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Monsoon 2013: Estimating the Impact on Agriculture

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Abstract

This paper attempts to project the likely impact of robust monsoon rains of 2013 on the Agricultural Gross Domestic Product (GDP) growth in India. The model hypothesizes that the performance of agriculture in India depends upon (1) investments in agriculture (private and public); (2) agricultural price incentives; and (3) rainfall. A log-linear model fitted over 1996-97 to 2012-13 period can explain 95 percent of the variations in agri-GDP with all variables being statistically significant. The model also forecasts that the agri-GDP growth rate for the agricultural year (July-June) 2013-14 is likely to be between 5.2% and 5.7%.

An alternative model to double check the results is also used. In this model, the AGCF is replaced by a simple trend variable; the idea being that the trend captures development of various investments and technologies that take place in agriculture over this period. Other variables remain the same. This model also suggests that the agri-GDP growth will be between 5.1% and 5.6%.

The paper estimates that agri-GDP growth in 2013-14 is likely to be about three times higher than last year. And it is likely to come largely from oilseeds, pulses, cotton, and coarse cereals belt of central and western parts of the country, which is less irrigated and thereby more dependent on rains. It is very likely that any damage to kharif crops due to excess rainfall (with extended monsoons and cyclones) would be offset by a bumper rabi crop, given that there is excellent soil moisture and ample surplus water in reservoirs. This high growth in agri-GDP is likely to trigger a multiplier effect on manufacturing and services sectors, and thereby propel overall GDP growth rate.

JEL Classification: *Q150, Q250, Q510*
Keywords: *Drought, Water, Agricultural and Environment, Rainfall, Contingent Valuation*

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Disclaimer:
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Executive Summary

Monsoon showers in 2013 have been one of the best the country has experienced during the last two decades or so. The June to September rainfall has been 5.6 percent higher than the Long Period Average (LPA). But if one counts the continuing rains in October (till October 31st), the excess rains turn out to be almost 10.2 percent above normal, thus making the Jun-Sep rains close to being the best since 1995 and the Jun-Oct rains amongst the top 10 the country has received in the last 54 years.

Apart from the favorable temporal trends of the monsoons in 2013, the showers have been encouraging in terms of their spatial spread too. Of the 4 broad regions of India: the north-east, the northwest, the central, and the south peninsular India, as categorized by Indian Meteorological Department (IMD), with the exception of north-east India, all the other three regions received normal or above normal showers. As a result of this bountiful rainfall, as on October 31st, 2013, the 85 major reservoirs in the country are also operating at 122% of the last year's storage, which is 123% of the average of the last ten years.

All this is a very good news for a country's agriculture, where 53% of the gross cropped area is still rain-fed, and monsoons alone account for more than 76% of the total annual rains. No wonder then that years of good rains are associated with robust agriculture GDP growth. This year too is likely to be one of those. By how much one can expect the agri-GDP to grow as a consequence of this bountiful rainfall, and what implications can it have on the overall economy, is the precise objective of this study.

The study reviews the pattern of rainfall, as also the increase and structural transformation in irrigation cover since 1950. Studying this is important as it is the interaction of these factors, along with many others, that impacts the performance of agriculture over time. We have tried to capture that by using a log-linear regression model with different variables influencing variations in agricultural GDP. But, since the monsoon rainfall (June to September) of any year influences the agricultural performance during the agricultural year (July to June); we had to construct a new series of agri-GDP as per the agricultural year (July to June). For this we needed quarterly data of agri-GDP, which is given only from 1996-97. Hence the analysis is restricted from 1996-97 to 2013-14, a period of 18 years.

The model specification hypothesizes that the performance of agriculture depends upon (1) investments in agriculture (both private and public, which incorporates the investments in irrigation and farm machinery, etc), as embedded in Gross Capital Formation in agriculture (AGCF); (2) agricultural price incentives, as reflected by the ratio of WPI agricultural price index to WPI of Non-agricultural prices index; and (3) rainfall, which is totally exogenous.

The model is fitted to the past data from 1996-97 to 2012-13. It can explain 95 percent of the variations in agri-GDP with all variables being statistically significant. It is then tested to track the past values by comparing the actual agri-GDP with the estimated values from the model. Once it is established that the model is robust and can successfully track the past performance of agriculture, only then it is used to project the likely values of agri-GDP for the agricultural year 2013-14 (July-June). Our results from this model indicate that the agri-GDP growth rate for the agricultural year (July-June) 2013-14 is likely to be between 5.2% and 5.7%.

We also use an alternative model to double check our results. In this model, the AGCF is replaced by a simple trend variable; the idea being that the trend captures development of various investments and technologies that take place in agriculture over this period. Other variables remain the same. This model also suggests that the agri-GDP growth will be between 5.1% and 5.6%.

It is very likely that any damage to kharif crops due to excess rainfall (with extended monsoons and cyclones) would be offset by a bumper rabi crop. The real boost to this year's farm GDP growth will come from excellent soil moisture and surplus reservoirs of water. Therefore, agri-GDP growth rate for the agricultural year 2013-14 would range from 5.1 to 5.7 percent.

Comparing these likely agri-GDP growth rates in 2013-14 (agricultural year) with the last year (2012-13) performance, it turns out that the agri-GDP growth is likely to be about three times higher than last year. And it is likely to come largely from oilseeds, pulses, cotton, and coarse cereals belt of central and western parts of the country, which is less irrigated and thereby more dependent on rains.

Such an increase in agri-GDP is likely to boost the overall performance of the economy via its multiplier effect. Also, given that food inflation is hovering in double digits, it is likely to increase farm incomes by almost 15 percent in nominal terms. Combine this with the fact that farm wages of agricultural labour have been increasing by more than 20 percent per annum for the last three years, and likely to continue this year too, it should mean lot of income accrual in rural areas (15 to 20 percent) in nominal terms. This should surely trigger some increased demand for agri-inputs to durable and fast moving consumer goods (FMCGs) in rural areas. Those in the manufacturing and services sector, who can tap this emerging demand, can grow fast sending overall growth impulses in the otherwise sagging economy. Tractors are already growing at more than 20 percent per annum, urea at almost 10 percent, but after the harvest, there is likely to be a surge in demand for mobiles and other FMCGs from rural areas. It would be a golden opportunity for the business CEOs to tap this potential boom in rural expenditure.

Monsoon 2013: Estimating the Impact on Agriculture

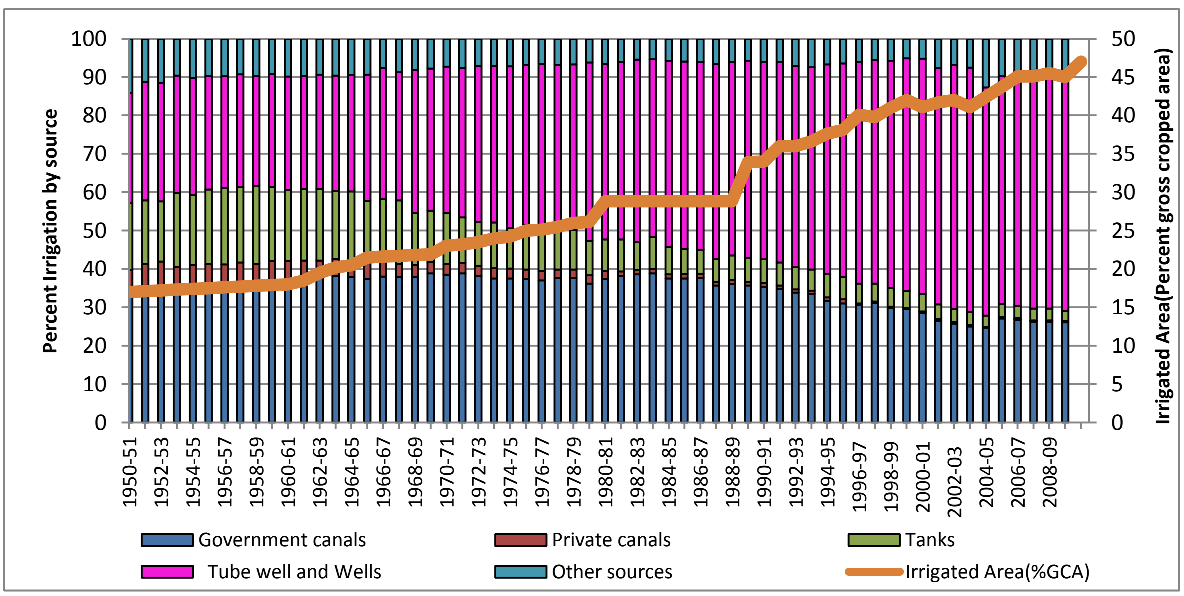
Ashok Gulati, Shweta Saini and Surbhi Jain

