

SUMMARY, CONCLUSIONS AND POLICY RECOMMENDATIONS

Madhya Pradesh state is the largest state in the Indian Union. It is predominantly an agrarian state as 53.6 per cent of income derived from agriculture and this sector employed about 80 per cent of the total work force. The physiography and agro-climatic conditions of the state exhibits a great deal of diversities. Its vast size presents an extensive array of agricultural situations resulting in formidable complexities of problem. This state comprises of 12 agro-climatic regions. These regions have great deal of heterogeneity in agro-climatic conditions which results in not only in different cropping pattern but diversities in agrarian structure which is result of heterogenous distribution of natural resources, climatic conditions and socio-economic frame-work.

The problem of regional disparities in the wake of green revolution has been engaging the attention of planner as well as researchers. The introduction of high yielding varieties and the associated new capital intensive technology during the late sixties provided an impetus to ~~show-down~~ agricultural growth in the state ^{but slow.} The annual foodgrain production was 1.84 per cent per annum in post-technological period in the state whereas it was 2.36 per cent at national level. Besides its slow pace of development in agricultural growth, the inter-regional disparities have also widened in the state.

In order to envisage the extent of regional disparities in the agricultural growth and factors associated with these regional variation, it is necessary to study the recent trend in the area, production and productivity at regional as well as cropwise disaggregate levels in the state. No comprehensive work at regional level has so far been attempted in Madhya Pradesh. The present study is proposed to fill this void and was undertaken to analyse the agricultural growth pattern and regional disparities in Madhya Pradesh with the specific objectives.

The main objectives of the study were to estimate the rate of growth in area, production and productivity of different crops/crop groups in different regions of the state of Madhya Pradesh and to study the inter-regional disparities in these growth rates and the factors causing these regional disparities during post-technological period.

The studies reviewed on the subject of research under study revealed that most of them relate regional, divisional and state level, ^{but} of other states than Madhya Pradesh. Only a few dealt with this state at state level or with few districts with one or two statistical tools. Therefore, this study was carried out to analyse the regional level data using various statistical tools for estimating the extent of disparities in area, production and productivity, and factors associated for regional variations.

As regards the methodology, all the 12 agro-climatic regions of the state identified in N.A.R.P. were selected. The area, production and productivity of important crops/crop groups and factors associated for agricultural development were taken into account. The variables considered in this study were:

- (a) Regions: Twelve agro-climatic regions and state as a whole. Total = 13.
- (b) Crops/crop groups: Area, production and productivity of important crops/crop groups viz. Total foodgrains, total cereals, rice, wheat, jowar, kodo-kutki, total pulses, gram, arhar, urid, teora, masoor, total oilseeds, mustard, soybean, linseed, sesamum, groundnut, sugarcane and cotton in each region and state. Total = 20.
- (c) Factors associated for crop growth: Area under; net area sown, total cropped area, cropping intensity, net irrigated area, total cropped irrigated area, irrigation intensity, area under irrigated crops; rice, wheat, total cereals, total pulses, total oilseeds, sugarcane and cotton, area under high yielding varieties; rice, wheat jowar, total high yielding varieties and total fertilizer consumption in each region and state. Total = 18.
- (d) Time period: Post-technological period 1966-67 to 1983-84. 18 years data.

Analytical tools

As regards the analysis of data, number of tools were applied.

(1) Moving averages: In order to minimise the irregular fluctuations in the time series data on the respective variables, the three years moving average were worked out. The entire 18 years original time series was transformed to 16 years time series moving average of the respective variable.

(2) Averages: The averages of each respective variable were estimated for the study period by arithmetic mean.

(3) Absolute and relative changes: Average of first triennium (i.e. 1966-67 to 1968-69) as base year and last triennium (i.e. 1981-82 to 1983-84) as current year were worked out to estimate change over period for each variable.

(4) Coefficient of variation: For each variable, the coefficient of variation was worked out to estimate regional variation in each variable.

(5) Linear trend: By linear regression analysis the linear trend was worked out for each variable to estimate trend during the post-technological period. Significance level of coefficients were tested at 1, 5 and 10 per cent level of significance.

- (6) Growth rate: Growth rate for each variable was worked out by log linear regression analysis ($\log y = a + bt$).
- (7) Correlation coefficient: Correlation coefficient between regional growth rate of area, production and productivity with causal factors associated for crop growth were estimated.
- (8) Multiple linear regression analysis: This analysis was used to estimate the influence of causal factors for production of important crops/crop groups at state level.

For background of the study area, triennium averages of current period (1981-82 to 1983-84) of each region and state on various aspects like: land utilization pattern, rainfall, soil type, cropping pattern, area under kharif and rabi crops, cropping intensity, area, production and productivity of important crops/crop groups; irrigation: percentage of net irrigated area to net area sown, sources of irrigation and sourcewise irrigated area, cropwise irrigated area; area under high yielding varieties: cropwise high yielding varieties, percentage to respective crop; fertilizer use - nutrient-wise and distribution of working force in agricultural sector were discussed.

