Agricultural growth rates have been measured at national, state, regional and district level by different researchers at different points of time. In doing so, the statistical techniques adopted are so different, which may require elaborate recording. Even while assessing the impact of Green Revolution, different methods were followed. The present chapter is devoted to review the relevant literature.

DHONDYAL (1964) has measured the variations in agricultural development and productivity between three representative districts chosen from the three regions of the Uttar Pradesh. He examined the role of credit, intensive crop enterprises and the influence of irrigation during the year 1962-63. According to him, the main factor accounting for regional differences in agricultural growth was, the capacity and willingness to borrow money for productive use.

DANDEKAR (1964) was of the opinion that, the extent of irrigation and use of the fertilizers might explain a good part of the existing variations in agricultural productivity. Apart from these, the institutional factors such as land tenure and agricultural credit were deemed to be relevant determinants.

SAPRE AND DESHPANDE (1964) while studying the impact of selected inputs on productivity in Maharastra State, concluded that 48 per cent of variation in productivity is explained by
three factors viz., rainfall, irrigation and soil. But rainfall alone explains 40 per cent of variations. Further, they reached the conclusion that the relationship between productivity and soil (input) was found to be statistically insignificant.

COPALAKRISHNA AND RAO (1964) while studying the degree of variations in the value of agricultural output per acre and output per head in Andhra Pradesh, a district-wise study was attempted to account for the causes of variations during 1959-60. The functional relationship between the value of output per acre and associated variables viz., percentage of irrigated area and percentage of area under foodgrains and fodder were studied. They have reached the conclusion that among the two input variables irrigation ought to be judged as an important factor affecting the value of output per acre, whose 't' value is significant at 5 per cent level and it is not significant with respect to the other variable.

RAO (1965) studied the trends in agricultural growth for the period 1949-50 to 1961-62 for the country as a whole and for different states. The main conclusions are that the rate of foodgrains output declined during the second seven year period, accompanied by slowing down of the growth of area in the later period. It was also recorded that the area accounted for 48 per cent of the growth of output during the overall thirteen year period and the yield has become a major factor for higher output during the later stages. The author emphasised the crucial role of irrigation.
SEN (1966) examined the growth and instability in Indian agriculture for the period 1900-1901 to 1965-1966. The total period was divided into two major parts, viz., 1900-1901 to 1947-48 and 1936-37 to 1965-66. Each of these periods were divided into two equal sub-periods. During the first 24 years, the country's foodgrain growth was 0.3 per cent. In the next 24 years, the foodgrain production showed a declining trend of 0.02 per cent on an average.

The growth rate was higher during the first 24 years of the century and again during the first 15 years of the planning era. High growth rate was associated with high instability and less instability during the period of stagnancy.

CHADHA (1966) studied the growth rates in Indian agriculture for the period 1949-50 to 1964-65. The linear growth rates of foodgrains in All India was 3.66, 1.48 and 1.80 per cent respectively for area, production and productivity. For Andhra Pradesh, such values are 3.06, 0.27 and 2.72 per cent per annum.

Results of the comparison made by him between growth rates of foodgrains production and population indicate that, the states with lowest growth rate of population had the highest growth rate of foodgrains production and vice versa. Population growth rate outstripped the growth rate of foodgrains. However, for all India, the growth rate of foodgrains was higher than the population growth rate.
RAO (1971) examined the inter-regional variations in agricultural growth in selected states in India for the period 1952-53 to 1964-65. The author concluded that it was the differences in growth of irrigation that has become the important proximate cause for variations. While public investment played an important role in the level of irrigation, the private investment is restricted to minor irrigation, which also played its own impact. The rich farmers did play a role in areas that had experienced favourable growth as they had greater access to sources of public investment and they seem to have readily responded to opportunities opened up by public investment.

SUDHIN (1976) has reached the conclusion that, the source of variation in agricultural productivity was explained by the differences in the level of input use, region and the temporal situation. It was observed that 41.0 per cent of the variation in output was explained by measured inputs. The decomposing of the large residuals into two components i.e., regional effects and temporal effects revealed that, 95.0 per cent of the variations of the total disturbances were attributed to the region effects.

