Trends in India's Agricultural Growth and Its Determinants

Elumalai Kannan
Institute for Social and Economic Change (ISEC), India
E-mail: elumalaik@isec.ac.in

ABSTRACT

The present study discusses the trends in crop sector growth at national and sub-national levels in India. Data on important variables such as area, production, input use, and value of output were compiled for the periods 1967-1968 to 2007-2008 from published sources. The analysis reveals that the cropping pattern in India has changed significantly over time, with a marked shift from the cultivation of foodgrains to commercial crops. Among foodgrains, the area planted to coarse cereals that is generally cultivated in dry regions declined by 13.3 percent between triennium ending (TE) 1970-1971 and TE 2007-2008. Similarly, the performance of pulses in terms of area and output was not impressive during the study period and the technological breakthrough witnessed in other crops was not conspicuous in pulses. Nevertheless, increase in crop yield has been a major factor in accelerating crop production in the country since the late 1960s. Modern varieties, irrigation, and fertilizers were the important contributors of higher growth in crop production. However, technology and institutional support for a few crops such as rice and wheat have changed crop area and output composition significantly in some regions. The results of the crop output growth model indicate that enhanced capital formation, better irrigation facilities, normal rainfall, and improved fertilizer consumption will help increase crop output in the country.

INTRODUCTION

The Indian economy has changed structurally over time with the anticipated decline in agriculture's share in the gross domestic product (GDP). Despite a fall in its share from 55.1 percent in 1950-1951 to 17 percent in 2008-2009, agriculture remains important for two major reasons. First, the country has achieved self-sufficiency in food production at the macro level but is still a food-deficit country.[1] It is challenged massively by the 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 relative to the sector's contribution to GDP. This has resulted in widening income disparity between agriculture and non-agriculture sectors

1 According to the Food and Agriculture Organization (FAO) (2009), 21 percent of the total population and 48 percent of children in India are undernourished. The country's hunger situation is described as alarming on the Global Hunger Index. FAO has also classified India under low-income food-deficit countries, which can be understood from frequent interventions by the government on import and export of food crops.

(Chand and Chauhan 1999).

The experiences of developed countries show that the transfer of labor force from agriculture to non-agriculture, particularly manufacturing, has promoted production growth in agriculture and thus 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 percent in the last three decades. Further, since the current economic growth pattern is driven by the service sector, labor absorption outside agriculture will remain slow until rural education improves dramatically.

Under these circumstances, higher agricultural growth is vital. It 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). Sustained agricultural growth, which is facilitated by constant policy and institutional support, could augur growth in the rural economy and associated secondary activities (e.g., food processing and retail trading). However, policy makers in the country have not given enough attention to agriculture-led rural industrialization. This is despite the fact that agricultural growth per se was not visible 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 remarkable during the 1980s. 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).

There has been a renewed policy thrust from the government since the mid-2000s to revive agricultural growth through various development programs. Examples of such programs are interest subvention on crop loans, national food security mission, the National Agriculture Development Program (Rashtriya Krishi Vikas Yojana), and pulses development program. These programs, which are likely to affect agricultural growth and farmers' income in the country, provide state governments better leverage to allocate resources to the priority areas of development. Also, trends in India's agricultural growth are relatively well researched. Systematic efforts have been made to examine crop output growth 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 as well as disparity and impact on farmers' income and employment have been studied by several scholars. Recent studies include those of Bhalla and Singh (2001), Radhakrishna (2002), Bhalla and Singh (2009), and Vaidyanathan (2010). A number of studies have also looked at the effect of agricultural technology on crop output growth 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 on Indian agriculture by estimating crop output growth through econometric methods. It also discusses the trends in agricultural growth at national and state levels.

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, Ministry of Agriculture. Data were collected for 44 crops for 17 major states of

India from 1967-1968 to 2007-2008. The study period was divided into several phases: early green revolution (1967-1968 to 1979-1980), mature green revolution (1980-1981 to 1989-1990), early economic reforms (1990-1991 to 1999-2000), economic reforms (2000-2001 to 2007-2008), and overall period (1967-1968 to 2007-2008). Compound annual growth rates were calculated using the semi log method. Meanwhile, data on value of crop output were compiled from the Central Statistics Office, Government of India. For trend analysis, three years average (i.e., triennium ending [TE] of different variables) were calculated to even out the inter-year fluctuations.

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, a Crop Concentration Ratio (CCR)—the ratio of share of area of a crop in a state to share of area of a crop in the country—was used (Deshpande et al. 2004). The crops with CCR of above 0.40 were identified as major crops in a particular state and thus included in the analysis.

