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Regional Inequalities of Agricultural Development in India with Special Reference to Growth of Output of Foodgrains*

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Economic development has not been uniformly distributed either over space or time. Therefore, only a few countries have grown almost exponentially while most of the countries of the world have either stagnated or have grown marginally. Even within the countries, only some regions are developed. Every country, howsoever small, faces the problem of North-South or polarisation. But the poverty of the people and the backwardness of the regions in which they live are inseparable from each other. Therefore, social and economic inequalities are reflected not only in inter-personal or inter-group differentials but also in inter and intra regional inequalities. Each of these aspects has received some attention in the successive five year plans of India. Balanced growth, dispersal of industries and extension of benefits of progress to the weaker sections of society and backward regions of the country have all along been among the major objectives of the planned economic development of the country.

In advanced countries and regions, industrial activities have been the king-pin of the dynamic process of growth. Some economists and the policy makers think that the industrial development is also a limiting factor in the developing countries upon which the growth of even agriculture and human resources hinges. However, agriculture accounts for a very high proportion of the domestic output, and it absorbs the largest proportion of the total workforce of these economies. Naturally, the growth performance of the economy is satisfactory whenever this sector registers high growth; and the entire economy slides down whenever the growth performance of this sector is poor. Besides, agricultural prices, especially those of the foodgrains, have been leading to the inflationary pressures in countries like India. Then, export of foodgrains, like those of the petroleum products, could also be used as a political weapon. Therefore, the growth of agricultural output for the attaining of self-sufficiency in foodgrains and the maintaining of the price stability in the economy is regarded as one of the important objectives of public policy.

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Nature of the developmental process itself is such as accentuates a functional specialisation that focusses relations in space and causes economic and social inequalities between metropolitan and non-metropolitan urban regions, on the one hand, and between urban and rural and rural regions, on the other. Besides, economic activities that yield more than average returns gravitate towards the urban regions; only those activities that yield less than average returns on investment are left to spread the process of development over all the regions of the country. It builds inequalities into the model design itself. Scarcity of resources and the productivity of investment induce the decision makers to concentrate developmental effort on those sectors of the economy and those regions of the country where the returns are maximum. Naturally, different sectors and regions grow differently. Similar considerations necessitate the extension of the strategy of development of selected sectors in selected regions from industry to agriculture also. Then, technical considerations and the constraints of natural resources dictate that the large scale multi-purpose projects of rural development such as Bhakhra-Nangal are located in selected regions which are richly endowed with natural resources and which are already more prosperous than others. Wide and uniform diffusion of other programmes of rural development over all or most of the regions is made infeasible by the scarcity of resources and the low productivity of investment. Under such circumstances, attempts to tamper with the strategy of selected development results in anomalous cases: Saugor is one of the most mechanised but the least irrigated districts, while Tikamgarh is one of the most irrigated but the least mechanised districts of M.P.. Limited supplies of modern agricultural inputs have been spread thinly over large areas under political pressures which has tampered with the package approach of the new agricultural technology. This has further accentuated the regional inequalities of agricultural development.

This paper attempts to examine the regional inequalities of agricultural development both in the pre and post green revolution periods in India.

SECTORAL AND REGIONAL GROWTH PERFORMANCE

Under conditions of balanced growth, all the sectors of the economy grow at the same rate; and if the different sectors have the same developmental levels in the base period, there will be no inter-sectoral differences. If, however, these sectors of the economy, which have already attained higher levels of development, grow more rapidly than others inter-sectoral differences will emerge if they do not exist already, otherwise the existing differentials will become still larger. On the other hand, if the lagging sectors grow more rapidly than the leading ones, the process of catching up will become operative and the differences in the growth performance of the different, sectors will tend to converge in the long run. Thus, the differential growth performance does not contribute to inequalities by itself.

Similarly, under conditions of balanced regional growth, all regions grow at the same rate; and if all regions are equally developed in the base period, there will be no regional inequalities. If advanced regions grow more rapidly than the developing ones; either the regional inequalities will be further accentuated or regional inequalities will emerge if they do not exist already. On the other hand, if the developing regions grow more rapidly than the developed ones, regional inequalities will tend to shrink in the long run. But an important feature of the growth rates is that a given change in the value of the variable will be associated with a higher growth rate smaller the value in the base period; and the variable will be associated with a lower growth rate higher the value of the variable in the base period. Notwithstanding this, growth rates can be used to evaluate intersectoral and inter-regional inequalities and temporal changes therein.

We have calculated the annual compound growth rates of per capita income, output of wheat, paddy, pulses and foodgrains for India as well as states separately for pre and post green revolution periods as well as for the composite period. Growth rates have been derived from the following equation which has been estimated by the method of least squares:

$$\text{Log} \quad = \quad \log a \quad b \quad T$$

where Y is the variable growth rate of which is to be estimated T is time - one year being its unit of measurement, log a and b are parameters to be estimated. Obviously, b provides an estimate of the growth rate.