VENKATA REDDY (1977) studied the growth rates of rice with the linear equation $y = a + bx$ for Andhra Pradesh state and its three regions for the period 1956-57 to 1970-71. He concluded that the favourable institutional factors, favourable
adjustment of economic factors and application of science and technology as the important aspects influencing productivity. Very poor per cent of the area under improved seeds, poor fertilizers consumption, floods and lack of assured irrigation are the main reasons for low agricultural productivity in Rayalaseema and Telangana regions.

Linear growth rates of area, production and productivity of rice were 1.46, 2.64 and 1.01 per cent in Rayalaseema region during the period 1956-57 to 1970-71. This region leads the other two regions in respect of the growth rate of the area. In the case of production and productivity, the growth rates in Rayalaseema region are better than Coastal Andhra but lower than Telangana. Productivity growth was at a lower rate during the Green Revolution period, than that of pre-Green Revolution period in all the three regions of Andhra Pradesh and also state as a whole.

Productivity contribution to rice output was higher during the pre-Green Revolution period while area contribution was a major factor for higher rice output during the Green Revolution period.

The co-efficient of variation (C.V) for area, output and yield was higher during the pre-Green Revolution period than the Green Revolution period (7.71 vs 5.86, 21.53 vs 19.46 and 16.89 vs 11.67).
SHARMA (1977) while studying the agricultural development in various regions of West Bengal, Bihar and Orissa has arrived at the conclusion that the imbalances in the distribution of land among households might explain the regional imbalances in agricultural development. The allocation of funds for systematic evaluation of ground water resources for the development of irrigation and expansion of inputs associated with it seem to have close impact on increasing the level of agricultural output.

RAHEJA et al., (1977) have studied the regional variations in the adoption of high yielding varieties and productivity variations of rice and wheat during 1973-74, covering 88 districts spread over 15 states of the Country. In the case of rice, it was observed that, the extent of adoption of high yielding varieties in different regions had no direct bearing on their yield rate. But it was identified that owing to lack of assured water supply and resource endowments of the farmers, the regional variations were more marked in rice as compared to wheat.

SINGH et al., (1977) in their study made an attempt to analyse the inter-relation between the crop yield and some of the selected inputs. The major conclusion drawn from the study was that the inter-relationship between the yield of foodgrains and some inputs viz., application of fertilizers, proportion of area sown more than once and gross area irrigated might be high.
DAS (1977) has reached the conclusion that the uneven distribution in the levels of irrigation, fertilizer consumption and area under high yielding varieties as major factors for increasing regional disparity in agricultural growth in Orissa State.

BHALLA AND ALAGH (1977) have made a significant study assessing the overall agricultural growth rate in India and district-wise growth rates. They have considered the average fertilizer consumption (NPK), area irrigated and land ownership as important independent variables which are likely to contribute to the variations in the agricultural productivity per hectare. They have applied multiple regression equation considering the agricultural productivity levels (1970s) as dependent variable and fertilizers, irrigation (per cent) and gini coefficient ratio of land ownership (1971) as independent variables. It was observed that, the differential rate of fertilizer usage alone explains 29.9 per cent of the variation in agricultural productivity per hectare. The contributions of irrigation and gini coefficient ratio of land ownership are positive but insignificant.

MISRA (1979) analysed the agricultural growth of 48 districts in Uttar Pradesh considering 40 crops, including rice, for the period 1950-77. The overall growth rate for the entire period was 1.75 per cent for the state as a whole. When the whole period was divided into four sub-periods (1950-59, 1956-65, 1962-71 and 1971-77), the growth rates were at variance. A
low growth rate of 0.83 per cent recorded during the first phase, increased to 1.83 per cent during the second and to 2.78 per cent during the third. The fourth phase witnessed a slump in the growth rate recording only 1.00 per cent.

He identified area as the major contributory factor in the first phase and gradually declining thereafter. The yield on the other hand was a negative contributor to begin with and has become a major contributor in the later three phases. Absence of significant influence of area from the mid phase onwards and a high contribution by cropping pattern and yield in the last phase were the characteristic features. Throughout the study period, each of the districts experienced different growth rates and different influencing factors have been identified.

