

**Analysis of Trends in
India's Agricultural Growth**

***Elumalai Kannan
Sujata Sundaram***

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ANALYSIS OF TRENDS IN INDIA'S AGRICULTURAL GROWTH

Elumalai Kannan and Sujata Sundaram*

Abstract

The present study discusses the trends and patterns in agricultural growth at the national and sub-national levels in India. Data on important variables like area, production, input use and value of output were compiled for the period 1967-68 to 2007-08 from various published sources. The analysis of data reveals that the cropping pattern in India has undergone significant changes over time. There is a marked shift from the cultivation of food grains to commercial crops. Among food grains, the area under coarse cereals declined by 13.3 per cent between 1970-71 and 2007-08. Similarly, the performance of pulses in terms of area and output was not impressive during the study period. The use of technological inventions in the cultivation of other crops was also not so conspicuous in pulses. Nevertheless, the increase in crop yield has been a major factor for accelerating production in the country since the late 1960s. The use of modern varieties, irrigation and fertilisers were important factors that ensured higher growth in crop production. However, technological and institutional support for a few crops like rice and wheat brought significant changes in crop area and output composition in some regions. The results of crop output growth model indicate that the enhanced capital formation, better irrigation facilities, normal rainfall and improved fertiliser consumption helped to improve crop output in the country.

Background

The Indian economy has undergone structural changes over time with the anticipated decline in the share of agriculture in the GDP. Despite a fall in its share from 55.1 per cent in 1950-51 to 17.0 per cent in 2008-09, the importance of agriculture has not diminished for two major reasons. First, the country achieved self-sufficiency in food production at the macro level, but still is a food deficit country^j facing massive challenges of high prevalence of malnourished children and high incidence of rural poverty. The pressure on agriculture to produce more and raise farmers' income is high. Second, the dependence of the rural workforce on agriculture for employment has not declined in proportion to the sectoral contribution to GDP. This has resulted in widening the income disparity between the agricultural and non-agricultural sectors (Chand and Chauhan, 1999). The experiences of developed countries show that transfer of labour force from agriculture to non-agriculture, in particular the manufacturing sector took place. This had brought enhanced productivity growth in agriculture and hence higher income (Gollin *et al.*, 2002). However, India's manufacturing sector witnessed volatile growth and its share in GDP has almost remained constant at 15 per cent for the last three decades. Further, given the fact that the current economic growth pattern is driven by the service sector, labour absorption outside agriculture will be slow until rural education improves dramatically in the near future.

Under these circumstances, higher growth in agriculture assumes great importance and is a matter of concern for policy planners and research scholars in recent times (Chand *et al.*, 2007; Balakrishnan *et al.*, 2008; Bhalla and Singh, 2009; Reddy and Mishra, 2009; Vaidyanathan, 2010).

* Associate Professor and Research Associate, respectively, ADRTC, ISEC, Bangalore – 560 072.

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Sustained agricultural growth, which is facilitated through constant policy and institutional support has the potential to augment growth in the rural economy and associated secondary activities like food processing and retail trading. However, agriculture-led rural industrialisation has not received due attention from policy makers in the country notwithstanding the fact that maintaining the growth of agricultural *per se* was lost sight of during the 1990s (Sen, 1992; Bhalla and Singh, 2001; Rao, 2003; Bhalla and Singh, 2009). In fact, the growth performance of agriculture at the national level was splendid during the 1980s and its deceleration during the 1990s was attributed to the reduction in and/or stagnation of public expenditure on agricultural infrastructure, defunct extension services and biased economic reforms (Thamarajakshi, 1999; Balakrishnan, 2000; Hirashima, 2000; Mahendradev, 2000; Vyas, 2001; Rao, 2003).

However, there has been a renewed policy thrust from the government since mid 2000s to revive agricultural growth through various development programmes such as interest subvention on crop loans, the National Food Security Mission, the National Agriculture Development Programme (Rashtriya Krishi Vikas Yojana) and the Pulses Development Programme. These programmes are likely to affect agricultural growth and farmers' income in the country by providing greater flexibility to the state governments to allocate resources to the priority areas of development. Aside, patterns and trends in India's agricultural growth is a well-researched subject. Systematic efforts were made to analyse growth in crop output and its elements through decomposition analysis (Minhas and Vaidyanathan, 1965; Sagar, 1977; Sagar, 1980; Sarma and Subrahmanyam, 1984; Majumdar and Basu, 2005; Joshi *et al.*, 2006). Historical aspects of agricultural growth, disparity and impact on farmers' income and employment have been studied by several scholars. Some recent studies include those of Sawant and Achuthan (1995), Rao (1998), Bhalla and Singh (2001), Radhadrishna (2002), Bhalla and Singh (2009) and Vaidyanathan (2010). Some studies also looked at the effect of agricultural technology on growth of crop output and its instability (Cummings and Ray, 1969; Hazell, 1982; Ray, 1983; Mahendradev, 1987; Deshpande, 1988; Vaidyanathan, 1992; Chand and Raju, 2009). The present study contributes to the existing knowledge base on Indian agriculture in a way that it estimates the crop output growth model through econometric method. The study also discusses the trends and patterns in agricultural growth at the national and state levels.

The paper is organised in seven sections. While the second section discusses sources of data used for the study, the third section analyses changes in cropping pattern and output at national level. Growth performance of major crops and crop output growth model at All India level are presented in the fourth and fifth section, respectively. The sixth section presents the growth performance of crops sector at regional level and the final section provides concluding remarks.

Data Sources

The study relies on secondary data compiled from various published sources. Data on area, production and yield were collected from the Directorate of Economics and Statistics (DES), Ministry of Agriculture. Data were collected for 44 crops for 17 major states of India for the period 1968-69 to 2007-08. The study period has been divided into four phases, viz., early green revolution (1967-68 to 1979-80), mature green revolution (1980-81 to 1989-90), early economic reforms (1990-91 to 1999-00), economic reforms (2000-01 to 2007-08) and overall period (1967-68 to 2007-08). Compound annual growth rates have been calculated by using the semi-log method. Data on value of crop output were compiled from the Central Statistical Organisation, Government of India. For trend analysis, three years average (triennium ending) of different variables were calculated to even out the inter-year fluctuations and then presented.