INTER-SECTORAL GROWTH PERFORMANCE

Per capita income of India has increased at the compound rate of 2.57 percent per annum over a period of 30 years from 1950-51 to 1979-80; but the output of foodgrains has increased at a much lower rate of 1.26 percent per annum. It is obvious that the other sectors of the economy have grown much more rapidly than the foodgrains sector. But within this sector itself, output of wheat has increased at a relatively higher rate of 2.70 percent per annum, output of paddy has increased at a tardy rate of 1.25 percent, while the output of pulses has remained practically stagnant, rate of growth of its output being as low as 0.06 percent. These growth rates reveal a fairly high degree of inter-sectoral differentials. Besides, the temporal differences also seem to be highly marked. Rate of growth of output of wheat in the post green revolution period is nearly 1.6 times more than its growth rate in the pre green revolution period. Besides, the output of wheat has grown much more rapidly than the per capita income throughout the period of study. Chow statistic shows that the growth performance of output of wheat in post and pre green revolution periods is significantly different. Output of paddy has increased at a rate of 1.58 percent per annum in the pre green revolution period which is higher than the rate of 1.15 percent at which the output has grown in the post green revolution period. But the growth performance in the two periods is not different significantly. Output of pulses in the pre green revolution period has decreased nominally

while it has remained stagnant in the post green revolution period. But the growth performance in the two periods is not different statistically. Output of all foodgrains has increased even more tardily than the output of paddy and the growth rates in both pre and post green revolution periods are practically identical. Chow statistic also reveals their differences to be negligible. Thus, it is only the growth of output of wheat that differs temporarily while the growth of output of paddy, pulses and foodgrains is not different in the two periods.

INTER-REGIONAL DISPARITIES OF GROWTH

Rates of growth of per capita income range from 1.92 percent for Assam to 4.17 percent for Haryana. Per capita income of 9 of the 18 states has increased at rates which are more than 3 percent per annum, per capita incomes of 4 states have increased at rates which are less than 3 but more than 2.57 percent per annum - the rate at which per capita income of India has increased during the same period, but per capita income of M.P. has increased at the same rates at which the income of the country as a whole has increased, while incomes of Assam and Orissa have increased at rates much lower than that of India. However, rates of growth of incomes of all the states except those of M.P., Rajasthan and West Bengal are significantly different from the all India average. Haryana, Karnataka, Punjab, Gujrat and Maharastra jointly with Manipur have the highest growth rates in that order. An interesting point to note is that the states like Bihar, H.P., J & K, Rajasthan and UP which are considered to be backward have matched the growth performance of the so called developed states like Tamil Nadu, West Bengal and Andhra Pradesh; and in the developmental process they have registered growth rate which are higher than the all India average. Low level of per capita income of H.P., Rajasthan and J & K in the base year accounts for their high growth performance. But these growth rates reveal, all the same, a marked degree of regional inequalities in the per capita income levels.

GROWTH OF OUTPUT OF WHEAT

Output of wheat has increased negatively throughout in A.P., in pre green revolution period in West Bengal, and in the post green revolution period in Tamil Nadu. In all other states, it has grown positively throughout. In the first period, positive growth rates range from 0.36 percent for Maharastra to 13.7 percent for Karnataka. Second highest growth rate is shown by Gujrat where output has increased at a high rate of 5.51 percent per annum. Output in five states has expanded at rates which are more than 2 percent, two states have just managed to record growth rates marginally more than the all India average, while the growth rates for four states are much lower than the all India average.

In the post green revolution period, the growth rates range from 0.54 percent for J & K to 11.53 percent for Assam. Seven states have registered growth rates which are greater than 3 percent per annum. Except Karnataka, all these states have succeeded in exceeding their growth performance in the pre green revolution period. But six states

have registered growth rates which are lower than their corresponding rates in the pre green revolution period, though the growth performance of the two of these states just matches the country's average in this period. Punjab has succeeded in raising its growth rate but its growth performance is not superior to that of the country as a whole. Base year value seems to have lowered its growth rate. On the other hand, high growth performance of Assam, Maharastra, Orissa and West Bengal is accounted by the low level of output in the base period, while high level of output of wheat in Gujrat, Karnataka and Rajasthan in the base year may account for their sluggish growth. But both Bihar and U.P. the two so-called most backward states, have succeeded in raising their growth rates substantially in this period. Thus the growth process has become more intensified in the eight states, but it has slackened in the remaining states in the second period. On the whole, output has grown more rapidly in this period. However, the differential growth rates reflect the marked degree of regional inequalities. Spectacular growth of output of wheat in non or marginal wheat growing areas like Assam, West Bengal, Gujrat, Rajasthan, Orissa, Maharastra and Karnataka highlights the declining tendency of these regional inequalities. Chow statistic, which is used to test the significance of the growth performance in the two periods, is significant in 9 states. It means that the growth performance of these states is different statistically in the pre and post green revolution periods.

GROWTH OF OUTPUT OF PADDY

Range of variation of the rates of growth of output of paddy is much less than the range of variation of growth rates of wheat. In the first period, the growth rates range from 0.51 percent in M.P. to 8.73 percent in Gujrat. In fact, output of paddy has increased at a rate as low as 0.76, 0.51, 0.73 and 0.72 percent in five states, three other states have also shown a tardy pace of growth ranging from 1.22 to 1.67 percent. However, five states have recorded highly impressive growth of output of paddy, while three states have registered growth rates which are greater than the all India average. In all, slightly more than 50 percent of all the states have recorded growth rates more than the all India average.

In the second period, the rates of growth of output range from .08 percent in H.P. to 6.56 percent in Punjab. One state has registered negative growth while six other states show only nominal growth of output at rates much less than 1 percent per annum. Growth of output in another six states has taken place at rates of more than one percent but much less than 2 percent. In fact, only three states viz., Punjab, Rajasthan and Maharastra show impressive growth of output in this period, whereas the growth rates of 9 states are much lower than their rates of growth of output in the first period. But growth performance of only seven states is statistically different from that in the first period.