1. Backdrop

Indian agriculture is still heavily dependent on monsoons. Almost 53 percent of its gross cropped area (GCA) is rainfed, and even the area that is irrigated through canals, tanks, watersheds, and groundwater gets impacted when rainfall is low, and reservoir levels and ground water levels dip. Broadly, only about 35-40 percent of its area is under assured irrigation. There is no doubt that over the years irrigation cover has increased from 17 percent in 1951 to 34 percent in 1991 to 47 percent[1] in 2011; and that the share of groundwater has surpassed the share of canal irrigation (Chart 1). This may have helped to build an increased resilience to droughts as in 2002-03, a year of severe drought, agricultural growth rate turned negative at (-) 6.6 percent but in the year 2009-10, the worst drought year since 1972; agriculture recorded a low but positive growth rate of 0.8 percent.

Chart 1: Increasing Irrigation Cover in Indian Agriculture

(Irrigated Area as percent of GCA, and structure of Irrigation by Sources since 1950-51)



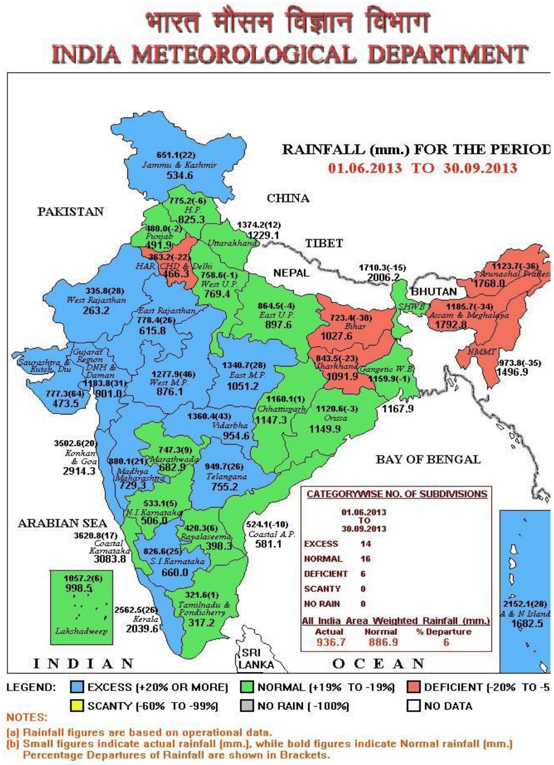
GCA: Gross cropped Area for the year

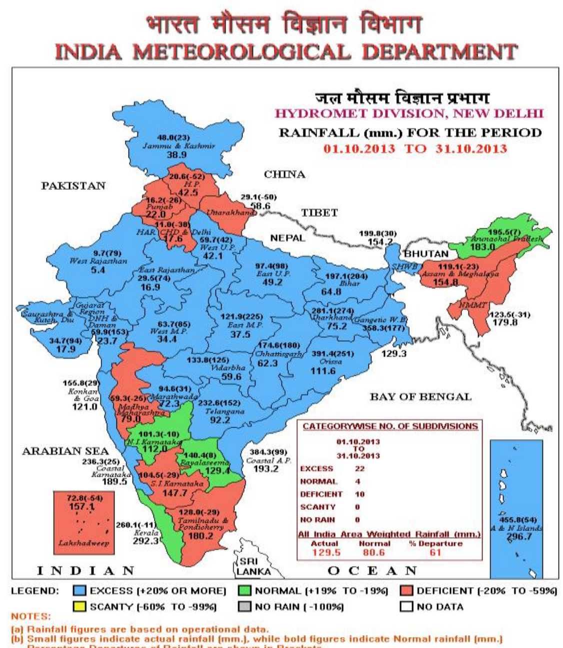
Source: Directorate of Economics and Statistics, Ministry of Agriculture

[1] Source: Planning Commission and Ministry of Agriculture, GOI

In 2013, the south-west monsoon has been bountiful and during June 1st to September 30th, India received 5.6 percent higher rainfall than the long period average (LPA) of 89 cms. But the rains this year have continued through October, and if one counts the period of June 1st to October 9th, rainfall was 6.94 percent higher than LPA of this period; including the north-east monsoon rains of October, the cumulative rainfall between June-October is 10.2 percent higher than normal.

Besides this cumulative precipitation, the spread of rains too has been fairly good. Except Bihar, Jharkhand, and sates of north-east, rest of India received either normal or above normal rainfall in the period between June 1 and September 30, 2013. As can be seen from the graphs below, of these states, Bihar and Assam & Meghalaya have benefitted from the unexpected extension of rains into October. These late showers have helped these states to move from being "deficient" to one experiencing "normal" rains.





This heavy downpour, and its wider spread, has also resulted in higher levels of water in the major reservoirs of the country; current year's water storage, as on 31st October 2013, in the 85 major reservoirs of the country is nearly 122 percent of last year's storage and 123 percent of the average of last ten years.[2]

[2] Central Water Commission, Ministry of Water Resources, GOI

The impact of this bountiful and reasonably well spread out rainfall on agri-production, agri-GDP and farm incomes, etc., is naturally an issue worth exploring. With agriculture contributing to 14 percent of India's GDP and providing employment to almost half of its work force, any impact of monsoons on agricultural growth would feed into prices, incomes and GDP growth. A vibrant growth in agriculture is also expected to spur the 'slowing down' economy with its wide backward and forward linkages. It is with this backdrop that we try to estimate the probable impact of a bountiful (above normal) monsoon on the agricultural sector.

For this, we first look at the pattern of rainfall since 1950-51, with a focus to identify the frequency of droughts and above normal rainfalls (section 2). In this section, we also look at the rainfall in 2013 from a time series perspective as well as its spatial distribution. In section 3 of the paper, we try to figure out the key determinants of agri-GDP, especially with respect to rainfall, over the last 17 years (since 1996-97). Needless to say, besides rainfall, there are many other factors that impact agri-GDP, and we try to capture the impact of some of those key variables in our econometric analysis. Based on this analysis, we also attempt to forecast the agri-GDP for agricultural year 2013-14 (July-June) as a result of generous 2013 monsoon. Obviously, this involves certain assumptions in specifying the model, empirically estimating it, validating it by tracking the past values, and then using it to forecast the agri-GDP for 2013-14 agricultural year (July-June). Finally, in section 4, we give the policy implications of this in a macro-economic environment, and how this opportunity of good rainfall can be used to kick-start some other reforms, which can get India out of the current economic turbulence somewhat less damaged.