Since the study covers all major and minor crops grown across major states, a method was devised to identify their relative importance in the cropping pattern. For this purpose, the Crop Concentration Ratio (CCR) defined as the ratio of share of area under a crop in a state to share of area under a crop in the country (Deshpande *et al.*, 2004). The crops with CCR above 0.40 have been identified as major crops in a particular state and are included in the analysis.

Changes in Cropping Pattern and Crop Output At National Level

The cropping pattern in India has undergone significant changes over time. As the cultivated area remains more or less constant, the increased demand for food because of increase in population and urbanisation puts agricultural land under stress resulting in crop intensification and substitution of food crops with commercial crops. In fact, it is striking to observe that area under food grains in gross cropped area (GCA) declined by 12.02 per cent mainly due to fall in area under coarse cereals by 13.34 per cent between triennium ending (TE) 1970-71 and TE 2007-08 (**Table 1**). Wheat has gained importance with area allocation of only 10.42 per cent in TE 1970-71, and it steadily increased to 14.18 per cent in TE 2007-08. Area under rice remained more or less constant during the period under study. Interestingly, area lost by food grains was used for the cultivation of oilseeds, fruits, vegetables and non-food crops to the extent of 4.0 per cent, 2.86 per cent and 7.02 per cent, respectively, between TE 1970-71 and TE 2007-08. Although the shift from coarse cereals to high value crops is likely to increase farm output and income to farmers, in dry land regions it will expose cultivators to serious weather-borne risks because high value crops have a high water requirement (Bhalla and Singh, 2009).

Table 1: Share of Area under Major Crops in India

(Percentage of GCA)

Crops	TE 1970-71	TE 1980-81	TE 1990-91	TE 2000-01	TE 2007-08
Rice	23.02	23.18	23.00	23.82	22.57
Wheat	10.42	12.98	13.04	14.28	14.18
Coarse Cereals	28.48	24.25	20.48	16.17	15.14
Total Cereals	61.93	60.41	56.53	54.27	51.88
Total Pulses	13.50	13.23	12.94	11.49	11.93
Total Food grains	75.54	73.67	69.47	65.32	63.52
Total Oilseeds	9.85	10.11	12.51	12.96	13.93
Groundnut	4.42	4.14	4.64	3.68	3.20
Cotton	4.70	4.27	4.08	4.70	4.68
Jute	0.42	0.51	0.39	0.45	0.41
Total Fibres	5.41	5.08	4.64	5.27	5.18
Sugarcane	1.62	1.62	1.90	2.23	2.47
Tobacco	0.27	0.25	0.22	0.21	0.19
Condiments and Spices	1.04	1.23	1.32	1.52	1.55
Potatoes	0.31	0.43	0.51	0.69	0.76
Onions	-	0.14	0.17	0.24	0.36
Total Fruits & Vegetables	2.24	2.77	3.57	4.35	5.10
Fodder Crops	4.15	4.50	4.59	4.55	4.26
Total Non-Food grains	19.39	20.13	23.60	25.44	26.41
Gross Cropped Area (GCA)	100.00	100.00	100.00	100.00	100.00

Source: Directorate of Economics and Statistics, Government of India

Increase in area under total oilseeds is not reflective of general rise in area across all oilseed crops, but seemed to be limited only to rapeseed and mustard, sunflower and soybean. Favourable market conditions for refined oil and protein-rich soya food might have been responsible for inducing farmers to allocate larger areas for these crops (Srinivasan, 2005). The area under groundnut came down from 4.42 per cent in TE 1970-71 to 3.20 per cent in TE 2007-08. However, the area under commercial crop like cotton almost remained constant at 4.5 per cent and that of sugarcane registered marginal increase from 1.62 per cent in TE 1970-71 to 2.47 per cent in TE 2007-08.

It is quite understandable from the above discussion that commercial crops are taking the lead in terms of area share. However, it would be interesting to analyse the contribution of different crops in total value of output. Besides the level of physical output, this will also capture the producer price of various crops in the country. Among crop groups, cereals accounted for the largest share of total output followed by fruits and vegetables, oilseeds and fibres (Table 2). While the contribution of cereals declined marginally from 35.02 per cent in TE 1970-71 to 31.24 per cent in TE 2007-08, the share of fruits and vegetables increased considerably from 15.88 per cent to 24.27 per cent during the same period. The changing share was largely determined by commodity price, which rose proportionately higher for fruits and vegetables rather than cereals during the recent decade (Chand *et al.*, 2011).

Among the individual crops, rice accounted for the major share in the total value of output, but declined from 2000 onwards.

Similarly, the value of wheat output reported a steady increase until 2000 and declined thereafter. Pulses also registered a decline in value of output from 8.42 per cent in TE 1970-71 to 6.25 per cent in TE 1990-91 and then to 4.38 per cent in TE 2007-08. Despite increase in producer price of pulsesⁱⁱ, output did not keep pace due to the vagaries of weather and allocation of smaller area for cultivation of pulses by farmers. Cotton, however, increased in value of output in the current decade to 4.86 per cent from 3.40 per cent in TE 1990-91. The widespread cultivation of Bt cotton was the major reason for the rise in production of cotton. It was found that productivity and profit from Bt cotton cultivation was substantially higher than the conventional hybrid cotton varieties (Naik *et al.*, 2005; Narayanamoorthy and Kalamkar, 2006). Condiments, spices and sugar also registered an increase in their share in total value of output in the last four decades. Overall, the analysis of the data clearly indicates that there was broad-based agricultural production in the 1980s but the phenomenon of commercialisation of agricultural production seems to have gained momentum since early 1990s. There is a definite shift from food grains to non-food grains such as fruits and vegetables, oilseeds, fibres and condiments and spices whose share in both area and in value of output has been increasing over time.