GROWTH OF OUTPUT OF PULSES

Eight states have recorded negative growth of output of pulses in the first period. Changes in the price structure and improvements in yield consequent upon the introduction of high yielding seed varieties have made the cultivation of wheat and paddy more attractive to the farmer than the cultivation of the traditional cash crops, like pulses, oilseeds, cotton etc. in certain areas. In fact, paddy has emerged as the cash crop in the wheat growing areas like Punjab while the traditional rice growing areas like Karnataka, West Bengal and Assam etc. have taken up the cultivation of wheat as one of the cash crops. However, the scarcity of pulses caused by such changes in the cropping patterns of major producers of pulses like U.P. and M.P. have found new pattern for the cultivation of pulses. The positive rates of growth of output of pulses range from 0.94 percent in H.P. to 11.16 percent in J & K which is followed by Gujrat with as high a rate of growth as 9.78 percent. In three states, output has increased at rates approximately higher than 2 percent per annum, three states show tardy growth, while U.P. and M.P. the two largest producers of pulses have shown a miserable growth performance. Differences in the growth rates highlight the existence of a marked degree of regional inequalities.

In the second period, five states show negative growth of output which is much less than the number of states which show negative growth in the first period. The highest rate of growth of output is shown by Tamil Nadu where it has increased at the rate of 2.59 percent per annum whereas the lowest growth rate is 0.01 percent recorded by Kerala. There are only three states where output has expanded at 2 or more than 2 percent rates of growth. All other states depict sluggish growth. Conditions in this period have further deteriorated for the cultivation of pulses. However, scarcity induced price increases have attracted the farmers of states like Tamil Nadu, Karnataka and Orissa to the cultivation of pulses. Growth performance of seven states differs significantly in the two periods.

GROWTH OF OUTPUT OF FOODGRAINS

In the first period, growth rates range from 0.40 percent in Maharastra to 2.68 percent in Orissa. Growth rates recorded by five states exceed 2 percent. But eight states show tardy growth, their rates of growth being 1 or slightly more than 1 percent per annum. Assuming that the population of India and that of the states within the Indian Union has been increasing at the same constant rate of 2 percent per annum throughout the period of study, a growth rate of less than 2 percent per annum implies less output per capita over the years. In the second period, growth rates of the states lie between 0.24 and 2.53 percent. Only three states register a growth rate equal to or more than 2 percent per annum, eight states have registered growth of output at rates equal to 1 or slightly more than 1 percent, while the output of foodgrains in four states has remained practically stagnant. Growth rates of nine states are lower than their corresponding growth rates in the first

period, while the growth performance of six states has improved during the second period, but only in three of these states growth performance in the two periods differs significantly. These growth rates imply that the regional inequalities have persisted in the post green revolution period.

GROWTH OF IRRIGATION AREA

Agricultural output is determined by the area under cultivation and the yield per unit of land cultivated. Area under cultivation at any time happens to be the limiting factor of agricultural growth because cultivated area in any economy can be increased only marginally. Thus, yield per unit of cultivated area emerges as the major source of growth of agricultural output. But the yield is dependent upon the use of modern agricultural inputs like hyv seeds water, fertilizers, and the adoption of scientific cultural practices. Water is, however, the most crucial input. Hence, we have examined the growth of irrigated area also.

In the first period, growth rates range from .01 percent in H.P. to 6.65 percent in Gujrat. Karnataka has registered the second highest growth rate of 2.85 percent. Three states show growth rates which are slightly higher than 1 percent, while the growth of irrigated area in all other states has been very low in this period.

In the second period, growth rates range from .001 in H.P. to 2.53 percent in M.P., five states have registered growth rates which are more than 1 but less than 2 percent, while the growth in all other states has been negligible. Growth performance of five states shows some improvement over their own performance in the first period. However, the growth performance of 12 states is significantly different from their own performance in the first period. Thus, these growth rates point to the existence of substantial regional inequalities in both the periods but these seem to have been further accentuated in the second period. States like Gujrat and Karnataka seem to have performed better than other states in the matter of growth of output of various crops because of their better growth performance in the field of irrigation.

Following conclusions emerge out of the analysis of the growth rates:

(1) Per capita income of all the states of the Indian Union has increased as a result of the implementation of various developmental programmes under Five Year Plans. But the growth process has not mitigated regional inequalities.

(2) Output of wheat has grown more rapidly than income and population. Hence, the wheat sector has contributed to the growth process more than any other agricultural sector. In the process of development, per capita output of wheat has increased. Growth performance of a large number of states in the pre and post green revolution periods differs significantly which implies that the pace of development

has been accelerated in the second period. As the growth performance of different states also differs sharply, it shows the existence of a marked degree of regional inequalities.

(3) Output of paddy has increased only gradually. It has increased more rapidly than population only in six states in the composite period which means that per capita output of paddy in most states is much less than what it was in the base period. Growth performance of only seven states is statistically different in the two periods, and the growth rates vary sharply between the states. It means that there are not only marked regional inequalities in existence but also these do not tend to decline.

(4) Output of pulses has remained stagnant in the country. Growth rates, all the same reveal temporal and regional inequalities.

(5) Only a few states have succeeded in keeping the growth of output of foodgrains ahead of the growth of population as their output, like that of paddy, has increased very slowly. Substantial degree of temporal and regional inequalities is revealed in this field also.

