth exploring some of these incentives in detail, because they offer potential

**FIGURE 12.5:** Incentives for Investment in Traceability Systems



Source: Tina George Karippacheril.

insights for preventing the adoption of systems that exclude smallholders. Among smallholders, clearly the benefits of establishing or investing in traceability systems should be balanced in relation to the associated costs, with considerations for the long-term sustainability of those investments.

### Preventing Recalls of Unsafe Food

Food traceability systems make it possible to take a proactive approach to food safety and prevent the reputational and economic damage—to producers, products, firms, and nations—inflicted by product recalls. For example, the complex recall of contaminated peanut products in the United States is estimated to have been one of the most expensive in that country (figure 12.6).

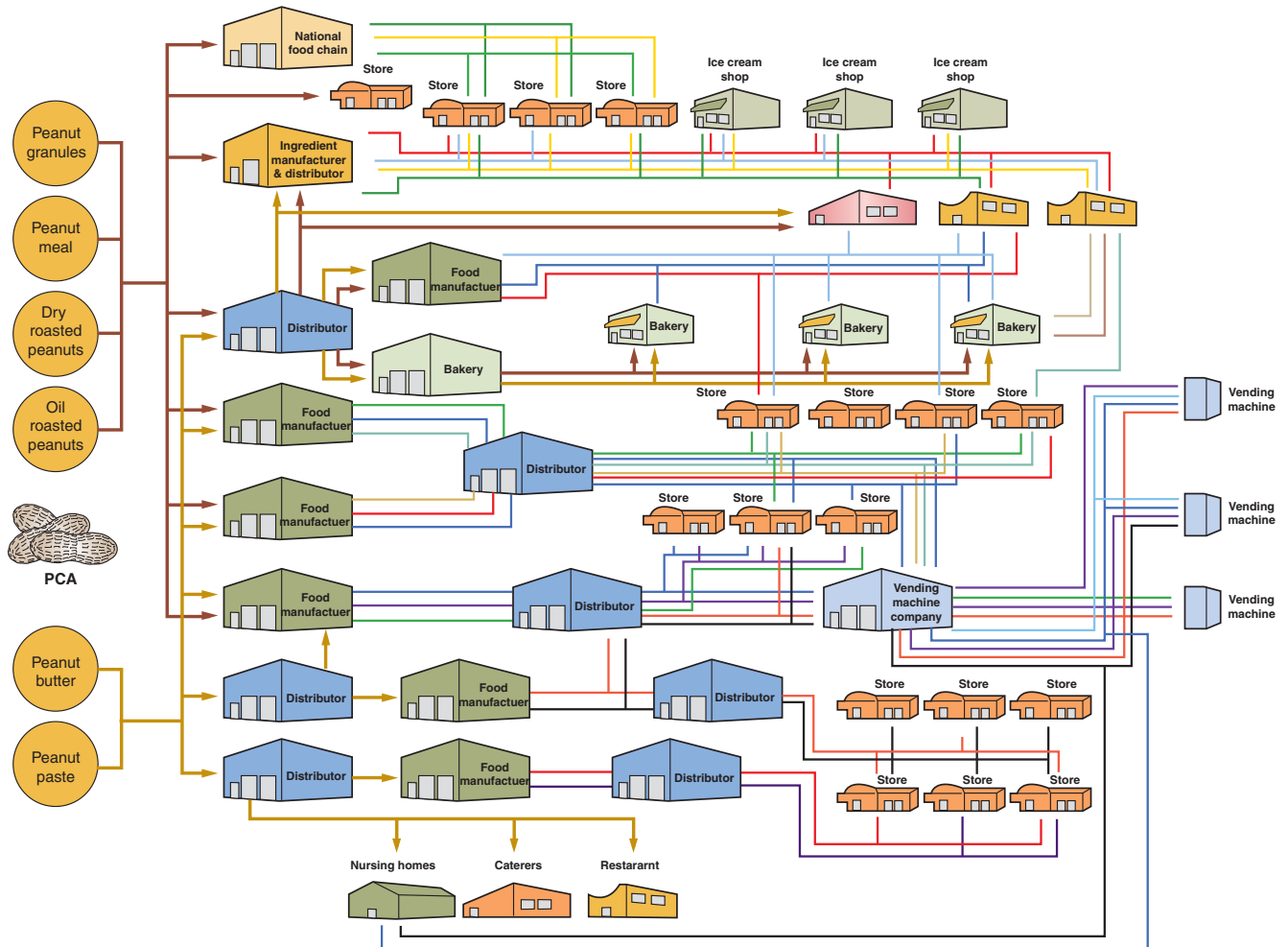
A well-known case of the potential damage of a recall on a young industry in a developing country occurred with raspberries in Guatemala. Following reports of a *Cyclospora*

outbreak, and in the absence of traceability capabilities, the United States Food and Drug Administration issued an import alert, denying all Guatemalan raspberries entry into the United States. The number of raspberry growers declined dramatically from 85 in 1996 to 3 in 2001. Producers around the world noted the devastating effects of the ensuing trade restrictions on the entire industry and the role traceability systems could have played in reassuring the public and containing the problem to a few growers (Calvin, Flores, and Foster 2003).

### Gaining Premium Prices for Safe, Traceable Food

As noted, traceability systems and technologies are also used to certify geographical origin, certify sustainable production processes, monitor the chain of custody, facilitate identity preservation and product marketing, and manage supply chains. Some of these applications enable producers to earn price premiums for sustainable, certifiable, and identifiable

**FIGURE 12.6:** Peanut Corporation of America Recall



Source: Adapted from U.S. Food and Drug Administration.

specialty food products. The Almacafe model, discussed earlier, enables smallholders to command a 200 percent premium for specialty coffee from unique regions in Colombia—strong motivation for farmers to adopt traceability technologies.

In Honduras, the ECOM Agroindustrial Corporation, whose customers are willing to pay high prices for high-quality, traceable products, supports farmers through technical assistance and training (Pfizer and Krishnaswamy 2007). With initial technical support, women belonging to a shea butter cooperative in Burkina Faso learned to use GPS to document the source of the shea fruit they processed and gain certification under Bio-Ecocert and Bio-NOP, which guarantee that a product is 100 percent natural and has been manufactured under conditions that respect human and environmental health. Certification enabled them to enter more lucrative export markets—despite the fact they are small-scale, predominantly illiterate producers. (See Module 8 for details.)

### ***Building Consumer Confidence***

Traceability not only ensures food quality but builds consumers' trust by making the supply chain more transparent (Bertolini, Bevilacqua, and Massini 2006). Consumer confidence builds demand for products. Studies suggest that consumers in developed countries may be willing to pay more for safe and traceable food. A study in Korea (Choe et al. 2008) found that consumers were willing to pay a premium for traceable food and to purchase it in greater quantities. A consumer preferences study of traceability, transparency, and assurances for red meat in the United States suggests that consumers are willing to pay for traceability and that the market there for traceable food may be profitable (Dickinson and Bailey 2002). Although traceability systems tend to be unidirectional, consumers in domestic markets in the developing world may also benefit from their countries' adoption of traceability techniques and systems.

## **Topic Note 12.1: THE IMPORTANCE OF STANDARD SETTING AND COMPLIANCE**

### **TRENDS AND ISSUES**

Increasing concerns about global food safety have positioned traceability as an important component of food safety and quality regulations, management systems, and certification processes. Stringent food safety and traceability requirements trigger a new set of transaction costs for small-scale producers without adequate capital investment and public infrastructure (Pingali, Khwaja, and Meijer 2007; McCullough, Pingali, and Stamoulis 2008). As a result, one of the main challenges in designing food traceability systems—and ensuring smallholder participation—is the development of fair, adequate, and broad food safety standards. Some studies have found that the introduction of safety standards associated with traceability requirements may lead smallholder farmers to switch to products with fewer transaction costs. It has also been argued that stringent safety standards introduced in Kenya's fresh green bean industry were responsible for smallholders' decision to switch to processed green beans (Narrod et al. 2008).<sup>8</sup>

An additional issue is data standardization. Although traceability implies an end-to-end process in the supply chain, only a few links in supply chains actually use software for traceability. Many organizations exchange data manually

(Senneset, Forås, and Fremme 2007), especially smaller-scale operations, which tend to record traceability data on paper. Data standardization is vital for end-to-end traceability. There are multiple, globally recognized standards but no standard nomenclature to describe how the data should look or be organized, and software applications vary. Many parts of the food supply chain do not use standardized formats for data. The variety of traceability software in use makes data integration difficult (Bechini et al. 2005). A unified approach to traceability across supply chains would promote rapid and seamless traceability, including web-based, open, and interoperable standards for end-to-end tracking systems.

### **Public Standards**

Public-sector interventions in food safety view it as a public good. Regulatory (mandatory) or nonregulatory (voluntary) public interventions are designed to provide consumers with basic food safety and provide information about the nature of the food. Public-sector interventions usually take the form of product or process standards but also comprise analytical procedures, inspection and certification systems, and the provision of public information. Food safety standards cover a wide range of parameters, including harmful substances in food (additives, pesticide residues, veterinary drug residues, and other contaminants) and residues in animal feed. Process standards, establishing how food is produced, prepared,

<sup>8</sup> More recent work has found mixed effects on stricter food safety and traceability requirements in this industry (Jaffee, Henson, and Diaz Rios, forthcoming).

treated, and sold, include standards for genetically modified organisms (GMOs), food hygiene, labeling, packaging, and requirements on traceability.

### Private Standards

In recent years, stricter public standards and regulations for food safety have been accompanied by a growing set of standards developed by the private sector. Private food safety standards, frequently characterized as surpassing requirements imposed through public standards, have emerged as a strategy to assure consumers that products meet a high level of regulatory compliance.

For example, private standards for particular attributes of food products might be higher and therefore perceived as more stringent or more extensive than public standards. Some private voluntary standards incorporate requirements related to traceability. Examples include standards dealing with social and environmental goals (fair trade, sustainably harvested products), as well as geographical indications and certification marks, which are generally applied to differentiate products (often as part of a marketing, branding strategy, or sustainable development strategy). These standards are not discussed in detail here.

### Domestic and International Standards

Although food safety standards may be set nationally, World Trade Organization agreements on technical barriers to trade for testing, inspection and certification, and sanitary and phytosanitary matters form an international framework of

agreements to prevent misuse of standards as barriers to trade. Private food safety standards do not fall under harmonized World Trade Organization guidelines. Their legitimacy and transparency are the subject of intense debate owing to their proliferation, prescriptive nature, potential to undermine public food safety, and potential economic development impacts, particularly for small-scale producers in developing countries. Many of the difficulties that small-scale producers reportedly encounter in applying private food safety standards relate to traceability, which is an area in which private food safety standards exceed Codex recommendations (CAC 2010).

As mentioned, traceability is mandated by law in the EU and Japan (for specific commodities). Until recently, extensive traceability was stipulated in the United States by the private sector for reasons including improved supply chain management, differentiation of products in the market, and product recall (Golan et al. 2003). With the passage of food safety regulations HR2749 and S.510, the United States has strengthened record keeping and traceability requirements.

The participation of developing countries in setting standards and assistance from developed countries in implementing them is particularly important. Traceability systems are by and large unidirectional, and exporting countries must accommodate different systems for verification and control from major importing countries. This situation increases the administrative burden and costs of compliance (CAC 2009). Table 12.3 lists examples of food traceability requirements related to food safety and/or security.

**TABLE 12.3:** Examples of Food Traceability-Related Regulations and Standards, with Particular Application in Food Safety and Security

CLASSIFICATION	ORGANIZATION	DEFINITION OF STANDARD AND REQUIREMENTS
International agreement	Codex Alimentarius Commission	Codex defines traceability as “the ability to follow the movement of a food through specified stage(s) of production, processing, and distribution.” Movement can relate to the origin of the materials, processing history, or distribution of feed or food, forward or backward. Traceability is referenced in several Codex texts, such as the Codes of Practice on good animal feeding and Codes of Practice for fish and fish products.
Domestic regulation	Food Safety Act, 1990 (UK)	The law radically transformed food safety management in the UK and provided strong stimulus for private-sector management of food safety by including “due diligence” requirements, making firms responsible for the safety and quality of food inputs, the conduct of suppliers, and the safety of consumers.
Domestic regulation	EU General Food Law, Article 18 of Regulation (EC) No. 178/2002	“The ability to track food, feed, food-producing animal or substance intended to be, or expected to be used for these products at all of the stages of production, processing and distribution.”
Domestic regulation	Bioterrorism Preparedness Act, 2002 (United States)	Requires the maintenance of records of manufacture, processing, packing, transportation, distribution, receiving, holding, and importation of food to allow identification of immediate previous sources and immediate subsequent recipients of food, including its packaging, to address threats of adverse health consequences or death of humans or animals. <sup>a</sup>

(continued)



**TABLE 12.3:** *continued*

CLASSIFICATION	ORGANIZATION	DEFINITION OF STANDARD AND REQUIREMENTS
Domestic regulation	<b>Food Sanitation Law, 2003 (Japan)</b>	The 2003 law requires full traceability for beef. A recent bill (2010) requires traceability for rice and rice products.
Domestic standard	<b>French National Organization for Standardization (AFNOR, Association Française de Normalisation)</b>	“Traceability in agriculture and the food industry sector is applied mainly to two combinations, i.e., product/process (progress), and product/localization (location). Traceability can be described, as it were, as a combination of the flow of substances and that of information.” <sup>b</sup>
Domestic regulation	<b>Food Safety Enhancement Act, HR 2749, 2009; S.510, 2010 (United States)</b>	The act, which passed the House in 2009 and the Senate in 2010, gives the Food and Drug Administration greater regulatory powers to ensure food safety, including establishing a national food traceability system, and imposes specific requirements on foreign suppliers. Each person who produces, receives, manufactures, processes, packs, transports, distributes, or holds such food would be required to maintain records to identify the immediate previous sources of such food and its ingredients and the immediate subsequent recipients of such food. Restaurants, grocery stores, and farms would also be required to keep records, with some exemptions as provided by the act. <sup>c</sup>
International standard	<b>ISO 22000:2005</b>	Establishes requirements for food safety management systems based on HACCP principles, as well as traceability requirements.
International standard	<b>ISO 22000:2007</b>	International standard for traceability in the food and feed sectors. Complementary to ISO 22000:2005.
Private standard	<b>Produce Traceability Initiative*</b>	Produces a common framework and standards to help the fresh fruit and vegetable industry maximize the effectiveness of trace-back procedures through consistent nomenclature and protocols for end-to-end connectivity and traceability. <sup>d</sup>
Private standard	<b>GS1 Global Traceability Standard (GTS) and Programme (GTC)</b>	Supports implementation of traceability systems across the supply chain both locally and globally, including the requirements of ISO 9001, ISO 22005, HACCP, British Retail Consortium Global Standard, International Food Standard, and GlobalG.A.P.
Private standard for primary production	<b>GlobalG.A.P. (Formerly EurepGAP)†</b>	HACCP-based reference standard for good agricultural practices, with traceability as a key obligation. “A traceability system is referred to as the totality of data and operations that is capable of maintaining desired information about a product and its components through all or part of its production and utilization chain. Traceability systems contribute to the search for the cause of nonconformity and the ability to withdraw and/or recall products if necessary. The objective of these requirements is to ensure that any product sold as certified is produced from material that originates from certified farms.”
<b>Global Food Safety Initiative (GFSI) benchmarked standards (private initiative)‡</b>	<b>Include: British Retail Consortium Global Standard, International Food Standard, Dutch HACCP, Safe Quality Food (SQF) 1000 and 2000 Codes, FS22000</b>	Standards or schemes benchmarked by GFSI must comply with the “GFSI Guidance Document” (GFSI 2007), which contains commonly agreed criteria for food safety standards against which any food or farm assurance standard can be benchmarked. With respect to traceability, the GFSI guidance document indicates in 6.1.17 that the standard shall require the supplier to develop and maintain appropriate procedures and systems to ensure: identification of any outsourced product, ingredient, or service; complete records of batches of in-process or final product and packaging throughout the production process; and a record of purchaser and delivery destination for all product supplied.

Source: Tina George Karippacheril and Luz Diaz Rios with information from (a) FDA 2009, (b) FMRIC 2007, (c) Johnson et al. 2010, and (d) Produce Traceability Initiative 2010.

\* Sponsored by the Canadian Produce Marketing Association, GS1 US, Produce Marketing Association, and United Fresh Produce Association.

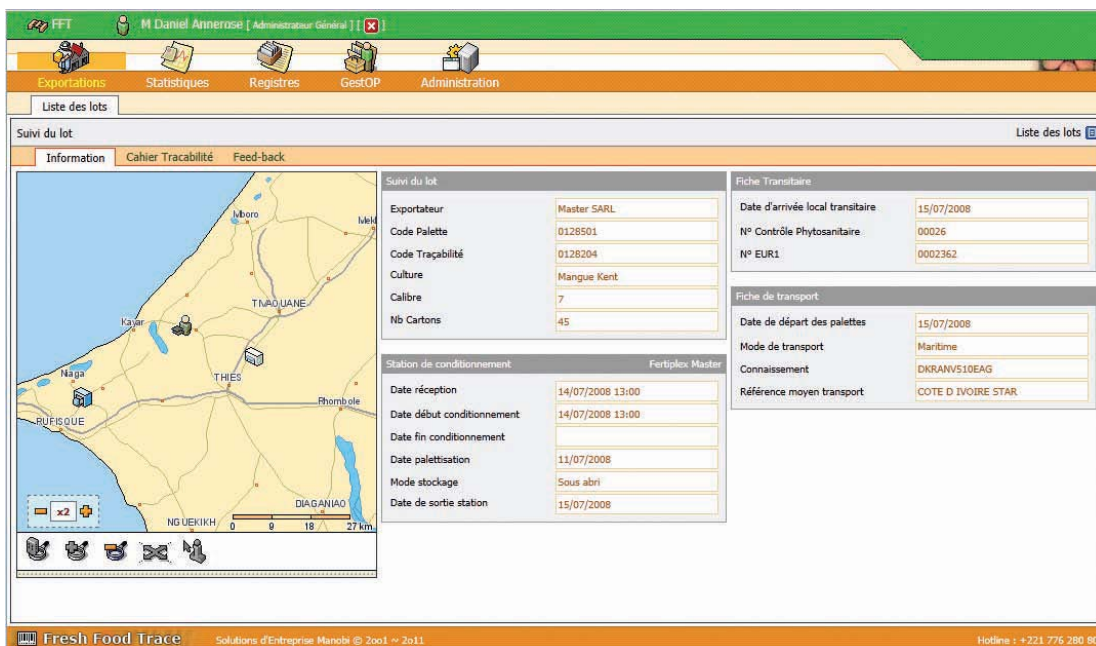
† Standard benchmarked by GFSI.

‡ GFSI was launched by the Consumer Goods Forum in 2000. GFSI brings together the chief executive officers and senior management of around 650 retailers, manufacturers, service providers, and other stakeholders across 70 countries. One of the GFSI’s objectives is “convergence between food safety standards through maintaining a benchmarking process for food safety management schemes.” GFSI (2007) contains commonly agreed criteria for food safety standards, against which any food or farm assurance standard can be benchmarked. According to the CAC (2010), as of June 2010, 13 schemes were recognized by GFSI.

### Data Standards

As discussed, data standardization is vital for end-to-end traceability. A key player in data standardization and open systems for product traceability is GS1, a global nonprofit organization with more than one million member organizations in 108 countries. The GS1 Global Trade Item Number (GTIN) and Global Location Number (GLN) are assigned to identify the product and location. The GTIN has two components—a

product identification code and a company prefix, assigned by GS1. GLNs usually are assigned to a company, which then assigns a unique GLN for each of its facilities. A GLN is typically associated with GPS coordinates for the facility or plant. RFID applications use the serialized GTIN standard, sGTIN, developed by EPCglobal. The United Nations Standard Product and Services Code (UNSPSC) is a global classification system for information on products and services, including

**FIGURE 12.7:** Fresh Food Trace Web Platform

Source: Annerose 2010.

food products. Access to UNSPSC is free and included as a classification option in ERP systems such as SAP and Oracle.

### INNOVATIVE PRACTICE SUMMARY Mango Traceability System Links Malian Smallholders and Exporters to Global Consumers

A produce traceability initiative is helping mango growers and exporters in Mali enhance traceability and comply with GlobalG.A.P. standards, connecting smallholder trade to global markets. Previously, Malian mango growers relied on importers in global markets who did not bear the risk associated with transporting perishable produce, and the market system had not yet earned a reputation for high-quality produce in export markets. The partners in the initiative included Manobi (<http://www.manobi.net/worldwide/>, the mobile data services operator), Fruiléma (<http://www.fruilema.com/>, an association of fruit and vegetable producers and exporters in Mali), and IICD (<http://www.iicd.org/>, a nonprofit that specializes in ICT for development).

The partners developed the Fresh Food Trace web platform (figure 12.7), which automates and visualizes data for tracking mango production, conditioning, transport, and export (IICD 2008). Growers log traceability data and product

information on mangoes on mobile devices at every step (image 12.1), thereby offering complete traceability to end markets. Importers, retailers, and customers are willing to pay US\$ 0.09 more per pound for individual farm sourcing and compliance with food safety standards (Annerose 2010). The traceability system also serves to enhance the market's reputation for supplying safe and traceable Malian mangoes sourced directly from smallholders.

**IMAGE 12.1:** Mango Growers in Mali Use Mobile Devices to Log Traceability Data

Source: Annerose 2010.

## Topic Note 12.2: TRACEABILITY TECHNOLOGIES, SOLUTIONS, AND APPLICATIONS

### TRENDS AND ISSUES

Systems for tracking products through supply chains range from paper-based records maintained by producers, processors, and suppliers to sophisticated ICT-based solutions. In addition to supporting product traceability, ICTs may also support data capture, recording, storage, and sharing of traceability attributes on processing, genetics, inputs, disease/pest tracking, and measurement of environmental variables. Table 12.4 describes some aspects of how traceability is used in agricultural and agrifood systems.

The costs associated with putting traceability systems into place are seen as barriers even among established actors and appear even more daunting to small-scale producers from less developed countries. Paper is still used as a cheaper option for traceability, although it limits the ability to record data accurately, store it, and query it to identify and trace products. Digital databases for traceability are seen as more expensive to implement, operate, and maintain, requiring investments in hardware and software, skilled human resources, training, and certification.

RFID tags are still relatively expensive for widespread adoption in the supply chain compared with the much cheaper and more widely available barcodes (Sarma 2004). Tags priced at less than US\$ 0.01 apiece could offer lower-cost mass-market options for the technology. Commercialization of advances such as those driven by nanotechnology may also push prices down by enabling RFID tags to be printed on paper or labels (Harrop 2008). RFID in its current form is a microchip and

could prove cheaper (and easier to use) in nano form. The following sections review the technologies that may be used in a variety of contexts in developing countries, depending on the associated costs and business models employed.

### Document-Based Solutions (Paper/Electronic Documents)

Smaller organizations and producers constrained for resources typically use pen and paper to record, store, and communicate data to partners in the supply chain. Paper invoices, purchase orders, and bills of lading, as well as electronic file formats (MS Word, PDFs, or others), may be used to store alphanumeric codes and other data on product lot number, harvest date, product receipt/shipping date, quantity, or ingredients. Document-based systems, whether physical or electronic, store data in an unstructured form. Searching through paper records is done by physically browsing through papers that are at best categorized and filed in shelving space. Searching through electronic documents requires users to locate the document and then perform full text or metadata searches within it.

Because document-based systems take time and effort to query, they increase the time needed to locate the precise source, location, or details of a suspected contaminated product. Data recorded on paper cannot be exchanged easily among partners in the food supply chain. They also have drawbacks related to illegible handwriting and human transcription errors when data are transferred from manual to database systems. Data may be inaccurate and quite difficult to verify through cross-checking.

**TABLE 12.4:** Traceability Applications in Agriculture and Agrifood Systems

APPLICATIONS	DESCRIPTIONS
<b>Product</b>	Tracking the physical location of a product for supply chain management and to facilitate recall—e.g., through barcode labeling, RFID tags and readers, mobile devices, GIS, GPS, and remote sensing systems.
<b>Process</b>	Determining the types and sequencing of activities affecting the product during cultivation and after harvest, such as mechanical, chemical, environmental, and atmospheric factors, and the absence or presence of contaminants—e.g., through sensors and instrumentation devices that transmit and store information to RFID tags.
<b>Genetic</b>	Determining the types, source, and origin of GM ingredients and planting materials affecting a product—e.g., through DNA testing and nuclear medicine.
<b>Inputs</b>	Determining the types and origin of inputs such as fertilizer, chemicals, irrigation water, livestock, feed, and additives involved in the processing of raw materials into a food product—e.g., through instrumentation devices, nanotechnology, sensors, electronic tags, and handheld devices for data collection, storage and transfer.
<b>Disease and pests</b>	Tracking the epidemiology of pests, bacteria, viruses, pathogens, zoonosis in raw materials—e.g., through GIS, GPS, and mobile devices.
<b>Measurement</b>	Tracking and calibrating product data against national or international standards throughout the supply chain—e.g., through measurement and instrumentation systems, sensors, and laboratory equipment for analysis of chemical and physical attributes.

Source: Opara 2003.

### Structured Database Solutions

Some organizations capture and store traceability data in their management information systems and other databases, such as ERP systems for inventory control, warehouse management, accounting, and asset management. They may also rely on homegrown custom solutions and legacy information systems. The advantage of capturing product traceability data in structured database systems is the ability to rapidly and precisely query data elements to isolate the source and location of products that may be contaminated. ERP systems such as SAP can read standardized data from barcodes and RFIDs, including GTINs and GLNs.

Electronic data interchange systems allow vendors and business partners to exchange data such as GTINs and GLNs. Businesses may also exchange information via ebXML (extensible markup language), which defines the structure of data and security for the transfer. Database solutions such as ERPs may be supplemented by web-based portals for data input and data exchange with business partners in the supply chain. In legacy systems and custom solutions, data used to identify products may not follow traceability data standards such as product lot number. Multiple data standards cause errors and confusion and impede accurate product tracing.

Emerging trends in ICT, such as the use of cloud computing and SaaS (software as a service) solutions, have reduced the cost of owning ERP and database management solutions to capture, record, store, and share traceability data.

### Barcode Technologies

Conventional methods of traceability through a chain of custody involve the use of barcodes and labels. Barcodes are commonly and recognizably used for inventory control management and global logistics of people and goods, such as air travel tickets or parcel shipping and delivery. Barcodes represent data to uniquely identify a product. Barcodes can be scanned by an electronic reader to identify and interpret key data elements stored in the barcode. The data can be used to trace the product forward and backward through the supply chain.

Barcode solutions require a printing component to print barcodes on labels or products and a scanning technology to read barcoded information. Barcode labels may also contain some information below the barcode to allow for human verification and cross-checking of data. Storage of data elements on a barcode depend on the type of barcode technology used. The GTIN uses a 14-digit barcode with information about companies, products, and product attributes

worldwide, which can be read upstream and downstream through a supply chain.

An even more precise system of barcode traceability is reduced space symbology. This system uses 14-digit GTIN barcodes on individual items, boxes, and pallets, which can all be linked by product and producer or distributor codes, allowing trace-back from the level of an individual item (Golan, Krisoff, and Kuchler 2004).

The Produce Traceability Initiative requires produce tracking via barcoded case labels with traceability information such as the GTIN and lot/batch number. The European Article Numbering–Uniform Code Council standard has a set of 62 product attributes for barcodes to track input, production, and inventory along the supply chain, permitting open real-time updates of information to all systems in the network when producers enter new information in the system.

### RFID-Based Solutions

RFIDs offer promising capabilities for traceability in the developing and the developed world and are seen as an alternative to older barcode systems. Passive RFID tags use an initial signal from an RFID reader to scavenge power and store data on an event at a specific point in time. Passive RFID tags do not use a power source and are less expensive than active RFID tags. Grain-sized RFID tags or transponders incorporated as particles or attached as labels to food products can identify the food item and become connected to the Internet as uniquely identified nodes.

Products tagged with RFID may also be fed with data through an interface with wireless sensor networks. Sensors, also called motes, may transmit data on motion, temperature, spoilage, density, light, and other environmental variables sliced by time to the RFID tag (“Organic RFID to Cut Waste on Produce,” *RFID News*, 2009). GPS, low Earth orbit satellites (Bacheldor (2009)), and motion sensors may interface with RFID tags to communicate variables on location and position coordinates (latitude/longitude). RFID readers to read data from RFID tags may be integrated as an application on a mobile device. Thus an “ecosystem”<sup>9</sup> built by combining RFIDs, wireless sensor networks, GPS, mobile devices, and applications can make it possible to manage traceability across the supply chain. Product traceability recorded through such an ecosystem-based solution may range from data on logistics and postharvest practices surrounding the trees of the small-scale producer right up to the table of the

9 Also described as the “Internet of things” (ITU 2005).

end consumer (Ampatzidis et al. 2007). Lower costs per device, nanotechnology advances that permit greater storage and smaller size, increased ruggedness in extreme temperatures and moisture, and rapid growth in wireless cellular network and device availability have led smaller producers in developing countries to use RFIDs, GPS, GIS, wireless sensor networks, and mobile phones to implement traceability systems, paving the way for connectivity to global markets.

RFIDs have been used for unique animal identification, storage of data on breeding history, animal health, disease tracking, animal movement, and nutrient and yield management. RFID-tagged animals are tracked from birth through slaughter to check and monitor disease, to meet the needs of global markets for safe meat, and to enable product recall.

The advantage of electronic traceability systems based on RFID is their staggering capacity to store data on product attributes. Barcodes permit only limited data storage. Unlike barcode systems, which are read-only, RFID systems possess read/write capability. Barcodes require the item and the scanner to be in the direct line of sight, and items must be physically moved to collect data on the product, whereas data are automatically collected via RFID without line of sight (Cronin 2008; Nambiar 2009; Sarma 2004; Stokes 2010).

The disadvantages of RFID solutions include their cost, complexity, and environmental sustainability (IFT 2009). RFID signals are affected by environmental conditions such as moisture, which absorbs electromagnetic waves; metal packaging, which scatters waves; and physical damage to the chipset in harsh conditions. Studies of RFID applications summarized in Nambiar (2009) identify challenges such as a lack of expertise, resistance to change, lack of systems integration (Attaran 2009), inconsistent information, lack of supporting tools for implementation (Battini et al. 2009), and integration difficulties as a result of the proliferation of RFID readers (Floerkemeier and Fleisch 2008). In practice, the implementation of RFID technologies is hampered by problems with tag detection, tag coverage, and reader collision (Carbunar et al. 2009). Other technological hurdles include protecting the privacy and security of data stored on the RFID tag from unauthorized access and tampering (Langheinrich et al. 2009).

### **Nano Solutions for Traceability and Precision Farming**

Transformative technologies such as nano solutions are creating new pathways for food security and precision agriculture. “Nanotechnology” is “the ability to engineer new attributes through controlling features at a very small scale—at or around

the scale of a nanometer. One nanometer is one-billionth of a meter, or about 1/80,000 the width of human hair.”<sup>10</sup> Nano solutions can help food security by decreasing input costs, increasing yields, and decreasing postharvest loss.

In the field of traceability, nano solutions enable food safety and food preservation. Nano materials may be used in smart packaging and in food handling to detect pathogens, gases, spoilage, and changing temperature and moisture. Traceability requirements for food safety may present a lower-risk, higher-benefit area for the application of nano solutions. (Froggett 2009, 2010). Current technologies to detect pathogens in food require considerable time, money, and effort. Nano solutions can detect contamination in real time. *Azonano*, an online journal of nanotechnology, reported in 2005 that researchers at Kraft Foods, Rutgers University, and the University of Connecticut were developing a nano solution called an “electronic tongue.” (“Food Packaging Using Nanotechnology Methods,” *Azonano*, 2005). An array of embedded nanosensors in the electronic tongue detect the presence of pathogens in packaged food and change the color of the tongue to signal spoilage to consumers. The EU Good Food Project has developed a portable nanosensor to detect chemicals, pathogens, and toxins in food at the farm and slaughterhouse and during transport, processing, and packaging. Nanotechnologies are also enabling the production of cheaper and more efficient nanoscale RFIDs for tracking and monitoring food through the supply chain for traceability (Joseph and Morrison 2006).

Nano solutions can help increase farm sustainability while decreasing environmental impact. Nanoscale sensors in fields enable targeted minimal application of nutrients, water, and/or pesticides (Froggett 2009). Encapsulation and controlled-release methods are used to deliver doses of pesticide and herbicide. Particle farming yields nanoparticles for industrial use by growing plants in specific types of soil (one example is the harvesting of gold particles from alfalfa plants grown in gold-rich soil). Nano solutions such as NanoCeram (2 nanometer diameter aluminum oxide nanofibers developed by Argonide in the United States) filter viruses, bacteria, and protozoan cysts from groundwater. Altairnano is working on Nanocheck (which contains lanthanum nanoparticles) to absorb phosphates from aqueous environments such as fish ponds. Research at the Center for Biological and Environmental Nanotechnology shows that nanoscale iron oxide particles are effective at binding with and removing

10 “The A to Z of Nanotechnology,” Institute of Nanotechnology, March 19, 2004, <http://www.azonano.com/Details.asp?ArticleID=631>, accessed February 2011.

arsenic from groundwater (Joseph and Morrison 2006). An emerging trend in agriculture and food security is the convergence of nanotechnology, biotechnology, information technology, and cognitive science, referred to by the United States government as “NBIC.”

The potential impact of nano solutions on smallholder farmers and agricultural producers is beyond the scope of this module but merits research and discussion. Investments in nano research and approaches to regulation continue in OECD countries such as Australia, Canada, EU member countries, Japan, Korea, New Zealand, and the United States, as well as non-OECD countries such as Brazil, China, India, Russia, and South Africa. Figure 12.8 depicts the use and convergence of information, communication, electronics, and nanotechnologies to enable information to flow from farmers to markets.

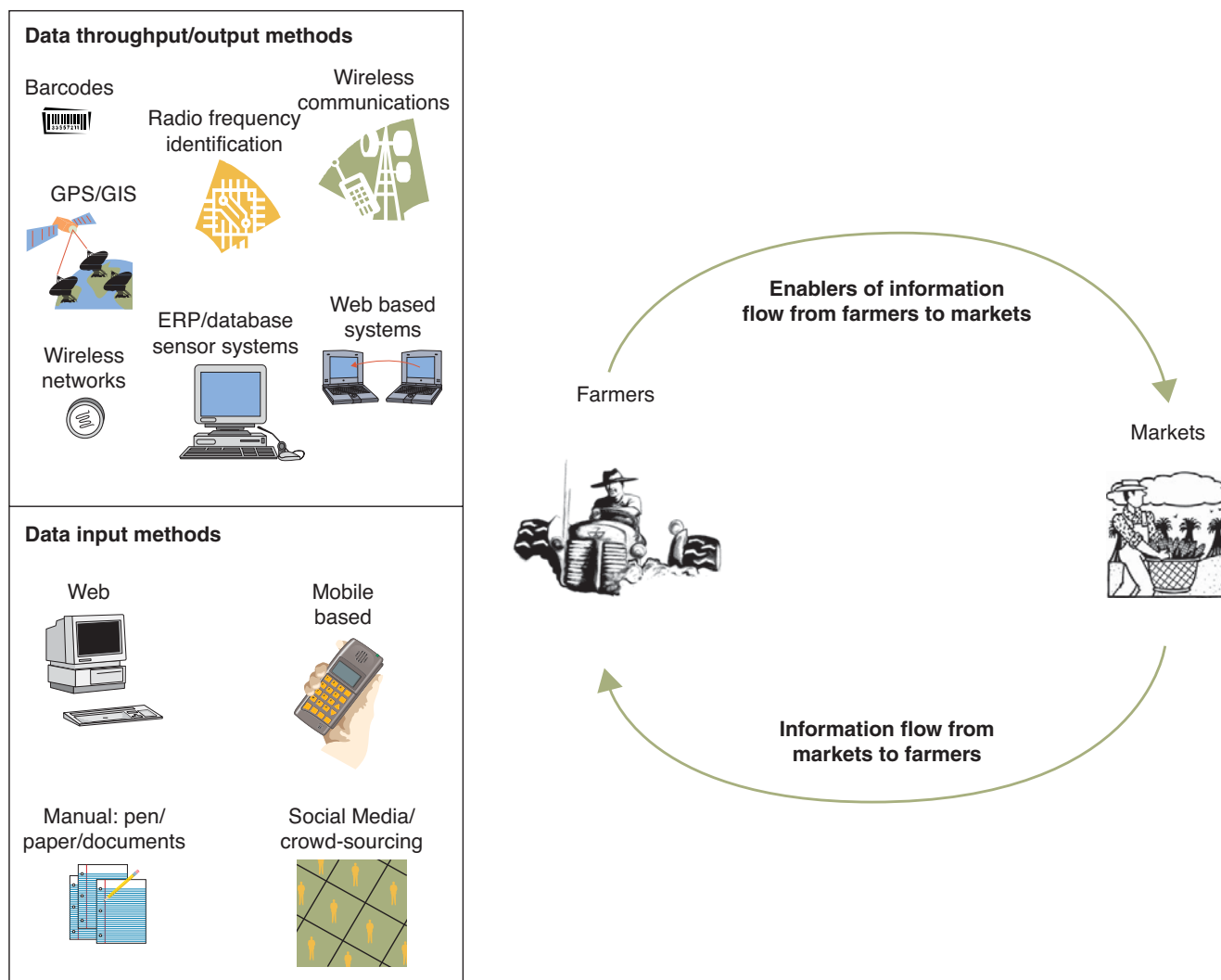
### DNA Techniques

While conventional methods of traceability work for labeling and tagging food products that are not genetically modified or engineered, DNA traceability offers a more precise form of traceability for animals and animal byproducts derived through biotechnology. DNA traceability works on the principle that each animal is genetically unique and thus byproducts of the animal can be traced to its source by identifying its DNA (Loftus 2005).

### Nuclear Techniques for Traceability

A joint research project of the Food and Agriculture Organization and the International Atomic Energy Agency (Cannavan n.d.) seeks to establish analytical techniques to determine the provenance of food by assessing its isotopic

**FIGURE 12.8:** ICTs Enable Information Flow from Farmers to Markets



Source: Tina George Karippacheril.

and elemental fingerprints.<sup>11</sup> These techniques are also used to identify the geographical origin of food and to identify sources of contamination.

### INNOVATIVE PRACTICE SUMMARY

#### ShellCatch in Chile Guarantees Origin of the Catch from Artisanal Fishers and Divers

In Chile, ShellCatch (<http://www.shellcatch.com/english/index.htm>) allows buyers to pinpoint the origin of shellfish and the condition of catchment areas in the Tubul, Arauco Gulf, and Bio-Bio regions. ShellCatch shifts the responsibility for daily monitoring of catch origin, including detection of extraction from legal catchment areas, from processing plants to harvesters—that is, artisanal fishers and divers.

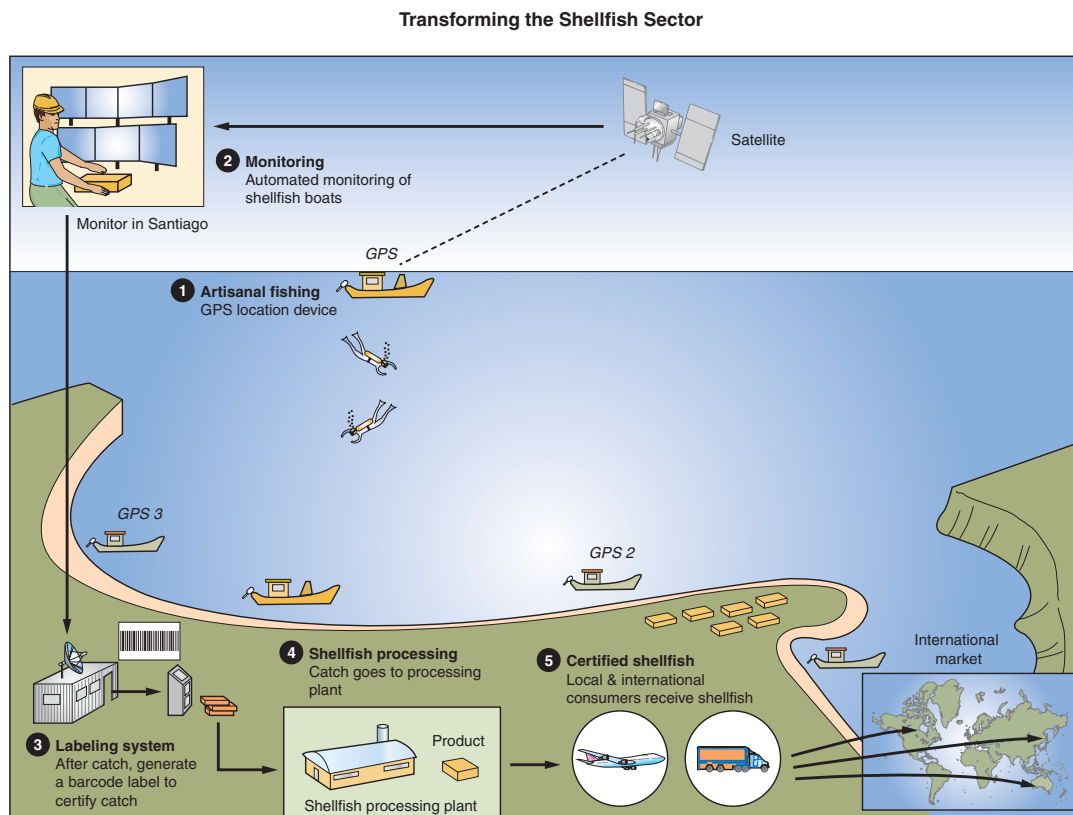
11 Joint FAO/IAEA Program. 2010. "Implementation of Nuclear Techniques to Improve Food Traceability," <http://www.naweb.iaea.org/nafa/fep/crp/fep-improve-traceability.html>, accessed February 2011.

GPS-equipped fishing boats transmit data on origin of catch to a Transdata center in Santiago to monitor fishing from legal fishing areas. When the catch is brought to port, a ticketing system cross-checks the origin of the catch via GPS data transmitted from the boats, then weighs, certifies, and labels bags of catch with traceability data in a barcode label. After ticketing, the certified catch is sent to processing plants and on to domestic and international markets for consumption. Figure 12.9 illustrates this process.

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**FIGURE 12.9:** Emloyment Management and Shellfish Traceability in Chile



Source: "Transforming the Shellfish Sector, Appropriate Technology for Coastal Management," Shellcatch, <http://www.shellcatch.com/english/index.htm>, accessed February 2011.

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## SECTION 4

Improving Public Service Provision



## Module 13: **STRENGTHENING RURAL GOVERNANCE, INSTITUTIONS, AND CITIZEN PARTICIPATION USING ICT**

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### IN THIS MODULE

**Overview.** Well-functioning public institutions in rural areas are critical to agricultural development and sustainability. However, these public institutions are often neglected as a result of underfinancing, isolation, a lack of technical support, and low levels of human capital. This module focuses on how information communication technologies (ICTs) can help governments, line departments, and civil society groups provide public services to the agriculture sector.

**Topic Note 13.1: Public Agencies and the Provision of E-government.** ICTs help governments decrease bureaucracy, cut transaction costs, and spread information to other stakeholders. While improving service provision and rural livelihoods, these technologies also form more efficient relationships between the government and citizens, producers, private enterprise, civil society, employees, and other public agencies.

- **Building Public Service Provision through Internet Applications**
- **Agricultural and Rural Information through Ministerial Websites**
- **Using Biometrics to Provide and Target Rural Services**
- **E-Government to Business**
- **E-Government to Government**

**Topic Note 13.2: Civil Society and the Provision of E-Services.** Civil society organizations provide many digitized services similar to those of public agencies. Yet they also perform the important function of using ICT in more sensitive activities such as publishing information on political figures, political parties, or new legislation. They can more easily direct their efforts to more specific groups or needs and fill voids in public agriculture services.