Table 2: Share of Various Crops in Value of Output (at 1999-2000 Prices)

(Per cent)

Crops	TE 1970-71	TE 1980-81	TE 1990-91	TE 2000-01	TE 2007-08
Cereals	35.02	36.25	36.95	34.40	31.24
Rice	18.65	18.61	19.59	18.10	16.54
Wheat	7.25	9.87	10.92	11.62	10.17
Coarse Cereals	9.17	7.74	6.44	4.68	4.53
Pulses	8.42	6.55	6.25	4.78	4.38
Gram	3.54	2.57	2.06	1.75	1.67
Arhar/Tur	1.55	1.37	1.38	1.06	0.96
Oilseeds	7.47	6.59	8.84	7.94	8.33
Groundnut	3.94	3.28	3.69	2.36	2.16
Sunflower	-	0.04	0.26	0.25	0.38
Coconut	1.33	1.11	1.28	1.42	1.32
Sugars	4.86	4.28	4.53	6.02	5.82
Fibres	3.60	4.04	3.83	3.41	5.25
Cotton	3.09	3.47	3.40	2.99	4.86
Tea	0.80	0.86	0.79	0.81	0.79
Coffee	0.30	0.36	0.35	0.47	0.40
Tobacco	0.78	0.78	0.68	0.56	0.42
Condiments & spices	2.70	3.20	3.49	4.16	4.52
Potatoes	0.73	1.10	1.27	1.57	1.45
Fruits & vegetables	15.88	18.83	17.87	23.25	24.27
Value of Output from Agriculture	100.00	100.00	100.00	100.00	100.00

Source: Central Statistical Organisation, Government of India

Growth Performance of Major Crops at National Level

It is well documented in the literature that growth in area was the major source of production growth until early 1960s (Bhalla and Singh, 2001; Vaidyanathan, 2010). The high yielding varieties introduced in wheat and rice during the late Sixties heralded India's green revolution. Along with technology, new institutional structures enabled the farmers to adopt improved methods of cultivation. The major changes included provision of better irrigation facilities, government procurement system, guaranteed support price and input subsidies. As evident from the Table 3, wheat production registered compound annual growth of 5.03 per cent during the early green revolution period (1967-68 to 1979-80). Both yield and area contributed to higher growth in production. In the case of rice, growth in yield contributed to production growth of 1.84 per cent per annum. For food grains as a whole, the growth in area and yield were 1.75 per cent and 0.43 per cent, respectively and resulted in production growth of 2.19 per cent.

Table 3: Compound Annual Growth Rates of Area, Production and Yield of Major Crops in India

Crops	1967-68 to 1979-80			1980-81 to 1989-90			1990-91 to 1999-00			2000-01 to 2007-08			1967-68 to 2007-08		
	Area	Prod	Yield	Area	Prod	Yield	Area	Prod	Yield	Area	Prod	Yield	Area	Prod	Yield
Rice	0.74	1.84	1.09	0.41	3.62	3.19	0.68	2.02	1.34	-0.11	1.9	2.01	0.45	2.47	2.01
Wheat	2.87	5.03	2.10	0.46	3.57	3.10	1.72	3.57	1.82	1.25	1.38	0.13	1.14	3.63	2.45
Coarse cereals	-0.98	1.11	2.11	-1.34	0.04	1.39	-1.83	-0.48	1.37	-0.47	3.52	4.01	-1.35	0.56	1.93
Pulses	0.71	-0.26	-0.97	-0.1	1.49	1.59	-0.6	0.67	1.28	1.93	3.31	1.35	-0.01	0.71	0.72
Total Cereals	0.39	2.16	1.77	-0.26	2.26	2.52	0.12	1.72	1.59	0.14	2.20	2.05	-0.06	2.06	2.12
Food grains	0.43	2.19	1.75	-0.23	2.73	2.97	-0.08	2.26	2.34	0.48	2.01	1.53	-0.07	2.27	2.33
Groundnut	0.00	1.64	1.64	1.65	3.76	2.08	-2.31	-1.25	1.08	-0.4	3.0	3.41	-0.26	0.86	1.12
Rapeseed and Mustard	1.05	0.64	-0.40	1.94	7.29	5.24	0.62	0.73	0.11	6.15	8.22	1.95	2.13	4.55	2.37
Oilseeds	0.76	1.88	1.11	2.44	5.46	2.95	0.15	2.27	2.12	3.43	7.44	3.88	1.53	3.51	1.95
Fibre crops	-0.34	3.44	3.79	-1.50	1.52	3.07	2.44	2.03	-0.40	1.08	9.68	8.51	0.35	2.45	2.09
Cotton	0.38	-0.41	-0.79	3.50	5.19	6.01	2.34	2.69	0.34	0.42	3.21	2.79	2.06	3.06	1.18
Sugarcane	1.41	1.99	0.57	1.26	2.71	1.43	1.67	3.05	1.36	1.91	2.39	0.47	1.63	2.68	1.03
Potatoes	4.08	8.07	3.83	2.93	5.17	2.18	3.84	5.44	1.54	3.46	1.65	-1.74	2.99	4.93	1.88
Coconuts	0.38	-0.41	-0.79	3.50	5.19	6.01	2.34	2.69	0.34	0.42	3.21	2.79	2.06	3.06	1.18

Source: Directorate of Economics and Statistics, Ministry of Agriculture, Government of India

However, it is interesting to observe a relatively higher growth in yield of all major crops during 1980-81 to 1989-90, i.e., the mature green revolution period. It indicates that crops other than rice and wheat shared the technological benefits. With decline in area, impressive growth in production of most crops was mainly contributed by growth in yield. Rice registered production and yield growth rate of 3.62 per cent and 3.19 per cent, respectively. Wheat yield also showed splendid growth of 3.57 per cent. Growth in yield of pulses and coarse cereals was appreciable. However, negative growth was reflected in the decline in area under food grains. Despite this, production of food grains was high at 2.73 per cent, which was contributed by yield growth of 2.97 per cent. Oilseeds recorded a growth rate of 5.46 per cent in production and 2.95 per cent in yield. This could be attributed to technology mission on oilseeds launched in mid-1980s, which laid emphasis on increasing productivity of oilseeds and bridging yield gaps between experimental stations and farmers' fields by adopting improved package of practices. Similarly, cotton showed high growth in area by 3.50 per cent, production by 5.19 per cent and yield by 6.01 per cent. Potato and coconut also recorded a high growth in production and yield.

