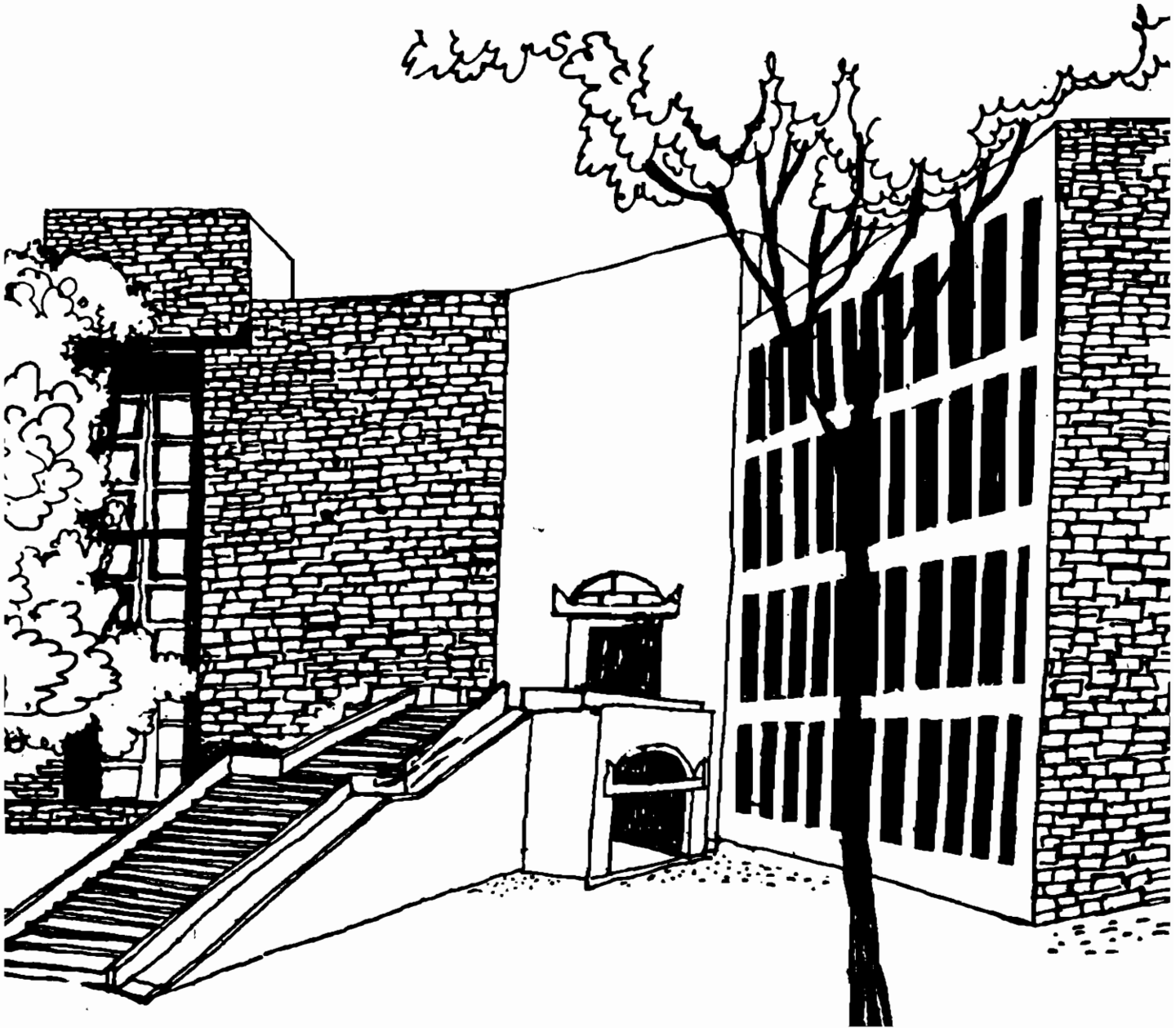




# Working Paper




**AN ANALYTICAL STUDY OF PERFORMANCE AND  
REGIONAL VARIATIONS IN INDIAN AGRICULTURE  
IN THE POST-GREEN REVOLUTION PERIOD**

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## **AN ANALYTICAL STUDY OF PERFORMANCE AND REGIONAL VARIATIONS IN INDIAN AGRICULTURE IN THE POST-GREEN REVOLUTION PERIOD**

### **Abstract**

The paper presents the results of an analysis of all-India and state level data on area, production and yield of major crops in the post-green revolution period. It reveals that there was a marked acceleration in the overall growth of agricultural production in India during the eighties as compared with the seventies. Improvement in foodgrains production was mainly because of improvement in crop yield, whereas, in case on non-foodgrains both area and yield increases were witnessed. Furthermore, agricultural growth has become regionally much more diversified. During the early phase of Green Revolution, the impact of new technology in transforming traditional agriculture was by and large confined to the north-western part of the country. The period of eighties marked a major departure from the earlier trend. The growth of agricultural production not only accelerated during this period but also spread to eastern region which had hitherto been left out. The period of eighties was also characterised by important cropping pattern shifts away from low value coarse cereals towards oilseeds and other commercial crops. However, during nineties there was a deceleration in overall growth performance of agriculture as compared with the eighties. This raises the question, whether India would be able to achieve 4.5 per cent growth rate in agriculture during the Ninth Five Year Plan, as proposed in the Approach Paper to the Plan. The study also brings out that levels and growth of land productivity and of output at all-India and state levels, are positively associated with the use of modern inputs like fertilisers, area under irrigation and HYV seeds. The results of the study clearly indicate that programmes and policies to promote agricultural growth should primarily focus on problems and prospects of the eastern region of the country. Further the growth performance of agriculture in the nineties indicates that the target of 4.5 per cent growth rate proposed for agriculture seems difficult to achieve unless policies and programmes for broadening the base of agricultural growth are strengthened. In this context, role of physical and infrastructure facilities such as rural roads, irrigation and other inputs, better extension services, input delivery system, marketing facilities, watershed management for the development of agriculture and rural sector needs to be strengthened.

## **AN ANALYTICAL STUDY OF PERFORMANCE AND REGIONAL VARIATIONS IN INDIAN AGRICULTURE IN THE POST-GREEN REVOLUTION PERIOD**

Agriculture historically has been the most important sector in the Indian economy, in terms of its share of national income and the employment of labour force. In 1996-97 the share of agriculture in the nation's Gross Domestic Product (GDP) was about 29 per cent but engaged almost two-third of the labour force (Government of India, 1997). The performance of Indian agriculture has been remarkable and foodgrain output growth rate has remained ahead of population growth since 1970s. But the pace of agricultural growth in the recent years has been constrained by a number of factors, including relatively slow growth of foodgrains. The annual compound growth rate of foodgrains during the nineties is lower than the annual population growth (1.9%) during the nineties and therefore, a matter of serious concern.

Agricultural growth rate in India till mid sixties which was 3.2 per cent, was marked mainly by expansion of area under cultivation. In contrast during the seventies a growth rate of 2.2 per cent was achieved due to increase in both area and productivity, while the rate of growth of agriculture during the eighties rose to around 3.4 per cent per annum and was mainly through further yield increases (Ranade and Dev, 1997). However, there are indications that there has been deceleration in overall performance of agriculture in the nineties, relative to the eighties. The deceleration is more pronounced for foodgrains than for non-foodgrains and the growth of production of non-foodgrain crops had accelerated and overtaken the foodgrains since the late eighties (Mukherjee and Vashishtha, 1996). The question therefore is whether it would be possible to improve output growth in agricultural sector to achieve 4.5 per cent growth rate in agriculture during the Ninth Five Year Plan, as proposed in the approach paper to the plan. Do past growth trends in agriculture justify it? What steps/ initiatives will be necessary to attain this growth rate?

There is a great population pressure on land with average agricultural land holding a mere 1.54 hectares. Foodgrains account for 30 per cent of agricultural production with rice being the largest crop. Apart from rice which occupies about 23 per cent of Gross Cropped Area (GCA), oilseeds with about 15 per cent of Gross Cropped Area and fibres are major non-food crops. During 1980s

oilseeds and sugarcane gained gross cropped area at the cost of coarse cereals. This implies that there is distinct trend towards higher land usage by non-food crops relative to food crops.

The performance of agricultural sector differs quite widely across the states/regions. The performance of individual crops also differs widely among the regions and within each region. Therefore, there is also a need to look into the trends of agricultural growth at the disaggregate level, that is which crops, in which states/regions indicate relatively higher growth potential and which are showing signs of saturation. It is equally important to identify the sources of output growth of different crops to find out whether it is the increase in area or yield or both which contributed to growth.

Performance of agricultural sector depends on numerous factors ranging from weather conditions to the use and optimum application of various inputs (like irrigation, fertilisers, seeds, insect pest and diseases control measures) besides institutional support through government price policies and organised marketing and credit supply. Therefore, there is a need to examine the role of these factors in explaining the divergent agricultural performance among the states/regions of the country.

Keeping in view the above mentioned broad objectives, an attempt has been made to analyse the growth and instability in area, production and yield per hectare of major foodgrain and non-foodgrain crops, sources of crop output growth and the impact of important factors on crop productivity at the national and state level using the most recent data.

The paper is divided into five sections. Section I describes the coverage of data, crops and the nature of analysis. Section II analyses growth performance and instability of major foodgrain and non-foodgrain crops at the all India level and investigate whether there has been acceleration or deceleration in their growth during different periods. Section III examines crop-wise and aggregate performance of agricultural sector, in terms of trends in production, yield and area across the states. Section IV discusses the role of infrastructure, institutional and government policies on the growth performance of important crops (namely rice and wheat) and at the end presents the conclusions of the study in Section V.

## Data Base and Analytical Framework

In order to study the agricultural growth performance, this paper has focused only on post-green revolution period, that is to the years from 1970-71 to 1995-96 at all India level and 1970-71 to 1990-91 for different states. The main focus is on the comparisons between the two sub-periods, namely the 1970s, i.e. the early phase of green revolution period covering the years from 1970-71 to 1980-81 and the 1980s, i.e., the late phase that includes 1980-81 to 1990-91. The analysis is restricted only to major foodgrain and non-foodgrain crops, namely rice, wheat, total coarse cereals, total pulses, total foodgrains, total oilseeds and sugarcane, and covers 17 major states. The study uses the published secondary data collected from various publications of the Government of India, viz., *Estimates of Area and Production of Principal Crops in India* (Government of India), *Fertiliser Statistics* (Fertiliser Association of India), *Indian Agriculture in Brief* (Government of India), *Statistical Abstract of India* (Government of India) and *Economic Survey* (Government of India).

The states are classified in four regions in order to discuss the results at state level. The organisation of four regions is as follows:

**Northern Zone** : *Haryana, Himachal Pradesh, Jammu & Kashmir, Punjab, Uttar Pradesh.*

**Eastern Zone** : *Assam, Bihar, Orissa, West Bengal*

**Western Zone** : *Gujarat, Madhya Pradesh, Maharashtra, Rajasthan*

**Southern Zone:** *Andhra Pradesh, Karnataka, Kerala, Tamilnadu*

To compute the compound growth rates of area, production and yield per hectare of principal food and non-food crops at the all India and state level, exponential trend equations are fitted by Ordinary Least Squares (OLS) technique. The following regression equation is estimated:

$$\ln(Y_t) = a_i + b_x t + u_{it}$$

Where  $Y_{it}$  is the original observation on area, production and yield for  $i^{\text{th}}$  crop at time  $t$  and  $u_{it}$  is the error term. Estimated  $b_i$  gives the growth rate of the  $i^{\text{th}}$  crop.

Compound growth rates are separately computed for different sub-periods for all the data sets and for the entire period in case of all India data and state level. All the statistically non-significant growth rates are treated as zero growth rates.