- **Providing ‘Hubs’ for ICT Innovation**
- **E-Learning through the Web and SMS**
- **Collecting Data to Protect Local Knowledge and Ecosystems**

**Topic Note 13.3: Increasing Citizen Participation through E-Democracy.** Citizen participation and demand for public goods is incredibly important in the agriculture sector: Because so few resources are available in remote locations, the quality of governance often depends on citizen involvement. ICTs hold great promise for enhancing democracy in rural areas, providing people with faster, real-time capacity to involve themselves in democratic initiatives, meaning that more stakeholders can affect local governance processes.

- **Information Kiosks in India**
- **Virtual Communities**
- **Government Responsiveness through Citizen Participation in Digitized Political Processes**
- **Digital Media Forums in Developing Countries**

## OVERVIEW

The widespread use of ICT in developing countries arrives at a critical time. Food insecurity, poverty, malnutrition, environmental degradation, and state failure are daunting trends that need to be slowed and quickly reversed. One of the foremost ways to reverse these trends is enlarging and improving the agricultural sector. Already, using ICT, the sector has reduced transaction costs, increased rural participation in the value chain, and raised producer incomes. Seeing the widespread benefits of ICT, development institutions and governments are now investing heavily in ICT opportunities, expanding the possibilities and scalability of interventions.

Like ICT for agriculture, ICT for governance holds incredible potential and has already proved successful in many countries. Governance—defined by the World Bank as the “traditions and institutions by which authority in a country are exercised for the common good” (World Bank n.d.)—is a vital component of rural development. How governments, civil society groups, and nongovernmental organizations (NGOs) offer their services in rural areas determines the quality of life for community members, including the extent to which improvements in agriculture raise farmers’ incomes and reduce poverty. “Good governance”—which is participatory, consensus-oriented, effective and efficient, accountable and responsive, transparent, inclusive, and follows the rule of law (ESCAP 2011)—is most difficult to provide in unconnected and remote areas. It requires active citizen participation, government attentiveness, functioning accountability mechanisms, and the financial means to fulfill public demands. Yet the expansive reach of ICT has made the provision of good governance more possible.

Some of the earliest e-governance (electronic governance) initiatives began around the mid-1990s. With Internet as the principal device (in which information would eventually be disseminated through other mobile tools), governments in developed countries began establishing technological windows of information and public services. As broadband Internet became more affordable and widespread, poorer countries tapped into this type of electronic government. Innovative approaches to offering electronic services both in the agricultural and public service sectors as well as for the private sector are on the rise in Asia, Latin America, and even Africa. Mobile phones, radio, geographic information systems (GIS), and other ICT expand government capacity to reach out, target, and provide appropriate services to rural communities. Beyond service provision, governments, civil society groups, and development institutions are now increasing rural public participation through electronic means.

Electronic voting, online complaint lines, and mobile legislative consultation are some of the most innovative forms of democratic participation occurring around the world.

Because less than 25 percent of the population living in developing countries is online, the benefits of using the Internet as the only tool for e-governance are limited. Initial investment costs pose the most significant challenge to increasing broadband accessibility: In 2009, an entry-level fixed broadband connection cost on average US\$ 190 purchasing power parity per month in developing countries compared to only US\$ 28 per month in developed countries (International Telecommunications Union 2010). Yet given that broadband Internet networks will continue to expand into rural areas, this module discusses public service provision using the Internet alongside mobile phones, the radio, and other devices. It aims to highlight and describe the most promising examples (both in developed and developing countries) of ICT for governance and institutions as infrastructure catches up, with a specific focus on rural and agriculture issues.

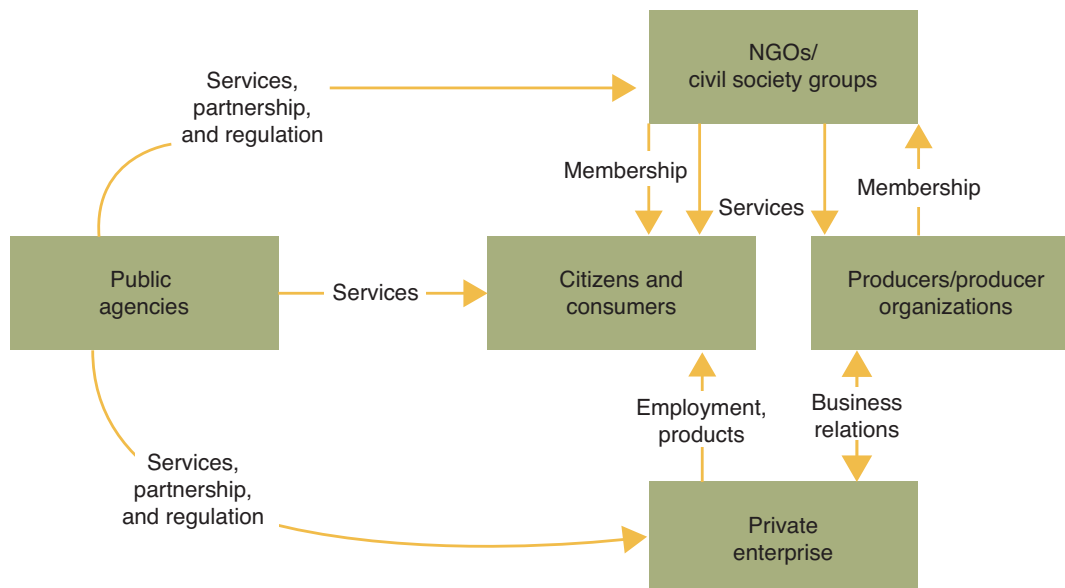
### Framing the Governance and Accountability Challenge

Figure 13.1 illustrates the services that public agencies, nongovernmental organizations (NGOs), and civil society groups, as well as private enterprise, offer citizens, producers, or producers’ organizations. The relationships that define these stakeholders are those that can be enhanced through ICT. Services, partnership, regulations, and membership characterize these relationships and define how rural institutions function in remote communities.

For citizens and producers, public agencies provide services such as agricultural extension, land administration, and infrastructure; for civil society groups and NGOs, they provide services such as legal frameworks. For private enterprises, public agencies provide regulation services such as business registration. Civil society groups, NGOs, and private enterprise can provide similar services to rural farmers. Because of distance, limited resources, low human capacity, and widespread poverty, however, providing these services to rural citizens is not easy in developing countries. As the gap between public agencies and the agrarian sector continues, service provision and good governance risk deterioration. Four main governance challenges, most strongly felt in rural government offices, are briefly described below. These challenges are addressed most effectively through the use of ICT.

#### **Human resource management challenges:**

- **Human capacity:** Limited education results in restricted human capital in public agencies.

**FIGURE 13.1:** Relationships Between Key Stakeholders in the Agrarian Sector

Source: Authors.

- **Low performance:** Incentives like good wages are minimal in poorly resourced governments.
- **Poor supervision:** Limited resources and staff reduce employee oversight.

#### **Corruption and procurement challenges:**

- **Corruption:** Loopholes and poor enforcement create spaces for unwarranted financial gain.
- **Poor procurement:** Unqualified staff and paper accounting result in poor transactions.
- **Rent seeking:** Funds obtained unfairly by government through private assets.
- **Bribery:** Lack of legal mechanisms motivates political and financial cheating.

#### **Targeting challenges:**

- **Elite capture:** Better-off and politically connected farmers capture public programs.
- **Assessment:** Low capacity to assess whether targets are met.
- **Research:** Low capacity to identify the most vulnerable or their needs.

#### **Bureaucratic procedures:**

- **High transaction costs for clients:** Resources needed to travel to, wait for, and pay for services.
- **High transaction costs for government:** Resources needed for logistics and travel to remote places.

By digitizing its services, the public sector improves its ability to address the governance challenges listed above through the mechanisms for transparency and accountability that ICT devices automatically invoke. For example, financial transactions through mobile phones or computerized systems discourage bribery and corruption because of their built-in traceability. Similarly, putting information online in a central location ensures accurate and more equal knowledge transfer to all citizens, not just to those who are politically connected. Using biometric data to transfer inputs or services to beneficiaries ensures that the targeted individuals are the intended recipients. Short messaging service (SMS) messages containing prices for certain crops reduce intermediaries' interference. As this module intends to demonstrate, ICTs adopted to improve only farm practices and producers' situations actually increase transparency in government processes, hold elected officials more accountable, reduce corruption, and boost citizen participation in the agrarian sector (Katz, Rice, and Aspden 2001; Mercer 2004; Selwyn 2004). Table 13.1 summarizes the applications described in this module.

This module follows the outline in table 13.1, splitting the discussion into three themes, with the most attention focused on the first: (1) how the public sector can use ICT to improve services and policies, (2) how civil society groups and NGOs can use ICT to reach beneficiaries, and (3) how democracy and citizen participation can be improved through ICT. Each thematic section will present current trends, lessons



**TABLE 13.1:** Examples of ICT in E-Governance

E-GOVERNANCE		
Organization	E-services (examples)	E-democracy
Public agencies	<i>E-government to citizens:</i> Tax payment, biometric identification cards, government websites, irrigation management, digitized land administration, SMS extension services, mobile or radio pricing information	Citizen report cards, complaint lines, discussion forums, virtual communities, participatory budgeting, chat rooms, mailing lists, opinion polls, citizen juries, online focus groups, petitions, blogs, online media, social networks, online video or news broadcasts
	<i>E-government to business:</i> Regulatory information, procurement, automated tax payments, electronic toll collection	
	<i>E-government to employees or government:</i> Knowledge management systems, intranet, financial management systems, automated payroll, online timesheets	
Civil society and NGOs	<i>E-services to citizens:</i> Agriculture websites, e-learning, radio broadcasts, online petitions, video-based information dissemination, SMS alerts, innovation hubs	

Source: Authors.

learned, and benefits of using ICT, followed by summaries of innovative practices from countries at a variety of electronic readiness levels.

### KEY CHALLENGES AND ENABLERS

The following sections highlight key challenges related to using ICT in efforts to improve the efficiency and overall functioning of governance. It also discusses the enablers that can help to ease these challenges as interventions are designed and implemented.

**Internal e-readiness:** Human resources pose challenges to e-government success. Staff and bureaucrats in public agencies often resist e-government development because they see it as a threat to job security (Jiang, Muhanna, and Klein 2000). Internal e-readiness helps calm employees' fears and prepares them for ICT interventions. The number of full-time IT employees and a firmly established IT department appear to be robust indicators of successful e-government adoption (Norris and Kraemer 1996; Schwester 2009). To ensure internal e-readiness, countries introducing e-government should try to condition staff through training and conferences.

**Interoperability:** The ability of a government website to connect people to information or to other websites is important to e-government development. As well as frequently updating their web pages, government agencies must provide clear, functioning links to other relevant information. Interoperability can extend to culture relevancy and content. Language is a major challenge. Providing government information in only one language, or even two, may not suffice to reach citizens in the most rural and poor areas. Finally,

interoperability is critical in infrastructure development. India's choice to pursue a government-wide centralized administrative system reduces financial burdens over the long term and ensures that data and management systems are integrated over multiple departments. However, implementing a centralized system is much more difficult than implementing singular systems. Oversight and technical support across diverse departments is a prerequisite, as are staff support, national leadership, and ample financial resources (Reidl 2001).

**Education and training:** Computer literacy, outside of literacy itself, is one of the biggest challenges to ICT development in rural areas. Countries implementing ICT for poor communities must remember that training and education are likely to be a necessity in the initial stages. Without them, users may struggle to use the Internet or other ICT applications. The resulting frustration and reduced enthusiasm about new technologies can spread quickly. For new users, education increases both accessibility and confidence. Public extension services can help meet the need for education and training in the use of ICTs.

**Privacy and security:** Privacy and security are also major challenges to e-government development (OECD 2003; Schwester 2009). Even in developed countries, securing citizens' profiles, credit information, addresses, and preferences becomes a critical issue. Before implementing an e-government initiative, practitioners should consider privacy protection programs and inform the public about the risks and safety concerns related to using the ICT. Leaks in personal information and increases in identity fraud are serious threats to e-government success.

**Matching e-government projects to local infrastructure:**

Investing in an e-government website when Internet access is limited for most households and businesses may not be a smart financial commitment. E-government projects should match the infrastructure capacity of the country or region. A project aimed at connecting rural farmers to buyers through the web is ineffective if the rural communities do not regularly have electricity. A kiosk, perhaps powered by a generator, or SMS alerts may be more appropriate. The Kosovo case demonstrates that ICT for governance does not have to be an all-or-nothing proposition. Building ICT requires creative solutions and gradual progress. Developing e-government in step with expanding technology capacities will sustain the effectiveness of the ICT.

**Sustained leadership:** Strong leaders are crucial for consistent e-government development. Public officials or leaders that are frequently “seen” are most effective in mobilizing citizen support for ICT. Increased and active leadership could help institutionalize the ICT in business development. Yet this type of “campaign support” for e-government initiatives is not the only important leadership role. Country leaders must also consistently and strategically prioritize ICTs ahead of other development needs so that e-government attempts are not “stop-and-go” (InfoDev 2002).

**Investment and public-private partnerships:** Financial planning and long-term revenue inflows are important to e-government as they develop (OECD 2003; Relani 2004; Schwester 2009). Generating revenue is crucial to sustainable ICT and public private partnerships should be pursued in order to maintain long-term growth and expansion. Governments can charge small fees to private enterprises or citizens who use their services, yet modicum fees require many years to pass before returns on investment are significant.

**Interorganizational collaboration and coordination:** A major challenge to e-government success is coordination between multiple public agencies. Almost all e-government services require interagency collaboration, particularly for financial management. Yet this collaboration is difficult to encourage and facilitate. Simply computerizing internal processes will not result in integration and flow if government agencies have a history of performing their duties in “rigid silos of departments” (Fuchs and Horak 2008). Haphazard computerization can actually worsen government effectiveness. Shared infrastructure like the same intranet or knowledge management system may ease the ICT transition.

**Social access:** Creating access for women (and other vulnerable groups) is usually the most difficult social task in ICT development. Democratic forms of participation like blogging often are unavailable to females who do not have the time or cultural access to participate. If kiosks are intended to reach women, they should be placed in women-centric locations like weekly markets or hospitals. Similarly, broadcasts for farmers should be run late in the evening when farmers have returned from their activities. Even more important is that leaders and donors must reflect on their intended objective. Is the ICT truly reaching disadvantaged groups? Do observations prove that the ICT contributes to a wide range of smallholder productivity? If not, strategy, targets, and objectives should be reconsidered.

**Content analysis:** Content analysis is another crucial element of successful delivery of e-services by government and civil society. Internet, SMS alerts, newsletters, and other ICTs must be relevant to the user. Content that may seem relevant may in fact not be relevant depending on the need. Technologies, climate change, and markets constantly shift the importance of messages. During a drought, radio broadcasts on collecting water for irrigation might be more appropriate than others. These analysis activities are particularly important in e-government because the information provided by governments (such as market price information) is not often up to date. Private sector initiatives offer more accurate and timely agriculture information compared to the public sector. Thus one of the first steps in improving e-government services should be enhancing the quality of the information provided. Routine checks for information accuracy are also critical.

**Userability:** Userability is user-friendliness. Text options and clear links to other sites create this friendliness. The Cereal Knowledge Bank does an excellent job of fostering userability. Buttons like “home” and “back” make it easy for people of all ages and skill sets to access information. The site offers downloadable printable information as well. Users can click on “small,” “medium,” or “large” text options, providing reading material for a variety of eyesight capacities. Giving the user options is also part of userability. Lack of options and links to nonexistent websites frustrate users.

**Active participants and institutionalization:** Participants matter in ICT development for governance. Just because an organization delivers an e-government website, virtual community, or radio broadcast does not mean citizens will

actually use it, so community involvement and buy-in are critical to success. For example, while a virtual community or extension service may have hundreds of members, only a few of those members may contribute to the knowledge base or discussion (Kim n. d.). Requiring participation in messaging, radio programs, and virtual communities in order to maintain membership, or rewarding contributions, may incentivize participants to comment, respond to queries, and add value to the community or cooperative. To further activate wide participation, practitioners must obtain community acceptance and buy-in, secure links to sustainable revenue flows, and maintain government support (Madon 2004). Stimulating valuable social interaction and interest with relevant groups and leaders will increase the prospects of successful ICT integration.

**Political and cultural environment:** Institutions introducing an ICT should consider the political and cultural environment during design and implementation. This consideration is particularly important in e-democracy projects. For example, if women do not normally participate or have a voice in government issues or politics, introducing an ICT for women without proper preparation, like training and community meetings, may have minimal positive effect. Saxena (2005) puts it well, stating that “while e-government is an automated government, the reverse does not inevitably hold true. Introduction of automation into the public sector will not automatically create better or more open governance unless it is based on open and democratizing principles.” In other words, simply computerizing government or services is not the same as improving e-governance (Fuchs and Horak 2008).

## Topic Note 13.1: PUBLIC AGENCIES AND THE PROVISION OF E-GOVERNMENT

### TRENDS AND ISSUES

Public agencies need to provide a wide array of public services to rural producers and citizens. However, providing agricultural services like irrigation and drainage systems, market assistance, extension and advisory services, or other services like health and education is extremely complicated due to poor roads, few human resources, and corruption in rural areas. The public sector must also create a friendly business environment for small and medium businesses, foreign investors, and innovative producers seeking to capitalize on a business idea.

Through ICTs, government agencies can provide services to producers and private enterprise while enhancing the quality of governance. E-government, or a government’s use of ICT to enhance public services, initially began as an intragovernmental communications tool (Moon 2002). Administrative ICTs like knowledge management systems, financial decision support systems, and intranets were and are still used to improve the internal workings of public agencies. As technologies developed, the boundaries of ICT in government expanded. Governments found that they could decrease bureaucracy, cut transaction costs, and spread information to other stakeholders like citizens and businesses by digitizing public services. These advantages are quite pronounced in the rural sector. For example, sending real-time price information through SMS increases producers’ bargaining power with traders, and tracking cattle through sensor technologies traces the health of the animals, opening doors to

export markets. While improving service provision and rural livelihoods, these technologies also form more efficient relationships between the government and citizens, producers, private enterprise, civil society, employees, and other public agencies.

One way to clarify the opportunities and steps in an e-government project is through the stages of e-government. The simple framework below outlines how the public sector can improve its digitized services over time. The stages in this e-government framework—publish, interact, and transact—are described below (InfoDev 2002):

- **In the publish stage**, a government might start with a website or two offering static information regarding public services. Hours of operation, addresses of public agencies, and basic regulations or laws might be posted online.
- **In the interact stage**, interests groups and citizens can interact online with government officials, receive market information via SMS, and assist in irrigation projects through ICT.
- **In the transact stage**, producers can make financial transactions through point-of-sale terminals, businesses can obtain licenses online, and citizens can buy or sell land through digital land administration.

Table 13.2 provides examples of e-government ICT with reference to the publish, interact, and transact stages. Country examples are also included.

**TABLE 13.2: E-Government Stages**

STAGE	TYPE OF ICT	COUNTRY EXAMPLE
<b>Publish</b>	Website with ministry information	Nigeria <a href="http://www.nigeria.gov.ng/">http://www.nigeria.gov.ng/</a>
	Market information systems	India <a href="http://agmarknet.nic.in/">http://agmarknet.nic.in/</a>
	Databases and resources	Brazil, EMBRAPA <a href="http://www.embrapa.br/english">http://www.embrapa.br/english</a>
<b>Interact</b>	Irrigation management	Afghanistan (See Module 5, page 107)
	E-mail communication with government	Singapore <a href="http://ele.ecitizen.gov.sg/news.htm">http://ele.ecitizen.gov.sg/news.htm</a>
<b>Transact</b>	Rural finance system	M-PESA, Kenya (See Module 7, page 157)
	Digital land administration	Indonesia (See Module 14, page 363)

Source: Authors.

The e-government sector has continued to grow with the expansion of ICT and infrastructure. A number of key trends should be noted:

- **A major trend toward a central interministerial committee.** These committees, often housed by the head of state or in the cabinet, lead and create national e-government policies and strategies. E-government committees at the national level help generate significant visibility, funding opportunities, and push both public and governmental digital transformation. Designating an ICT national leader also helps ease state and local governments into the national strategy and is now occurring more broadly in developing countries. However, these committees have a tendency to stagnate, existing more for show rather than progressive ICT action.
- **A shift from a computerized, technological approach to a more service-driven approach.** Governments are now looking into how technologies can integrate with public services and institution building, rather than the opposite. The service-driven approach is much more effective than the technological approach, because it taps into public demand, which is often latent owing to limited access to new technologies and education about them.
- **An increase in private-public partnerships.** Private firms are increasingly involved in e-government projects due to the technical features involved as well as the profitability of some services. This participation is critical to financing infrastructure that the government cannot afford, as well as to refining the public

sectors' sources of information, efficiency, and scaling opportunities.

- **A change in legacy.** Governments and development institutions are recognizing that electronic public services are not improved through ICT if they support rather than redesign dysfunctional policies and procedures. E-government is being viewed as a more complex overhaul in public service provision and government function rather than as a series of individual departmental projects (Hafkin 2009).

Finally, it is important to note that ICT projects specifically purported to resolve agriculture development also address governance challenges. Rather than repeat the examples covered in other areas of the sourcebook, table 13.3 (on the next page) cross-references ICT interventions from the public, private, and development sectors that are described in other modules. Their components are highlighted to demonstrate the positive effects that ICT-enabled agriculture has on rural governance even when the intended objectives are strictly agricultural.

## LESSONS LEARNED

Public service providers and development institutions assisting in the development of government-sponsored ICT projects should be aware of the challenges associated with them. Though impact studies are limited, there is some evidence of the difficulties that may present themselves during or after implementation. These effects can weaken the relationship between the rural sector and the government,

**TABLE 13.3: ICT-Enabled Agriculture Interventions and Their Impact on Rural Governance**

	<b>INTERVENTION</b>	<b>BUREAUCRATIC CHALLENGES</b>	<b>HUMAN RESOURCE CHALLENGES</b>	<b>TARGETING CHALLENGES</b>	<b>CORRUPTION AND PROCUREMENT CHALLENGES</b>
<b>Risk Management Module 11</b>	ILRI created index-based livestock insurance to provide insurance to 3 million pastoralist households in northern Kenya. Satellite images that captured the amount of vegetation on the ground were used to assess damages. Premiums and payments are collected by a rural agent through point-of-sale systems.	For private firms and government alike, it is too costly to assess the damages and collect premiums in remote areas. Administrative and logistical costs are minimized by satellite imagery and point-of-sale systems as government workers no longer have to travel to remote locations.	Human discretion, which is often used for assessing damages, is highly fallible. Satellite images improve the capacity to analyze and accurately assess damages. It also creates opportunities for long-term data collection, which could improve environmental or production projections.	A lack of data reduces the chances of targeting the right farmers during a disaster. To ensure the insurance was priced fairly and would reach the most vulnerable, analysts created an index that predicted livestock mortality based on the amount of vegetation on the ground. This was used in tandem with the satellite images to ensure fairness.	When government agents collect premiums or pay indemnities without a digital system, opportunities for bribery or theft increase significantly. Using point-of-sale systems not only reduces the logistical costs of providing insurance but also monitors financial transactions, preventing both government and producer losses.
<b>Market Information Module 9</b>	Esoko is a market information service in Africa set up through mobile phones that (1) delivers a wide range of market information and (2) serves as a platform for buying and selling agricultural commodities.	Providing market information through bulletins and other conventional means takes considerable financial resources and time and is often unreliable. Esoko.com allows any farmer with an Internet connection to register for a free account and access 800,000 prices from a diverse set of markets. Users can also connect with buyers and advertise their products.	Incentivizing the private sector to advertise through mobile telephones and Internet significantly increased the sharing of information on prices, market preferences, supply, and demand. The burden of sending trained government staff to collect this information is lightened; more resources and staff time can be allocated to other needs.	Users have the option of customizing the technology to meet their needs. By tracking harvest activities or selecting market information for certain products, farmers are finding relevant information faster than a traditional extension service could provide. Governments can use data on farmers' digital interests to target individuals or areas for specific types of training or input programs.	Through mobile applications, farmers can observe price fluctuations and financial transactions. Even without a subscription, farmers can request market data for the cost of one SMS message. Removing intermediaries' opportunities to take advantage of uninformed farmers drastically reduces the need for government intervention.
<b>Land Administration Module 14</b>	The Indonesian National Land Agency has created an SMS-based property inquiry service and a remote land titling program called the People's Land Title Service (LARASITA). The service, which uses a vehicle and a laptop with wireless connectivity, has brought land services to five rural provinces that would otherwise not have access to them.	Land titling, an often centralized service in developing countries, is not accessible for citizens living in the periphery. Insecure land rights are problematic in rural locations, resulting in lower yields and poor farming practices. Mobile land titling allows citizens do not have to spend unnecessary time and financial resources to travel to the main city to register their property.	Using computers and laptops reduces paperwork burdens for staff. Entering data directly into an electronic system connected to the central database also reduces the time it takes to complete these service-related tasks. Data entries should also reflect the rural situation accurately.	Digitizing the land system allows more people to access land and make transfers, even in remote locations. Agencies can ascertain which properties are not included in the land system and go about reaching them. Using the mobile system also improves targeting, particularly because rural inhabitants are most prone to exclusion in land titling systems.	Digital systems raise red flags when companies or persons obtain land without going through proper legal channels. It is also easier to prevent discrimination against certain groups as rural awareness of rights increases. Web portals and digital land systems provide tighter accountability mechanisms that prevent corruption, which also enhances citizen trust.
<b>Irrigation Management Module 5</b>	The Program for the Management of Irrigation Systems by Water Users, in collaborations with others, used digital orthophoto quads (DOQs) to help the government and local communities manage address problems of maintenance, drainage, canal structuring, system monitoring, and payment in the Dominican Republic.	Digitized irrigation management systems reduce the time spent in the field for M&E. DOQs capture information to help public agencies plan and implement better-functioning irrigation systems. Where GPS cameras and mobile phones are used, water users can send pictures of maintenance issues or system breakdowns, also reducing staff travel.	DOQs can be used over time to anticipate water challenges like increasing salinity. Creating a database with these images allows users to be more active in the irrigation network. Active participation usually increases public demand for good services, and it may lead to better staff performance and oversight.	Using ICT in irrigation systems improves public agencies' ability to target. Satellite images such as DOQs can distinguish land plots, water sources, and which producers have the most or least access to water from the system. With this information, public agencies can adjust water subsidies and infrastructure to better target those farmers with the fewest water resources.	Local users, who are active in monitoring the irrigation networks, can hold contractors accountable and reduce waste in financial resources. In addition, water fees are easier to assign if there is a more accurate picture of the water situation in rural areas. DOQs can prevent public agency discrimination in prices and water access.

worsen situations for farmers, and reverse positive trends in the development of sound governance.

Because ICTs are “disruptive technologies” that restructure bureaucracies, redistribute power, and alter the confidentiality of information (Hanna 2009) practitioners should be wary of political apprehension. ICT is not a panacea for development challenges, especially those relating to good governance. In fact, studies assert that the introduction of digital services into certain bureaucracies is prone to overlooking manifestations of “neopatrimonial” behavior (patronage taking place behind the facade of a modern state) that could render ICT ineffective in improving governance (Berman and Tettey 2001).

Strained resources and an unstable state or emerging democracy can make the productivity of ICT even more difficult to achieve. For example, because the results are not immediate, politicians do not always support e-government projects: Incentives to develop and begin implementing ICT are sometimes limited in terms of reelection or political clout. Using ICTs in societies with thin models of citizen participation may produce minimal change (Dahlberg 2001). As a result, e-government projects should be dependent on the institutional, political, and administrative capacity of the country.

The use of ICTs can also increase class divisions (Selwyn 2004). The “digital divide” is a global, national, and local phenomenon, even in developed countries (Jung, Qui, and Kim 2001; Loges and Jung 2001; Bonfadelli 2002). This divide is most clearly visible between the wealthy and poor. For example, traders or wealthy farmers, who typically have higher incomes compared to producers, also have more access to mobile phones, which can put poorer producers at an even greater disadvantage. Recent studies show that where citizens with higher levels of education and income use employment-related ICT like databases and bookkeeping, those with lower education and less income use ICT for games and entertainment (van Dijk 2006). As a result of these social challenges and others, institutions evaluating ICT for governance should examine “effective access,” or the users’ “actual engagement with, or use of, the technology” (Selwyn 2004).

Gender disparities in levels of ICT adoption are an additional social and economic concern (see Module 4 for more details on gender issues). Evidence shows that women in rural

areas are much less likely to have access to mobile phones or computers than men. In general, this disparity occurs because women do not have the income (often controlled by men in the household) to purchase mobile phones or gain the education to use them effectively. Contributing to the challenge are social norms in rural communities. One study found that men put restrictions on how women use mobile phones, further decreasing women’s freedom to use phones economically. Women’s incomplete understanding of how phones and even radio broadcasts could be used for agricultural and innovative purposes is a chief barrier to integrating women as users of ICTs. Most women see phones as security measures, not ways to access public services or improve livelihoods (E-Agriculture 2010). Evidence suggests that the gender disparity in ICT access decreases when women and men have similar educational backgrounds and incomes. Projects focused on increasing women’s primary education and basic computer skills should thus increase their effective use of ICT (Gillwald, Milek, and Stork 2010).

Beyond these challenges are others related to infrastructure and cost. As noted, initial costs for mobile and broadband Internet networks are so high that the public sector cannot extend them to rural areas. Incentivizing the private sector to finance infrastructure can reduce this burden. In addition, public agencies might want to further consider how to link mobile phone applications into online service systems as many development institutions and private firms have done. Increasing the number of applications that can be used through mobiles may improve rural access, as most rural producers do not have access to the Internet. (See Module 2 on affordability and accessibility for more information on these connectivity issues.)

### **INNOVATIVE PRACTICE SUMMARY** **Building Public Service Provision through Internet Applications**

Government portals are one of the most prominent forms of e-public services that agencies provide. Most government agencies begin their ICT development with these websites and, over time, develop their capacity to provide more services electronically or simultaneously through SMS. Some initiatives are designed and implemented in all ministries at once; others are designed and implemented one by one. At first, government websites may provide only bits of

information, but after years of sustained investment (including adequate investment in rural infrastructure), these portals can offer hundreds of transaction services.

Website development is a continuous process in all countries, developing and developed. Those involved in e-government initiatives in countries with few resources and low capacity can look to other public agency websites for ideas on how to improve or enhance their own efforts to reach citizens through ICT. Both <http://www.regulations.gov/> in the United States and <http://ec.europa.eu/> in the European Union are good references for governments trying to disseminate information on policy and law in their countries.

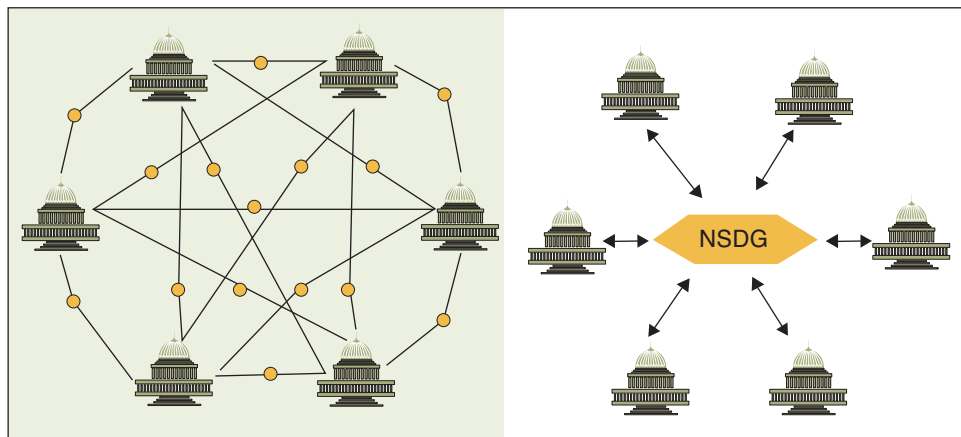
### India's E-Governance Initiative

India, revered as one of the most progressive countries in e-government, began the National e-Governance Plan (NeGP) in 2006. In the past five years, the project has seen substantial national growth in providing electronic information and services online. The NeGP includes both telecommunication and internal government systems infrastructure development, simultaneously building electronic public service delivery and strengthening rural access to the Internet. NeGP is composed of almost 50 projects, spread out over all ministries and line departments at the federal, state, and local levels. Each state also has the ability to select five e-government projects, which are dependent on and tailored to the state's economic and social development needs. These services are being generated through public (51 percent) and private funds (49 percent) funds (see <http://www.nisg.org/index.php>).

The National e-Governance Service Delivery Gateway (<http://www.nsdg.gov.in/administration/index.jsp>), which serves as a data exchange board between all government agencies, will help the Indian government track, monitor, store, and quickly reply to citizen inquiries. Whereas many government portals develop with singular infrastructure, India chose an infrastructure system that would allow for standards-based interoperability between agencies (see figure 13.2). A central system that acts like a behind-the-scenes routing service eases the transition from paper to electronic services, reduces the amount of overlap in agency efforts, minimizes costs, and improves information sharing between departments. Importantly, integrated infrastructure benefits the citizen: services should look similar and follow the same types of procedures in all government agencies.

As NeGP moves forward, citizens will be able to access public services from each relevant ministry through departmental websites with the gateway portal. Grievance redress, online permits and applications, and other relevant services are currently being implemented, along with programs that allow people to track the status of their submission and protect their privacy. The project has also made substantial efforts to reach out to the large rural populations. E-District is a service that allows rural citizens without computers or Internet to access services through community centers. In addition, the Department of Agriculture and Cooperation and the Directorate of Marketing and Inspection (<http://agricoop.nic.in/> and <http://agmarknet.nic.in/>) have developed impressive agricultural public services including a market information system, pages with technical advice, and even a public grievance program dealing with agricultural issues.

**FIGURE 13.2:** Singular Infrastructure versus Centralized Infrastructure in India



Source: <http://www.nsdg.gov.in/administration/>.

Finally, mobile government through SMS is an additional e-government initiative.

### Success in Singapore

Singapore's e-government portal provides another useful example of e-government development. Now in the transact stage, the country's e-government program is among the best in the world. Government workers were trained in ICTs as early as 1981, starting with a civil service portal through IBM. By 2006, data were shared across 13 ministries that were connected through an integrated central service system. Internet technology and penetration increased rapidly in Singapore. Even 10 years ago, 90 percent of the population already had Internet access. The expansion of government-sponsored "Citizen Connect" centers—placed in multiple strategic rural locations around the country—are partly responsible for this broad access. Singapore, through its efforts to connect all citizens to the Internet, even despite resource and infrastructure constraints, has experienced impressive ICT gains. For example, it only takes 20 minutes to register a business online, and the government offers almost all of its 2,600 public services online, making government interaction easier and possible in remote locations.

The 2,600 services range widely in scope and subject. Rather than printing documents to turn in to public agencies, people can complete most services fully through the web. For example, they can apply for maternity leave, pay taxes, register for university, make appointments with doctors, and search for information regarding housing (Hachigian and Wu 2003; Riley 2003). Citizens can also apply for passports, change addresses, and even register small court claims online (see <http://www.smallclaims.gov.sg>).

### BiblioRedes in Chile

Because of literacy and limited computer education, programs that help educate farmers and other citizens are crucial once network connections are available. Chile's Digital Equity Fund subsidizes broadband infrastructure in remote areas and funds a project called BiblioRedes. A product of the Digital Literacy Campaign, the BiblioRedes project connected 101 of 121 public libraries in municipal districts with low connectivity rates to the Internet. With this connection, even in isolated regions, a 14-hour "Digital Literacy" training program is available for new users to learn basic computer skills. A complementary course allows users to learn about other IT applications. Chilean libraries are used often, and as a result, these

systems—both the Internet availability and computer training programs—benefit over 3 million people. Women and young adults with low incomes have preferential access to the services. In fact, over 50 percent of the users are female (United Nations Department of Economic and Social Affairs 2009).

## INNOVATIVE PRACTICE SUMMARY

### Agricultural and Rural Information through Ministerial Websites

#### Making It Work in Malaysia

Government websites can be specifically related to agriculture as well. The Malaysian Ministry of Agriculture's Third National Agricultural Policy for 1998–2010 was formed to improve agricultural productivity and competitiveness following price increases in imported commodities. The use of ICT was a major aspect of the 12-year plan (Mathison 2002), which has made substantial progress over the last decade. In one of its major projects, the Ministry of Agriculture, along with farmers' organizations, developed a portal that allowed agriculturalists to share information. The website (now at <http://www.doa.gov.my/web/guest/home>) provides a wide array of services, including technical information on Malaysian agriculture, registered agriculture service providers (like fumigators), pricing information for producers, open forums through Agribazaar, permits, and archives. It also provides a bulletin service for advertisements and events. All of the information can also be accessed by listening to a voice recorder easily visible on the website. Farmers can also contact officials to locate experts for technical assistance. Through SMS or through the website, farmers can also contact extension agents and report paddy pest outbreaks to the ministry.

The development of the now quite advanced web (and SMS) portal was done carefully. The ministry did a baseline survey in certain rural areas before implementation. This survey included questions on farmers' economic status, electronic education, literacy, and agricultural challenges. Upon collecting the data, the leaders of the project found that 30 percent of respondents felt that they did not receive adequate agricultural information (through media, television, radio, and other ICT). They also found that only 15 percent of respondents owned a computer and 20 percent were computer literate. Not only did this survey help shape the website and its services, but it also confirmed that farmers would need additional support. The ministry



continues to survey farmers, which helps to update web designers, experts, and the ministry on agricultural issues in rural areas.

### Aggregating Research Information in Ghana

Making research results available to the public is also essential to fostering innovative solutions to poverty and economic growth. Much internal research done in developing countries sits in an office, restricting dissemination. Some countries are now actively posting data and country analysis on their websites and open access software (See TN 6.1 in Module 6 for more discussion on the dissemination of research results.) For example, the Ghana Statistical Service, which is closely linked with the Ministry of Finance and Economic Planning, created a website for in-country research and data. The website offers aggregate information on macroeconomic variables, national surveys, and downloadable publications like the Ghana Living Standards Surveys (<http://www.statsghana.gov.gh/Publications.html>) (image 13.1). Many of these survey results focus specifically on rural demographics, such as households engaged in agriculture, household income, assets, credit, expenditure, seasonal patterns, and home processing of agricultural products. The data serve as a resource for development partners and universities trying to address rural challenges. They also inform local governments and actors, as well as donors looking for new areas for investment.

It should be noted that web portals specifically purposed to help rural farmers are often largely ineffective due to lack of access and regularly updated information. This is even more pronounced for government websites attempting to provide market and price information (more information on these government challenges can be found in Module 9). Rather than abandon Internet portals that do provide worthwhile and open-access information to some farmers, governments should pursue SMS dissemination through web-to-phone software, while continuing to build regularly updated and reliable content.

### INNOVATIVE PRACTICE SUMMARY Using Biometrics to Provide Rural Services

Websites offering research, services, and information are not the only ICT that government can use to improve the provision of public services in rural areas. Biometric cards are up-and-coming examples of government-sponsored ICT in developing countries. Fingerprints, iris scans, and electronic passports are all useful applications for accurate

**IMAGE 13.1:** Online Access to Public Data Such as the Ghana Living Standards Surveys Can Stimulate Research and Development



Source: Ghana Statistical Service (<http://www.statsghana.gov.gh/Publications.html>).

identification. Identity theft or fraud is a common problem in all countries and poses many challenges to providing public services. For example, a sick person might try to access healthcare under a relative's plans by using the relative's identification, or a farmer who takes a loan one year might try to pass as another person to receive another loan the following year. Today, credit markets, voting, and targeting public service delivery are prominent identity challenges in agriculture development.

### Bangladesh Takes on Biometrics

Biometric ID cards, which are like laminated identification cards but with a microchip or barcode, are being used in developing countries like Brazil, South Korea, India, Senegal, and Bangladesh for public services like voting and employment programs (image 13.2). In Bangladesh, the Bangladesh Election Commission, the Bangladesh Army, and international organizations took part in designing, funding, and implementing a biometric identification system for 80 million Bangladeshi voters in just three years. During this time, huge training activities took place to build capacity in election workers, and more than 15,000 computers were delivered to voting registration centers. The Bangladesh project had 14 stages, including but not limited to form distribution and data collection, data verification, data export to server, proofreading/editing, preparation of proof voter list and verification, card preparation and handing over for distribution, card distribution, correcting mistakes in cards, and data safeguarding and distribution (Islam

and Grönlund 2010). The project used an Automated Fingerprint Identification System, as well as a multi-biometrics Face-fingerprint Recognition System that has proven to be very effective in capturing human traits (Jain and Ross 2006). The combined software package produced a two-dimensional barcode with fingerprint templates, along with a card including the person's name, gender, birth date, photo, and signature.

While the project had no shortages of trials, overall the biometric card initiative in Bangladesh was considered a success. Strategic planning and innovative methodologies helped the project deal with challenges like geography. Enumerators reached even the most rural areas using various types of transportation, including walking, human haulers, speedboats, and helicopters (Islam and Grönlund 2010). The UN stated that the biometric project produced the most credible election in the history of Bangladesh (UNDP 2008), maintaining a 98 percent accuracy rate (UNDP 2009). The success of these biometric identification cards has also generated discussion about future uses. Although use of the cards is now limited to conventional means (e.g., matching a person's card to his or her features through physical examinations), the World Bank is exploring new and cost-effective ways to use the cards for broader purposes, like agriculture or rural public services, through electronic means.

### Biometric Innovation in India

Over the next few years, over 1.2 billion people will be issued personal biometric cards that include simple data like birth dates and sex and in the future, more complex data like criminal records, credit histories in India (image 13.2) (see <http://uidai.gov.in/> for more information). Called "Aadhaar," the unique 12-digit identification numbers, which costs around 3USD each, will allow all citizens to gain access to public services like banking and education anywhere in the country through the biometric data and online verification systems. Already, 30 million people have been given a number (Polgreen 2011).

**IMAGE 13.2:** Biometric Identification Can Replace Traditional Forms of Identification



Source: Simone D. McCourtie, World Bank.

The use of these cards is expected to extend (and has already in some pilot areas) and improve agricultural and rural employment programs. An example of this is the National Rural Employment Guarantee Act (NREGA), established in 2006, which guarantees 100 days of annual employment at minimum wage rates to all rural adults who are willing to perform unskilled manual work. The act involves all levels of government, including the local (*panchayat*) institutions that are primarily responsible for registering households, issuing and distributing job cards, allocating employment, and monitoring the job sites. Applicants to the program must be issued a job card: Once it is issued, recipients can seek employment from a local NREGA program officer (Raabe et al. 2010) (<http://nrega.nic.in>).

Despite the benefits resulting from the program (including that more than half of the program's beneficiaries belong to Scheduled Castes and Tribes, and more than half are women), it has also had its fair share of challenges. Corruption by job card issuers, electoral politics that limit citizens' ability to get access, misappropriations in payment, and substantial delays in issuing cards are only some of the problems experienced. In the last four years, more than 1,200 complaints regarding program irregularities have come to the Ministry of Rural Development ("Biometric Cards to NREGA Workers on Anvil," 2010). However, biometric cards and devices provide opportunities to address these challenges. Biometric cards, instead of job cards, are

being piloted in Andhra Pradesh and Bihar to better identify and ensure payments and accessibility. Wage dispersion will also improve through the use of biometric ATMs (Patowary 2009). These ATMs require fingerprint authentication so rural employees can receive wages by way of a thumbprint scanner instead of a personal identification number. This procedure will help to reduce delays, improve transparency, and reduce irregularities.

Some issues in using biometric data should be noted. Aging or accidents that cause burning or deformities reduce the biometric software's ability to accurately capture all citizen groups (Giné, Goldberg, and Yang 2010). Costs can also be underestimated. The London School of Economics found that in India, the government grossly underestimated the 10-year rollout costs (Giné, Goldberg, and Yang 2010). Also, some societies do not support the use of biometrics. A survey in the United Kingdom concerning biometrics found that 55 percent of respondents felt that biometrics infringed on civil liberties (Giné 2010). Another problem is rollout costs. For just this fiscal year alone, Aadhaar will cost around US\$ 326 million (Polgreen 2011).