The findings of research project are summarised below:

Regional disparities of important crops for their area, production, productivity and linkage effect of important factors of development, which were put to various statistical analysis to measure the degree of imbalance in the agricultural growth revealed that regions are heterogenous in size of cultivated area. It varied from 1.8 per cent in Jhabua hill region to 19.2 per cent in Chhatisgarh plain region to state cultivated area. During post-technological period it had not shown any significant change which was revealed by relative change index for current over base year, coefficient of variation, linear trend and growth rates in all the regions. Total cropped area had increased slightly over cultivated area which indicates that area sown more than once had increased particularly in Northern hills of Chhatisgarh, Gird and Malwa regions. The cropping intensity of these regions were found to be comparatively more than other regions which was 134.7, 117.8 and 113.6 per cent, respectively. It was lowest in Central Narmada valley (103.5%), Vindhyan plateau (103.7%) and Bastar plateau (104.3%). The percentage irrigated area was found highest in Bundelkhand region (25.4%), followed by Gird region (19.2%), Chhatisgarh plains region (18.2%) and it was lowest in descending order in Northern hills of Chhatisgarh region (1.4%), Bastar plateau (1.5%), Vindhyan plateau (3.7%) etc. The growth rates of irrigated area have shown by and large significant increase in all the regions particularly in Central Narmada valley region 16.36 per cent per annum and having relative change index of 1037.6 per cent and

coefficient of variation 67.2 per cent. Only Bastar plateau region had not shown any increase in irrigated area. Similar results were found for cropped irrigated area. The irrigation intensity was found to be at low ebb in all regions which indicates that irrigation water was under utilized and there was ^{scope} ~~scope~~ for utilization of irrigation facilities available in all regions.

Total foodgrain crops

As regards the cropping pattern and growth rates of crops/crop groups during post-technological period, the results of various statistical measures revealed that foodgrain crops which occupied about 80 per cent of the total cropped area in most of the regions except in Nimar valley, Malwa plateau and Gird regions, had maximum coverage to the state area under foodgrain crops in Chhatisgarh plains (23.68%), followed by Malwa plateau (14.23%), Vindhyan Plateau (10.7%), Kymore plateau (10.3%) etc. and lowest in Jhabua hills region (1.72%). The contribution of foodgrains production to state was as per the coverage of the area. The productivity was found to be more than state average in few regions like Malwa (134.4%), Gird region (122.75%) and Bundelkhand region (115.45%) but far below ⁱⁿ Satpura plateau (79.4%), Northern hills of Chhatisgarh (79.9%) and Kymore plateau (83.4%). Foodgrain production have shown significant increase in

growth rates of production in Malwa, Bundelkhand and Jhabua hills regions. In these regions, relative change index, C.V. and linear trend confirmed the results of growth rates. The increase in production was mainly contributed by increase in area rather than productivity, as productivity had not significantly increased in most of the regions. Coefficient of variation showed great variation among regions which indicate regional disparities in foodgrain production. Correlation coefficient of regional growth rates of area, production and productivity to causal factor revealed that production is significantly correlated with area rather than productivity. Causal factors like cropwise irrigated area, cropwise HYV area, and total fertilizer consumption do influence the productivity of the foodgrain crops. Multiple regression and correlation analysis at state level revealed that production of foodgrain crop is significantly influenced by area, productivity, irrigated crop area and fertilizer consumption. The results indicate that foodgrain production had increased in all the regions and particularly in those where irrigated area and fertilizer consumption have increased like Malwa, Bundelkhand and Gird regions.

Total cereals

Total cereal crops have shown similar pattern as total foodgrain crops with some variation only in the magnitude of growth rates. However, in case of productivity of these

crops, the pattern as well as magnitude of growth rates considerably varied among the different regions. Bundelkhand, Malwa and Gird regions have shown significant increase. The C.V. for area in all regions vary less than the production and productivity which indicates that area under cereal crops had not changed much as production and productivity. The area under irrigation of cereal crops showed significant increase in all the regions during post-technological period. It had increased manifold in many regions like Central Narmada valley, Northern hills of Chhatisgarh, Vindhyan plateau, Malwa plateau regions. Only in Bastar plateau it had remained stagnant. As regards the area under total high yielding varieties which were mainly of cereal crops, showed significant sizeable increase in growth rates in all the regions but the share of high yielding varieties to total cereal crops was very less and have ranged from 4.21 per cent in Jhabua hills to 15.6 per cent in Chhatisgarh plain region. Surprisingly the area under HYV was less than the total irrigated cereal crops. It indicates that even in irrigated areas, the local varieties still dominated. The cereal crop production is significantly correlated with area and productivity of crops, productivity is significantly correlated more with irrigated cropped area than the area under HYV and fertilizer consumption. The results of multiple regression analysis at state level indicates that production is significantly influenced

by area, productivity and irrigated area under crop. HYV area had positive but insignificant influence.

