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Intellectual Property Protection to Plant Varieties: Issues in Transgenic Cotton Cultivation

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Abstract

As Trade Related Aspects of Intellectual Property Rights have been extended to agriculture, member countries are forced to provide intellectual property protection to plant varieties. As a member country, India has also passed the Protection of Plant Varieties and Farmers Rights Bill, 2001. A significant feature of this Bill is that protection is extended not only to new varieties but also to extant varieties, farmers' varieties and essentially derived varieties. Such protection will obviously promote research and investment by the private sector. The Seed Policy 2002 provides a broad framework for the conducive growth of the seed industry. Opening up of the seed sector has also resulted in multinationals forming joint ventures with the Indian counterparts and has resulted in the introduction of transgenic variety of cotton in India. While this could help in bridging the wide gap between the demand and supply of cotton seeds, issues regarding refugee crops, intellectual protection and infringement and compensation to farmers in the event of failure of seeds will have to be taken care of.

JEL Classifications: ***034, Q16***

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1. Introduction

World over the role played by private sector in agriculture is increasing in the days of globalisation, competition and research, with the result agriculture is becoming more technology and research oriented. One direct result of this trend is the current consolidation of the seed, pesticide and fertiliser manufacturing firms of the west, which has been supported by factors like, extension of intellectual property rights to all areas of technology, competition and financial resources required for continuing and sustaining research in emerging agricultural biotechnology. These firms are attracted towards the large agricultural markets in Asia particularly in India and China to market their new agricultural technologies.

Agriculture in developing countries is predominantly rural based with a vast majority of poor people dependent on it. Hence, any new technology that will result in improving the yield or reducing the cost of production will directly reduce poverty and indirectly help the poor by lowering the price of food for consumers, employment and wage effects in agriculture and employment and wages in other sector through linkage effects (Janvry and Sadoulet, 2002). Traditionally technical changes have occurred as on-farm experimentation, adapting different cropping pattern and such improvements were kept out of intellectual property protection. For instance, during the Green Revolution (GR) period in India, many hybrid and high yielding varieties were introduced particularly in rice and wheat. These were the types of seed variety that can be replanted each year, which made GR very successful. Also these seeds were then not protected by any intellectual property measures. It was only after the Uruguay Round of talks in 1994, IPR was extended to agriculture that too mainly at the instance of the developed countries though some form of protection already existed in a few developed countries. While the objective of providing protection is to promote innovation activities in agriculture, such IPR protection could limit diffusion of technology by making agriculture more market dependent and create more inequities in income and distribution partly as a result of size disparities.

The recent development in plant biotechnology that has taken the form of transgenic crops has generated lot of debates. Plant bio technology refers to the alterations made in some of the basic straits of crops with the objective of enhancing agricultural productivity or improving the value of the agricultural products by increasing the shelf life and availability of the product even during off seasons or by providing improved and hybrid seeds. World over the area under transgenic crops has been increasing ever since they were introduced in 1996 (Prakash, 2000, Zilberman 2000 and Chaturvedi 2002). Total area under the transgenic crops increased from 3 million hectares in 1996 to 46.9 million hectares in 2000 (Table 1). In the US alone, area under these crops increased from 1.5 million hectares to 30.3 million hectares (Chaturvedi, 2002), with a majority of this area covered under *Bacillus Thuringiensis* Cotton (hereafter referred to as Bt cotton). In Argentina, GM Soybean occupies more than 90 per cent of the national soybean area. James (2001) points that use of transgenic crops results in: "more sustainable and resource-efficient crop management practices that require less energy and fuel and conserve natural resources; a reduction in the overall amount of pesticides used in crop production, which impacts positively on biodiversity, protects predators and non target organisms and the environment; less dependency on conventional pesticides that can be a health hazard to producers and consumers; the potential health benefits associated with fewer pesticide poisonings from Bt cotton in China is an important finding, with significant implications for other developing countries where small farmers in particular may be at similar risk from heavy and over-use of conventional pesticides; Bt maize which has reduced levels of the fumonisin mycotoxin in maize grain which provides safer and healthier food and food products; conservation of soil moisture, structure, nutrients and control of soil erosion through no or low-tillage practices as well as improved quality of ground and surface water with less pesticide residues; improved pest control, lower cost of production and improved yields all contribute to a greater economic advantage to farmers who utilise the technology to develop more sustainable farming systems". In 2000, a total of 13 countries, 8 industrial and 5 developing countries grew GM crops.

Though the number of countries as well as the area under transgenic crops in these countries is increasing yet there are some concerns about adopting this technology on a large scale. These concerns widely emanate from the nature of technology, its environmental impact, and intellectual property protection available to such technology and diffusion of such technology. In a significant

development, India has also joined these countries recently by adopting the transgenic cotton for commercial cultivation. The other significant development is that India has also passed a Bill in the Lok Sabha in August 2001- known as the `Protection of Plant Varieties and Farmers Rights Bill, 2001 (herein referred to as Indian Plant Act, 2001) which provides intellectual protection for new varieties at the same time ensuring the farmers rights.

In this paper, an attempt is made to detail the issues in plant protection and the scope for cultivating transgenic crops in India. In doing so, in section 2 following this introduction we present a discussion on the type of plant protection that is currently prevailing elsewhere and the one adopted in India. This section also highlights the salient features of the recent seed policy of India. In Section 3 we present the nature of seed industry and the implication of the Indian Plant Variety Protection Act on the seed industry. Section 4 discusses the status of cotton cultivation in India and the experience of some of the countries in cultivating Bt cotton. In section 5 we discuss the scope of transgenic cotton and Section 6 presents the conclusion.

2. Plant Protection and Intellectual Property Rights

Private investment in biotechnology research is far ahead of the public investment in developed countries, though public investment in biotechnology with the purpose of benefiting the farmers and consumers is increasing in the developing world. The International Programme on Rice Biotechnology, the Casava Biotechnology Research and the research undertaken by the various centres of Consulative Group on International Agricultural Research invests an average of US $ 75 million per year in agricultural biotechnology and developing countries spend about $ 125 million, which is negligible when compared with the $5 billion private investment (Qaim, 2001). Such huge investment has resulted in the demand for strengthening the intellectual property rights system in agriculture.

Under Article 27.3 (b) of the TRIPS Agreement, members of the World Trade Organisation (WTO) may exclude from patentability `plants and animals other than micro organisms and essentially biological processes for the production of plants or animals other than non-biological and microbiological processes. However, members shall provide for the protection of plant varieties either by patents or by an effective *sui generis* system or by any combination thereof'. As

per this, all plants and animal varieties produced by asexual methods of production, become eligible for patent protection or *sui generis* protection or both. This pronunciation extends IPR protection to advances made in plant genetic engineering and plant biotechnology. Accordingly, a plant or a part of the plant can be protected under patents or plant variety protection or plant breeders' rights (PBRs). Not all the countries have protected their plant varieties. While the US believes that anything under the sun made by man is patentable, European Union has lots of resistance. After a decade of discussion in the various policy bodies, the European Union passed a new directive on the Legal Protection of Biotechnological Inventions in July 1998. The European directive states that an element isolated from the human body or otherwise produced by means of a technical process including the sequence or partial sequence of a gene may constitute a patentable innovation. Though, plant and animal varieties are still excluded, yet, farmers privilege to re-use patented plants or animals, has been allowed. Denmark, Finland and Ireland have accepted this definition and patent protection is available in these countries. While Germany required more amendments to go for patents in this area, Italy and Netherlands have objected to this concept. Austria and France have decided to wait for some more time. Canada and Norway exclude plant and animals *per se* from patentability, including their varieties and even define microorganisms narrowly. Developing countries such as Argentina, Brazil and the Andean Group that have implemented TRIPS so far allow patents only for micro-organisms and microbiological processes excluding plants, animals, genes and other biological material even if isolated by technical processes. These countries have also allowed for compulsory licenses and research exemptions in their patent laws. (Watal, 2000, Biotech International, June 2001).

A plant or plant variety becomes eligible for protection if it satisfies the criterion of stability, novelty, non-obviousness, uniformity and being distinct. Unlike the case of industrial products, it is difficult to establish novelty, non-obviousness etc in the case of living organisms that leads to conflicts and differences in defining the criteria of protection. Most developed countries now recognise that novelty is met if the claimed biotechnological product or process does not exist in the prior art.[1] Since non-obviousness is difficult to establish in plant varieties, a lower standard is used, which requires that plants or varieties for which protection is sought must be distinct i.e., must possess a combination of characteristics distinct form earlier

[1] This paragraph draws from Watal (2001).

plant varieties and should not have been commercialised before. Thus, more discoveries on the plants grown in the wild may be protected provided other criteria are met. It may be difficult to technically replicate or establish the industrial applicability of the biotechnological inventions in the same way as chemical or mechanical inventions. While replicability is a criterion for patent grants of biotechnological inventions, uniformity and stability are requirements under the law governing plant variety protection. Further fulfilment of disclosure requirements of patent law is difficult in the case of biological materials, where in addition to a detailed written description, a sample of the protected material is deposited with the depositories, particularly where this is necessary to replicate the process or product claimed.