(6) An interesting point to be noted is that the change in the price structure and the increase in yield rates of wheat and paddy have changed the cropping pattern in several states. For example, paddy has become a major cash crop of Punjab which registers highest growth rate in post green revolution period, while Gujrat shows the highest growth rate in the first period. Similarly Karanataka leads the rest of the states in the growth of output of wheat in the first period. (While this distinction goes to Assam in the second Period). States of Himachal Pradesh, Jammu and Kashmir, Gujrat, and Tamil Nadu have emerged as the leaders in the production of pulses.

(7) Only four states, namely Gujrat, H.P., Karnataka and Punjab have recorded impressive growth in all or most of the field examined in the study. Progress of irrigation has enabled Gujrat and Karnataka to join the ranks of the leading states in agricultural development.

(8) Another interesting point is that the so-called backward states like Assam, Bihar, Orissa and U.P. have also matched or even surpassed the growth performance of the so-called progressive states in more than one area of development. It means that no state has been completely bypassed by the developmental process. Therefore, there are no regions which are equally developed or under-developed in all the fields of economic activity.

GEOGRAPHICAL CONCENTRATION

Regional inequalities are a consequence of the spatial concentration of economic activities. Activities are said to be spatially concentrated if these are unequally distributed between regions. We have examined spatial distribution of regional development by two alternative techniques, index of growth performance and Ginni coefficient. Index of

growth performance expresses the performance level in any specified field of a region relative to the national level in that field in a given period.

$$I_{ik} = \frac{X_{ik}}{\Sigma X_{ik}} \quad \text{Where, } i = 1, 2 \ldots\ldots n, \quad K = 1, 2 \ldots\ldots r$$

X_{ik} represents the development level attained by the K th region in the i th field. Year to year movements in I_{ik} would reveal the growth performance of the K th region in comparison to the rest of the country a value equal to 100 would imply that K th region has kept pace with others in the development race in any given year, a value less than 100 implies that K th region has lagged behind the rest of the regions in the country, whereas a value exceeding 100 would reveal that this particular region is leading in the development race. However, year to year fluctuations may be accounted partly by seasonal factors and partly by the factors operating steadily and systematically over a long period of time. Influence of these factors can be captured by the trend values of indices of growth performance. Hence, we fitted the linear trend lines to the various indices of growth performance by the method of Ordinary Least Squares. The results are reported in Table No. 1.

A perusal of the table reveals that performance levels in the production of foodgrains in 6 out of 19 units have declined significantly over a period of 30 years. It implies that these regional units have failed to keep pace with the rest of the country. As against this 4 regional units do not depict any significant trend which means that their relative performance in the production of foodgrains has remained stagnant by and large. But the remaining 9 units have shown a significant trend which implies that as many as 47% of the total regional units have achieved higher than the average growth of output of foodgrains during the same period.

In case of pulses we find that 4 out of 19 regions have fallen behind the rest of the country as they show a significant change in their growth performance; whereas the relative performance of 5 regions has remained stable but as many as 10 out of the total regional units have shown above average growth performance. Incidentally, most of these 10 regions are the major producing areas. The indices of growth performances of wheat show that 5 regions have failed to keep pace with the rest of the country because they are below average growth performance; whereas 3 of them have succeeded in maintaining their initial position but as many as 50 percent of them have recorded growth of output at rate higher than the national average. In case of rice we find that nearly 1/4 of the total units have slided down the ladder, nearly 28 percent of them have kept pace with the rest of the country while the remaining 47 percent of the paddy producing areas have recorded growth at rate higher than the national average. This cropwise analysis of the various units does not differ either qualitatively or quantitatively in the field of all foodgrains. The following conclusions may be derived from the above results.

The growth performance seems to have mitigated to some extent the nature and extent of existing inequalities in the production of foodgrains during the period covered by the study. It implies that agricultural development has not remained confined only to a few selected pockets, as most of the regions seems to have made significant strides in the agricultural production. An interesting point to be noted is that agricultural production is a result of increase of area and yield. So far as the total area under foodgrains is concerned it is stagnating around 80-82 percent to the total cultivated area. This implies that most of the growth of output has been accounted by growth of yield which has been ignited by the change of technology. These results are at variance with the popular belief that green revolution has remained confined to few areas.

The spatial spread of development reflects the even or unevenness of factors lying behind it. If the factors of development are distributed evenly then development cannot be concentrated over a few units. Even otherwise inequalities by themselves are not of any interest until or unless the inequalities are analysed to throw light on issues of policy or theory. For the purposes of policy it is identification of the causes underlying inequalities which constitute the initial step. Hence we have tried to look into few factors of agricultural development such as oil engines, electric pumps and fractors. The first two factors reflect the nature and extent of irrigational facilities whereas tractors are associated with the new agricultural technology. Hence, we have worked out indices of growth performance for these factors as well. But the significance of trend parameter has been tested both at 5 percent and 10 percent probability levels. 10 percent probability level has been accepted in view of the limited number of observations. Eleven out of 17 units show statistically significant change in the relative growth performance. The results reveal that as many as 6 units have succeeded in maintaining their relative growth level of the base year intact while 6 of them have lagged behind in the process of tractorisation and only 5 of them have succeeded in forging ahead of the rest of the country. These results imply that tractorisation has not proceeded at an even pace. As against this, 10 out of the 15 units have maintained their relative position in the ownership of oil engines while 4 of them have improved, only one unit has lost in the race. In the case of electric pumps 7 units have maintained their relative ownership level, 4 of them have been affected adversely while the other 4 have improved their relative position. These results do not imply any significant change in spatial distribution of electric and oil pumps. These three factors can be taken to constitute major items of the package of green revolution technology. As these three factors go together with high yielding varieties, fertilizers and pesticides etc. Ginni coefficient is the most widely used coefficient of concentration. The measure of concentration ratio which is used in this study is the one that was developed first by Ginni and it was modified by Hirschman. The modified coefficient has been used extensively by michaely. Since then it has been used in several studies. The formula is given below:

$$C.R. = \sqrt{(X_1/X)^2} \quad X\ 100$$

where C.R. is concentration ratio, X_i is the value of variable in i-th region, and $\bar{X}$ is the value of the variable for the country as a whole. Value of the ratio varies between 100 and $100/\sqrt{n}$ where n is the total number of regions among which the variate values are distributed.

States of U.P., Punjab and M.P. taken together account for 79.42 percent output of wheat in 1951 which decreases to 76.04 and 73 percent in 1966 and 1980 respectively. Combined share of U.P. and M.P. alone is nearly 59 percent of the total in 1951, while the share of Punjab (including Haryana) is only 21 percent. But the combined share of U.P. and M.P. has declined to 41 percent while that of Punjab and Haryana has increased to 32 percent in 1980. This means that Punjab and Haryana have grown more rapidly than U.P. and M.P. in the post green revolution period. These states account for as much as 78.01, 75.68 and 75.9 percent of the total area under wheat in these years. Thus, their share in area is similar to their share in output. These states account for a very high proportion of total output and area under wheat. An implication of these results is that the yield rates of these states are not much different from those of the other states both in pre and post green revolution periods. But if we consider Punjab and Haryana alone, we find that their share in output in 1980 is double their share in 1951 while their share in area is only 19 percent of the total. It means that the yield per acre in 1980 is much higher than that in 1951. An interesting feature of the results is that though the output and area of wheat is highly concentrated, but the concentration tends to decline over time.

West Bengal, Tamil Nadu, Bihar and Andhra Pradesh account for 51 percent of total output of paddy in 1951, their combined share increases to 54.8 percent in 1966 and then declines to 51.47 percent in 1980. But the share of these states in the total area of paddy is only 44.69, 44.39 and 41.94 percent of the total in these years. Output of paddy is highly concentrated in these four states, and it does not tend to decrease with time. Besides, these four states seem to have much higher levels of yield per acre than those prevailing in other states. Green revolution in the field of paddy, like that of wheat, is also confined to a few states. Both in pre and post green revolution periods, share of output of paddy accounted by West Bengal, Tamil Nadu and Andhra Pradesh is much larger than their respective shares in area. But in the post green revolution period, Tamil Nadu and Andhara Pradesh have a much larger share in output than in area, while the share of West Bengal and Bihar in output is much lower than their share in area. In fact, combined share of West Bengal and Bihar in output decreases from 31.52 percent in 1951 to 21 percent in 1980, while the combined share of Tamil Nadu and Andhra Pradesh has increased from 19.01 in 1951 to 29.46 percent in 1980. It means that the yield per acre in these two states has increased much more rapidly than the yield in other states.

Bihar, M.P., U.P., Haryana and Punjab account for as much as 71.56 percent of total output of pulses in 1951, their combined share increases to 79 percent in 1966, but it declines to 49.52 percent in 1980. This fall in their combined share is accounted mainly by a sharp decrease in the shares of Bihar, U.P. and Punjab though the shares of M.P. and Haryana

have also declined. But the shares of the states of Gujrat, Karnataka, Maharastra, Rajasthan and Tamil Nadu have increased rapidly. As against this, the share of Bihar, M.P., U.P., Haryana and Punjab in the total area is much less than their share in total output in all these years. In fact, they account for only 54.54 and 45 percent of the total area in these years. Hence, their yield per acre has remained much higher than the yield per acre in all other states. With a breakthrough in the production of wheat, northern states seem to have preferred the cultivation of wheat to pulses, while the attractive prices of pulses resulting from their relative scarcity have made their cultivation in other states more popular than before. The concentration of output of pulses has consequently decreased with time.

Sixty-six percent of total output of all foodgrains is accounted by the states of Andhra Pradesh, Bihar, Haryana, M.P., U.P., Maharastra and Punjab. But their combined share decreases to 60 percent in 1966 and to 62 percent in 1980. The corresponding share of these states in the total area under foodgrains has been 70.61, and 62.5 percent of the total in the three years. Their shares both in output and area are very much similar which means that their yield rates are not higher than those prevailing in other states.

These results show that while northern and north-western states specialised mainly in the production of wheat and pulses, eastern, north-eastern and southern states specialise mainly in the production of paddy in the pre green revolution period. But there has been a perceptible change in the cropping pattern in states belonging to all the areas during the post green revolution period.

SPATIAL CONCENTRATION RATIOS

Analysis of proportionate shares of different units in the total provides some idea about the skewness of the distribution. But we do not get a single statistic which is based on all observation and statistical significance of which can be tested. We have, therefore, calculated the spatial concentration ratio of the variate values for each year.