In order to confirm the existence of statistically significance acceleration or deceleration in the growth of crop production, the differences between the 'b' values for the two periods were tested for significance using the formula of 't' test for the means of two independent samples (Alagh and Sharma, 1980; Desai and Patel, 1983). The test applied can be considered as first approximation as the two 'b' values are not really from two independent samples. When the test gives non-significant results, it may be erroneous as the covariance in the denominator is not taken into account but when the test gives significant results, it is likely to be true.

Several alternative measures are used in literature to measure the variations in year to year instability. In this paper the variability in area, yield and production was measured in relative terms by Cuddy-Della Valle Index, used in recent years as a measure of instability in time series data (Weber and Sievers, 1985).

The growth of agricultural crops has been uneven across regions and over time. Whereas some states witnessed a substantial improvement in growth performance of some crops, in other states performance of agriculture declined significantly and in still others performance was more or less stagnant. The question obviously arises as to what are the factors which have influenced the growth of agricultural crops in different regions during different time periods. In order to analyse yield response behaviour of important crops, namely rice and wheat, production function of the following form has been fitted to the data relating to the period from 1970-71 to 1992-93.

$$Y_{it} = a_0 X_{1it}^{a1}, X_{2it}^{a2}, X_{3it}^{a3}$$

where,

$Y_{it}$  = Yield per hectare for the year 't' in quintals.

'i' varies from 1 to 2 : 1 = rice; 2 = wheat

$X_{1it}$  = Fertiliser (NPK) use per hectare of total cropped area for year 't' for crop 'i' in kg.



$X_{2i}$  = Percentage of area under HYVs to total area under crop 'i' for year 't'.

$X_{3i}$  = Percentage of irrigated area to total area under the crop 'i' for year 't'.

Multiple linear regression using *Ordinary Least Squares* (OLS) technique has been fitted in order to estimate the coefficients in the yield response functions. The analysis is conducted at state level and hence can throw light on the role of different factors in different regions which may not be possible, if the analysis was at the national level only.

In order to adequately assess the role of different factors in different states, the states have been classified on the basis of typology of their growth. Since yield is selected as dependent variable in the response functions. The growth trend in yield has been used as a criterion for classifying states.

Based on the pattern of yield, two broad typologies have been identified - states reporting positive and significant trend in yield, we refer to them as yield increasing states and states where the trends in yield, positive or negative, but not significant, i.e., yield stagnant states.

## II

### **Performance and Instability of Major Foodgrain and Non-Foodgrain Crops: All India**

Many attempts were made earlier to analyse and measure the growth in crop production in India as well in different states. Notably among the studies are Vaidyanathan (1977); Dandekar (1980); Krishnaji (1980); Alagh and Sharma (1980); Nadkarni and Deshpande (1982); Ray (1983); Sawant (1983); Nadkarni (1986); Rao and Deshpande (1986); Dev (1987); Ninan and Chandershekhar (1993); Sawant and Achuthan (1995); Dev and Mungekar (1996); Bhalla and Singh (1997). But the present study uses the most recent data (upto 1995-96) to study the performance and instability of principal foodgrain and non-foodgrain crops at all India level and across different states/regions.

The annual compound growth rates in respect of area, yield, and production for major foodgrain, non-foodgrain and all crops of all-India for the three sub-periods i.e., 1970s, 1980s and 1990s, and entire period (1970-71 to 1995-96) are shown in Table 1. A perusal of the table shows that the foodgrain production increased at a rate of 2.28 per cent per annum during the seventies. This growth was shared by significant expansion in both components of production, i.e., 0.41 per cent increase in area under foodgrains and 1.85 per cent in yield per hectare. In contrast area under

foodgrains declined in the 1980s but the foodgrains output continued to increase at the rate of 2.92 per cent as the growth rate of yield per hectare of foodgrains exceeded 3 per cent neutralising the negative growth rate in area. The estimate of growth rate for 80's was higher (2.92%) than that for 1970s (2.28%). An obvious implication is that there was relative acceleration in the process of foodgrain production during eighties.

The performance of non-foodgrains is relatively superior in comparison to foodgrains during the recent period. During 1980s the compound growth rate of non-foodgrains (4.16%) exceeded significantly that of foodgrains. The increase in non-foodgrains production is attributed to the significant increase in area (1.46%) and yield (2.94%) in eighties. While the area under foodgrains declined during this period. This indicates that there has been an increasing shift of area from foodgrains to non-foodgrains in recent years.

The growth rate for all commodities also increased significantly from 2.10% during 70s to 3.46% in 80s. However, during 90s, there has been a deceleration (2.67%) in the growth performance of all commodities as compared to 1980s.

Changes in relative contribution of area and yield components during different periods indicate that the area under foodgrains, non-foodgrains and all commodities increased gradually during the 1970s. This positive trend in case of foodgrains was replaced by negative but statistically non-significant growth rate of 0.13 per cent in the 1980s and 0.64 per cent during 1990s. However, a significant increase in growth rate of yield, i.e., from 1.85 per cent in 1970s to 3.07 per cent in 1980s, more than offset for decline in area and increased output growth above the 1970s level. In contrast non-foodgrains showed acceleration in both area, i.e., from 1.05 per cent to 1.46 per cent and yield per hectare from 0.98 per cent to 2.94 per cent between 1970s and 1980s. The area under all crops increased at a growth rate 0.56 per cent per annum in the seventies and remained almost stagnant during 1980s and 1990s, however the growth rate of yield per hectare increased from 1.20 per cent in 1970s to 3.02 per cent in 1980s but again declined during 1990s. Improvement in performance of Indian agriculture in the 1980s was mainly because of rapid movement in yield growth across crops.

The preceding discussion clearly demonstrates that the overall growth in agricultural production has been faster during 1980s as compared to 1970s. The major driving force behind the upward movement in the pace of growth of foodgrains is the expansion in yield, whereas non-foodgrains benefited from significant expansion in both area and yield per hectare. However, there has been a deceleration in the performance of foodgrains as well as non-foodgrains during 1990s as compared to 1980s. Therefore the target of 4.5 per cent growth rate set for the agricultural sector for the Ninth Five Year Plan seems difficult to achieve unless an appropriate package of measures is put in place.

An examination of growth rates for major crops indicates that during the 1970s growth of wheat output has been higher than of rice output. One reason for higher growth rates of wheat production could be the early introduction of new technology (HYVs) in mid sixties as compared to rice (seventies). Another reason could be that wheat is mainly grown under irrigated conditions (about 84% of area under wheat is irrigated) while rice is having only about 47 per cent area under irrigation. Increase in output of foodgrains was due to increase in both area and yield.

During 1980s rice occupied a leading position among all the foodgrain crops with highest growth in production (3.76%), followed by wheat (3.68%) and pulses (1.87%). Improvement in output of crops was mainly because of increases in yield. Contribution of area was either non-significant (wheat and pulses) or significant and negative in case of coarse cereals. Only rice crop benefited marginally (0.53%) from expansion in area in addition to growth in yield. Pulses as group witnessed a statistically significant growth in output at the rate of 1.87 per cent during 1980s and increase in yield was solely responsible for growth in output.

In 1990s wheat again occupied a leading position among all the foodgrain crops with highest growth in production (3.44%), followed by rice (2.06%). Wheat benefited both from expansion in area (1.44% ) and yield (1.93%), while the rice acreage remained stagnant and the area under coarse cereals declined significantly (2.35%). Improvement in foodgrain production was mainly because of improvement in crop productivity.

A comparison of performance of foodgrains between two periods, i.e., 1970s and 1980s clearly shows that for rice and pulses as a group, the growth rates were significantly higher in the second

period. Whereas, growth rate of wheat production decelerated from 4.53 per cent in 1970s to 3.68 per cent in 1980s. The decline in production of wheat was due to reduced expansion in area (i.e., from 2.28 per cent in 1970s to zero per cent in 1980s.), however the yield per hectare increased from 2.70 per cent in first period to 3.15 per cent in second period. There was a jump in the yield growth of rice from 1.44 per cent in 1970s to 3.21 per cent in 1980s and of coarse cereals 1.85 per cent to 2.13 per cent and pulses zero per cent to 1.63 per cent. However, there has been a deceleration in the growth performance of all the crops excluding cotton during 1990s as compared to 1980s which is a matter of concern

Oilseeds as a group registered high growth in production with a growth rate of 5.99 per cent in 1980s. Expansion in both area and yield per hectare contributed to the growth. The growth rates for area, yield and production during 1970s were non-significant as against 2.91, 2.78 and 5.99 per cent, respectively in the eighties. This clearly demonstrates that this shift from low to very high growth in the oilseeds sector is mainly due to development of technology and government support in terms of assured and higher market price which needs to be continued in future too.

Production of cotton, the major fibre crop, recorded relatively higher growth rate (5.89%) in the 1990s as compared to moderate growth rate of about 3.1 per cent in the seventies and eighties. Cotton also registered an impressive growth in its acreage during the nineties i.e. from zero per cent in the 1970s to 3.15 per cent in the 1990s. Growth in productivity of cotton was responsible for its superior performance in the seventies and eighties, while area expansion contributed overwhelmingly to growth in production of cotton during the nineties.

Sugarcane is another major commercial crop. Production of sugarcane expanded rapidly at the rate of 3.27 per cent in the 1980s both due to the expansion in area and yield per hectare but much more so due to increase in its acreage. In contrast to good performance of sugarcane during the seventies and eighties, it represents stagnant growth in its output in the nineties.

The results clearly show that all the major crops except coarse cereals and pulses experienced high growth rates (i.e., about 3 per cent or more) in their output in 1980s and the improvement in foodgrain production was mainly because of improvement in yield per hectare. Whereas in case of non-foodgrains, the increase in output was due to increase in both area and yield. During 1990s

only wheat crop registered a growth rate of more than 3 per cent per annum but this was lower than the growth rate achieved during the eighties. There has been a deceleration in growth performance of all food and non-food crops excepting cotton during the nineties as compared to the eighties.

In order to examine the hypothesis of acceleration or deceleration in growth during different sub-periods 't' test used for significance of the difference between the means of two independent samples was used. The results of this analysis are reproduced in Table 2.

Statistically significant positive values of mean difference between 'b' coefficients for the two periods indicate the acceleration in growth rate, whereas significant negative values indicate the phenomenon of deceleration. It may be observed that in 1980s the output of rice, total foodgrains, sugarcane, cotton, non-foodgrains as a group and all commodities increased significantly as compared to 1970s. In contrast, wheat registered a deceleration in growth of output during 1980s in comparison to the 1970s. However in 1990s all the crops except cotton witnessed a significant decline in output growth as compared to the 1980s.

#### ***Instability in crop production:***

Issues relating to fluctuations in agricultural production are important for several reasons. Wide fluctuations in agricultural production affect prices and bring about sharp fluctuations in prices. Many attempts were made earlier to measure the extent of instability in crop production. Notable among the recent studies are: Mehra (1981), Hazell (1982), Ray (1983), Parthasarathy (1984), Dev (1987), Dhawan (1987), Deshpande (1988), Mitra (1990). This section discusses the variations in instability indices during 1970s, 1980s, 1990s and for the entire period of the study pertaining to principal foodgrain and non-foodgrain crops and all commodities.

The results of estimated measures of instability of area, yield and production for principal foodgrain and non-foodgrain crops for the periods 1970-71 to 1980-81, 1980-81 to 1990-91, 1990-91 to 1995-96 and 1970-71 to 1995-96 are presented in Table 3. It may be observed that the output of pulses, sugarcane and cotton showed a greater degree of instability in first period.

The degree of instability in the output of majority of crops except coarse cereals, oilseeds and cotton was lower in the second period, i.e., in 1980s as compared to the first period. During 1990s coarse cereals witnessed increase in instability. The fluctuations in crop yields turned out to be the major factor responsible for this instability. It may also be observed from the table that the degree of instability was highest in case of oilseeds followed by cotton and coarse cereals and lowest for wheat during the period 1970-71 to 1995-96. The contribution of fluctuations in yield to output instability was higher as compared to fluctuations in area.