Patents are the strongest form of intellectual property protection in the sense that they allow the rights holder to exert the greatest control over the use of patented material by limiting the rights of farmers to sell, or reuse seed they have grown or other breeders to use the seed (or patented intermediate technologies) for further research and breeding purposes. One of the concerns in providing patent protection to biotechnology-based research is that it could lead to patenting of research tools or the grant of broad patents that could potentially block further useful research. Under TRIPS developing countries can choose to provide patents or develop a *sui generis* system. Countries also have a third option of joining the *Union International Pour la Protection Des Abstentions Vegetables* named after its French acronym UPOV. UPOV has been an obvious choice for many countries between the tough standards of patents and the task of developing a *sui generis* system as it provides an off-the shelf solution to developing such legislation. UPOV entered as an international agreement in 1961, for administering the rules on plant variety protection and gave a new thrust to the recognition of plant breeders' rights in many countries. The main advantage of the UPOV Convention, 1961, as revised in 1978 and 1991, is the reciprocal national treatment or the same treatment to foreign right holders as accorded to nationals for the protection of new plant varieties from member countries. Unlike other subjects under TRIPS, there is no mention of adherence to UPOV in TRIPS. According to Watal (2001) the possible reason could be that UPOV 1991 had not entered into force when TRIPS was formulated; therefore a reference to UPOV 1978 was considered inadequate, while a reference to UPOV 1991 was considered premature. Another reason for the brevity of this provision is that there was no agreement among industrialised countries as to the details of an effective system of protection for plant varieties.

Though, TRIPS only specifies that there should be a patents/*suigeneris* regime, or both, yet, pressure have been put on various countries to join UPOV in the context of bilateral trade agreements[2]. The purpose of the UPOV Convention is to ensure that the member states acknowledge the achievements of breeders of new plant varieties, by making available to them exclusive property right, on the basis of a set of uniform and clearly defined principles. The minimum period of protection increased to 20 years (25 years for vines and trees) in the 1991 version (from 15 and 20 previously). The 1978 Act allowed breeders to use protected varieties as a source for new varieties, which could then be protected and marketed themselves. The 1991 Act has preserved the breeder's exception, but the right of the breeder extends to varieties, which are `essentially derived' from the protected variety, cannot be marketed without the permission of the holder of the original variety.

The 1978 Act also provided the breeder with protection in respect of production for the sale of seed, (Article 5 (1) and therefore implicitly allowed farmers to replant and exchange the seed (although this right is not spelt out). The 1991 Act is more restrictive of the rights of farmers. The right of the breeder now extends to production or reproduction, in addition to the marketing of propagated or harvested material (Article 14 (1). This is mitigated by an optional farmers exception which allows `farmers to use for propagating purposes, on their own holdings, the product of the harvest which they have obtained by planting, on their own holdings, the protected variety or (an essentially derived variety)) (Article 15 (2). Essentially, UPOV 1991 permits farmers to reuse their own crop for seed purposes on their own holdings but it does not allow for informal sale. In contrast, TRIPS only requires that there should be some form of IP protection for plant varieties, and does not define in any way the exceptions that may be provided to the rights of owners of protected varieties. Because of the restrictive rights of farmers in UPOV 1991, although some of the Asian countries allowed patenting of microorganisms and microbiological processes even before this was a TRIPS requirement, yet not all of them became members of UPOV other than China till mid 2000[3]. Watal (2001) observes that the expectation that UPOV

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[2] Discussion in this page draws from the Report of the Commission on Intellectual Property Rights (RCIPR) 2002.

[3] China became member of the UPOV convention of 1978 Act in April 23, 1999. It becomes the 39th member country of the UPOV convention. With China joining the UPOV, the new varieties of botanical genera of species from UPOV member states

membership will raise significantly may not materialise, as developing countries are reluctant to join the 1991 version, though the bilateral agreements may force them to do so. As of March 2003, UPOV had 52 members. 13 developing countries which joined during the period 1994-1997 and have adopted the 1978 version include: Uruguay, Argentina, Chile, Colombia, Paraguay, Ecuador, Mexico, Trinidad and Tobago, Brazil, China, Kenya and Panama. Argentina, Chile and Mexico protect all genera and species even though they follow UPOV 1978 (Watal, 2000). Given the ambiguity in defining the term `effective', and the leverage available in UPOV 1978, following UPOV 1978 would be a preferred option for many, though presently, membership to UPOV 1991 alone is open.

Apart from the use of patents and plant varieties protection, the intellectual property in plants can also be appropriated by technological means. For instance, crops such as commercial hybrid of maize cannot be reused if hybrid yield and vigour are to be maintained. This characteristic of some `hybrids confers a natural form of protection by which seed companies can more readily capture a return on their investment through repeat seed sales' (RCIPR, 2002).

2.1 Plant Protection in the US

While the paragraphs above give an idea about the various types of plant protection, a mention of plant protection prevailing in the US is essential since the private sector has a higher stake in agricultural biotechnology research and investment. Therefore, the demand for strict IPR protection will obviously arise from there and thus may eventually shape the policies pursued in developing countries.

Patents on plant varieties, are allowed only in the US, Japan and Australia and are most frequent in the US. The 1930 US Act introduced a special kind of Plant Patent for vegetatively propagated materials, but standard utility patents can also now be granted on plant varieties in the US. This is significantly different from PVP, proving that a new variety meets the criteria for patentability is more difficult and more costly than obtaining plant variety protection, where the criteria for protection are lower. Patent protection is also frequently obtained through a broad patent that claims the gene, which may cover a number of potential

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can be protected in China and Chinese varieties can be protected in UPOV member states. (IPR, Vol.5, No.4-6, April-June, 1999).

varieties or crops incorporating the gene and has the potential to block further research. Dutfield (2000) cites two examples of such broad patents. One is the US patent granted in 1992 to Agracetus for all transgenic cotton. This patent claim covered any variety of cotton produced by means of gene transfer technology. In 1994, this patent was cancelled by the US patent office on the ground that other researchers already knew what was disclosed in the patent application as being novel and new. Another broad patent owned by Novartis, which covered all insect resistant corn containing Bt, was invalidated after the company had taken Monsanto and Dekarb Genetics to court for patent infringement.

When plant varieties are subject to patents, the terms and conditions that bind patent applicability restrict the diffusion of technology and ensure monopoly rights to the innovator. Thus US type of countries where agriculture is predominantly commercialised, the breeding strategies of the multinationals have been naturally oriented to the needs of developed world markets, and the commercial sectors of middle-income developing countries (for example, Brazil, Argentina or China). The development of genetic traits such as herbicide tolerance has been determined principally by the search for commercial advantage, rather than for characteristics useful to poor farmers in developing countries (RCIPR, 2002). It only emphasises the fact that whatever the incentives provided by patenting, market forces will tend to direct research efforts by the private sector to where there is the most substantial potential return. Observing the divergence between the focus of research and the needs of developing countries, the RCIPR (2002) wonders `whether the current intellectual property regime is stimulating or hampering research is unclear'. Hence it observes that `developing countries should generally not provide patent protection for plants and animals, as is allowed under Article 27.3 (b) of TRIPS, because of the restrictions patents may place on use of seed by farmers and researchers. Rather they should consider different forms of *sui generis* systems for plant varieties. India has also chosen the path of *sui generis* systems only which is elaborated in the following paragraphs.

2.2 Plant Protection in India

The attitude of the Indian government till recently was preventive in providing IPRs in plants. However, now as the transitional period provided for India is drawing close, reform measures are being taken in sectors where current level of

protection in India is less than that is suggested in the WTO Agreement. Therefore, in August 2001, Government of India (GOI) passed the Indian Plant Act, 2001. This is a *sui generis* system to provide for protection of plant varieties, the rights of farmers and plant breeders and to encourage the development of new varieties of plants. It also covers aspects relating to the use of genetic material, compensation to farmers and protection to essentially derived varieties. Besides this Act, GOI has also formulated a seed policy to promote the growth of the seed industry. In the following paragraphs, the salient features of these two are discussed. Table 2 brings out the similarities and differences in the TRIPS, US patents, UPOV 1991 and the Indian Plant Protection Act. As is evident, the Indian Act combines some of the features of UPOV 1978 and UPOV 1991. According to this Act, a new variety, extant variety[4], which includes the farmer variety, can be registered under this Act. A new variety shall be registered under this Act, if it conforms to the criteria of novelty, distinctiveness, uniformity and stability. An extant variety shall be registered under this Act within a specified period if it conforms to the criteria of distinctiveness, uniformity and stability. An essentially derived variety (derived from an initial variety) is registered with the Registrar.

A variety according to the Indian Act is said to be novel, if at the date of filing of the application for registration for protection, the propagating or harvested material of such variety has not been sold or otherwise disposed of by or with the consent of its breeder or his successor for the purposes of exploitation of such variety (a) in India, earlier than one year; or (b) outside India, in the case of trees or vines earlier than six years, or in any other case, earlier than four years, before the date of filing such application. It is said to be distinct, if it is clearly distinguishable by at least one essential characteristic from any other variety whose existence is a matter of common knowledge *in any country* (this is not mentioned in other type of protections) at the time of filing of the application. A variety is said to be Uniform, if its essential characteristics remain unchanged after repeated propagation or in the case of a particular cycle of propagation at the end of each such cycle.

[4] Extant variety refers to a variety available in India about which there is common knowledge or any other variety which is in public domain: A farmers variety means a variety which has been traditionally cultivated and evolved by the farmers in their fields or is a wild relative or land race of a variety about which the farmers possess the common knowledge (Indian Plant Act, 2001).

A few other salient features of this Act are:

1. A new variety shall not be registered under this Act, if (a) is liable to mislead or to cause confusion concerning the characteristics, value, identity of such variety, or the identity or breeder of such variety; or (b) is not different from every denomination which designates a variety of the same botanical species or of a closely related species registered under this Act. Also registration of a variety shall not be made if (c) prevention of commercial exploitation of an variety is necessary to protect public morality or human, animal, and plant life and health or to avoid serious prejudice to the environment and (d) a variety of any genera or species which involves any technology that is injurious to the life or health of human beings, animals, or plants.