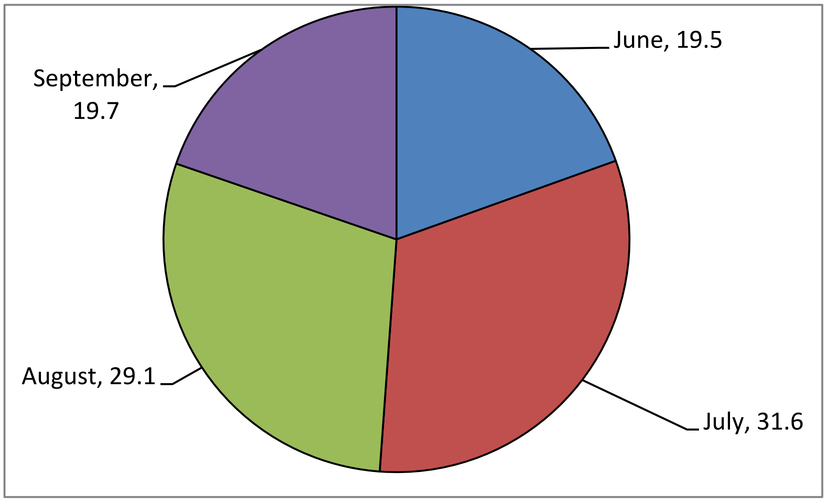
2. The Rainfall pattern since 1950

India has a tropical monsoon climate and rainfall is an important element for the economy. Although monsoons affect most parts of India, the amount of rainfall varies from heavy to scanty in different parts. Historically, it is known through official and unofficial records that practically every year, some part of the country experiences drought or flood, though there are certain areas more prone to such condition than others in the country. Traditionally Indian monsoon season is between June 1st to September 30th. The June-Sept rains (or South-West Monsoon Rains) account for nearly 76 percent of the annual precipitation and more than half of the total cultivated area is dependent on these rains[3]. The rainfall season between the months of October-December is known as the North-East monsoon season. The south Peninsular India consisting of five sub-divisions (Tamil Nadu, Coastal Andhra Pradesh, Rayalaseema, Kerala and south-interior Karnataka) receive about 30% of its annual rainfall during this season.

[3] Chapter 8, Agriculture and Food Management, Economic Survey 2012-13

Our study primarily involves the study of rainfall trends between the months of June to September each year since 1950. In these monsoon months, the months of July and August get more rainfall (almost 60 percent) than the months of June and September, which get roughly around 20 percent each (Chart 2).

Chart 2: Monthly Distribution Pattern of Monsoon Rains (percent)



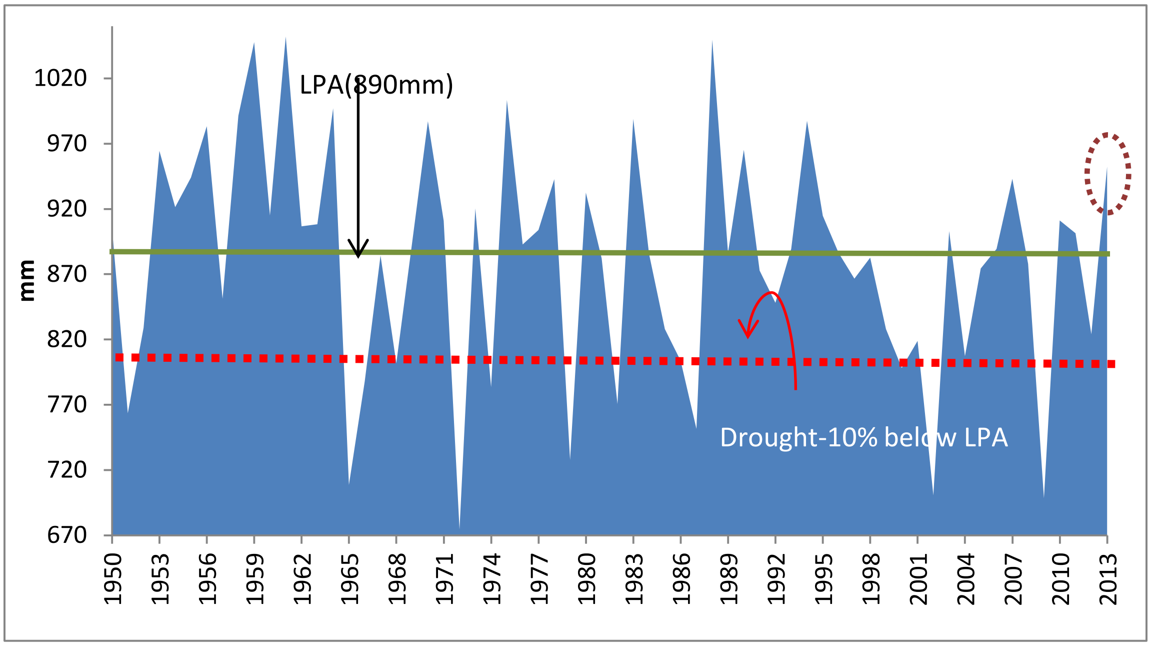
Average percentages for the period between 1996-97 and 2012-13
Source: IMD and Authors' calculations

As per Indian Meteorological Department (IMD), when the rainfall for the monsoon season of June to September for the country as a whole is within 10 percent of its long period average, it is categorized as a normal monsoon but when the monsoon rainfall deficiency exceeds 10 percent and affects more than 20 percent of the country's area, it is categorized as an all-India drought year. The LPA is the average or normal rainfall value calculated for all-India or for smaller areas based on an average of actual rainfall received between 1951 and 2000; all-India LPA for monsoon rains is 886.9 mm or 89 cm.

The performance of monsoons over the smaller areas of the country is similarly evaluated based on the deviation of their actual rainfall from the normal values, using the following criterion: when the rainfall deviation for an area is + 20% and more, the area has *excess rains*; when the deviation is ± 19%, the rainfall for the area is called normal. Negative deviation of rainfall of equal to and greater than 20% but less than 26% is called "deficient" rainfall. If for an area the rainfall falls equal to or greater than 26% from its LPA value but less than 46%, drought is declared for the area. A fall of equal to or more than 46% implies the area is struck with *severe drought*. (Details of rainfall categorization on a daily basis may be seen at Annex1).

Although at the all India level a declaration of drought requires more than 10 percent deficiency compared to LPA, but agricultural production gets impacted significantly even if the overall deficiency is say 5 to 9 percent over LPA. A decade-wise (1950-2013) study of the rainfall trends (Chart 3) shows that while there were three drought years every decade, it was the decade of 1950s which boasted of just one drought and more recently the decade of 1990s, which did not experience drought.

Chart 3: Trends in Indian Monsoon Rains



Source: IMD

Rainfall for 2013 is 7% above LPA for the period between June1 and 10 October,2013

A simple back-of-the-envelope calculation for this data shows that the country has faced drought nearly every four years and eight months. This time gap reduces to 4 years and four months when the data beginning 1960s is studied and increases to 5.2 years when the rainfall data from 1980s is viewed thus indicating the reducing and then increasing gaps between subsequent droughts. Post 1980s, the fall in the time gap is evidently a result of no drought in the decade of 1990s (Table 1).

In order to study the intensity and the volatility of the rainfall deviations, we looked at the decadal average deviation of the monsoon rains from LPA in the drought years and in the decade as a whole. So while there are not more than 3 years per decade (as seen from Table 1) categorized as drought, the average deviation (below LPA) of the decades is worsening. Even the intensity of the drought year is worsening; the average deviation of rainfall from LPA during drought years has increased from 13.9 percent fall in 1950s to close to 18.3 percent fall in the 2000s. Overall, it won’t be out of place to say that in a decade there is a high probability that India face two drought years (when rainfall is less than LPA by a margin of more than 10 percent) with relatively increasing negative deviations.

Table1: Study of Rainfall Data: 1950-2012

Decade	Frequency of droughts (years)	Drought Years (rainfall deviation from LPA >10%)	Average of Deviation from LPA for drought years	Average of deviation from LPA(%) for decade
1950s^	1	1951	-13.8	2.5
1960s	3	1965-66, 1966-67 and 1968-69	-13.9	-1.43
1970s	3	1972-73, 1974-75 and 1979-80	-18.3	-0.03
1980s	3	1982-83, 1986-87 and 1987-88	-15.53	-2.12
1990s	0	None	-	0.51
2000s	3	2002-03, 2004-05 and 2009-10	-18.27	-5.18

Source:IMD

^ For 1950s, the LPA value is 877.2, based on 1901 and 2003 mean rainfall values. LPA for all other decades is 890

In order to complete the analysis, we next looked at the extent of the positive deviations experienced by the country in the studied years and it was found that while there were 7 years of positive rainfall deviation in the decade of 1950s there were only two in the decade of 2000s. Even the average deviation from LPA for these years has also been falling in the recent times (Column 1 and 2 in Table 2). So in present times, we have realized that there are relatively lesser years per decade where the rainfall deviation from the LPA level is positive.