Rice

Performance of rice crop at regional and state level revealed that more than 82 per cent of area and production were in rice crop zone consisting of three regions viz., Chhatisgarh plains, Bastar plateau and Northern hills of Chhatisgarh. Another important region was Kymore plateau which covered 10 per cent of area and 7 per cent of production. Remaining regions covered 8 per cent of rice area and 6.2 per cent of rice production in the state. The growth rates have shown slow pace for area, production and productivity in rice growing regions. The coefficient of variation and relative change index of current year over base year revealed less variation in these regions. The area under irrigation though it had increased but not sizeable as compared to area under high yielding varieties, which had increased significantly for all the regions. At state level the area and production had increased very slightly but productivity had declined slightly. Correlation coefficient study revealed that productivity was not highly correlated with the causal factors like irrigated area, HYV area and total fertilizer consumption which was also revealed in multiple regression analysis. The probable reasons for negative growth rate in productivity of rice crop at state level, with

increase in area along with improvement in crop production technology may be due to the fact that the technology may not be sufficient to minimise the non-controllable crop production factors and addition of inferior lands for rice crop in non-paddy regions like Central Narmada valley, Gird, Nimar and Jhabua hills. In these regions there was decrease of area under inferior crops like kodo-kutki which were grown on inferior soils. This is further supported by high coefficient of variation values in these regions.

Wheat

Wheat crop performance at regional and state level revealed that this crop was also localised to certain regions, as only four regions have covered three-fourth of the state area under this crop, viz. Vindhyan plateau of wheat crop zone (28.65%), Kymore plateau of rice-wheat crop zone (16.43%), Gird region of jowar-wheat crop zone (15.34%) and Malwa plateau of jowar-cotton crop zone (14.68%). These regions contributed 70 per cent of state production of this crop. In wheat zone of Vindhyan plateau region, the growth rate of area remained stagnant but production had significant growth rate because of increased productivity. The coefficient of variation, relative change index, linear trend revealed the same. This may be due to growth rates of area under irrigation and HYV have significant sizeable growth rates. Gird and Malwa regions have shown excellent performance of

productivity level which in turn resulted in increased irrigated and HYV area in these regions. Coefficient of variation shows great variation in area, production and productivity among the regions which shows that there was regional disparity in growth rate for this crop. In non-wheat growing regions, the area under wheat was mostly irrigated and under HYV. The correlation coefficient revealed that production is highly correlated with area (0.84) and productivity (0.66). The productivity is correlated with irrigated cropped area, HYV area and total fertilizer consumption. The same results were observed in multiple regression analysis at state level. This crop had shown over and all growth in all regions but it needs more area to be brought under HYV and irrigation in wheat growing regions particularly in Vindhyan plateau. On the contrary to rice crop, the area under high yielding varieties was more than the irrigated area for this crop.

Jowar

Jowar crop in the state occupied 10 per cent of the total cropped area and was mainly grown in Malwa plateau (40.83%), Gird region (14.43%), Nimar valley (13.46%) and Satpura plateau (8.0%). These five regions covered 7.5 per cent of area and 84.3 per cent of production of jowar crop in the state. The growth rates have shown deceleration by and large in the regions for their area, production and productivity. Relative change index over base year triennium revealed

sizeable decline in most of the regions which is further established by high C.V. value in these regions. The deceleration in growth rates of production was mainly due to decline in area of this crop as productivity showed stangation/insignificant deceleration in most of the regions. The reason for deceleration in area might be that this crop was substituted by kharif competing crops like soybean^{and} Others which was noticed, an increase in area of soybean in these regions. This crop needs further break through in crop production technology for higher yields and reduction in maturity period.

Smaller Millets

Kodo-Kutki is the main smaller millet crops which occupied about six per cent of the total cropped area of the state. In the state it was mainly grown in regions of Chhatisgarh plains (26.9%), Northern hills of Chhatisgarh (26.9%), Kymore plateau (16.0%), Bastar plateau (11.0%) and Satpura plateau (11.0%). These five regions covered 92 per cent of area and 80 per cent of production for this crop in the state. The growth rates of area, production and productivity have shown significant deceleration in all the regions. The area had been reduced by 13% at state level over base year triennium. This crop might be substituted by other kharif competing crops. This crop had low potential for yield and fetches low price, might be reasons for deceleration

in area and production. The deceleration in productivity may be due to that more inferior lands are used to grow this crop. But this crop cannot be substituted in high proportion in tribal regions as this crop is the main diet of tribal people.