2. In order to register a variety, an application should contain a complete passport data of the parental lines from which the variety has been derived along with the geographical location in India from where the genetic material has been taken. Also all information relating to the contribution, if any, of any farmer, village community, institution or organisation in breeding, evolving or developing the variety needs to be disclosed.

3. While seeking registration an applicant should also make available a certain quantity of seeds to the Registrar, for the purpose of conducting tests to evaluate whether seeds of such variety along with parental material conform to the standards as specified by regulations.

4. The certificate of registration issued shall be valid for nine years in the case of trees and vines and six years in the case of other crops and may be reviewed and renewed for the remaining period on payment of fees as may be fixed by the rules made in this behalf. This is however subject to the condition that the total period of validity shall not exceed (a) eighteen years from the date of registration of the variety in the case of trees and vines; (b) fifteen years from the date of notification of that variety by the Central Government under section 5 of the Seeds Act 1966 in the case of extant varieties and in other cases, fifteen years from the date of registration of the variety.

5. On the issue of benefit sharing from a registered variety, the Act clearly points out that benefits will occur to (a) only persons or group of persons constituting citizens of India or (b) firm or governmental or non governmental organisation, if such firm or organisation is formed or established in India. The authority will also take into consideration (a) the extant and nature of the use of genetic material of the claimant in the development of the variety relating to which the benefit sharing has been claimed (the applicant while seeking registration will have to disclose

information regarding the use of genetic material conserved by any tribal or rural families in the breeding or development of such variety) and (b) the commercial utility and demand in the market of the variety relating to which the benefit sharing has been claimed.

6. On infringement it states that a right established under this Act shall not be deemed to be infringed by a farmer who at the time of such infringement was not aware of the existence of such right (though it would be very difficult to prove this).

7. Similar to pharmaceuticals, in the seed sector also, the option of compulsory licence may be exercised under certain conditions. The Act says that `at any time, after the expiry of three years from the date of issue of a certificate of registration of a variety, any person interested may make an application to the Authority on the grounds that reasonable requirements of the public for seeds or other propagating material of the variety have not been satisfied or not available to the public at a reasonable price and pray for the grant of a compulsory licence to undertake production, distribution and sale. (Countries like US, Japan, Australia and Brazil have also provided for compulsory licensing by which a protected variety could be allowed commercial cultivation on payment of a fee).

8. But the Indian Act however gives the benefit of doubt to the breeder in the circumstances leading to comply with compulsory licence (CL). It states that if a breeder of a variety registered under this Act makes a written request to the Authority on the ground that due to any reasonable factor, he has been unable to produce seed or other propagating material of the variety on a commercial scale, till the date of making such request for CL, the Authority may on being satisfied that the said ground is reasonable, adjourn the hearing of the application for a period not exceeding twelve months in aggregate as it may consider sufficient for optimum production of the seed or propagating material of such variety.

9. The Authority shall determine the duration of the compulsory licences granted which may vary from case to case keeping in view the gestation periods and other relevant factors, but in any case shall not exceed the total remaining period of the protection of that variety. The Act also states that the reproductive material of the variety obtained through compulsory license should be stored in the National Gene Bank or any other centre.

10. The Act also authorises that a reasonable compensation be given to the breeder of the variety relating to CL taking in to account factors like nature of the variety, the expenditure incurred by such breeder in breeding/developing the variety and other relevant factors. Importantly the Act states that no CL granted by the Authority shall authorise the licensee

to import the variety relating to such license or any seed or other propagating material of such variety from abroad and such import would constitute an infringement of the rights of the breeder of such variety.

11. However, registration of a variety does not prevent (a) using such variety for conducting experiment or research and (b) the use of a variety as an initial source of variety for the purpose of creating other varieties provided that the authorisation of the breeder of a registered variety is required where the repeated use of such variety as a parental line is necessary for commercial production of such other newly developed variety.

12. On the question of farmers rights the Act says that a farmer shall be deemed to be entitled to save, use, sow, resow, exchange, share or sell his farm produce including seed of a variety protected under this Act in the same manner as he was entitled before the coming into force of this Act; the farmer shall however not be entitled to sell branded seed of a variety protected under this Act.

13. In order to promote conservation of land races and other economic plants, the Act states that ` a farmer who is engaged in the conservation of genetic resources of land races and wild relatives of economic plants and their improvement through selection and preservation shall be entitled for recognition and reward from the gene fund.

14. On the issue of compensation which is relevant in the case of new and transgenic seeds, the Act says that where any propagating material of a variety registered under this Act has been sold to a farmer or a group of farmers or any organisation of farmers, the breeder of such variety shall disclose to the farmer or the group of farmers or the organisation of farmers as the case may be, the expected performance under given conditions. If such propagating material fails to provide such performance under such given conditions, the farmer or the group of farmers or the organisation of farmers as the case may be, may claim compensation in the prescribed manner before the Authority. The Authority shall after giving notice to the breeder of the variety and after providing him an opportunity to file opposition in the prescribed manner and after hearing the parties, may direct the breeder of the variety to pay such compensation to the farmer or the group of farmers or the organisation of farmers as the case may be.

15. A National Gene Fund has to be established and the amount set aside for benefit sharing has to be deposited in this fund.

16. The Act mentions several circumstances under which the protection given to a breeder can be withdrawn. For example, instances viz. (a) provision of incorrect information (b) inadequate provision of seeds or other propagating

material to person who has been granted compulsory license and (c) if the protection has not been in the public interest could lead to cancellation of protection.

These are the salient features of the Indian Plant Varieties Act. After comparing the types of plant varieties protection in more than 30 countries, Gupta (1999) observes that the protection offered to the extant and farmers varieties to protect the land races by the Indian Act is a bold attempt and has not been tried by any other country (p.251). However, some modifications in the following lines perhaps will be more useful for the farmers and the breeders. While it is appreciable that the Indian Act provides for the registration of extant and farmers varieties, yet the condition that such varieties will have to meet the criteria of distinctiveness, uniformity and stability (DUS) may not be realised at least in the case of local land races and wild relatives of economic plants. Dutfield (2000) argues that, although it appears relatively easy and inexpensive to get plant variety right than a patent, still the local communities cannot exercise such rights. The uniformity and stability requirements imply that only commercial breeders of genetically uniform varieties can benefit from the system. He points out that `local communities whose land races (or traditional cultivars) may be rich in intra-varietal genetic diversity (due in part to the preference of communities for versatility and adaptability) are unable to acquire protection because of this genetic diversity' (p.50). Hence, in view of this, the `DUS' requirement may be modified in the case of extant and farmers varieties. A related issue is that in order to provide effective protection to the local land races, cooperation of local communities having knowledge about such varieties and village organisations is very essential[5]. This would be useful in (a) creating and updating a national database of such varieties and (b) benefit sharing whenever such varieties are exploited for further development.

From Table 2 it is evident that the period of protection provided by the Indian Act is shorter than the period of protection offered by other types of plant protection.

[5] In Kerala, a biodiversity register programme is on. For instance in Thrikkakkara in Southeast Ernakulam, a massive collective exercise called the `People's Biodiversity Register Programme has helped in pointing to the richness as well as the threatened nature of biodiversity in the district. Information gathered from elders and other knowledgeable persons of each ward through informal interviews and group discussions point out that out of 66 varieties of rice that are known to have been cultivated in the district, only a handful of them is currently in use. Of the 50 species medicinal plants listed in Thrikkakkara, 23 plants are already in short supply and 11 have become extremely rare (Down to Earth, 2001).

Taking into account the role of plant biotechnology in agriculture and pharmaceutical sector, it is essential to protect the extant and farmers varieties for a longer period, so that the local communities also benefit by the research or developments that is based on the local land races.

The Indian Act provides for the farmers rights to save, use, sow, resow, exchange share or sell his farm produce including a protected seed variety, though a farmer cannot sell the protected seeds as a branded seed. Here, it may be essential to fix a ceiling of applicability say for instance – such rights may be extended to small and marginal farmers only. Providing such benefit indiscriminately to all the farmers may restrict the breeders returns earned on the R&D investment and may lead to (a) fixing a high price for the protected seeds to deny access to marginal and small farmers or (b) technological modification of a gene in such a manner to reduce the yield in successive propagation.

The Act provides for compensation from the breeder in case of failure of the seeds. In order to claim such compensation, it is essential that the appropriate conditions are stated clearly so that the gullible farmers are not exploited by unscrupulous breeders. In the case of CL, the Act states that the licensee cannot import the variety and such import would constitute an infringement of the rights of the breeder. Implicitly, the licensee will have to obtain the technology to produce it locally and cannot import the said seeds and cannot take advantage of differential pricing if any available for the product elsewhere. The point is that the licensee should be in a position to manufacture the seed domestically once the CL is obtained. In other words, without the required know how and technology, obtaining CL alone is not going to be helpful.

2.3 National Seed Policy 2002

Whereas the Indian Plant Act, 2001 ensures the farmers rights and privileges at the same time extending national treatment to the breeders, the Seed Policy 2002 of India provides a broad framework for the conducive growth of the domestic seed industry. The main objectives of the National Seeds Policy are: (a) provision of an appropriate climate for the seed industry to utilise available and prospective opportunities, (b) safeguarding the interests of Indian farmers and (c) conservation of agro biodiversity. The thrust area being varietal development and plant variety protection, features mentioned in the Policy are close to the Indian

Plant Act 2001. The Department of Agriculture & Cooperation (DAC) will supervise the overall implementation and monitoring of the Seeds Policy.