JOHAR AND RAIKHY (1980) have examined the factors accounting for inter-district variations in agricultural productivity in Punjab. They concluded that more than 70 per cent of the variations in productivity is explained by variations in the levels of irrigation, fertilizer consumption and high yielding varieties use.

BAWA AND PARMINDAR SINGH (1980) have studied the inter-regional variations in the agricultural productivity of Punjab and reached some different conclusions. According to them, 61.62 per cent of the inter-district variations are due to differences in availability of power, roads and level of
literacy. About 34.57 per cent of the variations are because of irrigation, chemical fertilizers, factor availability and credit. On account of the differentials in the availability of labour, 3.17 per cent variations are noticed. They came out with a useful suggestion that, the variations can be narrowed down to the extent of 61.0 per cent by providing uniform infrastructural facilities and another 29.0 per cent by making use of available inputs.

VIDYANATHAN (1980) has discussed the different methods of measuring agricultural growth and the limitations in the adoption of such models. It has been pointed out that rainfall had a significant effect on the productivity in case of even a predominantly irrigated crop like rice in Telangana and Rayalaseema regions, as the irrigation sources are highly dependent on rainfall. However, the influence of rainfall on production of rice was only marginal. But it was much greater in the case of other crops. Further, the interaction between rainfall and time trend showed no consistent pattern and seemed weak. Factors affecting growth of output were discussed under the broad classification of technical, economic and institutional. The rate at which land productivity can be raised is limited by the extent and quality of irrigation, the intensity of fertilizer use and the efficiency with which the cultivation practices necessary for optimum results are applied in the farms. Author is of the opinion that results from these studies enable
a better understanding of the inter-relationship between technical, economic and institutional factors in the over all process of agricultural growth and transformation.

CHANDAN MUKHERJEE AND VIDYANADHAN (1980) have examined growth and fluctuations in foodgrain yields. The following least squares method (linear) was employed to examine the causes of instability in yields.

\[ Y_i = f (x_{1i}, x_{2i}, \ldots, x_{ki}) + e_i \]

The independent variables considered in the study are south-west monsoon rainfall, total rainfall and index of input. The dependent variable is yield per hectare. The author reported that the level of uncertainty in yields reduces as level of inputs rise. At low level of inputs, the weather variation contributes to a great extent to the total variation in yield. The study concludes by saying that the use of inputs like fertilizer contribute to fluctuations in yields besides other factors such as quality of soil, water etc.

HAZELL (1982) studied the rate of instability and it's sources in foodgrain production in India for the period 1954-55 to 1977-78. The period was divided into two sub-periods viz., pre-Green Revolution period (1954-55 to 1964-65) and post-Green Revolution period (1967-68 to 1977-78). While doing the computations he has omitted two years viz., 1965-66 and 1966-67 as they are considered as drought years. The study was confined
to rice, wheat, bajra, barley, jowar, maize, ragi, small millets and total cereals production. Linear equation was fitted in the form of

$$Y_t = a + bt + et$$

where

- $Y_t$ = dependent variable
- $t$ = time, and
- $et$ = random residual

The following decomposition method was adopted while measuring the instability:

$$V(Q) = A_V^{-2}(Y) + Y_V^{-2}(A) + 2 \bar{AY} \text{ Cov}(AY) - \text{Cov}(AY)^2 + R$$

where

- $V(Q)$ = production variation
- $V(Y)$ = variances of yield
- $V(A)$ = variances of area
- $\bar{AY}$ = mean areas and yields; and
- $R$ = residual term.

The results show that the coefficient of variation around trend line of total cereal production was higher in post-CRP then pre-CRP. The analysis confirms that the changes in the variability of yields of individual crops within the states have been an important contributor to the increase in the coefficient of variation of total cereal production.
JOSHI et al. (1982) have examined the changes in yields and their spatial variability over a period of time. The study is restricted to four major food crops viz., rice, wheat, jowar and bajra. Coefficient of variation around trend line was used to measure the rate of instability.