### INNOVATIVE PRACTICE SUMMARY

#### E-Government to Business

E-government to business is also important to ICT development and economic growth. Public agencies can use ICT to bring foreign investment, expand small businesses, and link farmers to buyers. Financial transactions like paying taxes can be carried out online. Electronic markets can facilitate sales and purchases. Businesses can also obtain regulatory information and permits or licenses through government-sponsored ICT. Often businesses already conduct online transactions (e-commerce) with other firms. If the government also provides online services to businesses, many of the same benefits are gained. E-government services for firms diminish red tape and improve regulatory clarity. As a result, businesses are more competitive and efficient—qualities that are particularly important to the agricultural sector.

#### Providing Regulatory Information to Small and Medium Enterprises

Between 2003 and 2008, 24 governments created websites dedicated to serving private enterprises, which use these “one-stop shops” to register, pay taxes, obtain licenses, and complete other business processes (today, there are even more). The service is often very efficient, cutting delays in bureaucratic procedures like registration by 50 percent (Djankov 2008).

Many one-stop shops facilitate business start-ups. Business start-up involves numerous formalities—registration for taxes, pensions, and insurances, screening procedures, opening bank accounts, and obtaining environmental certificates (de Sa 2005). Even in developed countries, these formalities take time.

One-stop shops are most effective online, but some countries can provide only start-up information and documents online; entrepreneurs must travel to a city to complete their business registration. In 2005, Kosovo provided e-government services in this manner. Forms could be downloaded from an e-government website that also specified the sequence of procedures and costs, but the transactions had to be completed at a central location in the capital. Now the Kosovo government is establishing completion locations in each of the municipalities. Reform efforts like these, along with others aiming to expand business capacity, have led to a 47 percent increase in registered businesses from 2005 to 2009 (World Bank 2009).

Vietnam has worked for many years to develop quality e-commerce systems. In 2000, the Ministry of Planning and Investment began building a useful website for businesses, particularly foreign investors. The first experiments with e-commerce technology occurred in Ho Chi Minh City and Hanoi (Desai and de Magalhaes 2001). Working to simplify administrative procedures, the government created an online, one-stop shop for private enterprise (Vasavakul 2002). This website (in English and Vietnamese) now includes license and permit applications as well as standardized forms for the various departments with which firms must interact during or after registration (Wescott 2003) (For one-stop shop information, see <http://www.dpi.hochiminhcity.gov.vn/invest/index.html> and <http://www.business.gov.vn/mastertop.aspx?LangType=1033>.)

While this one-stop shop certainly expanded capacity for foreign investors, small businesses in rural locations struggled to access similar e-government services. A survey conducted in 2006 (five years after the one-stop shop was implemented) showed that most users living outside of the main cities had poor telecommunications services; one interviewee stated that the “connection in the rural Internet shop is very slow. Many times I wanted to send a message but had to drop since waiting so long” (Nguyen and Nguyen 2006). This rural-urban and domestic-foreign disparity increases the digital divide and reduces the participation of rural smallholders. Though foreign firms have access to one-stop shops, rural owners of small and medium enterprises must resort to slow, costly,

**IMAGE 13.3: One-Stop Shops Using ICT Can Increase Efficiencies in SME Start-Ups**

Source: Tran Thi Hoa, World Bank.

bureaucratic procedures. Development partners like the World Bank have been working to expand the one-stop shop service to Vietnam's small and medium enterprises by providing specific electronic and physical contact sites (image 13.3). (See <http://www.business.gov.vn/index.aspx> for government efforts to help small and medium enterprises and IPS "Vietnam's One-Stop Shop for e-Government Services" in Module 14 for application to land administration.)

### Securing Efficient Payment Systems and Tax Services

Automated payment software systems are very useful e-government technologies. In 2000, the Contribution Network Project (<http://mns.mu/index.php>) was implemented as a public-private partnership between the Mauritian Government, Bank of Mauritius, and the World Bank. As an e-government to business service, the Contribution Network Project provides one channel for all payments that Mauritian firms need to make to a variety of departments (Heeks 2002). A decade later, the Mauritius Revenue Authority (<http://www.gov.mu/portal/sites/mra/index.htm>), a product of the Contribution Network Project, in collaboration with the Companies Division (<http://www.gov.mu/portal/site/compdivsite/menuitem.e24cd2cc6b820a052eada810f6b521ca/>) collects revenue from both business and citizens electronically.

Businesses small and large can set up an account to automatically pay a variety of government-required expenses, including

but not limited to corporate income tax, value added tax, national pension scheme, and company registrations. The automated payment software facilitates a computerized relationship between the banks, business, and government.<sup>1</sup> Mauritius uses a Value Added Network, which is a secured private network between banks and the government, operated by a trusted domestic service provider. When a firm registers for the service, the bank will remove cash from the businesses and send it to the government. The government will then send an e-mail receipt to the business. Identity management software is also used, offering syntax checks,

user validation, and integrity checks, all of which are important to building user confidence.

This transaction scheme has a number of outstanding benefits. Taxes and business fees are crucial to economic development; in fact, in Mauritius "income taxes and VAT constitute around 34 percent of government recurrent revenue" (Lollbearree and Unuth 2001). The benefits of this faster electronic process include:

- Easing pressure on government during busy times like tax periods.
- Reducing employee numbers on government payrolls and preventing staff from making multiple data entries for records (even in developing countries, paper tax forms typically enter a computer system at some point).
- Speeding up cash flow.
- Generating revenue for sustainability.

Initial investment costs can be quite high for automated payment systems like these, but the returns on the investment can surpass them. Setting up the main facility for the Contribution Network Project required a capital investment of around US\$ 250,000. Employers then bear the costs for hardware, connection to the network, and training (this totals around

<sup>1</sup> For more on automated payment systems, see Sumanjeet (2009) and Frederick (2009).

US\$ 1,410). There are communications fees based on the volume of data transmitted—currently employers are charged about US\$ 0.18 per kilobyte (Lollbearree and Unuth 2001).

### Increasing Efficiency in Transportation and Logistics

Businesses, particularly agribusinesses, face major challenges in transportation infrastructure. Poor road conditions like potholes and soft shoulders cause terrible accidents and traffic. The resulting high transaction costs reduce firms' and growers' international competitiveness (Sriraman 2009). Import costs rise and trade declines when road infrastructure is poor; studies have shown that a 10 percent increase in transportation costs lead to a 20 percent decrease in trade volumes (Limao and Venables 2000). Transport costs can reduce the marketing value of rural producers' goods to such an extent that it is not cost-effective for businesses to purchase them for export. Similarly, transport costs for imported commodities can double shipping charges and make them unaffordable for rural citizens. In both cases, private enterprises are deterred from reaching out to rural locations.

Developing countries have adopted toll roads to overcome some of these challenges. Toll roads provide funding to maintain and expand roads, but collecting tolls and fines is quite difficult. Toll operators can pocket fees and bribe drivers for still more cash. Drivers can refuse to pay, and without strong vehicle identification schemes, governments cannot ensure that they are properly fined. Electronic toll collection is a more efficient way of collecting road fees. It reduces the scope for bribery and loss of revenue by tracking cash and vehicle flow, decreases waiting times, and

monitors traffic volumes, which help to predict potential maintenance needs.

Indian businesses face serious obstacles to smooth transportation. The logistics of getting people and goods from Point A to Point B constitute almost 10 percent of the country's GNP, out of which almost 40 percent is transportation (Sriraman 2009). Moreover, the use of vehicles to transport goods has grown in past decades. Road quality and accessibility are important factors in transport development, but another challenge is the speed of transport. Truck drivers carrying goods, especially over state lines, are stopped and checked, fined, taxed, and questioned. These activities slow traffic and increase transaction costs for both the government and the agribusiness.

India is one of the first developing countries to implement electronic tolling systems. The National Highways Development Project, chiefly funded by toll fees, began a long-term investment in improving road conditions on the country's National Highway Network. The primary initiative of the project was to expand automated tollbooths. The government chose radio frequency identification (RFID) technology, which uses electromagnetic waves to exchange data between a terminal and an object, like a vehicle, and cost less than other options (table 13.4). (For more information on RFID, see Shepard (2005) and Banks et al. (2007).) A number of activities can be tracked with RFID, such as activities involved in supply chain management, passport or other identification control, and animal identification. For India's toll roads, RFID is coupled with a national, unified, central management system; a legal framework to handle violators; vehicle classifications; and a prepaid system for interested

**TABLE 13.4:** Comparing Costs for Electronic Toll Collection, India

	ETC TECHNOLOGY	COST	SUPPLIERS	IN USE	COMMENTS
DSRC	Active Microwave 5.8 GHz	About Rs 2000 per OBU About Rs 5 Lac per Reader	Limited	Yes (Japan)	Due to higher bandwidth and data speed, supports many ITS applications
	Passive Microwave 5.8 GHz	Rs 1000 for OBU • Rs 2L for Reader	Multiple	Yes (Europe)	Very Simple OBU
	Infrared ISO-CALM	Rs 1000 for OBU • Rs 2L for Reader	Limited	Yes (Austria and Malaysia)	Can be easily extended to a contactless card and useful for other ITS applications
RFID	Passive RFID	About Rs 100 per Tag About Rs 2 Lac per Reader	Multiple	Yes (South America, Georgia, US)	Allows tamper resistant "stickers" Small, light, very cheap, almost unlimited life
	Active RFID	About Rs 1000 per On Board Unit (OBU)	Limited	Yes (Florida)	On-board transmitter, higher range, expensive Finite life as the battery has to be replaced
	GNSS/CN	About Rs 2 Lac per Reader About Rs 2000 per OBU	Limited	Yes (in Germany)	Too sophisticated and due to absence of toll plazas, enforcement on violations is very difficult in India.

Source: Nilekani 2010.

Note: ETC = electronic toll collection; OBU = on-board unit; DSRC = dedicated short-range communication; GNSS/CN = global navigation satellite system and cellular network; Rs = rupees; 1 lac = 0.1 million; ITS = intelligent transportation systems.

users (Nilekani 2010). Users can also pay their bill through mobile phones and credit cards. Technologies like RFID are not limited to federal government. In India, for example, Gujarat State has computerized its 10 internal checkpoints, a step that dramatically increased state tax revenue and reduced corruption (ADB 2003).

Not only do technologies like RFID dramatically reduce transaction costs for travel, they also create more opportunities to extend e-government to businesses and citizens. Once RFID is established, it can be applied for tracking stolen vehicles, paying vehicle taxes, and paying driving or parking fines (Nilekani 2010).

Even more important, these technologies benefit rural sectors. If businesses have smoother transport facilities and reduced road costs, they are more likely to travel further to buy or sell agricultural products. Similarly, the revenues gained from toll collection can be applied to infrastructure for rural feeder roads.

## INNOVATIVE PRACTICE SUMMARY

### E-Government to Government

This section discusses internal e-operations concerning government-to-government interactions. These ICT initiatives are equally important to e-government–citizen and e-government–business relationships, because public agencies that use ICT to service other organizations or people usually are required to use it themselves to make the ICT effective. E-government to government involves “agency to agency” interactions mentioned briefly in the NeGP example. E-government to government or employees is essentially an advancement of human resource and administration capabilities. For employees within a government agency, ICT projects can include human or knowledge management systems, purchasing requisitions, payroll processing, position applications, and department transfers (Fang 2002). It is vital that internal e-government projects integrate service delivery channels and common interministerial infrastructure and do not continue to reinforce fragmented ones (OECD 2003).

### Improving Internal Public Financial Systems

Integrated financial management information systems (IFMIS), or the computerization of public expenditure management, are designed to support and track budget decisions and execution, fiduciary responsibilities, and financial reports in various government bodies (USAID 2008). They help lock agencies into a single, common platform for data storage and sharing. IFMIS involves standard data classification, internal controls

over data entry and reporting, and common processes for transactions like procurement. In the long run, the systems should be able to interface with other financial software like payroll. Financial systems have extensive applications—they track incoming revenue, monitor debt, and enable resource management and audit operations (USAID 2008). An important feature is that they can also help federal agencies integrate with local ones to monitor financial flows.

A recent in-depth, qualitative study (Ezz, Papazafeiropoulou, and Serrano 2009) conducted on an IFMIS in Bezuck<sup>2</sup> illustrates the challenges in implementing integrated financial systems. The IFMIS included a variety of public agencies—the Central Bank, a number of ministries, and the Bezuck Information Support Center (ISC), a prominent think tank that guides cabinet leaders on economic, social, and political decisions. In the early 2000s, the agencies above were mandated to interact and collaborate with the ISC to improve financial decision making. The ISC introduced an IT system to facilitate this process by tracking and documenting the various agencies’ transactions. As financial processes became digitized, the historical challenges to collaboration became more apparent. Roles of certain ministries were not clear, and many employees did not understand the new system’s capabilities. Some traditional decision-making processes were interactive, some were sequential, and others depended on another person’s completed tasks. Because of this complexity, ministries struggled to use the new ICT to make financial decisions. Another challenge was overlap in IT support. Ministries have their own IT departments with their own procedures to deal with technology troubleshooting (Ezz, Papazafeiropoulou, and Serrano 2009). Despite these difficulties, the agencies’ attempt at financial integration led to training for over 50,000 government employees (United Nations Department of Economic and Social Affairs 2009).

### Decentralizing E-Government to Local Levels

Established in 2005, the Ministry of Local Government in Uganda in collaboration with DFID and the International Institute for Communication and Development began to pilot e-government at district headquarters and subcounties. Called DistrictNet, the digital system aimed to improve data and voice communications between district-level officials and the sublocal government actors below them. The system was implemented in 76 districts in all regions, initially focusing on 11 subcounties. Before the ICT was introduced,

2 Bezuck is a name invented to preserve the country’s anonymity, because of the challenges in implementing ICT.

subcounties collected data through hard-copy forms in the communities and sent the forms to district headquarters. This process yielded little data, caused backlogs of three to six months in paperwork, and caused data to be lost during paper shuffles (United Nations Department of Economic and Social Affairs 2009).

The objectives of digitizing some of these processes included increased coordination between district headquarters and subcounties, reduced travel between these locations, improved technical skills, and increased availability of information. To meet these goals, voice and data links were established between district headquarters and subcounty governments. Because many subcounties lacked electricity, other energy sources were used to create the links. A valuable aspect of the project was that it measured the initial results through a variety of indicators, such as the time it

took subcounty officials to respond to district queries, the volume of data exchanges, use of IT systems, and information requests by citizens (United Nations Department of Economic and Social Affairs 2009).

Data are still collected on paper at the community level, but they are digitized by the subcounty and electronically forwarded to district planners, who analyze it and provide feedback to their local government counterparts. Impact studies show that feedback is better and timelier, owing to more accurate, digital data transmission. Because the Ministry of Local Government is no longer involved in the district analysis, staff can focus their energy elsewhere. Significant challenges to implementing the system included low levels of professional technical knowledge and low computer literacy within the local government (Jager and Reijswoud 2003).

## Topic Note 13.2: CIVIL SOCIETY AND THE PROVISION OF E-SERVICES

### TRENDS AND ISSUES

Civil society organizes in groups that are not part of the local, state, or federal government. These groups include a wide range of institutions such as unions, trade associations, self-help groups, and NGOs. They can operate on a local, grassroots scale with a small, restricted membership or have a presence in multiple countries and communities. Their serious involvement in economic, social, and political development makes them important participants in the rural governance discussion. Moreover, ICTs are important to their efficiency and ability to contribute to growth.

Civil society groups can use ICTs to improve the lives of beneficiaries and internal management, especially given that ICTs are widely recognized for their role in promoting democracy, fostering compliance with human rights accords, and improving livelihoods (Ganie-Rochman 2002; Hadiwinata 2003). They provide many digitized services similar to those of public agencies. Civil society groups can facilitate the interactions between producers and extension agents or traders. They can partner with government and contribute to electronic voting and toll collection systems, or they can independently broadcast radio programs on agricultural technology or business. Yet civil society also has the opportunity to use ICT in more sensitive activities. These organizations can publish information on political figures, political parties, or new legislation. They can more easily direct their efforts to

more specific groups or needs and fill voids in public service, whereas government must sometimes function as a public service catchall. The environment, gender, agriculture, and education are all important niches for civil society operations, depending on the context.

Civil society groups are a growing presence in rural areas; of these groups, the most active are domestic and international NGOs. The innovative practice summaries focus on these organizations because they have been so active in rural agriculture. Over the last decade, other civil society organizations—producer groups and self-help groups particularly in relation to agriculture—have become increasingly involved. Their use of ICTs, though related, is addressed in Module 8 on farmers' organizations.

### LESSONS LEARNED

Civil society groups can improve rural governance dramatically, especially through ICTs. Civil society groups, which are often present in their beneficiaries' communities, have more opportunities to influence cultural and social dynamics than federal or even local government. This role is important, because culture, upbringing, values, and norms influence the extent that a person or farmer may desire to use ICT. For example, younger people are usually more adept with new computer technologies, the Internet, or SMS applications,

yet in rural societies where senior staff or family members have authority and the most access to information, younger citizens with the ability to learn these new technologies often are not permitted to do so (Mercer 2004). At other times, older people are not confident enough to experiment with new technologies. Civil society groups, especially if they are local organizations, can facilitate the knowledge transfer from youth to senior community members. Again, ICT to enhance governance or even agricultural productivity is not just a matter of physical access and ownership, but also a matter of obtaining social access (Flor 2001; OECD 2003; Madon 2004).

The most positive institutional reforms have grown out of public demand. Limited understanding of ICTs and their economic usefulness can restrict the demand for and success of these technologies in the agrarian sector. Creating demand for ICTs is often easiest when community leaders take a stand and engage both local citizen groups and local politicians. Local civil society organizations can nurture leadership figures and create forums for citizen education and awareness.

### INNOVATIVE PRACTICE SUMMARY

#### Providing 'Hubs' for ICT Innovation

NGOS can offer dynamic services by creating ICT hubs “to channel the information that the farmers need or use to help their work” (Mercer 2004) into one place. When NGOs and development partners offer Internet or ICT support in a central rural location, many people, including farmers, can access e-services more easily. These hubs not only increase farmers’ knowledge communication with others, but they also help the government achieve results. Governments cannot provide overly ambitious public services in developing countries. The participation of development organizations in providing e-services may help to reduce the pressure on underresourced public agencies and promote innovation in rural communities while providing relevant and context-specific information to local people.

*InfoDev*, in collaboration with a variety of other partners, has very recently developed an innovative hub: the mobile applications lab (or mLabs) (<http://www.infodev.org/en/TopicBackground.34.html>). Considering the rapidly expanding telecommunications infrastructure, mobile applications, and electronic public services, spaces that allow innovation and entrepreneurship to thrive are critical resources. In many developing countries, innovation is thwarted by financial, human, and technological constraints. Even where good

ideas transform into tangible tools, they struggle to gain attention and capital, limiting their viability as a business or service. mLabs seeks to improve this situation. In five different regions (East Africa, southern Africa, the Caucasus, East Asia, and South Asia), infoDev is establishing centers with the tools needed to experiment with and expand innovation, including agriculture innovation.

mLabs (image 13.4) will provide entrepreneurs with high-quality equipment, stable Internet connections, and technical and business training. These services will allow users to test ideas, scale software capabilities, expand scope, and hone the skills needed to capitalize on their tool or application. Through events, competitions, and business mentoring, innovators will also have easier access to investors. mLabs provides an innovative civil service: a hub that allows creativity, risk, failure, and success, coupled with the necessary tools and support needed to build new instruments that can service the population. This kind of hub is critical to development, particularly because local entrepreneurs know their communities’ needs better than external providers.

mLabs are in incipient stages, starting with an investment of approximately US\$ 380,000 each. This suggests that mLabs are largely unsustainable without additional and regular financing. While uncertain, mLabs does have a business model that may address common financial constraints. Firstly, depending on the business model used in that location, local programmers, entrepreneurs, developers, or designers can become members of the mLab. Membership is based on the services desired—some memberships are free and others

**IMAGE 13.4:** mLab in East Africa Assists Agricultural Entrepreneurs



Source: Tim Kelly, World Bank.



are fee based. “Incubatees,” which are at the highest level of membership, are members that are actually pursuing a business idea. Incubatee fees will vary based on location—some will charge a monthly fee and others will allow free use of the lab under the conditions that the lab receives an equity stake in the company. These incubatees will have full use of the lab and its services; they can also work for a paid salary within the mLab. Without going into great detail on the remaining levels of membership, mLabs expects to collect fees or receive income on companies that land in commercial markets. Additionally, mLabs will reach out to the private and public sector. Due to its entrepreneurial nature and mobile focus, the mobile applications generated in mLabs are likely to attract seed investment (for more information on mLabs’ business plan and sustainability prospects, see <http://www.infodev.org/en/Article.705.html>).

mLabs East Africa is currently the furthest along in development. The lab has recently selected its first set of incubatees, which includes entrepreneurs focused on agriculture and market information systems (see <http://www.ihub.co.ke/blog/2011/06/first-set-of-incubation-clients-selected-for-m-lab-east-africa/> for further information on these start-ups, which include mFarm and Zege Technologies). These start-ups, while receiving the opportunity to gain visibility, capital, and technical assistance, also receive the benefit of contributing to their communities, country, and social and economic development (with the caveat that these hubs and technologies become popular and widely known). mLabs, and the few similar to them (see Grameen AppLabs for innovative approaches on application development: <http://www.grameenfoundation.applab.org/section/index>) have the potential to improve agriculture public services and others by giving underresourced and contextually-based entrepreneurs the opportunities to grow.

### **INNOVATIVE PRACTICE SUMMARY** **E-Learning through the Web and SMS**

Like government, civil society groups can also provide agriculture information through websites tailored to particular technologies or needs. The Cereal Knowledge Bank is an innovative, interactive website on rice, wheat, maize, and cropping systems (<http://www.knowledgebank.irri.org/>). The International Rice Research Institute and International Maize and Wheat Improvement Center, who launched the website in January 2008, offer useful tools for improving rural agricultural productivity. Users can click on a large button entitled “Maize Doctor” to receive diagnostic tips. The Cereal Knowledge Bank also offers information on rice evaluation

systems and various cropping methods. Useful for nutrition and crop development, the website contains a glossary on rice as well as downloadable handbooks on disease, hybrid production, rice morphology, and natural disasters. The Cereal Knowledge Bank provides information on extension, like how to create an extension system, needs and opportunity assessments, and a checklist for extension start-ups.

The site demonstrates a high degree of user-friendliness, or usability, a critical aspect of successful ICT implementation. Text options and clear links to other sites create this friendliness. Useful buttons (“back,” “home,” and “help”) are at the top of each page and clearly marked, making it easy for people of all ages and skill sets to access information. Moreover, the Knowledge Bank maintains information on 13 countries. By clicking on the country flag, users can access the information in the country’s official language. Giving the user options is also part of usability; a lack of options and links to nonexistent websites frustrate users.

Through ICTs, development organizations can also provide online networking opportunities to citizens and farmers to increase their learning. Networking leads to empowerment, gives citizens a voice, and makes it easier to disseminate technology in agricultural communities. The Indian Society of Agribusiness Professionals (ISAP) is a civil society institution that was established in 2001. A network of agricultural professionals in India and other developing countries, it now hosts over 15,000 associate members, including 1,500 agri-experts, 525 partner NGOs, 1,050 researchers, and over 824 individual users (according to its website, <http://www.isapindia.org/Default.aspx>). One of the world’s largest agricultural networks, ISAP aims to serve farmers, rural entrepreneurs, and graduate students who do not find appropriate employment (Singh 2006). Its goals, as summarized on its website, include improving the livelihood pattern of smallholders through improving access to affordable technologies and market-related information, extension services and advice, access to market capital and risk management tools, as well as network development.

The network has a number of projects to achieve these goals. It offers training and conferences on commodity futures and trading; to date, ISAP has trained almost 80,000 farmers at 2,064 locations in India. The network also offers programs to upgrade skills. The most innovative aspect of ISAP is its membership program and network solutions. For free, individuals can apply for basic registration, which gives them access to online web sources like “Ask the Expert,” job search engines, an online query redress service, and technology assistance for commercializing products. For Rs 600, an individual can

receive an annual subscription to Weekly Market Newsletter in Hindi, access peer-to-peer networks, and obtain a 15 per cent discount on advertisements (posted on the ISAP site) and conference fees. These individuals can also participate in the ISAP consortium for consulting to receive or obtain referrals. For various prices, other development agencies, academic institutions, government agencies, agribusinesses, and overseas organizations can receive the same access.

Finally, the ISAP network connects producers to buyers. The organization involves producers, traders, NGOs, and farmers groups, thus obtaining end-to-end solutions in supply management. Through its networks online and activities on the ground, ISAP provides training on markets and gives technical advice on production and postharvest management to farmers. By tracking these farmers, private enterprises are assured of quality products because they know that the farmer or cooperative in question attended ISAP training.

### INNOVATIVE PRACTICE SUMMARY

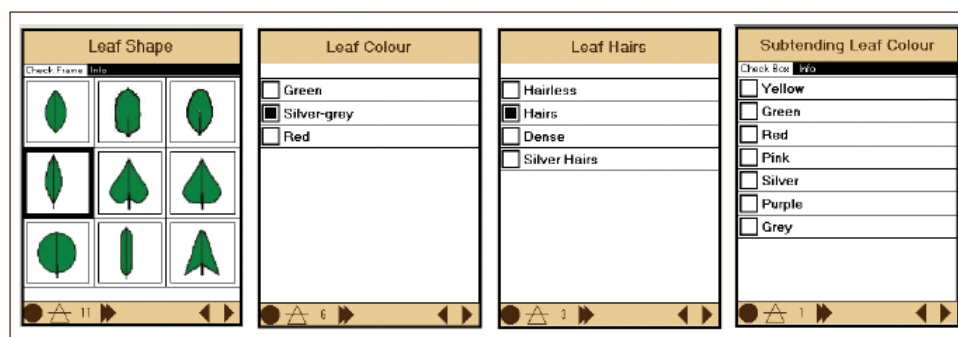
#### Collecting Data to Protect Local Knowledge and Ecosystems

Public agencies are limited in their ability to collect relevant data in all rural locations, but new ICTs make easy data collection possible through civil society groups. CyberTracker (<http://www.cybertracker.org/>), originally created to track animals and plants for conservation, has created opportunities for poor, rural, and illiterate people to collect useful information on a variety of subjects. The technology is open-source software developed in South Africa by CyberTracker Conservation in collaboration with the European Commission.

A user interface that uses words and icons (image 13.5) allows nonexpert civil society groups to record a variety of important data. The software can be installed on either a PDA or smartphone to collect large amounts of field observations with spatial references through a GPS. Using a touch screen, the technology can be customized to fit users' needs and improve efficiency in data collection (for example, users can select which icons or lists they would like shown on the screen). The software can also be customized to local languages. With an icon-based, simple screen, local people can use the technology to collect complex data. When the data are transferred to computers, interactive maps show detailed patterns of ecological features like animal traffic or agricultural areas. Analyzing these patterns has high potential to project future trends, especially if data are collected in a variety of locations (CTA n.d.).

CyberTracker is used all over the world for many purposes. In Africa, it is used primarily to track animals and plants, with the intention of monitoring ecosystem changes caused by climate change. The technology can also be used to monitor crop growth and livestock movement. Local people, even if they have little or no education, can be paid to track ecological change using the technology, because the interface is so user friendly. Aside from creating jobs in the rural sector, the technology captures invaluable local knowledge that is being lost as indigenous populations disperse and new technologies enter rural areas. Rural indigenous populations gain a more effective position and voice in policy dialogue. Civil society groups working to improve understanding of local needs in agriculture can use CyberTracker to capture relevant data cost-effectively, with few outside resources. They can also use the technology to capture social data through digitized surveys (CTA n.d.).

**IMAGE 13.5:** CyberTracker Gives Users Icon and Word Options



Source: CyberTracker (<http://www.cybertracker.org/>).

## Topic Note 13.3: INCREASING CITIZEN PARTICIPATION THROUGH E-DEMOCRACY

### TRENDS AND ISSUES

Waves of new ICTs have opened opportunities for citizen participation in various types of regimes and locations. In fact, experts feel that one of the most promising digitized applications of ICT is to foster broad participation, local innovation, and social learning (Hanna 2009). This potential, coupled with citizens' recent ability to increase their voice in state affairs and organize more effectively through ICT tools (like recently witnessed in the Arab Spring), motivates this discussion, as does the fact that citizen participation and demand for public goods is incredibly important in the agrarian sector. The quality of governance in remote locations often depends on citizen involvement, because so few resources are available to reach those locations.

Electronic democratic projects can be designed and implemented by a wide array of institutions. Using ICT to improve democracy is just like using more traditional media to improve democracy. Town hall meetings, complaint call lines, public surveys, petitions, and newspapers are all communications media. Residents of a village facing an economic downturn can meet in a central location to discuss possible community-based options. Political parties can organize a petition, and newspapers can present useful facts on the activities of politicians or proposed legislation. Each of these media has improved its methods through technologies such as the Internet and SMS. Now people around the world have faster, real-time capacity to involve themselves in democratic initiatives, meaning that more stakeholders can affect governance processes (Heeks 2001).

The ICTs used to foster citizen participation can involve a variety of complex processes. A practical taxonomy for these processes, or what ICT can help to create, is described below (Macintosh 2004):

- **Information:** One-way relationship; institutions produce and deliver political information to citizens through ICT.
- **Consultation:** Two-way relationship; institutions invite citizens to give feedback on issues; public agencies set the agenda and manage the process through ICT.
- **Active participation:** Partnership relationship; citizens actively engage in setting the agenda and creating content for policy making through ICT.

Digital democracy—a “collection of attempts to practice democracy without the limits of time, space, and other physical conditions, using ICTs” (Nugent 2001, cited in Schwester 2009)—is not synonymous with electronic voting (as perceived in the past). Considering the taxonomy described earlier, ICT can help citizens influence government decisions in many ways (Macintosh 2004). With ICT, institutions can disseminate information faster through cell phones, radio, or online. To participate in a policy meeting with the Ministry of Agriculture, farmers can use an ICT application like Skype and eliminate typical logistical concerns (such as organizing housing and travel reimbursements for 30 participants). Virtual communities, web complaint lines, e-mail correspondence between government officials and citizens, participatory budgeting, online media, and web-based political information sharing are all vectors of digital democracy. Fostering citizen participation through ICT allows citizens to form and find groups that have similar interests; for example, agrarian communities can share information on crop diseases, pests, prices, and technologies. In addition, these communities can discuss and subsequently act on policies that directly affect their activities and livelihoods. Though ICT for citizen participation is most heavily concentrated in wealthier countries, these tools are proliferating to poor countries. Botswana is in the top 25 percent of all countries using electronic means of participation, and five African countries have open web forums to discuss political topics (Hafkin 2009).

### LESSONS LEARNED

The challenges faced by institutions trying to use ICTs to improve citizen participation are similar to those faced by public agencies and civil society. Technical and infrastructure challenges are especially strong for voice conversations, because poor network connections hamper effective dialogue.

Unlike e-government and civil society projects intended to improve public services, institutions using ICT to enhance democracy may need to address more serious social and political difficulties. For example, increasing citizen participation shifts the relationship between government and citizens from vertical relationships to horizontal ones (Ndou 2004). Even decentralized and democratic governments have a fairly vertical power hierarchy, or a top-down structure. In many instances, ICT changes this structure rapidly (Fang 2002).

Giving citizens increased access to government information, allowing quick transfer of knowledge through cell phones or e-mail, and providing space for a real-time public forum reduces the vertical structure found in most governments and increases the horizontal one. This horizontal shift can dramatically challenge a societal structure (Saxena 2005). While this shift is generally a positive step toward citizen representation, it may provoke a far-reaching backlash from politicians, policy makers, elitists, traditional authorities, and others, reducing the effectiveness of the ICT for citizen participation. Some of these negative consequences are currently being witnessed in the regime changes occurring in the Middle East and North Africa.

Using ICT for democratic projects also increases the visibility of cultural challenges. Teaching rural citizens how to use ICT is a challenge in itself, as is fostering their understanding of participation. If digital exercises in participation are meant to be inclusive, addressing perceptions of equality within the community is also necessary. Women, youth, and other vulnerable groups are often excluded from political decision making within communities. Extending their participation to higher levels with new technologies is not effective unless root societal dynamics are explored and addressed.

### INNOVATIVE PRACTICE SUMMARY

#### Information Kiosks in India

The Gyandoot project (see <http://www.gyandoot.nic.in/>) in drought-prone, rural Madhya Pradesh in India is a solid example of both e-government services and e-democracy. Thirty-eight government-owned telekiosks were established in central locations like village markets and major roads in Dhar district (Cecchini and Raina 2004), where 60 percent of the population lives below the poverty line (Jafri, Dongre, and Tripathi 2002) (image 13.6). Rather than using expensive local area networks and very small aperture terminal technologies, the kiosks, which each serve approximately 25–30 villages through cybercafés (Meera, Jhamtani, and Rao 2004), operate through a dial-up network with modems from existing telephone lines. E-government services within the cybercafés include regularly updated price information, computer training, application for income and domicile certificates,

**IMAGE 13.6:** Rural Kiosks Can Lead to Information Sharing Between Agrarian Communities



Source: Ray Witlin, World Bank.

employment news, and a landholder's book of land rights and loans. Yet Gyandoot also provides ICTs that enhance democracy, partly because it is an intranet system—all of the kiosks are connected to allow citizens to share information. An online rural newspaper updates citizens with local political information like public expenditures and raises awareness in their villages. Complaint lines, expert opinions on legal matters, and e-mail are also available.

Gyandoot has had its successes and challenges.<sup>3</sup> First, providing services like price information and village auctions online and directly to farmers removes the intermediaries who commonly take advantage of rural impoverished citizenry (Meera, Jhamtani, and Rao 2004). Second, kiosk operators performed well. Third, almost 80 percent of users were satisfied with Gyandoot services. Finally, high rates of satisfaction match the fairly high rates of government action. Sixty percent of complaints put forth through the Gyandoot system were addressed within one week; according to one survey, district administrators felt that officials' performance improved dramatically and immediately because they knew citizens could file complaints (Jafri, Dongre, and Tripathi 2002).

<sup>3</sup> Though some of these figures are dated, they are worth including because the real impacts of many ICT e-governance initiatives have not been widely studied.

On the other hand, individual access to Gyandoot kiosks is fairly low. One survey showed that many kiosks served only one to four people per day (Cecchini and Raina 2004). Electricity outages and distance to the kiosk often caused this problem. Socioeconomic factors also posed challenges for Gyandoot. All surveys cited here found that most users were wealthier male community members. Start-up and intranet costs of more than Rs 2.5 million (Bhatnagar and Vyas 2001) were also expensive. Compared to user fees at Rs 5 to Rs 25 per service, incoming revenues could not cover the initial expense.

## INNOVATIVE PRACTICE SUMMARY

### Virtual Communities

The proliferation of virtual communities is another result of expanding Internet connectivity. Presently tens of thousands of virtual communities interact via web-based technology. Virtual communities are groups of people who join and participate in online organizations, usually for a specific purpose, practice, circumstance, or interest (Kim n.d.). The people in the community may never interact with one another in person, yet with open-source technology they can connect, discuss, and act on local, national, and international issues.

Types of virtual communities range widely. People create communities for commerce (such as eBay and craigslist). Development organizations create databases that members can access for research. Political groups can create websites for activists to sign petitions or receive information on events.

Practitioners can also set up “communities of practice” and organize continuous dialogue on projects or provide useful job-related material. These communities can help sustain conversation. For example, after a conference or workshop, interactions between participants usually cease. Yet some have found that forming an online community of practice after the event helps to retain long-term participation (Kim n.d.). Online communities could have potential for public agencies and civil society groups in developing countries. Often participants in meetings organized through ministries are required to travel to the capital. After the meeting or workshop adjourns, they return to their rural communities. If ministries could create a portal, or community of practice, for these participants, facilitating future meetings and continuing conversation over a sustained period of time might be easier.

Political virtual communities are also shaping democracy, holding great potential for creating transparency and

generating information on politicians, candidates, and policy. The United States has numerous websites that provide political information and express views on elected representatives. DNet (<http://dnet.org/>) and Project Vote Smart (<http://www.votesmart.org/>) are led by NGOs. DNet provides information about candidates’ positions on election issues. It also gives media reports, and encourages candidates themselves to post statements, biographical data, and endorsements. In some cases, citizens can communicate directly with candidates via e-mail and host live interviews. Discussion boards can also be generated for citizen-to-citizen communication.

In developing countries, political communities like these are slowly coming online and may help generate more public awareness and participation. As early as 2004, the Tanzanian National Assembly introduced a website for parliamentary decisions and data. Called POLIS, the site provides citizens with the proceedings of parliament and other government activities (<http://parliament.go.tz/POLIS/Bunge/Polis.asp?Menu=0>). Full texts of legislation, fact sheets, and information like parliamentarians’ voting records are housed in this portal. Easy navigation tools including the MP Profile Database, Bill Tracking System, Session Management System, and the Act and Documents Management System help citizens find information (United Nations Department of Economic and Social Affairs 2009). To achieve further transparency in rural areas and for illiterate citizens, future initiatives could include mobile phone applications or POLIS radio broadcasts.

## INNOVATIVE PRACTICE SUMMARY

### Government Responsiveness through Citizen Participation in Digitized Political Processes

Government responsiveness is one of the foundations of effective democracy. Innovative ICTs give governments the opportunity to respond more efficiently and broadly through issue-based and policy-based forums. Participation in political processes ranges from expressing online grievances to electronic consultation to participatory budgeting. The following section provides an example for each of these interventions.

The Government Information Agency in South Korea is considered the best-practice example for implementing this type of ICT. Even before 1990, Koreans could access a number of online services, including registering births and locating relevant economic statistics (Sang, Tan, and Trimi 2005). In addition to a frequently updated webpage, secure e-signature system, and personnel management system, the website also provides transparent and timely responses to citizens’

inquiries. (For more information on electronic signatures, see Gupta, Tung, and Mardsen (2004).) If someone requests information related to a specific government policy, public officials collect the applicable information and post results within the week (Holzer and Manoharan 2004), demonstrating fast and reliable government responsiveness.

In addition, Korea has created e-People (see <http://www.epeople.go.kr/jsp/user/on/eng/intro01.jsp>), an anticorruption portal that uses cloud computing, complaint lines, petitions, and discussion forums to reduce corruption and boost citizen engagement in the country. All government ministries and local government departments, along with 448 public-sector organizations are on e-People. The site receives over 100,000 hits per day, and over 8,000 complaints were documented in 2010 alone. When a complaint is made, it is categorized and forwarded to the relevant agency, where the agency has opportunity to respond. Citizens (and foreigners or diasporas, who are also allowed to use the site) can check the status of their complaint and evaluate the response given as well. Users can also view a record of the complaints sent by others, allowing them to choose whether to withdraw or submit a similar complaint. This option reduces the amount of petitions going to the agencies while also helping the government assess the magnitude of the problem.

Participatory budgeting, which is gaining traction around the world, occurs when communities and citizens directly determine how a portion of the public expenditure will be used. The first phase of a pilot project recently completed in the Democratic Republic of Congo has had remarkable success despite what would appear to be great hurdles. The World Bank in partnership with the provincial government forged a partnership with Airtel, the largest cell provider in DRC. Airtel provided geographic information and premium numbers to the team. After districtwide deliberations, where discussants debated and selected five to six main priorities for their district, a short list of numbered priorities was created. Before voting day, SMS messages were sent to the district's Airtel users (almost 300,000 people), directing voters on how to participate. On voting day, users sent a four-digit code that represented their district to the premium number. Once they received the short list of priorities for their district and responded, they received a confirmation of their vote. Their votes were documented in real time in an online database, which was connected to a GPRS modem with a very low bandwidth. Conventional means of voting were also made available for those without cell phones or an Airtel subscription.

Results were promising. After votes were in, public expenditure was allocated from the central government to the provincial government and was then used in local projects determined by the citizens within the given district. In some cases, over 80,000 dollars was invested in an intervention such as a school building, health clinic, roads, or irrigation structures. In most cases, this was the first time that any real investment was made in the districts.

Despite the success of the pilot, there are many challenges ahead. Implementing construction efficiently is challenging in rural areas because the work is often done in remote areas with few qualified staff. SMS hot lines or phones with camera capacity could be an option to address this challenge. Scalability is also in question: once initial donor support ends, public and governmental support for the project (which requires time and capital) may fade. SMS messaging is too expensive for citizens to pay, and public subsidization may be necessary for a number of years. (Source for all information: Weber, Maketa, and Tiago 2011).

### **INNOVATIVE PRACTICE SUMMARY** **Digital Media Forums in Developing Countries**

Media outlets also provide space for ICT initiatives to enhance good governance. Traditional newspapers that have created online websites generate real-time public participation through comments and letters. Live chat sessions are also possible through online newspapers, and experts or writers can respond to readers' comments to carry on discussions about the topic. These online and interactive news sources and chats are not limited to more technologically capable countries. Zimbabwe, Bolivia, Nicaragua, the Philippines, and Ghana are only a few of the many developing countries providing media online.

Online independent newspapers can be effective in strict political regimes with low freedom of speech. One such newspaper, *Malaysiakini* (<http://malaysiakini.com/>), made an enormous impact on governance in a country where the ruling party dominated the media. The newspaper provides information in four languages. Information includes alternative views on local politics (Pang 2006), and articles explore trade issues, government budgets, mining, foreign direct investment, migration, religion, and agricultural development. New legislation, politics, and corruption are frequently debated. When serious news arises, the online news source also sends subscribers SMS alerts.

In the last few years, the website has received almost 40 million page views and 800,000 video downloads per

month (Malaysiakini 2008). Its success stems largely from the fact that it is only online. Online media cost less than print media (Pang 2006), and the site is subscription based. Users pay approximately US\$ 40 to access the daily content. This fee may be high for rural citizens, yet civil society groups could help to pay this price to make the information available to poorer people through a hub like a telecenter. A significant limitation is that because the newspaper is not produced in a traditional print format, it cannot receive press accreditation, so its journalists cannot enter political spaces and attend potentially important meetings (Pang 2006).

An organization in Tanzania, Daraja (<http://www.daraja.org/>), is also experimenting with ICT and media to achieve improvements in local government and boost citizen inclusion in political processes. The new organization intends to build links between government and communities on critical topics in Tanzania. One such project involves water services: over half of Tanzania's rural water points are malfunctioning despite increases in government funding and population growth. The three-year "Raising the Water Pressure" program uses local populations and the media to place political pressure on government officials in rural areas. Through mobile phones, citizens can send feedback or grievances about their local water supply. This information is forwarded to the appropriate district officials and the local media. Local media can then interact with district officials to determine their plan of action regarding the poor water service (image 13.7).

The use of mobile phones also increases the voice of the common citizen or vulnerable group who may not receive access to the government. Since its inception, 500 texts have been sent to the water database, upon which 100 have been forwarded onto the district officials. Only 100 have been forwarded due to challenges with illegibility; illiteracy is a major barrier to the program's success. However, in the cases where grievances were passed to government officials, reactions have been positive. Daraja also plans to assist local governments in technical capacities in order to build a positive relationship with local officials (Taylor 2011). (For more information on this project, see <http://www.daraja.org/our-work/rtwp/>.)

Blogging is another innovative and inexpensive form of ICT used internationally

to improve public access to information and opinion. Blogs provide writers a space to express personal views or experiences and give readers the opportunity to learn from first-hand accounts. Most bloggers live in wealthier countries, but blogging is becoming more common in poorer ones.

Global Voices, an international nonprofit, offers a space for bloggers and readers in almost 20 languages. With a community of over 300 bloggers and translators, the organization aims to "aggregate, curate, and amplify the global conversation online" (<http://globalvoicesonline.org>). Global Voices partners with authors to produce relevant, region-specific blogs in countries all over the world. Readers can access blogs written on specific subjects like agriculture. Of course, many bloggers on Global Voices tend to be urban and more educated than rural farmers. As a result, the organization began an outreach project called Rising Voices. Twice a year, the initiative holds a microgrant competition to select new media outreach projects. Recipients of these grants teach ICT techniques to communities that are poorly positioned to take advantage of tools like blogging.