The increase in degree of instability in case of coarse cereals, pulses and oilseeds can be attributed to the fact that these crops are mostly grown as rainfed crops and are mainly dependent on rainfall. The percentage of irrigated area under coarse cereals, pulses and oilseeds is 10.3, 10.4 and 23.9 per cent, respectively as compared to about 47 per cent of rice area and more than 84 per cent of wheat area under irrigation.

The above discussion clearly demonstrate that the degree of instability as measured by the Cuddy-Della Valle Index for most of crops showed a declining trend in the eighties and nineties as compared to the seventies.

### III

#### Performance of Major Crops at State/Regional Level

##### *Trends in Production of Major Foodgrain and Non-Foodgrain Crops:*

The performance of agriculture differs quite widely across the states/regions. Therefore, to examine growth performance of major foodgrain and non-foodgrain crops in the 17 major producing states of India during 1970-71 to 1980-81 and 1980-81 to 1990-91 period, compound growth rates are computed separately for two periods. The results of this exercise are listed in Table 4. The results of state-wise analysis of foodgrain output show that for majority of the states the values of compound growth rates during 1980s are higher than the corresponding estimates for 1970s. This implies acceleration in output growth for foodgrains in 80s, though at different rates.

### *Northern Zone:*

Among the three main rice growing regions, viz., north, south and east, the introduction of HYVs led to increase in output of rice in north during the 1970s and in 1980s, the eastern region. The pattern of growth of production between north, east and south is also dissimilar. Growth of rice production decelerated in most of the states of north and south during the 1980s as compared to the 1970s, whereas the reverse has been the case with the eastern region.

In 1980s foodgrain output expanded at the rate of 4.39 per cent in Haryana, 4.35 per cent in Punjab, 3.68 per cent in Uttar Pradesh and remained stagnant with non-significant growth in Himachal Pradesh and Jammu & Kashmir. The comparison of growth performance of rice output between two periods clearly reveals deceleration in rice economy of the northern zone excepting Uttar Pradesh. In case of wheat an accelerated growth in output was noticed in Haryana and Jammu & Kashmir, while Punjab and Uttar Pradesh experienced deceleration in growth of wheat production during 1980s. Stagnancy or absolute decline in the production of coarse cereals during the 1980's was almost universal for all the states. Haryana performed extremely well with respect to growth in oilseed and cotton production. Punjab and Uttar Pradesh registered an impressive growth in production of cotton during 1980s.

### *Eastern Zone:*

There was a significant improvement in the growth performance of foodgrain production in all the states where zero growth rates during 1970s were replaced by higher growth rates in Bihar, Orissa, and West Bengal. Improvement was exceptionally high in West Bengal (from zero to 5.81%), followed by Bihar (0 to 3.69%), Orissa (0 to 2.77%), and Assam (1.54 to 1.79%). An examination of performance of major foodgrain and non-foodgrain crops showed an accelerated growth in rice production during eighties in comparison with 1970s. But improvement in growth of wheat production was recorded only in case of Bihar. As for coarse cereals, stagnancy in production was observed for all the states of eastern region during 1980s. The situation with respect to pulses was not very different from that of coarse cereals. Thus, the major contribution to relatively accelerated increase in foodgrain production was mainly from rice during eighties and from wheat during 70s.

Among the non-foodgrains, oilseeds performed extremely well with respect to growth in production. Growth rates of oilseed production varied from 1.91 per cent in Bihar to 13.21 per cent in case of West Bengal during 1980s. The growth rates of sugarcane production dropped significantly in Assam and Orissa in 1980s. Only Bihar represented a remarkable increase in sugarcane production in 1980s.

***Western Zone:***

Performance of foodgrains in this region was characterised by worsening of growth environment from the 1970s to the 1980s. The growth rate of foodgrain output declined from 9.81 per cent to zero per cent in Maharashtra. In Madhya Pradesh, zero growth rate realised in 1970s was replaced by a growth rate of 2.78 per cent in 1980s.

Oilseeds registered a high growth in production in 1980s with growth rates ranging from 5.14 per cent in Maharashtra to 16.54 per cent for Rajasthan. This represents a remarkable improvement in oilseeds production during the 1980s over the low growth in their output during 1970s. Performance of sugarcane was not satisfactory in 1980s. Only Madhya Pradesh, registered an increase in sugarcane production in the 1980s in comparison to 1970s. The growth rate of sugarcane declined from 8.86 per cent in 1970s to 6.06 per cent in 1980s in case of Gujarat State. On the whole the performance of agricultural sector was not satisfactory in the western region.

***Southern Zone:***

Performance of foodgrains in the Southern region too was characterised by deterioration in growth environment in 1980s as compared to 1970s. The foodgrain output increased at a low growth rate of 1.34 per cent in Andhra Pradesh, remained stagnant in Karnataka, declined significantly at a rate of 2.52 per cent in Kerala and increased at a high growth rate of 3.22 per cent in case of Tamilnadu in the 1980s. The performance of oilseeds in all the four states in the 1980s was satisfactory and much better than in the 1970s.

In order to assess the production performance of states in respect of rice, wheat and total foodgrains, the states were categorised into three categories based on the typology of growth: states reporting significant and positive trends in production; states reporting significant decline in production (i.e., those with negative and significant trends); states whose production is stagnant



(i.e., states with positive or negative trends but statistically non-significant). Classification of states based on the production performance of rice for 1970-71 to 1980-81 (1970s) and 1980-81 to 1990-91 (1980s) are presented in Table 5.

During 1970's Haryana, Jammu & Kashmir, Punjab, Assam, Maharashtra and Andhra Pradesh registered a significant increase in rice production and none of the state registered a decline in rice production. During the second period, the number of states showing a significant increase in rice production increased from six to ten. All the states of eastern zone reported a significant increase in rice production. Kerala had the dubious distinction of being the only state which recorded a significant decline in production of rice during 1980s, whereas in Himachal Pradesh, Jammu & Kashmir, Gujarat, Maharashtra, Rajasthan and Karnataka the rice production was stagnant during the same period. It is interesting to note that bulk of increase in rice production was accounted by the eastern states during 1980s.

Table 6 presents the relevant information for wheat crop with states classified as above for the 1970s and 1980s. As evident, during the 1970s, ten out of 15 states, recorded a significant increase in wheat output, where the number of states reporting a significant increase in wheat production during the 1980s declined to six. Karnataka registered a significant decline in wheat production. The performance of wheat in eastern region showed a stagnancy in wheat production. Gujarat and Maharashtra showing a significant increase in 1970s recorded a stagnancy in production. The above discussion clearly indicates that during the 1980s the performance of wheat was unsatisfactory in comparison with 1970s.

The classification of states based on their foodgrain production performance are presented in Table 7. During the 1970s out of 17 states only 6 states namely, Haryana, Punjab, Uttar Pradesh, Assam, Maharashtra and Andhra Pradesh registered a significant increase in foodgrain production. During the 1980's the number of states showing significant increase in foodgrain production increased to nine, which clearly indicates that the performance of foodgrains was better during the 1980s as compared to 1970s and the substantial improvement in growth performance of foodgrain production in the eastern region has been widely noted. In Kerala, a rapid growth of high value plantation crops has declined the output of staple food crops i.e., foodgrains.

### ***Instability in Foodgrain Production:***

The inter-state differences in the magnitude of instability for rice, wheat and total foodgrains for the 1970's and 1980's are presented in Table 8.

The estimated instability indices for the two periods reveal that there was a decline in instability in production of rice in most of states of northern and western zone excepting Himachal Pradesh in northern and Rajasthan in western region. However all the states in eastern region and Andhra Pradesh and Kerala in southern zone witnessed a marginal increase in the instability of rice production.

In case of wheat, instability was lower than rice and majority of the states witnessed a decline in instability of wheat output. The range of instability for total foodgrains varied from 3.60 in Punjab to as high as 29.0 in Gujarat. The estimates of instability for two periods reveal that there was a marginal decline in instability during 1980s as compared to the 1970s. However, it varied across states. Instability declined in some states (Haryana, Punjab, Uttar Pradesh, Bihar, Orissa, Madhya Pradesh, Maharashtra, and Tamilnadu), whereas in some other states (Himachal Pradesh, Jammu & Kashmir, West Bengal, Gujarat, Rajasthan, Andhra Pradesh, Karnataka and Kerala) it became progressively unstable. It is worth mentioning that foodgrain production in low irrigated states, viz., Himachal Pradesh, Gujarat, Rajasthan, Karnataka, etc., became more unstable in 1980s compared to the previous decade.

Table 9 which presents the distribution of states according to growth and instability in rice production during the two periods shows the picture more clearly. Of all the states, Jammu & Kashmir and Andhra Pradesh appear to be in the most favourable position in the 1970s whereas the number of states falling under this category increased to four (Punjab, Uttar Pradesh, Bihar and West Bengal) in the 1980s. These states fall under the range of high growth rate and low instability. The most undesirable situation is the stagnant or negative production associated with high instability. The number of states falling under this category decreased from three in 1970s to two in the 1980s. All other states were in the intermediate categories.

The grouping of states by instability indices and growth rates of wheat production are shown in Table 10. During 1970s, Haryana, Punjab, Uttar Pradesh, Orissa, Gujarat and Rajasthan are within the most favourable category of high growth rates and low instability. In contrast Bihar, West Bengal, Andhra Pradesh have stagnant or negative production associated with high instability, which is not a desirable situation. During the second period, the number of states falling in most favourable situation declined to five and that of in the most unfavourable position increased to five. These data clearly suggest that performance of wheat in 1980s is not satisfactory in comparison with 1970s.

In case of total foodgrains, only Punjab appears to be in the most favourable position during 1970s. It is the only state within the range of high growth rate and low instability. In contrast the number of states under this category increased to three (Haryana, Punjab and West Bengal) in 1980s. The most unfavourable situation is in the two states of western region, i.e., Gujarat and Rajasthan. In these states stagnant or negative growth rates are associated with high instability. The most problematic states which show low growth rates and high degree of instability are located in the low rainfall and less irrigated areas like Gujarat and Rajasthan. The above results clearly indicate that for most of the states there is a lower degree of instability in the 1980s as compared to the 70s.

#### ***Trends in Yields of Major Crops in Different Regions:***

The level of output growth rate is jointly determined by the growth rate in area and growth rate in yield. Therefore the growth rates of these two factors (yield and area) have been studied independently. Compound growth rates in respect of yield for important foodgrain and non-foodgrain crops across the states during the 1970s and 1980s are presented in Table 12.

#### ***Northern Zone:***

The growth rates for rice yields during the 1980s were significant and positive for Punjab (1.57%) and Uttar Pradesh (5.72) whereas in the 1970s Haryana, Punjab and Uttar Pradesh registered a significant positive growth in rice yield. There was a tendency of decline in growth of productivity in Haryana and Punjab during the 1980s compared to the 1970s. In case of wheat the growth rates of yields for the 1980s were higher in case of Haryana and Punjab as compared to 1970's. The yield of pulses showed an improvement in Haryana and Punjab in 1980's.

### ***Eastern Zone:***

Significant positive growth rates for total foodgrains during the 1980s in addition to of course rice and coarse cereals, vis-à-vis during 1970s suggest relative acceleration in growth of their yield in 1980s as against the 1970s for many states of the region. Wheat crop was lagging behind in the growth of yield per hectare. Pulses also registered an increase in their productivity in Bihar (2.27%) and West Bengal (2.57%) during the 1980s. The performance of oilseeds and sugarcane was also superior in the 1980s as compared to 1970s. The above results clearly show that a substantial improvement in the growth performance of agricultural sector in the eastern region was achieved during the 1980s.