Table 2: Percent deviations in Indian Rainfall: 1950 to 2013

Decade	Positive Percent deviation from LPA		Negative Percent deviation from LPA	
	Frequency (years) Col.1	Average deviation above LPA Col.2	Frequency (years) Col.3	Average deviation below LPA Col. 4
1950-59	7	8	3	8.3
1960-69	5	6.5	5	9.4
1970-79	7	7.8	3	18.3
1980-89	4	9.3	6	9.7
1990-99	5	5.7	5	4.6
2000-09	2	4	8	9.2
2010-13	3	3.53	1	7.1

Source: IMD

Monsoon Performance in 2013

Monsoons of 2013 offer a huge deviation from its long-term trend. The first half of the monsoons in 2013 experienced the heaviest rains in nearly two decades. But as per IMD records, the June-September rains in 2013 were 6 percent above its LPA of 88.7 cm[4]! The 1st June to 9th October, 2013 rains were 6.9 percent above LPA. The rainfall between 1st June and 31st October has been more than 10% above its normal value. As per these trends, it appears that monsoon this year may be the best yet received by the country since 1995 and amongst the top 10 rains the country has received (between June and October) for the last more than 50 years.

Even though the analysis is largely based on the trends of the south-west monsoon rains but it is imperative to highlight the huge deviation 2013 rains have offered in terms of the NE rains. Just between the 1st October and 31st October, 2013, the NE monsoon rains have been more than 61 percent above their normal values.

The monsoon 2013 seems to be very much in line with the observations made by IPCC about the evolving monsoon systems in its recently released *IPCC WGI Fifth Assessment Report*. The report says that "the global monsoon, aggregated over all monsoon systems, is likely to strengthen in the 21st century with increases in its area and intensity, while the monsoon circulation weakens. Monsoon onset dates are likely to become earlier or not to change much and monsoon retreat dates are very likely to delay, resulting in lengthening of the monsoon season." (IPCC, 2013)

In terms of spatial distribution, the rains have been evenly distributed over major crop growing regions of the country, except north-east India (Chart 4). The area-wise percentage deviation here is calculated as deviation of the actual rainfall in the period versus their normal values (calculated from the area-wise average rainfall received during the period 1951-2000). As on 30th September, 2013, out of 36 meteorological subdivisions, the rainfall has been excess over 14 (39%), normal over 16 (44%) and deficient over 06 (17%). In area-wise distribution, 48% area of the country received excess/normal rainfall. Remaining 14% area received deficient rainfall. The deficit areas include Arunachal Pradesh, Assam & Meghalaya, Nagaland, Manipur, Mizoram & Tripura, Jharkhand, Bihar and Haryana, Chandigarh & Delhi. First time in the last five years, states like UP, Punjab, Madhya Pradesh, Maharashtra and Gujarat have recorded "excess" rains.

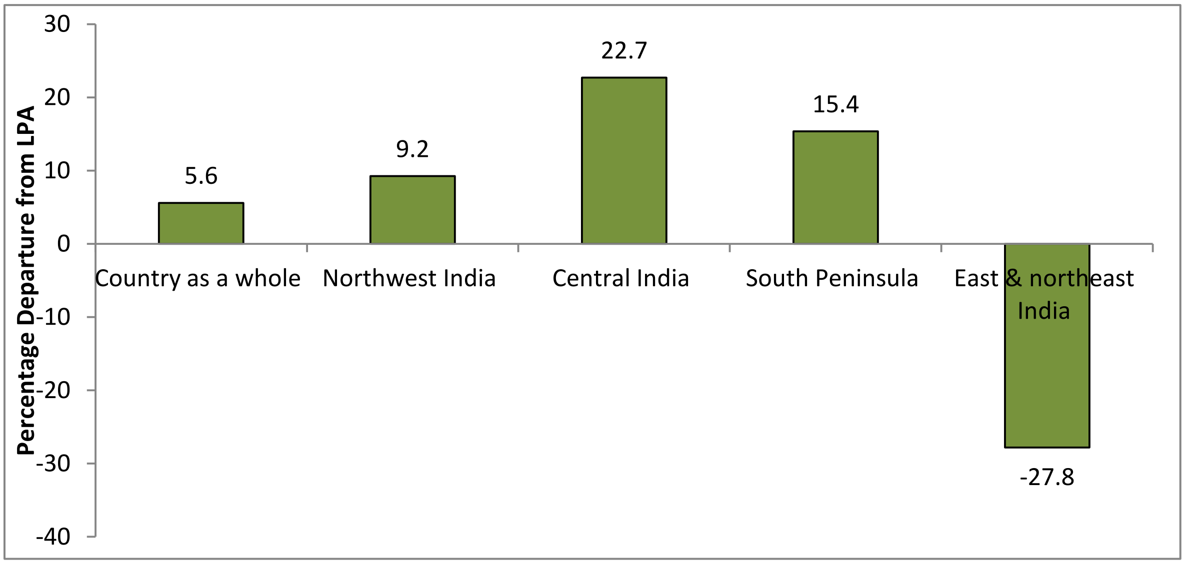
Towards the end of the SW monsoon season, the country witnessed Cyclone Phailin and Cyclone Helen. Gujarat and adjoining areas of south Rajasthan experienced extremely heavy rainfall and flood situation due to a revival of the monsoon activity associated with the former cyclonic circulation. This may have caused some harm to the standing kharif crops. Apart from these two states, some other sub-divisions/states which experienced flood situations owing to these two cyclones were Assam & Meghalaya, West Bengal &

[4] http://www.imd.gov.in/section/nhac/dynamic/press_eng_update.pdf

Sikkim, Odisha, Jharkhand, Bihar, UP, Haryana, Himachal Pradesh, Madhya Pradesh, Vidarbha, Chattisgarh, Andhra Pradesh, Tamil Nadu and Karnataka.

IMD deciphers the spatial trends of rainfall in the country by dividing the regions into four homogeneous regions[5]: namely northwest India (NWI), northeast India (NEI), central India (CI) and south peninsular India (SPIN). For the studied period, in terms of the four homogeneous regions, 2013 monsoons have been the third best monsoons for the NWI, worst yet for the NEI, best for CI and 5th highest for SPIN.

Chart 4: Spatial Distribution of Rainfall (1st June-30th September 2013)