Concentration ratios of output of wheat range from 40.31 in 1976 to 52.11 in 1952 whereas the highest and lowest values of the concentration ratio of area under wheat range from 39.82 to 47.20 in the same years. The calculated values of the ratios are much higher than their corresponding theoretical minimum values which implies that a considerable degree of regional inequalities exist. But there is a tendency for the spatial concentration to decline with time. Concentration ratio of output of paddy ranges from 29.51 in 1978 to 40.48 in 1957, but the concentration ratio of area ranges from 30.87 in 1979 to 36.1 in 1952. The calculated values are not much greater than their corresponding minimum values but they indicate only a moderate degree of inequalities. The concentration of output of rice and area under it is much less than those of output and area of wheat. Besides, the degree of concentration tends to decrease over time.

Concentration ratios of output of pulses lie between 33.17 in 1980 and 40.78 in 1966, but the values of the ratio of area lies between 32.74 in 1964 and 35.57 in 1958. These calculated values are not very much higher than their minimum values. Hence, the degree of concentration of output and area under pulses is indeed very low. Again, the ratios depict a decreasing trend. Spatial concentration of output of foodgrains is very low, and it varies from 27.98 in 1974 to 34.36 in 1975. Concentration of area is still lower than that of output of foodgrains. Their values also tend to fall with time. Value of the concentration ratio of irrigated area ranges from 31 in 1968 to 41 in 1952. All the calculated values of the ratio are not much greater than their corresponding minimum value. Hence, irrigated area does not show any considerable degree of inequality in its geographical spread. However, there is a perceptible trend for the geographical concentration to shrink over time. Thus, uneven distribution of irrigational facilities does not account for uneven distribution of output. Concentration ratio of oil pumps ranges from 41.41 in 1961 to 49.91 in 1951, the ratio of electric engines varies from 46.7 to 70.68, while the ratio of tractors lies between 33 in 1966 and 54.67 in 1961. All these values are much greater than the minimum values. The agricultural machinery depicts a much greater degree of concentration than area or output. Among the agricultural machinery, electric pumps show the greatest degree of concentration ratio. But the spatial distribution of agricultural machinery, like that of output and area, also tends to become more even over ti,e. An interesting feature of the distribution of machinery is that greater the value of the machine, more uneven tend to be its distribution. The above results show that even though output, area, irrigation and agricultural machinery are not exactly equally distributed over space, but there is a definite trend for these inequalities to shrink as the developmental process has gathered momentum over the years. This hypothesis is tested by means of the estimated trend of the concentration ratios. We have estimated the trends for the entire period, called the composite period, pre green revolution period, called the first period, and the post green revolution period, called the second period. We have also tested the difference between the first and the second periods by means of Chow statistic. Estimated trend lines are reported in Table 2.

Ten out of twelve trend equations fitted to the concentration ratios of output fit the data well. Regression and correlation coefficients are not significant statistically only in case of pulses in the pre and post green revolution periods and total foodgrains in the post green revolution period. In all other cases, the regression and correlation coefficients are statistically significant. Estimated equations of wheat explain as much as 28.5 to 70 percent of total variation. Proportion of the total variation explained by the estimated equations of pulses varies from 25 to 51 percent, while the equations fitted to the concentration ratios of foodgrains explain as much as 49 to 69 percent of total variation. All the regression coefficients are negative which means that the degree of concentration has been decreasing in all the states throughout the period of study and the rate of decrease has been significant in all but three cases. An interesting point is that the rate of decline in

the concentration ratio in the second period is much greater than what it is in the first period in all but one case. The difference in the post and pre green revolution periods in the trend behaviour of the concentration ratios is statistically significant in all cases except wheat. This leads support to the view that regional inequalities tend to shrink at mature stages of growth. It may be noted that the high values of concentration ratios are in the decade of fifties while their values have been reduced considerably in the decade of seventies in all the case. It implies that the agricultural economy of India has been moving rapidly towards the nature stages of growth during the last decade. Equations 13 to 24 relate to the concentration ratios of area under these crops. Nine out of twelve regression/correlation coefficients are statistically significant. Non-significant coefficients relate to rice in post green revolution period, to pulses in the composite as well as pre and post green revolution periods. Proportion of explained variation ranges from 51 to 80 percent for wheat, it varies from 60 to 70 percent in case of paddy, it is around 35 percent in case of pulses while it lies between 38 and 81 percent. All coefficients except one of pulses in the second period are negative. It means that the degree of concentration has been decreasing with time steadily. But in this case, the quantum of decline is much less in the second period than that in the first period.

The Chow statistic shows that the difference between the pre and post green revolution declines is statistically significant in all cases except wheat. As the growth of output of paddy has been much less than the growth of output of wheat, especially in the post green revolution period, the decline in the concentration ratio of paddy in the second period is also much less than that of wheat. Thus, faster the growth, more rapid is the decrease in the regional concentration. This hypothesis is amply supported by the results relating to the trend of decline depicted by the concentration ratios of pulses and all foodgrains which have shown much slower growth even that of paddy.

All the three regression coefficients of irrigated area are also negative. But only two of them are statistically significant. It means that the regional concentration of irrigated area in the post green revolution has decreased but the decrease is negligible. The fitted equations explain relatively low percentage of total variations in this case. Besides, Chow statistic is not significant statistically. All the three types of agricultural machinery also depict a decreasing trend but the rate of decrease is not significant statistically only in case of tractors. Since the other two types of machinery are related to irrigation which means that mechanised irrigation has become popular in a number of regional units which have experienced appreciable agricultural growth.

These results establish that only output and area of wheat are highly concentrated, output and area of paddy are only moderately concentrated, while output and area under pulses and foodgrains are fairly evenly distributed over space. Irrigation is evenly spread over various geographical units, while agricultural machinery is very highly concentrated in few regions. All the concentration ratios decrease with time.