A few other salient features of the policy are:

1. On seed production, the Policy emphasises that public sector seed institutions will be encouraged to enhance production of seed to meet the objective of food and nutritional security. Besides the public sector, private seed production agencies will also have access to breeder seeds subject to terms and conditions of the government.

2. Incentives will be provided to the domestic seed industry to enable it to produce seeds of high yielding varieties and hybrid seeds at a faster pace to meet the challenges of domestic requirements.

3. The policy also talks of seed crop insurance to seed growers. It states that seed growers will be encouraged to avail Seed Crop Insurance to cover risk factors involved in production of seeds. The seed crop insurance scheme will be reviewed so as to provide effective risk cover to seed producers and will be extended to all traditional and non-traditional areas covered under the seed production programme.

4. On quality assurance, the Policy states that, the Seeds Act will be revised to regulate the sale, import and export of seeds and planting materials of agriculture crops including fodder, green manure and horticulture and supply of quality seeds and planting materials to farmers throughout the country. A National Seeds Board (NSB) will replace the Central Seed Committee and Central Seed Certification Board. NSB will execute and implement the provisions of the Seeds Act. Distribution and marketing of seed of any variety, for the purpose of sowing and planting will be allowed only if the said variety has been registered by the NSB. NSB also has powers to cancel the registration granted to a variety, if the registration has been obtained by misrepresentation or concealment of data.

5. The Policy states that while registration will be compulsory for both domestic and imported varieties, certification of seeds is voluntary. The NSB will accredit individuals or organisations to carry out seed certification including self-certification on fulfilment of criteria as prescribed.

6. On registration it says that `provisional registration would be granted on the basis of information filed by the applicant relating to trials over one season to tide over the stipulation of testing over three seasons before the grant of registration'.

7. With the purpose of providing access to the best planting material available anywhere in the world, the seed policy states that all import of seeds and planting materials will be allowed freely subject to EXIM policy guidelines. Import of transgenic seeds will be governed by the Environment Protection Agency's rules. (The Plant Variety Protection Act however mentions that imports will not be allowed even under CL). A small amount of sample will have to be deposited with the Gene Bank maintained by NBPGR. Export of seeds however will be subjected to case-by-case consideration of proposals. It also talks about setting up a database on availability of seeds of different crops to assess impact of exports on domestic availability of seeds.

8. On transgenic varieties, the Policy states that such varieties will be tested as per the regulations and guidelines of the Environment Protection Act (EPA) 1986 for environment and bio safety before they are commercially released. All transgenic crops/ varieties will be tested to determine their agronomic value for at least two seasons under the All India Coordinated Project Trails of ICAR, in coordination with the tests for environment and bio-safety clearance as per the EPA before any variety is commercially released in the market. Even after their release, the Ministry of Agriculture and State Departments of Agriculture will monitor their performance in the field for at least 3 to 5 years. Once the transgenic plant variety is commercially released, its seed will be registered and marketed in the country as per the provisions of the Seeds Act.

9. Packages containing transgenic seeds/planting materials, if and when placed on sale, will carry a label indicating their transgenic nature. The specific characteristics including the agronomic/yield benefits, names of the transgenes and any relevant information shall also be indicated on the label.

10. The seed policy states that `membership to international organisations and seed associations like ISTA, OECD, UPOV, ASSINSEL, WIPO at the national level or at the level of individual seed producing agencies will be encouraged'.

11. In order to promote domestic R&D, the Policy states that tax rebate/ concessions will be considered on the expenditure incurred on in-house research and development of new varieties and other seed related research aspects. Also, the state governments will be encouraged to remove unnecessary local taxation on sales of seeds.

12. To safeguard the interests of the farmers, the policy says that seeds and planting materials imported for sale into the country will have to meet

minimum standards of seed health, germination, genetic and physical purity as prescribed.

Though overall the Seed Policy lays the foundation for further reforms in the seed sector yet a few aberrations need to be taken care of. For instance, whereas the Policy mentions that seed growers will be encouraged to avail of Seed Crop Insurance to cover against risks in the production of seeds, yet compensation to farmers for any eventual loss due to failure of seeds is not mentioned. On seed certification and on quality of the seeds used by the farmers, the Policy states that farmers will be encouraged to use certified seeds to ensure improved performance and output and stringent measures would be taken to ensure the availability of high quality of seeds and check the sale of spurious or misbranded seeds. At the same time, seed certification is made voluntary. This could lead to spurious seeds circulating among the farmers in the form of `truthful seeds'. Hence to prevent this the initiative mentioned in the Policy viz to accredit individuals or organisations to carry out seed certification should be speeded up. Similarly when concerns are expressed about India joining `UPOV', the Policy mentions that membership to international organisations and associations at the national level or at the individual seed producing agencies level will be encouraged. However, before getting membership to such international associations, it is essential to probe thoroughly the guiding factors and the conditionalities that are applicable and whether such membership is in line with the existing rules and regulations formed to protect the interests of farmers and breeders. Also the benefits of joining such conventions should be ascertained.

In order to get protection for the Indian plant varieties elsewhere, India also became party to the Budapest Treaty on the International Recognition of the Deposit of Micro Organisms for the Purposes of Patent Procedure 1977 on December 17, 2001. Budapest Treaty is open to all members of the Paris Convention and is administered by the World Intellectual Property Organisation. This treaty established international rules for the deposit of microorganism for the purposes of fulfilling the disclosure requirements in national patent laws. Membership to depositories eliminates the burden of depositing the sample material in each country where patent protection is sought (similar to patent co-operation treaty). Korea and China are the two developing countries with international depositories under this treaty. Presently 54 countries are members

of the Treaty. However, 20 countries have among them 33 depositories[6]. India became an International Depository Authority (IDA) in October 2002 after the notification of Microbial Type Culture Collection Centre (MTCC) at the Institute of Microbial Technology (IMTECH) Chandigarh by the Director General of WIPO. MTCC is the 34th IDA under the Budapest Treaty. Watal (2001) points out that an advantage of establishing such depositories is that generally, plant materials submitted can be used for experimental purposes even during the patent term once the patent application is published. Hence, countries wishing to develop biotech should aim to establish such depositories in their jurisdictions. Perhaps this is one of the reasons for the relatively faster growth of plant biotechnology in China.

India also has the National Gene Bank, which maintains the sample of all germplasms[7]. One reason for countries not having a single depository could be due to the enormous cost involved in maintaining such depositories. Quoting the Food and Agriculture Organisation, The Economist (2002) observes that there are about 1, 300 repositories around the world, ranging from a depot of almost 10,000 samples of lentils kept in Syria to a store of 1,200 varieties of banana held in Belgium. In total, these stocks add up to roughly 6 million samples of plants. Though the purpose of having these repositories is to protect the breeder's rights, many of the seed banks are facing hard times particularly in developing countries. Collecting and cataloguing thousands of samples costs money. Maintaining a sample in the gene bank could cost between $1.50 $ 12 a year depending on the variety and location. Simply keeping the lights on and refrigerating alone increases the energy bill in such places. The national gene bank in Kenya almost lost its collection when it was unable to pay its electricity bill. The Food and Agriculture Organisation and the Consulative Group of International Agricultural Research that hold roughly 10 per cent of the worlds' plant deposits, are trying to raise an endowment of $260 million to maintain the

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6 UK has 6, Russian Federation has 3, South Korea has 3, USA has 2, China has 2, Italy has 2 and the other 14 countries have the remaining 15 IDAs. India does not have an IDA as yet (IPR, Vol.8, No.1-2, 2002).

7 With a view to protect the biodiversity of the country, National Bureau of Plant Genetic Resources (NBPGR) has launched a twenty crore, five year project which involves the Indian Council of Agricultural Research, State Agricultural Universities, government departments, colleges and NGOS. The purpose of the project is to collect about one-lakh germplasm samples of different crops, which would be conserved at the National Gene Bank (IPR, Vol.5, No.8, 1999).

world's most important collections in perpetuity. Most countries of Asia, Africa and South America are not yet parties to this treaty, perhaps due to the fact that they are not members of the UPOV convention and also have not yet developed plant variety protection Acts.

The Plant Varieties and Farmers Rights Act, the Seed policy 2002 and membership to the Budapest treaty all indicate the policy interventions made by the government to promote and protect research carried out particularly in the private sector. Such policy framework has to be in place taking in to consideration the global developments in plant biotechnology and breakthrough in germplasm. In the following paragraphs, the status of the seed industry of India and the probable implication of such policy framework is detailed.

3. Seed Industry of India

Seed industry of India has been conservative in nature. It consists of a very large public sector –National Seeds Corporation, State Farm Corporation of India and the State Seeds Corporations and an emerging private sector. Historically the public sector has been responsible for the development and distribution of seeds. Since trade liberalisation in the '90s, private seed firms have also been engaged in development and distribution of seeds. The Seed Policy of 1988 was explicitly motivated by the objective of facilitating rapid technology transfer from private sector, in particular from the multinational seed firms to the farmers (Ramaswamy, 2002). There are no precise estimates of the number of private seed companies operating in India. Ramaswamy (2002) notes that private seed firms are heterogeneous with respect to size, research capacity and product segments and plant-breeding research is found in the large firms. Private sector is largely concentrating in the area of profit generating hybrids since, with successive cultivation hybrids loose their vigour and hence, need to be repurchased. Hence, the private sector's presence is more in vegetables, oil seeds, cotton, maize and pearl millet and small in open pollinated varieties like wheat and rice. In the self-pollinated varieties, private sector's presence is in selling the public varieties and hybrids. Whereas about 10 per cent of the seeds of self-pollinated crops like rice and wheat are supplied by the commercial seed system, in the case of sorghum, maize and sunflower, the proportion of seed supplied by the commercial seed industry ranges between 25 and 43 percent

(quoted in Ramaswamy, 2002). Private sector also sells the seeds developed in the public sector under its own brand name.