Pulse crops

Total pulse crops covered about 21 per cent of cropped area in the state and it varied from 7.0 per cent in Bastar plateau to 37.0 per cent in Central Narmada valley regions. The important regions for pulse crops in the state were Chhattisgarh plains (21.32%), Malwa plateau (18.4%), Vindhyan plateau (13.0%) and Gird region (11.0%). Among these regions, Malwa and Vindhyan plateau have shown sizeable increase in area and production over base year triennium with high coefficient of variation and sizeable growth rates. In other two regions insignificant increase growth rates were observed for area and production. The regions which are coming up for pulse production were Central Narmada valley and Bundelkhand. Pulse crops were generally grown under rainfed conditions but now in certain regions they were being irrigated to the extent of 12 per cent of pulse area. The area and production of pulse crops at state level have shown an increase of growth rate of 1.46 and 1.62 per cent, respectively. The correlation coefficient studies revealed that production was highly correlated with area (0.94) and productivity (0.72). The productivity was correlated with irrigated area only. Similar results were found in multiple regression analysis.

Gram

Among the pulse crops, gram is the important crop which had 8.32 per cent of cropped area in the state during the study period. The important regions where it was mainly grown were Malwa plateau (22.15%), Gird (18.32%), Vindhyan plateau (22.27%) and Kymore plateau (13.05%). These four regions covered about 72 per cent of area and 75 per cent of production in the state. The relative change over base year triennium have shown remarkable increase with high coefficient of variation in Malwa and Vindhyan regions but declining trend in Kymore and Gird regions. There was regional disparities in its growth rates in area and production because of varying level of productivity of this crop. In Gird region the area had shown stagnant growth rate but production had shown growth rate of 4.69 per cent and productivity to the extent of 5.27 per cent whereas declining productivity in Vindhyan plateau stagnated the growth in production of this crop. Malwa and Central Narmada valley regions have an increase in growth rates of area, production and productivity. At the state level, gram production had recorded an increase of 2.69 per cent of which the share of area was more (2.61%) than the productivity (0.49%). The correlation coefficient and multiple regression analysis have also revealed the same. Irrigated cropped area have positive influence on the productivity of gram crop.

Arhar

Arhar crop was generally grown by and large in most of the regions. During the post-technological period the area and production have not shown any noticeable increase in growth rates; on the contrary, have declined in several regions. Malwa and Central Narmada valley regions were important regions for arhar production. The productivity of this crop remained stagnant or declined in most of the regions except in Gird region. The growth rate at state level for area, production and productivity were at low ebb. There is need of break through in crop production technology for higher yield and short duration varieties. There was wide regional disparities for arhar production which was revealed by high C.V. relative change, linear trend and growth rates.

Urid

Urid, another important crop, was widely grown in different regions of the state. Mostly it was grown in Malwa plateau (25.2%), Chhatisgarh plains (22.23%), Nimar valley (13.67%), etc. In Chhatisgarh region, the area and production have declined but in rest of the regions its area and production have significantly increased particularly in Malwa, Vindhyan and Kymore plateau regions. Productivity remained stagnant in most of the regions except in Central Narmada valley and Vindhyan plateau regions. At state level, the

area and production have increased by growth rate of 1.74 and 1.70 per cent, respectively but productivity had declined. For this crop, no break through in crop production technology had occurred. The area might be increasing because of higher prices in the market.

Teora

Teora crop is mostly grown in Chhatisgarh plains region which covered 83 per cent of area and 77 per cent of production of the state. In this region, it had shown less variation in area during study period as revealed by less C.V., relative change and growth rate. Despite the discouragement by government to grow this crop on medical ground, area had not declined because its cultivation was practised under 'utera' cultivation in which teora is sown in standing paddy crop fields. The other regions where it was grown were Central Narmada valley, (5.44%), Vindhyan plateau (5.3%) and Kymore plateau (3.96%). In these regions, area, production and productivity have declining growth rates. Malwa region which had very less area under this crop had shown increase in area, production and productivity. This crop needs suitable varieties free from toxic effect.

Lentil

Lentil crop had only 1.4 per cent of state cropped area. This crop was mainly grown in Vindhyan plateau (42.16%), Kymore plateau (19.58%) and Gird region (10.2%). These regions have increased growth rates of area and production but in rest of the regions the area and production have receded or stagnant. At state level, the growth rate of area, production were very low and productivity had declining growth rate.

For pulse crop there is need to evolve suitable varieties at regional level for drought resistance and less duration. Plant protection measures will boost the pulse production which is the utmost need of the state.