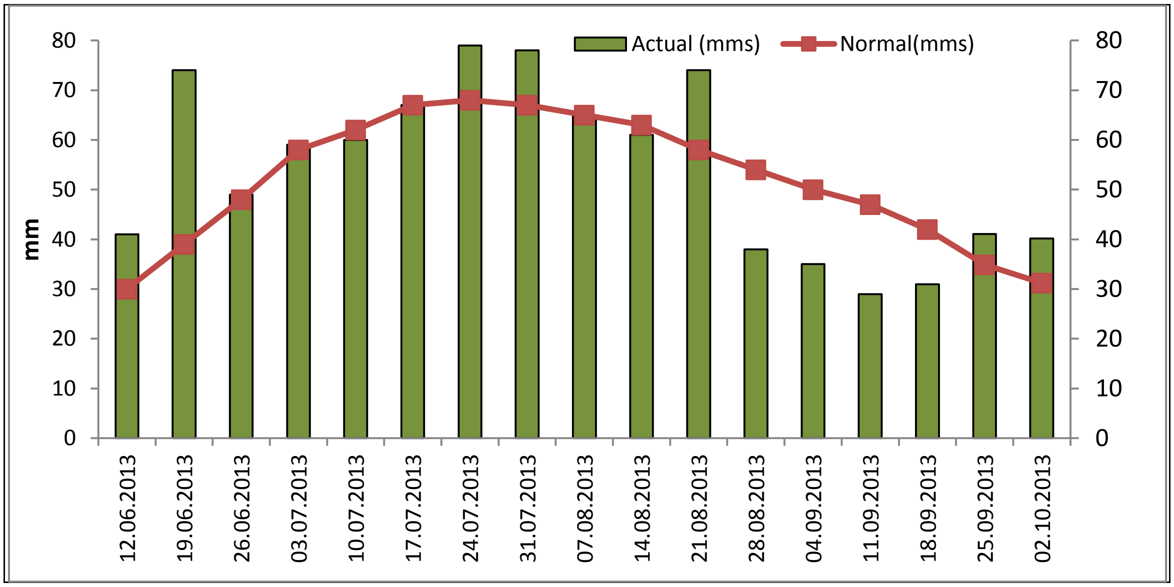


Source: IMD

It is not just the intensity and the spatial spread of rainfall which is important for a favorable growth of a crop. The timing of the rain during critical growth periods is if not more, but equally important. The water support at strategic times may reduce or increase yield and quality of crops. Interestingly during the initial weeks on the bountiful monsoons (Chart 5) the summer crops in major parts of the country, except for some areas in the eastern part of the country, had entered in their growing stage where even moderate levels of precipitation would have ensured good harvest.

[5] NEI includes *Arunachal Pradesh, Assam & Meghalaya, Nagaland, Manipur, Mizoram, Tripura, Sikkim, West Bengal, Jharkhand, Bihar*; CI *includes Gujarat, Madhya Pradesh, Maharashtra, Goa, Chhattisgarh, Orissa;* SPIN *include A & N Islands, Andhra Pradesh, Tamilnadu, Puducherry, Karnataka, Kerala, Lakshadweep and* NWI *include Jammu & Kashmir, Himachal Pradesh, Punjab, Haryana , Chandigarh, Delhi, Uttarakhand, Uttar Pradesh, Rajasthan.*

Chart 5: Trends in Weekly Rainfall Distribution in Monsoon 2013-All India



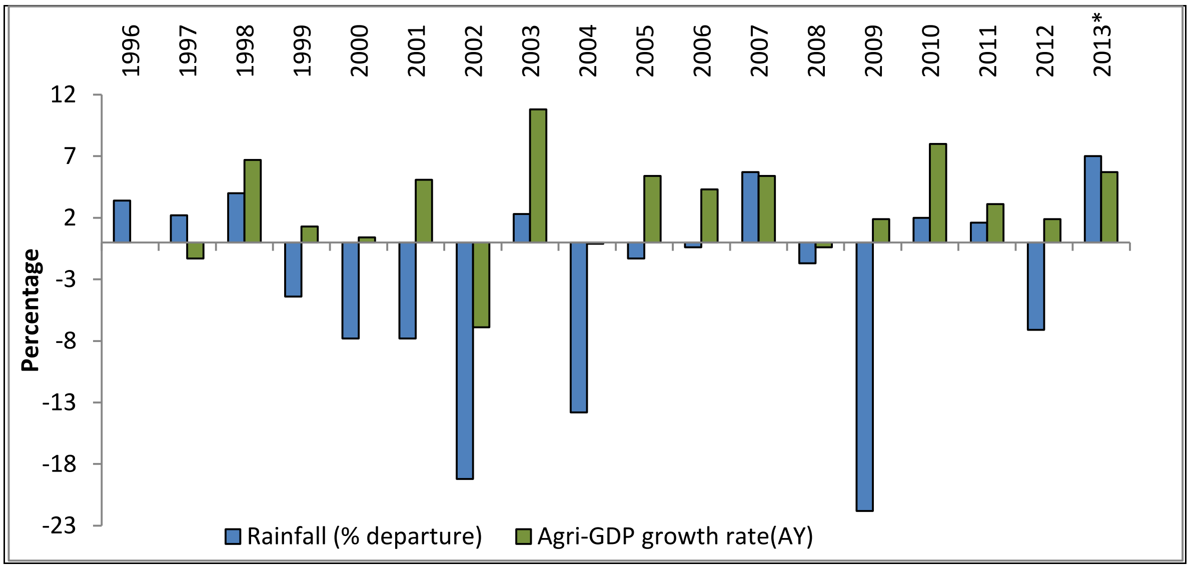
Source: IMD and MoA, GOI

Good rains have raised prospects for a rich harvest in the agricultural year (July to June), 2013-14. The water reservoir levels, as per Central Water Commission (CWC), are presently at 123 percent of their 10 years' average. As per the Ministry of Agriculture advance estimates as on 4 October, 2013 the all-India area sown under all kharif crops taken together have gone up by 5 percent, from 988.7 lakh hectares to 1046.32 lakh hectares as compared to the corresponding period of last year. In terms of particular Kharif crops for 2013-14 the growth trigger in the current crop year's production will come not from traditional crops like rice but majorly from crops like coarse cereals, pulses, oilseeds (especially ground-nuts) and cotton which are said to have benefited more owing to the present rains. India is likely to achieve the second highest foodgrain production at 129.32 million tonnes this kharif season on better monsoon[6] after a record 131.27 million tonnes in the kharif season of 2011-12. Higher levels of production in pulses and coarse cereals are projected to lift the overall kharif foodgrain output, while cotton and oilseeds production are set to be at all-time record levels. This should reflect in a vibrant agricultural growth from the third quarter when the crops will be due for harvest. While the impact on summer crops may be more direct, there is also an indirect impact on rabi (winter) crops like wheat and oilseeds. Rainfall during June-September season impacts ground water and reservoir levels and is also critical for irrigation of rabi crops. We have seen earlier that the reservoir levels are better than last year which portends well for rabi crop. As per estimates released on 14 November, 2013 by the Ministry of Agriculture, the total Rabi crop sown area increased by 6%, with largest increase witnessed in the areas sown for oilseeds and pulses.

[6] First Advance Estimates, DES

At the present juncture, it may be imperative to highlight the historical association rains have shared with agriculture performances. Based on the study, we have found that historically too, rains and agri-GDP growth rate have been positively associated. As can be seen (Chart 6), that drought years or below normal rainfall years are associated with lower agriculture GDP growth rates, and relatively better growth rates are associated with better rains!

Chart 6: Co-movements of Rainfall (% deviation from LPA) and Agri-GDP



**Rainfall %deviation as on 30 September,2013*
**Growth projections as per the Paper estimates*

For example, for the two years 1999 and 2000 when rainfall was 4.4 percent and 7.8 percent respectively below its LPA value, the Agri-GDP(agriculture year) dwarfed from 6.7 percent in 1998 to 1.3 percent in 1999 to stunted 0.4 percent in 2000. Interestingly, like any other data series, there are years of outliers even in these numbers. So while the negative rainfall deviations continued from 1999 through to the all-India drought year of 2002, the agri-GDP growth was commendable 5.1 percent in the year 2001, even with a close to 8 percent negative deviation in rainfall from its LPA value! 10 out of the 18 studied years, when the rainfall deviation was negative vis-à-vis its LPA value, 7 years were associated with a fall in the agri-GDP value compared to the previous year. It were the years 2000, 2005 and 2009, where despite negative rainfall deviations, the year-on-year agriculture GDP grew.

Based on this analysis, we can comfortably assert that while good rains are historically associated with good agri-GDP performance, bad rains may not necessarily imply worse performances. Good agricultural investments, better irrigation integration, use of high-yielding or weather-sturdy seeds, fertilizers could be among the many factors which could assert a push to the agri-GDP even in years of relatively scanty rainfall. This becomes the precise premise based on which we evaluate the various determinants with a likely impact on agri-GDP for a year.

With this background, we proceed next to build an empirical model to estimate the likely favorable impact of the present monsoons on the agricultural GDP growth rate of the Indian economy. We begin by first highlighting the likely explanatory variables for explaining the level and growth of agri-GDP in the Indian economy.