The 1980s marked significant development in the seed sector particularly favouring the private sector. In 1983, Government of India decided to provide public bred breeder seeds to the private seed companies for multiplication and distribution. In 1986, the Department of Biotechnology was established in the Ministry of Science and Technology. In 1987, the government abandoned its earlier protectionist stand towards the sector and allowed MRTP and FERA companies to participate in seed activity. New Policy on seed development announced in 1988, allowed import of seeds of coarse cereals and horticultural crops. In a significant policy measure, the New Industrial Policy announced in 1991 identified seed industry as a priority sector and foreign collaboration was encouraged. In 1998, foreign equity was increased to 100 per cent. Ramaswamy (2002) observes that in terms of ownership, private firms are closely held and not listed in the stock exchanges although some of the large firms have sold equity to foreign seed companies. Foreign firms maintain a presence through equity stakes in Indian firms, technical alliances or through wholly owned subsidiaries. Pray et al (1998) observe that after the 1986 policy which allowed large Indian firms into the seed industry, J K Industries, SPIC, Khatau-Junker Ltd, Godrej, Dunlop and Harrisons entered the Indian seed industry for the first time, though the last three soon dropped out. In addition, large well-established firms that were partially foreign owned such as Hindustan Lever Ltd, ITC, ICI and Sandoz also entered the seed industry. This is in essence the broad structure of the seed industry.

3.1 Implication of the Indian Plant Protection Act on the Indian Seed Industry

In contrast to the developed countries, in India research to produce new varieties is primarily conducted by the Indian Council of Agricultural Research (ICAR), State Agricultural Universities (SAU) and International Agricultural Research Centres such as ICRISAT. ICAR and SAU spent about Rs. 1960 million on crop research in 1994 and the private sector spent about Rs.155 million on plant breeding research (Pray et al, 1998). This trend could soon change in favour of the private sector due to the intellectual property protection provided to the plants and plant varieties through the Indian Plant Varieties Act and the emphasis laid by the Seed Policy 2002.

So far since agriculture was out of the purview of TRIPS, parental lines developed by the public sector were not protected by any system. Now, in the present regime, if such varieties are protected, then effective licensing procedures need to be evolved. This is because the private sector has been using the parental lines developed in the public sector, which in turn might have used parental lines from other countries. For instance, use of the patented vitamin A rice involves clarifying user licenses for over 70 patents.

The Indian Act extends protection to the extant and farmers varieties and emphasises on sharing the remuneration with the local community wherever genetic resources have been used (though the formula of benefit sharing is not fixed). This requires co-opting the local communities and other village level organisation to identify and list the local land races. Further, in order to assess the varieties submitted for registration, the Authority should also be well equipped with data and prior art information to assess the `DUS' nature' of the variety. These are essential prerequisites to prevent infringement and also to decide the mechanism of benefit sharing.

With the emergence of biotech based transgenic crops, a different trend in research could emerge. This requires an increased role of the government in monitoring the research and closely monitoring the research outcomes in the private sector, before they are commercialised. Once the viability of the transgenic seed is proved, then the government should ensure that such seeds are available in required quantities. Already opening up of the seed industry has resulted in multinationals promoting joint ventures with the Indian companies and introducing patent protected transgenic varieties in India on payment of license fees.

Though plant biotechnology is considered to have solution to the growing food insecurity among the developing countries, yet lack of appropriate and concrete answers to the concerns raised relating to the environment have made the developing countries to tread cautiously in the area of transgenic crops. Research in this area is nevertheless expanding. For instance, there are about 50 public research institutions in India, which are engaged in modern biotechnology tools for agriculture. At least 10 of these are engaged in plant genetic engineering with rice, chickpea, oilseeds, cotton and number of horticultural products. Further more there are about 45 private and foreign

companies carrying out research in agricultural biotechnology (Qaim, 2001). Table 3 shows the list of transgenic trials in India. Qaim (2001) lists that green house experiments have already been carried out on transgenic research projects like chickpea, pigeon pea, and vegetables such as potato, cauliflower and cabbage and laboratory research to test the Golden Rice technology and adjust it to Indian conditions has also been approved by the Department of Biotechnology. Delhi University, Bose Institute, Calcutta and the Tamil Nadu Agricultural University are all working on rice. Private companies like Rallis India and MAHYCO are working on vegetable crops and cotton respectively. But so far, Bt cotton has been the first and only crop that has been approved for commercial sale since March 2002 and Bt mustard awaits commercialisation. Before we discuss the experience of cultivating Bt cotton here and elsewhere and examine the issues concerning Bt cultivation, in the following paragraphs, a brief note on cotton cultivation is presented.

4. Cotton Cultivation in India

In India, cotton is planted in about 9 million hectares. Sidhu (1999) observes that there is a large gap between the demand for cottonseeds and the supply of the same (Table 4), which has remained above 1.5 lakh tonnes in all the study years. Interestingly, his study also points out the various sources of seeds for the cotton crop, which is presented in Table 5. This table reports that but for the 50 per cent of the seeds that come from the fellow farmers, about 28 per cent comes from the unorganised seed sellers. Sidhu also notes that as far as hybrid seeds are concerned, farmers buy such seeds from the seed companies because hybrid seeds loose vigor with each succeeding crop. Hence farmers sowing hybrid cotton variety have to depend on the market for the seed input. Not only for the seeds, the repeated pest attacks have made the farmers to rely on the chemical pesticides which have impact on the crop, the health of the farmers and the environment. The increased reliance on the market by the farmer indicates that their traditional knowledge of cultivation has been of limited use.

Another issue is that, in recent years, the seed traders have emerged in a significant manner in seed selling. These traders get their seeds from the seed companies through line of credit, which they pass on, to the farmers. Since most seed traders also stock pesticides, fertilisers etc, generally all the inputs are provided on credit to the farmers. These agencies play an important role in

promoting particular brand or company's seeds and are also responsible for selling adulterated seeds, which lead to low yield, heavy pesticide and fertiliser use, and leave the farmer in a debt trap. Besides, Cotton cultivation in India has been plagued with rising cost of cultivation, ineffective pesticides, adulterated seeds and other inputs leading to consecutive crop failures and heavy indebtedness. Some of the recent studies (Vasavi 1999, Mohanti 2001, Parthasarathy 1998, Deshpande 2002) have attributed the crop failure/low yield to the adulterated seeds and the farmers' lack of knowledge of suitability of different varieties of seeds to their land, which in the final analysis lead to suicide by the farmers[8].

Organic cultivation is an alternative to avoid the problems caused by chemical fertilizers and the pesticides. But, the bio pesticide market accounts only for about 3000 tones of the 0.1 million tones worth of annual pesticide trade in India (Down to Earth, February 2002). It also implies that unless the farmers are educated about the proper use and impact of the market inputs, there could be adverse implications on their health, environment and the crop. For instance, many farmers were misinformed by the pesticide traders that endosulfan is the best bio-pesticide (Down to Earth, February 2002). Ironically use of endosulfan has been found to be the cause of physical deformities and mental derangement among the newly born and other diseases among the adults in the cashew grove of Kerala (Down to Earth, June 2001). Most often the pesticides have been ineffective in controlling the pest attack and unseasonal rainfalls in the late 1990s have added to the misery of the farmers by increasing the pest population (Mohanty 2001, Parthasarathy, 1998).

This is the background of cotton cultivation in India, in which Bt cotton has been introduced.

4.1 Experience of Different Countries in Cultivating Bt Cotton

In simple terminology, Bacillus Thuringiensis or popularly known as Bt technology, provides farmers an `inbuilt pest management system'. BT is a naturally occurring soil bacterium that acts against pests. Recent research in biotechnology has enabled researchers to introduce the Bt gene into the cotton

[8] To get an average return of Rs. 10,000 a hectare, a cotton farmer had to spend around Rs.11, 000 just to save the crop, where spraying of pesticides alone cost Rs.7000 a hectare (Times of India, March 8, 2002).

plants DNA. So, when a target pest eats the plant, the Bt protein interferes with the insect's digestive system and causes death. The targets of Bt cotton are major caterpillar pests, including tobacco budworm, bollworm and pink bollworm which are the major pests affecting the cotton crop world wide. Thus the genetically modified Bt cotton is expected to reduce the use of broad-spectrum insecticides.

Two varieties of Bt cotton were commercially introduced in the US by the US based Monsanto (which has patented this technology) in 1996, after getting the necessary approval from the US Department of Agriculture, Environmental Protection Agency (EPA) and Food and Drug Administration. About 5,700 cotton growers planted Bt cotton in nearly 1.8 million hectares or in 13 per cent of total US cotton acreage, despite a $ 32 technology fee per acre largely guided by the severe cotton crop failure in 1995 due to budworm attack, which varied across the country. Bt adoption rates were over 60 per cent in Alabama, Georgia, Arizona and Mississippi. The EPA in 2001 extended a conditional registration for Bt cotton for another five years after evaluating the previous time limited registration and consultation with an independent panel of scientific experts and medical communities it determined that Bt cotton does not pose a risk to human health or environment. However, environmentalists and organic cotton growers were successful in gaining a requirement `that Monsanto implement a pest resistance management plan as a condition of EPA registration (Rissler, 1997) which meant that, for every 100 acres of the Bt cotton plot, 4 acres of refuges-the traditional cotton varieties should be planted'. These refuge plants, are not to be treated with any pesticides[9]. Other provisions to maximise protection of the environment include an EPA requirement that Monsanto will conduct monitoring of any potential impacts from its continued use. The company must also educate growers about the best methods of planting BT cotton to minimise any potential development of insect resistance or gene transfer to other plants (EPA, 2001).