However, the impressive growth in crop production observed during the 1980s was not sustained during the 1990s. Growth in the yield of almost all crops declined during 1990-91 to 1999-00, i.e., the early economic reforms period. This was, in fact, a disturbing scenario, which resulted in low growth in crop output. However, there was increase in area for rice and wheat during this period. This occurred particularly in North West India where market incentives were in force in terms of price support, assured government procurement for wheat and rice and favourable policy environment for providing inputs to farmers at subsidised rates (Umali-Deininger *et al.*, 2005). Growth in area under sugarcane and potato also increased during this period. Despite recording almost the same level of growth in yield, the negative growth in area resulted in a fall in production for coarse cereals. In the case of pulses, the decline in the growth of yield and negative growth in area led to fall in production. Consequently, growth in food grain production declined to 2.26 per cent during the economic reforms period when compared to 2.73 per cent in the mature green revolution period.

There was slight improvement in production and yield of some crops during 2000-01 to 2007-08. Growth in yield of rice increased at 2.01 per cent but negative growth in area resulted in sluggish growth in production when compared to the early economic reforms period. In contrast, growth in both area and yield of wheat declined. Impressive growth in yield of coarse cereals at 4.01 per cent led to 3.52 per cent growth in production. Groundnut, which witnessed negative growth in area and production in the previous decade, registered growth of 3.0 per cent in production due to high growth in yield (3.41 per cent). Thus, impressive growth in groundnut along with rapeseed and mustard led to increase in production of oilseeds. Fibres witnessed a whopping growth of 9.68 per cent in production as a result of impressive growth of 8.51 per cent in yield.

The Government of India has envisaged an annual growth rate of 4 per cent in agriculture and allied sectors since the 9th Five-Year Plan (1996-97 to 2001-02). As the crop sector constitutes over three-fourth of total output its growth performance assumes great importance in achieving this target. However, the long term growth rate (during 1967-68 to 2007-08) shows that only rapeseed and mustard, and potato registered production growth of more than 4.0 per cent annum. Other crops that showed respectable growth in production were wheat, cotton, coconut, sugarcane and rice. Further,

growth in food grain production was 2.06 per cent, which was only a little higher than the annual population growth of 1.64 per cent as per Census 2011. This implies that production of food grains has to be enhanced to achieve long-term food security in the country. It is also discernible from the long-term growth that area shifts have been taking place from coarse cereals and pulses towards high value crops like sugarcane, potato and the more remunerative oilseeds and fibres. Policy interventions are required to encourage production of pulses and coarse cereals. Further, crop productivity has to be improved through better soil and water management, profitable crop rotation, innovative marketing and investment in farm education and rural infrastructure. Among these factors, the former two are essential in ensuring sustainability of agricultural production through effective maintenance of soil fertility and controlling pests and diseases. The latter factors are important in making agriculture profitable through efficient marketing, access to and adoption of new technologies and providing incentives for making on-farm investment.

Crop Output Growth Model

The growth performance of the crop sector is influenced by several factors such as use of physical inputs by farmers, markets, irrigation, credit availability, weather conditions and government policies. It is difficult to analyse the effect of all the variables in a simple framework because these variables affect crop output through various mechanisms. However, an attempt has been made here to examine the determinants of aggregate growth of crop output at the national level through the neo-classical growth model, which is described as follows.

The aggregate production function can be specified as

$$Y = F(F, K, R, CI, IRR) \dots\dots\dots (1)$$

Where Y is the aggregate crop output value (1999-00 prices), F is fertiliser consumption, R is the rainfall, CI is cropping intensity and IRR is the gross irrigated area. The rationale for the inclusion of rainfall in the production function is that a significant proportion of cultivated area depends on rainfall and its variation affects crop output substantially. Similarly, as the net cultivated area remains more or less constant over time, the ratio of gross cropped area to net cropped area (cropping intensity) is taken as proxy for land. The gross irrigated area represents use of water from all sources of irrigation for crop production. Gross capital formation in agriculture is considered as agricultural capital (1999-00 prices).

Assuming the Cobb-Douglas production function and taking differentiation of equation (1), the following equation is obtained.

$$\%Y_t = \beta_0 + \beta_1\%F_t + \beta_2\%K_t + \beta_3\%IRR_t + \beta_4CI + \beta_5R + e_t$$

All the variables are in logarithmic form except cropping intensity and rainfall. Rainfall is expressed as a ratio of actual rainfall to long period average rainfall. The model was estimated through the OLS method and the results are presented in Table 4. Due to the problem of multicollinearity, two

models were estimated. The effect of capital, rainfall and irrigation on growth of crop output was positive and significant in the first model. The gross capital formation with its two-year lagged growth had a significant effect on the growth of crop output. This result implies that capital investment by farmers at the farm level and by the government, by providing agricultural infrastructure facilities, are important and any decrease is likely to affect the growth of output. Inclusion of rainfall and irrigation in model 1 has explained much of the variation in the aggregate growth of crop output compared to model 2, whose R-squared was only 32.88 per cent. The coefficient of consumption of fertilisers was positive and significant. This indicates that growth in fertiliser consumption has a positive effect on growth of crop output because most of the ruling crop varieties and hybrids are highly fertiliser intensive. The coefficient of cropping intensity was positive but not significant in both the models probably because cultivated land is more or less fixed and the increase in intensification of land-use does not contribute to growth in crop output significantly. Overall, the regression results indicate that enhanced capital formation, better irrigation facilities, normal rainfall and improved fertiliser consumption will increase the growth of crop output in the country.

Table 4: Regression Results of Agricultural Growth Model: 1968-69 to 2007-08

Dependent Variable: Growth in Crop Output Value

Variables	Model 1	Model 2
Constant	-0.4902	-0.2828
ΔF_t	-	0.31122** (2.34)
ΔK_{t-2}	0.1309*** (2.81)	0.1792** (2.67)
GCA/NSA	0.0938 (0.82)	0.2170 (1.25)
Rainfall	0.3741*** (4.83)	-
ΔGIA_t	0.7316** (2.61)	-
	-	-
R-Squared	0.7027	0.3288
D-W Statistics	2.21	2.39
No. of observations	37	37

Note: Figures in parenthesis are 't' values; ***Significant at 1 per cent, ** Significant at 5 per cent

Growth Performance of Major Crops at State Level

The present section presents the growth performance of major crops across major states/regions in India. Table 5 provides the per cent share of various crops in gross cropped area across regions from TE 1962-65 to TE 2003-06. The area under rice has been more or less stable except in the North West region. In fact, Northwestern Indiaⁱⁱⁱ has witnessed major changes in the cropping pattern between TE

1962-65 and TE 2003-06. These changes were brought about mainly by increasing area under rice and wheat. Rice occupied only 15.4 per cent of GCA in TE 1962-65 and it increased to 23 per cent in TE 2003-06. Similarly, wheat area increased by a little less than double the area between these periods. Expansion of area under these two crops resulted in reduction of area under coarse cereals, pulses and oilseeds^{iv}.