3. Modeling the Determinants of agri-GDP:

Economic Survey 2012-13 attributes the recent better agriculture performance of the country to three factors: farmers' response to better prices, continued technology gains and to timely and appropriate policies. Economic literature adds the role of climate to above factors in understanding any agriculture production variability in a time-series space.

Following the practice, we study agricultural production variability being caused by three broad variables: two controlled and one uncontrolled or exogenous variable. The former two being Investments in agriculture (both private and public, which incorporates the investments in irrigation and farm machinery) embedded in the Agricultural Gross Capital Formation (AGCF), and agricultural price incentives as reflected by the ratio of WPI agricultural price index to WPI of Non-agricultural prices index. The exogenous factor is rainfall.

To study the monsoon rainfall impact on the agriculture GDP of our country, a need was felt to construct a new series of Agri-GDP data, which is originally given for a financial year. The monsoon months of June to September account for the majority annual precipitation for India, so agri-GDP data for a financial year (April-March) may not be able to appropriately capture the year's rainfall impact. For example, the first quarter of a financial year is devoid of any rains; monsoons start from 1st June and run through till September end, with a likely impact felt through Kharif (September-Jan) and Rabi (February-June) crop marketing seasons. In order to capture the monsoon impact, it was imperative to create a series for Agri-GDP which shall be representative of the impact of the rainfall in a particular year. For this we needed quarterly data of agri-GDP, which is given only from 1996-97. Hence the analysis is restricted from 1996-97 to 2013-14, a period of 18 years. Details of which are elucidated below.

3.1 Rainfall

We use rainfall as the proxy for the entire gamut of uncontrolled climate variables affecting production of any crop. Now this may appear as an over-simplification of the underlying mechanism where many uncontrolled or climatic factors (spatial spread of rainfall, temperatures, sunshine days, etc) influence agricultural productivity. However, as we will see eventually that quantum of rainfall alone explains most of the variations in the agricultural production thus making it a preferred choice to represent the uncontrolled set of variables, not matter how crude it is, impacting Indian agriculture production.

As discussed before, the effect of rainfall on any crop output at any location is very difficult to measure precisely. For, it is not only the volume of rainfall but also its distribution at different stages of the plant growth what influences the total output. Similarly, the volume and distribution of rain at the time of sowing, flowering, maturing, and harvesting affect crop yield. Consideration of these issues would necessitate introduction of a large number of explanatory variables into the agri-production-rainfall relationship. The problem is the short production data series of less than 20 years, which is available, does not provide enough scope for such a rigorous analysis. Use of a large number of explanatory variables in the structural equation will reduce the precious degrees of freedom for estimating the parameters with adequate level of confidence. Consequently, aggregation of the rainfall data from different parts of the country into some suitable rainfall index at the national level becomes necessary. India receives 76 percent of its annual precipitation in the monsoon months (or also called the South-west monsoon) of June to September and thus we have used the Monsoon rainfall data, collected by the IMD for 36-identified meteorological sub-divisions, as a proxy of the annual rainfall for the country.

For our analysis, we have created a rainfall index, whereby treating the Long-period average (LPA) rainfall value of 890 mm as 100, and splicing the data to get a rainfall Index.

3.2 Gross Capital Formation in Agriculture (AGCF)

Despite large weather shocks faced by the country, there is a greater resilience shown by Indian agriculture growth. A step-up in the gross capital formation in this sector has emerged as an important reason for such dynamism on the agriculture growth front. Overall AGCF (of agricultural and allied sectors) has almost doubled in real terms since beginning of this century with a compound annual average growth rate of more than 8%. Both the private and the public sector contribute to this capital formation, with consistently more than 70% share contributed by the private sector alone. The real change started occurring from 2004-05 onwards, when AGCF was about Rs 76K crore and increased to more than Rs 158K crore by 2012-13. This did not happen on its own. Since the larger chunk (more than 85 percent in 2011-2012) of this AGCF came from the private sector, it was responding to the relative price structure in the economy, which improved substantially in favor of agriculture. As we will see later, the index of the ratio of agri to non-agri prices improved by more than 40 percent during 2004-05 to 2012-13. A major stimulus to this came from the rising global prices of agri-products during this period, including global agri-price eruption in 2007-08 and also partly from rising minimum support prices (MSPs).

Improved incentives led to major (private sector) investments in agriculture, from groundwater irrigation to farm machinery, which then induced better and higher usage of seeds, fertilizers, etc. Agricultural investments as a percent of the agricultural GDP have increased nearly 2.5 times in the studied period (from 8% in 1996-97 to close to 20% in 2011-12). Access and availability to adequate, timely and low cost- credit, along with other inputs, is also vital for establishing sustainable and profitable farming systems.

Evidently, there will be a lagged response to all such investments in the sector- as the benefit will reflect via increased production/productivity only in the eventual year(s). Therefore, for our analysis we have used a one-period lag in the AGCF data, which implies that the investments in present year will echo positive response on agri-production only in the following year.

3.3 Price Incentives

The government's price policy for agricultural produce seeks to ensure remunerative prices for the farmers with a view to encourage higher investments and returns. Prices in the open market help the farmers to take informed decisions on cropping. Open market prices, including the prices in the international markets, are one of the important components used while estimating MSPs. So for our analysis, we use a proxy variable of the price incentive in terms of relative open market prices for the agriculture produce.

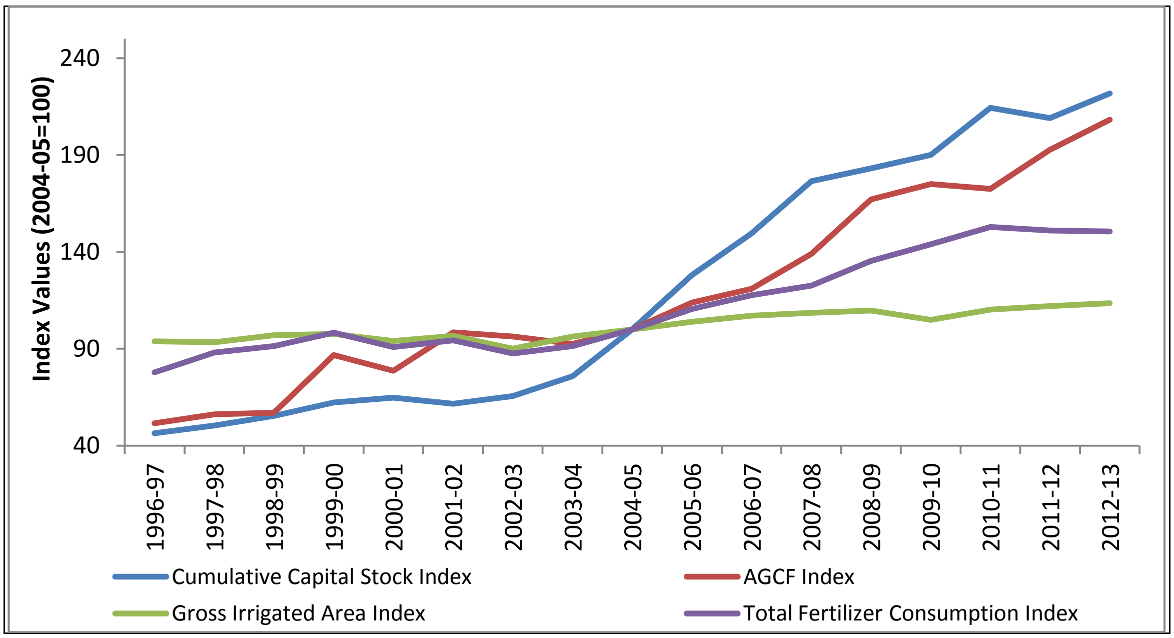
We have constructed a ratio of sub-groups of WPI indices, namely the agricultural price and the non-agricultural price Index. The former includes the price index for food articles and non-food articles while the latter is the price index for manufactured goods. This ratio shows the relative incentives the farmers are offered vis-à-vis other commodities, so inherently the higher the ratio the greater the foreseeable benefit for a farmer by increasing production of crops.