### ***Western Zone:***

In 1980s Madhya Pradesh registered a significant increase in the yield of rice, wheat, pulses, total foodgrains, oilseeds and sugarcane and the growth rates seem to accelerate in the 1980s compared to 1970s. In Rajasthan yields of wheat, total foodgrains, oilseeds, and sugarcane were higher in the 1980s in comparison to the 1970s. On the contrary, in Maharashtra and Gujarat there was tendency of decline in growth rate of yield for most of the crops excepting pulses in Maharashtra and cotton in Gujarat.

### ***Southern Zone:***

Andhra Pradesh and Karnataka witnessed a decline in the yield of total foodgrains in the 1980s as compared to the 1970s, whereas the growth rates of yield in case of Kerala and Tamilnadu were higher in the 1980s compared to 1970s. Andhra Pradesh registered an increase in the yield of pulses and oilseeds during the 1980s, while Karnataka showed a deceleration in the growth rate of yields for all the crops during the 1980s. Tamilnadu showed a dramatic increase in the growth rates of yield of most of the crops during the 1980s.

### ***Growth in Acreage of Principal Crops at the State/Region Level:***

The compound growth rates of area under principal crops for the two periods: viz., 1970s and 1980s were calculated and are presented in Table 13.

### ***Northern Zone:***

During 1980s, growth in area under total foodgrains received a setback. The trend in area under foodgrains was significant and positive in Jammu and Kashmir (0.59 per cent) and Punjab (1.43 per cent) and non-significant in all other states. Comparison of growth rates between the 1970s and 1980s reveals a deceleration in growth of acreage in all the states. Compound growth rates of area under rice declined from 6.63 per cent in the 1970s to 2.72 per cent in the 1980s in Haryana and from 12.37 per cent to 5.24 per cent in Punjab. The area under wheat also declined in all the states excepting Jammu and Kashmir during the 1980s as compared to the 1970s. Similar trends were observed for coarse cereals and pulses. In Haryana, the growth rate of oilseeds moved up steeply from zero per cent in the seventies to 7.79 per cent in the eighties. The area under sugarcane remained stagnant in all the states excepting Uttar Pradesh.

### ***Eastern Zone:***

During 1980s the growth rate in area under total foodgrains was positive and statistically significant (0.92%) in case of West Bengal only. In case of Assam and Orissa, where area expansion in total foodgrains took place in the seventies, remained stagnant during the eighties. The comparison of growth rates of area under rice, wheat, coarse cereals, pulses and total foodgrains between the two periods shows that area expansion has slowed down during 1980s for majority of states.

### ***Western Region:***

The growth rates for rice area in the region were significantly lower during the 1980s than those of 1970s. The area under wheat declined significantly in Maharashtra (3.52 per cent) during the 1980s and remained stagnant in case of Gujarat, Madhya Pradesh, and Rajasthan. The area under coarse cereals also remained almost stagnant in the 1980s. Among the non-foodgrain crops oilseeds registered an increase in area during the 1980s in all the oilseeds registered an increase in area during the 1980s in all states excepting Gujarat. The comparison of growth rates for two periods show that the area expansion has increased during the 1980s. The total foodgrain acreage remained stagnant in the 1980s.

### ***Southern Zone:***

The growth in area under foodgrains received a severe set back in the 1980s with the negative trend emerging in Andhra Pradesh (1.65 per cent) and Kerala (3.92 per cent). The growth rate for rice

area also declined in Kerala and Tamilnadu and remained stagnant for Andhra Pradesh and Karnataka. During the 1980s, southern zone experienced significant absolute decline in area under foodgrains leading to negative growth in output of foodgrains. In contrast the area under oilseeds and sugarcane registered an increase in 1980s in comparison to the 1970s.

In order to analyse the relative contribution of area and yield towards the observed growth in the production of rice, wheat and total foodgrains, the states have been categorised into different groups on the basis of their growth trends: *states showing significant increase in area/yield* (those with positive and significant trends); *those representing significant decline in area/yield* (those with negative and significant growth rates); *state reporting stagnation in area/yield* (those with positive or negative growth rates but statistically non-significant).

Table 14 presents the relevant information for rice crop with states classified as above for the periods 1970s and 1980s. During the 1970s, out of 17 states only six states recorded a significant increase in yield. While the number of states reporting significant increase in yield increased to 10 in the 1980s. During the 1970s eight states reported a significant increase in area under rice, whereas the remaining nine states reported area to be more or less stagnant. During the 1980s there was a change in this scenario with only five out of seventeen reporting a significant increase in rice acreage. From the point of view of improvement in rice economy, the best situation is the first category with significant increase in area associated with significant increase in yield followed by stagnant area and significant increase in yield, whereas the situation of significant decline in both area and yield is the worst. None of the states was in the worst situation in both the periods. However, the number of states showing significant increase or stagnant acreage and significant increase in yield increased from five in the 1970s to eight in the 1980s, which indicates an acceleration in the rice output.

Table 15, shows that Haryana, Jammu & Kashmir, Punjab, Uttar Pradesh, Gujarat, Maharashtra, and Rajasthan reported a significant increase in area and yield of wheat during the 1970s. During the subsequent period there was a dramatic change in this scenario with only three states, viz., Haryana, Punjab and Bihar reporting a significant increase in both area and yield. During the 1980s, Orissa was in the most unfavourable situation of significant decline in area associated with significant decline in yield. All the states reported either significant increase or stagnation in the

acreage under wheat during the 1970s while Maharashtra, Andhra Pradesh and Karnataka witnessed a significant decline in the wheat area during the subsequent period.

From our analysis it seems that rice has performed better as compared to wheat in the 1980s as evinced by significant expansion of area under rice and improvement in the crop yields.

Table 16 presents the summary information of the growth performance of the states in respect of area and yields per hectare of total foodgrains, classified on the basis of criterion mentioned earlier. It is evident that during the 1970s, only six states recorded a significant increase in yield and significant increase or saturation in the acreage under total foodgrains. During the 1980s, it is gratifying to note that eleven out of seventeen states reported a significant increase in the yield. From the table it is clear that during 1970s expansion in area and improvement in yields were responsible for increase in foodgrains production. However, during the 1980s the improvement in foodgrain production was mainly due to improvement in crop productivity because only three states reported an increase in area under foodgrains. Kerala witnessed a significant decline in area under foodgrains during both the periods.

#### IV

#### Factors Influencing Agricultural Output

The preceding section indicates that the growth of agricultural sector has been uneven across regions and overtime. Whereas, in some states per hectare crop yields expanded significantly, in other states they declined and in still others yields were more or less stagnant. The question obvious arises as to what are the factors which influence the growth of agricultural sector in different regions. In this section, the influence of different factors on the crop yields will be analysed.

It is also important to examine the trends in crop yields and major yield increasing inputs, namely, irrigated area, area under HYVs and the average fertiliser consumption per hectare. Table 17 shows 1970-72 (triennium) to 1990-92 (triennium) trends in yield, irrigation level, and area covered by HYVs of rice. Fertiliser consumption is the average rate (nutrients) in kg per hectare of the total cropped area under all crops because cropwise consumption data is not available.

It is evident from the table that there has been an uninterrupted increase in the rice yield and use of all three inputs at all India level. The percentage of rice area irrigated increased from 39.2 in 1970-72 to 46.0 in 1990-92. The fertiliser consumption has increased more than four times during the same period. The area under HYVs also increased from 18.9 per cent in 1970-72 to 65.2 per cent in 1990-92 and nearly two-thirds of this increment came in the period between 1970-72 and 1980-82 which dominated growth in yield. This period accounts for more than 70 per cent of the increment in rice yield.

The results at disaggregate levels show that there are important differences among the different regions and also within the region. Haryana and Punjab have almost all the rice area under irrigation against less than 25 per cent in Assam, West Bengal, and Madhya Pradesh. Fertiliser consumption levels also vary widely between 8.9 kg per hectare in Assam and 163.4 kg per hectare in Punjab. Punjab ranks first in terms of yield per hectare among all the states.

All-India level average yield of wheat increased from 1319 kg. per hectare in 1970-72 to 2333 kg/ha in 1990-92 (Table 18). There has been a vast growth in the use of yield increasing inputs in case of wheat. The average yield of wheat in 1990-92 was about 77 per cent higher than in 1970-72. There has been significant increase in the area under irrigation and the coverage of HYVs. The area under irrigation increased from 54.4 per cent in 1970-72 to about 83 per cent in 1990-92. Punjab again ranks first with respect to wheat yield and the coverage of HYVs. Haryana comes next to Punjab.

The above results clearly reveal that the yield performance of rice and wheat in most of the states and all-India level has been quite impressive in the recent years. There is a clear evidence that the growth in the use of these inputs has significant impact on the performance of crops, but it needs a thorough investigation. Therefore, in order to examine the impact of important factors on the crop yields, production function technique has been used. Performance of agricultural sector depends on number of controlled and uncontrolled factors ranging from weather conditions to the use and optimal allocation of various inputs like irrigation, fertiliser, seeds, besides institutional support through government price policies and organised marketing and credit supply. In the present study, only important variables such as fertiliser consumption, area under irrigation and HYVs have been



taken into account to ascertain the impact of these variables on the crop yields. The scope of investigation has been restricted to rice and wheat only, because these are the major foodgrain crops.

The OLS estimates of rice yield response functions for the selected states during 1970-71 to 1992-93 are presented in Table 19. It is interesting to note that application of fertiliser has normally positive and statistically significant effect on yield rates of rice in all the states except Maharashtra where the coefficient was negative but non-significant. The increase in yield rate of rice due to one per cent increase in fertiliser ranges from 0.07 per cent in Karnataka to 0.44 per cent in Orissa. Fertiliser consumption in Orissa (21 kg/ha) seems to be quite low in the country. So an increase in application of fertiliser can ensure an increase in the quantum of production of rice. The HYVs variable is positive in some cases and negative in other cases; however the coefficient was positive and significant in case of Haryana and Maharashtra only. Irrigation plays an important role in determining the quantum of rice production. So far less than half of the rice area is under irrigation in the country. The irrigation variable has a positive and significant influence on rice yield in Uttar Pradesh, Karnataka and all-India level.

The OLS estimates of wheat yield response for major wheat producing states for the period under study, i.e., 1970-71 to 1992-93 are presented in Table 20. The results for all-India indicate that the fertiliser consumption and area under irrigation have significant and positive contribution towards the growth of wheat yield. The regression coefficient for fertiliser is found to be positive and statistically significant in all the states implying that there is still scope to increase the wheat yields by applying higher doses of fertilisers. The irrigation variable has positive impact on wheat yields in all the states except Punjab though it is significant in Uttar Pradesh, Rajasthan and all-India level. It is also observed that the HYVs variable has negative regression coefficients in some cases and positive in other cases but statistically non-significant.

## V

### **Summary and Conclusions**

The study of growth rates of production of major foodgrain and non-foodgrain crops indicate that the overall growth in agricultural production has been faster during the 1980s as compared to the

1970s. During the seventies both area and yield increases were witnessed whereas, during the eighties the major driving force behind the upward movement in the pace of growth was expansion in productivity. In contrast, non-foodgrains registered accelerated expansion in both area and yield per hectare. The pace of growth in yield per hectare of foodgrains increased significantly during the eighties as compared to 1970s. There has been a shift of land from foodgrains to non-foodgrains in the recent period. It is quite clear that the non-foodgrains acquired a distinct lead over foodgrains in India's agricultural growth during the eighties.

During the 1990s, there has been a deceleration in the growth performance of Indian agriculture. Growth in output of foodgrains decelerated in the nineties reaching a level of 1.88 per cent from its earlier level of 2.92 per cent realised in the eighties. The growth rate of non-foodgrains also declined from 4.16 per cent in the eighties to 3.91 per cent in nineties. Consequently, the growth in output of all commodities too decelerated in the nineties reaching the level of 2.67 per cent.