Changes in Cropping Pattern and Crop Output at National Level

The cropping pattern in India has changed significantly over time. As the cultivated area remains more or less constant, the heightened demand for food due to the increase in population and urbanization has put agricultural land under stress. This has led to crop intensification and substitution of commercial crops with food crops. It is striking to observe that the share of area planted to foodgrains in gross cropped area (GCA) declined by 11.62 percent. This was mainly due to the decrease in coarse cereals area by 13.34 percent between TE 1970-1971 and TE 2007-2008 (Table 1). Wheat gained importance but had an area allocation of only 10.42 percent in TE 1970-1971. However, it increased steadily

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 foodgrains	75.43	73.63	69.47	65.76	63.81
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
Total fibers	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
Potato	0.31	0.43	0.51	0.69	0.76
Onion	-	0.14	0.17	0.24	0.36
Total fruits and vegetables	2.24	2.77	3.57	4.35	5.10
Fodder crops	4.15	4.50	4.59	4.55	4.26
Gross cropped area (GCA)	100.00	100.00	100.00	100.00	100.00

Source: Directorate of Economics and Statistics, Government of India

to 14.18 percent in TE 2007-2008. Rice area remained more or less constant. Interestingly, area no longer planted to foodgrains was used to cultivate oilseeds (4%) as well as fruits and vegetables (2.86%) between TE 1970-1971 and TE 2007-2008. The shift from coarse cereals to high value crops is likely to increase farm output and farmers' income. However, in dry land regions, it exposes the cultivators to serious weather-borne risks because high value crops have higher water requirements (Bhalla and Singh 2009).

The increase in total oilseeds area does not reflect a general rise in area across all oilseed crops. It appears to be limited only to rapeseed and mustard, sunflower, and soybean. Favorable market conditions for refined oil and protein-rich soya food might have encouraged farmers to allocate more area to these crops (Srinivasan 2005). Groundnut area declined from 4.42 percent in TE 1970-1971 to 3.20 percent in TE 2007-2008. However, the area planted to commercial crops like cotton almost remained constant at 4.5 percent. Sugarcane area increased marginally from 1.62 percent in TE 1970-1971 to 2.47 percent in TE 2007-2008.

Commercial crops were leading in terms of area share during the study period. However, it was interesting to analyze the contribution of different crops to the total value of output. Aside from determining the level of physical output, this also captured producer prices 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 fiber (Table 2). While the contribution of cereals declined marginally from 35.02 percent in TE 1970-1971 to 31.24 percent in TE 2007-2008, the share of fruits and vegetables increased considerably from 15.88 percent to 24.27 percent during the same period. The change in share was determined largely by commodity price, which rose proportionately higher for fruits and vegetables than cereals in the recent decade (Chand et al. 2011). Among 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 drop in their contribution to the total value of output from 8.42 percent in TE 1970-1971 to 6.25 percent in TE 1990-1991, then to 4.38 percent in TE 2007-2008. Despite the increase in producer price of pulses,[2] output did not keep pace because farmers allocated a smaller area for its cultivation. Output was also affected by weather changes. Meanwhile, the value of output of cotton in the current decade increased to 4.86 percent from 3.40 percent in TE 1990-1991. Cotton production escalated primarily because of the widespread cultivation of Bt cotton. It was found that productivity and profit from Bt cotton cultivation is substantially higher than the conventional hybrid cotton varieties (Naik et al. 2005; Narayanamoorthy and Kalamkar 2006). The share of condiments and spices as well as sugars in the total value of output also increased in the last four decades. Overall, data analysis shows that agricultural production in the 1980s was broad. However, the commercialization of agricultural production seems to have gained momentum in the early 1990s. There was a definite shift from foodgrains to non-foodgrains (e.g., fruits and vegetables, oilseeds, fiber, and

2 For instance, the minimum support price for pigeon pea (*tur)* was INR 2000 per quintal in 2008-2009. This increased to INR 3000 in 2010-2011. Similarly, the price of gram increased from INR 1730 to INR 2100 and mung bean (*moong*) from INR 2520 to INR 3170 between the same period (Government of India Economic Survey 2008-2009, 2010-2011).

Table 2. Percentage share of various crops in value of output (at 1999-2000 prices)

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
Pigeon pea	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
Coconut	1.33	1.11	1.28	1.42	1.32
Sugars	4.86	4.28	4.53	6.02	5.82
Fibers	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
Potato	0.73	1.10	1.27	1.57	1.45
Fruits & vegetables	15.88	18.83	17.87	23.25	24.27
Others*	20.18	18.24	16.43	14.20	14.60
Total value of crop output	100.00	100.00	100.00	100.00	100.00

Source: Central Statistics Office, Government of India
Note: *includes rubber, by-products, kitchen garden, indigo, dyes and tanning materials

condiments and spices), whose share in both area and in value of output has been increasing over time.

Growth Performance of Major Crops at the National Level

It is well documented that area growth was the major source of production growth until the early 1960s (Bhalla and Singh 2001; Vaidyanathan 2010). The high-yielding varieties of wheat and rice that were introduced in the late 1960s heralded India's green revolution. Along with technology, new institutional mechanisms including provision of better irrigation facilities, a government procurement system, guaranteed price support, and supply of inputs at subsidized rates enabled farmers to adopt improved cultivation methods. Table 3 shows that wheat production had a compound annual growth of 5.03 percent during the early green revolution period (1967-1968 to 1979-1980). Both yield and area contributed to higher production growth. In the case of rice, yield growth contributed to a production growth of 1.84 percent per annum. For foodgrains as a whole, area (1.75%) and yield (0.43%) growth led to a production growth of 2.19 percent.