The concentration ratios in the post green revolution period decrease faster than in the first period in all the cases, except wheat. Hence, we get empirical support for the hypothesis that the benefits of the green revolution have percolated to a large number of areas. An interesting result is that more rapid is the growth, greater is the pace of decline of regional inequalities.

VARIANCE AND INTRA-CLASS CORRELATION ANALYSIS

In view of the results that we have obtained in the preceding sections, we formulate the twin hypotheses that the levels of development of each state in various areas of agricultural development are homotypic, and the mean levels of development of all the states taken together in different years are not different. First hypothesis is tested by variance analysis whereas the second hypothesis is tested by intra-class correlation.

Analysis of variance can be used to select the best amongst the several alternative ways of classifying a given set of statistical data. Best classification is defined as the one which yields the maximum sum of squares between classes and the minimum sum of squares within the classes. If within class variation is greater than between class variation, intra-class correlation coefficient will be negative. If between class variation is greater than within class variation, intra-class correlation will be positive. A negative intra-class correlation coefficient will indicate that the mean level of development of all stages in a year is significantly different from the levels attained in other years.

Empirical results of variance analysis and intra-class correlation are reported in Table 3.

Nine out of thirteen ratios are statistically significant even at 1 percent probability level. F ratios of per capita income and all the agricultural machines are not significant statistically. It means that the null hypothesis of equal levels of development of the states is supported only in case of per capita income and agricultural machinery while there is empirical evidence in support of the alternative hypothesis that the developmental levels of different states differ significantly in the other nine cases. Incidentally, results of variance analysis in case of income and machinery are at variance with those obtained in the preceding sections. The results, however, reveal a significant degree of regional inequalities in agricultural development. Nine of these thirteen intra correlation coefficients are positive which support the hypothesis that the mean level of development attained by all the states taken together is not significantly different from the mean levels of development attained in other years. Intra-class correlation coefficient is negative in case of per capita income, oil engines and electric pumps which implies significant temporal differences in the mean level of development attained by different states. Thus, the mean level of agricultural development does not differ significantly between different years while the development levels of income and agricultural machinery does differ from year to year. These results are not in consonance

with those obtained from the Chow statistic. This may be due to any one of the following two alternative reasons; either agricultural development has taken place gradually but steadily in all the years or that the agricultural development has taken place rapidly only in few regions in few years which has left the average of all the states in different years homotypic. The second interpretation implies a marked degree of regional inequalities which is in conformity with the results of the analysis of variance.

We have also analysed the developmental performance of states in all the fields simultaneously. For this, we have worked out the mean level of development of a state in a given area over all the years by taking the geometric mean of the indices of development. In this case, the twin hypotheses are that the different developmental factors are homotypic, and the mean levels of development in all the fields for each unit are not different significantly. The results are tabulated below:

Source	Sum of squares	d.f.	Mean sum	f	Intra-correlation
Between	0.057237	15	.003816	.0627	- .0781
Within	11.689318	192	.060882		

Between factor variation is much less than the within factor variation, hence the F ratio is much less than 1 which is not significant statistically. It means that the mean level of development of all the states taken together in one field is not statistically different from the development in other fields. But the intra-class correlation coefficient is negative which means that the mean level of development of a unit in all these fields taken together is different statistically from the mean development levels of other units (states). This shows that there are significant regional inequalities of development, especially the agricultural development.

CONCLUSIONS

Our results confirm that there exist a marked degree of regional inequalities in the field of agricultural development. But with movements of the economy along its developmental path, these inequalities have tended to shrink. The inequalities have decreased faster in those fields in which the development has occurred more rapidly. Temporal differences in the developmental performances have also been indicated even though this has not been confirmed by the results of intra-class correlation analysis the results of which are at variance with those obtained from the trend analysis of the regional concentration ratios and the Chow statistic. As a result of agricultural development, changes in cropping pattern of the states has also taken place. Prices in general and the overall profitability of a crop seem to have been the motivating forces behind these changes in the cropping pattern.