The analysis of pattern of acceleration or deceleration in output growth supported the hypothesis of significant acceleration in the production of foodgrain and non-foodgrain crops during the eighties as compared to the seventies. However during the nineties, significant deceleration in aggregate production in Indian agriculture was witnessed in comparison to the eighties. These results raise the doubt about achieving the 4.5 per cent growth rate in the agricultural sector during the Ninth Five Year Plan.

The results of instability indices show that the instability in production for the entire period 1970-71 to 1995-96 varied from 6.1 in case of wheat to as high as 16.34 in oilseeds. The estimated instability index for the three sub-periods revealed that there was a progressive but marginal decline in instability at all India level. Trends in instability for major foodgrain and non-foodgrain crops show that instability was lowest in case of wheat, followed by total foodgrains, rice and the highest in case of pulses during the seventies and oilseeds during the eighties and the nineties. The fluctuations in crop yields turned out to be the major factor responsible for this instability.

With regard to regional outlook the analysis indicate that the growth performance of Indian agriculture has varied from state to state and region to region. This has affected the overall national performance too depending upon the weightage of the states in the production of various

agricultural crops. Recent trends in production growth clearly indicate that in the northern region though high growth in foodgrain production at the rate of more than 4 per cent continued in the eighties, but the large incremental increase in output of atleast traditional crops seems unlikely due to saturation in productivity of major crops. Farm level evidences indicate that in Punjab and Haryana, yields of rice are catching up to the yield frontiers and that further exploitation of yield gap is not economical, as the incremental costs of further yield gains exceed incremental returns. Therefore, major attention must be focused on increasing annual crop production and income through diversification. This may involve partially replacing rice with other crops or enterprises, or both. There may be a greater promise in non-traditional crops such as fruits and vegetables but much will depend on the availability of economically more attractive competing options to rice and wheat and the how the food processing industries come up in the region.

In the eastern zone, all the major foodgrain growing states experienced a rapid improvement in foodgrains output growth. Absolute stagnation in yield and production of foodgrains in the seventies was replaced by growth rates closer to or higher than 3 per cent in all three important foodgrain growing states of the region, namely, Bihar, Orissa and West Bengal. This indicates that the policies to promote agricultural growth should increasingly focus on the problems and prospects of the eastern region, because this region has the comparative advantage in the production of foodgrains. A large part of this agricultural production in this region is under rainfed condition, therefore, irrigation development may be a laudable long run objective.

The performance of the western region has been most unsatisfactory during the eighties. This region is also predominantly dry farming region. One of the reasons for poor performance of agricultural sector in this region could be because the resources available were put to better use in other sectors of the economy since the sectors other than agriculture enjoy a comparative advantage in most of the states of this region.

The southern zone showed a mixed picture in respect of performance of agricultural sector. Kerala recorded a downturn in foodgrain production and this was mainly caused by shift of area away from staple foodcrops to the high value plantation crops. Therefore, the scarce resources should be allocated to the crops other than food crops.

Trends in instability for rice, wheat and total foodgrains across states show that the instability for rice and total foodgrains declined in some states and increased in some other states. On the contrary, it declined in most of the states for wheat. Instability of total foodgrain production reveal that nine states, namely, Haryana, Punjab, Uttar Pradesh, Assam, Bihar, Orissa, Madhya Pradesh Maharashtra and Tamilnadu recorded a declining trend, while an upward trend was observed in rest of the states. Analysis on the relationship between growth and instability revealed that there is no significant relationship between growth rates of production and instability. Therefore, there is no basis to believe that high growth causes high instability.

Yield response analysis revealed that in the states where there has been a significant increase in yield of rice and wheat, fertiliser consumption played a major role in the variation of yield in all the states. In case of rice, the regression coefficients of irrigation were significant for Uttar Pradesh, Karnataka and all India level, whereas in case of wheat it was significant for Uttar Pradesh and Rajasthan. The effect of HYVs was not significant in case of wheat for all the states because the coverage of HYVs in wheat has reached almost the saturation level. Therefore an increase in application of fertiliser and irrigation facilities can ensure an increase in the quantum of crop production.

Based on the above findings one thing is clear that improvement in crop yields will have to be the main part of any growth in agricultural production in future since there is a little likelihood of any significant increase in new cultivated area. The area shifts are possible only within agricultural crops. Reclamation of wastelands, on sustainable basis, is only the way to increase the total arable area but the experiences with reclamation of wastelands for agricultural purposes have not been very encouraging. The recent trends in production growth clearly indicate that programmes and policies to promote agricultural growth should primarily focus on the problems and prospects of the eastern region of the country. Further the growth performance of agriculture in the nineties indicate that the target of 4.5 per cent growth rate proposed for agriculture seems difficult to achieve unless policies and programmes for broadening the base of agricultural growth are strengthened. In this context, role of physical and infrastructure facilities such as rural roads, irrigation and other inputs, better extension services and input delivery system, better marketing facilities, watershed management etc. for the development of agriculture and rural sector needs to be strengthened.

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**TABLE 1. ALL INDIA COMPOUND GROWTH RATES OF AREA, YIELD AND PRODUCTION OF MAJOR FOODGRAIN AND NON-FOODGRAIN CROPS**

Crops	1970-71 to 1980-81			1980-81 to 1990-91			1990-91 to 1995-96			1970-71 to 1995-96		
	Area	Yield	Production	Area	Yield	Production	Area	Yield	Production	Area	Yield	Production
Rice	0.83 <sup>*</sup>	1.44 <sup>***</sup>	2.29 <sup>**</sup>	0.53 <sup>***</sup>	3.21 <sup>*</sup>	3.76 <sup>*</sup>	0.13	1.91 <sup>**</sup>	2.06 <sup>*</sup>	0.54 <sup>*</sup>	2.47 <sup>*</sup>	3.02 <sup>*</sup>
Wheat	2.28 <sup>*</sup>	2.20 <sup>**</sup>	4.53 <sup>*</sup>	0.50	3.15 <sup>*</sup>	3.68 <sup>*</sup>	1.44 <sup>***</sup>	1.93 <sup>***</sup>	3.44 <sup>*</sup>	1.24 <sup>*</sup>	3.11 <sup>*</sup>	4.38 <sup>*</sup>
Coarse Cereals	-0.81 <sup>*</sup>	1.85 <sup>**</sup>	1.27	-1.31 <sup>*</sup>	2.13 <sup>**</sup>	0.70	-2.35	1.67	-0.72	-1.31 <sup>*</sup>	1.92 <sup>*</sup>	1.01
Pulses	0.38	-0.80	-0.42	0.23	1.63 <sup>*</sup>	1.87 <sup>**</sup>	-0.31	0.62	0.35	0.11	0.90 <sup>*</sup>	0.99 <sup>*</sup>
<b>Total Foodgrains</b>	<b>0.41<sup>***</sup></b>	<b>1.85<sup>*</sup></b>	<b>2.28<sup>*</sup></b>	<b>-0.13</b>	<b>3.07<sup>*</sup></b>	<b>2.92<sup>*</sup></b>	<b>-0.37</b>	<b>2.26<sup>*</sup></b>	<b>1.88<sup>**</sup></b>	<b>-0.01</b>	<b>2.71<sup>*</sup></b>	<b>2.70<sup>*</sup></b>
Oilseeds	0.48	0.17	0.66	2.91 <sup>*</sup>	2.78 <sup>**</sup>	5.99 <sup>*</sup>	1.23	2.82 <sup>**</sup>	4.09 <sup>*</sup>	2.09 <sup>*</sup>	2.04 <sup>*</sup>	4.18 <sup>*</sup>
Sugarcane	1.29 <sup>***</sup>	2.61 <sup>*</sup>	2.24 <sup>***</sup>	1.75 <sup>**</sup>	0.99	3.26 <sup>*</sup>	1.54	1.41	3.06	1.66 <sup>*</sup>	1.50 <sup>*</sup>	3.19 <sup>*</sup>
Cotton	0.41	2.72 <sup>**</sup>	3.11 <sup>**</sup>	-0.96 <sup>***</sup>	4.15 <sup>*</sup>	3.15 <sup>***</sup>	3.15 <sup>*</sup>	2.71	5.89 <sup>*</sup>	0.04	2.88 <sup>*</sup>	2.94 <sup>*</sup>
Non-food Crops	1.05 <sup>*</sup>	0.98 <sup>*</sup>	2.04 <sup>*</sup>	1.46 <sup>*</sup>	2.94 <sup>*</sup>	4.16 <sup>*</sup>	1.63 <sup>*</sup>	2.03 <sup>*</sup>	3.91 <sup>*</sup>	1.46 <sup>*</sup>	1.98 <sup>*</sup>	3.44 <sup>*</sup>
All Commodities	0.56 <sup>**</sup>	1.20 <sup>*</sup>	2.10 <sup>*</sup>	0.26	3.02 <sup>*</sup>	3.46 <sup>*</sup>	0.18	1.81 <sup>*</sup>	2.67 <sup>*</sup>	0.36 <sup>*</sup>	2.01 <sup>*</sup>	2.98 <sup>*</sup>

\* : Significant at 1 per cent level; \*\* : Significant at 5 per cent level; \*\*\* : Significant at 10 per cent level.



**TABLE 2. SIGNIFICANCE OF GROWTH RATES IN PRODUCTION OF MAJOR FOODGRAIN AND NON-FOODGRAIN CROPS IN INDIA**

Crops	1970-71 to 1980-81		1980-81 to 1990-91		1990-91 to 1995-96		Change in 1980's over 1970's	Change in 1990's over 1980's
	$b^{(a)}$	SE ( $b_1$ )	$b^{(a)}$	SE ( $b_2$ )	$b^{(a)}$	SE ( $b_3$ )		
Rice	0.0226	0.0094	0.0369	0.0075	0.0204	0.0079	A (3.9439*)	D (5.1421*)
Wheat	0.0443	0.0085	0.0361	0.0053	0.0338	0.0080	D (2.7150**)	D (0.6326)
<b>Total Foodgrains</b>	<b>0.0225</b>	<b>0.0076</b>	<b>0.0288</b>	<b>0.0056</b>	<b>0.0186</b>	<b>0.0074</b>	<b>A (2.2133**)</b>	<b>D (3.4609*)</b>
Oilseeds	-	-	0.0582	0.0130	0.0404	0.0059	-	D (3.8690*)
Sugarcane	0.0222	0.0104	0.0321	0.0073	0.0301	0.0193	A (2.5841**)	D (0.2445)
Cotton	0.0306	0.0113	0.0310	0.0152	0.0572	0.0123	A (0.0700)	A (3.8538*)
<b>Total Non-Foodgrains</b>	<b>0.0202</b>	<b>0.0051</b>	<b>0.0408</b>	<b>0.0066</b>	<b>0.0202</b>	<b>0.0051</b>	<b>A (8.1913*)</b>	<b>D (7.2262*)</b>
<b>All Commodities</b>	<b>0.0208</b>	<b>0.0065</b>	<b>0.0340</b>	<b>0.0055</b>	<b>0.0208</b>	<b>0.0065</b>	<b>A (5.1416*)</b>	<b>D (4.2183*)</b>

A: Acceleration in growth rates; D: Deceleration in growth rates

@ : Where trend growth rates are significant in both the sub-periods; Figures in parentheses are the 't' values

\* Significant at 1 per cent level; \*\* Significant at 5 per cent level; \*\*\* Significant at 10 per cent level