The cropping pattern in eastern India is dominated by rice (54.3 per cent). The area under food grains declined and it has been offset by oilseeds and other crops like vegetables and fruits. The area under sugarcane has also increased during recent years. Interestingly, coarse cereals, pulses and oilseeds dominate the cropping pattern in Central India. Though the share of area under coarse cereals has been declining, it remained high at 22.3 per cent in TE 2003-06. The area under pulses was constant in the recent decades but in case of oilseeds, it increased from 11.4 per cent in TE 1962-65 to 20.7 per cent in TE 2003-06. However, it is also interesting to note that Gujarat in Central India has expanded the area under cotton in the current decade with 16.2 per cent of state GCA (Bhalla and Singh, 2009).

The southern region has witnessed a decline in area under food grains over time. However, the cropping pattern is still dominated by cereals and pulses. Unfortunately, the area under coarse cereals has reduced by 50 per cent between TE 1962-65 and TE 2003-06. On a positive note, the area under pulses and oilseeds increased marginally over time though with declining area for the latter during the recent decade. The area share of other crops, including fruits and vegetables, increased considerably to 15.2 per cent of GCA in TE 2003-06. Among the Southern states, Kerala has different cropping pattern, which is dominated by high value and plantation crops. Food grains (mostly rice) constituted only 9.9 per cent of GCA and the area under all other field crops was negligible (Bhalla and Singh, 2009; Kannan, 2011). Thus, it can be deduced from the analysis that technology and institutional support for rice, wheat and plantations crops brought significant changes in crop output composition across regions.

To analyse the long term growth patterns of major crops across the states, the compound annual growth rates calculated for the period 1967-68 to 2007-08 have been grouped into four categories, viz., high (>4.0 per cent), medium (2.0-3.9 per cent), low (0-1.9 per cent) and negative. This long-term growth analysis will help to identify lagging crops and states and suggest suitable technology, policy and institutional options for accelerating growth. Table 6 shows growth in area of major crops by states. It is clear that a few oilseed crops like sunflower, rapeseed and mustard, sesamum and coconut registered more than 40 per cent growth in area in different states. Onion registered high growth rate in Gujarat, Karnataka and Maharashtra. Punjab was the only state, which showed high growth in area under rice. Similarly, potato emerged to be the major crop along with rapeseed and mustard, and sesamum in West Bengal. Surprisingly, coconut registered high growth in Tamil Nadu. At all-India level, only sunflower showed more than 4.0 per cent growth in area during 1967-68 to 2007-08.

Table 5: Region Wise Share of Various Crops in Gross Cropped Area

(Per cent)

Region	Triennium	Rice	Wheat	Coarse Cereals	Pulses	All Food grains	Oilseeds	Fibres	Cotton	Sugarcane	Plantation	Cardamom and Spices	Remaining Crops
North-Western	1962-65	15.4	20.1	23.3	21.1	79.8	12.3	2.5	2.2	4.6	-	0.2	0.6
	1980-83	19.0	33.9	16.1	10.8	79.7	10.7	2.9	2.8	4.7	-	0.1	1.8
	1990-93	20.9	35.2	11.8	8.9	76.9	6.3	3.0	2.9	5.2	-	0.1	8.4
	2003-06	23.0	37.3	9.6	7.2	77.1	4.6	2.5	2.5	5.6	0.1	0.2	9.8
Eastern	1962-65	57.0	2.6	6.7	14.2	80.5	3.0	3.8	0.1	0.9	0.9	0.3	10.6
	1980-83	55.7	7.1	7.2	11.9	81.9	5.5	3.2	-	0.8	1.0	0.6	7.0
	1990-93	54.9	7.3	4.5	9.8	76.5	6.3	2.8	-	0.7	1.0	0.8	11.9
	2003-06	54.3	8.0	3.7	6.2	72.3	4.5	2.8	0.1	2.2	1.3	1.0	16.1
Central	1962-65	10.0	9.1	36.1	15.8	70.9	11.4	9.0	8.8	0.4	-	0.6	7.7
	1980-83	9.9	9.9	33.5	16.6	70.0	11.2	7.5	7.4	0.6	-	0.6	10.1
	1990-93	9.9	9.3	28.4	16.4	64.0	17.6	6.4	6.3	0.8	-	0.6	10.6
	2003-06	9.5	9.6	22.3	16.4	57.9	20.7	7.1	7.0	0.8	-	0.8	12.7
Southern	1962-65	23.9	1.0	35.2	9.2	69.4	11.7	5.9	5.5	0.8	1.0	2.0	9.2
	1980-83	23.6	1.0	28.4	10.8	63.9	13.2	5.4	5.0	1.6	1.7	2.6	11.7
	1990-93	21.9	0.6	20.1	11.7	54.4	20.7	4.8	4.5	2.0	2.2	2.5	13.4
	2003-06	21.2	0.8	18.5	13.5	53.9	18.4	4.9	4.7	2.1	2.9	2.6	15.2

Source: Adapted from Bhalla and Singh (2009)

Table 6: Compound Annual Growth Rates of Area for Major Crops by States:

1967-68 to 2007-08

State	High (> 4.0%)	Medium (2.0 - 3.9%)	Low (0 - 1.9%)	Negative (< 0%)
Andhra Pradesh	Sunflower	Maize, Cotton, Onion, Pigeon pea	Groundnut, Rice, Total Pulses, Total Oilseeds	Total Food grains, Ragi, Jowar, Sesamum, Tobacco, Total Cereals
Assam	-	Arecanut, Onion, Potato	Rice, Total Food grains, Rapeseed & Mustard	Jute
Bihar	-	-	Wheat, Jute, Onion, Potato, Tobacco	Rice, Ragi, Maize, Barley, Total Food grains, Linseed, Total Cereals
Gujarat	Onion, Rapeseed & Mustard, Sesamum	pigeon pea	Maize, Cotton, Total Oilseeds, Groundnut	Bajra, Tobacco
Haryana	Rapeseed & Mustard	Wheat, Cotton	Total Food grains, Total Cereals	Bajra, Barley, Gram, Sugarcane
Himachal Pradesh	-	-	Wheat, Maize	Barley, Total Food grains, Potato, Small Millets
Jammu & Kashmir	-	-	Rice, Wheat, Maize, Total Food grains, Rapeseed & Mustard	Small Millets
Karnataka	Onion, Sunflower, Maize	Arecanut, Total Oilseeds, Coconut, Sugarcane, Tobacco, Pigeon pea	Total Pulses, Total Food grains, Groundnut, Sesamum	Ragi, Jowar, Cotton, Cardamom, Safflower, Small Millets, Total Cereals
Kerala	-	Pepper	Arecanut, Coconut	Cardamom
Madhya Pradesh		Total Oilseeds, Rapeseed & Mustard	Wheat, Maize, Cotton, Total Pulses, Gram	Rice, Total Food grains, Linseed, Small Millets, Tur, Total Cereals
Maharashtra	Onion, Sunflower	Gram, Sugarcane, pigeon pea	Total Pulses, Total Oilseeds, Cotton	Bajra, Ragi, Jowar, Total Food grains, Groundnut, Linseed, Safflower, Sesamum, Total Cereals
Orissa	-	Pigeon pea	Rice, Onion	Ragi, Total Pulses, Total Food grains, Total Cereals
Punjab	Rice	Potato	Wheat, Cotton, Total Food grains, Total Cereals	Barley, Sugarcane, Sunflower
Rajasthan	Total Oilseeds, Rapeseed & Mustard	Total Pulses	Bajra, Wheat, Maize, Total Food grains, Total Cereals	Barley, Gram, Sesamum
Tamil Nadu	Coconut	Sugarcane	Total Pulses, Onion	Rice, Ragi, Jowar, Cotton, Cardamom, Total Food grains, Groundnut, Sesamum, Small Millets, Tobacco, Tur, Total Cereals
Uttar Pradesh	-	Potato	Rice, Wheat, Total Food grains, Sugarcane, Total Cereals	Bajra, Maize, Total Pulses, Total Oilseeds, Barley, Gram, Linseed, Rapeseed & Mustard, Sesamum, pigeon pea
West Bengal	Potato, Rapeseed & Mustard, Sesamum	-	Rice, Total Food grains, Jute, Total Cereals	-
India	Sunflower	Arecanut, Coconut, Onion, Pepper, Potato, Rapeseed & Mustard	Cardamom, Cotton, Jute, Maize, Sugarcane, Pigeon pea, Rice, Wheat, Total Oilseeds	Bajra, Barley, Total Food grains, Gram, Groundnut, Jowar, Linseed, Safflower, Sesamum, Small Millets, Tobacco, Total Cereals, Total Pulses, Ragi

Source: Directorate of Economics and Statistics, Government of India

In the medium growth range also, most of the crops appear to be oilseeds and other commercial crops like cotton, arecanut, sugarcane, pepper, potato, tobacco and onion. Only a few food grains like pigeon pea, maize, wheat and gram are in this category. It is interesting to observe that pulses, in particular pigeon pea, registered medium growth rate in states like Andhra Pradesh, Gujarat, Karnataka, Maharashtra and Orissa. There was widespread cultivation of this crop, compared to other pulse crops, probably due to availability of short duration high yielding varieties/hybrids and high market price. Given the high domestic demand for pulses and volatile international prices, cultivation of pulses should be encouraged by providing input incentives to farmers. In this regard, the National Food Security Mission (NFSM), in which pulses form an important component, has the potential to increase production in the country. Meanwhile, the area under cotton registered medium growth rate in Andhra Pradesh and Haryana. Growth in sugarcane fell to the medium growth category in Karnataka, Maharashtra and Tamil Nadu. At the all-India level, arecanut, coconut, onion, pepper, rapeseed and mustard and potato registered medium growth rates.

However, most of the food grain crops registered low or negative growth rate across the states. Negative growth in area under food grains was visible in Andhra Pradesh, Bihar, Himachal Pradesh, Madhya Pradesh, Maharashtra, Orissa and Tamil Nadu. This implies that crop diversification is increasingly inclined towards commercial crops in these states resulting in shrinkage of area under coarse cereals and small millets. Interestingly, none of the crops registered negative growth in area in West Bengal during the period under study indicating that farmers continued to allocate the same proportion of area for cereals, vegetables and fibres. At the all-India level also, cereals, pulses, small millets and oilseeds like ground nut, linseed, safflower and sesamum registered negative growth in area.

With respect to production, oilseeds and commercial crops registered high growth rate in most of the states during 1967-68 to 2007-08 (Table 7). Under food grains, only rice, wheat and pigeon pea showed growth rate of more than 40 per cent. As observed in growth of area, the growth in the production of rapeseed and mustard was impressive in Gujarat, Haryana, Rajasthan and West Bengal. Similarly, high growth in production of sunflower was observed in Andhra Pradesh, Karnataka and Maharashtra. As expected, maize production was high in Karnataka and Andhra Pradesh where industrial poultry has developed in a big way. Maize is mostly used as feed in the poultry industry. However, it is surprising to note that Uttar Pradesh and Tamil Nadu had relatively more number of crops with negative growth in production. The expansion in area under potato and sugarcane in Uttar Pradesh and coconut and sugarcane in Tamil Nadu seem to be responsible for this change. At the all-India level, cardamom, onion, potato, rapeseed and mustard and sunflower registered high growth in production.