3.4 Trend

The aspect of technology adoption and its influence on the agricultural GDP is not fully captured by the AGCF levels in a country. Over time we know that factors like adoption of HYV crops, weather-sturdy seeds, use of fertilizers affect the performance of agriculture. Therefore it was felt that AGCF, as used as one of the explanatory variables in Model 1, be replaced by a wider variable, called Trend. Trend essentially looks at two types of advances: acreage- augmenting and productivity- augmenting. Greater access to water, farm machinery and weather-resistant seed quality are but many of the ways of augmenting the acreage under crops. Apart from getting the barren lands to be used for production purposes, weather- adopted seed technology promotes yields in areas otherwise.

Four variables (Chart 7), at all-India level, were considered in this regard: influence of cumulative capital stock of a country, agriculture GCF, gross irrigated area of the country and total fertilizer consumption.

Chart 7: Trends in Agriculture Investments, Irrigation and Fertilizer

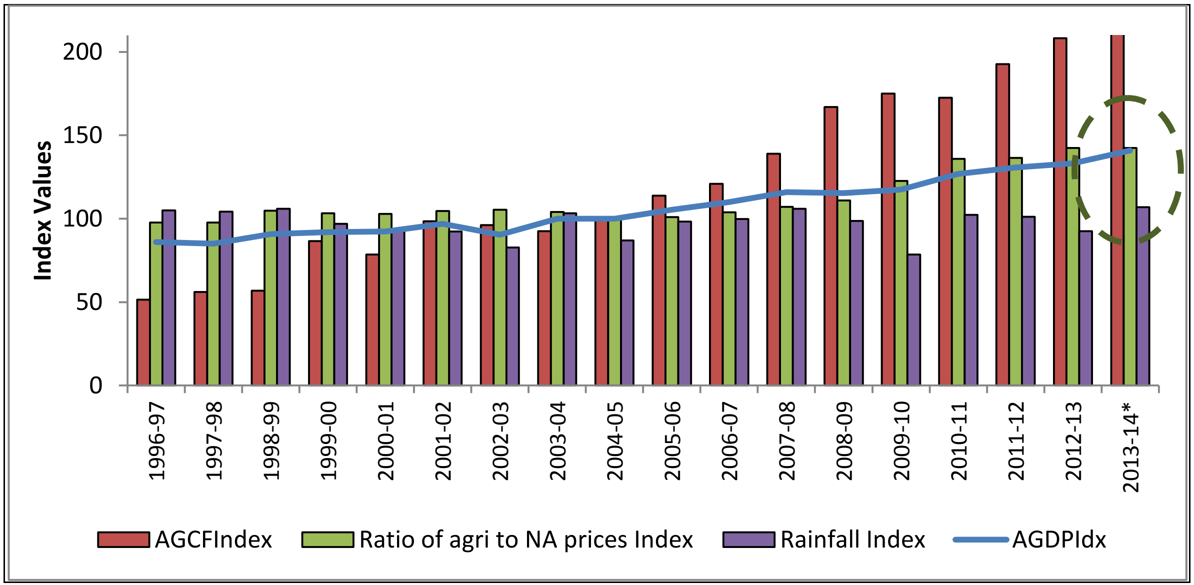


Instead of treating each of these explanatory variables in the regression model, we have used trend as a representative variable, representative of all the underlying dynamics exerting positive influence on the agri-GDP. Subsequent to running regression iterations, two robust regression results and the models are shared below.

Model 1:

Having listed the likely main factors influencing the agriculture production of the country, the next logical step is to test for their relevance. We have used a log-linear model to test the hypothesis about the plausible factors influencing agricultural production in India. The dynamics between the studied variables under this model are presented below. Based on the results and analysis for the discussed model, the dotted area on the graph represents the present year predictions.

Chart 8: Factors Influencing Agri-GDP



**2013-14 values are based on 7% rainfall deviation for the year 2013-14*
Forecasts for AGDP(AY) and for explanatory variables are based on Model1

Details of the regression analysis, carried out at the all-India level with the data from 1996-97 through to 2012-13, yield some interesting results. The three independent variables together explain more than 94.7% variations in the Indian agricultural production for the studied period.

$$\text{Log AGDP} = 3.201 + \underset{(3.179)}{0.364}\ \text{Log RNI} + \underset{(7.032)}{0.275}\ \text{Log AGCF(T-1)} + \underset{(1.796)}{0.248}\ \text{Log PR}$$

The parenthesis gives t- values.
AGDP: Agriculture Gross Domestic Product, AGCF: Agriculture Gross Capital Formation, RNI:Rainfall Index, PR:Ratio of Agri-prices to Non-Agri Prices T-1: Lag of one period

Given that the model is a log-linear model, the beta coefficients are the elasticity values between the respective dependent and the independent variable. Therefore, what this means is that a 1% change in the rainfall index, brings about 0.36% change in the agricultural production levels. Based on the beta values one can say, from the present analysis, that rainfall seems to have the greatest impact on the agricultural production levels, followed closely by level of investments (AGCF) and then lastly by the price incentives, which as it appears have had relatively lesser impact on the dependent variable.

In order to check for the accuracy of the estimated values, we analyzed the correlation between the error term (calculated between the actual AGDP values and the estimated AGDP values) and the dependent variable. The correlation was low and the t-value significant thus highlighting the randomness of the error term. The estimated equations now provide results enough to speak with some confidence about the effect of rainfall on the agricultural production levels of the country.

In order to forecast the impact of good monsoon in 2013 on the agricultural production levels of the country we will first have to build some likely scenarios vis-à-vis the expected rainfall for the entire monsoon period, i.e. between June and September, extending this year well into October. For our analysis, we assume three likely monsoon situations: one where the present monsoons are 5.6% above LPA value (which is the case for monsoon rains between 1 June, 2013 and 30 September 2013). Second, where the 2013-monsoon records 7% above LPA deviation -the most likely situation owing to the late but robust rains in October, 2013. In the third scenario, we create a counterfactual scenario, what if the rains were just equal to LPA; i.e., zero deviation from LPA indicating normal rains.

In order to make a forecast for the agri-GDP levels, we use a long-run trend growth rate in the AGCF level so to find the AGCF value for FY2012-13, as the latest data for AGCF belongs to FY2011-12. Similarly, we have assumed the ratio between the agricultural prices and the non-agricultural prices as same as that for the last year. The assumptions in wake of the present developments are modest and justified. **So as per this model, the agriculture GDP for the 2013-14 crop year will grow in the range of 5.2% and 5.7% for a rainfall deviation from LPA of 5.6% and 7% respectively.**

Model 2:

In order to decipher the larger dynamics, we used a different set of independent variables, namely ratio of agri-prices to non-agri prices with a one-period lag i.e. PR(T-1), rainfall and a larger variable called *Tend*, which is taken to represent all the other factors affecting agriculture production (as mentioned before). These factors are used to explain variations in agri-GDP in a crop year. The log-linear analysis of these variables shows that more than 89% variations in the dependent variable are explained together by these factors, with price ratio appearing as the most dominant factor. The model is:

$$\text{Log AGDP} = 3.653 + \underset{(2.1)}{0.541 \text{ Log PR (T-1)}} + \underset{(4.9)}{0.340 \text{ Log RNI}} + \underset{(3.1)}{0.121 \text{ Log Trend}}$$

The parenthesis gives t- values.
AGDP: Agriculture Gross Domestic Product, RNI:Rainfall Index, PR:Ratio of Agri-prices to Non-Agri Prices
T-1: Lag of one period

The highest beta value for the price ratio between agri-prices and non-agri prices of the last year are enough to buttress the fact that the current level of production by a farmer are based on the price he expects to get for the production, which in turn is formed by the last year's price levels. Evidently enough, 1 percent change in monsoon rainfall in a year cause close to 0.34 percent change in the agri-GDP for the year. Trend as an independent variable covers all the other factors which shall be influencing the production levels in the country's agriculture sector.