**TABLE 3. INSTABILITY IN AREA, YIELD AND PRODUCTION OF MAJOR FOODGRAIN AND NON-FOODGRAIN CROPS IN INDIA**

Crops	1970-71 to 1980-81		1980-81 to 1990-91		1990-91 to 1995-96		1970-71 to 1995-96	
	Area	Yield Production	Area	Yield Production	Area	Yield Production	Area	Yield Production
Rice	1.64	7.58 9.05	2.61	4.75 6.89	0.73	1.80 2.54	2.17	6.70 8.13
Wheat	3.61	5.53 7.87	2.75	3.27 4.94	1.83	2.29 2.44	4.02	5.07 6.16
Coarse Cereals	2.55	6.53 9.47	2.40	8.75 9.39	2.35	16.10 15.55	3.45	11.79 11.71
Pulses	3.89	8.56 11.05	3.01	4.49 6.91	3.31	3.28 5.55	3.88	7.28 8.93
<b>Total Foodgrains</b>	<b>1.92</b>	<b>5.85</b> <b>7.26</b>	<b>2.02</b>	<b>3.77</b> <b>5.39</b>	<b>1.43</b>	<b>0.99</b> <b>2.16</b>	<b>2.39</b>	<b>5.41</b> <b>6.11</b>
Oilseeds	2.65	7.90 9.44	4.39	10.05 12.96	3.04	3.30 2.47	7.79	9.44 16.34
Sugarcane	7.28	4.02 10.02	6.67	6.36 7.15	4.41	2.02 7.88	6.77	8.27 9.70
Cotton	4.14	8.37 10.28	4.93	10.88 14.63	2.68	3.87 5.78	3.28	10.88 14.29

**TABLE 4. STATEWISE COMPOUND GROWTH RATES OF PRODUCTION OF MAJOR FOODGRAIN AND NON-FOODGRAIN CROPS** (per cent)

States/Region	Rice		Wheat		Coarse Cereals		Pulses		Total Foodgrain		Oilseeds		Sugarcane	
	70s	80s	70s	80s	70s	80s	70s	80s	70s	80s	70s	80s	70s	80s
<b>Northern Zone</b>														
Haryana	11.52	3.03	5.37	5.93	-5.45	-2.00	-0.89	1.33	3.75	4.39	1.29	16.01	-1.46	3.02
Himachal Pradesh	0.04	-1.07	1.85	3.58	1.36	1.73	-1.44	-4.20	1.25	2.06	4.45	-2.62	(a)	(a)
Jammu & Kashmir	3.78	-0.56	3.55	3.70	1.86	-0.31	0.67	-4.13	2.86	0.20	7.58	-6.72	(a)	(a)
Punjab	17.74	6.46	4.65	4.17	-3.95	-6.52	-3.12	-4.63	5.79	4.35	-5.02	-1.96	-0.46	2.32
Uttar Pradesh	2.83	5.99	5.97	3.54	-3.80	1.72	-3.08	0.67	2.24	3.68	-1.76	-3.48	2.46	3.83
<b>Eastern Zone</b>														
Assam	1.69	1.67	12.06	-2.05	7.59	0.56	2.09	0.31	1.54	1.79	4.63	3.92	5.22	-2.22
Bihar	1.12	4.37	1.93	4.70	2.85	1.34	-2.02	0.99	0.84	3.69	0.60	1.91	-4.13	6.43
Orissa	-0.53	3.80	13.26	-8.67	6.08	-1.87	6.38	2.01	0.88	2.77	5.39	5.88	5.50	0.51
West Bengal	1.02	6.38	-1.28	1.40	0.06	3.09	-2.50	-1.34	0.97	5.81	8.57	13.21	-3.68	-2.74
<b>Western Zone</b>														
Gujarat	4.36	1.11	5.74	-3.46	0.72	-4.20	5.41	2.51	2.58	-2.60	6.97	-1.07	8.86	6.06
Madhya Pradesh	-1.17	2.90	0.98	4.48	-0.38	0.84	0.36	2.16	-0.50	2.78	1.16	13.78	-1.73	2.51
Maharashtra	6.16	0.44	11.39	-1.15	12.07	2.48	4.41	6.25	9.81	2.09	5.08	5.14	7.37	2.09
Rajasthan	3.76	-2.48	4.60	-3.26	-4.71	2.71	-0.14	-1.81	-0.46	2.20	-2.05	16.54	1.61	-5.39
<b>Southern Zone</b>														
Andhra Pradesh	4.35	2.80	-2.42	-2.37	2.51	-4.48	-0.54	4.76	3.55	1.39	-2.79	8.22	-0.44	-0.55
Karnataka	1.45	0.59	6.17	-5.81	1.67	0.71	4.13	0.18	1.19	2.39	0.04	7.63	3.54	5.24
Kerala	-0.30	-2.81	(a)	(a)	(a)	(a)	4.04	-1.66	-0.48	-2.52	-2.23	-1.96	(a)	(a)
Tamilnadu	-0.63	3.55	-0.12	11.71	0.74	0.92	2.62	9.87	-0.22	3.22	-2.56	4.12	4.95	3.90

(a) : Not a major crop

**TABLE 5. CLASSIFICATION OF STATES ACCORDING TO GROWTH TRENDS IN RICE PRODUCTION DURING SEVENTIES AND EIGHTIES**

<i>Typology of growth</i>	<i>1970-71 to 1980-81</i>	<i>1980-81 to 1990-91</i>
<i>Significant increase in production</i>	Haryana, Jammu & Kashmir, Punjab, Assam, Maharashtra, Andhra Pradesh	Haryana, Punjab, Uttar Pradesh, Assam, Bihar, Orissa, West Bengal, Madhya Pradesh, Andhra Pradesh, Tamilnadu
<i>Significant decline in production</i>	Nil	Kerala
<i>Stagnant production</i>	Himachal Pradesh, Uttar Pradesh, Bihar, Orissa, West Bengal, Gujarat, Madhya Pradesh, Rajasthan, Karnataka, Kerala	Himachal Pradesh, Jammu & Kashmir, Gujarat, Maharashtra, Rajasthan, Karnataka

**TABLE 6. CLASSIFICATION OF STATES ACCORDING TO GROWTH TRENDS IN WHEAT PRODUCTION DURING SEVENTIES AND EIGHTIES**

<i>Typology of growth</i>	<i>1970-71 to 1980-81</i>	<i>1980-81 to 1990-91</i>
<i>Significant increase in production</i>	Haryana, Jammu & Kashmir, Punjab, Uttar Pradesh, Assam, Orissa, Gujarat, Maharashtra, Rajasthan, Karnataka	Haryana, Punjab, Jammu & Kashmir, Uttar Pradesh, Madhya Pradesh, Rajasthan
<i>Significant decline in production</i>	Nil	Karnataka
<i>Stagnant production</i>	Himachal Pradesh, Bihar, West Bengal, Madhya Pradesh, Andhra Pradesh	Himachal Pradesh, Assam, Bihar, Orissa, West Bengal, Gujarat, Maharashtra, Andhra Pradesh

**TABLE 7. CLASSIFICATION OF STATES ACCORDING TO GROWTH TRENDS IN FOOD GRAIN PRODUCTION DURING SEVENTIES AND EIGHTIES**

<i>Typology of growth</i>	<i>1970-71 to 1980-81</i>	<i>1980-81 to 1990-91</i>
<i>Significant increase in production</i>	Haryana, Punjab, Uttar Pradesh, Assam, Maharashtra, Andhra Pradesh	Haryana, Punjab, Uttar Pradesh, Assam, Bihar, Orissa, West Bengal, Madhya Pradesh, Tamilnadu
<i>Significant decline in production</i>	Nil	Kerala
<i>Stagnant production</i>	Himachal Pradesh, Jammu & Kashmir, Bihar, Orissa, West Bengal, Gujarat, Madhya Pradesh, Rajasthan, Karnataka, Kerala, Tamilnadu	Himachal Pradesh, Jammu & Kashmir, Gujarat, Maharashtra, Rajasthan, Andhra Pradesh, Karnataka

**TABLE 8. INSTABILITY IN PRODUCTION OF RICE, WHEAT AND TOTAL FOODGRAINS IN DIFFERENT STATES OF INDIA**

<i>Regions/ States</i>	<i>1970-71 to 1980-81</i>			<i>1980-81 to 1990-91</i>		
	<i>Rice</i>	<i>Wheat</i>	<i>Total Foodgrains</i>	<i>Rice</i>	<i>Wheat</i>	<i>Total Foodgrains</i>
<b><i>Northern Zone</i></b>						
<i>Haryana</i>	18.44	11.75	13.05	11.64	5.97	9.30
<i>Himachal Pradesh</i>	14.28	20.10	8.18	16.42	18.94	12.04
<i>Jammu &amp; Kashmir</i>	10.72	9.08	6.18	8.13	11.77	8.75
<i>Punjab</i>	14.40	6.42	7.96	8.56	4.66	3.60
<i>Uttar Pradesh</i>	20.71	12.59	12.13	9.32	5.04	4.92
<b><i>Eastern Zone</i></b>						
<i>Assam</i>	7.19	44.09	7.75	8.11	12.99	7.26
<i>Bihar</i>	12.57	21.20	9.88	14.73	5.69	8.75
<i>Orissa</i>	14.14	22.12	14.42	15.85	14.04	12.95
<i>West Bengal</i>	8.88	23.11	8.02	10.34	20.95	9.40
<b><i>Western Zone</i></b>						
<i>Gujarat</i>	32.23	14.02	20.40	29.24	31.76	29.00
<i>Madhya Pradesh</i>	21.57	15.49	12.68	11.97	8.88	7.08
<i>Maharashtra</i>	18.84	24.84	35.24	12.92	20.43	13.60
<i>Rajasthan</i>	33.01	9.79	17.51	35.44	12.76	20.31
<b><i>Southern Zone</i></b>						
<i>Andhra Pradesh</i>	10.98	31.55	8.74	13.09	32.16	10.38
<i>Karnataka</i>	11.00	27.13	14.54	8.06	16.87	18.13
<i>Kerala</i>	2.95	-	2.81	4.22	-	4.02
<i>Tamilnadu</i>	13.92	-	13.10	10.16	-	9.40

**TABLE 9. CLASSIFICATION OF STATES ACCORDING TO GROWTH AND INSTABILITY IN PRODUCTION OF RICE**

<i>Growth rate/ Instability</i>	1970-71 to 1980-81			1980-81 to 1990-91		
	<i>Instability less than 15</i>	<i>Between 15 and 20</i>	<i>More than 20</i>	<i>Instability less than 15</i>	<i>Between 15 and 20</i>	<i>More than 20</i>
<i>Stagnant or negative production</i>	Himachal Pradesh, Bihar, Orissa, West Bengal, Karnataka, Kerala, Tamilnadu	Nil	Gujarat	Maharashtra	Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala	Gujarat, Rajasthan
<i>Growth rate of less than 2 per cent</i>	Assam	Nil	Nil	Assam	Nil	Nil
<i>Between 2 per cent and 4 per cent</i>	Nil	Nil	Uttar Pradesh, Rajasthan, Madhya Pradesh	Andhra Pradesh, Haryana, Tamilnadu, Madhya Pradesh	Orissa	Nil
<i>Above 4 per cent</i>	Jammu & Kashmir, Andhra Pradesh	Haryana, Punjab	Maharashtra	Punjab, Uttar Pradesh, Bihar, West Bengal	Nil	Nil

**TABLE 10. CLASSIFICATION OF STATES ACCORDING TO GROWTH AND INSTABILITY IN PRODUCTION OF WHEAT**

Growth rate/ Instability	1970-71 to 1980-81			1980-81 to 1990-91		
	Instability less than 15	Between 15 and 20	More than 20	Instability less than 15	Between 15 and 20	More than 20
Stagnant or negative production	Nil	Himachal Pradesh, Madhya Pradesh	Bihar, West Bengal, Andhra Pradesh	Assam	Himachal Pradesh, Rajasthan, Karnataka	West Bengal, Gujarat, Maharashtra, Andhra Pradesh
Growth rate of less than 2 per cent	Nil	Nil	Nil	Nil	Nil	Nil
Between 2 per cent and 4 per cent	Jammu & Kashmir	Nil	Nil	Jammu & Kashmir, Uttar Pradesh	Nil	Nil
Above 4 per cent	Haryana, Punjab, Uttar Pradesh, Orissa, Gujarat, Rajasthan	Nil	Assam, Maharashtra, Karnataka	Haryana, Punjab, Bihar, Madhya Pradesh	Nil	Nil