Harvest time reported mixed results with farmers from the West to the East coast reporting of bollworm damage of varying degrees and there was change in the behaviour of the pest attack but a substantial reduction in the pesticides use was however observed. According to a survey carried out in the US (reported in Edge et al 2001) in 1999, cotton growers perceived that they had better control of

[9] In 2004, EPA will review this condition.

tobacco budworms (77 %), bollworms (66%), and pink bollworms (57%) when they compared their experiences of Bt cotton with conventional cotton pest control systems. As compared to this another survey reported that two Bt cotton varieties provided 95 per cent control of tobacco budworm, 90 per cent control of bollworm and 99 per cent control of pink bollworm in Texas. Benedict and Altman (in Edge et al 2001[10]) observe that the negative effects of insecticides on non-target animals found in streams, rivers and ponds would reduce due to the reduction in the use of insecticides. They further point out that assuming an average reduction of 2.2 sprays per hectare on the 972,000-hectare cotton produced in 1998 in the US actually implies that 962,280 Kg insecticide active ingredients did not enter the environment and local watersheds thus reducing the potential exposure to non-target animals and farm workers. Interestingly, while, Frisvold et al (1999) observe a reduction in acreage under Bt cotton from 10096 to 8396 acres between 1996 and 1998, yet many studies reported an average net return of $94.32 from Bt cotton compared to the non-Bt varieties.[11] Implicitly the yield per acre in Bt crop improved. Shiva et al (1999) point out that the returns from the Bt and non-Bt cotton were the same for the US farmers.

After successfully introducing the Bt cotton technology in the US, Monsanto turned its attention to the developing countries. However, even before Monsanto entered the picture in China, the Biotechnology Research Centre of the China Academy of Agricultural Sciences (CAAS) initiated a major research program to develop Bt cotton varieties and the first successful genetically engineered cotton plant was produced in China in 1993 and was also patented. After experimental field trials in 1995, the first Bt varieties were given to farmers for commercial planting on a small scale the next year. In 1997, the Chinese bio safety committee approved four CAAS varieties for commercial use in nine provinces.

In 1996, Monsanto formed a joint venture with the Hebei provincial Seed Company to produce and market genetically engineered cottonseed through a company called Dijai. By 1999, 20 new Bt cotton varieties were produced with the government taking the major initiative. Pray et al's study in China (2001) analysed the economic impact of Bt cotton and compared it with the conventional

[10] Edge et al (2001) present a review of all the studies on Bt cotton in the context of the US.

[11] This is based on compilation of results from various studies done in different states of the US.

cotton and other varieties in China among 283 farmers who were mainly small and poor farmers. This study finds that Bt cotton reduced the cost of production for the farmers, where the total cost of non Bt cotton was much more than the cost of the Bt varieties and overwhelms the savings due to lower seed costs and higher yield. Interestingly, it was found that Bt cotton was not replacing the genetically diverse landraces. But they were replacing a few major older varieties that came from Delta and Pineland. This study also quotes that the Chinese government extension agents found that insect diversity and the number of beneficial species of insects increased in the fields of Bt cotton. Exchange of Bt seeds with fellow farmers continued which meant that monetary benefits accrued to the farmers were higher than that of the seed companies, which is attributed to the weak intellectual property rights regime in China. It is not very clear whether refuge varieties were planted along with Bt crops in China. Nevertheless, the Chinese biotech researchers observe an 80 per cent reduction in insecticide use due to Bt cotton, which comprises 35 per cent of the nations crop, and is the biggest environmental benefit (Down to Earth, July, 2002).

Though the known benefit of this technology viz, the reduction in the pesticide use is beneficial to farmers, yet as Damodaran (1999) and Qaim (2001) observe, intellectual property rights of the concerned country will play an influential role in diffusing this technology on a wide scale. Both in the US and Canada, Monsanto has filed cases against large farmers for illegally cultivating the patented canola, while the farmers insist that such crops have entered their field through pollination[12].

While all these studies point out the positive aspect of Bt yet, North Carolina State University's research study reported that 1 in 350 tobacco budworms carried resistance to the Bt toxin. This estimate forewarns (a) a swift evolution of resistant insect populations and (b) with 4 per cent refuge, Bt cotton could remain effective against tobacco budworm for 10 years. However, Bt cotton has less resistance to other pests such as cotton bollworm and European corn borer and hence this study predicts a boom cycle of only 3-4 years for Bt (Prakash, 1997). Bt cotton is not effective against other pests like boll weevil and whitefly.

[12] Monsanto has filed a case against a large farmer in Canada for allegedly infringing its Canola roundup crop and the case is going on for several years (Fox, 2002).

4.2. Bt Cotton in India

In 1996, Monsanto entered India by creating a joint venture with Maharashtra Hybrid Seed Company Limited, (the largest commercial producer of cottonseeds in India) called MAHYCO-Monsanto Biotech. In 1997, MAHYCO crossed one of its seed varieties with Monsanto's Bt variety to obtain a new strain to suit the Indian soil and climate. Field trials of Bt cotton were under taken by MAHYCO in 1997[13] which was resisted by environmentalists and farmers organisation on the basis of the probable impact of Bt on environment, other land races, non targeted species, human beings and the possible monoculture which eventually would lead to more pest attack. Controversies apart, harvest time reported that bollworm attack was less on Bt cotton, though the cost of cultivation of Bt and non-Bt were same (Shiva et al, 1999).

In June 2001 when MAHYCO sought the required approval from the GOI's, Genetic Engineering Approval Committee (GEAC) for commercial cultivation, the GEAC ruled that the trial data were unreliable as the crops were grown off-season when the pest attack was low. Hence, GEAC asked the company to repeat the field trials on a larger scale under the supervision of Indian Council of Agricultural Research (ICAR). Based on the field trials conducted under the supervision of ICAR, GOI gave permission for commercial sale of Bt cotton. This permission is for a three-year period from April 2002 to March 2005 and holds good only for Gujarat, Maharashtra, MadhyaPradesh and Andhra Pradesh, and not in northern states[14].

Following the steps of EPA of the US, the GEAC has stated that 20 per cent of the field should be planted with refuge cotton. MAHYCO will have to periodically report to the GEAC about production, varieties sold and the destination of the Bt seeds. The company has also been asked to conduct studies to assess the (a) pest resistance to Bt toxin and (b) impact of pollen transfer on other species. The company should also inform farmers about the Bt cotton in vernacular press. More importantly, GEAC has said that there is no harm in using the transgenic

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[13] The controversies surrounding these field trials have been detailed in Iyengar and Lalitha (2002).

[14] Incidentally in Punjab, cotton production reduced from 7-8 lakhs bales in 1999-2000 to 0.90 lakh bales in 2000-2001 due to bollworm attack (Jain Sonu, Indian Express, April 10, 2002).

cotton in food products and no labelling is required for the domestic market, while labelling will be essential for the export market. With all these conditions GOI has granted permission to MAHYCO to commercialise the Bt cottonseeds in March 2002. Now various agencies are evaluating the performance of Bt cotton in different states.

A survey conducted in Warangal and Khammam district of Andhra Pradesh points out that `in the Northern region of Warangal district, where pest attack is severe, on an average, bollworm attack was about 30 per cent lower on Bt cotton compared with non Bt cotton. In some of the fields damage due to Bollworm attack was as high as 80 per cent in case of non-Bt cotton, whereas damage to Bt cotton was up to 40 per cent. It was observed that most of the farmers surveyed, already sprayed pesticides for 4 to 5 times and no distinction of Bt or non Bt is made for spraying pesticides' (Dravid and Sai, 2002). However, recent reports coming from the Warangal district quoting the government of Andhra Pradesh point out that Bt cotton has not yielded positive and encouraging results to the farmers (Economic Times, March 7, 2003). The NGOs operating in this area have urged the company to provide compensation to the farmers. However, the overall impact of this variety will conclusively emerge with harvest results coming from other states. Interestingly, in April 2003, GEAC has decided not to commercialise Bt cotton in North India on the grounds that `the Bt hybrid meant for Punjab and Haryana was vulnerable to the leaf-curl virus' (Times of India, April 26th).

In a significant development in India, Genetic Engineering Approval Committee (GEAC) has stalled the release of the first Bt food crop mustard on the basis that the company Proagro has to prove the commercial viability of the seed. According to the company, it undertook both limited and large- scale field trials between 1997-98 and 2001-02. The company trials have also proved that the leaves and oil do not create any allergic reaction on humans or animals and the pollen flow is within the limited range of distance. The ICAR also undertook 8 field trials –four to test the agronomic characters and four to test the bio safety. Further use of this seed is expected to give an additional income of Rs-3500 to 4500 per hectare. However, GEAC has not been satisfied with the test data and the release has been stalled on the ground that the ICAR results were not conducive and the health risk issues were also not addressed (Times of India, April 26th).