Oilseed crops

In the state total oilseed crops covered 9.2 per cent of the cropped area during post-technological period. At regional level, the share of oilseed crops varied from 7 to 12 per cent. At regional level, there was wide variation for contribution to state oilseed production. Malwa region had shared 29 per cent, followed by Gird (14%) and Chhatisgarh plains (10.7%) to state oilseed production. Though Chhatisgarh plains had maximum share of area (16.8%) but due to low productivity level it had contributed only 10.7 per cent to state. The similar trend was observed in Vindhyan plateau

and Nimar valley regions. Central Narmada valley, Gird and Malwa regions have shown significant growth rates of production - 8.27, 5.03 and 2.21 per cent per annum, respectively with high coefficient of variation and relative change index. The low productivity level was observed in most of the regions except in Malwa and Gird regions. The reasons for low yield may be due to uncared management for oilseed crops production as they were grown on inferior land or mixed with cereal crops, as linseed with paddy crop in Chhatisgarh region and mustard and linseed with wheat crop. Almost negligible irrigation and fertilizer were applied for these crops and moreover no break through in high yielding varieties was achieved. In few regions oilseed crops were irrigated, like in Gird region about 13 per cent area under oilseed crop was irrigated and it had shown significant sizeable increase in growth rate. Irrigated area had influenced the productivity leaving few exception as in Chhatisgarh plains and Bundelkhand region. Oilseed crops have shown wide regional disparities in area, production and productivity in the state on account of agro-climatic and different oilseed crops grown in the regions.

Mustard

Among the oilseed crops, mustard was important crop but its area was localised to Gird and Northern hills of Chhatisgarh regions. These two regions contribute about 75

per cent of area and 80 per cent of production to state. In both the regions, growth rates have shown significant increase in area, production and productivity particularly in Gird region. The relative change index (352.2%), C.V. (27.5%) and linear trend (5.103) were found high in Gird region. In Malwa and Bundelkhand regions though the area under this crop was less but the growth rates for area, production and productivity were found significantly increasing. At state level, the production had recorded growth rate of 6.02 per cent which was contributed by area and productivity by 3.13 and 2.17 per cent, respectively. The different statistical measures revealed that there was wide regional disparities with regard to area, production and productivity of this crop.

Soybean

Soybean crop is the most important crop of the state. For its area and production this state is called 'soya state' in India. This crop was mainly grown in Malwa plateau which covered 63 per cent of the state area. The other important regions were Vindhyan plateau (11.8%), Central Narmada valley (10.4%) and Satpura plateau (8.9%). In these regions, the growth rates of area and production have shown a very highly significant increase particularly in Malwa region where it had recorded 147.23 per cent increase in area and 155.10 per cent in production during the reference period. By and large, similar growth rates were observed in other regions

also. Relative change index revealed manifold increase in area and production in all the regions, as this crop has become popular for the last one decade. The coefficient of variation was found abnormally high and very significant linear trend was noticed for this crop. But the productivity had not shown any significant change in growth rate. At state level, the production had recorded 52.72 per cent growth rate which was contributed mainly by area of 48.45 per cent and only 0.8 per cent by productivity. There is need to raise the productivity of this crop by mobilizing the farmers to use rhizobium culture, suitable HYVs, adequate fertilizer dose and plant protection measures.

Sesamum

Sesamum crop was grown by and large in all the regions of the state. Comparatively more area was covered in Northern hills of Chhatisgarh (18.6%), Central Narmada valley (15.06%), Bundelkhand (13.33%), Gird (13.27%), Vindhyan plateau (10.90%) and Kymore plateau (10.2%). At regional and state level, the sizeable area was declined during the reference period which was revealed by relative change index of current over base triennium and coefficient of variation figures. Except Bundelkhand and Central Narmada valley regions, the area had significantly declining growth rates in rest of the regions. Sesamum production and productivity have witnessed significant deceleration in all the regions of the state. Probable

reasons for deceleration in area may be due to this crop is being substituted by other crops like soybean as this crop had very low yield potential i.e. only 150 kg/ha. For decelerated productivity, this crop might have shifted to more inferior lands.

Linseed

Linseed was the important oilseed crop of the state grown by and large in most of the regions of the state. It was mainly grown in Chhatisgarh plains (37.03%), Kymore plateau (19.44%), Vindhyan plateau (12.02%), Malwa plateau (9.6%). Its growth rate for area were erratic in regions, some have shown significant increase like Bastar plateau (7.08%), Malwa (3.27%) and Gird region (2.77%); and certain regions have negative growth rates like in Chhatisgarh plains (-0.5%), Kymore plateau (-1.67%) and Vindhyan plateau (-0.31%). The wide variation in relative change index for current over base triennium and high value of C.V. was observed among regions. The growth rate for production were also erratic because productivity had declined in most of the regions. Only in Gird and Malwa regions have registered significant increase in growth rate of area, production and productivity. At state level the area had remained stagnant but production and productivity have declined marginally.

Groundnut

Groundnut was mainly grown in the regions of Malwa plateau (48.77%), Nimar valley (20.38%), Satpura plateau (9.0%) and Jhabua hills (5.9%). These regions shared about 84 per cent of area and 81 per cent of production in the state for this crop. The growth rates of area and production have shown significant decline in these regions which was further revealed by lower value of relative change index over base triennium and high C.V. values. The productivity in these regions was almost stagnant. The reason for decline of area of this crop may be due to replacement of area by soybean crop which had increased significantly in these regions. The reasons for shift may be that groundnut crop has low yield potential, involves more labour cost and prone to risk of insect pests than soybean crop. At state level, the area, production and productivity have shown declining growth rate of -2.34, -2.47 and 0.27 per cent, respectively.