The all India mean yields of wheat showed higher growth associated with lower instability since mid 60's. The study indentified certain states as best practice states for specific crops. For instance, Punjab for wheat and Tamil Nadu and Punjab for rice. However, rice yields variability increased over time across states. Slow growth in the adoption of the yield enhancing technologies for the coarse grains is mainly due to the competition from more lucrative crops. It is evident from the analysis that, higher growth is associated with higher fluctuations in the post 1965-66 period. The fluctuations in wheat have narrowed as against the widening variability in case of rice. In Punjab and Haryana, the wheat yields rose rapidly and inter-state yield differences have narrowed to some extent. Commercial crops replaced other traditional crops to a great extent, as the area under traditional crops experience competition from commercial crops.

RAY (1983) has chosen rice, wheat, cereals, pulses, foodgrains, oilseeds, sugarcane, cotton, jute and tobacco to assess the nature and causes for growth and instability in Indian
agriculture for the period 1950-1980. The growth of production was decomposed into three components viz., area, yield and crop pattern. The variability in annual output growth rates over a specified period was decomposed with the following formula:

\[ V(Go) = V(Ga) + V(GY) + V(Gc) + 2Cov(Ga, Gv) + 2Cov(Ga, Gc) + 2Cov(Gy, Gc) \]

where

- \( G \) = growth rate
- \( o \) = production
- \( Y \) = yield
- \( a \) = area
- \( C \) = crop pattern
- \( V \) = variance
- \( Cov \) = co-variance
- \( t \) = time

The study showed that instability in production was lower during the 1950's for all the crops and crop groups, except tobacco. In 60's and 70's instability in production was high due to new agricultural technology. The authors concluded that with rapid growth stability can be achieved if the environment for production is brought under human control and even with a slower growth, production can be made more unstable through price policies.
MAHENDER REDDY (1983) studied the growth and instability of agriculture in different districts and regions of Andhra Pradesh state for the period 1956-57 to 1980-81. The total period was divided into two sub-periods viz., pre-Green Revolution period (1956 to 1965) and post-Green Revolution period (1965 to 1981). The study was confined to the output of foodgrains, groundnut, pulses and rice. Linear equation was fitted for calculating growth rates. For measurement of instability two different methods viz., simple coefficient of variation (C.V) and coefficient of variation around trend line (CVTL) were adopted. The main results of the study are that Rayalaseema region showed higher production fluctuations followed by Telangana and Coastal Andhra. Area fluctuations are smaller than the production fluctuations and the instability was higher in post-Green Revolution period than the pre-Green Revolution period. The use of modern inputs such as high yielding varieties and fertilizers have shown lower instability under assured source of irrigation. Pulses have shown greater instability than the other crops. The study supports the positive correlation between growth and instability.

PARTHASARATHY (1984) studied the growth and fluctuations in agricultural production in the different districts of Andhra Pradesh for the period 1955-56 to 1978-79. The total period was broken into two sub-periods i.e., 1955-56 to 1966-67 as pre-Green Revolution period and 1967-68 to 1978-79 as post-
Green Revolution period. The study was confined to major cereals, which include rice, wheat, jowar, bajra, maize, ragi, korra and pulses. Exponential function has fitted by using \( \log y = a + bt \) formula for assessing growth rates. The instability was measured with the following formula

\[
\frac{1}{\log y} = \sqrt{\frac{\sum (\log y - \log \bar{y})^2}{N - 1}} \times 100
\]

where

- \( y \) = index numbers of agricultural production
- \( N \) = number of observations.

The author observed that growth rates of all crops and foodgrains were higher in Telangana as compared to north Coastal Andhra and Rayalaseema. Instability in foodgrain production was high in north Coastal Andhra, while the south Coastal Andhra districts registered a low degree of instability. Chittoor and Anantapur had a high degree of instability and low degree of instability was noticed in Cuddapah and Kurnool districts. Four districts of Telangana region showed a relatively lower degree of instability.

SHAFL (1984) has studied the relationship amongst a number of factors which may cause spatial variations in agricultural productivity. As many as nine independent input variables were selected for the study. The variables are
(1) area irrigated by canals, (2) irrigation by tube wells, (3) irrigation by other sources, (4) area under high yielding varieties, (5) fertilizer consumption, (6) agricultural workers per thousand hectares, (7) animal power, (8) tractor power, and (9) agricultural credit advance (in Rs.). With the help of the standard nutrition techniques, the productivity index was constructed for wheat crop as dependent variable and multiple regression analysis was fitted to study the impact of the nine independent variables on productivity variation during 1966-67 and 1975-76 in Uttar Pradesh.