Interestingly, all major crops had a relatively high yield growth during the mature green revolution period (1980-1981 to 1989-1990). This indicates that crops other than rice and wheat shared the technological benefits. Given the decline in area, the production of most crops rose impressively because of yield growth. Rice registered production and yield growth rates of 3.62 percent and 3.19 percent, respectively. Wheat yield also grew

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
Foodgrains	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
Fiber 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
Potato	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
Coconut	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

remarkably at 3.57 percent. The yield growth of pulses and coarse cereals was appreciable though negative area growth led to a decline in area planted to foodgrains. Despite this, the production of foodgrains was still high at 2.73 percent due to a yield growth of 2.97 percent. Oilseeds recorded a growth rate of 5.46 percent in production and 2.95 percent in yield. This could be attributed to the technology mission on oilseeds launched in the mid-1980s, which emphasized (1) increasing the productivity of oilseeds, and (2) bridging yield gaps between experimental station and farmers' fields by adopting an improved package of practices. Similarly, cotton showed high growth in area by 3.50 percent, production by 5.19 percent, and yield by 6.01 percent. Potato and coconut also recorded high production and yield growth.

The impressive growth in crop production observed during the 1980s was not sustained until the 1990s. The yield growth of almost all crops declined during the early economic reforms period (1990-1991 to 1999-2000). This was a disturbing scenario that resulted in low crop output growth. However, the area for rice and wheat increased during this period. This occurred particularly in northwestern India where market incentives in terms of price support assured government procurement for wheat and rice, and favorable policy environment for providing inputs to farmers at subsidized rates were available (Umali-Deininger et al. 2005). Area planted to sugarcane and potato also increased during this period. Despite recording almost the same level of yield growth, the negative area growth resulted in lower production of coarse cereals. In the case of pulses, a decrease in yield growth and a negative area growth led to a drop in production. Consequently, growth in foodgrains production declined to 2.26 per cent during the early economic reforms period compared to 2.73 percent in the mature green revolution period.

The production and yield of some crops improved slightly in 2000-2001 to 2007-2008. Rice yield rose at 2.01 percent but negative area growth resulted in sluggish production growth compared to the early economic reforms period. In contrast, growth in both area and yield of wheat declined. The impressive yield growth of coarse cereals at 4.01 percent led to a production growth of 3.52 percent. Groundnut, which witnessed a negative growth in area and production in the previous decade, registered a production growth of 3 percent due to high yield growth (3.41%). Thus, the impressive growth of groundnut along with rapeseed and mustard led to an increase in oilseeds production. Fiber witnessed a whopping production growth of 9.68 percent because of impressive yield growth at 8.51 percent.

The Government of India envisaged achieving an annual growth rate of 4 percent in agricultural and allied sectors in the 9th Five-year Plan (1996-1997 to 2001-2002). As the crop sector constitutes over three-fourths of the total output, its growth performance is crucial in achieving the target. However, the long-term growth rate from 1967-1968 to 2007-2008 shows that only crops like rapeseed and mustard as well as potato registered production growth of more than 4 percent per annum. Other crops that showed respectable production growth were wheat, cotton, coconut, sugarcane, and rice. Growth in foodgrains production was at 2.06 percent, which was only slightly higher than the annual population growth of 1.64 percent as per the Population Census 2011. This implies that foodgrains production should be enhanced to achieve long-term food security in the country.

It is also discernible from the long-term growth that areas were shifted from coarse

cereals and pulses toward high value crops like sugarcane and potato, and more remunerative oilseeds and fiber. Policy interventions are required to encourage the production of pulses and coarse cereals. Further, crop productivity needs 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 first two are essential in ensuring sustainability of agricultural production through effectively maintaining 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 investments.

CROP OUTPUT GROWTH MODEL

The growth performance of the crop sector is influenced by several factors such as the farmers' use of physical inputs, markets, irrigation, credit availability, weather conditions, and government policy. It is difficult to analyze the effect of all the variables in a simple framework, since the mechanism through which these variables affect crop output growth varies. This study examines the determinants of aggregate crop output growth at the national level through the neo-classical growth model, which is described as follows:

The aggregate production function can be specified as

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

where Y is the aggregate crop output value (1999-2000 prices); F is fertilizer consumption; K is capital; R is rainfall; CI is cropping intensity; and IRR is the gross irrigated area.

The rationale for including rainfall in the production function is that a significant proportion of cultivated area depends on rainfall, and its variation affects the crop output substantially. Similarly, as the net cultivated area remains more or less constant over time, the ratio of GCA 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 (1999-2000 prices).

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

$$\Delta Y_t = \beta_0 + \beta_1 \Delta F_t + \beta_2 \Delta K_t + \beta_3 \Delta IRR_t + \beta_4 CI + \beta_5 R + e_i$$

All the variables are in logarithmic form except cropping intensity and rainfall. Rainfall is expressed as ratio of actual rainfall to long-period average rainfall. The model was estimated through the ordinary least squares (OLS) method and the results are presented in Table 4. Two models were estimated because of multicollinearity. The effect of capital, rainfall, and irrigation on crop output growth was positive and significant in the first model. The gross capital formation, with its two-year lagged growth, had a significant effect on crop output growth. This result implies that capital investment by farmers at the farm level, as well as by the government through agricultural infrastructure facilities, are important. Any decrease is likely to affect output growth.