Commercial crops

Sugarcane crop occupied very negligible cropped area in the state but by and large grown in all the regions. Main growing regions were Malwa plateau (30.4%), Vindhyan plateau (17.22%), Chhatisgarh plains (11.07%) and Satpura plateau (11.0%). Except Malwa and Satpura regions, the rest of the regions have shown much lower value of relative change index

over base year and significant declining growth rates. The similar results were observed for production. The productivity performance was very erratic in regions. Most of the area under sugarcane was irrigated, which had shown significant increase in all the regions. At state level, the growth rates of area had declined by 1.62 per cent per annum, but production and productivity have increased marginally i.e. 0.13 and 0.64 per cent, respectively. The less area under irrigation and agro-climatic condition have not favoured this crop to be taken up as commercial enterprise of the state or any region.

Cotton crop was mainly grown in jowar-cotton crop zone of the state which consists of Malwa plateau, Nimar valley and Jhabua hills regions. About 87 per cent of cotton area in the state was in Malwa plateau (45.60%) and Nimar valley (41.23%). In Malwa region, the growth rate of area exhibit significant decline of 4.48 per cent per annum, which was further revealed by 50 per cent reduction in relative change index over base year triennium for area and high C.V. value. This decrease in area of cotton might have been encroached by soybean crop. In this region, the demand for soybean had increased by the establishment of soybean solvent plants. Nimar valley region had shown an increased growth rate of 1.32 per cent. The production and productivity have shown increase in all the regions. Cotton being kharif crop had very small area under irrigation, but during the post-

technological period the irrigated area under this crop had registered significant increase in growth rate.

Factors associated with crop growth

As regards the growth in use of capital inputs, both HYV and fertilizer consumption registered significant positive growth in all the regions with variation in the regional pattern as well as the magnitude. But in case of net irrigated area the regional growth rates were quite low particularly in Bastar plateau (-1.5%), Bundelkhand (3.23%), Kymore plateau (4.6%) and Gird (4.9%) regions, as compared to other regions like Central Narmada valley (16.36%) and Northern hills of Chhatisgarh (9.3%). Regarding cropwise irrigated area, significant positive growth have occurred for total oilseed (29.0%), wheat (8.3%), total pulses (5.5%) and total cereal crops (4.8%) but percentage of crop irrigated area was very less as only 14.38 per cent in total cereals, 15.4 per cent in rice, 21.8 per cent in wheat, 3.3 per cent in total pulses and 2.0 per cent in total oilseed crops. The growth rate of total high yielding varieties have shown significant increase in all the regions. For rice HYV, growth rate have shown very wide variation as it was only 15.6 per cent in Chhatisgarh plains region (rice crop zone) and 73.46 and 72.18 per cent in Bundelkhand and Central Narmada valley regions (non-rice crop zone) respectively. This was further

supported by the results of relative change index and C.V. in which wide regional variation was found. These results indicate that in rice crop zone, local varieties still have strong liking by the cultivators. Wheat HYVs have shown sizeable positive growth rates in all the regions with less variation in C.V. This reflects that HYV of wheat are widely adopted by the cultivators. Regarding fertilizer consumption, there was wide variation in their use. It varied from 0.67 kg/ha in Bastar plateau to 10.45 kg/ha in Malwa plateau region. At state level, the average was 6.25 kg/ha. The growth rate of fertilizer consumption though have positive significant but have revealed wide variation as Gird and Malwa have shown 18.27 and 17.73 per cent, respectively whereas in Chhatisgarh plains region it was only 7.3 per cent. Thus, various statistical analysis for regional use of capital inputs reflects wide regional disparities in their use. This might be due to regional cropping pattern and endeavour of cultivators.

The factors causing regional disparities in agricultural growth were found to be insignificant to effect the change in area of the crops/crop groups. However, in case of total production of crops, the area under the crop and the productivity were found to be significant factors causing inter-regional variations. Productivity of wheat, gram, total oil-seed crops was significantly corrected with cropwise irrigated area, and HYV area. These results were obtained by

correlation coefficient and multiple regression and correlation analysis.

Conclusions

The above discussion for cropwise performance at regional and state level was based on various estimates of mean, absolute and relative change of current over base year triennium, coefficient of variation, linear trend, growth rates, correlation coefficient and multiple regression and correlation of various crops/crop groups and causal factors during post-technological period. The analysis indicated the presence of wide regional disparities. The magnitude of regional disparities vary with different crop profile of the regions with their area, production and productivity. For some crops/crop groups like total food grain and total cereal crops, the inter-regional disparities were found to be low but in other crops these disparities were quite high. Some crops have shown significant increase in growth rate of area like wheat, gram, urid, soybean, mustard and cotton; some crops have shown almost stagnated growth rate like rice, arhar, lentil, linseed and sugarcane; and some crops have shown decelerated growth rates like jowar, kodo-kutki, teora, sesamum and groundnut. However, in case of growth rate of production and productivity, the inter-regional disparities were found quite large in almost all the crops with only few exception of wheat and mustard crops.