The study reveals that irrigation by canal, irrigation by other sources, fertilizer consumption and agricultural labour are important determinants accounting for variations in productivity.

RAJPUT (1985) taking only normal years, has studied the agricultural productivity at the district level in Rajasthan for the period from 1956-57 to 1976-77. The total period was divided into four sub-periods i.e., 1956-57 to 1958-59, 1962-63 to 1964-65, 1968-69 to 1970-71 and 1974-75 to 1976-77. Trends in variation and factors influencing productivity were broadly grouped into four classes viz., environmental, technological, institutional and others. The factors included are annual average rainfall, soil rating index, percentage of gross irrigated area to gross cropped area, fertilizer consumption per 10000 hectares, percentage of high yielding varieties hectarage, mechanisation
index, male workers per hectare, gross cropped area, net sown area and cropping intensity.

Though an increase in yield was recorded during the total period, the growth rates of agricultural productivity was negative during the pre-Green Revolution period in many districts.

Through regression analysis, it was noted that rainfall, fertilizers and the number of agricultural workers were the important factors during the pre-Green Revolution period. The acreage under high yielding varieties, crop intensity and fertilizers have become important during the Green Revolution period. Despite this general trend, the relative importance of the factors during the four periods varied. In the light of the emerging importance of high yielding varieties and fertilizers, the author emphasised development of irrigation potential.

MAHENDRA DEV (1985) has examined the direction of change in the performance of Indian agriculture over the period 1962-65 to 1975-78. The study covered 289 districts and 56 agro-climatic regions of India and referred to 19 major crops. The study also examined the weather imbalances in terms of output per capita and output per unit of area for all the crops. Compound growth rates have been computed. The author compared the productivity levels of 1975-78 with those of 1970-73
and 1962-65 at the district level. The districts have been classified on the basis of growth rates as high growth (more than 4.5 per cent), medium growth (between 1.5 to 4.5 per cent), low growth (between 0.0 to 1.5 per cent) and negative (less than 0). During the period 1962-65 to 1970-73, one-fourth of the Indian districts recorded negative growth and nearly half of the districts (133), with about 48 per cent of the cultivated area, have shown less than 1.5 per cent growth. Against this, during 1962-65 to 1975-78, only 16 districts recorded negative growth rates. As many as 72 districts with one-fourth of the cultivated area were in low growth class and 88 districts with about 31 per cent of cropped area have recorded growth of less than 1.5 per cent a year.

MEHANDRA DEV (1987) studied the growth and instability in food grain production for the period 1960-61 to 1984-85 for 17 major states. The trends in instability was measured by a moving period approach. The factors causing to inter-state variations in growth and instability were closely analysed. For this, the entire period was divided into two sub-periods viz., pre-Green Revolution period (1960-61 to 1969-70) and Green Revolution period (1970-71 to 1985-86).

The growth rates differ from state to state for the period 1970-71 to 1984-85. Growth rate of around 6 per cent was experienced in the states of Maharashtra and Punjab. It exceeded 3 per cent in Uttar Pradesh, Haryana and Andhra Pradesh and in as many as twelve states it was less than 2.5 per cent. The growth rate was negative in Kerala and Tamil Nadu.
For the entire period (1960-61 to 1984-85), the range of instability varied from 7.4 per cent in Kerala to as high as 32.2 per cent in Gujarat. The standard deviation was more than 20 per cent in five more states viz., Rajasthan, Maharashtra, Bihar, Orissa and Madhya Pradesh. It was around 20 per cent in three states viz., Harayana, Karnataka and Tamil Nadu. On the other hand, Kerala, Punjab, Assam, Andhra Pradesh and Jammu and Kashmir recorded less than 15 per cent standard deviation. Low rainfall and/or low irrigated states registered relatively higher magnitude of instability than the other states.