Table 1
Trend Lines of Indices of Growth Performance

	Foodgrains			Pulses			Wheat			Paddy		
	a	b	t	a	b	t	a	b	t	a	b	t
A.P.	9.0731	-.0534*	2.3092	2.5429	0.019	0.8143	0.3703	-0.0130*	2.5732	10.2159	.0990*	2.1239
Assam	2.6755	-.0250*	4.6265	0.2214	0.0056*	3.1989	-.1980	0.0229*	3.0631	6.7727	-.0827*	6.8765
Bihar	8.7623	-.0326	1.1604	10.0760	-.0967*	1.8942	.7760	.2942*	5.3138	13.6833	-.1258*	2.8239
Gujrat	2.1224	.0488*	3.6892	1.3357	0.0095	0.9485	2.1643	.0656*	3.6608	0.6256	.0184*	2.2942
Haryana	2.4754	.0671*	5.8292	11.9084	-0.2089*	4.0652	6.5403	.1063*	6.7482	-.0407	.0582*	10.1403
H.P.	0.2498	0.0242*	5.0121	-0.0485	0.0128*	8.0970	.9745	.0091	1.3759	.1241	.0051	1.8392
J & K	0.6267	0.0124*	3.8648	-0.0139	0.0117*	6.1546	1.1686	-.0170*	4.1528	.6866	.0104*	3.1757
Karnatak	4.8608	0.0305*	2.0667	1.3231	0.1360*	4.6143	.3843	.0141	1.7092	3.0346	.0743*	4.1892
Kerala	1.5456	-0.0134*	4.2723	0.1321	0.0004	0.4693	-	-	-	3.0247	-.0015	0.1080
M.P.	12,8958	-0.1328*	4.9480	12.2776	0.2363*	3.9759	19.7283	-.3656*	6.0539	10.8031	-.1421*	4.002
Maharastra	9.1398	-0.0807*	2.1004	5.8193	0.1052*	2.4310	4.6198	-.0752*	3.8035	4.5497	-.0291*	1.9303
Orissa	4.4439	0.0090	0.4317	0.8330	0.1681*	6.5910	-.0613	.0122*	8.0762	9.7938	-.0177	0.5329
Punjab	2.8979	0.2007*	7.6391	8.2605	-0.2112*	2.6165	14.7428	.2815*	7.376	-0.9157	0.1724*	7.9505
Rajasthan	6.7046	-0.0402	1.7572	7.9493	0.1750*	2.6690	9.0941	-.0442	1.1712	0.2221	.0034	1.4826
Tamilnadu	7.5543	-0.0484*	2.6993	0.4217	0.0417*	4.6348	-	-	-	12.2566	-.0276	0.6061
U.P.	18.4763	-0.069*	2.2662	33.2769	-0.4019*	5.0744	38.2916	-.3016*	4.8828	9.0599	-.0123	0.5157
W.B.	7.2400	-0.0141	0.9364	3.5212	-0.0058	0.2778	-.4955	.1219*	6.0170	17.7254	-.1488*	4.7564
N.E.	0.3164	0.0141*	5.2679	-0.0384	0.003*	5.0770	-	-	-	.8639	.0283*	7.0497
U.T.	-0.0950	0.0175*	5.8292	0.0818	0.0002	0.1154	.1958	.0073*	6.2804	-.1786	.0284*	11.9124

Table 2
Trend Equations of Concentration Ratios

	Inter-cept	Slope I	t	r^2	Inter-cept	Slope II	t	r^2	Inter-cept	Slope III	t	r^2	F
Production													
Wheat	50.6824	-0.3234	4.3759*	0.6147	74.6278	-1.3586	2.7836*	0.3924	50.7474	-0.3392	10.9017*	0.8205	0.1544
Paddy	35.0071	-0.2379	5.3064*	0.7012	55.8466	-1.0493	2.6750*	0.3736	60.8214	-1.7652	3.2159*	0.2846	5.5563*
Pulses	40.8075	-0.1211	1.0841*	0.1438	42.5249	-0.2488	1.9906	0.2482	41.8646	-0.2197	4.7171*	0.5145	3.2900
Foodgrains	34.0070	-0.2959	4.5038*	0.6927	31.9969	-0.1179	1.2611	0.1170	32.6879	-0.1521	4.7088*	0.4908	3.0572
Area													
Wheat	49.5224	-0.5371	4.8501*	0.6814	47.4582	-0.2496	2.8781*	0.5087	47.3235	-0.2658	9.2103*	0.8016	0.3837
Paddy	34.7032	-0.2139	5.0450*	0.6982	32.3961	-0.0417	1.0156	0.1224	33.7785	-0.1069	5.5758*	0.5970	7.4218*
Pulses	36.7153	-0.1790	1.8082	0.3514	34.0072	0.0165	0.4558	0.0253	34.9844	-0.0275	1.0707	0.0669	4.0307*
Foodgrains	34.9841	-0.3890	5.5829*	0.7391	30.5855	-0.0237	2.2044*	0.3779	32.3507	-0.0997	9.4949*	0.8111	8.4820*
Total cultivated area	35.8715	-0.2754	2.2043*	0.3064	30.9957	-0.0606	0.5092	0.0280	34.4183	-0.0999	2.0191*	0.1563	1.7998
Tractors	-	-	-	-	-	-	-	-	44.4457	-0.3979	0.8527	0.1538	-
Oil pumps	-	-	-	-	-	-	-	-	50.2677	-0.5777	5.1502*	0.8984	-
Electric pumps	-	-	-	-	-	-	-	-	66.3487	-0.7911	1.529	0.438	

Notes: I - Pregreen revolution period.
II - Post " " "
III - Composite period.

Table 3
Analysis of Variance

	Between Mean sum of squares	d.f.	Within mean sum of squares	d.f.	F	ra
Production						
Wheat	3480512.61	14	1468058.52	405	2.37	0.04
Rice	3043484.02	15	673979.48	432	4.52	0.10
Pulses	596185.72	15	60111.45	368	9.92	.26
Foodgrains	15571803.82	15	3650679.84	400	4.27	.10
Area						
Wheat	1970526.77	14	193637.42	315	10.18	.28
Rice	3423605.40	15	131246.52	336	26.09	.52
Pulses	2099444.20	15	153452.90	272	13.69	.40
Foodgrains	28283089.78	15	993451.58	352	28.47	.53
Total irrigated area	2344828.53	15	208414.41	368	11.25	.28
Tractors	17549032.02	15	8367102.45	80	2.10	.14
Oil engines	255484310.0	15	485478559.3	64	.53	-.11
Electric pumps	118868740.00	15	410047675.0	64	.29	-.15
PCI	12657.13	15	87821.82	368	.14	-.04

Where ra = intra - class correlation coefficient.

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