From the regional as well as state level estimates of growth rates obtained in the present study, it is apparent that with the exception of some crops in some regions, the growth rates in area, production and productivity in general were quite low. For example, in case of total foodgrains and total cereal crops, the regional as well as state growth rate in production and productivity were around 2-5 per cent or even less which are far below the required.

Cereal crops

The growth rate in production for rice was insignificant in Chhatisgarh plains region (rice crop zone) and Kymore plateau (rice-wheat crop zone). Even the growth rate of productivity was quite low in these regions. But in certain other regions like Vindhyan and Bundelkhand (non-paddy region) the growth rates of production and productivity were significant. The regional disparities in production and productivity of rice call for in-depth analysis of operating constraints in view of significant positive growth rate of HYV area, irrigated area and total fertilizer consumption in rice crop zone consisting of Chhatisgarh plains, Bastar plateau, Northern hills of Chhatisgarh and Kymore plateau. For wheat the significant growth in production were observed by and large in most of the regions ranging from Vindhyan plateau of wheat crop zone to Malwa and Jhabua regions of jowar. Cotton crop zone. Productivity estimates were also satisfactory for

all the regions. Jowar and kodo-kutki have shown deceleration of growth rate in production and productivity. The area under these crops might have been substituted by more remunerative crops like soybean. Deceleration in productivity may be due to shift of area to more inferior lands for cultivation. But these crops cannot be substituted to large extent as jowar crop apart from staple food crop, its by-product is used as cattle fodder and kodo-kutki is the main food in tribal dietary habits and still continue dominance in agricultural economy of tribal regions like Chhatisgarh plains, Bastar plateau, Northern hills of Chhatisgarh, Kymore plateau and Satpura plateau, so more remunerative alternative crops be developed and tested in these regions.

Pulse crops

The growth rate of area, production of total pulse crops were found significant in Malwa, Bundelkhand, Central Narmada and Vindhyan plateau regions but productivity remained insignificant in all the regions. For gram crop, the area, production and productivity were significant in Malwa, Vindhyan and Gird regions and at state level the area and production have shown significant growth rates. For urid crop the area and production were found significant in Malwa, Bundelkhand, Gird and Satpura plateau regions but productivity had not shown significant increase in any region. For arhar crop, the growth rate for area and production were

significant in Central Narmada valley and Bundelkhand regions but significant decline in area and production was observed in Chhatisgarh plains, Bastar plateau and Vindhyan plateau regions. Productivity remained quite low and stagnant in all the regions. At state level, the area, production and productivity have shown almost stagnated growth rates. Research needs to be directed towards evolving short duration HYVs of arhar crop which can be fitted into existing crop cycle so as to increase cropping intensity and which have higher degree of resistance to insects and pests. Similarly, the lentil crop had behaved at state level but at regional level the significant growth for area and production were observed in Gird, Bundelkhand, Vindhyan, Malwa and Nimar regions. Productivity was observed significant in Vindhyan, Bundelkhand and Nimar regions. Teora crop, which was mainly grown in Chhatisgarh plains region, had shown deceleration in area, production and productivity. There is need of research to evolve toxic-free varieties. With the growing demand of pulse crops and more remunerative prices, there is need to develop suitable HYVs specifically for each region, with better soil management, cultural practices, irrigation, specific fertilizer dose and plant protection measures to improve the productivity of pulse crops.

Oilseed crops

As regards to total oilseed crops, area and production have significantly positive in Vindhyan plateau, Central Narmada valley, Gird and Malwa regions. Among oilseeds, soybean crop had shown sizeable significant positive growth rate of area and production in most of the regions particularly in Malwa, Satpura, Central Narmada valley and Vindhyan regions but productivity had not shown any significant increase. This needs serious attention to motivate farmers to use rhizobium culture, HYVs seed, adequate fertilizer dose and plant protection measures to raise the productivity. Mustard is another important oilseed crop, which has shown significant increase in area, production and productivity in the state and particularly in Malwa, Satpura, Gird and Bundelkhand regions. Linseed crop had shown stagnation at state level but has shown increase in Malwa and Gird regions. Sesamum and groundnut crops have shown deceleration in area, production and productivity. They might be substituted by other more remunerative crops like soybean. The growing demand of oilseed and secular rise in prices the oilseed production has to be raised by developing suitable HYVs for specific regions, soil and water management techniques and plant protection measures to avoid import of edible oil.