Employing a moving period approach on a three year basis, the author reached the conclusion that instability varied from a high declining trend in Punjab to high increasing trend in Tamil Nadu. Seven states witnessed a declining trend while five states had rising trend. In others, there was an insignificant upward trend.

The author arrives at the conclusion that, no positive association between growth and instability was clearly discernable. As compared to 60's, the growth rates have slowed down in 70's. Rainfall was the major contributory factor responsible for production variability. The states which have assured irrigation facilities showed relatively lower instability. The inter-state variations in growth and instability are said to be due to the variations in quality and quantity of irrigation.
LALITH ACHOT et al. (1988) analysed the variations in pulses production in Karnataka. They have tried to identify the components of pulse production variability. Variance decomposition method of Hazeel was adopted to measure instability. Linear, semi-log and exponential equations were fitted to understand the trend. The results showed that year-wise fluctuations in area and yields for each district are mainly due to long term effect, the trend and short-term variations. The analysis showed that, more than 85 per cent of the variation in pulse production is attributable to yield variance. The study supports positive association between growth and instability in the Green Revolution period. It is observed that, despite support price, farmers did not respond and acreage response for pulses is not significant due to lower yields.

LAKSHMANA RAO (1988) while studying the inter-state (selected states) and inter-district (Andhra Pradesh) variations in foodgrain yields, has reached the conclusion that differences in irrigation potential, fertilizer use, size of operational holdings and rainfall as the major factors for yield variations.

DESHEPANDE (1988) studied the relationship between growth and instability in Maharashtra agriculture for the period from 1951-52 to 1980-81. Linear growth rates for individual crops and correlations between growth and instability across crops and districts were computed. For measuring instability,
coefficient of variation adjusted for trend, crop loss ratio and probability of failure of yields were used. The study mainly examined the changes in growth and instability relationship across crops between drought prone (DP) and non-drought prone (NDP) districts after the advent of Green Revolution.

The study reported negative relationship between growth and instability in the pre-Green Revolution period both in DP and NDP districts, which changed to positive and non-significant during the Green Revolution period. But NDP districts showed relatively strong positive association. However, individual crop variances could not influence crop groups. On a positive note, the author concluded that the fluctuations between peaks and troughs in the yield of total foodgrains are on the decline.

HANUMANtha RAO et al. (1988) studied the growth and instability in Indian agriculture for the period 1950 to 1985. The entire period was divided into two sub-periods, as (1) Pre-Green Revolution period (1950-65) and (2) Green Revolution period (1966-85). The authors have computed two types of growth rates; (a) unadjusted and (b) adjusted. Semi-log function in the form \( \log Y_t = a + bt \) was used to estimate the unadjusted growth rates, where

\[
Y_t = \text{variable for which the growth rates is to be estimated, and}
\]

\[t = \text{time.} \]

To correct the variation due to weather, adjusted growth rates were estimated from the following modified functional form:
\[ \log y_t = A + BT + C \log W_t \]

where

\[ y_t = \text{crop specific rainfall index with the normal value as 100.} \]

The rainfall indices were computed by measuring the relative departure of weighted actual rainfall from its corresponding weighted historic normal levels during the biological growth period of each crop. To identify the sources of instability, variability in the annual output growth rates was decomposed into its constituent parts over different periods. Authors used the following relation for decomposing instability in output:

\[ E \left( C_{O_t} - C_{O}^* \right)^2 = E \left( C_{Y_t} - C_{Y}^* \right)^2 + E \left( C_{o*} - C_{o}^* \right)^2 + 2 \text{CoV} \left( \left( C_{o} - C_{o}^* \right) \left( C_{Y_t} - C_{Y}^* \right) \right) \]

where \( C_{O}^*, C_{a}^*, C_{y}^* \) are the growth rates in output area and yield estimated over the sub-period.