There are certainly constraints to blogging in developing countries, especially rural areas; lack of electricity and low bandwidth are typical challenges. Blog tools are often in English, which limits who can use them, but the number of blog tools is expanding quickly. A number of providers like Wordpress, Google, and Aeonity offer free hosting and troubleshooting help for users. In fact, Weebly has a "drag

**IMAGE 13.7:** ICT Can Support Well Water Infrastructure Monitoring



Source: Curt Carnemark, World Bank.

and drop” editor so users can simply drag pictures and text onto their webpages.

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## Module 14: ICT FOR LAND ADMINISTRATION AND MANAGEMENT

ROBIN MCLAREN (Know Edge Ltd) and VICTORIA STANLEY (World Bank)

### IN THIS MODULE

**Overview.** This module identifies how ICT is more effectively supporting land markets and land reform activities, explores how more open approaches to Public Sector Information policy and innovative business models are making investments in ICT more sustainable, recognizes how ICT is an essential component of good governance, and details how interoperable ICT approaches to Land Information Infrastructure extend and integrate land administration services into the wider e-government arena.

**Topic Note 14.1: Supporting Land Markets with ICT.** Innovative and competing public and private property information services help buyers and sellers make intelligent decisions and allow policy makers to monitor market trends. These services also provide transparency and thereby discourage corruption.

- **ICT-based Property Value Estimate Information Services**
- **European Land Information Service**

**Topic Note 14.2: ICT Support for Land Management, Planning, Development, and Control.** Governments have established e-planning portals that allow citizens to access land-use control information, including access to zoning development plans and planning regulations. Public Participation GIS is being applied to participatory community planning to help neighborhood community groups and individuals use mapping and spatial analyses in community development and public participation.

- **E-Planning Portal in Denmark**
- **Virtual Landscape Theatre**

**Topic Note 14.3: ICT Support for Land Reform.** Using GIS to manage the spatial complexities of managing, analyzing, deriving, and communicating new, fair distributions of parcels has become an important tool for land reform. ICT supports the entire life cycle of land reform, from identification of current owners and patterns of tenure through analysis of reallocation options to the provision of registration.

- **Sweden's Large-Scale Land Consolidation Projects**
- **Turkey Land Consolidation Project**

**Topic Note 14.4: ICT Support of Good Governance in Land Administration.** ICT significantly supports good governance in land administration by facilitating open, transparent access to land records for all. These records can now be obtained through mobile phones, either through web- or SMS-based information services, greatly improving the outreach of land administration services, especially to groups that were long excluded from such information. The World Bank's Land Governance Assessment Framework offers guidance on the role of ICT.

- **ICTs and the Land Governance Assessment Framework**
- **Improving Public Access to Land Administration Services in Indonesia**

(continued)

**Topic Note 14.5: Public-sector Information Policy Supporting Effective ICT-based Information Services.** Land administration agencies and policy makers must ensure the maximum exposure and reuse of land administration information in the public domain. Progress has been made in making copyright, licensing, and pricing arrangements as simple and consistent as possible. Governments have also developed Open Government Licenses, which provide a single set of terms and conditions for anyone wishing to use or license government information.

- **A Policy Framework to Support Lao PDR's National Land and Natural Resource Information System**
- **Vietnam's One-Stop Shop for E-Government Services**

**Topic Note 14.6: Sustainable Funding of ICT in Land Administration.** A number of countries have found that land registration systems and even the cadastre can finance themselves. Public-private partnerships are also being employed to spread the cost of development and maintenance more equitably among those who benefit from the systems.

- **ICT Derived Efficiencies in Kyrgyz Republic Benefit Land Office Staff**
- **Philippines—A Public-Private Approach to ICT Financing and Risk Sharing**

**Topic Note 14.7: Designing Scalable and Interoperable Land Information Infrastructures.** Data model standards help ensure that land information can be easily ported across generations of ICT, open interoperability standards allow same-generation systems to work well with each other, and web services provide a standard means of interoperation among diverse software applications.

- **Combining Open-Source Solutions with Open Geospatial Consortium Standards**
- **Kyrgyz Republic's Open-Source Strategy and GIS Solutions**
- **Social Tenure Domain Model**

## OVERVIEW

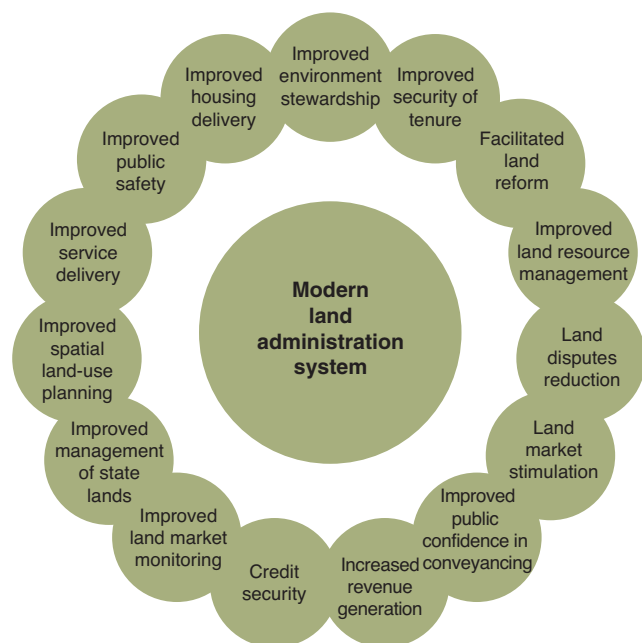
Good land administration creates accurate, accessible, interoperable, timely, secure, and complete information about land and property in an affordable and efficient way that promotes confidence between the public, its commercial enterprises, and government. The records commonly held for land administration are also the foundation for integrated spatial information systems that link multiple users in the provision of government services by electronic means (e-government). They often provide the key data needed by all local and central government organizations and, to a lesser extent, by the public.

Figure 14.1 illustrates examples of the benefits of good land administration (UNECE 2005), ranging from guarantee of ownership and security of tenure through support for environmental monitoring to improved urban planning, infrastructure development, and property tax collection. Agriculture productivity, though not explicitly featured, is also greatly increased where good land administration practices exist.

Where countries lack robust and tested land administration systems, significant dysfunctions can occur, including the following examples:

- Weak land markets, conflicts over ownership, land grabs, and social disharmony.
- Reductions in yields, diminished food security, negative impacts on the environment.
- Lack of an essential policy tool that can assist governments in creating a civil society with democratic norms.
- Reduced potential for economic growth as the large amount of capital typically invested in real property is never formalized and integrated into the financial system.

ICT has an increasingly fundamental role to play in improving the operation of land administration and in making information services more readily available in support of land markets and urban and rural economic development. ICT can provide innovative outreach channels to the poor and disadvantaged to ensure that land administration and its benefits are more inclusive and can be pro-poor. Significantly, land administration information is providing fundamental reference information, such as property addresses and transportation networks, which enables the integration of wider spatial information systems managed by the public and private

**FIGURE 14.1:** Benefits of Good Land Administration

Source: Adapted from UNECE 2005.

sectors. This integration facilitates the building of spatial data infrastructures (SDI) linking multiple users and allowing the delivery of a wide range of integrated e-government services. (See <http://inspire.jrc.ec.europa.eu/> on the Europe-wide SDI program; <http://www.anzlic.org.au/> on Australia-New Zealand SDI; and <http://www.fgdc.gov/nsdi/nsdi.html> for US SDI information.)

This is an unprecedented moment for ICT in support of land administration and management as geospatial information improves and increases worldwide. The three core ICT technologies for land—the Internet, global navigation satellite systems (GNSS), and geographic information systems (GIS)—are converging and creating huge opportunities to manage land and property using ICT in much more thorough, inexpensive, and effective ways. It is still early in this process, and most countries are not fully prepared to take advantage of ICT and this convergence in technology, nor are countries fully ready to embrace the bottom-up potential of the emerging technology. This module provides some guidance and examples of how some jurisdictions are increasingly taking advantage of the new technology.

### Elements of Land Administration

Land administration has been defined by the United Nations Economic Commission for Europe (UNECE) as “the process

of determining, recording, and disseminating information about ownership, value, and use of land, when implementing land management policies” (UNECE 1996). Typically it is the formal governance structures within a nation that define and protect rights in land. Recognition is growing, however, that nonformal or customary institutions can and should play a role in defining and protecting land rights and that they need to be included in the ongoing development of land administration. The following sections describe the elements of land administration systems, with an emphasis on the range of information they encompass.

### Land Tenure Systems

The term land tenure refers to the way in which land rights are held. There are formal systems, laid down in statutes, and informal systems conducted in accordance with custom and tradition. All formal systems are subject to state-imposed restrictions such as planning legislation that limits the use rights associated with any area of land and restriction of ownership by foreigners (McAuslan 2010). The most common formal systems include what in some jurisdictions is called “freehold” or “fee-simple” or “full title” (*titulo o dominio pleno*), which represents the fewest restrictions on the landowner’s ability to do what he or she likes with the land, and “leasehold,” under which these rights are held for a limited period.

Informal systems operate in traditional areas and where formal systems have not been put in place or have broken down, as in squatter camps and other informal settlements. Traditional systems often impose restrictions on the disposal and use of land, which according to custom is usually regarded as belonging as much to deceased ancestors and future generations as to the present stewards of the land and therefore not a commodity that is open to market forces. Customary law is, in general, not written but established through long usage (Delville 2010). Sometimes, as in Uganda, customary law is recognized in formal statutes, although in many countries this is still not the case. The inclusion of informal systems of land rights is a challenge for land administration agencies.

### Land Registration

A major component of any land administration system is a record of landownership. Because of the uncertainties that can arise over who owns the land and under what conditions, in many societies it became customary to document the transfer of land rights in the form of legal deeds and

certificates. To provide additional security, official copies of these records were kept in deeds registries, or what in some countries are called land books. Historically, the deeds system was inefficient in that it did not prove who the owner was; it merely showed that two parties had exchanged a deed of sale. Today, many deeds registries and land book systems have been computerized, with data on land rights linked to records of the land parcels, their addresses, and owners.

To improve on the deeds system, two versions of what is known as a land titling or title registration system emerged in the nineteenth century, one in England and the other in Australia (where it was known as the Torrens system). A title is a proof of ownership. In both countries the basis for the register became the parcel of land, to which the name of the owner was attached. Given the address or other reference to any particular parcel, plot, or lot of land, one could look for it in the register and find the owner and vice versa. The certificate issued when this process is complete is known as a certificate of title and is normally guaranteed by the state.

Although quick and easy to operate, registration of title does assume that there has been a survey of the land so that its physical location, size, and shape can be described. It also assumes that prior to compiling the register, the true owner of the land and the nature and extent of the land rights have been established. The process for doing this is known as adjudication, which is a legal procedure that may entail investigations on the ground. Survey and adjudication can be time-consuming, expensive processes. Once the information has been compiled, however, the mechanics of handling the records can be fully computerized, and the system can operate cheaply, efficiently, and effectively.

The registration of deeds, land book systems, and registration of title are often referred to as “land registration.” While many registration systems focus on the private ownership of land, either in outright ownership or in long-term leasehold, they can include other forms of tenure such as land-use rights and shorter-term leases. These variations are important for countries where immovable property is technically “owned” by the government but where there are privately held land-use rights. As a result of modernization and computerization combined with rigorous quality control procedures, the distinction between these systems is now minimal, each mirroring the conditions on the ground, no longer requiring investigation of the history of a parcel and giving in effect a guarantee of ownership.

### *The Cadastre*

Records of land parcels began to be collected long before the invention of land titling. They were known as cadastral records and were designed principally as an aid to tax collection. They identified each taxable parcel of land with the name of the taxpayer on a cadastral map. The taxpayer is not necessarily the owner, and hence in much of Europe there was and still is a dual system: The data on land ownership appear in land books under the ministry of justice and are often managed by the courts, whereas the data on location, shape, and size of parcels are registered in the cadastre, usually managed under the ministry of finance. In the great majority of countries in Latin America, registries are under the judiciary, whereas cadastres are under the executive.

The original meaning of the term cadastre has been extended to include a variety of land records, with the land parcel, lot, or plot at the heart of the systems. For example:

- **Fiscal cadastre**, a register of properties recording their value.
- **Juridical cadastre**, a register of parcels of land according to their ownership or use rights.
- **Land-use cadastre**, a register of land use based on individual parcels.
- **Multipurpose cadastre**, a register that includes many attributes of land parcels and addresses the wide range of issues identified in figure 14.1.

Increasingly the cadastral and land book records are computerized and linked electronically, though not necessarily institutionally. In some cases—as in the Netherlands, where land records are integrated fully under the Dutch Kadaster—one organization manages both types of record. Similarly in Albania, Czech Republic, El Salvador, Honduras, Indonesia, Lao People’s Democratic Republic (PDR), Lithuania, Romania, Serbia, Slovakia, and Thailand, one agency—typically the department of lands or a cadastre agency—undertakes base mapping for cadastral purposes, development of standards for adjudication, cadastral surveying, registration functions, and policy coordination. Many other countries, such as Croatia and Slovenia, have retained separate organizations.

In Latin America, a lack of institutional integration is often regarded as the single most significant challenge to achieving ICT improvements to land registration. Land registration services are often a major source of revenue for the judiciary, who are often extremely autonomous and reluctant to hand over their earnings to another part of government. In some cases, such as Brazil and Haiti, these services are carried out by private

agents who are similar to, but more powerful than, notary publics and are equally reluctant to surrender their autonomy.

### ***Land Valuation and Taxation***

As noted, the cadastre has been most commonly used to support a system of land and property taxation. A land- and property-based tax is cheap to administer, transparent, hard to avoid, and imposes political accountability at the local level. In many countries, taxes on land and property provide a significant source of revenue for local government, accounting, in some cases, for as much as 40 percent of all subnational tax revenue.

Land is both a cultural and an economic asset. In an economic sense, its value is determined from market information in countries where formal land markets exist. Land information infrastructures and GIS technology are used increasingly to support valuations and mass appraisals in which comparisons can be made between all properties in a country. Aside from recording and transmitting relevant information, ICTs can provide transparency, leading to a reduction in the amount of fraud that can occur. Much of the cost of compiling land registers can be more than recouped from enhanced tax collections.

### ***Land Management and Development Control***

Many land administration systems are regarded as a support to land management and planning/development control, which are seen as separate functions. Others see land management as the end product of a process in which the resources of land are put to good use, and hence, an integral part of land administration. Often land administration officials will check and record building permits and notify the relevant authorities when regulations are breached. With the growth of the multipurpose cadastre and extensions to the use of the information recorded in land administration systems, the line of responsibility between agencies is becoming blurred. In land consolidation projects, for example, where the shape and size of parcels are redesigned, close cooperation between the recording agencies and the implementing agencies is essential and is helping to make land consolidation part of the wider rural development agenda. ICT has a crucial role to play in sharing and analyzing land information among agencies and in communicating and testing change scenarios with the citizens involved.

### ***Location Information Infrastructure***

ICT is an umbrella term that encompasses all forms of computing, information technology, Internet, and

telecommunications. In the context of land administration, the terminology may be even a little broader and also covers surveying and positioning technology, including global navigation satellite systems (GNSS) such as the Global Positioning System (GPS); measuring equipment such as total stations and electronic theodolites; Light Detection and Ranging (LiDAR), digital aerial photography, and satellite data acquisition systems and imagery processing; GIS; land data records management systems built on relational database management systems, workflow management systems; wide and local area networks; wireless technology; data storage systems, including data warehouses and Data as a Service on the Internet; and web services delivered by Internet. The diversity of uses for ICT in land administration is remarkable.

The evolution of ICT and location information infrastructures (also known as land information systems or services) in underpinning land administration is illustrated in figure 14.2. The initial phase focuses on large-scale programs for capturing data by scanning records or conducting field surveys, with corresponding computerization of internal land administration processes. The next series of phases are all outward facing, improving the level of customer services and increasingly providing online services. Initially this effort involved providing extranet services to key customers; as Internet services matured, they supported an increasing number of information services and e-transactions. Finally, as interoperability among government agencies improves, radical changes and efficiencies will be achieved in delivering e-government services based on land administration.

Several key ICTs support land administration. Database management systems, usually of the relational variety, provide robust and secure repositories to manage the significant volumes of land information (textual and geospatial) in a distributed environment and to support efficient searching and querying of the information. The associated digital record management systems efficiently store and retrieve raster scanned documents such as paper deeds. Lastly, GIS supports the capture and editing of geospatial information such as parcel boundaries and interfaces to the land information repositories and wider national spatial data infrastructures (NSDI) to support spatial analysis and visualization, including a map-based interface for web information services.

### ***Land Administration Supporting Business***

Since 2005, 105 economies have undertaken 146 reforms making it easier to transfer property (table 14.1 provides



**FIGURE 14.2:** Evolution of ICT in Land Administration

Year	ICT in land administration	Surveying and data capture
1970	Manual	Traditional surveying
1980	Internal data capture and computerization DBMS/DRMS	Scanning and digital records management Total stations
1990	Internet-based information services	GNSS
2000	Transactions with customers over Internet	High-resolution satellite imagery and digital aerial photos
2005	Interoperability with other government agencies (e-gov/NSDI)	Open data sources
2010	Web and mobile-phone-based services and e-transactions with customers and suppliers	

Source: Authors.

Note: DBMS = database management system; DRMS = digital record management systems, NSDI = national spatial data infrastructure, and GNSS = global national satellite systems.

examples of countries ranked by the ease of such transactions). Globally, the time to transfer property fell by 38 percent and the cost by 10 percent. The most popular feature of property registration reform in those six years, implemented in 52 economies, was lowering transfer taxes and government fees. This reform reduced the cost by 3.1 percent of the property value on average. Sub-Saharan Africa was the most active, with 22 economies lowering costs. The second most popular feature, implemented in 32 economies, was streamlining procedures and linking or improving agencies' systems to simplify registration. These measures reduced interactions between customers and agencies—saving two procedures on average—while maintaining security and controls.<sup>1</sup>

Worldwide, 61 percent of economies have an electronic database for encumbrances, including almost all Organisation for Economic Co-operation and Development (OECD) high-income and Eastern European and Central Asian economies. But in Sub-Saharan Africa and South Asia, more than 80 percent retain paper-based systems. This lag in automation makes a difference. In economies with

computerized registries, transferring property takes about half as much time. Twenty-nine of 30 high-income OECD economies have electronic registries, and 85 percent allow online access to information on encumbrances, either for all or for professionals such as notaries. Eleven, including France, the Netherlands, and New Zealand, offer electronic registration.<sup>2</sup>

**TABLE 14.1:** Where Registering Property Is Easy and Where It Is Not

MOST BUSINESS FRIENDLY	RANK	LEAST BUSINESS FRIENDLY	RANK
Saudi Arabia	1	Angola	174
Georgia	2	Guinea-Bissau	175
New Zealand	3	Liberia	176
United Arab Emirates	4	Belgium	177
Armenia	5	Eritrea	178
Belarus	6	Nigeria	179
Lithuania	7	Timor-Leste	180
Norway	8	Micronesia, Fed. Sts.	181
Slovak Republic	9	Marshall Islands	182
Azerbaijan	10	Brunei Darussalam	183

Source: Doing Business database, <http://www.doingbusiness.org/data/exploretopics/registering-property>.

Note: Rankings are the average of the economy's rankings on the procedures, times, and cost to register property.

### Emerging Trends in ICT for Land Administration

Recent advances and convergence of technologies applied to land administration are creating new opportunities to generate greater efficiencies in delivering land administration services, to reach out to excluded segments of society, and to integrate land administration information into the wider e-government arena. This section summarizes some emerging opportunities.

#### Surveying and Satellites

Advances in global positioning, mapping, and imaging technology present some of the most promising opportunities for ICT to support land administration services. By 2015, multi-constellation GNSS will provide around 100 satellites for global positioning. These new GNSS signals and constellations will provide better accuracy and reliability, leading to positioning to within centimeters in a mobile environment. This capacity opens up the potential for GNSS technology to reach a wider range of stakeholders, including citizens.

<sup>1</sup> "Registering Property." Doing Business, <http://www.doingbusiness.org/data/exploretopics/registering-property>, accessed May 2011.

<sup>2</sup> Ibid.

The costs of surveying (and the time it takes) have prevented many poor communities from being surveyed—the cost of the survey surpassed the value of their land. Fortunately, this situation is changing. National mapping agencies are introducing Continuously Operating Reference Stations, networks of geodetic-quality GNSS receivers that make data available for precise positioning for national survey and mapping programs, including cadastral surveying. This positioning infrastructure increases the efficiency and consistency of cadastral surveys and has multiple applications. A new generation of ground-based LiDAR, mounted on vehicles, is also emerging as next “big” advance in surveying. Boundary features can be captured very quickly to an accuracy of around half of a centimeter, just by driving around. Normally such precision is not required, although some surveyors may claim that it is necessary. However, the location of physical features does not necessarily coincide with the location of legal boundaries, which means adjudication supported by human interpretation is still needed and can be costly and time consuming.

Finally, although aerial photographs have been used in recording boundaries since the 1950s (in Kenya, for example), digital cameras, high-resolution (less than 1 meter) satellite imagery, digital terrain models, and new software techniques are increasing the availability of reasonably priced orthophotos, presenting opportunities for more cost-effective, efficient, and participatory ways of registering the boundaries of land rights. These approaches have been used successfully in Ethiopia (Lemmen and Zevenbergen 2010), Rwanda, Thailand, and Namibia. In Namibia, however, the systematic registration of communal land rights was 32 percent cheaper than surveying with handheld GPS (Kapitango and Meijs 2010).

### ***Information Transparency***

Under governments’ transparency, accountability, and citizen participation agendas, public-sector information policy is changing (see Module 13 on governance for more examples of e-government interventions). Increasingly, public-sector data sets once intended for internal consumption, accessed for a fee, or restricted owing to security concerns are provided as open data, free to be used for other purposes, under “data.gov” initiatives (see <http://www.data.gov.uk/> for an example). Although few countries currently release land ownership and rights information under their open data initiatives, primarily because of concerns related to revenue generation and privacy, it is just a matter of time until the wider economic benefits are understood by more countries. The private sector already makes much mapping available

for free; examples include Google (<http://earth.google.com/> and <http://maps.google.com/>) and Microsoft (<http://www.bing.com/maps/>). Prior to investing in ICT to update land administration services, it is essential that legislation and policies surrounding information transparency and access are updated, wherever possible. This step will ensure more-efficient investments in ICT and delivery of effective land administration services by removing many current restrictions, such as restrictions on involving foreign firms in validation or requirements that all orthophotos must be produced within a country.

### ***Integration with Wider Agendas for E-Government and National Spatial Data Infrastructure Initiatives***

Most countries are developing initiatives to widen access to and use of geospatial information, but their maturity and success vary across the regions. In Latin America, for example, Chile, El Salvador, and Honduras are more advanced than others. A good example of this type of initiative is Australia and New Zealand’s Spatial Information Council, which is responsible for coordinating the collection and transfer of land-related information between the different levels of government; and promoting the use of that information in decision making. NSDIs involve the cooperation of public and private organizations to implement interoperable technologies, data standards, and business approaches within a policy framework that facilitates the sharing and reuse of geospatial information (Williamson et al. 2010). This effort normally supports the discovery of geospatial information at first but eventually supports web-based services based on that information—in other words, Data as a Service. Over time, the myriad versions of similar data sets will be harmonized to generate and to reference common base themes in the data, such as transportation networks, property addresses, administrative boundaries, and land ownership, substantially increasing interoperability. Land administration information is a fundamental component of NSDIs. Participation in NSDIs promotes the culture shift for government agencies to share interoperable land and property information and leads to more integrated and effective e-government services for land administration, as experienced in Vietnam (Warnest and Bell 2009d). GIS technology provides the framework within NSDI to manage, integrate, and spatially analyze multiple sources of geospatial information.

### ***More Sources of Open Data, Both Formal and Crowdsourced***

Crowdsourcing is the term for citizens contributing content, and its roots lie in the increasing convergence of three

phenomena: (1) the widespread use of GPS and image-based mapping technologies by professionals and expert amateurs; (2) the emerging role of Web 2.0, which allows more user involvement and interaction (for example, “wikis,” which allow any number of interlinked web pages to be created and edited via a web browser, and standards-based authentication processes to contribute information to the web); and (3) the growth of social networking tools, practices, and culture. Within land administration, there is growing recognition that the current surveyor-based paradigm is not scalable to meet demand. Around 70 percent of land and property is unregistered, and this figure is increasing as urbanization generates ever-higher levels of informal settlements and slums. One option to fill this gap is for surveyors to partner with citizens and communities to provide crowdsourced land administration information. For example, community-supported mapping recently occurred under the OpenStreetMap (<http://www.openstreetmap.org/>) initiative in Nairobi’s Kibera neighborhood, one of Africa’s largest slums. (See “Audio Slideshow: On the Map,” BBC, <http://www.bbc.co.uk/news/technology-12164081>.) Different levels of authentication can be applied to crowdsourced data, from simple conflict checks to legal validation, to ensure citizens obtain some level of security of tenure along the continuum of rights.

### ***Free, Open-Source Systems***

Proprietary software has traditionally supported land administration systems, even though they have recently embraced open standards. Over the past decade, however, free, open-source systems have come to prominence. Licenses for these programs give users the freedom to run the program for any purpose, to modify the program, and to redistribute copies of either the original or modified program without having to pay royalties to previous developers. The promise of open-source software is better quality, higher reliability, more flexibility, lower cost, and an end to proprietary vendor lock-in. (See the Open Source Initiative, <http://opensource.org/docs/osd>, and the Open-Source Geospatial Foundation, <http://www.osgeo.org>.) The development of systems based on open-source software also encourages local capacity building. The obvious advantages of open-source development can be seen in the emergence and success of major projects like the Apache HTTP server (now running more than half of all websites globally).

The use of open-source solutions for land administration will increase in developing countries that cannot afford the high costs of licensing commercial solutions. A cooperative effort among IT experts to foster open-source software development and accessibility is led by FAO with support from New

Zealand’s University of Otago. The initiative, involving the extension of the Open-Source Cadastre and Registration software development concept (FAO and FIG 2010) and its follow-on project, Solutions for Open Land Administration, will eventually offer governments a choice between licensing often restrictive and costly proprietary software and promoting the development of free, nonproprietary applications and communication software. (See the Solutions for Open Land Administration, <http://www.flossola.org>).

Open-source GIS solutions are being implemented in land administration in Bavaria, Bosnia and Herzegovina, Cambodia, Ghana, the Kyrgyz Republic, and Samoa, and in Solothurn, Switzerland. They underpin the initial prototyping of the Social Tenure Domain Model (Lemmen et al. 2007). Open-source land registration and cadastral solutions are likely to succeed in countries where the government embraces the idea of using open-source software for its information systems and supports its use in education and research. Such a national context makes it easier to find local ICT specialists who are familiar with free, open-source products and form the human resource base to maintain systems.

Although the total ownership costs, including license, maintenance, and support costs will probably be lower than costs for proprietary systems, the costs are not to be underestimated, especially the costs surrounding software integration. Open-source software may make maintenance easier (problems can be solved without external support and with advice from international user and developer communities) and cheaper (the absence of license fees releases funds to maintain and further develop the system). The use of free, open-source software will not change the fact that a proper business plan is the key requirement for introducing ICT systems for land administration (FAO and FIG 2010).

### ***Risk-Sharing Relationships Between Clients and Suppliers***

Under the traditional approach to investing in ICT to support land administration, the client assumed all of the risk: The client issued a tender for ICT and selected the best value proposition; the chosen supplier would deliver and provide support for the ICT solution. If the delivered solution defined by the client is delivered satisfactorily to specification but is subsequently found to be inappropriate or ineffective in operation, then the fault lies solely with the client. Under a number of new partnership arrangements, however, risk is shared more equitably. For example, the Government of the Philippines is engaging the private sector under public-private partnerships and outsourced service provision models to build computerized land information infrastructure,

applications, and land-related e-services. A private consortium is delivering a Build/Own/Operate system that government will fully own after an agreed “concession” (payback) period is concluded (Warnest and Bell 2009c). These private sector delivered solutions may increasingly consist of some open-source components.

### ***Cloud Computing for Land Information Infrastructure***

Cloud computing is a set of services or resources offered by different providers through the Internet. Characteristics of the cloud are (1) the cloud provides storage space for your files; (2) the cloud provides software to process files (word processor, photo editing, e-mail, contact management, calendar); (3) the cloud automatically backs up files, and copies of files are stored in different geographical areas; and (4) data can be accessed by multiple users at the discretion of the creator of the data. Within the land administration context, an agency could place its entire land information infrastructure, including data, on the cloud and directly manage and maintain it over the Internet through web services. Customers would also access it over the Internet and be unaware that it was on the cloud. The cloud is the next computing paradigm, and many land administration agencies will start to adopt it over the next five years, once confidence in security and portability is built.

The main advantages of this approach are that clients can outsource the burden of maintaining servers and applications, scale systems up or down on demand, access their data and services from anywhere with an Internet connection, and substitute regular, predictable operational expenditures for occasional heavy expenditures on ICT (for servers, for example). Cloud computing requires a robust, high-bandwidth broadband connection to the Internet and has real benefits, but there are also reasons for caution. Risks include loss of service and data if the provider has downtime or goes out of business, regulatory problems when personal data are stored internationally, security concerns when users lose control of how their data are protected, one-sided service agreements that give users little redress in the event of a calamity, and lock-in dependency on proprietary cloud applications (Thompson and Waller 2011).

### **Extended Scope of Land Administration Solutions**

In many countries, land administration services have been notoriously difficult for some segments of the population to reach and have focused exclusively on supporting formal land rights. ICT has changed this scenario through the rise

of the Internet and mobile phones, the implementation of fully web-based conveyancing, more local participation in the planning and development dialogue, and support for customary land rights.

### ***Web- and Mobile Phone-Based Information Services***

Online access to information services related to land administration is expanding with the expansion in broadband infrastructure and the use of mobile phones to deliver Internet and SMS-based services; Indonesia is one example of a country that had taken this approach (Warnest and Bell 2009a). Agencies that previously excluded many people, especially in rural areas, are becoming more open and rapidly building public trust through the provision of simple, transparent, and accessible services.

Mobile phones have made a bigger difference to the lives of more people, more quickly, than any previous communications technology, and their use is growing most significantly in developing countries. Mobile phones are connected to phone networks at ever-higher bandwidths, which has opened real-time access to the Internet and information services. For those living outside of the main cities, mobiles may be their only means of accessing the Internet.

### ***E-Conveyancing***

Many land administration agencies are transforming paper-based conveyancing systems into a fully electronic procedure, using electronic documents, applications, and signatures. (Developments in England and Wales are described at <http://www.landreg.gov.uk/e-conveyancing/>.) The aim is to reduce the delays and anxiety that can be experienced in current land and property transactions. Fully electronic conveyancing procedures are enabled by encouraging open access to property information and providing a mechanism for all payments relating to the transactions in a chain of property transfers to be paid simultaneously and electronically, with automatic registration on completion. The implementation of this kind of system assumes that stakeholders have the capability to support all aspects of their transactions electronically, however.

### ***Fostering Citizen and Community Participation***

Greater involvement of citizens in a dialogue with planning officials and property developers around development opportunities and development control should legitimize political decision making and ensure that it is combined with responsibility for the financial, social, and environmental

**IMAGE 14.1:** Women Use GIS Instruments to Map Land and Measure Soil Qualities



Source: Work funded by AgCommons, a program executed by the CGIAR.

consequences of development. Many governments have established e-planning portals that allow citizens to access information related to land-use control, including zoning development plans, planning regulations, and general land-use information. A new generation of web-based GIS initiatives in public participation provides citizens with tools to analyze proposals, suggest and evaluate alternatives, and frame an online discussion of alternatives (Zhao and Coleman 2006) (image 14.1).

#### **Support of Social and Customary Tenure**

Until recently, land information infrastructure supported only the management of formal land rights, but a recent initiative led by UN-HABITAT and the International Federation of Surveyors (FIG) has developed a Social Tenure Domain Model (Lemmen et al. 2007), which was piloted in Ethiopia. The Social Tenure Domain Model is a specialization of the Land Administration Domain Model, which is in its final stage of reaching the status of a global International Organization for Standardization (ISO) standard (Lemmen and Zevenbergen 2010). (See [http://www.gdmc.nl/publications/2010/Spatially\\_Enabled\\_Society.pdf](http://www.gdmc.nl/publications/2010/Spatially_Enabled_Society.pdf).) The inclusion of social tenure support in land information infrastructures will result in more secure tenure for many, and it directly supports the UN-HABITAT “continuum of land rights” approach, which advocates registering a range of informal rights rather than formal rights alone (UN-HABITAT 2008).

#### **KEY CHALLENGES AND ENABLERS**

Work on improving land administration systems goes back many years. As a result of all this activity, a number of lessons have been learned, as discussed in the following sections.

***A legal framework is needed to underpin ICT-based land administration services.*** As ICT and e-government services are introduced into land administration, the legal framework underpinning land administration needs to change to allow for electronic signature and new electronic services, such that computerized information/records are accepted as being

legal and valid. Significant legal changes will also be required to support the recognition and inclusion of customary tenure within the formal land markets and land tenure systems. This transition needs to be well planned, as passing new legislation can be time consuming. The capacity within countries to implement legal framework reforms is also necessary and may affect the design of legal reform strategies.

***It is necessary to create a land policy framework to let the land administration function more effectively.*** Land administration products and services must be aligned with a country’s current needs. These requirements must be defined in land policy, describing how governments intend to deal with the allocation of land and land-related benefits and how land administration systems are supposed to facilitate the implementation of the policy. Such implementation includes the rules for land tenure and land tenure security, the functioning of the land market, land-use planning, development, land taxation, management of natural resources, land reform, and so on. The formulation and subsequent monitoring of land policies requires access to appropriate land information. ICT in land administration has a key role in supporting and informing policy makers.

***The poor do not necessarily benefit.*** Computerization of land administration without outreach to otherwise disconnected segments of the population can further disadvantage the poor. However, innovation in ICT and modeling

of customary tenure is supporting outreach to rural areas, for instance in Indonesia. In many countries, although the middle classes, entrepreneurs, and rich have benefited from relatively easy and cheap methods to transfer land and secure title, the poor have been excluded by the costs and, more often, insufficient understanding of the benefits. Hardly anyone disputes the need for secure tenure and that citizens in rural and urban areas should have guaranteed rights to the land that they legitimately use. Not everyone, however, agrees that state-backed certificates of title provide the best solution. Even where land titling is required to support a formal land market, titling may benefit the rich but not the poor. Some form of land titling along the continuum of land rights may be necessary to bring about all the potential benefits that land administration can provide, but land titling alone will not suffice to do so. Other institutional arrangements and social and economic support need to be in place.

**Modernizing land administration can be challenging.**

Significant legacy issues often exist, and professional and political biases are normally encountered. These can have serious detrimental effects on the modernization program unless the associated risks are understood and mitigated effectively. Here are some general principles in designing new land administration modernization programs:

- If there is a no possibility to reduce multiple agencies involved, focus on improving coordination among them with formal memorandums of understanding agreed.
- Begin the land administration change program with a business case and associated business cases to sustain it.
- Adopt an approach that uses the same land administration regime for urban and rural land, even if the institutions must be different. However, there may be variations in precision of cadastral surveys and development control standards, for example, between city centers and remote rural areas.
- Build in an effective and dedicated dispute resolution system that leaves the courts as a last resort.
- Try to ensure that the land administration system benefits all and that barriers to entry are low.
- If the existing data are in poor condition and decades out of date, there needs to be a plan and budget for data improvement and ongoing maintenance.
- Bring land professionals (surveyors, lawyers) into the process as partners and try to mitigate their inclination to lobby against introducing pragmatic change.

- Insist that the land administration change program has political support and a sufficient time horizon to deal with the existing problems.

**Existing problems with land administration information can greatly increase system modernization costs.**

The costs of implementing modern land administration solutions in countries of the former Soviet Union have been greatly reduced compared to others since they were starting with fewer legacy issues to contend with. In other regions existing land administration systems are being modernized with inherent problems that significantly increase the costs and time frames for implementation. One of the most serious issues is the poor quality of the data on immovable property with textual and geospatial data out of date. This can be further compounded by the number of land disputes in the courts, and the number of potential disputes that are lying dormant, which might be triggered by the process of adjudication. Simply eliminating the existing land administration system is usually not an option. The modernization program must be built around data upgrading and quality maintenance mechanisms, along with streamlined processes for resolving disputes, preferably through dedicated land dispute resolution structures. Automation by itself brings less transformative change in these cases, but can be the start of a long process of evolutionary improvement.

**Governments should accept and plan for high costs and long time frames.**

The implementation of a fully operational land administration system involves high costs and can take many years before the majority of properties are registered. For example, the early Thailand project involved loans of US\$ 183 million over 18 years, covering capacity building, surveying and mapping, and the high costs of early ICT solutions. More recent initiatives have been less expensive, especially when starting from scratch—where the cost impacts of poor quality of the data on immovable property and large numbers of active and dormant land disputes can be mostly avoided. In the Kyrgyz Republic, more than 2.5 million properties (more than 90 percent of private properties in the country) were entered into a new registry system under a seven-year project costing less than US\$ 12 million. A second four-year project costing about US\$ 7.5 million is currently making further improvements in the quality of the spatial data and overall ICT capacity, but the registry system is already highly functional. The process of surveying and registering each individual land parcel can be expensive and time consuming and, in some countries, open to corruption. There is a need to understand the local context, to assess existing judicial capacity, to prioritize implementation, adopt

the faster and more innovative ICT techniques, reduce red tape and multiple procedures, and engage communities in the process. Changes in ownership due to transfers or inheritance must be undertaken at the same time as new titles are being brought into the registers, so that as the project progresses, more staff can be taken off first registration and put onto record maintenance. Certificate of Title holders do not necessarily report changes, for instance, in areas where customary tenure still operates alongside the formal title system. Failure to carry out record maintenance at the same time as new titles are being added will cause records to be outdated before the system is complete. Full-life costs of a land administration system must include its maintenance.

**Business models should support continual investment in ICT.** Business models for land administration systems must directly generate revenue, obtain guaranteed state funding, or share the financial investment and risk with the private sector to ensure that ICT is sustainably maintained and replaced. However, choosing the appropriate business model is not easy, as it may change over time as the land market matures. Guarantees of funding over the long term are unlikely from governments. The generation of revenue depends on information policies for the public sector, which often restrict access to land information, thus reducing potential benefits and income streams as well as transparency. The recent financial crisis has precipitated crises in property markets around the world, significantly reducing the number of land administration transactions. The result has been reduced revenue streams for many land administration agencies and their ICT partners, leaving them in a financial predicament. Projects need to start with a strategy and a corresponding, robust business case, updating it as needed.

**Effective and mature land administration systems need computerization.** The driving rationale behind the increasing use of ICT for land administration is that the volume, complexity, and expected processing times of transactions can no longer be handled in an efficient and transparent manner through manual processes. The increasing demand by the general public and the private sector for open access to land administration information cannot be met without ICT. For example, ICT can support greater access to and sharing of information, improve data quality and completeness, increase security and transparency of operations and information (potentially reducing the risk of corrupt dealings in land), increase revenue generation around new services, and provide a basis for monitoring and evaluation.

**Planners should avoid the fallacy that ICT is a silver bullet.** ICT is an enabling infrastructure requiring appropriate, significant, full-life investment. Technology is changing rapidly, and what was appropriate five years ago may not satisfy today's demands. Land records may need to stand the test of time over centuries, so sustainable methods for archiving material are essential. Simply investing in new technology without understanding citizen, state, and commercial customer requirements; training staff; adequately testing and piloting solutions; building capacity; and simplifying the business processes may not achieve the desired effect and can lower staff morale and customer satisfaction. ICT may also fail to achieve some of its objectives if delivered in isolation. Although significant evidence has been gathered around the world that property titling and registration will enhance access to credit, it does not always do so (box 14.1).

#### **BOX 14.1: Outcomes of Automating Land Registration in Andhra Pradesh**

Did the gradual computerization of land registry systems across Andhra Pradesh's 387 sub-registry offices influence access to credit? Quarterly data on credit disbursed by all commercial banks over 11 years (1997–2007) were aggregated at the sub-registry office level and examined in light of the date when the land registry system shifted from manual to digital records. Computerization had no credit effect in rural areas but led to increased credit supply in urban areas. A marked increase of registered urban mortgages following computerization supports the robustness of the result. At the same time, estimated impacts from reduction of the stamp duty (a tax levied on legal instruments and transactions such as those involved in sales of land or mortgages) are much larger, suggesting that, without further changes in the property rights system, impacts of computerization will remain marginal.

*Source:* Deininger and Goyal 2010.

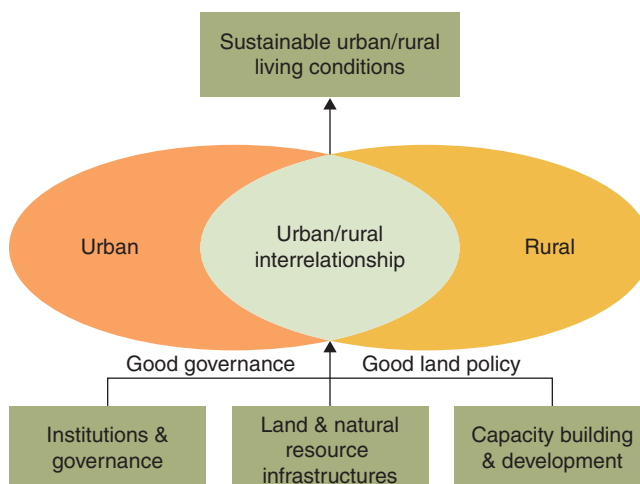
**Home-grown ICT solutions should be used where possible.** Within World Bank-financed projects in Europe and Central Asia, land information infrastructures have been developed either through large contracts bid out to the private sector or through building systems in-house. The internal approach has generally been more successful, because systems can be built in a modular form as agencies build their own capacity to use and manage the different modules and technology. Another advantage of in-house development

is that agencies can retain their own specialists (or use local companies) to amend and maintain the software rather than being locked into their supplier's source. Large internationally bid contracts have proven very difficult to manage, very time consuming to tender, and very slow to produce a functioning system. Moldova was one of the first in the region to establish a system developed by the cadastre agency's own staff with technical support, packaged software, and equipment financed by a World Bank loan. As it upgraded the system, the agency used part of the credit to hire international consultants for advice on the design and latest technology, yet the agency remained in the leading role (World Bank 2009a). Successful in-house development processes for ICT solutions have also been implemented in El Salvador and Honduras. Where in-house capacity is not available the work can be outsourced, but it is necessary to assess the capacity of land agencies to manage large contracts and the capacity of the private sector to handle the work. Another option is to complete the work incrementally as capacity is built.

**Professional and institutional compartmentalization must be eliminated.** Professional and institutional compartmentalization can lead to a fragmented view of land. Cooperation, especially between ministries responsible for land registration and those for the cadastre, often has been lacking. The lack of institutional cooperation reflects a lack of cooperation between professions, notably the lawyers and the surveyors, with each group taking a different view of the land and hence of priorities. Failure to take a holistic view and fundamentally change business processes leads to inefficiencies, higher costs, and time delays and ultimately heightens the cost and complexity of offering services to citizens. It is important to keep institutional arrangements as simple as possible (World Bank 2009a), because simplicity will enable more integrated and effective ICT and e-government solutions. Single cadastre and registration agencies work best, but they are not always politically feasible, and failure to agree on a single agency should not prevent projects from going forward.