The inclusion of rainfall and irrigation in the first model explains much of the variation in aggregate crop output growth compared to the second model, in which R-squared was only 32.88 percent. The coefficient of consumption of fertilizers was positive and significant. This indicates that fertilizer consumption growth has a positive effect on crop output growth, since most of the dominant crop varieties and

hybrids are highly fertilizer responsive. The coefficient of cropping intensity was positive but not significant in both models. This can be attributed to the fact that cultivated land is more or less fixed. In addition, the increase in intensification of land use does not contribute to crop output growth significantly. Overall, regression results indicate that enhanced capital formation, better irrigation facilities, normal rainfall, and improved fertilizer consumption will increase crop output growth in the country.

Growth Performance of Major Crops at State Level

This section presents the growth performance of major crops across major states or regions in India. Table 5 provides the percent share of various crops in GCA across regions from TE 1962-1965 to TE 2003-2006. Rice area was more or less stable except in the northwest region. Northwestern India[3] witnessed major changes in cropping patterns between TE 1962-1965 and TE 2003-2006. These changes were due to increases in rice and wheat areas. Rice occupied only 15.4 percent of GCA in TE 1962-1965, which increased to 23 percent in TE 2003-2006. Similarly, wheat area nearly doubled between these periods. Expansion of area for these two crops resulted in reduction of area for coarse cereals, pulses, and oilseeds.[4]

In eastern India, rice (54.3%) dominated the cropping pattern. The area planted to foodgrains declined and was offset by oilseeds and other crops like fruits and vegetables. Sugarcane area also increased in recent years. Meanwhile, coarse cereals, pulses, and oilseeds dominated the cropping pattern in central India. Though the share of area planted to coarse cereals had a declining trend, it remained high at 22.3 percent in TE 2003-2006. The area planted to pulses was constant in recent decades. Oilseeds area

Table 4. Regression results of agricultural growth model: 1968-69 to 2007-08

Variables	Model 1	Model 2
Dependent variable: Growth in crop output value		
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 observation	37	37

Note: Figures in parentheses are *t* values; ***Significant at 1 percent; ** Significant at 5 percent

3 Northwestern 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 southern India comprises Andhra Pradesh, Karnataka, Kerala, and Tamil Nadu.

4 For instance, rice was not a major crop until the late 1970s in Punjab. However, its area has increased considerably over time because of strong market incentives for farmers. These have pushed rice to occupy about one-third of the total GCA in TE 2003-2006.

Table 5. Regionwise share of various crops in gross cropped area (percent)

Region	Triennium	Rice	Wheat	Coarse Cereals	Pulses	All Foodgrains	Oilseeds	Fibers	Cotton	Sugar-cane	Planta-tion	Cardamom and Spices	Remaining Crops
Northwestern	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)

increased from 11.4 percent in TE 1962-1965 to 20.7 percent in TE 2003-2006. However, it is also interesting to note that Gujarat in central India expanded the area planted to cotton in the current decade with 16.2 percent of state GCA (Bhalla and Singh 2009).

The southern region has witnessed a decline in foodgrains area over time. However, the cropping pattern is still dominated by cereals and pulses. Unfortunately, coarse cereals area dropped by 50 percent between TE 1962-1965 and TE 2003-2006. On a positive note, area planted to pulses and oilseeds increased marginally over time. However, oilseeds area declined in the recent decade. The area share of other crops including fruits and vegetables increased considerably to 15.2 percent of GCA in TE 2003-2006. Among southern states, Kerala had a different cropping pattern, which was dominated by high value and plantation crops. Foodgrains, mostly rice, constituted only 9.9 percent of GCA while the area for 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 a few crops such as rice, wheat, and plantation crops brought significant changes in crop output composition across regions.

To analyze long-term growth patterns of major crops across states, the compound annual growth rates calculated for the period 1967-1968 to 2007-2008 were grouped into four categories: high (>4.0%), medium (2.0-3.9%), low (0-1.9%), and negative. This long-term growth analysis will help 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 4 percent area growth in different states. Onion had a high growth rate in Gujarat, Karnataka, and Maharashtra. Punjab was the only state, which showed high growth in rice area. Similarly, potato emerged to be a major crop along with rapeseed and mustard as well as sesamum in West Bengal. Surprisingly, coconut registered high growth in Tamil Nadu. At all India levels, only sunflower showed more than 4 percent area growth during 1967-1968 to 2007-2008.

In the medium growth range, most of the crops appeared to be oilseeds and other commercial crops like cotton, arecanut, sugarcane, pepper, potato, tobacco, and onion. Only a few foodgrains like pigeon pea (tur), maize, wheat, and gram fell into this category. It is interesting to observe that pulses, particularly pigeon pea, registered a growth rate of more than 2 percent in Andhra Pradesh, Gujarat, Karnataka, Maharashtra, and Orissa. Pigeon pea was cultivated widely compared to other pulse crops probably because short-duration high-yielding varieties/hybrids and high market price were available. Given the high domestic demand and volatile international prices, the cultivation of pulses should be encouraged by offering farmers input incentives. In this regard, National Food Security Mission, in which pulses form an important component, can increase their production in the country. Meanwhile, cotton area registered medium growth in Andhra Pradesh and Haryana. Sugarcane area belonged to the medium growth category in Karnataka, Maharashtra, and Tamil Nadu. Across India, arecanut, coconut, onion, pepper, rapeseed and mustard, and potato registered medium growth rates.