5. Issues in Cultivating Bt Cotton

Based on the issues plaguing cotton cultivation and the experience of other countries in cultivating Bt cotton, one will be tempted to say that India should go for transgenic crops in full-fledged manner. Whereas environmental issues concerning transgenic crops need to be ascertained before we go ahead with these crops, yet it need to be remembered, in the absence of this technology also, enough and more damage has already been done to the environment due to heavy use of chemical insecticides, pesticides and fertilisers. While administrative lapses in conducting and evaluating the field trails of transgenic crops need to be avoided, the focus should not be on shunning the technology. The basic infrastructure required to ensure that biosafety measures are followed, need to be in place. Whereas the State Level Biotechnology Coordination Committees (SBCC) should be involved in the field trials, yet, Chaturvedi (2003) notes that none of the states have established SBCC or the district level committees. Besides attention should also be paid to the following areas of concern.

1. The issue of refuge poses a serious concern. Adhering to this may create some problem since unlike the US where large-scale farming is the norm in India, majority are small-scale cultivators. In April 2002, MAHYCO decided that for each 450gm packet of the Bt cotton sold (which will cover 1 acre), a separate 120 gm non-bt seeds will be provided free of cost (this will cover 0.27 acres). Whereas the hybrid cotton costs around Rs.350-450 per packet of 450gm, the Bt cotton is expected to cost Rs.1350-1450 per 450 gm packet (Hindu, Business line, April 20, 2002). Obviously, any profit motivated company will announce such schemes only as a marketing strategy to promote its new product and might discontinue the scheme once the sale of Bt cottonseeds has picked up. Given the price difference of nearly Rs.1000 between the hybrid and the Bt cottonseed and the fact that majority of the farmers being small and marginal landholders, it is not known how many farmers will be able to afford Bt cotton seeds and stick to the refuge schedule. Further, evidence suggests that whenever there is a shift from subsistence to commercial agriculture, small and marginal farmers join in a big way (Shah, Shah and Iyengar, 1991). A typical cropping pattern in such an event is that between 70-80 per cent area is devoted to commercial/ market crops and rest is used for food grains for self-consumption. If farmers are tempted to shift to Bt cotton, they will have to decide between the refuge and food crops.

2. Bt cottonseeds are priced at around Rs.1450 for a 450-gram packet. The price is fixed exorbitantly high basically to recoup the amount that has been

invested in R&D to develop the seed to suit the Indian soil and climate and amount that is paid towards licence fee. It is reported that MAHYCO had already spent around US$ 8 millions (Jayaraman, 2001) by then by way of developing the seed and in field trials, at a time when the government asked the company to repeat the field trails under the ICAR's supervision. Hence, the price is fixed high. Further, the Indian Plant Act enables the farmer to save, use, sow, resow, exchange, share or sell the seeds of protected variety. Assuming that the Bt cotton seeds yield do not reduce at least in the first three successive cultivation, farmers will be more interested in saving and exchanging the seeds for further use, which will affect the sales of the company. Perhaps keeping this in mind, the price is fixed high to reduce access to the small and marginal farmers. However, in order to increase the volume of sales, the company will have to reduce the price of the seeds.

3. Currently, MAHYCO is the only licensed user of the Bt cotton technology, and entered the market with one lakh seed packets. It is reported that even if MAHYCO's capacity at Jalna is completely utilised to produce Bt seeds, then about 1,50,000 hectares will be under Bt cultivation of the total 9 million hectares under cotton cultivation that still leaves a huge gap that can be bridged only if more capacities are added. Already, eight Indian seed companies have formed a consortium called `Swadeshi Biotechnics' to jointly explore possibilities of obtaining and commercialising Bt technology (Dravid and Sai, 2002). This would also make possible obtaining compulsory license in case the Bt seeds are not available in adequate quantity[15]. This also points out that there will be large scope for infringement of intellectual property rights. For instance, when MAHYCOs application to commercialise its cotton seeds was still pending before GEAC, around September 2001, scientists from MAHYCO observed that transgenic cotton was being grown at nearly 10,000 acres of Gujarat. It was reported that these farmers had purchased the seeds from `Navbharat'- a seed company which is thought to have developed the seed as a hybrid from transgenic seed imported from the US. Since this large-scale plantation was undertaken without GEAC's permission, GEAC ordered to destroy the crop. The farmers however, were elated because of the higher yield and the reduced pesticide consumption. MAHYCO has filed a case against Navbharat for infringing its intellectual rights. Incidentally, Navbharat had so far not claimed those seeds as transgenic variety. Interestingly not only the crop was not destroyed, it also reached the market and entered the different product chain, the impact of

[15] A related report points out that seven companies would be commercially releasing the Bt cottonseeds in India. These are Mahendra and Paras of the Emergent Group, Nath Seeds, Ankur Seeds, Ajeet Seeds, Raasi Seeds, Krishi Dhan and Nuziveedu Seeds. These are preparing to commercialise their Bt cotton hybrids by 2006. While Nath is sourcing the gene from a Chinese firm `Biocentury Transgene Company' others have entered into sublicensing agreements with Monsanto (Economic Times, March 14).

which is not yet known. Also, in India, where smallholdings are popular, Bt cotton could spread to nearby lands due to pollination, which can be called as potential act of infringement. Farmers need to be educated about the possible acts of infringements and their impact.

Besides infringement, there is also the chance for adulterated and hybrid seeds entering the market as transgenic variety. In order to prevent this, certification of the seeds should be encouraged. However, the long time taken to certify the seeds is cited as one of the reasons for the companies to sell their seeds as `truthful seeds'. Hence, it is essential that more individuals and agencies be accredited to certify the seeds as stated in the Seed Policy 2002, so that the sale of adulterated and other seeds could be checked.

4. If the Bt cotton proves to be good, then there could be a large-scale demand for these seeds, in the coming seasons. Since, MAHYCO is the only licensed producer, obviously there will be a gap between the demand and supply. This combined with the fact that the seeds are priced very high can be a case for obtaining compulsory licence (CL). CL will induce competition and reduce the price of the seeds but the point as mentioned earlier is that the licensee should have the required know-how to produce the seeds.

5. The impact of HYV varieties introduced during the Green Revolution days was felt in the form of `loss of the landrace seeds as the cultivation of commercial/cash crops displaces the cultivation of local crops. Linked to the use of increased amounts of fertilisers and pesticides there is depletion of soil fertility and increase in crop susceptibility to pests and diseases. As a whole, there is a lack of fit between the ecological specificity of the region and commercial agricultural practices (Vasavi, 1999). Also intensive use of fertilisers lead to lowering the soil water retention capacity of the soil, thus demanding more water resources like tube wells which decreases the water tables. In the case of Bt crops, the whole plant is a pesticide; hence only in the long run the above-mentioned impacts could be confirmed. Hence, the Bt cotton cultivation should be scrutinised as stated in Seed Policy during the conditional registration period.

6. The Indian Plant Variety Act does provide for claiming compensation if the seed variety does not give the same performance as promised by the breeder. However, farmers need to be educated of their rights and the legitimate claims they have when they opt for new or transgenic seeds. But awareness of farmers is alarmingly low and `they are hardly familiar with formal seed quality regulations and they do not know what to do if they happen to buy poor quality seed' (Pal and Tripp, 2002). Especially the terms and conditions in fine prints should be explained to the farmers. For

instance, a company could deny compensation on the ground that the particular seeds were effective against a particular insect and hence may deny compensation to loss of crop due to any other pests[16]. In this context, the system designed by the AndhraPradesh government is worth replicating. In Andhra, wherever crops have failed because of seeds, the government helps the farmer with all the procedures and formalities in getting the compensation.[17]

7. According to the plant breeders rights any new plant or seed variety should be deposited with the National Gene Bank. Adequate precautions need to be taken to maintain such gene banks.

8. If farmers accept transgenic seeds for their performance, then it could lead to land consolidation in the near future. There is already a fear that the large scale funding that is given to the Government of AndhraPradesh to set up large scale mechanized farm to grow genetically modified crops, will eventually lead to consolidation of the small farms and render them landless (The Straits Times, Singapore, April 4, 2002).

6. Concluding Observations

As agriculture has also been included in the arena of intellectual property protection, all member countries will have to either provide (a) patent protection, (b) a *sui generis* system or (c) adopt UPOV 1991 to protect the plant varieties. The Indian government has chosen the *sui generis* system and accordingly has passed the Plant Variety and Farmers Protection Act and also has a new seed policy. The language adopted by both the documents is that of promoting private research initiatives in agriculture. While this will be helpful in bridging the wide gap between the demand and supply in the seed sector, it calls for massive investments in R&D sector, particularly in plant biotechnology. Already the trend to adopt transgenic technology is swaying across the world and it is expected that more such transgenic crops would be introduced in the near future. While

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16 In a different context, a Monsanto-MAHYCO official has pointed out that the varieties released in India are meant to protect against bollworm and not meant to increase the yield of the crop. The official has also said that the cotton crop failure in 2002 has been due to the severe drought and para-wilt disease (Economic Times, March 24, 2003). Reasons and explanations like this could prevent the farmer claiming any compensation from the company.

17 Private communication with a farmer on reforms introduced in Andhra Pradesh.

the Indian Plant Act gives protection to such new varieties, the seed policy provides incentives to attract investment. Importantly, protection is extended not only to new varieties but also to extant and farmers' varieties. This will benefit the farmers to protect varieties, which are becoming extinct. Access to protected materials should boost research in private and public sector. A large database also needs to be created with the help of the local communities for appropriate benefit sharing and to prevent possible infringement. Hence, in the days of globalisation, the role of the government as a regulator is very essential.