**Land administration must operate efficiently in various settings.** From a land administration perspective, there should be a unified land system for both urban and rural areas (see figure 14.3). There should be one land law and one set of procedures to accommodate the needs of all regions in a country, including customary tenure in rural areas. Many rural communities, which make up the agrarian sector of a country, are geographically excluded from land offices, reducing levels of registrations in rural areas. Innovative ICT solutions are supporting mobile land offices (see IPS "Improving

**FIGURE 14.3:** Sustainable Development Needs Both Urban and Rural Inputs



Source: FIG 2004.

Public Access to Land Administration Services in Indonesia" in Topic Note 14.4) that can provide land administration services to remote rural communities (Warnest and Bell 2009a).

**Significant investment is needed in capacity building.** To realize the full benefits of ICT investments in land administration, countries must implement an effective program to build technical and management capacity across the public and private sectors and civil society. The public sector has significant issues with building the capacity of, and retaining, ICT professionals, especially in developing countries. Younger professionals, having received ICT training in government service, often move to the private sector where the short-term rewards tend to be higher. The rollout of ICT in land administration can strongly benefit from partnership with the local private sector and corresponding capacity building for professionals. Finally, government needs to coordinate awareness and capacity-building programs for the public, as an increasing number of government services are electronic. Human capacity to carry out and sustain reforms in land administration, including the management of large ICT contracts, is a long-term activity and should be built into project design from the start.

**Early investment is the key to positioning infrastructures to realize benefits in a wide range of land applications.** Historically, national triangulations (measurements) have formed the basis for consistency in land surveying. Today, sophisticated positioning infrastructures not only constitute the basis for land surveying and place-based land information in all its forms, but support a wide range of land applications.



The performance of land administration has proven to be enhanced strongly by applying appropriate ICT tools, including satellite imagery, aerial photographs, and GNSS. Early investments in this positioning infrastructure are crucial and significantly reduce the cost of data capture.

**ICT investments should be shared through interagency collaboration.** Too often, investments in ICT are isolated within projects and do not consider the possibility of the wider sharing and reuse of the resources. This narrow

perspective has led, for example, to multiple purchases of the same remote-sensing imagery by different agencies and the generation of multiple base maps with varying specifications. Apart from the simple collaboration approach, the adoption of interoperability standards and web services is promoting the implementation of shared services leading to the creation of national spatial data infrastructures (NSDI). This approach allows different agencies to access and use the same geospatial information, reducing the initial and continuing maintenance costs.

## Topic Note 14.1: SUPPORTING LAND MARKETS WITH ICT

### TRENDS AND ISSUES

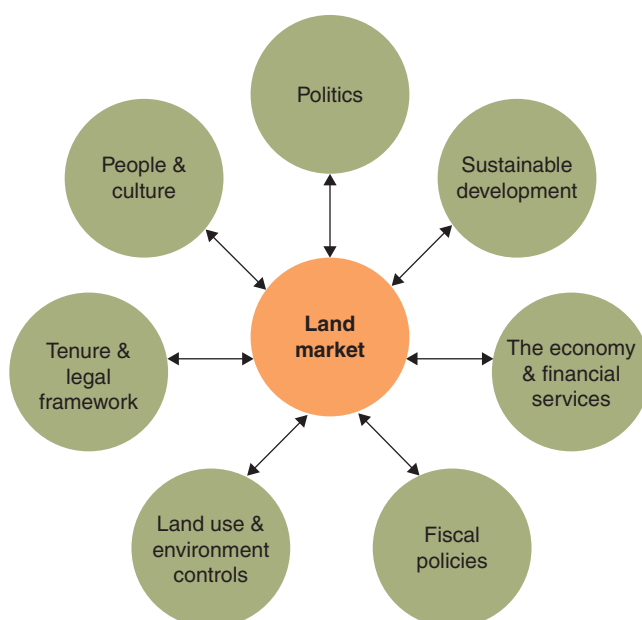
Land markets allow capital to be released and hence influence productivity and efficiency in agriculture and the level of investment in industry. An efficient land market underpins the capacity of banks and other financial organizations to lend money and for landowners to invest. The form and success of any land market depends on a number of external factors (figure 14.4). The relationships between these elements and the market operate in two directions: They influence the day-to-day activities within the market and they in turn are influenced by it. A successful market stimulates economic growth for individual landowners by releasing capital for investment in other fields. It can also benefit government by facilitating a

variety of forms of taxation on what is essentially wealth. The market can also encourage changes in land use and stimulate moves toward the optimal use of resources. In theory, market forces should result in the “highest and best use” of the land, although in practice other factors may prevent this outcome.

ICT plays a key role in providing information to stimulate, support, and monitor land markets. ICT can be used for the following purposes:

- Provide a single point of access to all the relevant land and property information.
- Record and analyze all land held by the state. In many countries the state is the largest landowner, but all too often it fails to manage its assets in an efficient and effective manner.
- Monitor the performance of property prices and make relevant information available to the public and private land and property companies, and policy makers. (For examples on residential property, see <http://www.zillow.com/> for the United States and <http://www.zoopla.co.uk/> for the United Kingdom.)
- Map the location of formal property sales.
- Compare property values as part of a mass appraisal for land and property taxation (UNECE 2002), and monitor changes in land use that may affect the taxable value of property.
- Provide transparency and thereby discourage corruption in the land market.
- Monitor the gender and other demographics of those taking part in land transactions to discourage prejudice against women and minority groups.

**FIGURE 14.4:** Influences on the Land Market

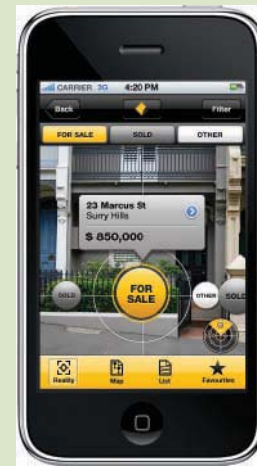


Source: Dale, Mahoney, and McLaren 2010.

Following the initial phase of computerization in land administration agencies, when land records are digitized and land

**BOX 14.2: Augmented Reality in Real Estate Marketing**

Smart phones deliver innovative location-based services for mobile real estate marketing. Using a smart phone, a person can walk up to the front of a house for sale, aim the phone's camera at it, and within seconds view and capture all the information about the real estate listing. The viewer can see pictures of the property, watch a video walkthrough of the property, browse information about the property (such as the selling price), email the information, and contact the listing agent. This kind of mobile marketing is achieved using an augmented reality browser such as Layar (<http://www.layar.eu/>). The mobile phone opens a window into the virtual real world where you can directly point at features and obtain the associated information.

**Example of Augmented Reality in Real Estate Marketing**

Source: McLaren 2010; source for figure, <http://buildar.com/>.

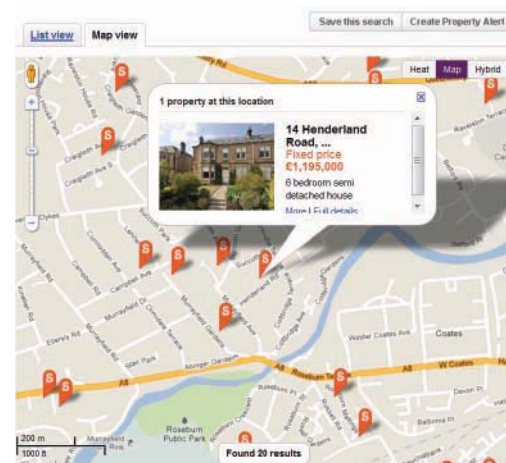
and property transactions supported, land administration agencies normally start to provide information services on land market activities and trends, such as statistical trends in house prices by geographical region. In many countries this land and property information is then made available to the private sector for other uses, either under a chargeable license or free. The release of this information usually requires amendments to public-sector information policy and associated legislation. Once the information is in the public domain, the private sector innovates and starts to deliver new information services to the land market. These services include locating a property to buy or rent in a specific area, identifying the price paid for properties sold in an area of interest, estimating the market value of a property, and receiving an e-mail or SMS alert if a property of a certain type, cost band, and location comes on the market. Some information services encourage owners of properties to enter more detailed information about their properties so that more accurate valuations can be estimated. GIS technology is also used to determine the amenities in an area of interest to support property-buying decisions. These applications are increasingly available on mobile phones, and some are starting to use augmented reality, in which a user can point the device at properties and obtain corresponding information (see box 14.2). These innovative and competing public and private information services reflect an open, transparent, and competitive land market that needs to be supported by effective ICT within land administration.

### INNOVATIVE PRACTICE SUMMARY

#### ICT-based Property Value Estimate Information Services

In mature land markets, a number of innovative land and property information services allow users to identify properties for sale or rent that meet their specific requirements, obtain an estimated market value, and to select and contact a range of professional and financial services to support their transaction. Good examples can be found at <http://www.zillow.com/> in the United States and <http://www.zoopla.co.uk/> (figure 14.5) in the United Kingdom.

**FIGURE 14.5: A Property Information Service in the United Kingdom**



Source: Zoopla.co.uk.

At the heart of these information services are computer-based value estimate systems often known as automated valuation models. The Zoopla valuation algorithm, for example, continuously analyzes property data from multiple sources—including government, estate agents, surveyors, and users—on all 27 million homes in the United Kingdom. The model looks at the relationships between transaction prices and property characteristics (type, style, number of bedrooms, and other variables) and uses these patterns and trends to estimate present values. The algorithm uses previous sale prices for the specific property and recent transactions nearby, changes in market values for similar local properties, various characteristics of the property in question and those around it, current asking prices for specific properties and others in the local area, the size of the property in question relative to those around it, and the current values of comparable properties.

The model works on an extremely local level and adapts to the specific information available for each property, thereby creating a custom approach to valuing each property. In effect, tens of thousands of models work together, each optimized for the accuracy of the small set of properties they exist to serve. New data are received continuously from a variety of sources, and the systems are built to absorb this information quickly into the valuation process, allowing estimates to take advantage of the most recent data. Each day the valuation algorithm knows more than it did the day before. Estimates are found to be within 10 percent of the actual transaction price in the majority of cases. The estimated valuations allow users to identify properties within their price range and support their property bid price.

## INNOVATIVE PRACTICE SUMMARY

### European Land Information Service

The European Land Information Service (EULIS) (<http://eulis.eu>) is an online portal for professionals to access land and property information from land registries across Europe. It is also a hub of information on land registration conditions in each country. EULIS' long-term mission is to underpin a single European property market through cross-border lending, involving 23 organizations representing the land registries of 20 member states. Currently, the land registries of five countries are connected to EULIS: Austria, Ireland, Lithuania, the Netherlands, and Sweden.

The main applications of this cross-border land and property information service are as follows:

- **Second home searches.** Europe is becoming smaller because it is easier to travel, live, and work across borders. EULIS makes it possible for solicitors and estate agents to check out property and land in other countries for their clients, paving the way for second home purchases.
- **Business acquisition.** EULIS investigates premises and land on behalf of international businesses seeking to acquire sites for their operations.
- **Credit checks.** A risk assessment is required when citizens request credit or make other financial commitments. Lending institutions can use EULIS to confirm ownership of any assets such as land and property proposed as collateral for such commitments.

## Topic Note 14.2: ICT SUPPORT FOR LAND MANAGEMENT, PLANNING, DEVELOPMENT, AND CONTROL

### TRENDS AND ISSUES

In countries fortunate to have mature ICT infrastructures, governments have established e-planning portals that allow citizens to access land-use control information, including

- access to zoning development plans, planning regulations, and general land-use information;
- submission of development applications;
- access to proposed developments, associated drawings, and their current status;
- submission of comments associated with proposed developments to be used as material evidence in the decision-making process; and
- access to the results of development control decisions.

A new generation of GIS-based tools is now available, supported by maturing spatial data infrastructures, to enhance the interaction experience and effectiveness with the citizen. Public Participation GIS (PPGIS) is being applied to participatory community planning (Zhao and Coleman 2006) to help neighborhood community groups and individuals use mapping and spatial analyses in community development and public participation. A new generation of web-based PPGIS initiatives is providing users with tools to analyze existing proposals, suggest and evaluate alternatives, and frame an online discussion of alternatives within a geospatial context.

The ease and increasing use of mashups (websites or applications that seamlessly combine content, typically sourced from

third parties via a public interface, into an integrated experience) and wider access to open geospatial data allows communities, citizens, or pressure groups to create an accessible simulation of the proposed development. This environment can then form the basis for dialogue among stakeholders.

Mobile phones are also opening channels for citizen participation in the development control process and have significant potential to increase constituents' participation. For example, citizens can register for mobile phone alerts on specific types and/or locations of new development proposals and can text objections to development proposals to the planning authorities with associated authentication (Enemark and McLaren 2008).

### INNOVATIVE PRACTICE SUMMARY E-Planning Portal in Denmark

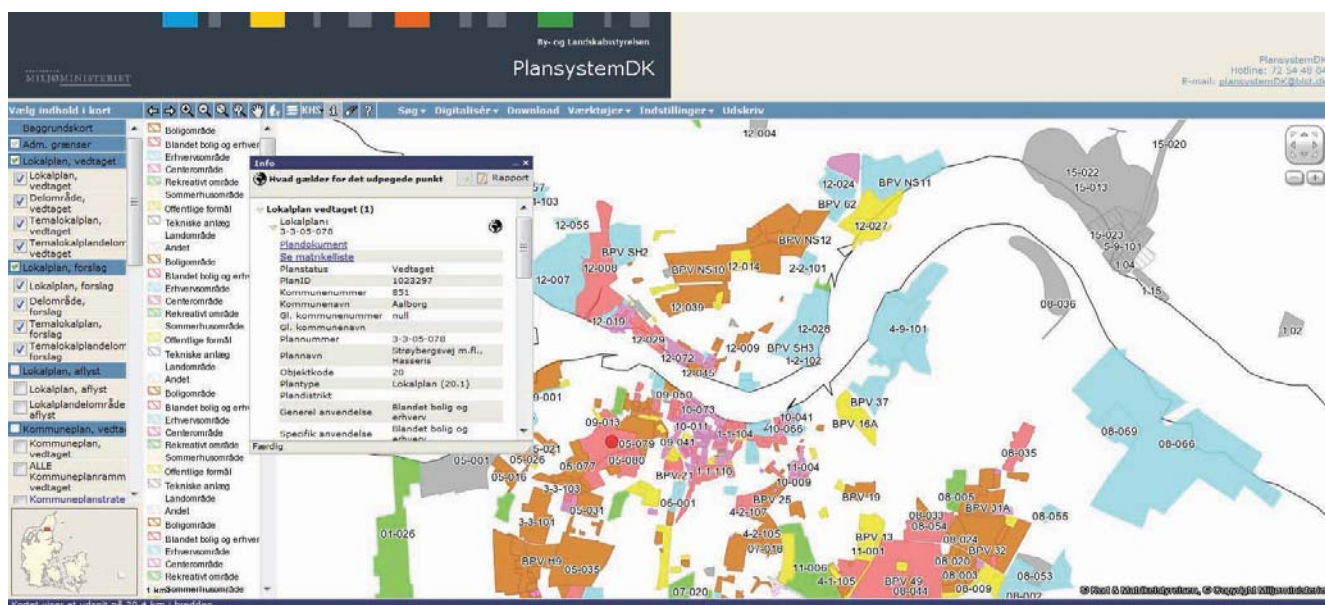
One of the most advanced and participatory e-planning portals is in Denmark (see <http://plansystemdk.dk>). The solution provides public access to all statutory land-use plans such as municipal plans and development plans (called a *lokalplan*), both adopted or proposed, across Denmark. The map-based interface provides a range of navigation tools, including address, cadastral parcel number, municipality, and area polygons (see figure 14.6 showing the region of Aalborg). The areas of the development plans can be displayed in combination with cadastral maps, topographic maps, orthophotos and other kind of land-use constraints, such as conservation

areas and coastal protection zones. Once the citizen has identified the development plan of interest, the system provides direct access to an electronic copy of the *lokalplan* and can display and generate a list of all properties (cadastral parcel numbers) impacted by the development plan. The e-planning portal also allows citizens to provide direct feedback on proposed development plans during the statutory eight-week consultation period. Citizens preparing to build or extend their house can use the system to determine what planning restrictions apply in their area. This open, transparent e-planning portal also serves as an authoritative legal register. It is an excellent example of land registration and cadastral information services being integrated into wider e-government services.

### INNOVATIVE PRACTICE SUMMARY Virtual Landscape Theatre

For many citizens the use of PPGIS environments is either too advanced for their use or they are on the wrong side of the digital divide. However, there are emerging virtual and augmented reality techniques that allow citizens to access sophisticated GIS and visualization technology through mediators. One such example is the Virtual Landscape Theatre, developed by The Macaulay Institute in Scotland, that uses cutting edge virtual reality technology to recreate landscapes and provide a forum for people to visualize and assess impacts of proposed change (The Macaulay Institute

FIGURE 14.6: Example of E-Planning Portal



Source: <http://plansystemdk.dk>.

2011). By allowing groups of people the opportunity to view, debate, and offer informed opinions, the planning process benefits from a greater understanding of what is really valued in the landscape and what isn't. The Virtual Landscape Theatre is composed of a mobile curved-screen projection

facility in which people can be immersed in computer models of their environment to explore landscapes of the past, present, and future. Small groups have the opportunity to experience landscapes by moving around the virtual world and can provide feedback by means of a voting handset.

## Topic Note 14.3: ICT SUPPORT FOR LAND REFORM

### TRENDS AND ISSUES

The term land reform has different meanings in different regions or countries. At its simplest level, land reform refers to the various processes involved in altering the pattern of land tenure and land use of a specified area. It is most often applied to rural areas to allocate more land for settlement by landless people, to provide stability in the pattern of land settlement through land tenure reform, or to consolidate land holdings and increase agricultural efficiency by redistributing an existing pattern of land parcels. For example, in Latin America it typically means land redistribution from large *haciendas* or *latifundia* to smaller farms, while in South Africa land reform also involves restitution of lands and land tenure reform. The procedures adopted in land reform can be applied to urban areas and used to address some of the problems of informal urban settlement.

ICT supports the entire life cycle of land reform, from identification of current owners and patterns of land tenure through the analysis of reallocation options to the provision of land registration. ICT can be used to:

- Identify owners, extent of ownership, land use, and land values in areas where land consolidation is planned.
- Design new parcels using GIS, in which all landowners voluntarily trade land parcels or are allocated an area that is as equivalent as possible to the size and quality of their existing holdings. The GIS is also used to support the citizens' participation in the design and evaluation of reallocation options, speeding up the consultation and decision process.
- Calculate levels of compensation when necessary as a result of adjustments to the status quo or when land has to be expropriated for state purposes.
- Help in planning new infrastructure such as roads, underground services such as drainage, and other subsurface and above-surface utilities.
- Assist in the preparation of plans for land allocation to landless or otherwise dispossessed people.
- Maintain records of state land that is being held in anticipation of future needs.

- Map informal settlements, using aerial photography or satellite imagery, to plan any upgrades.
- Support the creation of forest inventories and associated valuations by using laser scanning.

Land reform is costly and time consuming. There must be a strong business case or political driver for its implementation. For example, large cooperative farms in Ukraine were broken up and distributed to citizens as part of political and market reforms, but it is still forbidden to buy and sell agricultural land, and there is no formal land market. Prior to land reform in Moldova, parcels were so fragmented that agriculture was very inefficient, and no active land market existed; now the land market is very active.

Land consolidation is becoming an integral part of rural development. ICT enables a more holistic approach that takes into account the broader environmental requirements, leisure and other social needs, rural business development, and other factors. Now it is also common to include land consolidation in urban settings to promote business districts and urban development. For example, Germany currently does more urban land consolidation than rural consolidation. The FAO advocates a voluntary approach to land consolidation based on buying, selling and exchanging parcels in a coordinated way (for a recent successful example, see Republic of Moldova 2009). Other approaches are more formal and involve significant, compulsory intervention, as in the examples from Sweden and Turkey that follow.

### INNOVATIVE PRACTICE SUMMARY Sweden's Large-Scale Land Consolidation Projects

Sweden consolidates land through formal, large-scale procedures that rely on compulsory rules in the Property Formation Act. An intervention can cover 2,000–54,000 hectares, involve up to 2,000 participating landowners,<sup>3</sup> and normally takes five years to implement. Appeals of the principal decisions are rare; since 1990, only 33 landowners have appealed to the court and only seven appeals have been upheld. This positive result comes from strong mediation and negotiation with landowners and effective use of ICT.

3 The information in this section was provided through personal communication with Mats Backman, Telia.

In 1995, Sweden introduced a customized GIS to help implement its land consolidation reforms. The system, GISOM, is based on ESRI products and other database and analysis tools; it manages layers of information from the land registry, cadastre, cadastral index map, and photogrammetric and field data. Additional GIS applications have been developed to match the requirements from authorities and landowners, including valuation methodology, reallocation design, and decision support. The valuation methodology in forest land consolidation projects ranges from the complete enumeration of trees to the use of aerial photointerpretation combined with laser scanning, which is now very successful.

The use of GIS allows landowners to view proposed reallocation designs and show them the consequences of changes in geographical location and size of the proposed reallocation. It also allows changes to the reallocations to be made in real time. Normally landowners wish to decrease the monetary compensation in land consolidation as much as possible. The use of GIS has made it possible to match their desires to a great extent.

### INNOVATIVE PRACTICE SUMMARY

#### Turkey Land Consolidation Project

Turkey's rural population is growing rapidly. Because most rural dwellers cannot pursue livelihoods in sectors other than agriculture,<sup>4</sup> agricultural land is often split into successively smaller farms. Consequently, most farmers operate on highly dispersed parcels whose small size is not suitable for irrigation and mechanization. On average, only 50 percent

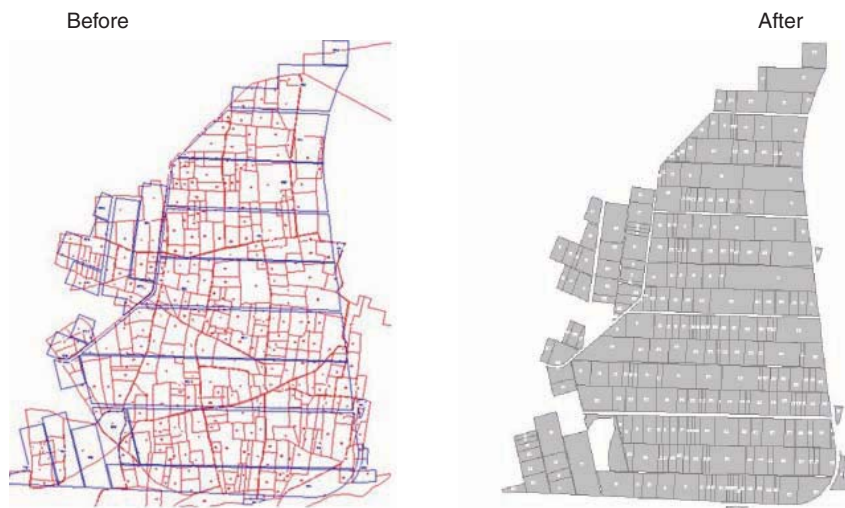
of the parcels have access to irrigation and transportation networks.

Land consolidation was initiated in the 1980s, when legislation was passed to support the Ministry of Agriculture and Rural Affairs in its responsibility to prepare and implement land consolidation projects. Further land consolidation legislation was passed in 2005 to empower other government ministries to implement land consolidation projects involving, for example, irrigation and transport infrastructure. The private sector is involved in implementing the projects.

Turkey faces the tremendous challenge of consolidating approximately 8 million hectares in eight years. The government plans to meet this challenge through a major national land consolidation program, primarily intended to resolve agricultural issues. Under a project with the Netherlands, Turkey has developed a land consolidation approach, supported with ICT, which can be scaled to meet the ambitious targets of the national land consolidation program. A key component of the approach is a GIS-based solution, called TRANSFER, to support reallocation design within project areas. TRANSFER uses a variety of data sets to support reallocation, including soil maps, productivity maps, digital terrain models, proximity to villages and roads, ownership boundaries, and owners' preferences for new allocations. Figure 14.7 shows a project area before and after land consolidation. The result features a new parcel pattern, minimizing parcel transfer in accordance with the wishes of villagers (the average parcel size is bigger than before); new roads (placed to minimize impact on agriculture and provide access to all new parcels); a new irrigation scheme accessible to all new parcels; and a reduction in the number of parcels per farmer, which reduces transportation between parcels.

4 This section draws on information from Jansen et al. (2010).

**FIGURE 14.7:** Parcels Before and After Land Consolidation with New Irrigation Network



Source: Jansen et al. 2010.

## Topic Note 14.4: ICT SUPPORT OF GOOD GOVERNANCE IN LAND ADMINISTRATION

### TRENDS AND ISSUES

The need for good land governance is reinforced by three broad global trends. First, increased and more volatile commodity prices, population growth, and the resulting increased demand for rural and urban land make it all the more important to define and protect rights over land resources as a precondition for the broad sharing of benefits from economic development. Second, climate change is likely to have particularly damaging effects on land in areas traditionally considered hazardous or marginal. Adequate land-use planning, together with geospatial tools that use land administration information to manage disasters, can help mitigate or adapt to these problems. Finally, global programs to provide resources for environmental services (for example, reduced deforestation) are likely to affect behaviors at the local level and thus accomplish their objectives only if local land rights are recognized and resources are transferred effectively to right holders (Deininger et al. 2010).

Good governance requires a legal framework and a will to enforce it. Legislation that, for example, outlaws gender discrimination is often flouted in practice when it comes to land ownership and inheritance, which is why organizations such as the Huairou Commission were established (see <http://huairou.org/issue> and <http://huairou.org/land-housing>). Good governance is essential, because land administration is often perceived as one of the most corrupt sectors in government. Although individual amounts may be small, petty corruption on a wide scale can add up to large sums. In India the total amount of bribes paid annually by users of land administration services is estimated at US\$ 700 million (Transparency International India 2005), equivalent to three-quarters of India's total public spending on science, technology, and the environment. For an example of how ICTs can stem corruption in land transactions, see box 14.3.

ICT significantly supports good governance in land administration by facilitating open, transparent access to land records for all. Until recently land records were available only on paper in land offices or to a few large customers over the extranet. These records can now be obtained through mobile phones, either through web- or SMS-based information services. As the example from Indonesia indicates, ICT can greatly improve the outreach of land administration services, especially for groups that were long excluded from such information, and the cost of providing services has fallen.

### BOX 14.3: Reducing Corruption in Land Offices

The mobile phone can play an important role in reducing corruption associated with financial transactions in the land sector. For example, in Pakistan's Jhang District, all clerks were asked to submit a list of their daily transactions, giving the amount paid and the mobile numbers of the buyers and sellers. Supervisors then called buyers and sellers at random to find out whether they had been asked to pay any extra bribes or commissions. After charges were brought against one clerk who had asked for a bribe, service improved markedly. This two-way interaction with clients opens opportunities for essential feedback and quality checks.

*Source: "A Special Report on Telecoms in Emerging Markets," The Economist, 2009.*

Aside from investing in broadband and mobile phone infrastructures to extend coverage, land administration agencies need to ensure that the national public sector information policy supports open and transparent land records. They must also launch awareness programs to raise interest in and knowledge of the new information services. These information service initiatives are good opportunities for leveraging investment and knowledge from the private sector through public-private partnerships.

### INNOVATIVE PRACTICE SUMMARY ICTs and the Land Governance Assessment Framework

Guidelines on how to achieve good governance have been prepared by the World Bank. The Land Governance Assessment Framework (World Bank 2010) addresses five thematic areas: legal and institutional framework; land use planning, management and taxation; management of public land; public provision of land information; and dispute resolution and conflict management. Given that ICT in land administration generates statistics to determine many of the Land Governance Indicators, land administration computerization projects need to be guided by the role of ICT in the Land Governance Assessment Framework. The following are some of the areas where ICT can support Land Governance Indicators within this framework.

**LGI-2(iv):** A high percentage of land registered to physical persons is registered in the name of women either individually or jointly.

ICT can increase the involvement of the so-called Third Sector of nongovernmental and local organizations, including those representing women. Transparency and analysis of land administration information will highlight any gender imbalances in ownership across a country. Online communities (for example, <http://www.womenandhumansettlements.org/> and <http://www.huairou.org/>) allow grassroots women's organizations to share experiences and advance their capacity to collectively influence local to global political spaces on behalf of their communities.

**LGI-5(iv):** Information related to rights in land is available to other institutions that need this information at reasonable cost and is readily accessible, largely due to the fact that land information is maintained in a uniform way.

ICT can overcome the historic separation between the land registry and the cadastre by providing electronic linkages between both organizations. ICT can also be a catalyst for better interoperability and integration with other departments of government, although there must be political will to make this happen. ICT can also reinforce links between the public and private sectors. In recent years, many land administration functions and activities from surveying through the provision of ICT to the delivery of various land information services have been shared with the private sector, often through formal public-private partnerships.

**LGI-7(i):** In urban areas, public input is sought in preparing and amending changes in land use plans and the public responses are explicitly referenced in the report prepared by the public body responsible for preparing the new public plans. This report is publicly accessible.

ICT and especially GIS can provide effective forums for public consultation, allow more scenarios to be presented, and extend the normal outreach of the consultations.

**LGI-10(i):** The assessment of land/property values for tax purposes is based on market prices with minimal differences between recorded values and market prices across different uses and types of users, and valuation rolls are regularly updated.

ICT can compare property values as part of a mass appraisal for land and property taxation, monitor changes in land use that may affect the taxable value of property, and compare prices paid for similar properties.

**LGI-12(v):** All the information in the public land inventory is accessible to the public.

ICT can provide efficient Internet access to public registers that are transparent and searchable by a number of criteria, including map-based searches.

SMS-based property enquiry services via mobile phone remove the need for intermediaries to access land administration services and provide simple, transparent, and accessible services that can rapidly build public trust.

**LGI-16(i):** Most records for privately held land registered in the registry are readily identifiable in maps in the registry or cadastre.

ICT can provide efficient access, including Internet information services, to public registers that are transparent and searchable by a number of criteria, including map-based searches.

**LGI-18(iii):** There is significant investment in capital in the system to record rights in land so that the system is sustainable but still accessible by the poor.

ICT can provide innovative channels to deliver services to many who had previously been excluded, especially in rural areas. Mobile phones can be used to deliver Internet- and SMS-based services, and remote access to the Internet can support mobile land offices.

### INNOVATIVE PRACTICE SUMMARY

#### Improving Public Access to Land Administration Services in Indonesia

With World Bank support, Indonesia's National Land Agency, Badan Pertanahan Nasional (BPN), has set out an exciting and ambitious plan for land reform, with ICT at the center. Improving public access to land services is a priority of the BPN Karanganyar office in Central Java, where involvement in the land office computerization project triggered innovative uses of ICT to build public trust in land administration. The office has expanded its services to include an SMS-based property inquiry service, known as Interactive Land Information. This service removes the need for intermediaries to access BPN's services. It is simple, transparent, and its accessible services rapidly build public trust.

The BPN Karanganyar office has also developed the People's Land Titling Service (LARASITA), a mobile land office (see image 14.2) that travels to villages to provide to BPN's



property services to previously disconnected communities. The mobile office (a modified van) is equipped with laptops connected to the main database in BPN's Karanganyar office through wireless connectivity (WLAN), a 2.4 GHz wireless antenna installed on top of the van and on top of a 60-meter tower behind the BPN office. This infrastructure enables the LARASITA van to operate in real time within a 20-kilometer radius of the tower. The head of the BPN Karanganyar office observed that "as long as we can bring BPN presence and services closer to the people, and provide the right information, then LARASITA has achieved its mission." BPN rolled out LARASITA to an additional five provinces in 2009, increasing its outreach significantly.

**IMAGE 14.2:** LARASITA: A Mobile Land Office in Indonesia



Source: Warnest and Bell 2009a.

## Topic Note 14.5: PUBLIC-SECTOR INFORMATION POLICY SUPPORTING EFFECTIVE ICT-BASED INFORMATION SERVICES

### TRENDS AND ISSUES

Since open, transparent access to land administration information is a prerequisite for developing effective land markets, reducing corruption, and building a trusting relationship with civil society, it is essential that land administration agencies work closely with policy makers to ensure the maximum exposure and reuse of land administration information in the public domain. Recent progress in making copyright, licensing, and pricing arrangements as simple and consistent as possible includes the following developments:

- Many countries release land administration information, at a charge, to the private sector to allow innovative information services to be created. Such services require robust copyright, licensing, and pricing arrangements, but if these arrangements are too complex and too variable across customers, they will deter uptake, innovation, and potential revenues. The National Mapping Agency of Great Britain recently overhauled and greatly simplified its licensing agreements with partners. (See "Licenses and Agreements Explained, Ordnance Survey (United Kingdom), <http://www.ordnancesurvey.co.uk/oswebsite/licensing/>

index.html.) This change involved close dialogue with partners in the private sector and reduced the overheads of public-private partnerships.

- A number of governments recently introduced transparency agendas that emphasize the need for governments to be accountable to taxpayers and have driven programs to publish key government data sets through the establishment of a single access point for government data. In parallel with this development, governments have also developed Open Government Licenses, which provide a single set of terms and conditions for anyone wishing to use or license freely available government information. This form of licensing allows developers and entrepreneurs wishing to use government data to create new applications without any formal application for permission. It is normally interoperable with other internationally recognized licensing models, such as Creative Commons (box 14.4). Although these government open data initiatives have not yet influenced land administration domains, inevitably they will come under increasing pressure to release their data as open data. This move will

#### **BOX 14.4: Creative Commons Supports Open Government Licenses**

Creative Commons (<http://creativecommons.org>) develops, supports, and stewards legal and technical infrastructure that maximizes digital creativity, sharing, and innovation. The infrastructure consists of a set of copyright licenses and tools that create a balance inside the traditional “all rights reserved” setting that copyright law creates. The tools give everyone from individual creators to large companies and institutions a simple, standardized way to keep their copyright while allowing certain uses of their work—a “some rights reserved” approach to copyright—which makes their creative, educational, and scientific content instantly more compatible with the full potential of the Internet. The combination of the tools and the users is a vast and growing digital commons, a pool of content that can be copied, distributed, edited, remixed, and built upon, all within the boundaries of copyright law. A recent example of an Open Government License was created by the National Archives in the United Kingdom, where it is now being adopted by agencies providing open geospatial information services.

*Source:* “Open Government License for Public Sector Information,” National Archives (United Kingdom), <http://www.nationalarchives.gov.uk/doc/open-government-licence/>, accessed May 2011.

test the sustainability of their business models, as revenue streams from selling data and information services will be challenged. Land administration agencies must work closely with their governments to ensure the fine balance between supporting the transparency agenda and the financial sustainability of their organizations.

Policies ensuring that copyright, licensing, and pricing arrangements are kept as simple and consistent as possible will enable strong business interoperability and generate cooperation and shared services among government agencies and their partners. Two examples—one from Lao PDR and the other from Vietnam—emphasize the important role of public information policy in e-governance. Information for the examples comes from Warnest and Bell (2009b, 2009d).

#### **INNOVATIVE PRACTICE SUMMARY** **A Policy Framework to Support Lao PDR’s National Land and Natural Resource Information System**

In Lao PDR, land registry officials, decision makers, and urban planners use a variety of ad hoc and often nonstandardized GIS and mapping applications and in many instances still

rely on paper-based processes. However, new approaches to computerizing land records and delivering e-government services are helping expand the land information services offered to Lao PDR’s urban and rural communities.

In 2004, with support from UNDP, Lao PDR’s Science, Technology, and Environment Agency (STEA) developed the ICT for Development Project under the Office of the Prime Minister. The project’s main objectives were to develop a policy framework for the management, standardization, and exchange of national digital information to implement the government’s ICT master plan and strategy for 2006–2010.

A critical component of a national information base is information on land and natural resources. Lao PDR’s comprehensive strategy for land information coordination and management centers on the development of the Lao Spatial Data Infrastructure, a framework of land information, access policies, data standards, and ICT infrastructure that will benefit a range of users and agencies. Two key organizations are building the LSDI: the National Geographic Department and STEA. LSDI is being piloted in Vientiane Capital City.

As part of this effort, the second phase of the Lao Land Titling Project (2004–2009) developed a computerized national land information service to serve as the backbone of an efficient land administration system. The planned national information service will give registry officials access to a complete, reliable land inventory linked to information on who has rights over land. This information will be stored in an interoperable database available online, seamlessly linking textual and mapping information. The land information service will free government agencies from paper-based processes and make it possible to deliver the full range of land services in each land office and online. Kiosks in rural districts will enable communities to access government land services online.

LSDI is viewed as an increasingly important factor in Lao PDR’s socioeconomic development. Integrating land use, ownership, planning, agricultural, and environmental data themes, the LSDI will eventually support all land-related governance and management activities at the central and local levels. The far-reaching benefits will include improved natural resource management and environmental protection, which are vital given the increasing pressure on Lao PDR from international investors. Success in implementing the comprehensive strategy for land information coordination and management has been achieved by consolidating responsibilities for land under one organization, formulating and approving land policy, implementing institutional and regulatory reform, building institutional capacity, and strengthening project management mechanisms.

## INNOVATIVE PRACTICE SUMMARY

### Vietnam's One-Stop Shop for E-Government Services

The government of Vietnam views land reform as a core component of its gradual market reforms (*doi moi*), which are recognized as one of the most important drivers of Vietnam's rapid growth and poverty reduction. The Vietnam Land Administration Project (VLAP), approved in March 2008, will develop a land information system and deliver government land services online. In this way, VLAP will provide greater accessibility and community participation in Vietnam's land administration system, improving transparency and strengthening accountability. VLAP focuses particularly on modernizing the land registration system and improving the delivery of land registration services.

One of the most active e-government initiatives, the Bac Ninh land information system, is providing online services and electronic service centers in rural districts. Just 30 kilometers from Hanoi, Bac Ninh Province is Vietnam's smallest and most densely populated province, with an estimated population of 1 million. Twenty-one local area networks have been established to serve government agencies, and an additional seven to serve rural districts outside the capital city. Remarkably,

each department in the province is connected via fiber optic networks to the provincial Data Integration Center.

The integrated land and house management information system established in Nam Dinh City is a successful example of the synergy between land administration, house management, and ICT. The city's new Center for Land and House Information and Registration is a one-stop shop for critical and highly demanded land services, extending from land titling and urban land plans to construction permits, management, and taxation. ICT removed the walls between the local government agencies involved in these procedures, such as the departments for land, house management, and taxation and the people's committees in 25 wards. They have been able to review and streamline their business processes and maintain close collaboration through online data exchanges and process monitoring.

The prime minister has approved a Strategy for Information Technology Application and Development for Natural Resources and Environment to Year 2015 with a vision to 2020. A central element of the proposed reforms is the development of a system for accessing, retrieving, and distributing land information nationwide.

## Topic Note 14.6: SUSTAINABLE FUNDING OF ICT IN LAND ADMINISTRATION

### TRENDS AND ISSUES

Land administration systems need to be a revenue-generating, self-sustaining activity. Most land administration agencies have adopted computerized technology, the life span of which is rarely more than four years and often less. The more an agency becomes capital intensive, the more it needs to spend on maintaining and replacing its ICT.

It is generally agreed that the state has primary responsibility for ensuring that appropriate policy, legal, and institutional frameworks for land administration are in place and that the formal land market operates efficiently. But should land administration be operated only by the state, and should it be paid for wholly by the state? Should there not, for example, be a partnership with the private sector to charge for services based on the concept that those who benefit most contribute most to the cost? Strategic and business planning are needed to develop modern business models for land administration and for services to be provided in a business-like, cost-effective manner.

### Sustainable Business and Organizational Models

The experience of a number of western countries and increasingly of countries in Eastern Europe, Latin America, and Asia (including Central Asia) shows that land registration systems and even the cadastre can finance themselves. These agencies can achieve full cost recovery by charging for the goods and services they provide, once the necessary basic investment has been made and services have been made more efficient.

There are two elements in financing a land information infrastructure: the building of the infrastructure and its maintenance. Building a national cadastre and land registration solution is expensive. The cost of rebuilding an out-of-date cadastre can run into many millions of dollars, depending on the size of the country and the precision of the survey data. Such an investment is hard to justify unless it can be shown to generate sufficient revenue when it has reached a critical mass of transactions. For this reason, one of the first tasks in modernizing land administration is to understand the different types of users, determine their specific requirements for

services, and create a business case for the corresponding investments in ICT. This type of strategic planning is often anathema to traditionally state-funded, output-based organizations such as land administration agencies.

It is generally accepted that building a land administration infrastructure needs a substantial level of support from the state or external funding sources. Maintaining the system is a different story, and experience suggests that self-sufficiency is possible. Where there is no attempt at cost recovery and all operations are paid for by the state, there is always a risk that the funds needed to improve service and replace equipment will not be provided, especially when government funds are in short supply. With governments currently trying to reduce the burden of public services on their state treasuries, it is a good opportunity to establish self-funding, autonomous, business-oriented agencies. El Salvador, Kyrgyz Republic, Macedonia, Serbia, and Singapore have all planned autonomous, self-financing land administration agencies, while Lithuania, Moldova, and Georgia have attained self-financing agencies. The registration agency in Kazakhstan was obliged to be self-financing from the day it was established.

### **Leveraging Knowledge and Finance from the Private Sector**

New models are being adopted for involving the private sector in sharing the investment and risk in designing, implementing, and sometimes operating land administration infrastructure and associated services. The complexity and management requirements of these large, lengthy ICT programs are frequently underestimated. As discussed, some of the earliest investment in ICT for land administration featured large, internationally bid contracts that proved difficult to manage, involved lengthy tendering periods, and ultimately were slow to deliver operational solutions. In-house development has generally proven more successful and allows agencies to either retain their own specialists or use local companies to build and sustain local capacity. This approach is easier to manage, is more compatible with incremental implementation, and (importantly) is very effective at amending and maintaining the solution downstream.

An innovative approach is to engage the private sector under public-private partnerships. For example, the Register of Scotland (<http://www.ros.gov.uk/>) has formed a 10-year partnership with a technology provider under which it shares the ICT investment but the agency still delivers the services. Another model of public-private partnership has emerged in the Philippines, where a private

consortium has been contracted to deliver a Build/Own/Operate system for the Land Registration Authority over an estimated 10-year project period. In such partnerships, after the agreed concession (payback) period is concluded, the government fully owns the land administration infrastructure. Until that time, revenue generated through an agreed fee structure will be retained by the consortium (Warnest and Bell 2009c).

There are risks associated with these long-term public-private partnerships, as the assumptions underpinning the agreements will inevitably change over the extended time frames. A good example is the recent global financial crisis, which has depressed land and property markets and reduced the revenue streams that support ICT investments and service provision. It is therefore essential that these public-private partnerships have flexibility for change over their life cycle to accommodate new business realities.

When setting fee rates within a self-sustaining business model, the danger is that the cost of transactions will deter some people from registering property transfers, with the result that an informal land market runs in parallel with the formal one. The cost of transactions needs to be kept at a level that will encourage citizens to engage with and benefit from land administration. While underpricing may encourage use of the data and generate volumes sufficient to achieve lower unit costs through economies of scale, there will come a time when nonusers, including the poor, are effectively subsidizing the rich.

### **Behavioral Change Requirements**

The idea that a government agency should operate as a business making at least a marginal profit has required a significant cultural shift that is often very difficult for those who have been accustomed to a central government service-driven environment. In reality it should improve the provision of services, based on what people want and need rather than on what those in authority think is good for the general public. Agencies become more accountable to the public and develop an improved understanding and identification of those products and services that are of a commercial nature and those that are essentially a public good. The downside of the commercial approach is that financial incentives that benefit individual agencies may be incompatible with “joined-up” government and attempts to encourage cooperation between government departments. Yet if each department works to its own business plan and the maximization of its own income, the common good can become marginalized.

### INNOVATIVE PRACTICE SUMMARY

#### ICT Derived Efficiencies in Kyrgyz Republic Benefit Land Office Staff

Kant Registration Office is one of Kyrgyz's most successful land registration offices and is financially self-sufficient, with the status of a state enterprise.<sup>5</sup> Growth in business increased revenues from its services (land transactions, information, and other services) from around US\$ 90,000 in 2005 to US\$ 265,000 in 2008. Fees are the standard (low) fees set by Gosregister, the national coordinating agency. Despite the low fees, the revenues cover all operating costs, including salaries, utilities, materials, and renewals of equipment and furnishings. (Start-up investments, however, were financed by Land and Real Estate Registration Project.) The land registration office itself has funded the progressive digitization of old paper records.