Growth rate of rice production, which was over 3.3 per cent per annum during the pre-1965 period has declined significantly to 2.4 per cent during the later period. For coarse cereals, the decline was to 0.85 per cent, as compared to 2.2 per cent earlier. Pulses too have recorded a sharp decline as their pre-1965 output growth rate has been halved. Inspite of these sharp decline, foodgrains output as a whole has maintained a growth rate well above 2.6 per cent in both the periods.
RAJU and RAO (1988) in their study examined the pattern of movements in agricultural production in Andhra Pradesh during 1956-57 to 1982-83. They are of the opinion that, although there was an increase in the yield indices of cereals, pulses and foodgrains it was marked by more instability. Hence, the need to bring about improvement in varieties and crop management practices to minimise instability in agricultural production assumes importance.

BALLA AND TYAGI (1989) has studied the district and statewise performance of agricultural growth at two levels; (a) major crops (19 crops) and (b) the total crop sector (41 crops). This study was based on the data pertaining to the periods 1962-65, 1970-73, and 1980-83. During the first period i.e., from 1962-65 to 1970-73, except in Andhra Pradesh, the southern region recorded a high growth rate of output. During the second period, except Andhra Pradesh, the remaining states recorded a significant deceleration in their growth rates. During the overall period 1962-65 to 1980-83, about half of the incremental output was contributed by the north-western states, whereas the eastern region contributed only about eight per cent. The contribution of the central region to the aggregate incremental output was 24 per cent and that of southern region 15 per cent. It was the districts with higher percentage of area under irrigation, which recorded higher levels of productivity during both the periods. Many districts in the arid zone parts of India were unable to adopt the new technology, primarily because of lack of irrigation facilities.
The authors have summarised that, the new seed-fertilizer technology has played a major role in raising yield levels of various crops and thereby augmenting agricultural production in India since the mid sixties. They further concluded that, there is evidence to suggest that new technology has made a significant headway in some of the dryland crops like jowar, ragi and cotton.

ALOKBANDHOPADHYAY (1989) studied the pattern of growth and instability of production in rice in West Bengal and in wheat production in Punjab and Haryana. The period covered was 1950 to 1984. The study examines the relation between the growth and instability during pre and post-Green Revolution periods by taking 1966-67 as cut off point between the two periods. Linear growth rates and coefficients of variation around trend line were estimated for the purpose. The study reveals that during the pre-Green Revolution period most of the districts in West Bengal showed lower growth rates as against higher growth rates during the Green Revolution period. In Punjab and Haryana, the growth of production during the pre-Green Revolution period has increased considerably. But during the Green Revolution period, most parts of the states showed lower growth rates. Some positive association between growth and instability was observed in West Bengal rice production. Instability in wheat production has diminished during the Green Revolution period in Punjab than in West Bengal which was ascribed to increased assured irrigation in Punjab.
NARENDER et al. (1989) analysed the spatio-temporal variations in agricultural output in Andhra Pradesh and factors that had influenced growth during the period 1956 to 1981. The entire period was divided into four sub-periods, i.e., 1956-59 to 1962-65, 1962-65 to 1966-69, 1966-69 to 1972-75 and 1972-75 to 1978-81. The computations were done for the overall period using modified version of 'Decomposition Model' as developed by Minhas and Vaidyanathan (1965) and modified by Sharma (1975) was adopted. Constant price weights were assigned to different crops which accounted for 90 per cent of the total cropped area.

The compound annual growth rate for Andhra Pradesh was 10.4 per cent for overall period. The growth rate was highest (14.57 per cent) during the second period (1962-65 to 1966-69), which subsequently declined to 4.79 per cent during third period and to 1.39 per cent during last period. Growth rate for the overall period was 10.4 per cent.

Regarding component contribution, area had negative contribution in all the periods, excepting the first sub-period. Even during the overall period area contributed negatively (-21.25 per cent). Yield contribution amounted to 73.81 per cent during the first period, 88.87 in second period, 107.45 in third period and 60.96 in fourth period. During the overall period, the yield contribution was 63.32 per cent. Cropping pattern too contributed significantly along with the yield. Growth of yield
overtook the growth in area in a big way in Andhra Pradesh. High output growth rate was attributed to the cultivation of high value crops like sugarcane, chillies, groundnut, cotton and tobacco.