Most of the foodgrains registered low or negative growth rates across the states. Negative growth in foodgrains area was visible in Andhra Pradesh, Bihar, Himachal Pradesh, Madhya Pradesh, Maharashtra, Orissa, and Tamil Nadu. This implies that crop diversification in these states is increasingly inclined toward

Table 6. Compound annual growth rates of area for major crops, by state (1967 to 2008)

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 foodgrains, ragi, jowar, sesamum, tobacco, total cereals
Assam	-	Arecanut, onion, potato	Rice, total foodgrains, rapeseed & mustard	Jute
Bihar	-	-	Wheat, jute, onion, potato, tobacco	Rice, ragi, maize, barley, total foodgrains, linseed, total cereals
Gujarat	Onion, rapeseed & mustard, sesamum	Pigeon pea	Maize, cotton, total oilseeds, groundnut	Bajra, tobacco
Haryana	Rapeseed & mustard	Wheat, cotton	Total foodgrains, total cereals	Bajra, barley, gram, sugarcane
Himachal Pradesh	-	-	Wheat, maize	Barley, total foodgrains, potato, small millets
Jammu & Kashmir	-	-	Rice, wheat, maize, total foodgrains, rapeseed & mustard	Small millets
Karnataka	Onion, sunflower, maize	Arecanut, total oilseeds, coconut, sugarcane, tobacco, pigeon pea	Total pulses, total foodgrains, 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 foodgrains, linseed, small millets, tur, total cereals
Maharashtra	Onion, sunflower	Gram, sugarcane, pigeon pea	Total pulses, total oilseeds, cotton	Bajra, ragi, jowar, total foodgrains, groundnut, linseed, safflower, sesamum, total cereals
Orissa	-	Pigeon pea	Rice, onion	Ragi, total pulses, total foodgrains, total cereals
Punjab	Rice	Potato	Wheat, cotton, total foodgrains, total cereals	Barley, sugarcane, sunflower
Rajasthan	Total oilseeds, rapeseed & mustard	Total pulses	Bajra, wheat, maize, total foodgrains, total cereals	Barley, gram, sesamum

Source: Directorate of Economics and Statistics, Government of India

Table 6. Compound annual growth rates of area for major crops, by state (1967 to 2008) ... *(continued)*

State	High (> 4.0%)	Medium (2.0-3.9%)	Low (0-1.9%)	Negative (< 0%)
Tamil Nadu	Coconut	Sugarcane	Total pulses, onion	Rice, ragi, jowar, cotton, cardamom, total foodgrains, groundnut, sesamum, small millets, tobacco, tur, total cereals
Uttar Pradesh	-	Potato	Rice, wheat, total foodgrains, 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 foodgrains, 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 foodgrains, gram, groundnut, jowar, linseed, safflower, sesamum, small millets, tobacco, total cereals, total pulses, ragi

Source: Directorate of Economics and Statistics, Government of India

commercial crops, resulting in the shrinkage of area planted to coarse cereals and small millets. Interestingly, none of the crops registered negative area growth in West Bengal, indicating that farmers in the state continued to allocate similar area sizes for cereals, vegetables, and fiber. Across India cereals, pulses, small millets, and oilseeds like groundnut, linseed, safflower, and sesamum registered negative area growth.

In terms of production, oilseeds and commercial crops registered high growth in most of the states from 1967-1968 to 2007-2008 (Table 7). Under foodgrains, only rice, wheat, and pigeon pea showed a growth rate of more than 4 percent. As observed in area growth, the growth in the production of rapeseed and mustard was impressive in Gujarat, Haryana, Rajasthan, and West Bengal. Similarly, high growth in the 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 was progressive. Maize is mostly used as feed in the poultry industry. However, it is surprising to note that Uttar Pradesh and Tamil Nadu had a relatively high number of crops with negative production growth. The expansion in area planted to potato and sugarcane in Uttar Pradesh, and coconut and sugarcane in Tamil Nadu seemed to be responsible for this change. Across India, cardamom, onion, potato, rapeseed and mustard, and sunflower registered high production growth.

Only five states (i.e., Andhra Pradesh, Haryana, Punjab, Rajasthan, and Uttar Pradesh) showed medium growth in the production of foodgrains. Other states registered a growth rate of less than 2 percent. The central government has recently enacted a law granting the right to minimum amount of food. As such, augmenting food production across the country assumes great significance. However, it may not be wise to put pressure on a few states that are already reeling from agricultural degradation[5] due to intensive cultivation, to produce more food (Gadgil et al. 1999). In this context, regional comparative advantage in terms of weather, soil conditions, water availability, and entrepreneurship need to be understood to develop appropriate strategies for crop planning. The cropping pattern should be devised according to 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 germane needs of the farming community, which is willing to adopt high payoff technology to raise its income and living standards (Rao 1996).

Grouping of crops based on yield growth by states is shown in Table 8. Only safflower in Karnataka and cardamom in Kerala had growth rates above 4 percent. Most of the other crops showed medium to low growth. Important rice-growing states like Assam, Bihar, Madhya Pradesh, Orissa, and Tamil Nadu registered less than 2 percent yield growth. Interestingly, coarse cereals like barley and bajra (pearl millet) showed increased growth rates in the major growing states. However, the decreasing yields of sugarcane in Maharashtra, maize in Karnataka, small millets in Himachal Pradesh and Jammu and Kashmir, and pigeon pea in Uttar Pradesh and Karnataka are worrisome. Among the states, Karnataka had a negative growth in yield of six crops: maize, cardamom, coconut, sunflower, pigeon pea, and arecanut. Pulses mostly registered low growth rates.