Kant Registration Office pays its staff well above government rates and adds bonuses quarterly and on special holidays. The director has nearly tripled staff members' salaries in the last four years. She believes that such salaries develop trust and provide incentives for quality work. As fees are modest in comparison to those charged in most countries, financial self-sufficiency has been achieved primarily through gains in efficiency.

### INNOVATIVE PRACTICE SUMMARY

#### Philippines—A Public-Private Approach to ICT Financing and Risk Sharing

One approach for the public sector to finance ICT is to share the risks and rewards of ICT investments with private

organizations or consortia.<sup>6</sup> The Philippines has adopted this approach for a 10-year project to computerize 159 local and provincial Registries of Deeds, 16 regional Registers, and the central Registry of Deeds office in Manila. The project is implemented by the private consortium LARES, which will deliver a Build/Own/Operate system for the Land Registration Authority. The International Finance Corporation, part of the World Bank Group, is one of the financiers, providing US\$ 22 million. The project aims to digitize all Land Registration Authority records. Local and wide area network infrastructure will be installed to enable interagency and public online access to land information and land titles. The revenue generated from the new system will accrue to the consortium until the agreed concession period ends, at which time the government will fully own the system.

The Philippines has also been successful with ICT innovations for e-government and online land services. Outsourcing service provision to the private sector is the Philippines' leading strategy for harnessing ICTs to communicate with citizens and conduct business effectively. The telecommunications company SMART developed an innovative "I-Connect" SMS-based customer management service. The potential benefits of I-Connect are many when coupled with land information infrastructure technologies such as those in Leyte, Quezon, and the longer-term Land Administration and Management program. It is anticipated that readily accessible online land services and property inquiries via mobile phone will improve public perceptions of government and confidence in land administration.

## Topic Note 14.7: DESIGNING SCALABLE AND INTEROPERABLE LAND INFORMATION INFRASTRUCTURES

### TRENDS AND ISSUES

Implementing land information infrastructures to support land administration is a complex process, normally achieved over a number of years. Many countries will take up to 10 years to achieve comprehensive coverage with a rich set of e-services. Over this period, a number of disruptive technologies will arrive to challenge and potentially change the choice of ICT. This section aims to identify approaches to ensure that investments in ICT possess the scalability and interoperability that will potentially sustain the solution over the life cycles of new technology and reduce the risk of becoming

prematurely obsolete. A robust, extensible architecture should be defined, tested, and available early in the project.

There are no turnkey solutions. However, there is a great deal of practice and experience worldwide in implementing ICT for land administration and there is no need to reinvent the wheel. The following issues have been dealt with in other countries, and there is much to learn from those experiences. An ICT solution should never be developed in isolation from trends and experience worldwide.

<sup>5</sup> Information in this section is drawn from World Bank 2010.

<sup>6</sup> Information in this section is drawn from Warnest and Bell 2009c.

### Data Model Standards

The major investment component in land information infrastructure is in the collection and maintenance of land registration and cadastral information. It is imperative that this information be easily ported across generations of ICT. This possibility is gradually being achieved through interoperable data model standards. For example, European countries implementing the EU INSPIRE Directive must be able to make specific data themes discoverable and accessible through adherence to data specifications (that is, data model standards). One of these themes is “cadastral parcels.” (See [http://inspire.jrc.ec.europa.eu/documents/Data\\_Specifications/INSPIRE\\_DataSpecification\\_CP\\_v3.0.pdf](http://inspire.jrc.ec.europa.eu/documents/Data_Specifications/INSPIRE_DataSpecification_CP_v3.0.pdf).) Another initiative in setting data model standards is the Social Tenure Domain Model under the wider Land Administration Domain Model developed by UN-HABITAT and FIG (Lemmen et al. 2007), which provides a standard model for social/customary tenure that ISO is ratifying and adopting. The Land Administration Domain Model is being used to support Solutions for Open Land Administration (SOLA) Project (see <http://www.flossola.org>).

### Open Interoperability Standards

The implementation of shared information services within the concept of an NSDI has only been possible through the agreement and adoption of open standards. ICT has a vast array of open standards, but within the geospatial domain, the Open Geospatial Consortium, Inc. (OGC) is a nonprofit, international, voluntary, consensus standards organization that is leading the development of standards for geospatial and location-based services (<http://www.opengeospatial.org/>). OGC standards are technical documents that detail interfaces or encodings. Software developers use these documents to build open interfaces and encodings into their products and services (see IPS “Combining Open-Source Solutions with Open Geospatial Consortium Standards”). Ideally, when OGC standards are implemented in products or online services by two software engineers working independently, the resulting components “plug and play” with other components compliant with the same OGC standards. OGC works closely with the ISO TC 211 Geographic Information/Geomatics and submits OGC standards for ISO approval and adoption (see [http://www.iso.org/iso/iso\\_catalogue/catalogue\\_tc/](http://www.iso.org/iso/iso_catalogue/catalogue_tc/)). When bidding for land administration ICT, it is essential that the statement of requirements explicitly specifies the use of the appropriate OGC/ISO standards in the design of the solution to ensure interoperability of the solution.

### Service-Oriented Architecture and Web Services

Web services provide a standard means of interoperation among diverse software applications, running on a variety of

platforms and/or frameworks. Web services are characterized by their great interoperability and extensibility, as well as their descriptions, thanks to the use of XML (Extensible Markup Language). Today, XML is one of the most widely used formats for sharing structured information—between programs, between people, between computers and people, both locally and across networks. Web services can be loosely coupled to achieve complex operations. Programs providing simple services, which can be built on different hardware and software platforms, can interact with each other to deliver sophisticated added-value services (see <http://www.w3.org/standards>).

As an example of how web services can be used, a message could be sent from a home location application to a web-service-enabled properties-for-sale search website, such as a real estate price database, with the parameters needed for a search. The property-search website would then return an XML-formatted document with the resulting data, such as prices, location, and features. Because the data are returned in a standardized format, they can be integrated directly into the application. The home location application could then send messages to other web-service-enabled sites to obtain other property information on local amenities, crime statistics, public transport facilities, and similar parameters. The information can be integrated easily into the home location application to support decision making. Service-oriented architecture and web services are increasingly used in designing modern land information infrastructures to support incremental development, extension, and ease of integration with other web-based information services.

### INNOVATIVE PRACTICE SUMMARY Combining Open-Source Solutions with Open Geospatial Consortium Standards

GeoServer, MapServer, and Deegree are open-source map server products focusing on Internet mapping applications using Open Geospatial Consortium (OGC) webGIS standards. These OGC interoperability standards—such as WMS, WFS, and WFS-T—allow the cross-platform exchange of geographic information over the Internet.<sup>7</sup> Using these standards, map data stored in ArcSDE or Oracle Spatial and PostGIS databases, for example, can be accessed over the Internet with a standard web browser or GIS client software. With WMS, map data can be accessed and displayed as an image that can be overlaid with GIS data from other data sources to produce composite maps. With WFS, users can

<sup>7</sup> Information in this section drawn from FAO and FIG 2010.

access the actual geographic features in vector format, while WFS-T allows features to be created, deleted, and updated.

MapServer, GeoServer, and Deegree are server-based “map engines” that display spatial data (maps, images, or vector data, depending on the OGC web service) over the Internet to users based on their requests. MapServer has proved to be a very mature and reliable product to distribute maps from GIS data sources over the Internet through the WMS, WCS, and other OGC interoperability standards. GeoServer and Deegree are more recent projects built with Java technology. While comparable to MapServer in many ways, GeoServer and Deegree go further by supporting transactional WFS services, allowing users to insert, delete, and modify geographical data at the source from remote locations. In land administration solutions, this functionality would allow notaries to sketch new parcel boundaries resulting from property transactions on a digital map in their preferred GIS client software and send this new boundary information in the GML data format to the cadastral database on the WFS-T server.

A number of European cadastres already use WMS and/or WFS to give citizens access to public cadastral data sets over the Internet, and are thus following the INSPIRE principles to provide public access to spatial data sets that are collected by the government. With the availability of high-quality, open-source Internet mapping tools, other national cadastre agencies are expected to follow this trend.

### **INNOVATIVE PRACTICE SUMMARY** **Kyrgyz Republic’s Open-Source Strategy and GIS Solutions**

The Kyrgyz Republic has adopted a national strategy, “ICT for Development,” which envisions ICT as an engine for economic development throughout the country.<sup>8</sup> The major components of the strategy are e-commerce, e-government, e-education, and the public sector. In all of these areas, open-source technologies provide a mechanism for achieving strategic goals and overcoming the digital divide. ICT-based development requires active growth in the local community of the IT professionals, and open-source projects provide local IT professionals with very effective opportunities to accumulate and share experience. As local capabilities develop and as support for open-source systems grows, government and industry can rely more on local firms to build cost-effective open-source solutions. In this iterative process, the more open-source systems a country uses, the greater the growth of the local ICT industry and the greater the possible savings for government and industry in building more open-source

systems. Starting from a base of a few projects, the process should result in consistent economic growth.

For example, the Land and Real Estate Registration Project in the Kyrgyz Republic was implemented to support the development of markets for land and real estate through the introduction of a reliable and well-functioning land and real estate registration system. The open-source approach adopted by the project appears to be successful. For example, open-source GIS software piloted by the Bishkek Land Registration Office is being rolled out to the other 46 land registration offices (World Bank 2011). The project has also been successful in the sense that the value of annual property sales rose from US\$ 120 million in 2002 to US\$ 1.5 billion in 2007, and the annual value of new mortgages increased from less than US\$ 100 million in 2002 to US\$ 1.3 billion in 2008.

From this experience, the open-source initiative appears to have potential to focus implementation of the national ICT for Development strategy and enable rapid ICT development in Kyrgyz Republic. This model may be applicable in other developing countries that view ICT as a strategic tool for economic development.

### **INNOVATIVE PRACTICE SUMMARY** **Social Tenure Domain Model**

In developing countries, large portions of land remain untitled, with less than 30 percent of cadastral coverage conforming to the situation on the ground.<sup>9</sup> Where there is little land information, there is little land administration and management. Conventional land information systems cannot adequately serve areas that do not conform to the land parcel approach applied in the developed world. A more flexible system is needed for identifying the various kinds of land tenure in informal settlements. This system has to be based on a global standard, and the local community must be able to manage it. The Social Tenure Domain Model (STDM) introduces new, unconventional approaches in land administration by providing a land information management framework that integrates formal, informal, and customary land systems as well as administrative and spatial components.

STDM relies on tools for recording all forms of land rights, all types of rights holders, and all kinds of land and property objects or spatial units, regardless of the level of formality. The thinking behind STDM goes beyond established conventions. For example, traditional or conventional land administration systems relate names or addresses of persons to land parcels via rights. An alternative option provided by STDM

8 Information in this section is drawn from Abdrisaev et al. (2005).

9 Information in this section is drawn from FAO and FIG (2010).

relates personal identifiers, such as fingerprints, to a coordinate point inside a plot of land through a social tenure relation such as tenancy. The STDM thus provides an extensible basis for an efficient and effective system for recording land rights.

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## Module 15: USING ICT TO IMPROVE FOREST GOVERNANCE

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### IN THIS MODULE

**Overview.** Information communication technology (ICT) applications can be harnessed to enhance public participation and transparency, make law enforcement more efficient, and improve forest management. The module uses the World Bank Framework for Forest Governance to assess the potential of ICT applications to address different aspects of forest governance.

**Topic Note 15.1: Pillar 1—Transparency, Accountability, and Public Participation.** Approaches to increasing transparency, accountability, and public participation for forest management through ICTs include e-government services and open government applications, advocacy campaigns through text messaging and Internet social networking sites, community radio, crowdsourcing, and collaborative and participatory mapping.

- **Participatory Mapping in Cameroon**
- **The Central Vigilance Commission Website—India**
- **PoiMapper in Kenya**

**Topic Note 15.2: Pillar 2—Quality of Forest Administration.** Comprehensive forest management information systems have been seen as the ideal solution, yet it is possible to deploy smaller-scale ICT solutions to manage information requirements in key areas, such as management of fires, inventories, and wildlife tracking.

- **Fire Alert Systems Integrating Remote Sensing and GIS**
- **Kenya: Solving Human-Elephant Conflicts with Mobile Technology**

**Topic Note 15.3: Pillar 3—Coherence of Forest Legislation and Rule of Law.** Effective law enforcement systems in the forest sector usually follow the steps of prevention, detection, and suppression. Technology has an important part to play in each of these steps in the efforts to curb illegal logging, transportation, and processing of timber and illegal trade in wildlife.

- **Ghana National Wood Tracking System**
- **Liberia: LiberFor Chain of Custody**

**Topic Note 15.4: Pillar 4—Economic Efficiency, Equity, and Incentives.** ICT applications can promote business transactions with the private sector, as with the online auction of public timber, or e-auction. ICTs such as RFID chips can increase productivity and improve efficiency in the supply chain.

- **RFID Chips for Efficient Wood Processing**

### OVERVIEW

The management of forests is very dependent on information, knowledge management, and the capacity to process information. This module presents lessons learned on the use of ICT to promote good forest governance.<sup>1</sup> The main

focus is on institutions, their interaction with stakeholders, and how their performance can be strengthened. It does not cover forest inventories and technical resource assessment. While the module is intended to be comprehensive on particular subjects, it does not present all possibilities and current practices of ICT use in forest governance. The objective is to demonstrate the range and diversity of approaches and feasibility of using technology in forested areas (see image 15.1).

<sup>1</sup> The module builds on the 2011 World Bank report “Forest Governance 2.0—A Primer on ICTs and Governance,” available at <http://www.profor.info>.

### Forest Governance as a Development Challenge

Good governance is a vital ingredient in development and sustainable resource management (Collier 2007); investments in sustainable development are widely recognized to yield better development outcomes within conducive governance environments. Poor governance in the forest sector manifests itself in several ways. Forest crime—such as illegal logging, arson, poaching, or encroachment—is a problem in many areas. In many countries, corruption in the forest sector and rent seeking has caused forest agencies to lose both revenue and credibility. It has created an uneven playing field for legitimate private sector actors due to price undercutting and unreliable access to forest resources. The unpredictable business environment has also led to short-term profit maximization and has discouraged socially and environmentally responsible long-term investments in the forest sector.

#### *The Impact of Poor Forest Governance*

Poor governance in the forest sector is an impediment to achieving good development outcomes within the sector. In developing countries, an estimated 1 billion rural poor depend at least partially on forests for their livelihoods, and about 350 million live in and around forests and are heavily dependent on them for economic, social, and cultural needs.

In developing countries, illegal logging in public lands alone causes estimated losses in assets and revenue of more than US\$ 10 billion annually, more than eight times the total official development assistance dedicated to the sustainable management of forests. As much as US\$ 5 billion is lost to governments annually because of evaded taxes and royalties on legally sanctioned logging. In addition to financial and economic costs, the equity impact of poor forest governance and illegality are considerable. These rough global estimates give an idea of the magnitude of the problem but mask country-specific variations. Despite the grim global estimates, the situation has improved in some countries. For example, a recent Chatham House mapping shows that illegal logging has fallen more than 50 percent in the past 10 years in Cameroon, the Brazilian Amazon region, and Indonesia.<sup>2</sup>

#### *Using ICTs to Reduce Emissions from Deforestation and Forest Degradation*

All schemes to reduce emissions from deforestation and forest degradation (REDD+) emphasize the fundamental

<sup>2</sup> Information in this section was drawn from World Bank 2006a and Lawson 2010.

### IMAGE 15.1: Scanning Barcodes in Forests Enhances Forest Management



Source: Helveta Ltd.

importance of good governance. Forests ensure the sustainability of environmental services—biodiversity conservation, carbon sequestration, and watershed protection. All these services are at risk if forests are not managed in a sustainable manner.

Pilot projects around the world are currently testing different approaches to REDD+. Some projects are focusing on increasing the involvement of and benefit sharing with indigenous and local communities, especially in terms of mapping and measuring forest boundaries, degradation, and carbon levels. Interesting examples are the Community Carbon project in Mexico (Peters-Guarin and McCall 2010) and the Surui Indigenous Peoples project in the Brazilian Amazon.<sup>3</sup> Both projects experiment with smart phones/PDAs with preloaded software for data collection on biomass from sample plots and boundary demarcation using global positioning system (GPS) functions. These projects are training local communities to update data and use simple interfaces on the devices to convert the data into carbon estimates.

<sup>3</sup> The Amazon Conservation Team, Google Earth Outreach, and the Moore Foundation, ([http://www.amazonteam.org/index.php/233/The\\_Sete\\_de\\_Setembro\\_Indigenous\\_Reserve](http://www.amazonteam.org/index.php/233/The_Sete_de_Setembro_Indigenous_Reserve)) & (<http://www.google.org/earthengine/>).

A pilot project in Ethiopia<sup>4</sup> also tried to have farmers access the international carbon offsets market and receive payments directly, through a mobile phone. In this case, smallholders near Bahir Dar were asked to measure the diameters of trees on their land twice a year and put the information into a text message, which was sent, along with each farmer's unique identification code, to the regional Watershed Users' Association office. Standard software computed the amount of carbon stored on each farm as well as the change from the previous measurement; any increase in stored carbon dioxide was converted into cash using the going rate of carbon dioxide on international markets, and farmers were paid by their local association.

### *The Pillars of Forest Governance*

It needs to be recognized that even legal activities may lead to unsustainable management of resources and that good governance and legality do not always deliver sustainability. The opposite also holds true: not all technically illegal activities are unsustainable. Development outcomes in forestry depend on many factors both inside and outside the sector. To help improve forest governance, the World Bank has developed a conceptual framework for forest governance that consists of five pillars or building blocks, each with two to seven subcomponents (World Bank 2009a) (see box 15.1). This module analyzes each principal component and assesses how information management and ICT can be used to promote the specific dimension of forest governance. It is clear that governance cannot be promoted by knowledge management and technology alone: fundamentally, it is a matter of political choice and the capacity to implement those choices. Therefore, the mere introduction of information technology will not lead to reforms and good governance if the overall environment is not conducive.

### **Information Management, Development, and Governance: The Role of ICT**

New technologies have dramatically changed the way this information is collected and applied in the forest sector. For example, World Bank experiences from Eastern Europe and South Asia demonstrated the importance of appropriate management and generation of information and the need for information on financial and operational issues, as well as performance assessment of state agencies. Public access to this information is a prerequisite for greater accountability (World Bank 2008, 2005).

<sup>4</sup> Personal communication, project team.

### **BOX 15.1: The Building Blocks of Forest Governance and Their Principal Components**

#### **Pillar I: Transparency, accountability, and public participation**

- Transparency in the forest sector
- Decentralization, devolution, and public participation in forest management
- Accountability of forest officials to stakeholders
- Accountability within the forest agencies

#### **Pillar II: Stability of forest institutions and conflict management**

- General stability of forest institutions
- Management of conflict over forest resources

#### **Pillar III: Quality of forest administration**

- Willingness to address forest sector issues
- Capacity and effectiveness of forest agencies
- Corruption control within the forest sector
- Forest monitoring and evaluation

#### **Pillar IV: Coherence of forest legislation and rule of law**

- Quality of domestic forest legislation
- Quality of forest law enforcement
- Quality of forest adjudication
- Property rights recognized/honored/enforced

#### **Pillar V: Economic efficiency, equity, and incentives**

- Maintenance of ecosystem integrity—sustainable forest use
- Incentives for sustainable use and penalties for violations
- Forest products pricing
- Commercial timber trade and forest businesses
- Equitable allocation of forest benefits
- Market institutions
- Forest revenues and expenditures

*Source: World Bank 2009a.*

These lessons gradually resulted in forest management information systems (FMIS) becoming an essential element in forest sector institutional reform programs. These systems were tried in forestry projects in countries as diverse as Argentina, Bosnia and Herzegovina, Kazakhstan, Russia, Romania, Vietnam, and several states in India (World Bank 2008). The systems focused on forest administration

in the narrow sense and lacked cross-sectoral linkages.<sup>5</sup> Information system development has also been integrated into wider forest sector reform programs, as described in the following section and box 15.2.

### *Experience of World Bank Support to Forest Management Information Systems*

Implementation completion reports for a sample of recent World Bank forestry projects show that the introduction of computerized information management systems to facilitate institutional reform had limited success.

For three forestry projects in India, the report notes that the project objectives for FMIS implementation were not achieved or were limited in their success due to delays in assigning the consultancy contracts and lack of technical capacity.<sup>6</sup> More positive outcomes have been noted in projects in Romania and Bosnia and Herzegovina.<sup>7</sup> In Romania, the report found that “the full system has been installed and tested in headquarter and field office.” The project in Bosnia has had a positive outcome, and the reason for this seems to be a phased approach. The initial focus was on developing overall IT capacity, followed by the introduction of more specialized capabilities such as geographical information systems (GIS) mapping tools.

While forestry administrations seem to have welcomed computers, the link between technology, information management, and institutional reform was not always maintained. The most important reason often was the lack of clarity in how to get the best from the technology. There was inadequate analysis on how technology could be used to improve information management to improve core business processes. Technology was seen as a means to spruce up the “front office” while

5 See, for example, the Bosnia and Herzegovina case study in World Bank (2008).

6 The report for the Andhra Pradesh Forestry Project notes that “the project has, in the latter stages, obtained up-to-date GIS hardware and software and established a new Geomatics Centre . . . However, the system has only been fully operational in the latter stages of the project.” The report for Uttar Pradesh Forestry Project notes that “the main weaknesses at (project) entry were . . . an expectation that the implementing agency would manage large consultancies (such as the Forest Management Information Systems (FMIS)) when its capacity in this area was limited. Other shortcomings were in the development of the FMIS which was rudimentary and not a full-fledged planning tool at project closure.” The Madhya Pradesh Forestry Project report found that “another shortcoming in sector management was the failure to deliver an improved macro-level planning process supported by a FMIS and associated capacity building.”

7 Romania Forest Development Project (P067367) and Bosnia-Herzegovina Forest Development and Conservation Project (P079161).

“back office” processes largely remained unaltered. Based on these findings, it would be easy to assume that forestry departments did not need information technology to improve their functions. However, it would be more appropriate to conclude that information management needs were insufficiently assessed before executing such a large-scale introduction of new technologies. Other important reasons these projects were not as effective include the following:

- FMIS components were too big and complex.
- Government staff were less familiar with the technical side of information management and thus drawing up specifications for consultants’ to develop the systems was difficult.
- Delays in award of contracts meant that the systems could not be tested by the client till the end of the project period.
- Insufficient attention to “change management” to generate “buy in” from staff at all levels.

### **BOX 15.2: Vietnam—Management Information System for the Forestry Sector**

The Management Information System for the Forestry Sector (FORMIS) aims to introduce modern approaches to information management in the Vietnamese forest sector. This includes technological solutions for information integration, remote-sensing technologies, and mobile technologies. FORMIS will contain a number of subsystems and modules to provide information for steering and managing the forestry sector toward sustainable forest management. The FORMIS information strategy will also guide the Ministry of Agriculture and Rural Development in aligning IT investment in other development projects to obtain a harmonized, cost-effective system.

FORMIS is expected to reduce the fragmentation of information by harmonizing standards within the agriculture ministry. The project will come up with consistent data structures, standardized and consistent data collection methodologies, and centralized coding systems. The fragmented nature of existing forestry information is partially caused by a case-by-case approach when planning and building information systems, without having a strategic overview. The project pays particular attention to the initial planning of the information strategy and the information system architecture of the systems to be built.

*Sources:* Development of Management Information System for Forestry Sector (FORMIS): overall work plan (March 3, 2010, unpublished); Fowler et al. 2011; Vietnam Development Report 2011.

### *ICTs in Forest Governance: Experience from Three Countries*

Three detailed country reports were prepared to analyze what lessons could be drawn from the experiences of countries with different forest governance challenges and different stages of advancement in the application of ICTs in development. The country reports are from Finland, Ghana, and Uganda.

Finland is one of the world's leading countries in applying ICT across all levels of society and different economic sectors. Forests have held a remarkable role in Finnish society for over a century. Alongside the rapid overall development of ICT, forest sector actors have actively developed and applied different ICT solutions to improve efficiency. Conventional ICT applications have been developed to support decision making and to improve the efficiency of the wood supply. During the past decades, the importance of communication between forest actors and the general public has become an emerging requirement, and new solutions have been introduced in response. ICT solutions in Finland are currently in a transition period to second-generation solutions, with a large proportion of solutions and e-services being revised and improved. The major drivers for this are the changes in the operating environment and the rapid development of hardware and communication possibilities.

In general, the readiness for ICT solutions in the Finnish forest sector is very high, which reduces the need for capacity building and technical support in introducing new solutions. The key success factors for ICT solution development and application processes are the involvement of the stakeholders, adequate capacity, and a high level of trust between the government and the private forest owners. For developing countries, the Finnish model presents two important lessons: (1) good outcomes from ICT solutions can be expected only through a good communication strategy and upfront involvement of stakeholders and (2) piloting with a smaller user group is beneficial for the final product quality.

The Uganda report shows that the country has put in place the legal and policy architecture for expanding the role of ICTs in all spheres of development. However, in general, the forest sector has been lagging behind in adopting these technologies. The high cost and specialized technical skills needed for traditional remote sensing and GIS applications have been a limiting factor. However, corruption, illegal logging, and other forest crimes are notable governance problems in the country. The lack of avenues for citizens to hold their public office bearers accountable has been cited as one of the governance challenges in the sector. On the other

hand, the growth of mobile phone connectivity in the country is being exploited by illegal loggers and poachers.

The experience from Uganda also demonstrates how linking ICT and e-readiness assessment with extensive governance diagnostics provides a good basis for reform.

The important example from Uganda is the spontaneous development of ICT applications through radio and SMS in response to governance challenges (see box 15.5). Other initiatives led by the private sector are using technologies to optimize plantation management and processing. Thus, Uganda is an example where the government has created the space for ICT applications to be widely used, but has not really provided direct support. It is an environment where low-cost, innovative applications would thrive and where radio is still the most influential technology to reach the rural population.

In the case of Ghana, while the country has made a lot of progress with Internet and mobile connectivity in general, applications in the forest sector are lacking. The National Wood Tracking System, which aims to establish a system for tracing the chain of custody, is a notable exception. The system is still being piloted and when complete will enable the forest department to trace timber slated for exports all the way back to the stump, thus meeting its requirements to certify legal timber under the Voluntary Partnership Agreement with the European Union. However, it is a donor-driven system, which does raise questions regarding its sustainability after external funding ends.<sup>8</sup>

#### *Developing a More Integrated Approach*

The three main interlinked drivers of change toward a more integrated approach in forest sector information management are as follows:

- 1. Technological change and convergence:** Enables exploring data from anywhere in the world and collaborating with others.
- 2. Increased openness, transparency, and participation:** The forest sector can no longer work in isolation and needs to share information with other stakeholders.
- 3. National e-strategies and e-development programs:** Forest sector information systems development needs to have a whole-government approach.

<sup>8</sup> Information in this section is drawn from Country Reports for Finland, Uganda, and Ghana—unpublished consultant reports, available at <http://www.profor.info/profor/knowledge/information-management-and-forest-governance>.

ICT experiences in the forest sector have not been systematically studied, but new applications are being piloted in various countries, and there is a wealth of experience from the field. Experience with ICTs in other sectors such as banking, agriculture, fisheries, and public-sector governance has also generated lessons on how ICTs can be effectively used to improve governance and service delivery. This module explores the range of ICT applications available and relevant for forest governance, using a sample of field experiences. While most of the cases are directly from the forest sector, non-forestry cases have been included for their relevance to the forest sector. The discussion is focused on understanding what works under real-world conditions, the potential for replication and scaling up, and what can be learned from other sectors.

To understand how ICTs can best serve forest governance needs, this module uses the World Bank framework for forest governance (see box 15.1) to classify the selected examples. Information is a key cross-cutting requirement for all the pillars of forest governance. The role of ICTs in improving information management under each pillar is explored with the help of field examples through the subsequent Topic Notes (each Topic Note represents a pillar). Table 15.1

summarizes the relationship of ICTs to the five pillars. The only pillar in the World Bank framework that has not been specifically addressed is “Stability of Forest Institutions and Conflict Management.” This is closely related to the four other pillars. If issues such as transparency, quality of administration, and economic efficiency are ensured, conflicts in the sector can be reduced.

### KEY CHALLENGES AND ENABLERS

Though there is great potential for using ICT to improve forest governance, there are no ready-made or easy solutions. This section looks at the operational challenges that confront national forest agencies and practitioners when using ICT for forest governance. It also reviews the key enablers that can help to overcome these challenges. Some of the following discussions address issues generic to all agricultural ICT and e-government initiatives, while others deal with issues specific to forestry.

***Be familiar with national ICT policies and e-readiness. Projects can be developed in countries with low readiness, but they must be designed accordingly.*** E-readiness is an essential factor ensuring that e-services can be used

**TABLE 15.1:** Pillars of Forest Governance and ICT

PILLAR OF GOVERNANCE	WHAT IS THE INFORMATION MANAGEMENT PROBLEM?	WHICH ICT APPLICATIONS CAN HELP?
I. Transparency, Accountability, and Public Participation	<ul style="list-style-type: none"> <li>• Insufficient access to key information on forest management, land tenure, concessions, etc.</li> <li>• No forums for public to share ideas, alert forest managers, or register complaints.</li> <li>• Lack of information or public consultations on planned development projects and major land use changes.</li> </ul>	<ul style="list-style-type: none"> <li>• E-government and open government applications</li> <li>• Advocacy and awareness campaigns through text messaging and Internet social networking sites</li> <li>• Community radio</li> <li>• Crowdsourcing to increase public participation</li> <li>• Collaborative and participatory mapping</li> </ul>
II. Stability of Forest Institutions and Conflict Management	(Applications presented under other pillars.)	
III. Quality of Forest Administration	<ul style="list-style-type: none"> <li>• Costly and difficult to gather detailed information for forest inventories and carbon estimation.</li> <li>• Extensive damage from forest fires and insufficient advance information for forest managers to take action.</li> <li>• Conflicts between humans and wildlife; wildlife poaching.</li> </ul>	<ul style="list-style-type: none"> <li>• Forest cover and carbon stock assessment with CLASlite and airborne LiDAR</li> <li>• Real-time fire alerts</li> <li>• Wildlife tracking and conflict management</li> </ul>
IV. Coherence of Forest Legislation and Rule of Law	<ul style="list-style-type: none"> <li>• Difficult to monitor movement of logs from forest areas.</li> <li>• Information for legality verification is easily tampered with.</li> <li>• Lack of awareness of forest laws.</li> <li>• Surveillance of all critical areas for illegal activities is expensive.</li> </ul>	<ul style="list-style-type: none"> <li>• Technologies for surveillance and deterrence—computerized check posts and GPS</li> <li>• Technologies for tracking timber—chain of custody systems</li> <li>• Legal information management systems: Global Legal Information Network</li> <li>• Mobile and online crime reporting services</li> </ul>
V. Economic Efficiency, Equity, and Incentives	<ul style="list-style-type: none"> <li>• Lack of transparency in auctions, sales and allocations of licenses for planting.</li> <li>• Accurate information on distance and time needed to optimize timber transportation and increase cost efficiency.</li> </ul>	<ul style="list-style-type: none"> <li>• Online timber sales, licenses, and auctions</li> <li>• Logistics</li> <li>• Mobile phone or PDAs for carbon estimation and receipt of payments</li> </ul>

Source: Authors.

and that investments in new systems provide the desired outcomes. The existing and potential capacity needs to be assessed and mapped, and applications need to match the capacity. Development programs may also have components to strengthen the e-readiness in partner forest organizations; this needs to happen in full alignment with national e-government development strategies. Particularly in environments with weak capacity, there is a risk of systems being developed independent of each other, adding to the difficulties associated with building e-government systems across sectors.

**Define the problem clearly, assess the information needs, and compare possible solutions.** Defining the problem to be addressed is a fundamental requirement for any project, and ICT projects are no exception. ICTs are tools or enablers, and having good devices alone is no assurance that forestry management will be improved. Therefore, it is essential to properly identify the underlying causes and effects before looking for a technological solution. The objective is also to find the most cost-efficient and feasible solution. Mobile and Internet applications provide many benefits, but traditional communication channels may also be appropriate. Particularly in environments where access to information networks and electricity is limited, lower-tech solutions may be needed. If no systematic feedback systems are required or the information is not time sensitive, conventional strategies like public posters, community meetings, or radio can also help disseminate important information.

**Determine the best entry points and the appropriate technology.** In ICT, the gradual introduction of new services based on existing ones can be also beneficial. In particular, systems that are aimed at the public and where extensive end-user training cannot be provided should be based on familiar user interfaces. Another decision that needs to be made when selecting entry points is the type of technology to be used. Technology choice depends heavily on the existing capacity: mobile phones and even smartphones are much more common in poorer developing countries than Internet-connected computers.

**Design culturally appropriate and relevant content.** Services provided have to be locally adapted and relevant and meet the requirements of the target audience. The key element is to ensure that applications do not require language skills that are not widely available. Particularly in areas with low literacy rates, it is essential that e-applications form part of a more extensive service package where illiterate users can also access the information through various agents that help them with the applications. This can be arranged through

public agencies or voluntary nongovernmental organizations (NGOs). Working at the local level ensures that applications are responsive to local needs and that there is uptake of the models being developed.

**Information and communication technologies can improve forest governance, but operation, maintenance, and project design issues must be addressed.** All cases show that if planned properly, both mobile and Internet applications can be developed to improve various aspects of governance. Moreover, these systems can be combined with others to provide a full range of services to public and forest professionals. But having appropriate technology alone is not adequate. One needs to consider two issues crucial to the long-term sustainability of the applications: (1) Project design has to be appropriate and focused on meeting demand and (2) operational and maintenance issues must be addressed. Recurrent issues like power supply (for recharging laptops, mobile phones, and PDAs), spare parts (such as replacement batteries), and service also need to be addressed.

**Some services are consumer driven and can become financially self-sustaining, while others are public goods and need to be financed from public sources.** In designing projects, consider costs, long-term financial sustainability, and scalability. Many pilot studies and applications are funded and subsidized by international donors, NGOs, or national governments. However, particularly for commercial services, the long-term sustainability of an application depends mainly on end-user participation and out-of-pocket expenditures. These costs arise from the purchase of various information technology services, such as sending responses to text messages, in which cases the total cost depends on the cost of a text message. Very few pilot projects have focused on the financial sustainability of the models, including how much investment is required. To be sustainable, programs need to consider scaling up and replication. This is exceptionally important to forestry because the sector is inherently public-service oriented. For example, law enforcement is a public good and should be financed from public resources. Well-functioning business models and reliable revenue streams are critical to public forest management (image 15.2).

**Address data security and privacy issues, and develop risk mitigation to prevent misuse of technology and inaccurate data.** Having access to ICTs to track illegal activities facilitates better law enforcement; the converse could also be true. Loggers and wildlife poachers may intercept communications between forest authorities and voluntary informers, and text messages can be used to mislead law enforcement agencies. Consequently, law enforcement



**IMAGE 15.2: Long-Term Investments Are Critical to Scaling Up Interventions**

Source: Douglas Sheil, CIFOR.

bodies need to be prepared to counter disinformation, have at least comparable resources, and be capable of investigating criminal activities. If ICT applications are developed to encourage public participation on forest law enforcement—for example, by opening hotlines for reporting corruption, illegal logging, poaching, or other forest sector crimes—it is critical that the identities of sources not be disclosed, as this could jeopardize their personal safety.

**Ensure that there is adequate information on the resource (for example, forest inventories and resource assessments) or readiness to improve data collection.**

Having adequate data to be processed in the system is a precondition for transparent information sharing. The lack of data cannot be overcome by any investment in technology. Nevertheless, these investments do not need to be sequential. In most cases it is possible to collect inventory information while developing ICT applications.

**Identify the right stakeholders and ensure their participation and avoid local elite capture; include indigenous peoples, women, and rural poor.** The forest sector, by its nature, has diverse stakeholders with varying levels of competence. Large enterprises, senior management, and technical specialists in forest administrations and international NGOs have better knowledge than rural and indigenous

communities, who may have little formal knowledge of the sector and poor or no access to information networks. Also, within the communities, access may be unequal and women or poor may be excluded even if local elites have some access and knowledge. To avoid any potential unintended exclusion of key stakeholders, it is essential that any information system development plan include a comprehensive stakeholder or client mapping. This needs to assess what the information needs are and how to provide the required information services, including training.

**Ensure buy-in from forest authorities at all levels.** Ensuring adoption of an e-governance agenda in forest agencies may also happen through

other means. It may require strong normative guidance from national e-government programs and agencies and may also require the provision of financial incentives. Often, increased use of new technology is driven by efficiency gains and cost savings. If these can be clearly analyzed and demonstrated, agencies have incentives to stay engaged and expand the use of ICT. Even if many NGOs and international organizations have been developing innovative models, if the right authorities are not involved, the new systems have limited value if their operators do not have access to relevant information and data. Frequently, donor-funded projects have been able to equip the project implementation units with modern hardware and software while other departments remained much more poorly equipped. If wide-scale ICT reforms are expected to happen, it is essential that relevant agencies be upgraded in a way that allows for their participation. This requires adequate investment funding for upgrading hardware, system development, and human capacity building.

**Users are able and willing to use new technologies but they need to be aware of the service and motivated to use it.** Even models that are fully functional from a technical perspective may fail to deliver or perform below expectations if users are not aware of them or do not have the right incentives. It is essential for clients to be able to provide feedback

and to be genuinely involved. Making information available by the forest authorities serves several purposes: information is a basis for public consultations and inclusive decision making. However, even limited dissemination is beneficial; if authorities disseminate information through websites, for example, the information is available to the media and NGOs for scrutiny, even if the public only has limited access to the information.

**Applications using mobile phones, radio, and the Internet can be deployed quickly with minimal technological**

**support.** In many cases, the underlying technology already exists and only applications need to be developed. The examples discussed in the Topic Notes clearly demonstrate that many of the forest applications have been developed on existing platforms based on a demand-driven innovation. These have been used in a number of ways to increase public participation and surveillance of forest areas, to monitor fires, and to reduce human-wildlife conflicts around protected areas.

Additional observations and practical implications from the field examples in the Topic Notes are summarized in table 15.2.

**TABLE 15.2:** Summary of Field Examples

PILLAR OF GOVERNANCE	SUITABLE ICT APPLICATIONS	ISSUES TO BE CONSIDERED
Transparency, Accountability, and Public Participation	<ul style="list-style-type: none"> <li>E-government and open data initiatives</li> <li>Advocacy and awareness campaigns through text messaging and internet social networking sites</li> <li>Community radio</li> <li>Crowdsourcing to increase public participation</li> <li>Collaborative and participatory mapping</li> </ul>	<ul style="list-style-type: none"> <li>Applications are mostly Internet and mobile phone based, technologically less challenging, and cheaper to deploy. Cell phone applications would be more useful in forested areas.</li> <li>Legal and political support is necessary for e-government and open data initiatives, and these applications are best led by government agencies.</li> <li>NGOs and civil society can establish and manage mobile phone applications, community radio, and participatory mapping.</li> <li>Costs to users/communities need to be offset through funding from donors/private sector. Community radio (FM) stations can be set up for US\$ 5,000–US\$ 15,000 and managed by community members; SMS can be purchased at bulk rates from cell phone companies.</li> <li>For mapping applications, GPS capability is necessary; PDAs (US\$ 800–US\$ 1200) or smartphones (US\$ 150–US\$ 200) can be used, depending on how rugged the device needs to be.</li> </ul>
Quality of Forest Administration	<ul style="list-style-type: none"> <li>Forest cover and carbon stock assessment with CLASlite and airborne LiDAR</li> <li>Real-time fire alerts through MODIS</li> <li>Wildlife tracking and conflict management through mobile phone applications</li> </ul>	<ul style="list-style-type: none"> <li>These applications are for government agencies.</li> <li>Satellite imagery is now available at lower or no cost; recent developments have simplified software for interpretation. However, technical training is essential to interpret images and generate maps.</li> <li>The LiDAR approach for carbon assessment is still in the early stages, and costs are estimated at US\$ 0.10/Ha. Currently, the Carnegie Institution for Science (Department of Global Ecology) is the main provider of the LiDAR technology for forest cover and carbon assessment.</li> <li>CyberTracker software is free to download onto PDAs and can be tailored for different uses: tracking wildlife, movement of logs, location of specific tree species, etc. It is a good technology for working in collaboration with communities.</li> <li>Fire alerts from MODIS and through Fire Alert system are free text and e-mail services.</li> </ul>
Coherence of Forest Legislation and Rule of Law	<ul style="list-style-type: none"> <li>Technologies for surveillance and deterrence: computerized checkpoints and GPS tracking of vehicles</li> <li>Technologies for tracking timber—chain of custody systems</li> <li>Legal information management systems: Global Legal Information Network</li> <li>Mobile and online crime reporting services</li> </ul>	<ul style="list-style-type: none"> <li>Comprehensive chain of custody systems are expensive operations. They are useful where the benefits of legality assurance outweigh the costs, such as in timber exporting countries. Costs of these systems could be shared between industry and government as benefits accrue to both.</li> <li>Less expensive crime reporting hotlines could be set up to work through voice and text messages. All crime reporting systems need to assure citizens anonymity and safety.</li> </ul>
Economic Efficiency, Equity, and Incentives	<ul style="list-style-type: none"> <li>Online timber sales, licenses, and auctions</li> <li>Logistics</li> </ul>	<ul style="list-style-type: none"> <li>These applications would work well in situations where the forest sector is fairly advanced in the use of information technology. While the government agency may need to set up and maintain the applications initially, some services such as online auctions and inventory data, which are used by the industry can have a user fee to offset the cost to the public sector.</li> </ul>

## Topic Note 15.1: PILLAR 1—TRANSPARENCY, ACCOUNTABILITY, AND PUBLIC PARTICIPATION

### TRENDS AND ISSUES

Information availability is a precondition for transparency, accountability, and efficient public participation. Enhancing the accountability of the government and its institutions, including forestry institutions, is a key issue in all countries. Transparency and access to information are essential if public-sector forest institutions are to be held accountable for their performance. Making the public aware of forest sector policies, laws, and the rights and responsibilities of citizens and the state is the first step in increasing transparency and accountability. Public participation and support for forest activities can be increased by actively seeking public opinion and suggestions on government actions through easily accessible avenues. Approaches to increasing transparency, accountability, and public participation through ICTs include the following:

- e-government services and open government applications
- advocacy campaigns through text messaging and Internet social networking sites
- community radio
- crowdsourcing—mapping for the people, by the people
- collaborative and participatory mapping.

### E-Government and Open Government/Open Data Applications

Open government, open data, and e-government initiatives are meant to increase access to government-owned information and increase transparency and accountability in general. Open government and open data initiatives are giving more access to information that would otherwise be out of bounds. On the other hand, e-government solutions are designed from the perspective of increased efficiency, reduced corruption, and better service delivery. While open government/open data may not strictly be the same as e-government, all of these approaches use ICTs to make governments more transparent and efficient.

Websites are the first and simplest point of communication with the public in the digital world. Several ministries of forests and the environment have websites with information on key policies, programs, and organizational responsibilities; however, only a few have interactive features that allow them

to receive information from the site's users. A very advanced example is the website of the Forestry Commission of the United Kingdom. This site provides users with information, access to relevant policies and procedures, and links to wider e-government applications in the country (see box 15.3).