Similar to the case of Model 1, we have analyzed the correlation between the error term (calculated between the actual AGDP values and the estimated AGDP values) and the dependent variable and owing to insignificant t-value, we can talk about the randomness of the error term and thus making the regression more robust. **As per this model, the agriculture GDP for the 2013-14 crop year will grow in the range of 5.1% and 5.6% for a rainfall deviation from LPA of 5.6% and 7% respectively.**

So compiling the results from the two econometric models, the Agri-GDP (AY) growth rate predictions are:

Scenario in terms of Percent deviation from LPA	Rainfall-mm	Model 1: Expected Agri-GDP growth Rate in AY2013-14 (y-o-y)	Model 2: Expected Agri-GDP growth Rate in AY2013-14 (y-o-y)
7%	952.3	5.7%	5.6%
5.6%	939.84	5.2%	5.1%
Normal	890 (LPA)	3.1%	3.2%

This shows that in case the present forecasts of good rainfall are true and overall we end up having 5 to 7% positive rainfall than LPA, there is a likelihood that agri-GDP growth as measured by the agri-year (July-June), year-on-year, would range from 5% to 6%! This growth in agri-GDP will be 2 to 3 times higher than last year, and would come largely from oilseeds, pulses, cotton, and coarse cereals belt of central and western parts of the country, which normally are less irrigated. It offers an opportunity for industry to tap the demand emanating from rural areas.

If we integrate the rainfall data for the period till late October 2013, i.e. for period between 1 June and 31 October, the cumulative actual rainfall was 10.2 percent above its normal[7]. But late retreat of rains may have damaged standing crops, particularly paddy, which needs some days of clear sunshine to dry, change colour and fully ripen. Additionally, poor rains in Bihar, excessive rains in Gujarat and the devastation caused by cyclone Phailin in Odisha & Andhra Pradesh may curb overall kharif output especially paddy and corn production. But this should be more than offset by other harvest in pulses and oilseeds. The real boost to this year's farm GDP growth will come from excellent soil moisture and surplus reservoirs of water. This would benefit the rabi crops which account for almost half of the overall agricultural output. So it is very likely that any damage to kharif crops due to excess rainfall would be offset by a bumper rabi crop. Therefore, agri-GDP would grow by 5-6% in the AY 2013-14 as derived from the above models.

4. Policy Implications

A likely agri-GDP growth ranging between 5.2 percent (or 5.1 percent) and 5.7 percent (or 5.5 percent) has the potential to raise farm incomes by about 10-15 percent in nominal terms. Now if the incomes of the 49 percent of all-India workers[8] are scheduled to rise, with farm wages already growing at 20 percent per annum for the last three years there is a greater likelihood than ever for such rural prosperity to trigger an income/growth multiplier across the Indian economy.

This can imply enhanced demand for credit to buy seeds, fertilizers, farm machinery, and after the harvest, the demand for several consumption goods in rural areas, besides propelling logistics, agro-processing and retailing. Additionally such bumper crops are set to benefit the Indian companies with increasing footprints in the rural areas; coupled with increased penetration of mobile telephony, internet usage and improved road connectivity the growth prospects multiply for India Inc. In fact, to benefit from such a likely rally of gains, increasing number of investment banks have already been advising clients to increase exposure on stocks of companies who are likely to benefit from such rural theme.

For the June quarter over corresponding period last year, companies especially the ones producing agricultural inputs such as seeds and agro-chemical makers, have recorded

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[7] When this surplus of 10.2% is incorporated in the model, then the agri-GDP growth projections would be 6.8% (Model 1) and 6.7%(Model 2).

[8] As per the 68th NSS Round report, 48.9% of all- India workers were employed in the agriculture sector. (Page 20)

revenue growth rates ranging between 10 percent and 55 percent. The record sales are said to be the result of the upbeat market-sentiment and the resultant increasing demand caused by timely and generous rains. Tractor sales alone have gone up close to 23 percent for the period between April-June vis-à-vis values in the corresponding last year.As per World Gold Council the gold demand, more than 60 percent of which emanates from rural India, is expected to expand phenomenally owing to increasing farm incomes.

Now there may appear sufficient conditions for one to believe that the economy is bound for an economic revival once the farm incomes increase. But unless the necessary condition of increasing rural or farm incomes is realized, the virtuous cycle of economic growth may just be a distant dream! Unless the policy makers play their facilitator's role well, the "automatic" cascading of bumper harvests to increasing economic activity in the country might not be realized. There is a greater need today of creating and delivering, timely, conducive and proactive policies by the Indian policy makers to realize the likely benefits.

Preparing well for a big harvest and taking action on the following may help. First, clear as much excessive grain stocks as possible to make space for the incoming crop. Government needs to liquidate at least 20 million tonnes of rice and wheat from its stocks in the domestic market and/or for exports, without compromising on the needs for Food Security Bill. Wheat could be sold at Rs 1400/qtl and rice at Rs 1900/qtl. This would immediately bring down food inflation from 12 percent to less than 7 percent, and also save on high carrying costs of grains and thus reduce fiscal deficit.

Second, announce de-listing of fruits and vegetables from APMC Act, and incentivize processors and modern retailers to buy directly from farmers. This would compress their value chains benefitting both the consumers and producers, saving on large wastages, and further bringing down food inflation. Once food inflation is down, subsidies on fuel and fertilizers can be cut more aggressively reducing fiscal deficit, while easing interest rates. These can, therefore, kick-start a virtuous cycle and India can emerge out of this economic storm without much damage.

Facilitating and creating conducive international trade rules and policies so as to hedge the farmer from the falling domestic prices, owing to the increased supplies in the market, is another befitted policy in this regard. It is very likely that in view of increased supplies in the market the prices of some, if not all, may actually fall even below the MSPs. So in order to ensure enough incentives for the farmers to grow the crops in the next year, it is vital to create an alternate market for the produce. As in the case of ginger, in view of rock-bottom prices last year, the farmers abandoned ginger farms and moved away from its production which has resulted in sharp decline in production and thus supply this year leading to steep prices this year.

Favorable monsoons and the resultant rural prosperity is seen as a key driver of growth in revival for the entire economy, but unless the nature's efforts are coupled with policy incentives, the benefits are far from being realized.

Annex 1

Categorization of area-wise daily rainfall.

Category of Rains	**Daily Actual Rains(mm)**
Very-right Rains	0.1-2.4
Light Rains	2.5 – 7.5
Moderate Rains	7.6-35.5
Rather Heavy Rains	35.6 – 64.4
Heavy Rains	64.5 – 124.4
Very Heavy Rains	124.5 – 244.4
Extremely Heavy Rains	Greater than 244.5

Source: RMC, Delhi

- Notes on rainfall data

    - When the rainfall for the monsoon season of June to September for the country as a whole is within 10% of its long period average, it is categorized as a “Normal” monsoon. It is categorized as “Excess” monsoon, if it is above 110 % of long period average and “Deficient”, if it is below 90% of long period average. The performance of monsoon rainfall over smaller areas of the country is monitored by evaluating the departures from the normal for each meteorological sub-division and district.

    - In India, two time series data on rainfall are available and popularly used. The All-India area-weighted mean summer monsoon rainfall, based on a homogeneous rainfall data set of 306 rain gauges in India, developed by the Indian Institute of Tropical Meteorology (IITM),Pune (www.tropmet.res.in) is widely considered as a reliable index of summer monsoon activity over the Indian region. Long time series of this index since 1871 have revealed several interesting aspects of the inter-annual and decadal-scale variations in the monsoon as well as its regional and global teleconnections. Rainfall time series of 36 meteorological sub Divisions of India using 1476 rain gauge stations has also been constructed by India Meteorological Department, IMD Pune since 1901. This series includes hilly regions also.

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