---

5 Intensive cultivation, for example rice-wheat rotations in northwestern India, has resulted in salinity and waterlogging, 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).

Table 7. Compound annual growth rates of production for major crops, by state (1967 to 2008)

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 foodgrains, rice	Groundnut, total oilseeds, tobacco, total cereals	Jowar, sesamum, ragi
Assam	Onion, potato	Arecanut, rapeseed & mustard, rice	Total foodgrains	Arecanut, ragi, jute
Bihar	-	Wheat, total cereals	Rice, maize, total foodgrains, 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 foodgrains	Bajra, sugarcane	Barley, gram
Himachal Pradesh	-	Potato	Wheat, maize, total foodgrains	Barley, small millets
Jammu & Kashmir	-	Wheat	Rice, maize, total foodgrains, rapeseed & mustard	Small millets
Karnataka	Maize, onion, sunflower	Arecanut, total pulses, total oilseeds, coconut, safflower, sesamum, sugarcane, tobacco	Ragi, cotton, total foodgrains, 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 foodgrains, total cereals	Rice, linseed, small millets, pigeon pea
Maharashtra	Total oilseeds, gram, onion, sunflower	Bajra, cotton, total pulses, sugarcane, pigeon pea	Jowar, total foodgrains, safflower, total cereals	Ragi, groundnut, linseed, sesamum
Orissa	Pigeon pea	-	Total foodgrains, onion, total cereals, rice	Ragi, total pulses

Table 7. Compound annual growth rates of production for major crops, by state (1967 to 2008) ... (Continued)

State	High (> 4.0%)	Medium (2.0-3.9%)	Low (0-1.9%)	Negative (< 0%)
Punjab	Potato, rice	Wheat, total foodgrains, total cereals	Cotton, barley, sugarcane	Sunflower
Rajasthan	Wheat, total oilseeds, rapeseed & mustard	Bajra, maize, total foodgrains, total cereals	Total pulses, sesamum	Barley, gram
Tamil Nadu	Coconut	Total pulses, sugarcane	Rice, total foodgrains, groundnut, onion, sesamum, total cereals	Ragi, jowar, cotton, cardamom, small millets, tobacco, tur
Uttar Pradesh	Potato	Wheat, total foodgrains, 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 foodgrains	
India	Cardamom, onion, potato, rapeseed & mustard, sunflower	Rice, wheat, arecanut, coconut, cotton, pepper, total foodgrains, maize, jute, sugarcane, total cereals, total oilseeds	Bajra, gram, groundnut, safflower, sesamum, total pulses, tobacco, pigeon pea	Barley, jowar, linseed, small millets, ragi

Table 8. Compound annual growth rates of yield for major crops, by state (1967-68 to 2007-08)

State	High (> 4.0%)	Medium (2.0-3.9%)	Low (0-1.9%)	Negative (< 0%)
Andhra Pradesh	-	Cotton, total foodgrains, rice, maize, total pulses, total cereals, sunflower	Groundnut, ragi, jowar, total oilseeds, sesamum, tobacco, pigeon pea	-
Assam	-	-	Rice, total foodgrains, jute, potato, rape-seed & mustard	Arecanut
Bihar	-	Maize, barley, total cereals	Rice, wheat, ragi, total foodgrains, jute, linseed, tobacco	Potato
Gujarat	-	Cotton, rapeseed & mustard	Bajra, maize, total oilseeds, groundnut, sesamum, tobacco, pigeon pea	-
Haryana	-	Wheat, bajra, barley, total foodgrains, rapeseed & mustard, total cereals	Cotton, gram, sugarcane	-
Himachal Pradesh	-	Potato	Wheat, maize, total foodgrains	Barley, small millets
Jammu & Kashmir	-	-	Rice, wheat, maize, total foodgrains	Rapeseed & mustard, small millets
Karnataka	Safflower	Cotton	Ragi, jowar, total pulses, total oilseeds, total foodgrains, total cereals ground-nut, sesamum, small millets, sugarcane, tobacco	Maize, cardamom, co-conut, sunflower, pigeon pea, arecanut
Kerala	Cardamom		Arecanut, coconut, pepper	-
Madhya Pradesh	-	Wheat, total oilseeds, total foodgrains, total cereals, rape-seed & mustard	Rice, maize, total pulses, gram, linseed, small millets, tur	-
Maharashtra	-	Bajra, cotton, total oilseeds, total cereals, gram	Ragi, jowar, total pulses, total foodgrains, groundnut, linseed, safflower, sesamum, sunflower, pigeon pea	Sugarcane
Orissa	-		Rice, total foodgrains, pigeon pea, total cereals	Ragi, total pulses

Table 8. Compound annual growth rates of yield for major crops, by state (1967-68 to 2007-08) ... *(Continued)*