### BOX 15.3: Website of the Forestry Commission, United Kingdom

The Forestry Commission of the United Kingdom is one of the best examples of e-government in action in the forest sector. The commission's website (<http://www.forestry.gov.uk/>) not only disseminates information on the forests under its jurisdiction, but also serves as a platform for interaction with citizens, including e-commerce services. The site is user friendly and, from a governance perspective, has a number of features:

- Information on all aspects of forestry (educational, recreational, scientific, and industrial).
- Up-to-date statistics on timber production, sales, inventory.
- Information search feature through the land information search, which is a map-based tool giving information about land designations.
- Information on grants and licenses for planting and felling, with a feature for online comments on individual applications.
- Environment Impact Assessment register shows details of the decisions that the commission makes after assessing the potential environmental impact of work to carry out afforestation or deforestation or to build forest roads or quarries.
- Online auctions through the e-timber sales portal.

In addition to these interactive features, the site provides the commission's policies and standards for sustainable forest management, the government's policies on freedom of information and the rights of citizens to information held by state agencies, and the process of consultation the commission follows before planting or felling in any woodland. The commission also carries out an annual survey where public opinion on forestry is gathered and posted on its site.

Source: <http://www.forestry.gov.uk>.

Australia, New Zealand, and the United Kingdom have open government or open data policies to share information with the public. There are numerous benefits of having access to such large volumes of public data. For example, budget information for the forest sector could be used to monitor performance of the state agencies' projects; data on harvesting volumes and area could be used by interested civil society organizations to monitor whether harvest levels are sustainable and whether critical ecosystems are being protected.

While open data policies are primarily initiated by government agencies, the Open Budget Initiative demonstrates that it is possible for civil society organizations to generate demand for open data policies. The Open Budget Initiative is a global advocacy program to promote public access to budget information and the adoption of accountable budget systems. It is anchored in a biennial Open Budget Survey that evaluates whether governments give the public access to budget information and opportunities to participate in the budget process at the national level. To measure the overall commitment of the countries surveyed for transparency and for comparisons among countries, the Open Budget Index (OBI) was developed, which is a score assigned to each country based on the information it makes available to the public throughout the budget process. The OBI was initiated by the NGO International Budget Partnership. The OBI could also be applied in the forest sector, and NGOs could initiate an OBI for the forest sector in their country. The role of ICTs in this case could be to increase access to information through websites or mobile phones.<sup>9</sup> The Central Vigilance Commission of India is another example of a "partial" open government initiative.

E-government services have been high on the agenda of many countries for over a decade. The primary motive for launching e-government services from the perspective of the government is often to improve the efficiency and cost-effectiveness of operations; reducing corruption is often not stated as one of the objectives. However, studies have shown that e-government programs have a great impact on user perception of corruption and transparency. For example, the World Bank (2009a) found that in India, users' perception of corruption in the electronic land registration and records services called Bhoomi, CARD, and Kaveri was lower when compared to the older manual systems. (For discussion of ICT in land management, see Module 14.)

<sup>9</sup> <http://www.internationalbudget.org/what-we-do/open-budget-initiative/>.

#### **BOX 15.4: Advocacy and Awareness Tools**

FrontlineSMS is free, open-source software that turns a laptop and a mobile phone into a central communications hub. Once installed, the program enables users to send and receive text messages with groups of people through mobile phones. Its features include the following:

- No Internet connection is required.
- A phone and SIM card can be attached and the local mobile phone service operator paid per SMS as usual.
- All phone numbers and records of all incoming and outgoing messages are stored.
- Data are stored on the user's computer, not on external servers.
- Messages can be sent to individuals or large groups and can be replied to individually, which is useful for fieldwork or during surveys.
- Easy to install and requires little or no training to use.
- Developers can freely take the source code and add their own features.
- It can be used anywhere in the world by switching the SIM card.

Source: <http://www.frontlinesms.com/>.

#### **Advocacy and Awareness Campaigns through Text Messaging and Social Networking Sites**

The large number of mobile phone subscribers in developing and developed countries and the relatively simple technology for setting up mass text messaging systems (see box 15.4) are helping NGOs and advocacy groups reach out to greater numbers than is possible through traditional mass media. NGOs have used text messages effectively in their campaign for a new forest law in Argentina and to generate public pressure on a food company to stop it from sourcing palm oil from companies that cut down primary rain forests to make room for oil palm plantations. Sites such as <http://www.mobileactive.org> connect NGOs and advocacy groups using mobile technologies for social change and help them with information on the latest trends, do-it-yourself guides, and reviews of mobile applications.

The growth of text messages in advocacy campaigns could be attributed to the following:

- Mobile phones are carried everywhere as a personal accessory and are kept switched on almost 24 hours each day, so the target audience is almost always accessible.
- Messages targeted at individuals are more likely to generate a response than those broadcast to a mass audience.
- Responding to a text message is easier and quicker than making phone calls or sending letters, especially when the responder does not have to pay for sending the message.
- Mobile phones allow two-way interaction, and feedback can be received almost instantly.

NGO campaigns have started using Internet social networks such as Facebook and Twitter to target the youth, who are the primary users of these networks. For example, an international NGO carried out a two-month campaign through Twitter, Reddit, Facebook, and online video against an international food company during 2010 for its use of palm oil from suppliers linked to rainforest destruction. As a result of the campaign, the food company announced in May 2010 that it will partner with the Forest Trust, an international nonprofit organization, to rid its supply chain of any sources involved in the destruction of rain forests.<sup>10</sup> This approach may be more feasible in medium- and high-income countries where there is more access to the Internet than in low-income countries (see more on how civil society and NGOs can participate in e-government in Module 13). In many developing countries, text messaging is still the primary means of data collection and dissemination. A combination of media can be used successfully, as the example from Uganda demonstrates (see box 15.5).

### Community Radio

The use of radio to broadcast development issues is not new. However, community radio is relatively new, and over the past decade several community radio stations have been established around the world to help women and marginalized groups to build networks and gain access to information on health, livelihoods, farming, weather, and markets, as well as to educate communities on democracy, citizen rights, and gender issues.

Radios are relatively cheap and easily repaired and widely available, even in the poorest regions. In several African countries, radio broadcasts are the primary medium for

### BOX 15.5: Uganda—Environment Alert: Civil Society Organizations Use ICTs in Advocacy Campaigns

In 2007, the government of Uganda wanted to give away a third of the Mabira Central Forest Reserves to a sugar company after the government was asked to remove the reserve status of the forest and allocate the land to the company. At the same time, sensitivity to environmental matters had been heightened in Uganda by the campaigns about the impact of the loss of forests on floods, unpredictable weather, and rising food prices.

As a result, civil society organizations used ICTs to alert individuals about official actions that would affect them adversely and to mobilize them to save the Mabira Forest. Environmentalists took their fight to discussion groups on FM radio stations and used text messages to campaign against buying the company's sugar until the plan to grab part of Mabira Forest was dropped.

The text messages were particularly effective. The company saw a decline in sales, and some retail businesses withdrew their products from store shelves entirely. Environmentalists argued that apportioning part of the Mabira Forest would bring more adverse effects than the sugar shortage. Opposition politicians also picked up the slack and started criticizing the government for the lack of concern. In this particular example, text messages helped in alerting people what would happen next if they did not join the movement to stop the forest giveaway. The campaign of the civil society organizations was complemented by other actions in the country and strong reaction from the international development partners. Eventually, the plan was withdrawn.

*Source:* Uganda country report (available at <http://www.profor.info/profor/knowledge/information-management-and-forest-governance>).

communicating political and religious messages. In the poorest areas of the globe, radio is the medium of choice, far outstripping other mass media in terms of audience numbers. For instance, in West Africa, radio ownership dwarfs that of all other communication equipment, including TV and mobile phones. In Africa in general, between 80 and 90 percent of households have access to radio.<sup>11</sup>

Radio programs can be combined with other media as well. Radio browsing of the Internet is a more recent format that

<sup>10</sup> <http://www.mongabay.com> and <http://www.greenpeace.org>.

<sup>11</sup> Statistics for 11 countries for which consistent data were available, Myers (2010).

combines the power of the Internet with the reach of the radio. During the program, the presenter browses the Internet with a local expert (for example, a forestry or agriculture extension official or a community development expert) and together they describe, explain, and discuss the information in the languages used by the community. This has been successfully demonstrated by the community media centers piloted by UNESCO in Sri Lanka, Bhutan, and Nepal, among others. Similarly, mobile technology is being combined with radio programming, where listeners can call or text message the program.

With the availability of bandwidth on WorldSpace satellite radio subscription through First Voice International or RANET, community radio stations in remote locations can access news and entertainment programs on other stations. However, the main benefits of community radio are in programming that is in local languages, in formats that communities relate to, and on issues of local importance. For example, in Papua New Guinea, a mix of community radio and digital audio programming has been used to convey messages on forest management and sustainable land management.<sup>12</sup> The programs

were presented in the form of drama in several local dialects and were listened to in community meetings, where the questions raised by the key characters were discussed by the gathering. This technology could serve forest communities in other countries as well, to keep them aware of policy changes and developments that can affect their resources and their lives. Box 15.6 summarizes how community radio can help promote better forest governance. (See IPS “Farm Radio International Involves Men and Women Farmers” in Module 6 for more on participatory radio.)

### Crowdsourcing to Increase Public Participation

Combining a web-based platform with inputs from text messages increases the versatility of information gathered. Information can be instantly geo-referenced and provide an overview to a decision maker on where activities should be prioritized. In addition to increasing transparency and public

<sup>12</sup> <http://ictupdate.cta.int/en/Feature-Articles/Digital-audio-in-Papua-New-Guinea>.

### BOX 15.6: How Can Community Radio Benefit Forest Governance?

**Fighting corruption and increase awareness of citizens’ rights:** In **Malawi**, the Development Communications Trust broadcasts “village voice” recordings from a network of radio clubs around the country. These programs report (among other things) on local-level delays, corruption, malpractice, and mismanagement by service providers, including international NGOs and local authorities and politicians. These problems are then broadcast on national radio, and the ministry, individual, or organization responsible is invited to reply on air in a context of a mediated dialogue with the community in question. The Development Communications Trust says that 70 percent of radio club problems are resolved satisfactorily after they have been aired nationally. It is currently supported by UNDP, Oxfam, and the Malawi national AIDS body.

**Reporting on corruption and governance:** In **Sierra Leone**, KISS-FM in Bo and SKY-FM started a series called “Mr. Owl” to report on local police corruption. This resulted in increased pay for the police and the establishment of a community affairs department. A voter education program, “Democracy Now,” resulted in higher voter turnout in the station’s listening area compared to other parts of the country.

**Increasing women’s empowerment:** USAID’s Women in Governance pilot program in **Mali** distributed more than 500 Freeplay radios to women’s listening groups in April 2004. The radios were designed for rural African conditions and can function without batteries. Instead, batteries can be charged manually by winding or through solar power.

**Increasing awareness of environmental issues and public participation in policy development:** In September 2009, Developing Radio Partners (DRP), a U.S. NGO, launched a year-long pilot project called “Our Environment, Our Future” that brings residents the information they need in the way they can best use it. DRP is working with 99.6 Breeze-FM, a community-oriented private station in Chipata, Zambia, to help six radio stations in rural Zambia and Malawi create and broadcast local environmental programming. It also encourages innovative use of mobile phones to expand the stations’ interaction with listeners, using the text messaging software FrontlineSMS (box 15.4). The project is helping build skills in environmental reporting and in developing relevant content on topics such as the impact of deforestation on local agriculture, sustainable farming methods, and many others.

Sources: Myers 2010; USAID 2005; <http://developingradio.org>.

participation, it can also serve as a means to track accountability of civil servants. This application gained popularity after Ushahidi became a success story in the aftermath of the Kenyan riots in 2008, as a means of keeping citizens informed on safety and security through information reports from individuals. The success of Ushahidi has led to its replication in other countries for other purposes (see box 15.7).

A similar application by the Blue Link Information Network in Bulgaria was initiated to gather information on illegal logging, which was simultaneously posted on the website, to show authorities where the illegal activities were concentrated. The project “Expose and Improve—The Power of Information

### **BOX 15.7: Public Participation and Crowdsourcing of Data**

**Ushahidi**, which means “testimony” in Swahili, is a platform designed to take input from hundreds of people by mobile phone or e-mail. It uses free software called FrontlineSMS that turns a laptop and a mobile phone into a text-broadcasting hub. As an SMS is sent from a hot zone, the message syncs with the Ushahidi software and shows up in a web administrator’s inbox. The web administrator can decide to send a text message back to the sender to verify the information, send out a blast alert to large numbers of people, or post the information onto a web page with location information from Google Maps (or do all three). Ushahidi is free, and although it was primarily developed as a quick information-gathering and broadcasting tool during the riots in Kenya in 2008, it has quickly been adapted for uses other than crisis response. The following programs use the Ushahidi platform to gather information from people and then show on a map where the events are happening and how large an area is affected:

- Wildlife Trackers is a citizen science project in Kenya.
- Stop Stockouts is an initiative to track near-real-time stockouts of medical supplies at pharmacies (in a medical store or health facility) in Kenya, Uganda, Malawi, and Zambia.

The Ushahidi platform combines the benefits of the Internet and mobile phones and could be used to generate near-real-time information on forest crimes, fire, wildlife sightings, and so on. The advantage of mobile SMS-based data inputs is immense in remote and rural areas.

Source: <http://www.usshahidi.com/>.

Technologies (IT) in Combating Illegal Logging” was started in 2008 by developing a broad network of active citizens and NGOs to support the integration of a web-based platform for information alerts about instances of illegal logging into the work of Bulgaria’s forestry administration.

Crowdsourcing can be used for many different purposes. While it is a useful and cost-efficient way of collecting information, there needs to be a way to ensure that the data entered are valid and have not been fabricated. The managers of the urban forest map in San Francisco, California, have built in some specific algorithms to raise red flags in case of dubious data inputs. They also propose carrying out random verifications in the field (box 15.8). Alerta Miraflores in the municipality of Miraflores in Peru is an expansive system for tracking and reporting incidences of crime.

### **BOX 15.8: Citizen-Powered Urban Forest Map of San Francisco**

An example of crowdsourcing, this project is a collaboration of the government and nonprofits and businesses and citizens of San Francisco to map every tree in the city. Citizens can create an account and upload a tree’s location, its diameter, and a photo of the tree following instructions on the website. There is a link to an online guide called “Urban Tree Key” to help in identification of the trees.

The project is the first of its kind, and there has been concern regarding the quality and authenticity of the data entered by the public. The collaborators intend to overcome this challenge by carrying out field verification of random samples of data.

Sources: <http://www.urbantreekey.org>; <http://www.urbanforestmap.org>; Friends of the Urban Forest (<http://www.fuf.net>).

### **Collaborative and Participatory Mapping**

Maps are vital for decision making in forestry. While public-sector forestry institutions prepare maps to record changes in cover with data from satellites, day-to-day changes at a smaller scale are often not recorded or not available in easily accessible formats to a wider audience. Mapping devices and software have been out of reach for nonspecialists until recently. However, new software makes it possible to put the power of creating and updating spatial information in the hands of field staff and local communities (see image 15.3). Open-source programs make this more affordable for application developers. Communities can partner with forest agencies to help create and update information on forest maps. Information

**IMAGE 15.3:** User-Friendly Tools Allows Local Participation in Forest Mapping

Source: Helveta Ltd.

on boundaries, use rights and planned developments, and small-scale logging or clearing for agriculture have implications for land-use management and governance. Information presented on maps is a powerful visual tool for decision making. It also increases transparency, which is essential when the interests of several stakeholders are involved.

Collaborative mapping is a tool to facilitate spatial data collection and analysis. This tool is more appropriate for the forest sector than basic crowdsourcing, as it allows mapping of points of interest and other geo-referenced information such as specific routes and areas. It can be useful for the staff of forest departments, NGOs, and national-level planning and policy-making bodies.

With the availability of open-source and simpler software for desktop computers, even nonspecialists can view and upload data to maps. Greater accessibility to data is expected as a result of high-speed Internet services around the world, and data on forest cover, deforestation rates, density, and so on are now accessed by a wide range of audiences. Collaborative mapping has the potential to increase and widen the scope of stakeholder participation in project design and management and to facilitate the viewing and updating of project data. Three applications relevant for forestry are discussed:

- PoiMapper
- World Wildlife Fund's Moabi
- CI Earth's Participatory Mapping

**Moabi** is a collaborative mapping system that enables groups and individuals to build a large database for sharing, viewing, editing, and discussing spatial information relevant to REDD+. The system has been developed by the World Wildlife Fund (USA) and is current being applied in Democratic Republic of Congo. Moabi allows policy makers, research institutions, and carbon project developers to view, download, and edit relevant spatial data. It will facilitate on-the-ground monitoring of activities such as illegal logging, mining, and the bush-meat trade. By using mobile mapping devices, data can be collected and directly uploaded to the system either through the Internet or mobile phones. To compensate for slow Internet connectivity, data can be sent to proxies who will upload the data, making it available

to global users. The site is built on open-source, widely used free software such as Google Maps and Drupal, which is a web content management system. This helps ensure that the design is flexible, easily customizable, and functional on a wide variety of computers and web browsers.

Any registered user in Moabi can post data to the website, but the data can only be approved by a peer review member. Users will be able to view both approved and unapproved data in the system and provide ratings on comments on any material posted. The system provides users with incentives to contribute information by recognizing regular contributors through elevated status or promotion to the peer review panel. For mobile phone contributors, incentives may be offered through phone credit awards. Moabi is being developed with funding from a donor. However, once the first pilot is successfully tested in the Democratic Republic of Congo, it is thought that subsequent replications can be developed with a smaller budget of US\$ 30,000 to US\$ 50,000.<sup>13</sup>

Moabi has a high level of utility in forest governance, to increase transparency and public interest and participation in development activities that could lead to deforestation and illegal logging and to promote law enforcement. This application

13 WWF (USA), pers. comm.



will be more useful when it allows data collection and uploads via mobile phones to offset the lack of Internet connectivity in rural areas. However, the peer review process for information displayed on the portal may become a point of contention between different stakeholder groups, and it would be important to ensure the integrity of the peer review process.

Participatory mapping is used extensively by development agencies and NGOs around the world. However, customizing a handheld PDA with icons and images and training members of local and indigenous communities in its use are important advances in this area. Helveta Ltd., an international corporation that develops and deploys supply chain and asset management software for timber and agrocommodities has pioneered the use of its Control Intelligence (CI) Earth software to create maps of forest inventory in an online environment accessible by all registered users.

This innovative project is not without its share of problems. An interim review pointed out a number of concerns, mainly with project management and coordination between project partners and improvements in technology, such as more appropriate methods of recharging the GPS batteries, for which the communities currently travel long distances, and to improve the icon designs.<sup>14</sup>

The use of handheld computers by local communities shows that technology can be customized for all needs, and that it need not be a barrier for illiterate members of the community. However, the handheld devices currently used in the project cost between US\$ 800 and US\$ 1200, putting them out of reach for most forestry departments. The need for such expensive devices may be justified by the nature of the task—extensive data collection in remote locations necessitating the need for rugged devices—but the appropriate technology has to be selected on a case-by-case basis.

### **INNOVATIVE PRACTICE SUMMARY** **Participatory Mapping in Cameroon**

This project has been implemented in a partnership among local and indigenous forest communities across the southern forest zone of Cameroon and the Forest Peoples Programme, University College London, Centre pour l'Environnement et le Développement, and Helveta Ltd. Local forest-dependent communities were trained in using GPS-enabled handheld

14 Interim evaluation report of project, "Enabling Independent Monitoring of Forest Resources by Local and Indigenous Forest Communities" (unpublished, November 2009).

computers with the specially developed icon-driven software CI Earth, which requires no literacy skills, to create forest inventory maps. Data are captured using CI Mobile and GPS reader technology. CI Mobile combines handheld data entry with data from GPS, RFID, and barcode readers to gather accurate records of how assets are being managed and processed in the forest or factory. CI Earth uses a CI Mobile interface configured to record data types that are relevant to the particular user or region. CI Earth data are synchronized with CI World through any locally available means of Internet connection, ranging from satellite to dial-up modem. GPS-referenced data are then made available within CI World in chart form and through GIS applications such as Google Earth and ESRI's ArcView.

The communities are meant to use the devices during their daily expeditions to the forest, recording their use of the resources and their observations of illegal logging activities. These data are then transferred to a secure website via satellite to a data center in the United Kingdom and can be accessed by authorized users and translated into maps. Accurate manipulation of these devices will thus create reliable data and maps that can define resource use, document customary areas, and expose illegal logging practices. So far, data have been collected south of Dimako in eastern Cameroon. Logging activities were monitored both in and outside communal forest areas where Baka Pygmies currently reside or hunt. Forest communities in the Mbalmayo region recorded bulldozer tracks that indicated industrial logging activities near illegally felled trees found outside of the legal commercial logging boundaries. Data gathered by local communities assisted a logging company operating in the area in identifying which communities it should consult over management plans for local forest areas as part of their Forest Stewardship Council certification process.

The CI Earth software with handheld computers has also been used in Nigeria to monitor biodiversity in the Afi Mountain Wildlife Sanctuary, which is home to a subpopulation of the critically endangered Cross River gorilla.<sup>15</sup>

### **INNOVATIVE PRACTICE SUMMARY** **The Central Vigilance Commission Website—India**

The Central Vigilance Commission (CVC) was designed to be India's top vigilance institution, free of control from any

15 The source of information within this section is [http://corporate.helveta.com/uploads/news/20100107015150-Helveta%20Cameroon%20CaseStudy\\_2009.pdf](http://corporate.helveta.com/uploads/news/20100107015150-Helveta%20Cameroon%20CaseStudy_2009.pdf).

executive authority. It monitors all vigilance activity under the central government and advises various authorities in central government organizations in planning, executing, reviewing, and reforming their vigilance work. The CVC is a statutory body, and its website (<http://cvc.nic.in/>) contains the following sections and features:

- Information on its role, responsibilities, and strategies to combat corruption.
- Communication directly with the public through messages and speeches to bolster confidence in the institution.
- Instructions for how any citizen can lodge a complaint against corruption, without fear of disclosure or reprisal.
- Central Vigilance Officer's List: Each organization is expected to nominate a senior officer to whom an employee can take a complaint on corruption.
- Statistical reporting of the achievements of the CVC and its annual report.
- Details of convictions of public servants by the courts, along with information on officers against whom an inquiry has been initiated or a penalty imposed. This section also highlights the performance of various departments responsible for conducting investigations.

A decade ago, publishing names of officers undergoing inquiries on charges of corruption on the CVC website created a stir in the media, but it quickly caught the public's attention. Despite the low level of access to computers and the Internet, the information has been widely disseminated by radio and print media throughout the country. Thus, the site has had a wider impact than what could be expected based on India's computer density alone.

Given the explosion in mobile phone ownership and widespread use of the Internet, the CVC has stepped up its use of ICTs. The "Blow Your Whistle" site is a technology-supported anticorruption initiative of the CVC. The site allows citizens to report through mobile phones and the Internet by uploading text, audio, and video files. Known as Project Vigeye, the system requires registration, and once a complaint is filed, the complainant can log in and check the status of the complaint. The "Blow Your Whistle" site also has discussion forums and podcasts on corruption in the country, videos, and links to other resources.<sup>16</sup>

<sup>16</sup> The source of information within this section is <http://blowyourwhistle.in/pages/about-us/>.

## INNOVATIVE PRACTICE SUMMARY

### PoiMapper in Kenya

The **PoiMapper** ("Poi" stands for "point of interest") is being piloted by Plan in Kenya to develop a geospatial database for project planning and management. Plan Kenya field staff upload answers to preloaded questionnaires on mobile phones and take photos to record the status and use of development infrastructure such as schools, drinking water sources, and clinics. Information collected includes the number of school-age children and population without access to sanitation facilities; each point of interest, such as a school, is tagged with GPS referencing. This information is uploaded to the PoiMapper portal, where it is overlaid on a digital map to provide the agency with a spatial overview of its projects. This database provides the management of Plan Kenya a comprehensive overview of its projects in the field, and facilitates better planning for available resources. One feature of this application is that it allows organizations to share their data, especially when working in the same region.

**PoiMapper**, as a mobile geomapping, data management, visualization, and sharing solution that can be integrated with open-source portal tools such as Drupal or Vaadin and map engines such as Google Maps or Geoserver. It runs on standard low-end GPS-enabled phones as well as on smartphones. It enables mapping of

- **places**, such as location of schools and water points;
- **routes**, such as roads and water pipes;
- **areas**, such as community boundaries, forests, fields;
- **structured survey data**, such as numbers, text, exclusive, and multiple choice; and
- **multimedia**.

PoiMapper can be used in offline mode for work in locations where connectivity is unavailable and allows viewing of data on digital maps on a web browser. It eliminates the need for expensive hardware and license investments or the need for software licenses. The application allows open access of the stored data and the possibility to integrate open-source analytics tools such as Pentaho for data mining (image 15.4).

The system requires a subscription fee and registration for users to download the software and upload their data to the portal. It will be tested for use in the forest sector through a pilot in Vietnam. Having offline and online capabilities is an advantage in the forest sector, where access to the Internet or cellular networks is often erratic. The cost of the application as a software-as-a-service is a monthly fee per active user. The

**IMAGE 15.4:** POIMapping in Kenya

Source: Plan Kenya.

price depends on volume, whether a project is associated with it, and in which country it is used. The current default pricing is US\$ 15 for NGOs and local users in developing countries and US\$ 30 for commercial organizations and users in developed countries. The developer currently requires a minimum monthly engagement of US\$ 750 (25 users) to set up a new database and support agreement. The price of mobile phones on which the system works starts from US\$ 50 if GPS is not

required and US\$ 150 with embedded GPS, making them affordable for certain project-specific applications. Field staff already use mobile phones, and the application, if useful for project management, is no more complicated than text messaging.

Multiple users can browse and update the same information, and previous versions of data are maintained for tracking purposes. Data are accessible via a web browser, with appropriate authorization. Once an organization registers on the PoiMapper website and creates its account, the software can be downloaded to the mobile phone. Questionnaires relevant to the organization's work can be created and downloaded to the mobile phones. Existing data from a particular location on the portal

can be downloaded, and only new fields can be updated, which makes the system fast and efficient. The application is available for a monthly subscription fee per user, which allows the organization to store its data and edit them on the PoiMapper portal. At this stage, PoiMapper does not have options for data input through icons, which can be developed if needed, but this would restrict the type of data that could be collected or monitored.<sup>17</sup>

## Topic Note 15.2: PILLAR 2—QUALITY OF FOREST ADMINISTRATION

### TRENDS AND ISSUES

High-quality professionals and good information management are key requirements for effective forest management. Distance learning programs are now available on the Internet from a wide range of universities around the world. In addition, some public-sector forest service websites host customized training packages online. For example the U.S. Forest Service has several online training programs on a number of technical tasks, ranging from basic statistics to cruising and scaling. One application on this site is the "Timber Theft Program," which uses regression analysis to estimate standing tree volumes from stumps. Demonstrations include

how to input data, how to perform regression analysis, and how to generate reports in the program.<sup>18</sup>

Not all online training courses have been sustainable. For example, in Chile, the Catholic University of Chile developed extensive online professional development courses and modules for forestry professionals called UC Virtual. After some time, these had to be discontinued due to lack of user demand.<sup>19</sup>

<sup>17</sup> The source of information within this section is <http://www.pajatman.com>.

<sup>18</sup> <http://www.fs.fed.us/fmnc/measure/index.shtml>.

<sup>19</sup> Gurovich (2006) and pers. comm.

Information management, and more specifically, spatial information management is the second key requirement for forest administration. In Finland, MESTA is a free, Internet-based software application that is used to prepare and discuss forest management plans with communities (see box 15.9). Similarly in the United Kingdom, the Forestry Commission found that discussions over management plans with communities were more productive when the commission was able to present digital plans with three-dimensional

### **BOX 15.9: MESTA—Participatory Forest Management Application**

MESTA is open-access Internet software developed and funded by Metla (a Finnish forest research institute). It was first developed to serve as a tool for Metsähallitus (a state entity that manages state forests and most protected areas) for participatory forest management, but it has become available to private forest owners for evaluating different management strategies. Developed for holistically evaluating different decision alternatives, it is based on the definition of so-called acceptance borders for decision criteria (for example, the minimum income from the forest cuttings).

The strength of the software is that it can facilitate the illustration of the effects of different strategy alternatives at stakeholder meetings. A better understanding of the different alternatives and corresponding results can help one stakeholder group in accepting the needs of another stakeholder group. Through the evaluating process, the stakeholders will get information concerning potential costs and benefits.

MESTA has been used in participatory forest management by Metsähallitus in eastern and western Lapland, where decision making often requires difficult compromising on different objectives and needs, such as combining logging with nature-based tourism.

Compared to other methodologies of evaluating different management alternatives, MESTA allows the study of alternatives with less input information and knowledge on the subject. Therefore, it is considered to be efficient, especially when used in communicating with stakeholder groups that have less direct contact with forestry.

*Source:* Finland country report (available at <http://www.profor.info/profor/knowledge/information-management-and-forest-governance>); [http://mesta.metla.fi/index\\_eng.cfm](http://mesta.metla.fi/index_eng.cfm).

maps and images that make the presentations more appealing and make it easier for nonspecialists to comprehend the long-term outcomes of the proposed management actions.

The quality of forest administration also depends on good policy and administration, financial and human resource management, law enforcement and land tenure, and timber sales and revenue management—all of which require unhindered information flows both within the forestry department and with other parts of the government, as well as with the private sector and citizens. Comprehensive forest management information systems have been seen as the ideal solution to enhance the capacity of public-sector forestry institutions to manage these information flows. However, it is possible to deploy smaller-scale ICT solutions to manage information requirements in key areas, such as management of fires, inventories, and wildlife tracking, without investing thousands of dollars in hardware and software. Four such applications are discussed below:

- Real-time fire alerts
- Forest cover and carbon stock assessment with CLASlite and airborne LiDAR
- Google Earth Engine
- Wildlife tracking

#### **Real-Time Fire Alerts**

One innovation in forest management is the near-real-time fire alert system that has been developed by combining NASA's Moderate Resolution Imaging Spectro-radiometer (MODIS) data with GIS. The Fire Information for Resource Management System (FIRMS) by the University of Maryland analyzes the data from MODIS and presents it in a form that is easy to use by field personnel. The system can deliver e-mail alerts to subscribers with information on likely fires in their area of interest.

A more focused alert system is being developed by Conservation International. The Fire Alert System has been developed for use in specific biodiversity hot spots around the world and is currently piloted in Madagascar, Bolivia, Peru, and Indonesia. This system delivers alerts on fires within a few hours after the NASA satellites sweep the earth. The Fire Alert System is a fully automated analysis and alert system that delivers a range of products tailored to a user's specific needs.

There are some other highly advanced fire management systems such as the one used by the New South Wales Rural Fire Service in Australia, which received a Meridian Award

in 2007 (<http://www.meridianawards.com>). HeliFIRE turns MapInfo Professional into a purpose-built application for the airborne mapping of fires. Using a GPS connection, HeliFIRE becomes a moving map application, showing the user's current position. Fire features such as active/non-active fire edge, fire trails, threatened properties, water sources, and firefighter locations can be recorded accurately as the aircraft flies over the features. This information is transmitted immediately via the Internet to users on the ground who make the response decisions.

A second application, MapDesk, turns this information into updated fire maps. This custom application from MapInfo Professional has several features that have been standardized to allow the quick generation of maps with minimal training. Information derived from these applications is delivered to all 70,000 personnel, many of whom are volunteers, as well as to other agencies and the broader community.<sup>20</sup> These custom systems are expensive to build and maintain. But the e-mail and text message updates such as the ones sent by FIRMS are free.

### Forest Cover and Carbon Stock Assessment with CLASlite and Airborne LiDAR

The Carnegie Institution for Science's CLASlite (Carnegie Landsat Analysis System-lite) is a software package designed for highly automated identification of deforestation and forest degradation from satellite imagery. Outputs from CLASlite include maps of the percentage of live and dead vegetation cover, bare soils, and other substrates, along with quantitative measures of uncertainty in each image pixel (see image 15.5).

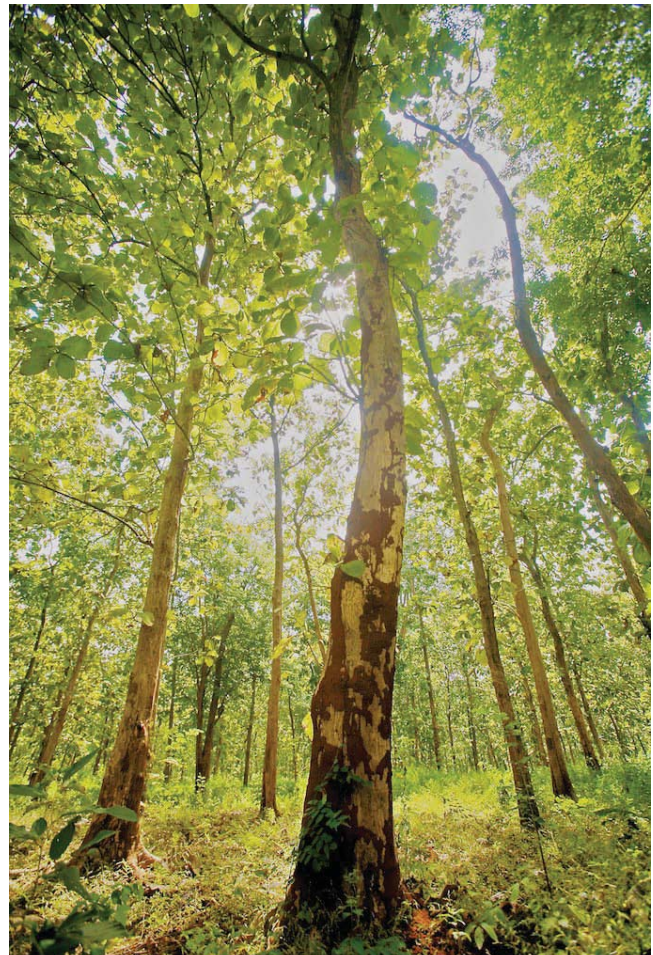
CLASlite converts satellite imagery from its original (raw) format, through calibration, preprocessing, atmospheric correction, and cloud-masking steps, and then performs a Monte Carlo Spectral Mixture Analysis to derive high-resolution output images. Its algorithms easily identify and accentuate areas where clearing, logging, and other forest disturbances have recently occurred. CLASlite does not provide a final "map" but rather a set of ecologically meaningful images identifying forest cover, deforestation, and forest degradation that can be readily analyzed, processed, and presented by the user.

The new approach involves four steps undertaken in concert to produce a rapid high-resolution assessment of forest carbon:

1. Mapping of vegetation type and forest condition using freely available satellite data and CLASlite.
2. Large-area mapping of forest canopy three-dimensional structure using airborne LiDAR.
3. Conversion of LiDAR structural data to aboveground carbon density estimates using LiDAR-carbon metrics along with a tactical use of field calibration plots.
4. Integration of the satellite map with the airborne LiDAR data to set a regional, high-resolution baseline carbon estimate.

CLASlite runs on standard Windows-based computers and can map more than 10,000 km<sup>2</sup> (at 30 m spatial resolution) of forest area per hour of processing time. While CLASlite is highly automated, its user guide recommends a level of training corresponding to the complexity of the forest area.

### IMAGE 15.5: Satellite Imagery Can Map Levels of Vegetation, Forest Cover, and Forest Degradation



Source: CIFOR.

<sup>20</sup> <http://www.meridianawards.com/hall-of-fame/view/combating-bushfire-wild-land-fires-in-the-state-of-nsw-australia/>.

According to the developers of the system, the cost using a combination of commercial and free data sources is approximately US\$ 0.10 per hectare and is likely to fall further. Free licensing of CLASlite is granted to nonprofit/noncommercial organizations in Latin America following completion of technical training. The CLASlite website<sup>21</sup> reports that as of June 2010, more than 150 governmental institutions, NGOs (non-commercial), and academic or research institutions have been trained in the use of CLASlite.

The developers of CLASlite have also tested airborne Light Detection and Ranging (LiDAR) in conjunction with remote sensing and ground mapping to carry out carbon stock assessments, to establish it as a low-cost and efficient method of assessing carbon in different types of tropical forests (see Module 5 on productivity for more on LiDAR).<sup>22</sup>

### Mapping in the Cloud: Google Earth Engine

Google Earth Engine is a technology platform that puts an unprecedented amount of satellite imagery and data—current and historical—online for the first time. It enables global-scale monitoring and measurement of changes in Earth’s environment. The platform will enable scientists to use Google’s extensive computing infrastructure to analyze this imagery. The images of Earth from space contain a wealth of information. Scientific analysis can transform these images into useful information—such as the locations and extent of global forests, detecting how forests are changing over time, directing resources for disaster response, or mapping water resources. The challenge has been to cope with the massive scale of satellite imagery archives and the computational resources required for their analysis. As a result, many of these images have never been seen or analyzed. Now scientists will be able to build applications to use these data on Google Earth Engine and will be able to take advantage of the following features and benefits:

- Landsat satellite data archives over the last 25 years for most of the developing world available online, ready to be used together with other data sets, including MODIS. A complete global archive of Landsat is expected to be available soon.
- Reduced time to do analyses, using Google’s computing infrastructure. By running analyses across thousands of computers, for example, unthinkable tasks are now possible for the first time.

- New features that will make analysis easier, such as tools that preprocess the images to remove clouds and haze.
- Collaboration and standardization by creating a common platform for global data analysis.

Google Earth Engine can be used for a wide range of applications—from mapping water resources to ecosystem services to deforestation. Initial use of Google Earth Engine is most likely to support development of systems to monitor, report, and verify efforts to stop global deforestation.

During the United Nations Framework Convention on Climate Change, COP 16, in Cancun in December 2010, it was announced that 10 million CPU-hours a year over the next two years would be donated on the Google Earth Engine platform to strengthen the capacity of developing world nations to track the state of their forests, in preparation for REDD. The Earth Engine was developed in collaboration with the Gordon and Betty Moore Foundation, the U.S. Geological Survey, Mexico’s state forest agency (CONAFOR), scientists of the Carnegie Institution for Science, the Geographic Information Science Center at South Dakota State University, and Imazon to develop and integrate their desktop software to work online with the data available in Google Earth Engine.<sup>23</sup>

### Wildlife Tracking and Management

Conflicts between humans and wildlife are common where communities live in or near wildlife sanctuaries and parks. The following applications prove that ICTs can be used for wildlife tracking and management with the assistance of communities. Even simple mobile text messages sent on a regular basis to communities to keep them updated on the movement of wild animals can go a long way in helping people stay safe and in turn not harm the wildlife. “Push to talk” is a rather infrequently used feature of mobile phone networks in developing countries. However, there is an interesting example of its use to alleviate conflicts between humans and elephants in the Laikipia District of Kenya. This case demonstrates that park management, communities, and the private sector can, assisted by the innovative use of mobile phones, come together to find a viable solution for management of wild elephants and crops.

21 <http://claslite.ciw.edu/en/index.html>.

22 The sources of information within this section are Asner et al. 2009, <http://claslite.ciw.edu/en/index.html>, and [http://claslite.ciw.edu/documents/CLASlite\\_PeruREDD.pdf](http://claslite.ciw.edu/documents/CLASlite_PeruREDD.pdf).

23 Information in this section is drawn from Google Blog (<http://googleblog.blogspot.com/2010/12/introducing-google-earth-engine.html>) and <http://www.unep.org/stap/Portals/61/docs/SFM/20.Moore.pdf>.

Another example of ICTs being employed to track wildlife is CyberTracker, a free software application that was developed to enable indigenous communities with little or no literacy to track wildlife in game parks. The software uses icons and pictures to guide data inputs and works on handheld computers with GPS capability. One of the longest ongoing uses of CyberTracker is at Kruger National Park in South Africa, where rangers collect vast amounts of data on, among other things, the movements and behaviors of key species, fires, availability of water, illegal presence and activities of humans, and the presence of new or invasive species of plants. CyberTracker has been piloted in several countries in Africa, mainly for recording and monitoring wildlife and biodiversity data to aid research and management (CyberTracker Conservation 2007).

### **INNOVATIVE PRACTICE SUMMARY** **Fire Alert Systems Integrating Remote Sensing and GIS**

Remote sensing and GIS are now being integrated to provide timely information on large-scale fires in the tropics. The Moderate Resolution Imaging Spectro-radiometer (MODIS) that flies on NASA's Aqua and Terra satellites as part of the NASA-centered international Earth Observing System provides the data. Both satellites orbit Earth from pole to pole, seeing most of the globe every day.<sup>24</sup>

#### **The Fire Information for Resource Management System**

While NASA's MODIS Rapid Response system provides near-real-time images and data on global fires in the public domain on the Internet, forest managers in the field would be unable to find the time and technical skills to analyze the data quickly. The University of Maryland developed the Fire Information for Resource Management System (FIRMS) to serve MODIS fire observations to this community. FIRMS displays active fires detected in near-real time using thermal and mid-infrared data from the MODIS instruments; this means the data are processed and available on the web four to six hours after the satellite passes over. Subscribers can sign up for e-mail alerts on fires in their area of interest. The Web Fire Mapper of FIRMS is an open-source, Internet-based mapping tool that delivers locations of hot spots and fires. These can be viewed on an interactive world map showing hot spots or fires for a specified time, combined with a selection of GIS layers and satellite imagery. Each

hot spot/active fire location represents the center of a 1 km (approx.) pixel flagged as containing one or more hot spots or fires within that pixel. FIRMS is currently being transitioned to an operational system at the United Nations Food and Agriculture Organization.

#### **Conservation International's Fire Alert System**

The Center for Applied Biodiversity Science at Conservation International, International Resources Group, Madagascar's Ministère de l'Environnement, des Forêts et du Tourisme, and USAID have teamed up with the MODIS Rapid Response System and FIRMS to develop an e-mail alert system for fires in or around protected areas and areas of high biological importance. This system currently focuses on some biodiversity hot spots: Madagascar, Bolivia, Peru, and Indonesia. The Fire Alert System is a fully automated analysis and alert system that delivers a range of products tailored to a user's specific needs. These include simple text-based e-mails containing the coordinates of active fires within protected areas, areas of high biodiversity, different vegetation and land cover types, administrative units, or user-defined regions. The e-mails can include JPEG attachments showing a satellite image of a protected area with the active fire depicted as red squares, ESRI shape files for importing into GIS software, and KML files for importing data into Google Earth. Each e-mail alert also provides information on the time and date of satellite observations and a confidence value for each fire detected. Subscribers may select from a range of background images and maps. The next phase of this system will include multivariate/multicriteria analysis, which enables more flexible user customization, and an advanced report generator.

In addition to fire response and management, the Fire Alert System is now being extensively used to monitor and inform enforcement officials of suspected illegal activity such as illegal logging and encroachment taking place in protected areas.

### **INNOVATIVE PRACTICE SUMMARY** **Kenya: Solving Human-Elephant Conflicts with Mobile Technology**

The Laikipia District is home to the second-largest population of wild elephants in Kenya. There is competition for land between the wealthy farmers who own large ranches and private conservancies, small agriculturists, and the elephant herds whose natural habitat and corridors have been made inaccessible by human activity. The frequent encounters between people and elephants have caused human and elephant deaths.

<sup>24</sup> Information within this section is drawn from Davies et al. 2009 and <https://firealerts.conservation.org/fas/home.do>.

To find a viable solution to this situation, the GSMA Development Fund in collaboration with the University of Cambridge Laikipia Elephant Project, the Laikipia Nature Conservancy, Laikipia Wildlife Forum, Safaricom, Wireless ZT, Nokia, and Nokia Siemens Networks devised a closed-group communication network between the park staff, ranch owners, and farmers in the district with special push-to-talk mobiles. This technology combines the functionality of a walkie-talkie or two-way radio with a mobile phone and enables communication between two individuals or a group of people, as needed, with the push of a single button. With stakeholder consultations and training, the pilot project initiated communication between the Kenya Wildlife Service staff, ranch owners, farmers, and NGOs that normally would not take place in a systematic way. The pilot was meant to reduce human-elephant conflict, by facilitating early communication between the stakeholders regarding elephant movement and seeking the help of wildlife rangers when needed.