**Table 7: Compound Annual Growth Rates of Production for Major Crops by States:
1967-68 to 2007-08**

State	High (> 4.0%)	Medium (2.0 - 3.9%)	Low (0 - 1.9%)	Negative (< 0%)
Andhra Pradesh	Cotton, Maize, Total Pulses, Onion, Sunflower, pigeon pea	Total Food grains, Rice	Groundnut, Total Oilseeds, Tobacco, Total Cereals	Jowar, Sesamum, Ragi
Assam	Onion, Potato	Arecanut, Rapeseed & Mustard, Rice	Total Food grains	Arecanut, Ragi, Jute
Bihar	-	Wheat, Total Cereals	Rice, Maize, Total Food grains, Jute, Onion, Potato, Tobacco	Ragi, Barley, Linseed
Gujarat	Onion, Rapeseed & Mustard, Sesamum, pigeon pea	Maize, Cotton, Total Oilseeds	Groundnut, Tobacco	Bajra
Haryana	Wheat, Cotton, Rapeseed & Mustard, Total Cereals	Total Food grains	Bajra, Sugarcane	Barley, Gram
Himachal Pradesh	-	Potato	Wheat, Maize, Total Food grains	Barley, Small Millets
Jammu & Kashmir	-	Wheat	Rice, Maize, Total Food grains, Rapeseed & Mustard	Small Millets
Karnataka	Maize, Onion, Sunflower	Arecanut, Total Pulses, Total Oilseeds, Coconut, Safflower, Sesamum, Sugarcane, Tobacco	Ragi, Cotton, Total Food grains, Groundnut, pigeon pea, Total Cereals	Arecanut, Jowar, Cardamom, Small Millets
Kerala	Cardamom	Pepper	Arecanut, Coconut	-
Madhya Pradesh	Total Oilseeds, Rapeseed & Mustard	Wheat, Maize, Gram	Total Pulses, Total Food grains, Total Cereals	Rice, Linseed, Small Millets, Pigeon pea
Maharashtra	Total Oilseeds, Gram, Onion, Sunflower	Bajra, Cotton, Total Pulses, Sugarcane, Pigeon pea	Jowar, Total Food grains, Safflower, Total Cereals	Ragi, Groundnut, Linseed, Sesamum
Orissa	Pigeon pea	-	Total Food grains, Onion, Total Cereals, Rice	Ragi, Total Pulses
Punjab	Potato, Rice	Wheat, Total Food grains, Total Cereals	Cotton, Barley, Sugarcane	Sunflower
Rajasthan	Wheat, Total Oilseeds, Rapeseed & Mustard	Bajra, Maize, Total Food grains, Total Cereals	Total Pulses, Sesamum	Barley, Gram
Tamil Nadu	Coconut	Total Pulses, Sugarcane	Rice, Total Food grains, Groundnut, Onion, Sesamum, Total Cereals	Ragi, Jowar, Cotton, Cardamom, Small Millets, Tobacco, Tur

Uttar Pradesh	Potato	Wheat, Total Food grains, Total Cereals, Rice, Sugarcane	Bajra, Maize	Total Pulses, Total Oilseeds, Barley, Gram, Linseed, Rapeseed & Mustard, Sesamum, Tur
West Bengal	Potato, Rapeseed & Mustard, Sesamum	Jute, Total Cereals, Rice	Total Food grains	
India	Cardamom, Onion, Potato, Rapeseed & Mustard, Sunflower	Rice, Wheat, Arecanut, Coconut, Cotton, Pepper, Total Food grains, Maize, Jute, Sugarcane, Total Cereals, Total Oilseeds	Bajra, Gram, Groundnut, Safflower, Sesamum, Total Pulses, Tobacco, Pigeon pea	Barley, Jowar, Linseed, Small Millets, Ragi

However, only five states, viz., Andhra Pradesh, Haryana, Punjab, Rajasthan and Uttar Pradesh showed medium growth in production of food grains. Other states registered a growth rate of less than 2.0 per cent only. Given the recent initiatives of the Central Government's law granting the right to minimum amount of food, raising food production across the states in the country assumes great importance. However, it may not be wise to put pressure on a few states that are already reeling under agricultural degradation^v to produce more food due to intensive cultivation (Gadgil *et al.*, 1999). In this context, regional comparative advantage in terms of weather, soil conditions, water availability and entrepreneurship need to be understood for developing appropriate strategy for crop planning. The cropping pattern should be devised according to the inherent potential of the regions to achieve enhanced agricultural production. For this to happen, policy and institutional structures have greater roles to play. These structures should be attuned to facilitate and respond to the germane needs of the farming community, which is willing to adopt high payoff technology to raise their income and living standards (Rao, 1996).

Grouping of crops based on growth in yield by states is shown in Table 8. Only safflower in Karnataka and cardamom in Kerala registered growth rate of more than 4.0 per cent. Most of the other crops showed medium to low growth rates. Important rice growing states like Assam, Bihar, Madhya Pradesh, Orissa and Tamil Nadu registered less than 2.0 per cent growth in yield. Interestingly, coarse cereals like barley and bajra showed increased growth rates in the major states. However, the decreasing yield of sugarcane in Maharashtra, maize in Karnataka, small millets in Himachal Pradesh and Jammu & Kashmir and pigeon pea in Uttar Pradesh and Karnataka is worrisome. Among the states, Karnataka showed negative growth in yield of five crops viz., maize, cardamom, coconut, sunflower, pigeon pea and arecanut. Pulses mostly registered low growth rates. At the all-India level, only cardamom registered growth rate above 4.0 per cent and food grains like rice, wheat, maize, barley and barja showed medium growth rate. Nevertheless, sunflower, pigeon pea and ragi showed negative growth rates. There is greater potential to improve the yield of major crops through techniques like biotechnology and genetic engineering. This will go a long way in improving the crop production, farmers' income, nutrition and thus, reduce rural poverty.