SATYA SEKHAR (1989) has studied the performance of growth and made projections of agricultural growth in Andhra Pradesh for the period 1954-55 to 1986-87. The total period was broken into two sub-periods; (a) 1954-55 to 1966-67 pre-high yielding varieties period and (b) 1967-68 to 1986-87 high yielding varieties period. Exponential function has fitted to calculate the growth rates. To analyse the trends of area, yield and production of important crops the following model was chosen:

\[
\ln y_t = b_0 + b_1 t + b_2 (t - t_1) D + b_3 Sw_t + b_4 Nw_t + u_t
\]

where

- \( y \) = production/area/yield
- \( t \) = time in year
- \( t_1 \) = 1967-68
- \( D \) = 0 for 1954-55 to 1966-67 (Pre-HYV period)
  = 1 for 1967-68 to 1986-87 (post-HYV period)
- \( Sw_t \) = rainfall during June-September
- \( Nw_t \) = rainfall during October-December
- \( u_t \) = error term.

The district-wise exponential growth rates showed that the agricultural production growth rate exceeded 3.0 per cent.
only in four out of 21 districts. The growth rate of rice production was around 3.0 per cent during the two sub-periods. Cash crops sugarcane and groundnut suffered a contraction during the post-HYV period. All pulses recorded a growth rate of 3.3 per cent during the post-HYV period against a low growth rate of 0.04 per cent in area.

DEVASENA NAIDU (1991) measured agricultural growth rates and fluctuations and discussed related issues for the period 1956-87 at disaggregated districts level in Andhra Pradesh. Factors discussed include income level, institutional infrastructure development, extension system, marketing and price policy, climatological factors, farmer's response and technological aspects. The author reached the conclusion that generally growth rates failed to explain instability in time-series data.

NAIDU AND KRISHNUDU (1991) have worked out linear and compound growth rates of area, production and productivity of paddy, jowar, bajra, groundnut, sugarcane and total pulses of Chittoor district in Andhra Pradesh. The results are obtained in three segregated periods viz., (1) whole period (1954-55 to 1985-86), (2) pre-Green Revolution period (1954-55 to 1964-65) and (3) post-Green Revolution period (1965-66 to 1985-86). The main results are that during the whole period paddy, jowar, bajra and pulses have registered negative growth in respect of area, but the yield exhibited a positive growth in all the cases. A comparative study of pre- and post-Green
Revolution periods reveal that the 'area effect' seems to be greater than the 'yield effect' in the case of all the crops except sugarcane and bajra during pre-Green Revolution and it is vice-versa in post-Green Revolution period in respect of all the crops except groundnut and sugarcane. They finally reached the conclusion that new agricultural technology is yet to take roots in the case of these crops.

HAFFIS et al. (1992) analysed the growth patterns of area, production and productivity of foodgrains in India during 1949-50 to 1988-89 adopting compound growth rate technique. They have sub-divided overall period into two sub-periods viz. 1949-50 to 1967-68 and 1968-69 to 1988-89. They arrived at a growth rate of 2.69 per cent in foodgrain production for overall period. The results show the slowing down of growth rate during the later period (1968-69 to 1988-89) as compared to the earlier period (1949-50 to 1967-68). Another interesting conclusion was that contribution of area to the growth of foodgrain output has declined from 46.58 per cent during the first decade of their study to -4.06 per cent by the last decade. On the contrary, the productivity contribution increased from 53.43 to 104.06 per cent for the corresponding periods.

TILAK (1993) while examining the relation between education and agricultural productivity in Asia have found out that education significantly influences methods of production, use of modern inputs like fertilizers, seeds, machines and
selection of crops. The threshold level of education (the secondary level during the seventies) is relevant not only for farmers efficiently, but also for other activities like utilization of credit facilities, improved seeds and better methods of farming.

From the review made above, some of the gaps of research on agricultural growth are obvious. The main gaps relevant to our study are (1) analysis of overall growth rates of agriculture at district and region level with both constant and current prices, (2) reassessment of the impact of the Green Revolution. The reassessment is necessary to examine the impact of Green Revolution with a subsequent base compared to the traditional base. This helps us in understanding the impact of Green Revolution when it is covering more area and more crops as compared to its confinement only to rice and wheat at the initial periods of Green Revolution and (3) examine whether crop productivity reached any stagnation levels with the presently available HYV seeds and cultural practices.