**TABLE 11. CLASSIFICATION OF STATES ACCORDING TO GROWTH AND INSTABILITY IN PRODUCTION OF TOTAL FOODGRAINS**

Growth rate/ Instability	1970-71 to 1980-81			1980-81 to 1990-91		
	Instability less than 15	Between 15 and 20	More than 20	Instability less than 15	Between 15 and 20	More than 20
<i>Stagnant or negative production</i>	Himachal Pradesh, Jammu & Kashmir, Bihar, Orissa, West Bengal	Madhya Pradesh, Rajasthan, Karnataka, Kerala, Tamilnadu	Gujarat	Himachal Pradesh, Jammu & Kashmir, Maharashtra, Andhra Pradesh, Kerala	Karnataka	Gujarat, Rajasthan
<i>Growth rate of less than 2 per cent</i>	Assam	Nil	Nil	Assam	Nil	Nil
<i>Between 2 per cent and 4 per cent</i>	Haryana, Uttar Pradesh, Andhra Pradesh	Nil	Nil	Uttar Pradesh, Bihar, Orissa, Madhya Pradesh, Tamilnadu	Nil	Nil
<i>Above 4 per cent</i>	Punjab	Nil	Maharashtra	Haryana, Punjab, West Bengal	Nil	Nil

(per cent)

States/ Region	Rice		Wheat		Coarse Cereals		Pulses		Total Foodgrain		Oilseeds		Sugarcane	
	70s	80s	70s	80s	70s	80s	70s	80s	70s	80s	70s	80s	70s	80s
<b>Northern Zone</b>														
Haryana	4.57 <sup>*</sup>	0.31	2.36 <sup>**</sup>	4.05 <sup>*</sup>	-3.70 <sup>***</sup>	1.88	3.60	5.14 <sup>***</sup>	3.32 <sup>**</sup>	4.90 <sup>*</sup>	1.05	6.90 <sup>*</sup>	-1.92	3.03 <sup>**</sup>
Himachal Pradesh	0.19	0.43	0.88	2.97	0.57	1.40	-0.89	-2.11	0.60	1.95	3.74	-1.40	(a)	(a)
Jammu & Kashmir	1.46	-0.50	2.53 <sup>**</sup>	1.68	2.08 <sup>**</sup>	-0.91	-0.19	-1.32	1.96 <sup>*</sup>	-0.38	3.60 <sup>**</sup>	-9.23 <sup>*</sup>	(a)	(a)
Punjab	4.71 <sup>*</sup>	1.57 <sup>***</sup>	2.26 <sup>*</sup>	2.92 <sup>*</sup>	1.08	0.77	-1.63	3.07 <sup>**</sup>	3.17 <sup>*</sup>	2.91 <sup>*</sup>	-0.62	2.68 <sup>*</sup>	3.09 <sup>*</sup>	0.37
Uttar Pradesh	1.29 <sup>**</sup>	5.72 <sup>*</sup>	2.81 <sup>**</sup>	2.76 <sup>*</sup>	-1.05	3.83 <sup>*</sup>	-0.56	0.32	1.92	3.61 <sup>*</sup>	-1.85	5.39 <sup>*</sup>	0.49	1.99 <sup>*</sup>
<b>Eastern Zone</b>														
Assam	0.27	0.97	1.81	-0.64	0.86 <sup>*</sup>	0.35 <sup>*</sup>	-0.08	0.48	-0.13	1.21 <sup>***</sup>	0.10	0.59	-1.15 <sup>**</sup>	0.78
Bihar	0.48	4.37 <sup>*</sup>	-0.06	2.68 <sup>*</sup>	4.37	5.51 <sup>*</sup>	-0.13	2.27 <sup>*</sup>	0.76	3.70 <sup>*</sup>	0.14	2.84 <sup>*</sup>	-1.70 <sup>***</sup>	5.18 <sup>*</sup>
Orissa	0.45	3.38 <sup>**</sup>	1.27	-1.58 <sup>*</sup>	-1.28	2.29 <sup>**</sup>	1.43	-0.01	0.66	2.21	-3.01 <sup>*</sup>	1.44 <sup>*</sup>	0.46	1.11 <sup>*</sup>
West Bengal	1.29	5.05 <sup>*</sup>	-2.64 <sup>**</sup>	-0.63	2.93 <sup>*</sup>	4.59 <sup>***</sup>	-0.92	2.57 <sup>*</sup>	1.07	4.84 <sup>*</sup>	3.17 <sup>*</sup>	7.25 <sup>*</sup>	1.25	2.42 <sup>*</sup>
<b>Western Zone</b>														
Gujarat	3.87	0.52	2.03 <sup>**</sup>	-0.38	2.92	-1.84	1.67	-0.06	3.24	-1.33	3.94	-0.25	1.82 <sup>*</sup>	6.53 <sup>**</sup>
Madhya Pradesh	-2.16	2.46 <sup>**</sup>	1.01	3.91 <sup>*</sup>	-0.29	2.78	-2.68 <sup>**</sup>	2.43 <sup>*</sup>	-0.53	3.08 <sup>*</sup>	1.09	6.29 <sup>*</sup>	-0.70	2.86 <sup>*</sup>
Maharashtra	4.50 <sup>***</sup>	0.29	7.43 <sup>*</sup>	2.45	10.47 <sup>*</sup>	2.44	1.62	4.06 <sup>*</sup>	7.80 <sup>*</sup>	1.84	2.62	1.42	3.33 <sup>*</sup>	-1.21 <sup>*</sup>
Rajasthan	-1.09	1.89	1.54 <sup>**</sup>	4.05 <sup>*</sup>	-3.16	3.12	0.35	0.23	0.14	3.13 <sup>***</sup>	-1.05	6.64 <sup>*</sup>	-0.26	1.91 <sup>***</sup>
<b>Southern Zone</b>														
Andhra Pradesh	2.65 <sup>*</sup>	2.00 <sup>*</sup>	-1.71	3.99	4.16 <sup>*</sup>	1.85 <sup>***</sup>	-0.52	3.70 <sup>*</sup>	3.70 <sup>*</sup>	3.11 <sup>*</sup>	0.10	2.82 <sup>**</sup>	-0.92	-1.33 <sup>**</sup>
Karnataka	1.56 <sup>***</sup>	0.20	4.78 <sup>***</sup>	-1.34	2.06 <sup>**</sup>	0.32	1.62	-0.68	1.68 <sup>***</sup>	0.16	-0.86	-0.72	-1.43 <sup>**</sup>	0.08
Kerala	0.80 <sup>**</sup>	1.30 <sup>*</sup>	(a)	(a)	(a)	(a)	4.93 <sup>*</sup>	1.82 <sup>*</sup>	0.69 <sup>***</sup>	1.46 <sup>*</sup>	-3.83 <sup>*</sup>	-1.10	(a)	(a)
Tamilnadu	-0.05	5.83 <sup>*</sup>	(a)	(a)	2.60 <sup>**</sup>	2.72 <sup>**</sup>	1.72	4.35 <sup>*</sup>	0.72	4.01 <sup>*</sup>	-0.33	2.16 <sup>**</sup>	2.59 <sup>*</sup>	0.99

TABLE 13. STATEWISE COMPOUND GROWTH RATES OF AREA OF MAJOR FOODGRAIN AND NON-FOODGRAIN CROPS

States/Region	Rice		Wheat		Coarse Cereals		Pulses		Total Foodgrain		Oilseeds		Sugar cane	
	70s	80s	70s	80s	70s	80s	70s	80s	70s	80s	70s	80s	70s	80s
<b>Northern Zone</b>														
Haryana	6.63	2.72	2.95	1.81	-1.37	-3.81	-3.38	-3.62	0.34	0.47	0.74	7.97	0.47	0.38
Himachal Pradesh	-0.23	-1.48	0.95	0.60	0.78	0.33	-0.56	-2.16	0.63	0.10	0.68	-0.46	(a)	(a)
Jammu & Kashmir	2.29	-0.07	0.98	2.09	-0.21	0.60	0.84	-2.85	0.88	0.59	3.84	2.79	(a)	(a)
Punjab	12.37	5.24	2.33	1.22	-4.97	-7.23	-0.85	-7.52	2.44	1.43	-4.43	-4.52	-3.46	1.95
Uttar Pradesh	1.55	0.26	2.98	0.76	-2.77	-2.03	-2.54	0.87	0.29	0.15	0.07	-8.42	1.12	1.82
<b>Eastern Zone</b>														
Assam	1.42	0.69	10.09	-1.42	6.68	0.20	2.17	-0.16	1.67	0.56	4.52	3.31	4.42	-2.99
Bihar	0.63	0.37	1.99	1.96	-1.46	-3.93	-1.88	-0.98	0.08	-0.01	0.46	-0.92	-2.46	1.19
Orissa	-0.97	0.46	12.40	-7.21	7.45	-4.06	7.99	2.02	1.55	0.37	8.65	4.38	5.01	-0.59
West Bengal	-0.00	1.27	1.40	2.04	-2.80	-1.82	-1.61	-3.80	-0.09	0.92	5.24	5.56	-4.86	-5.04
<b>Western Zone</b>														
Gujarat	0.47	-0.99	3.69	-3.09	4.69	-2.04	3.68	2.58	-3.05	-0.69	2.92	-0.83	6.91	2.11
Madhya Pradesh	0.90	0.42	-0.03	0.54	0.05	0.04	1.04	-0.22	0.52	-0.31	0.06	7.05	-1.62	-0.35
Maharashtra	1.59	0.16	3.69	-3.52	1.45	-1.92	2.74	1.91	1.87	0.24	2.41	3.68	3.91	3.33
Rajasthan	4.91	-2.93	2.98	-0.76	-1.62	-0.39	-0.63	-2.05	-0.61	-0.90	-0.99	9.30	1.87	-6.89
<b>Southern Zone</b>														
Andhra Pradesh	1.58	0.78	-0.72	-6.12	-1.63	-6.15	-0.03	1.02	-0.17	-1.65	-2.89	5.26	0.48	0.74
Karnataka	-0.11	0.38	1.32	-4.49	-0.49	0.41	2.47	0.87	0.22	0.32	0.91	7.51	5.04	5.16
Kerala	-1.08	-4.04	(a)	(a)	(a)	(a)	-0.86	-3.35	-1.15	-3.92	1.65	-0.87	(a)	(a)
Tamilnadu	-0.59	-2.16	(a)	(a)	-1.82	-1.69	0.86	5.28	-0.87	-0.76	-2.23	1.92	2.28	2.87

**TABLE 14. CLASSIFICATION OF STATES ACCORDING TO GROWTH TRENDS IN AREA AND YIELD PER HECTARE OF RICE**

<i>States showing</i>	<i>1970-71 to 1980-81</i>			<i>1980-81 to 1990-91</i>		
	<i>Significant increase in yield</i>	<i>Significant decline in yield</i>	<i>Stagnant yield</i>	<i>Significant increase in yield</i>	<i>Significant decline in yield</i>	<i>Stagnant yield</i>
<i>Significant increase in area</i>	Haryana, Punjab, Uttar Pradesh, Maharashtra	Nil	Jammu & Kashmir, Assam, Madhya Pradesh, Rajasthan	Punjab, West Bengal, Madhya Pradesh	Nil	Haryana, Assam
<i>Significant decline in area</i>	Kerala	Nil	Orissa	Kerala, Tamilnadu	Nil	Himachal Pradesh
<i>Area Stagnant</i>	Karnataka	Nil	Himachal Pradesh, Bihar, West Bengal, Gujarat, Tamilnadu	Uttar Pradesh, Bihar, West Bengal, Orissa, Andhra Pradesh	Nil	Jammu & Kashmir, Gujarat, Maharashtra, Rajasthan, Karnataka