**Table 8: Compound Annual Growth Rates of Yield for Major Crops by States:
1967-68 to 2007-08**

State	High (> 4.0%)	Medium (2.0 - 3.9%)	Low (0 - 1.9%)	Negative (< 0%)
Andhra Pradesh	-	Cotton, Total Food grains, Rice, Maize, Total Pulses, Total Cereals, Sunflower	Groundnut, Ragi, Jowar, Total Oilseeds, Sesamum, Tobacco, Pigeon pea	-
Assam	-	-	Rice, Total Food grains, Jute, Potato, Rapeseed & Mustard	Arecanut
Bihar	-	Maize, Barley, Total Cereals	Rice, Wheat, Ragi, Total Food grains, Jute, Linseed, Tobacco	Potato
Gujarat	-	Cotton, Rapeseed & Mustard	Bajra, Maize, Total Oilseeds, Groundnut, Sesamum, Tobacco, Pigeon pea	-
Haryana	-	Wheat, Bajra, Barley, Total Food grains, Rapeseed & Mustard, Total Cereals	Cotton, Gram, Sugarcane	-
Himachal Pradesh	-	Potato	Wheat, Maize, Total Food grains	Barley, Small Millets
Jammu & Kashmir	-	-	Rice, Wheat, Maize, Total Food grains	Rapeseed & Mustard, Small Millets
Karnataka	Safflower	Cotton	Ragi, Jowar, Total Pulses, Total Oilseeds, Total Food grains, Total Cereals Groundnut, Sesamum, Small Millets, Sugarcane, Tobacco	Maize, Cardamom, Coconut, Sunflower, Pigeon pea, Arecanut
Kerala	Cardamom		Arecanut, Coconut, Pepper	-
Madhya Pradesh	-	Wheat, Total Oilseeds, Total Food grains, Total Cereals, Rapeseed & Mustard	Rice, Maize, Total Pulses, Gram, Linseed, Small Millets, Tur	-
Maharashtra	-	Bajra, Cotton, Total Oilseeds, Total Cereals, Gram	Ragi, Jowar, Total Pulses, Total Food grains, Groundnut, Linseed, Safflower, Sesamum, Sunflower, Pigeon pea	Sugarcane
Orissa	-		Rice, Total Food grains, Pigeon pea, Total Cereals	Ragi, Total Pulses
Punjab	-	Wheat, Barley, Total Food grains, Total Cereals	Rice, Cotton, Potato, Sugarcane, Sunflower	
Rajasthan	Total Oilseeds	Wheat, Bajra, Barley, Total Food grains, Total Cereals, Rapeseed & Mustard, Sesamum	Maize, Gram	Total Pulses
Tamil Nadu	-	Groundnut	Rice, Ragi, Jowar, Cotton, Total Pulses, Coconut, Total Food	Cardamom

			grains, Total Cereals, Sesamum, Small Millets, Sugarcane, Tobacco, Tur	
Uttar Pradesh	-	Rice, Wheat, Bajra, Maize, Total Oilseeds, Barley, Total Food grains, Total Cereals, Potato, Rapeseed & Mustard	Total Pulses, Gram, Linseed, Sesamum, Sugarcane	Pigeon pea
West Bengal	-	Rice, Rapeseed & Mustard, Total Cereals	Total Food grains, Jute, Potato, Sesamum	-
India	Cardamom	Barley, Bajra, Cotton, Total Food grains, Total Cereals, Rapeseed & Mustard, Maize, Safflower, Sesamum, Rice, Wheat	Areca nut, Coconut, Gram, Groundnut, Jowar, Jute, Linseed, Pepper, Potato, Small Millets, Total Pulses, Total Oilseeds, Sugarcane, Tobacco	Sunflower, Pigeon pea, Ragi

Conclusions

The present study has discussed the trends and patterns in the growth of the crop sector at the national and state levels. It has also estimated crop output growth model to analyse its determinants at the all-India level. The cropping pattern in India has undergone significant changes with a significant shift from the cultivation of food grains to commercial crops. The area under coarse cereals, which is generally cultivated in dry regions, has declined by 13.3 per cent between TE 1970-71 and TE 2007-08. The performance of pulses in terms of area and output was not impressive during the study period. Nevertheless, increase in crop yield has been a major factor for accelerating crop production in the country since late 1960s. The use of modern varieties, irrigation and fertilisers were important aspects of higher growth in crop production in the country. The crop output growth model indicates that the enhanced capital formation, better irrigation facilities, normal rainfall and improved fertiliser consumption will help to improve crop output in the country.

However, technological and institutional support for a few crops like rice and wheat have brought significant changes in crop area and output composition in some regions. Rice accounted for only 15.4 per cent of GCA in TE 1962-65 and it increased to 23 per cent in TE 2003-06 in North West India. Similarly, wheat area almost doubled in these periods. The expansion of area under these two crops resulted in a contraction of area under coarse cereals, pulses and oilseeds in that region. In the central region, the share of cotton increased in the 1980s and constituted about 10 per cent of total value of crop output in recent years. Apart from this, the annual growth in yield during 1967-68 to 2007-08 for major crops was worked out to be low. In comparison with the FAO data, yield per hectare of rice in China was 6.56 ton and in USA it was 7.67 ton against the all-India average of 2.15 ton. Similarly, the yield of wheat in China was 4.76 ton and in USA it was 3.02 ton against the all-India average of 2.71 ton. Hence, there is potential for enhancing yield of major crops through better soil and water management, profitable crop rotation, innovative marketing, genetic engineering and investment in farm education and rural infrastructure.

Notes

- ⁱ According to FAO (2009), 21 per cent of India's population and 48 per cent of children are undernourished. The Global Hunger Index describes the country's hunger situation as alarming. The FAO has also classified India under low income-food deficit countries. Further, country's food deficit situation can be understood from frequent interventions by the government on import and export of food crops.
- ⁱⁱ For instance, minimum support price for turn was ` 2,000 per quintal in 2008-09. It increased to ` 3,000 in 2010-11. Similarly, price of gram increased from ` 1,730 to ` 2,100 and moong from ` 2,520 to ` 3,170 during the same period (Economic Survey, 2008-09 and 2010-11, Government of India).
- ⁱⁱⁱ North West India includes Haryana, Himachal Pradesh, Jammu and Kashmir, Punjab and Uttar Pradesh; Eastern India comprises Assam, Bihar, Orissa and West Bengal; Central India includes Gujarat, Madhya Pradesh, Maharashtra and Rajasthan and the Southern region comprises Andhra Pradesh, Karnataka, Kerala and Tamil Nadu.
- ^{iv} For instance, rice was not a major crop until the late 1970s in Punjab. However, its area has increased considerably overtime due to the operation of strong market incentives for farmers and comprised about one-third of total GCA in TE 2003-06.
- ^v Intensive cultivation, for example rice-wheat rotations in north western India has resulted in salinity and water logging, groundwater depletion, loss of soil nutrients, formation of soil hard pans and building up of pests and diseases (Narang and Virmani, 2001; Pingali and Shah, 2001).

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Dr V K R V Rao Road, Nagarabhavi P.O., Bangalore - 560 072, India
Phone: 0091-80-23215468, 23215519, 23215592; Fax: 0091-80-23217008
E-mail: lekha@isec.ac.in; Web: www.isec.ac.in