Regarding the protection of farmers interests, though the Act mentions that compensation should be paid to the farmers in the event of failure of seeds, yet the task in hand is that the farmers should be made known the circumstances under which such claims can be made and should also be provided procedural help to make such claims. The company selling such new varieties should clearly specify the expected levels of performance and the related conditions in clear terms. Similarly in order to prevent the sale of adulterated and spurious seeds, facilities for faster certification should be made. Accredition of individuals and organisation to certify the seeds mentioned in the Plant Variety Act should be speeded up.

As elaborated in the text, Bt cotton's effectiveness on bollworm has been observed in the US, China and even in India. If these claims continue to hold good for India, then the pesticide companies may lobby against the large-scale adoption of this technology unless they consolidate themselves like the firms in the West. Hence, keeping the positive impacts of this in mind, the government should conduct the trials in a more methodical manner and make available the technology with adequate precautions.

In both Bt cotton and mustard cases, the government has stalled the release of these varieties in the last moment and had asked for fresh round of trials. While it is essential that India proceeds cautiously in this venture it is also essential that the government should decide whether it needs the GM technology or not. Either the government institutions should be involved in the closed/field trials from the initial stage onwards or a mechanism should be worked out to crosscheck the data supplied by the GM technology provider. Otherwise, stalling the commercial release in the final stages will send negative signals for companies and institutions interested in venturing this area. Seed companies in order to reap monopoly profits might under play the possible social costs of such varieties and

the distressed farmers would be more than willing to plant anything that assures them of a proper yield. The public sector has an important role in monitoring the research outcomes of the private sector. It also has to ensure that new technologies do not affect the livelihood of the present farmers and sustain the bio diversity and safeguard the environment for the future generations.

Table 1: Global Area of Transgenic Crops by Country, 1996-2000

(Million hectares)

Country	1996	1997	1998	1999	2000
USA	1.5	8.1	20.5	28.7	30.3
Argentina	0.1	1.4	4.3	6.7	10
Canada	0.1	1.3	2.8	4	3
China	1.1	1.8		2.3	2.5
South Africa			<0.1	0.1	0.2
Australia	0.1	0.1	0.1	0.1	0.2
Romania				0.1	0.1
Mexico	0.1	0.1	<0.1	0.1	0.1
Bulgaria					0.1
Spain			<0.1	0.1	0.1
Germany					0.1
France			<0.1	0.1	0.1
Portugal				0.1	
Ukraine				0.1	
Uruguay					0.1
Total	3.0	12.8	27.8	42.5	46.9

Source: Chaturvedi (2002)

Table 2: Commonalities and Differences in TRIPS, US Utility Patent, UPOV 1991 and the Indian Plant Varieties and Farmers Rights Bill, 2001

Particulars	TRIPS Agreement	US Utility Patent	UPOV 1991	IPVFRB (2001)
Granting Criteria	Novelty, inventive type and industrial applicability	Novelty, non-obviousness, utility	New, Distinct, Uniform and Stable	Novelty, distinctiveness, uniformity and stability
Industrial applica-bility/ Utility	Not defined	Advantage over the prior art	Not a requirement	Not a requirement
Distincti-veness	Not defined even as a requirement for the *sui-generis* system of protection mandated for plant varieties under Article 27 (3) (b)	Not a requirement	The variety must be clearly distinguishable in its essential characteristics from other varieties, which are a matter of common knowledge (e.g. protected by a plant variety right) at the time of application	The variety should be clearly distinguishable by at least one essential characteristic from any other variety whose existence is a matter of common knowledge in any country at the time of filing of the application
Extent of protection	Where the subject matter of the patent is a product the right allows the holder to prevent third parties, not having the consent of the holder using, offering for sale, selling or importing the product. (a) Patent holder can deny usage of the process he has developed or even the sale of product of that process	(a) Right to prevent all others from using the invention (b) Protection extends to all biological materials, genes to genotype	(a) Right to produce, reproduce, sale or stock any plant variety (b) Right to extend to harvested material and other products obtained from material of the variety provided	Registration under this Act shall confer an exclusive right on the breeder or his successor, his agent or licensee, to produce, sell, market, distribute, import or export the variety

Table 2 (Contd…)

Farmers privilege	Not specific-but possibly permitted via Article 30	Not permitted	Optional Contracting parties, may within reasonable limits and subject to the safeguarding of the legitimate interests of the breeder, restrict the breeders right in relation to any variety in order to permit farmers to use for propagating purposes	A farmer shall be deemed to be entitled to save, use, sow, resow, exchange, share or sell his farm produce including seed of a variety protected under this Act in the same manner as he was entitled before the coming into force of this Act: (b) Provided that the farmer shall not be entitled to sell branded seed of a variety protected under this Act.
Breeders/ Research Exemption	Not specific-but possibly permitted via Article 30	Free use of protected material for research purposes is permitted but only where it is for non-commercial purposes	Yes-non-infringing include (a) acts done privately and for non-commercial purposes (b) Acts done for experimental purpose and for breeding	Nothing contained in this Act shall prevent- (a) the use of any variety registered under this Act by any person using such variety for conducting experiment or research; and (b) the use of a variety by any person as an initial source of variety for the purpose of creating other varieties, provided that the authorization of a breeder of a registered variety is required where the repeated use of such variety as a parental line is necessary for commercial production of such other newly developed variety.

Table 2 (Contd…)

Compulsory Licenses	Yes but only where (a) the applicant has requested for and been refused a license from the patent holder (b) The use for which the applicant wishes to use the protected invention is non-exclusive (c) The use is predominantly within the domestic market (d) The license holder pays an adequate remuneration where the license is needed in order to exploit a second patented invention which is dependent then a license will be granted only where (1) the invention claimed in the second patent involves an important technical advance of considerable economic significance in relation to the invention claimed in the first patent; (2) the owner of the first patent is entitled to a cross-license on reasonable terms to use the invention claimed in the second patent; and (3) the use in respect of the first patent is non-assignable except with the assignment of the second patent. Each case is assessed on its individual merits and is subject to termination when the circumstances change and any decision is subject to judicial review.	No, although the ability of the patent holder (the licensor) to dictate the terms of any license he/she chooses to grant are subject to extensive restrictions via the common law doctrine of patent misuse and anti-trust laws.	Not mentioned as such. Article 17 states that (1) Except where expressly provided in this convention, non-contracting party may restrict the free exercise of a breeders right for reasons other than of public interest (2) When any such restriction has the effect of authorising a third party to perform any act for which the breeders' authorization is required, the contracting party concerned shall take all measures necessary to ensure that the breeder receives equitable remuneration	Yes. At any time, after the expiry of three years for the date of issue of a certificate of registration of a variety, any person interested may make an application to the Authority alleging that the reasonable requirements of the public for seeds or other propagating material of the variety have not been satisfied or that the seed or other propagating material of the variety is not available to the public at a reasonable price and pray for the grant of a compulsory license to undertake production, distribution and sale of the seed or other propagating material of that variety.

Table 2 (Contd…)

Duration of protection	20 years from the date of filing	20 years from the date of filing	30 years for trees and vines, 25 years for all other varieties (Article 19)	Registration is valid for nine years in the case of trees and vines and six years in the case of other crops and may be reviewed and renewed for the remaining period on payment of fees as fixed by the rules. The total period of validity shall not exceed (a) 18 years from the date of registration of the variety in the case of trees and vines, (b) fifteen years from the date of the notification in the case of extant varieties and (c) in other cases 15 years from the date of registration of the variety.

Source: Column 1-4 from Chaturvedi, (2002). Materials in column 5 compiled by the author from `The Protection of Plant Varieties and Farmers' Rights Bill, 2001'.

Table 3: Transgenic Field Trials in India, 1994-2000

Crop	Trait	Organisation
Brinjal	Insect Resistance (bt)	Indian Agricultural Research Institute, New Delhi
Cotton	Insect Resistance (Bt)	MAHYCO, Mumbai
Mustard	Herbicide tolerance	Proagro PGS India, New Delhi
Tobacco	Insect Resistance (Bt)	Central Tobacco Research Institute, Rajamundri
Tomato	Insect Resistance (Bt)	Proagro PGS India, New Delhi
	Insect Resistance (Bt)	Indian Agricultural Research Institute, New Delhi

Source: Qaim, 2001.

Table 4: Gap Between Demand and Supply of Cotton Seeds in India (Cotton Seed Rate: 20 Kg Per Hectare)

Year	Cropped Area (Mn ha)	Seed Requirement (Lakh Quintals)	Seed Distributed (Lakh Quintals)	Gap (Lakh Quintals)
1990-91	7.44	3.72	1.92	1.80
1991-92	7.66	3.83	1.77	2.06
1992-93	7.54	3.77	1.87	1.90

Source: Sidhu (1999) P.377

Table 5: Sources of Seed for Cotton with Selected Farmers in Punjab, 1992-93 (Quintals)

Source of Seed	Cotton (American)
1.Self Retained seed	38.03 (55.20)
2. Fellow Farmers	
(a) Quality Seed	0.07 (0.10)
(b) General Seed	1.20 (1.74)
(c) Sub-Total	1.27 (1.84)
3. Department of Agriculture	0.59 (0.86)
4. Commission Agents	9.16 (13.30)
5.Seed Dealers	
(a) Authorised	0.35 (0.51)
(b) Unauthorised	19.49 (28.29)
(c) Sub-total	19.84 (28.80)
Total	68.69

Note: Figures in parenthesis are percentages

Source: Compiled from Sidhu (1999(P.373)

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