**TABLE 15. CLASSIFICATION OF STATES ACCORDING TO GROWTH TRENDS IN AREA AND YIELD PER HECTARE OF WHEAT**

States showing	1970-71 to 1980-81				1980-81 to 1990-91			
	Significant increase in yield	Significant increase in yield	Significant decline in yield	Stagnant yield	Significant increase in yield	Significant increase in yield	Significant decline in yield	Stagnant yield
<i>Significant increase in area</i>	Haryana, Jammu & Kashmir, Punjab, Uttar Pradesh, Gujarat, Maharashtra, Rajasthan	Nil	Nil	Himachal Pradesh, Assam, Orissa	Haryana, Punjab, Bihar	Nil	Himachal Pradesh, Jammu & Kashmir, Madhya Pradesh	
<i>Significant decline in area</i>	Nil	Nil	Nil	Nil	Orissa	Nil	Maharashtra, Andhra Pradesh, Karnataka	
<i>Area Stagnant</i>	Karnataka	West Bengal	Bihar, Madhya Pradesh, Andhra Pradesh	Rajasthan	Nil	Assam, West Bengal, Gujarat		

**TABLE 16. CLASSIFICATION OF STATES ACCORDING TO GROWTH TRENDS IN AREA AND YIELD PER HECTARE OF FOODGRAINS**

<i>States showing</i>	<i>1970-71 to 1980-81</i>		<i>1980-81 to 1990-91</i>	
	<i>Significant increase in yield</i>	<i>Significant decline in yield</i>	<i>Significant increase in yield</i>	<i>Significant decline in yield</i>
<i>Significant increase in area</i>	Jammu & Kashmir, Punjab, Maharashtra	Nil	Himachal Pradesh, Assam, Orissa, Madhya Pradesh	Punjab, West Bengal Nil
<i>Significant decline in area</i>	Kerala	Nil	Gujarat	Andhra Pradesh, Kerala Nil
<i>Area Stagnant</i>	Haryana, Andhra Pradesh, Karnataka	Nil	Uttar Pradesh, Bihar, West Bengal, Rajasthan, Tamilnadu	Haryana, Uttar Pradesh, Assam, Bihar, Madhya Pradesh, Rajasthan, Tamilnadu Nil
				Himachal Pradesh, Orissa, Gujarat, Maharashtra, Karnataka Jammu & Kashmir

**TABLE 17. TRENDS IN RICE YIELD, IRRIGATED AREA, AREA UNDER HYVs AND FERTILISER CONSUMPTION IN DIFFERENT STATES**

States	1970-72 (Triennium)				1980-82 (Triennium)				1990-92 (Triennium)			
	Yield (Kg/ha)	Irrigated area (%)	HYV's area (%)	Fertiliser consumption <sup>(a)</sup>	Yield (Kg/ha)	Irrigated area (%)	HYV's area (%)	Fertiliser consumption <sup>(a)</sup>	Yield (Kg/ha)	Irrigated area (%)	HYV's area (%)	Fertiliser consumption <sup>(a)</sup>
Haryana	1713	88.1	22.5	17.6	2560	97.7	87.5	45.6	2755	99.4	67.1	104.4
Himachal Pradesh	1047	47.6	37.9	7.3	999	51.8	86.5	18.8	1280	59.9	57.5	33.5
Jammu & Kashmir	1670	92.1	53.6	8.2	2090	90.3	85.2	25.2	1995	89.6	55.2	42.7
Punjab	1939	91.8	60.1	50.6	2945	98.2	94.3	123.1	3292	99.0	93.4	163.4
Uttar Pradesh	786	16.6	19.0	20.7	1087	25.9	48.6	54.1	1773	46.2	81.8	87.6
Assam	1009	26.6	10.1	3.2	1108	23.3	35.1	3.4	1295	21.2	44.5	8.9
Bihar	903	29.5	8.1	9.9	830	34.3	28.5	18.1	988	36.5	30.5	57.2
Orissa	877	19.8	6.1	5.5	902	28.9	33.4	10.1	1300	35.8	58.7	21.1
West Bengal	1223	27.0	12.9	13.7	1193	26.3	35.2	33.9	1973	21.7	58.3	88.5
Gujarat	893	33.5 <sup>b</sup>	14.2	17.1	1223	46.0	64.1	37.2	1362	57.1	88.9	70.7
Madhya Pradesh	778	14.4	8.7	5.5	777	17.4	30.3	10.4	1072	21.9	56.5	35.0
Maharashtra	945	24.7	16.7	11.0	1425	26.5	62.7	24.7	1444	25.6	79.6	59.0
Rajasthan	970	31.1	15.2	4.3	871	35.0	30.3	8.3	1090	28.4	29.4	23.2
Andhra Pradesh	1455	94.1	26.0	22.1	2038	94.1	80.9	49.6	2382	95.1	90.9	119.1
Karnataka	1762	67.1	16.1	16.3	1965	63.8	69.9	34.6	2203	64.0	79.0	70.5
Kerala	1534	57.1	31.2	22.8	1666	34.9	54.2	34.4	1985	40.6	30.8	74.7
Tamilnadu	1966	91.6	76.6	43.7	1991	94.2	81.1	62.8	3040	90.7	96.3	124.1
<b>India</b>	<b>1111</b>	<b>39.2</b>	<b>18.9</b>	<b>15.4</b>	<b>1292</b>	<b>41.6</b>	<b>47.6</b>	<b>34.4</b>	<b>1746</b>	<b>46.0</b>	<b>65.2</b>	<b>68.5</b>

@ : Average fertiliser consumption (nutrients) kg. per hectare of gross cropped area of all crops

**TABLE 18. TRENDS IN WHEAT YIELD, IRRIGATED AREA AND AREA UNDER HYVs IN DIFFERENT STATES**

	1970-72 (Triennium)			1980-82 (Triennium)			1990-92 (Triennium)		
	Yield (Kg/ha)	Irrigated area (%)	HYVs area (%)	Yield (Kg/ha)	Irrigated area (%)	HYVs area (%)	Yield (Kg/ha)	Irrigated area (%)	HYVs area
<i>Haryana</i>	1957	82.7	67.9	2413	93.4	91.9	3566	97.5	97.1
<i>Himachal Pradesh</i>	1020	18.2	38.3	1222	16.7	77.8	1584	17.7	93.4
<i>Jammu &amp; Kashmir</i>	845	19.9	38.7	1038	25.7	91.5	1233	23.7	92.6
<i>Punjab</i>	2292	86.8	72.1	2889	91.5	98.9	3763	96.4	100.0
<i>Uttar Pradesh</i>	1259	67.9	40.6	1710	82.8	77.8	2249	89.7	96.4
<i>Bihar</i>	1331	42.9	71.5	1352	74.1	79.8 <sup>@</sup>	1790	86.4	85.5
<i>Gujarat</i>	1548	72.7	39.5	2023	74.1	69.6	2151	83.8	73.1
<i>Madhya Pradesh</i>	776	17.9	9.0	998	30.2	32.7	1444	57.6	65.6
<i>Maharashtra</i>	456	31.8	28.2	842	50.8	76.9	1074	61.9	79.1
<i>Rajasthan</i>	1274	69.2	32.7	1651	56.9	89.3	2393	64.0	74.6
<i>Karnataka</i>	405	10.0	17.2	586	20.9	35.7	677	37.2	34.7
<b>India</b>	<b>1319</b>	<b>54.4</b>	<b>45.3</b>	<b>1712</b>	<b>70.7</b>	<b>73.3</b>	<b>2333</b>	<b>82.6</b>	<b>87.9</b>

<sup>@</sup> : Data relates to the year 1980-81 because area under HYVs has been reported higher than the total area under wheat during 1981-82 and 1982-83



**TABLE 19. ESTIMATED COEFFICIENTS OF THE YIELD RESPONSE FUNCTIONS FOR RICE IN INDIA, 1970-71 TO 1992-93**

State	Intercept	Regression coefficients of			R <sup>2</sup>
		FERT.	HYVs	IRRI.	
<b>Yield Increasing States</b>					
<i>Haryana</i>	12.9063	0.2445* (0.0817)	0.1546*** (0.0825)	-1.3887 (1.4615)	0.70
<i>Punjab</i>	-1.6881	0.1950* (0.0617)	0.2110 (0.0937)	1.7896*** (0.9690)	0.87
<i>Uttar Pradesh</i>	5.1585	0.1739* (0.0881)	0.1244 (0.0967)	0.3536* (0.1062)	0.94
<i>Bihar</i>	6.4498	0.1793* (0.0776)	-0.0429 (0.0970)	0.1117 (0.4085)	0.41
<i>Orissa</i>	6.4400	0.4363** (0.1986)	-0.0732 (0.1457)	0.0191 (0.5591)	0.51
<i>Madhya Pradesh</i>	8.2784	0.4241** (0.1861)	-0.0745 (0.1407)	-0.6980 (0.6545)	0.43
<i>Maharashtra</i>	7.4531	-0.0408 (0.1136)	0.3245** (0.1211)	-0.3178 (0.4645)	0.50
<i>Andhra Pradesh</i>	-6.8901	0.2492* (0.0428)	0.0584 (0.0530)	3.7872 (3.2693)	0.89
<i>Karnataka</i>	3.7848	0.0701* (0.0480)	0.0669 (0.0478)	0.8878* (0.2309)	0.69
<i>Kerala</i>	7.4246	0.1781* (0.0195)	-0.0128 (0.0298)	-0.0544 (0.0466)	0.82
<i>Tamilnadu</i>	8.3655	0.3726* (0.0781)	0.0932 (0.2857)	-0.4949 (1.5576)	0.70
<b>India</b>	<b>5.5447</b>	<b>0.3214*</b> <b>(0.1097)</b>	<b>-0.0972</b> <b>(0.1164)</b>	<b>0.3525*</b> <b>(0.2590)</b>	<b>0.88</b>

Figures in parentheses are the standard errors of regression coefficients. \* Significant at 1 per cent level; \*\* Significant at 5 per cent level; \*\*\* Significant at 10 per cent level

**TABLE 20. ESTIMATED COEFFICIENTS OF THE YIELD RESPONSE FUNCTIONS FOR WHEAT IN INDIA, 1970-71 TO 1992-93**

State	Intercept	Regression coefficients of			R <sup>2</sup>
		FERT.	HYVs	IRRI.	
<b>Yield Increasing States</b>					
<i>Haryana</i>	2.7091	0.3152* (0.1105)	-0.6760 (0.3687)	1.5353 (1.1254)	0.90
<i>Punjab</i>	7.5217	0.3890* (0.0595)	-0.1665 (0.2566)	-0.1309 (0.2077)	0.86
<i>Uttar Pradesh</i>	1.3570	0.3147* (0.0850)	-0.3099 (0.2425)	1.4061*** (0.7495)	0.91
<i>Bihar</i>	6.5619	0.1859* (0.0530)	0.0799 (0.1546)	-0.0542 (0.1709)	0.57
<i>Gujarat</i>	6.7192	0.1821* (0.0404)	0.0096 (0.0654)	0.0313 (0.0707)	0.60
<i>Madhya Pradesh</i>	6.1282	0.3121* (0.1105)	0.0138 (0.0789)	0.0165 (0.2780)	0.88
<i>Maharashtra</i>	5.0862	0.3402* (0.1102)	0.0528 (0.1050)	0.0746 (0.2983)	0.57
<i>Rajasthan</i>	4.7030	0.2409* (0.0769)	0.0920 (0.1228)	0.4066*** (0.2142)	0.86
<b>India</b>	<b>3.6529</b>	<b>0.2638*</b> <b>(0.0791)</b>	<b>-0.3363</b> <b>(0.2201)</b>	<b>1.0137*</b> <b>(0.4163)</b>	<b>0.95</b>

Figures in parentheses are the standard errors of regression coefficients.

\*, \*\*, \*\*\* : Significant at 1, 5 and 10 per cent level, respectively.