The results of this pilot proved that improved communication between the various stakeholders significantly reduced

human-elephant conflict: 73 percent of the users in the pilot said that the technology provided early warning of elephant raids and allowed the farmers to take preventative actions. Sixty-five percent of the users also reported that the system helped prevent theft of livestock and recover stolen livestock. Twenty-one percent also reported that management response improved, especially by the Wildlife Service staff. An important observation by one user was that group communication increased pressure on the government staff, because several members listen in to a request for intervention. Thus, accountability of the Wildlife Service staff seems to have increased. The use of this technology was also appreciated by the Wildlife Service, which reported that receiving reliable information over a larger area helped it to be more effective in the job.

While the results of this pilot were very encouraging, the service was not rolled out on a larger scale. Cellular operators did not find this technology commercially attractive in Kenya. Nevertheless, the pilot proves that “push to talk on cellular” has benefits in specific situations and could be used in other locations where similar challenges in wildlife management exist.<sup>25</sup>

## Topic Note 15.3: PILLAR 3—COHERENCE OF FOREST LEGISLATION AND RULE OF LAW

### TRENDS AND ISSUES

In the forest sector, various types of resource use, both commercial and noncommercial, are governed by various laws. At the same time, forests have several characteristics that make them prone to timber theft and other illegal activities:<sup>26</sup>

- owner absent
- potential witnesses indifferent or hostile to owner
- easy to bribe way out of trouble
- asset unsupervised/unguarded
- loot easy to sell
- owner/manager unaware of inventory and value
- police untrained, underequipped, uninterested
- staff untrained and underpaid
- lax business practices/procedures

Many of these vulnerabilities can be addressed through ICTs. Effective law enforcement systems in the forest sector

usually follow the steps of prevention, detection, and suppression. Technology has an important part to play in each of these steps in the efforts to curb illegal logging, transportation, and processing of timber and illegal trade in wildlife. A variety of ICT applications can be used to improve deterrence and response measures, and these have been discussed in detail in previous World Bank reports.<sup>27</sup> A few innovative ones are reviewed here:

- **prevention**—e.g., crime mapping, corruption hotlines
- **detection**—e.g., timber tracking, chain of custody systems, checkpoints, satellite images, GPS surveillance
- **suppression**—e.g., crime databases, case management systems

### Mobile and Online Crime Reporting Services

Governments around the world are increasingly involving citizens in crime reporting through e-government services to

<sup>25</sup> Information within this section is drawn from Graham et al. 2009.  
<sup>26</sup> Magrath, William. 2009: Presentation at World Bank—FAO workshop on forest law enforcement and governance in Asia-Pacific, Kuala Lumpur, November, unpublished.

<sup>27</sup> See, for example, Magrath et al. 2007, Asia-Pacific Forestry Commission 2010, and Dykstra et al. 2003.



report incidences of corruption and crime. Members of the public can send text messages, leave a voice message or send e-mails to report incidences of corruption and crime. Allowing citizens to report crime to the authorities is a cost-effective and reliable way of preventing crime. The website of India's Central Vigilance Commission has a similar system where anonymous callers can report corrupt officials of state agencies. The example from a crime prevention project in Peru shows how citizens can effectively contribute to law enforcement and crime reduction in a municipality. The municipality of Miraflores in Peru has developed a system called Alerta Miraflores to manage crime, using an Internet and phone-based system that does the following:

- gives citizens a way to report incidents to local security officials to record and take action
- captures data electronically and displays the information on reports and maps to let public safety officials pinpoint the areas from which citizens are calling, define priorities, and dispatch the closest officers
- allows municipal officials to manage citizen security proactively, respond more rapidly, and analyze results

By improving its ability to rapidly respond to reported incidents, providing timely feedback to citizens, and capturing detailed crime information, the municipality was better able to prevent crime and increase citizen security. Alerta Miraflores has reported a 68 percent drop in robberies since 2003, and a 30 percent reduction in assaults and a significant reduction in overall crime.

The tools and methods used in this project have a lot to offer to the forest sector. One application was used by the Blue Link Information Network's project in Bulgaria called "Expose and Improve—The Power of Information Technologies (IT) in Combating Illegal Logging." Individuals participate by registering alerts (30 alerts have been logged

in the system since its launch in July 2009) and by supporting NGO experts in the preliminary checks on the registered alerts. Alerts are checked against a checklist of indicators to verify the criminal character of the case before submitting it to the authorities. Established environmental NGOs in Bulgaria have demonstrated their genuine interest and active support of the project by providing expert advice on forestry issues, participating in preliminary checks, and lobbying for the integration of the online platform into the work of the Bulgarian forestry administration. While this project was developed and executed by an NGO, it could be easily undertaken by forest law enforcement agencies. The system could enlist the services of interested NGOs and citizens to report suspicious activities that can trigger additional investigation by the forest agency. The ability to receive information via mobile text messages or voice messages helps the system to be used by anyone.<sup>28</sup>

A key issue to be solved is the confidentiality of information and safety of the informants. It is essential that all information is dealt with very carefully both to ensure the safety of the individuals who report crimes and to ensure that the reporting system is not used for spreading unfounded allegations.

Tracking and suppressing illegal logging and trade in endangered wildlife often needs information beyond the borders of a single country. The United Nations Office on Drugs and Crime has developed a series of software applications to help countries collect, analyze, and share intelligence and information on international crime (see box 15.10).

### Technologies for Surveillance and Deterrence

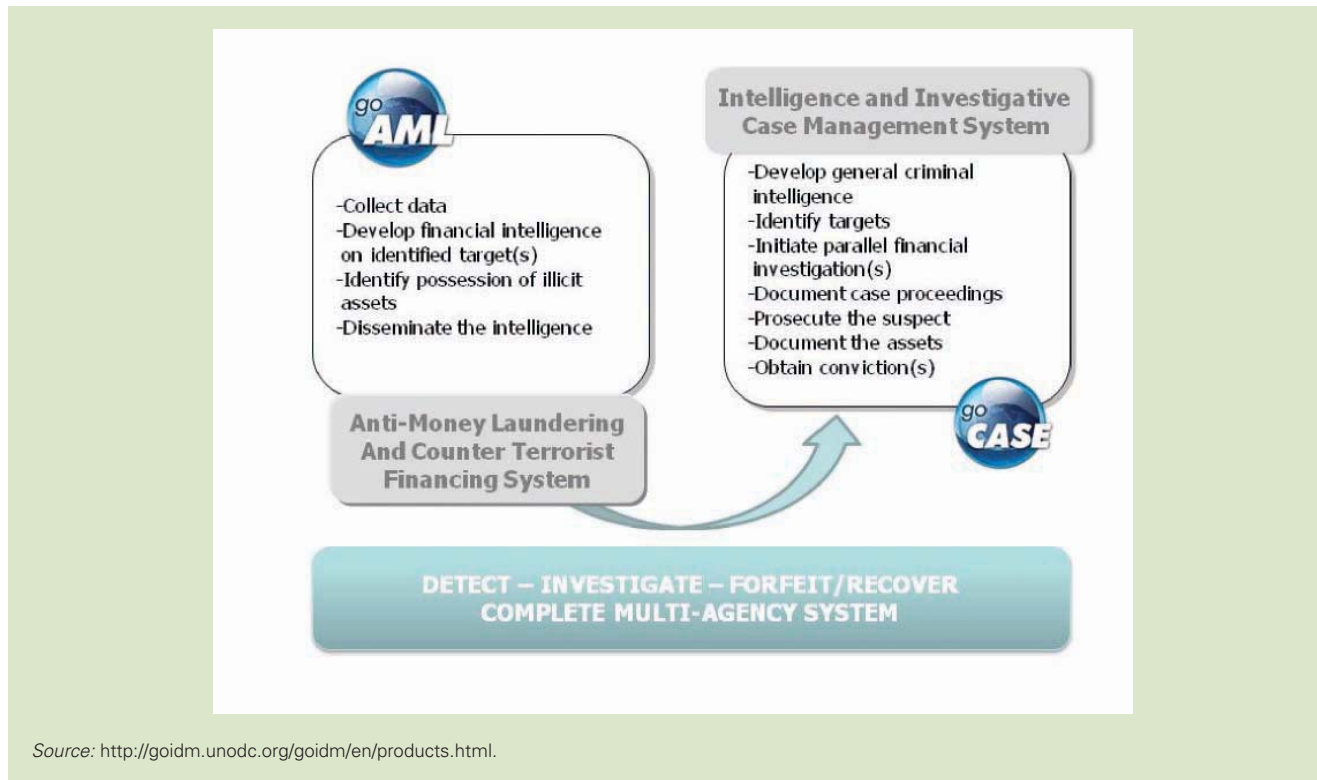
While there are several sophisticated technologies available for crime detection, only some are specific to the forest

<sup>28</sup> <http://www.spasigorata.net/> and <http://www.bluelink.net/en/>.

### BOX 15.10: UNODC's "Go" Family of Products

The Information Technology Service of the United Nations Office on Drugs and Crime (UNODC) specializes in the development, deployment, and support of software applications for use by member states in a range of UNODC's program areas. The Government Office ("go") family of products are part of UNODC's strategic response to crime, particularly serious and organized crime. The "go" family includes integrated investigative case management and intelligence analysis tools for financial intelligence units, law enforcement, investigative, intelligence, regulatory, prosecution, and asset recovery agencies, and for courts and other government agencies involved in the criminal justice process. All the software products include multifaceted integration and can function as stand-alone applications or together to form one global system, depending on the needs of the country. The application of systems able to interface with each other encourages inter-agency and cross-border cooperation and information sharing at the national, regional, and international levels.

*(continued)*

**BOX 15.10:** *continued*

sector. The computerization of checkpoints in Gujarat, India, is a good example of how technology can lead to better law enforcement and increased revenues for the state.

A slightly different approach for surveillance—with the help of GPS—has been tried with success in fisheries in West Africa under the Sustainable Fisheries Livelihoods Program, sponsored by FAO and the UK Department for International Development. Community surveillance of fishing grounds in Guinea has succeeded in reducing illegal incursions by industrial trawlers by 59 percent. Members of the fishing community on Guinea’s northern coast use GPS technology to track poachers. The fishermen can calculate the exact location of a poaching trawler using a handheld GPS receiver and radio the information to the nearest coast guard station. The GPS coordinates generate an alert if the trawler is in within the prohibited zones.<sup>29</sup> The fisheries example has a lot of relevance for the forest sector; while communities may not

be in a position to monitor vehicle movement inside forests, forest authorities could use similar means to track vehicle movement in unauthorized locations.

### Technologies for Timber Tracking and Chain of Custody Systems

Radio frequency identification (RFID) holds considerable promise for use in systems tracking the timber supply chain. RFID uses radio waves to exchange data between a reader and an electronic tag attached to an object, for the purpose of identification and tracking. Some tags can be read from several meters away and beyond the line of sight of the reader.

On average, an appropriate RFID chip costs from US\$ 0.07 to US\$ 0.15. An important advantage of RFID systems for log tracking is that signals can be read rapidly, remotely, and under difficult conditions. RFID labels can potentially store a large amount of data with a high level of security. The labels can be difficult to counterfeit or tamper with and can provide a high level of covert security. These devices can significantly facilitate data capture, data processing, and security audits. It is possible to encode RFID labels at all stages of the wood

29 Lowrey, Peter. 2004. “SFLP: Arming Fishermen with GPS to Combat Poachers.” ICT Update No.16, February ([http://ictupdate.cta.int/en/\(issue\)/16](http://ictupdate.cta.int/en/(issue)/16)); <http://www.fao.org/english/newsroom/focus/2003/sflp4.htm>.

supply chain from the field to the end user. RFID labels can enhance logistics and inventory functions.

Microtaggant tracers are microscopic particles composed of distinct layers of different colored plastics that can be combined to form a unique code. Millions of permutations are possible by combining several colors in different sequences. Codes can be read in the field with 100-power pocket microscopes. These tracers can be used together with other labels to provide additional security and to aid investigations of log theft or log laundering. They do not represent a stand-alone labeling technology.

Chemical and genetic fingerprinting offer promise for the future but are currently too expensive and have not been fully developed for routine use in wood supply chain tracking systems. They are likely to prove most useful in proving the origin of wood in investigations of log theft or log laundering.

GPS tracking devices for vehicles can be used to track movement of vehicles and can quickly point to vehicles in unauthorized locations. The GPS vehicle tracking unit can have a wireless modem that is able to communicate with global tracking systems<sup>30</sup> (image 15.6).

30 Information in this section is drawn from <http://gpstrackit.com/faq> and Dykstra et al. 2003.

**IMAGE 15.6: Tracking through Barcodes, RFID, GPS, and Other Technologies Improves the Chain of Custody**



Source: Tuukka Castrén.

More technologies and two examples of timber tracking are discussed in IPS “Ghana National Wood Tracking System” and IPS “Liberia: LiberFor Chain of Custody.”

**Legal Information Management Systems: Global Legal Information Network**

The Global Legal Information Network (GLIN)<sup>31</sup> is an electronic online tool that gives access to authentic and updated official legal information at a low maintenance cost. The system has been developed by the U.S. Library of Congress to improve access to original legal texts. In Gabon, GLIN has been used by the government to publish the primary sources of the law and all environmental legal information. The government chose to become a member of GLIN to provide the stakeholders (forest administrations, private sector, donors, civil society, NGOs, and so on) with a modern legal archiving system. The system helps to strengthen the rule of law and to start a discussion among stakeholders. Experience from courts and government institutions has shown that the Internet was their only source of access to reliable, up-to-date legal information.

**INNOVATIVE PRACTICE SUMMARY  
Ghana National Wood Tracking System**

The Ghana National Wood Tracking System (WTS), developed by Helveta Ltd., provides a timber legality assurance system that is an important tool in reducing illegal logging—a key initiative under the EU–Ghana Voluntary Partnership Agreement. The system addresses the traceability of wood in on-reserve areas destined for export. However, a chain-of-custody system should track all wood and wood products in circulation in a given market. Otherwise the system makes it easy to “launder” illegal wood—that is, mix it with legitimate sources. The system uses hand-held computers in remote forest areas in conjunction with plastic barcoded tree and log tags to capture data such as species, diameter, length, and geospatial location. WTS is based on an existing

31 <http://www.glin.gov> and PROFOR (2010).

system from Helveta Ltd. called CI World. It consists of four main components:

- identification and tagging of individual products or consignments using barcoded labels or RFIDs
- incorporation of these tag numbers onto the statutory forms used for declarations, inspections, and other relevant records and reports
- use of electronic technology for data collection and transmission
- development of a database to receive, analyze, and report all wood production and movements

WTS allows Ghana to demonstrate compliance and control across to their timber supply chains and secure access to premium markets in the European Union and United States. Trees are numbered (engraved on the tree), and next to the numbering is a white tag that has a barcode with the corresponding number.

A PDA equipped with GPS, scanner, camera, and data input is handed out to the enumerators who venture into the reserve with the field rangers and supervisors. The stock enumeration involves numbering and tagging the yet-to-be harvested timber with a barcode near the base of the tree. When harvested, the timber would also have a replica number and barcode, allowing tracking of the timber through the process to export. Information collected includes the following:

- Allocation of reserves, compartments, and lots
- Consortium holding
- Consortium harvesting schedule and by whom
- Plant species and how harvest is done
- Where to mill
- Due diligence on taxes
- GPS position of trees

The timber flows monitored and verified are standing trees in the lots or compartments in the forest reserves; the system has not yet proceeded to tracking the timber through logging and processing, import to processing, and local sales or export. WTS will enable the tracking of individual logs and consignments of processed products. It will include product labeling, physical inspections, and documentation checks electronically. The use of ICT in this case allows a more comprehensive review of all wood movements than paper-based systems alone can provide, which is the current method.<sup>32</sup>

<sup>32</sup> Information in this section drawn from the Ghana country report, available at <http://www.profor.info/profor/knowledge/information-management-and-forest-governance>.

## INNOVATIVE PRACTICE SUMMARY

### Liberia: LiberFor Chain of Custody

LiberFor is a public-private partnership developed in 2007 to implement a tracking system for the forest product supply chain. The chain extends from the stump to the point of export to prevent illegal timber from entering the supply chain and being exported. The system is currently managed by a private international company, but management will be gradually transferred to the Liberian Forest Development Authority.

The system will be able to monitor all timber flows in Liberia and ensure the integrity of regulatory documents and sampled field checks. It will also prepare all the timber sales and taxation invoices and monitor payments made by logging companies to the government. Ultimately, after checking that all requirements have been met and payments have been made, LiberFor issues an export permission for the timber.

Forests cover 45 percent of the total land area in Liberia, and they are an essential source of revenue and economic development for the country. After coming out of a 14-year civil war, the country needed to build a system to manage its forest resources professionally and in a sustainable way. Previously, illegal logging had been a key driver of corruption and financial, social, and legal problems. For example, in 2006 approximately US\$ 64 million of logging revenues were in arrears and only 14 percent of revenues were accounted for.

The new chain-of-custody system has been designed to ensure that there is no return to the past uncontrolled logging in the country. Like WTS in Ghana, LiberFor is based on the Helveta platform. Its main components are as follows:

- **CI Earth—mapping**
  - block maps
  - stock surveys
  - plantation compartment maps
- **TracElite—chain of custody**
  - tree felling
  - cross-cutting, dressing, and log registration
  - transport of logs and wood products
- **Performance management**
  - data reconciliations
  - data verifications
  - random samplings and inspections
- **Document management**
  - concession registrations
  - invoicing and regulatory document
  - management tag control

The system has tagged and located approximately 440,000 trees, verified approximately 180,000 trees in the system, and invoiced more than US\$ 11 million in revenue, mainly from areas fees.

With the new system, the Liberian Forest Development Authority will be able to do the following:

- Manage the supply chain for all wood products from the point of origin to the export gate or domestic markets.
- Manage the conditions for release of timber export permits.
- Ensure that taxes and fees related to timber production and trade are collected.
- Invoice and monitor payments by logging companies to the government through an information system involving the forest administration, Ministry of Forestry and Central Bank.
- Strengthen the capacity of the Liberian Forest Development Authority.
- Help both the Forest Development Authority and private concession holders to better know the resource

base in the forest, which is a precondition for sustainable forest management.

The LiberFor chain-of-custody system is being operated on a build-operate-transfer basis by SGS Liberia. While the system is technically functioning and able to meet the requirements of law enforcement and revenue collection, there are severe concerns regarding the sustainability and feasibility of the system. Both public and private sector stakeholders have raised concerns that the system is extremely complicated, has increased transaction costs unnecessarily, and is inappropriate for the Liberian context. The main concerns were based on the need to have a 100 percent inventory (above a threshold size) of the logging sites (as opposed to only collection information on commercial species), inappropriate design of the tags, and dependence on LiberFor inspectors. One issue of concern is that the system runs on Helveta servers in the United Kingdom rather than in Liberia. Long distances and limited international bandwidth may lead to reliability issues.<sup>33</sup>

## Topic Note 15.4: PILLAR 4—ECONOMIC EFFICIENCY, EQUITY, AND INCENTIVES

### TRENDS AND ISSUES

Timber sales and auctions and concession-allocation processes are prone to unfair practices, collusion, and nontransparent decision making. This ultimately has an impact on both state revenues and private sector competitiveness. In general, participatory design and proper enforcement of the law should result in more equity and economic efficiency. Thus, technologies aiding law enforcement could be considered tools for enhancing equity and efficiency as well.

#### Online Timber Sales, Licenses, and Auctions

There are examples of ICT applications that are designed to promote business transactions with the private sector. One such example is the online auction of public timber, or e-auction. Most forest agencies in developing countries do not have integrated and well-functioning forest management and information systems that would enable e-auctions. Even in developed countries there are only a few instances of fully online systems.

The Forestry Commission of the United Kingdom has an advanced online auction system (image 15.7). The auction process is fully online and integrated into the e-government service of the United Kingdom. This site is simple to use and

has a help feature that tackles most of the common problems faced by users. The site explains the different types of auctions and allows bidders and nonbidders to view sales events, which increases transparency. All terms and conditions are posted, so that bidders are fully informed before bidding. In addition, there are links and phone numbers to provide help. As a truly online auction, the sale closes automatically when the bid closes and the winner is informed, with no further need for paperwork. Bidders cannot see other bidders' quotations, and losing bidders are only given the name of the winning bidder on request. The system has been operational since 2004, and about one-third of the Forestry Commission's annual production of about 6 million m<sup>3</sup> is sold on the open market, indicating that electronic sales are an effective model. Cost-benefit analyses carried out by the commission reveal that approximately £100,000 are being saved annually as a result of electronic sales.<sup>34</sup>

The commission also operates an online grants and licences system that provides private forest and farmland owners an opportunity to apply for grants to plant trees or seek permission to fell trees on their lands. The system enhances transparency by displaying all applications on the website,

<sup>33</sup> Information within this section was provided by the LiberFor team.

<sup>34</sup> Pers. comm.

linking each application by a case number to the map, which shows the location of the proposed activity.

### Logistics

Two examples from Finland demonstrate the use of tracking devices to improve efficiency and productivity. One project, called Indisputable Key, used RFIDs to reduce waste and increase the usable volume of wood from the harvest, while the Metka project was aimed at reducing transportation costs to increase productivity. Transportation costs are optimized when only those piles of bioenergy wood that have dried to the right moisture content are transported by the company. Both examples could be adapted to any wood-processing unit around the world.

## INNOVATIVE PRACTICE SUMMARY

### RFID Chips for Efficient Wood Processing

The multinational development project Indisputable Key was a three-year EU-funded endeavor with a total budget of €12 million. It was launched in 2006 and held its final seminar in March 2010. The primary objective of the project was to decrease the proportion of timber that is wasted or used for lower-value end products than the initial timber quality would have warranted. The data management is based on Individual Associated Data

methodology. According to this methodology, each felled tree has a unique code through an embedded microchip connected to a database. The chip or tag can also include information about the log parameters, felling location, and time of felling. This information is used in subsequent stages of the production chain to optimize process exploitation. Within the project, a new type of RFID tag was developed. By using new, pulping-compatible raw material, the tag does not affect any of the processing options. The project also resulted in the development of transponders that could read and modify tag data in harvesters and in tools such as large metallic saws, which had been problematic with the old transponders. The system was designed to be usable in all possible field conditions within the European Union, from the northern icy conditions to the southern warm and dry conditions.

The increased efficiency of the timber supply is achieved through the ability to source the raw material from the harvesting point all the way to the most profitable producing unit. Currently, the forest industry consumes timber in bulk without taking full advantage of the different characteristics of wood harvested from different origins. By being able to identify different sources, manufacturers can take into account the differences in timber quality in the processes. The quality aspect is noticed in market transactions through premiums for better timber quality. The methodology and technology behind the system are fully transferable to any geographical area.

**IMAGE 15.7:** Online Timber Sales in the UK

The screenshot displays the 'View Tender' interface for the 'FC England Territorial Timber Tender 07 July 2011'. The main window shows the tender details, including the time remaining (25 days), description, type (English Sealed), open time (8/16/11 12:30 PM), bidding stop time (7/7/11 12:00 PM), and phase (Preview). A secondary window titled 'Lot Information' is open, showing details for 'SHERWOOD - Morkerywood'. The lot details include: Contract Number: F18958, Lot No. and Name: SHERWOOD - Morkerywood, Product: Clearfell, Point of Sale, Unit of Sale: Tonnes, Quantity: 2,197, Species Summary: GF/SY, Stand Mean DBH (cm): 81/11, Start Date: 1/01/12, End Date: 1/01/12, Log lots only, Minimum Top Diameter UB (cm): N/A, Length Specified (m): N/A. Comments state: 'All maps can be viewed through the View Maps.' Attachments include: Biosecurity.doc, User Terms and Conditions, Purchase Terms and Conditions, and Lot Summary.

Source: UK Forest Commission.

## Metka

Metka is a development project that uses an RFID tracking system. The project's objective is to develop an operational tracking system for local bioenergy supplier Vattenfall; the client benefits from increased profitability of wood-based bioenergy production. The software developer Protacon built the information database, basing the system on existing Oracle-based stock management software. The tracking system is built on RFID tags attached to the bioenergy wood piles when harvested. The cost efficiency of the system is achieved by using cheap, low-capacity bulk tags. This makes it possible to track low-value items as well. The tag allows the company to follow the chain of custody more carefully and to optimize the processes to reduce the transportation costs. Another benefit from the information in the tags is the ability to optimize the drying time of harvested wood in order to minimize the transportation costs and maximize the calorific value per transported units. This has a remarkable effect on the chain profitability. The system has been taken into operational use by Vattenfall. At the moment, the system is in use in the areas of two forest management associations and by two operators. The total number of vehicles and forest tractors using the system is about 10.<sup>35</sup>

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<sup>35</sup> Information in this section is drawn from the Finland country study (available at <http://www.profor.info/profor/knowledge/information-management-and-forest-governance>) and <http://www.indisputablekey.com>.

# GLOSSARY

**2G, 3G, 4G.** Second-, third-, and fourth-generation [developments in mobile wireless technology]. 2G mobile wireless has basic functionality: voice and short messaging service (SMS); 3G has advanced functionality: general packet radio service; and 4G has broadband functionality: long-term evolution (LTE).

**Active infrastructure sharing.** The shared use of electronic infrastructure such as network components (for example, access node switches), radio transmission equipment, and core network software systems. See *passive infrastructure sharing*.

**Aerial photography and orthophoto mosaic.** An image (once a photograph, now a digital image) of the ground taken from an airplane, helicopter, or radio-controlled aircraft at a given altitude. Aerial images are presented as an orthophoto mosaic that is an alternative to a map. These images are higher in resolution (decimeter) than satellite images, proving useful for those who want more details of the terrain such as crop conditions or land use.

**Agricultural innovation system (AIS).** A network of organizations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organization into economic use, together with the institutions and policies that affect their behavior and performance.

**Application.** A software program or groups of programs enabling users to perform particular operations. They consist of systems software (operating systems for managing computer resources, for example) and programs such as those for data processing, word processing, and a multitude of functions that run on systems software. An IT application for managing dairy cooperatives, for example, relies on numerous kinds of applications running on the operating systems of any number of devices and the Internet. See <http://www.webopedia.com/TERM/A/application.html>.

**Basis risk.** In index-based insurance, the imperfect relationship between the policy holder's potential loss and the behavior of the index. One farmer's loss from drought may not perfectly match that of all others; some farmers will lose more and some less.

**Biometric cards.** Identification cards with a microchip or barcode that contains information on the physical characteristics of the holder. These cards can help prevent fraud and identity theft by providing a more accurate means of identification.

**Broadband.** Specifically, a signaling method that handles a relatively wide band (spectrum) of electromagnetic frequencies. More generally the term refers to a telecommunications signal or device of greater bandwidth than another standard or usual signal or device (and the broader the band, the greater the capacity for traffic). The wider (or broader) the bandwidth of a channel, the greater the information-carrying capacity, given the same channel quality. (Based on [http://en.wikipedia.org/wiki/Broadband#Internet\\_access](http://en.wikipedia.org/wiki/Broadband#Internet_access), accessed July 2011.)

**Chain traceability.** Recording and transferring product or process data through a supply chain between various organizations and locations involved in the provenance of food. See *internal traceability*.

**Cloud computing.** A model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. Cloud computing permits organizations without the resources to invest in extensive computing power to rent this service from a provider and access it remotely. (Based on [http://en.wikipedia.org/wiki/Cloud\\_computing?oldid=0](http://en.wikipedia.org/wiki/Cloud_computing?oldid=0), accessed August 2011).

**Commercial supply chain.** In agriculture, a supply chain in which a private agribusiness is sourcing agricultural produce from farmers or selling products to farmers in accordance with a profit-seeking business model. Often used interchangeably with supply chain and value chain.

**Commodity futures exchange.** A market in which multiple buyers and sellers trade commodity-linked contracts on the basis of rules and procedures set out by the exchange. Such exchanges typically act as a platform for trade in futures contracts (standardized contracts for future delivery of a commodity). (Based on a definition by the United Nations Conference on Trade and Development.)

**Crowdsourcing.** Shorthand for leveraging mass collaboration through ICTs by distributing tasks to or requesting information from a large group of people or community ("crowd") through an open call or message.

**Data mediation.** The process of using many data sets to produce a single, coherent set of information. Data mediation software organizes different types of data (such as hourly versus daily) and synthesizes different approaches to classification (for example, the use of different classification vocabulary), helping to mediate differences between data sources—particularly those on the internet.

**Data mining.** The extraction of stories or patterns from large amounts of data. Data mining can find four major patterns: clustering (discovering groups), classification (forming a structure), regression (finding a function), and associations (finding relationships).

**Digital divide.** Differences in the capacity to access and use ICTs among individuals, men and women, households, geographic areas, socioeconomic groups, ethnic groups, and so forth. The capacity to access ICTs encompasses physical access as well as access to the resources and skills to participate effectively as a "digital citizen." (Based on the definition in [http://en.wikipedia.org/wiki/Digital\\_divide](http://en.wikipedia.org/wiki/Digital_divide), accessed July 2011.)



- Digital orthophoto quads.** Digital maps that combine the geometric information of a regular map with the detail of an aerial photograph.
- Digital soil mapping.** The creation and the population of a geographically referenced soil database generated at a given resolution through field and laboratory observation methods coupled with environmental data through quantitative relationships. A variety of technologies, including satellite, remote sensors and cameras, can be used to survey soil and collect data to create digital soil maps.
- Digital terrain model.** A digital representation of an area's terrain on a GIS that provides accurate position and elevation coordinates. Such models can be used for meticulous engineering projects such as roads, drainage, gravity-fed irrigation works, and detention reservoirs. At the field level, digital terrain models can monitor and improve areas affected by waterlogging or flooding.
- E-government.** A government's use of ICT to enhance public services.
- E-Learning.** is the use of electronic technologies to deliver, facilitate, and enhance both formal and informal learning and knowledge sharing at any time, any place, and at any pace.
- Elite capture.** When better-off or politically connected farmers capture public programs.
- Enterprise resource planning (ERP).** Software integrates the many functions of an enterprise into a single system. It centrally stores many kinds of organizational data and manages data transmission and use between departments within the organization and external partners, such as suppliers. ERP is more of a methodology than a piece of software, although it does incorporate several software applications under a single, integrated interface.
- E-readiness.** The ability to use ICT to develop or improve one's economy or situation through proper preparation.
- Farmer-led documentation (FLD).** A process in which local communities take the lead role in the documentation process. The results are used by community members for learning within the community (internal learning) and exchange between communities (horizontal sharing) and communities, development agents and policymakers (vertical sharing). See [www.prolinnova.net/flid.php](http://www.prolinnova.net/flid.php).
- Feature phones.** A modern low-end phone that is not a *smartphone*. Feature phones do not run a mobile operating system like smartphones but run on specialized software enabling them to access various media formats in addition to offering basic voice and SMS functionality. They substitute for multiple ICT devices that are also available as standalone appliances (digital camera, voice recorder, flashlight, radio, and MP3 player). Rural consumers prefer the combined devices because of their affordability. (Based on [http://en.wikipedia.org/wiki/Feature\\_phone](http://en.wikipedia.org/wiki/Feature_phone), accessed July 2011.)
- Financial inclusion.** The delivery of affordable financial services to disadvantaged and low-income segments of society. Research on financial exclusion and its direct correlation to poverty has made the availability of banking and payment services to the entire population without discrimination a prime objective of public policy. (Based on [http://en.wikipedia.org/wiki/Financial\\_inclusion](http://en.wikipedia.org/wiki/Financial_inclusion), accessed July 2011.)
- Fixed-mobile convergence.** The increasingly seamless connectivity between fixed and wireless telecommunications networks, devices, and applications. Also refers to any physical network that allows mobile phones to function smoothly with the fixed network infrastructure. FMC seeks to optimize transmission of all data to and among end-users, no matter their locations or devices. (Based on the definition in <http://searchmobilecomputing.techtarget.com/definition/fixed-mobile-convergence>, accessed July 2011).
- Genetically modified (GM).** A genetically engineered or modified organism (GMO) in which the genetic material has been transformed using the techniques of genetic engineering. Examples include cotton that has been genetically transformed to resist a particular herbicide. Many countries strictly control the production, use, export, and import of GM plants and animals.
- Geographical information systems (GIS).** Geographic data collected through computer hardware and software to capture, store, update, and display all forms of geographically referenced information by matching coordinates and time to other variables. Data sets formed by GIS constitute "layers" of information (for example, on topography, population size, or agricultural household income) that can be merged and analyzed to establish relationships and produce maps or charts that visualize geographical traits.
- Georeference.** To establish the position of something through its geographical coordinates.
- Global positioning system (GPS).** A satellite-based positioning and navigation system with three basic components: satellites that orbit the earth, control and monitoring stations on the earth, and the GPS receivers owned by users. GPS receivers pick up signals from the satellites, including precise orbital information (latitude, longitude, and ellipsoidal GPS altitude) of a given object or location, as well as the time.
- Index-based insurance.** Insurance that substitutes individual loss assessments with an indicator that is easy to measure (such as weather) as a proxy for the loss. Weather indices have been used in insurance products protecting against drought and loss of inputs. Vegetation has been used in livestock insurance products as an indicator of livestock losses. See also *weather-based index insurance* and *basis risk*.
- Infomediary.** An infomediary works as a personal agent on behalf of consumers to help them take control over information gathered about them for use by marketers and advertisers. (Based on <http://en.wikipedia.org/wiki/Infomediary>, accessed September 2011.)
- Internal traceability.** Data recorded within an organization or geographic location to track a product or process. See *chain traceability*.
- Laser scanning, or light detection and ranging (LiDAR).** An active airborne sensor using a set of laser beams to measure distance from an aircraft to features on the ground. Airplanes and helicopters can be used for laser scanning. The data from laser scanning are three-dimensional at very high accuracy, and they also allow ground elevation under the tree canopy to be measured.
- Market intelligence.** Information relevant to the markets that a producer (or company) wishes to reach. Gathered and analyzed specifically for making strategic decisions that will help to maximize profits in relation to market opportunities, market penetration, and market development. Market intelligence is necessary when entering a new market (foreign or domestic).

- Mobile application.** Software on a portable device (such as a mobile phone handset, personal digital assistant, or tablet computer) that enables a user to carry out one or more specific tasks that are not directly related to the operation of the device itself. Examples include the ability to access specific information (for instance, via a website), make payments and other transactions, play games, and send messages.
- Nanotechnology.** The ability to engineer new attributes through controlling features at or around the scale of a nanometer (one-billionth of a meter, or about 1/80,000 the width of human hair).
- Passive infrastructure sharing.** The sharing of nonelectronic infrastructure, equipment, and services at mobile network base stations, including the site space, buildings, towers, masts, and antennas; power supply, back-up batteries, and generators; security; and maintenance.
- Precision farming (precision agriculture).** Farming based on observing and responding to variations within a field detected through ICTs such as satellite imagery. Precision farming also makes use of GPS, GIS, and variable rate technology to match practices more closely to the needs of crops, soils, animals, or fisheries.
- Primary wholesale market.** Market large enough to dominate trade in some goods over a large area. (Based on <http://www.merriam-webster.com/dictionary/primary%20market>, accessed July 2011.)
- Radio-frequency identification (RFID).** Uses radio waves to transfer data between a reader and an electronic tag attached to a product, animal, or person for identification and tracking. The technology uses hardware (readers) and tags (also known as labels) as well as software. Most tags contain at least two parts: one is an integrated circuit for storing and processing information and the other is an antenna for receiving and transmitting the signal. (Based on [http://en.wikipedia.org/wiki/Radio-frequency\\_identification](http://en.wikipedia.org/wiki/Radio-frequency_identification), accessed July 2011).
- Risk.** Imperfect knowledge where the probabilities are known. Traditional risks to agriculture in developing countries include inclement weather, pests, disease, outbreaks, fire, theft, and conflict. Newer risks include commodity and input price volatility. Risks can be idiosyncratic—affecting only individual farms or firms or covariate, affecting many farms and firms simultaneously.
- Risk coping.** Actions that help the victims of a risky event (such as a drought, flood, or pest epidemic) cope with the losses it causes. They include government assistance to farmers, debt restructuring, and remittances.
- Risk mitigation.** Actions that prevent events from occurring, limit their occurrence, or reduce the severity of the resulting losses (for example, pest and disease management strategies).
- Risk transfer.** Actions that transfer risk to a willing third party, at a cost. Financial transfer mechanisms trigger compensation or reduce losses generated by a given risk, and they can include insurance, re-insurance, and financial hedging tools.
- Sanitary and phytosanitary (SPS) protection.** Measures, including regulations and agreements, to protect: (1) human or animal health from risk arising from additives, contaminants, toxins, or disease organisms in food, drink, and feedstuffs; (2) human life from risks associated with diseases carried by plants or animals; (3) animal or plant life from pests, diseases, and disease-causing organisms; and (4) a country from other damage caused by the entry, establishment, or spread of pests. Such measures include national control of contaminants, pests, and diseases (vaccination programs, limits on pesticide residues in food) as well as international controls to prevent their inadvertent spread (for example, the rejection of insect-infested food shipments that pose a risk to domestic food production).
- Satellite imagery.** An image of Earth taken from satellites in orbit. Satellite imagery can be spatial (size of surface area); spectral (wavelength interval); temporal (amount of time); and radiometric (levels of brightness). Each type of images captures a variety of variables about a given area of varying size. The resolution (in meters) of these images depends on the satellite system used and its distance from Earth; weather can interfere mainly with satellite systems utilizing visible wavelengths of light.
- Side-selling.** A farmer sells produce to a buyer other than the agreed buyer. Farmers may fail to honor contracts with buyers for a number of reasons (buyers pay late, or prices in the local market are higher than the original price agreed with the buyer, for example).
- Smartcard.** A pocket-sized (usually plastic) card with embedded integrated circuits containing volatile memory and microprocessor components. They include credit cards, identification cards, and the SIM cards used with mobile phones. As discussed in this sourcebook, one of their most influential roles has been to extend the use of mobile phones in financial transactions such as purchases of subsidized inputs, conditional cash transfers, agricultural credit, and agricultural information services. (Based on [http://en.wikipedia.org/wiki/SmartCard#Cryptographic\\_smart\\_cards](http://en.wikipedia.org/wiki/SmartCard#Cryptographic_smart_cards), accessed July 2011).
- Smartphone.** A high-end mobile phone that offers more advanced computing ability and connectivity than a contemporary feature phone. A smartphone runs a complete mobile operating system and combines the functions of a personal digital assistant (PDA) and a mobile phone. Today's models typically serve as portable media players and camera phones with high-resolution touchscreen, global positioning system (GPS) navigation, Wi-Fi and mobile broadband access. (Based on <http://en.wikipedia.org/wiki/Smartphone>, accessed July 2011.)
- SMS (short messaging service).** A service to send text messages via mobile or fixed-line phones, usually limited to around 160 characters.
- Soil carbon sequestration.** Transferring carbon dioxide from the atmosphere into the soil through crop residues and other organic solids (like mulch), is one technique to restore carbon levels in soils.
- Soil organic carbon.** Carbon held within the soil as a result of the decay of once-living plants and animals. The amount of carbon within soil is used as a measure of soil organic matter; soils with high levels of organic matter are better at holding water and contain more nutrients.
- Spatial modeling (among other models).** Closely related to spatial analysis or statistics, models are an attempt to simulate real-world conditions and explore systems using their geographic, geometric, or topological properties.

- Spectrum rights.** Rights to specific parts of the radio spectrum used for radio transmission technologies and applications. The radio spectrum is typically regulated by governments and in some cases sold or licensed to operators of private radio transmission systems (for example, cellular telephone operators or broadcast television stations). (Based on [http://en.wikipedia.org/wiki/Radio\\_spectrum#Broadcasting](http://en.wikipedia.org/wiki/Radio_spectrum#Broadcasting), accessed July 2011).
- Subscriber identity module (SIM).** An integrated circuit that securely stores the service-subscriber key used to identify a subscriber on mobile devices (such as mobile phones and computers). A SIM is held on a removable SIM card, which can be transferred between different mobile devices. (Based on [http://en.wikipedia.org/wiki/Subscriber\\_Identity\\_Module](http://en.wikipedia.org/wiki/Subscriber_Identity_Module), accessed October 2011.)
- Supply chain.** The set of buy-sell interactions as goods flow from raw materials through production to the final retailer where consumers can buy them. Often used interchangeably with commercial supply chain and value chain.
- Supply-chain management (SCM systems).** Software running on networked computers and handheld devices to perform some or all of the following functions: store information about suppliers; transmit an order to the supplier (in an agricultural supply chain, often the farmer); monitor production and quality; transfer payments; and track goods from the farm gate to the warehouse or retailer.
- Technology neutrality.** A leading regulatory policy principle for ensuring the affordability of ICTs, technology neutrality is the principle of refraining from specifying technology requirements within telecommunications licenses.
- Telecenter.** A public place where people can use digital technologies (computers, the Internet, even mobile phones) to gather information, create, learn, and communicate with others. Some centers are established specifically for people to learn these essential digital skills; others simply operate profit; but telecenters often help to support community, economic, educational, and social development—reducing isolation, bridging the digital divide, and creating economic opportunities. (Based on <http://en.wikipedia.org/wiki/Telecenter>, accessed July 2011).
- Traceability (product tracing system).** The information system necessary to provide the history of a product or a process from origin to point of final sale. Traceability is used in the food sector primarily for food safety, but agrifood and nonfood sectors such as forestry and textiles have instituted traceability requirements for product identification, differentiation, and historical monitoring. For food products, traceability systems involve the unique identification of products and the documentation of their transformation through the chain of custody to facilitate supply chain tracking, management, and detection of possible sources of failure in food safety or quality.
- Uncertainty.** Imperfect knowledge where the probabilities are not known. Many losses expected from risks inherent in modern agrifood systems are related to uncertain events for which there are no known probabilities.
- Universal access (UA).** (also termed “public,” “community,” or “shared” access) occurs when everyone can access communications networks somewhere, at a public place. (Generally the goal is to have at least one point of access per settlement over a certain population size.) As a policy objective, UA is used primarily in developing countries, which seek to expand geographic access to ICTs by the population at large, often for the very first time. UA obligations provide for a minimum level of coverage, especially of remote communities.
- Universal service (US).** A concept underpinning the definition of access to ICTs, US occurs when every individual or household can have service from communications networks, accessing services privately at home or increasingly through portable wireless devices. US focuses on upgrading and extending communication networks so that a minimum level of service is delivered, even in the least accessible areas. As a policy objective, US is used primarily in developed countries and generally pursued by imposing universal service obligations on network operators. For some services, a goal of US is too ambitious at present in a developing country, because the services must be affordable as well as available. Goals may be cast in terms of the proportion of the population that can afford private service.
- Userability.** The degree to which an ICT application is user friendly—a critical aspect of successful ICT implementation.
- Value chain.** The whole ecosystem of players involved in producing and marketing an article, from the retailer back to the producer. Often used interchangeably with commercial supply chain and supply chain.
- Variable rate technology.** Technology enabling farmers to vary the rate of an input applied to a crop. This technology uses a variable rate control system in combination with application equipment to supply inputs at the precise time and/or place where they are required. Components of the technology include a computer, software, differential GPS receiver, and controller. See *precision farming*.
- Weather-based index insurance.** Insurance that substitutes individual loss assessments with an indicator that is easy to measure (in this case, weather) as a proxy for the loss. Weather events or visible vegetation have served as typical indicators. This practice reduces the cost of assessing damage and problems of adverse selection, because the insured cannot influence the index or the loss assessment.
- Web 2.0.** Web 2.0 sites (unlike websites where users passively view content) incorporate applications that facilitate participatory information sharing, interoperability, user-centered design, and collaboration through the Internet. Examples include social networking sites, blogs, wikis, video sharing sites, and hosted services. (Based on [http://en.wikipedia.org/wiki/Web\\_2.0](http://en.wikipedia.org/wiki/Web_2.0), accessed September 2011).
- WiFi.** Wireless local area network that allows various devices to connect to the Internet remotely.
- Wireless sensor network.** A group of small sensing devices, or nodes, that capture data in a given location and send it to a base station in the network, which transmits the data to a central computer that performs analysis and extracts meaningful information.



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