State	High (> 4.0%)	Medium (2.0-3.9%)	Low (0-1.9%)	Negative (< 0%)
Punjab	-	Wheat, barley, total foodgrains, total cereals	Rice, cotton, potato, sugarcane, sunflower	
Rajasthan	Total oilseeds	Wheat, bajra, barley, total foodgrains, total cereals, rapeseed & mustard, sesamum	Maize, gram	Total pulses
Tamil Nadu	-	Groundnut	Rice, ragi, jowar, cotton, total pulses, coconut, total foodgrains, total cereals, sesamum, small millets, sugarcane, tobacco, tur	Cardamom
Uttar Pradesh	-	Rice, wheat, bajra, maize, total oilseeds, barley, total foodgrains, total cereals, potato, rapeseed & mustard	Total pulses, gram, linseed, sesamum, sugarcane	Pigeon pea
West Bengal	-	Rice, rapeseed & mustard, total cereals	Total foodgrains, jute, potato, sesamum	-
India	Cardamom	Barley, bajra, cotton, total foodgrains, total cereals, rapeseed & mustard, maize, safflower, sesamum, rice, wheat	Arecanut, coconut, gram, groundnut, jowar, jute, linseed, pepper, potato, small millets, total pulses, total oilseeds, sugarcane, tobacco	Sunflower, pigeon pea, ragi

Across India, only cardamom recorded a growth rate above 4 percent while foodgrains like rice, wheat, maize, barley, and bajra showed medium growth rate. Nevertheless, sunflower, pigeon pea, and ragi (finger millet) had negative growth rates. There is greater potential to improve the yield of major crops biotechnology and genetic engineering. This will improve crop production, farmers' income, and nutrition sustainably, and thus, reduce rural poverty.

CONCLUSIONS

The cropping pattern in India has changed significantly with a marked shift from the cultivation of foodgrains to commercial crops. Among foodgrains, the area for coarse cereals declined by 13.3 percent between TE 1970-1971 and TE 2007-2008. The performance of pulses in terms of area and output was not impressive during the study period. Nevertheless, increase in crop yield was a major factor in accelerating crop production in the country since the late 1960s. Modern varieties, irrigation, and fertilizers have greatly contributed to higher crop production growth in the country. The results of the crop output growth model indicate that enhanced capital formation, better irrigation facilities, normal rainfall, and improved fertilizer consumption will help boost crop output in the country.

Technology and institutional support for a few crops such as rice and wheat brought significant changes in crop area and output composition in some regions. Rice occupied only 15.4 percent of GCA in TE 1962-1965. This increased to 23 percent in TE 2003-2006 in northwest India. Similarly, wheat area almost doubled in these periods. The expansion of area for these two crops resulted in a contraction of area planted to coarse cereals, pulses, and oilseeds in that region. In the central region, the area for cotton increased from the 1980s and constituted about 10 percent of the total value of crop output in recent years. Meanwhile, the annual yield growth during 1967-1968 to 2007-2008 for major crops was low.

International comparisons based on Food and Agriculture Organization (FAO) data for the year 2008 (2009) show that yield per hectare of rice in China was 6.56 tons and 7.67 tons in the USA against the all-India average of 3.42 tons. Similarly, the yield of wheat in China was 4.76 tons and 3.02 tons in the USA against the all-India average of 2.80 tons. Hence, there is potential for enhancing the 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.

REFERENCES

Balakrishnan, P. 2000. "Agriculture and Economic Reforms: Growth and Welfare." *Economic and Political Weekly* 35 (12): 999-1004.

Bhalla, G.S., and G. Singh. 2001. *Indian Agriculture: Four Decades of Development*.New Delhi, India: Sage Publications.

_____. 2009. "Economic Liberalization and Indian Agriculture: A Statewise Analysis." *Economic and Political Weekly* 44 (52): 34-44.

Chand, R., and S.S. Raju. 2009. "Instability in Indian Agriculture During Different Phases of Technology and Policy." *Indian Journal of Agricultural Economics* 64 (2): 283-288.

Chand, R., and S. Chauhan. 1999. "Are Disparities in Indian Agriculture Growing?" *Policy Brief No. 8.* New Delhi, India: National Centre for Agricultural Economics and Policy Research.

Chand, R., P. Shinoj, A. Gulati, and K. Ganguly. 2011. "Managing Food Inflation in India: Reforms and Policy Options." *Policy Brief 35.* New Delhi, India: National Center for Agricultural Economics and Policy Research.

Chand, R., S.S. Raju, and L.M. Pandey. 2007. "Growth Crisis in Agriculture: Severity and Options at National and State Levels." *Economic and Political Weekly* 42 (26): 2528-2533.

Cummings, R.W., and S.K. Ray. 1969. "The New Agricultural Technology: Its Contribution to 1967-68 Production." *Economic and Political Weekly* 4 (13): A7-A16.

Deshpande, R.S. 1988. "Growth and Instability in Maharashtra Agriculture." *Artha Vijnana* 30 (4): 317-339.

Deshpande, R.S., M.J. Bhende, P. Thippaiah, and M. Vivekananda. 2004. "Crops and Cultivation." In *State of the Indian Farmer: A Millennium Study, Volume 9,* Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India. New Delhi, India: Academic Foundation.

Food and Agriculture Organization (FAO). 2009. *State of Food Insecurity in the World 2009*. Rome: FAO.

Gadgil, S., Y.P. Abrol, and P.R. Seshagiri Rao. 1999. "On Growth and Fluctuation of Indian Foodgrain Production." *Current Science* 76 (4): 548-556.

Gollin, D., S. Parente, and R. Rogerson. 2002. "Role of Agriculture in Development." *The American Economic Review* 92 (2): 160-164.