Technological inputs

As regards the growth in use of capital inputs like cropwise irrigated area, HYVs area and total fertilizer consumption, registered significant positive growth in all the regions with variation in regional pattern and its magnitude. But in case of net irrigated area, the regional growth rates were quite low particularly in Bastar, Bundelkhand, Kymore and Gird regions. Cropwise irrigated and HYVs area reflects that for rice, area had not shown sizeable increase in regions of rice crop zone viz. Chhatisgarh plains, Bastar plateau, Northern hills of Chhatisgarh and Kymore plateau but have shown sizeable significant increase in Bundelkhand and Central Narmada valley regions (non-rice crop regions). At state level, the area under irrigated crop and HYV was only 15 and 18 per cent, respectively, which reflects that local varieties are still dominating the rice area. Research needs to be directed to evolve suitable HYVs competing with palatability of local varieties and there is need to replace the old HYVs with new breeder seed to increase the productivity. The irrigated and HYV area of wheat have shown significant increase in most of the regions but wide variation in magnitude of growth rate among regions was found. The irrigated and HYV of wheat covered only 21.8 and 20.0 per cent of area respectively at state level which needs to be raised in all the regions. The new hybrid seed technology for rice and wheat needs to be developed and the technology should be

diffused to cultivator for higher productivity. HYV of jowar, which covered very less area need short duration varieties so that rabi crop can be taken up for increasing the cropping intensity. Though the irrigated area under pulse crops and oilseed crops have shown significant increase in all the regions but its area was very meagre i.e. 3.23 and 2.03 per cent, respectively. The area under pulse crops and oilseed crops which needs less irrigation should be raised with HYVs which is quite negligible. Fertilizer consumption had also shown wide regional disparity, as it was very low in Bastar, Northern hills of Chhatisgarh and Jhabua hills regions even at state level (6.25 kg/ha) as compared to Malwa plateau, Chhatisgarh plains and Gird regions.

The use of these capital inputs revealed wide regional disparities in their use. This might be due to cropping pattern of the regions and endeavour of the cultivators.

The factors causing regional disparities were found to be insignificantly correlated to effect the change in area of crops/crop groups. However, for total production of crops, area under crops and productivity were found to be significantly correlated factor causing inter-regional variations. For productivity of crops, particularly wheat, gram and total oilseeds were found significantly influenced by cropwise irrigated area and HYV area.

Hence it can be concluded that regional disparities in agricultural growth is the result of unbalanced growth of area, production and productivity of different crops/crop groups. Imbalances in development process may be inevitable though they are to be kept within desirable limits through policy decision taking into account the natural endowment of the region. A further farm level detail investigation into regional production practice to identify the constraints operating there upon is required.

The results analysed and conclusions derived at, area, production and productivity of important crops/crop groups and factors associated with agricultural growth at regional and state level during post-technological period refuted the following null hypothesis formulated in this research study:

- (1) Improved technology of crop production practices are neutral to regional soil and climatic variations.
- (2) In post-technology period, the productivity of major crops at regional and state level remained the same.

Policy implications

The research study leads to the following policy implications:

- (1) Location-specific agricultural research be developed by regional planning for agricultural development so as to reduce the regional disparities.
- (2) Productivity of major crops is not maintaining its role, although improved technologies are available. Extension agencies and communication media be given the task to diffuse the technology from lab to land.
- (3) Technological break through in pulse and oilseed crop production technology is required by evolving short duration HYVs with drought and pest resistant varieties, pulse culture specifically suited at regional level.
- (4) Crucial importance of extending irrigation to all regions particularly in those regions where it was below 5 per cent like Bastar, Northern hills of Chhatisgarh, Vindhyan plateau and Jhabua hills. Since opportunities for extending canal irrigation may be limited in these regions, minor irrigation sources like dug wells and tubewells should be tapped, after making hydro-geological survey and feasibility studies. Also, micro-watersheds need to be planned and executed so as to utilise the run-off water from rainfall, which is quite high in these regions.
- (5) As the major cropped area was under rainfed condition at regional and state level, there is need to develop improved dryland farming and low input technology specific to

each agro-climatic region such as short duration crop cultivars suited to efficient cropping season, soil management, timely sowing, use of drought resistant HYVs, water harvest technology and adequate fertilizer doses.

- (6) Unless more and better irrigation facilities (with proper drainage) and suitable crop cultivars (HYVs) are made available to farmers, fertilizer off-take may not increase. Fertilizer use is very low in many regions and at state level (6.25 kg/ha) and even in advanced regions. So there is scope to tap this potential for increasing crop yields.
- (7) Rural infrastructure be improved to provide possession, form, time and space economic gains to farmers of each region like markets, transport and supply line.
- (8) Investigation into constraints in natural, economic and social which are in way of regional disparities for agricultural growth, be carried out so that imbalances can be reduced.
- (9) Analytical studies similar to this research be initiated at micro level i.e. district or at farm level to investigate into regional production practices to identify the constraints operating there upon.

- (10) The systemic farming approach within the agro-climatic zones needs be undertaken and be extended at the planning level and economic contents be fully studied for short-term and long-term projections.

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