Hanumantha Rao, C.H. 1998. "Agricultural Growth, Sustainability and Poverty Alleviation: Recent Trends and Major Issues of Reforms." *Economic and Political Weekly* 33 (29/30): 1943-1948.

Hazell, P. 1982. "Instability in Indian Foodgrain Production." *Research Report 30.* Washington D.C., USA: International Food Policy Research Institute.

Hirashima, S. 2000. "Issues in Agricultural Reforms: Public Investment and Land Market Development." *Economic and Political Weekly* 35 (43/44): 3879-3884.

Joshi, P.K., P.S. Birthal, and N. Minot. 2006. "Sources of Agricultural Growth in India: Role of Diversification towards High Value Crops." *MTID Discussion Paper No. 98.* Washington D.C., USA: International Food Policy Research Institute.

Kannan, K.P. 2011. "Agricultural Development in an Emerging Non-Agrarian Regional Economy: Kerala's Challenges." *Economic and Political Weekly* 46 (9): 64-70.

Mahendradev, S. 1987. "Growth and Instability in Foodgrains Production: An Inter-State Analysis." *Economic and Political Weekly* 22 (39): A82-A92.

_____. 2000. "Economic Reforms, Poverty, Income Distribution and Employment." *Economic and Political Weekly* 35 (10): 823-835.

Majumdar, K., and P. Basu. 2005. "Growth Decomposition of Foodgrains Output in West Bengal: A District Level Study." *Indian Journal of Agricultural Economics* 60 (2): 220-234.

Minhas, B.S., and A. Vaidyanathan. 1965. "Growth in Crop Output in India, 1951-54 to 1958-61: An Analysis by Component Elements." *Journal of Indian Society of Agricultural Statistics* 17 (2): 230-252.

Naik, G., M. Qaim, A. Subramanian, and D. Zilberman. 2005. "Bt Cotton Controversy, Some Paradoxes Explained." *Economic and Political Weekly* 40 (15): 1514-1517.

Narang, R.S., and S.M. Virmani. 2001. "Rice-Wheat Cropping System of Indo-Gangetic Plain of India." *Rice-Wheat Consortium Paper Series 11*. New Delhi, India: Rice-Wheat Consortium for the Indo-Gangetic Plains and ICRISAT.

Pingali, P.L., and M. Shah. 2001. "Policy Re-Directions for Sustainable Resource Use: The Rice-Wheat Cropping System of the Indo-Gangetic Plains." In *The Rice-Wheat Cropping System of South Asia: Trends, Constraints, Productivity and Policy*, edited by P.K. Kataki, 113-118. New York: Food Products Press.

Radhakrishna, R. 2002. "Agricultural Growth, Employment and Poverty: A Policy Perspective" *Economic and Political Weekly* 37 (3): 243-250.

_____. 2003. "Reform Agenda for Agriculture." *Economic and Political Weekly* 33 (29): 615-620.

Rao, V.M. 1996. "Agricultural Development with a Human Face: Experiences and Prospects." *Economic and Political Weekly* 31 (26): A50-A62.

Reddy, D.N., and S. Mishra. 2009. "Agriculture in the Reforms Regime." In *Agrarian Crisis in India,* edited by D.N. Reddy and S. Mishra, 1-19. New Delhi, India: Oxford University Press.

Sagar, V. 1977. "A Component Analysis of the Growth of Agricultural Productivity in Rajasthan: 1956-61 to 1969-74." *Indian Journal of Agricultural Economics* 32 (1): 42-59.

_____. 1980. "Decomposition of Growth Trends and Certain Related Issues." *Indian Journal of Agricultural Economics* 35 (2): 42-59.

Sarma, P.V., and S. Subrahmanyam. 1984. "A Note on the Decomposition of the Growth Rate of Aggregate Crop Output." *Agricultural Situation in India* 39 (9): 691-694.

Sawant, S.D., and C.V. Achuthan. 1995. "Agricultural Growth Across Crops and Regions: Emerging Trends and Patterns." *Economic and Political Weekly* 30 (12): A2-A13.

Sen, A. 1992. "Economic Liberalisation and Agriculture in India." *Social Scientist* 20 (11): 4-19.

Srinivasan, P.V. 2005. "Impact of Trade Liberalization on India's Oilseed and Edible Oil Sector." *Research Report*. Mumbai, India: Indira Gandhi Institute of Development Research.

Thamarajakshi, R. 1999. "Agriculture and Economic Reforms." *Economic and Political Weekly* 34 (14): 2393-2395.

Umali-Deininger, D., M. Sur, and K.W. Deininger. 2005. "Foodgrains Subsidies in India: Are They Reaching the Poor?" Paper presented at the American Agricultural Economics Association Annual Meeting, Rhode Island, USA, July 24-27. http://ageconsearch.umn.edu/bitstream/19486/1/sp05um01.pdf.

Vaidyanathan, A. 1992. "Instability in Agriculture: Extent, Causes and Consequences: A Review Article." *Indian Economic Review* 27 (2): 211-222.

_____. 2010. Agricultural Growth in India, Role of Technology, Incentives, and Institutions. New Delhi, India: Oxford University Press.

Vyas, V.S. 2001. "Agriculture: Second Round of Economic Reforms." *Economic and Political Weekly* 36 (14): 829-836.