

Agricultural Development and Sources of Output Growth in Maharashtra State*

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Abstract

In the present study, an attempt has been made to analyse agricultural growth and the contribution of various components to the overall output growth of the Maharashtra State for the period from 1961-62 to 1997-98. It is observed that the growth in area of major crops in the state revealed mixed trend. For the overall period of study, except jowar, bajra and wheat all other crops recorded a growth in area. The growth in production and productivity of all these crops was visible in the second period (1971-72 to 1980-81), whereas commercial crops recorded remarkable increase during third period (1981-82 to 1997-98) of the study. There has been growth in the use of crucial inputs like irrigation, chemical fertiliser and high yielding variety seeds. The growth in production of kharif jowar, paddy, bajra, rabi jowar, wheat and cotton is mainly on account of change in yield, while production of gram, tur and sugarcane increased due to expansion of area. The productivity growth and shift in cropping pattern were major factors that accounted for the growth of crop output in the state. The future strategy of agricultural development of the state will have to be centered on increasing productivity through the expansion of area under irrigation and HYVs.

Key words: Area, Yield, Production, Inputs, Growth, Decomposition

Introduction

Agriculture plays an important role in economic development, such as provision of food to the nation, enlarging exports, transfer of manpower to non-agricultural sectors, contribution to capital formation, and securing markets for industrialisation (Johnston and Mellor, 1961). Agricultural development is an integral part of overall economic development. The Indian economy comprises of several important sectors, which contribute to total national product. But by far, agriculture is the main stay of Indian economy and prosperity of agriculture can significantly contribute to the general prosperity of the nation. With a 24.2 per cent contribution (triennium ending

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2001-02) to gross domestic product, agriculture still provides livelihood support to about two-thirds of country's population. The sector provides employment to 56.7 per cent of country's workforce and it is the single largest private sector occupation. Agriculture accounts for about 14.7 per cent of total export earning and provides raw material to several industries (GOI, 2003). Agriculture forms the backbone of Indian economy and despite large industrialisation in last 50 years, agriculture still occupies a place of pride. Maharashtra is an important state of India so far as its contribution to the agricultural development is concerned.

Maharashtra is the second largest state in India in terms of population and third in respect of area. The state had the third highest per capita State Domestic Product (SDP) among all the Indian states in the year 2000-01 (GOM, 2003). Though Maharashtra is one of the industrialised states in the country, agriculture and allied activities are still predominant in the state. Agriculture continues to be the major source of income for most of the population. As per the population census 2001, 55.41 per cent population is dependent on agriculture for livelihood. However, contribution of agriculture sector in the state income is reducing over the period. The share of agriculture and allied activities in net state domestic product (SDP) declined steeply from 36 per cent in 1961-62 to 16.0 in 2001-02. The comparable shares for all India are 47 and 28.3 per cent respectively. Thus, the contribution of agriculture to the net SDP has been less in Maharashtra as compared to the national average. Yet, in terms of the proportion of labour force engaged in agriculture (55.41 per cent) as mentioned earlier, Maharashtra's economy continues to be predominantly agrarian. Indeed, the share of State's rural labour force employed in agriculture was as high as 80.08 per cent even in 2001, near about half (38.39 per cent) of the agricultural workers being labours. Thus, the crucial dependence of its rural labour force on agriculture is quite evident and it unlikely to diminish drastically in the future (Sawant, *et.al*, 1999). In this context, it is important to examine critically the past performance of agriculture and based on it, future prospects of growth is needed.

Keeping in view the importance of agriculture, quantitative assessment of the contribution of the various factors to growth of crop output at the state or regional level is helpful in reorienting the programmes and priorities of agricultural development so as to achieve higher growth. There are so many factors, which affect the growth of crop output. Among these, area, productivity and cropping pattern are the major one (Singh, 1981 and Cauvery, 1991). These sources of output growth have relevance in deciding programmes of agricultural development and priorities of investment in it (Ranande, 1980). The growth rates as such offer no explanation for desperate performance of agriculture. Thus, it becomes important to find why these growth rates differ from one another, so that the bottlenecks could be removed to achieve the speedy development of agricultural sector (Sikka and Vaidya, 1985). Decomposition of growth in agricultural output has remained of active interest to researchers and policy makers. A breakdown of growth into various components-area, yield, cropping pattern, etc. facilitates output projection with alternative targets and policies (Jamal and Zaman, 1992). Thus, decomposition of agricultural growth among its constituent forces is of great importance. An analysis of the behaviour of agricultural production in the past and estimation of its growth rates can provide a basis for future projections of agricultural output (Lakshmi and Pal, 1988). Therefore, an attempt is made in the present study to analyze agricultural growth and the contribution of various components to the overall output growth of the Maharashtra

State for the period from 1961-62 to 1997-98. The specific objectives of the present study are as under:

1. To estimate the growth in area, production and productivity of major crops in Maharashtra State,
2. To estimate the growth in the use of major inputs in the state,
3. To assess the relative contribution of area and yield to change in the output of major crops,
4. To decompose the total change in agricultural production into its constituent forces and
5. To study the extent of crop diversification and changes therein in the agriculture of the state.

Present Scenario of Agriculture in Maharashtra

Maharashtra is one of the progressive states in the country but it has been reported to be a deficit state for long when one considers to major pursuit of economic activity, that is agriculture. Geographical area of Maharashtra State is 3.08 lakh sq.km., out of which the net area under agriculture is about 1.77 lakh sq.km., i.e. 57.5 per cent. This proportion at the national level is less at 43.4 per cent. However, the proportion of gross irrigated area to gross cropped area at national level is 38.7 per cent, while in Maharashtra State it is only 16.4 per cent. Thus, 83.6 per cent of the area under agriculture in the state is directly dependent on monsoon. Nearly one-third area of the state falls under rain-shadow region where the rains are not only scanty, but also, erratic. The soil, topography, rainfall and climate in Maharashtra are not much favourable to agriculture. As a result, the per hectare crop yield in Maharashtra is in general lower than that at the national level (GOM, 2002).

In 60's, Maharashtra was not self sufficient in foodgrains production (Singh and Baleka, 1998). Various yield-increasing methods have been tried in Maharashtra on a massive scale during the last three decades. As a result of this, the state experienced a growth in agricultural production with the foodgrains production increasing from 5.41 million tonnes in 1970-71 to 12.69 million tonnes in 1999-00. The area under high yielding variety seeds (HYVs) in the state increased more than twenty times while irrigated area increased from 12.20 lakh ha (1960-61) to 33.74 lakh ha. (1999-00). The fertilizer consumption increased from 150 thousand tonnes (1969-70) to 1931 thousand tonnes (1999-00) in which per hectare consumption of fertilizer increased about 10 times, but it is still very low as compared to Punjab. In respect of irrigation, the state (16.4 per cent) is far below as compared to Punjab (95.2 per cent), Haryana (75 per cent), Tamil Nadu (48 per cent) and the national average (39 per cent). A large part of Central Maharashtra and Marathawada is in rain shadow. Thus, agriculture in the state is characterised by the low rainfall and low irrigation (Dev,1996 and Kurulkar, 1998). Maharashtra lags behind in the productivity of all the crops as compared to the national averages, which itself is way behind the averages of some of the other progressive countries of Europe and Asia (Dastane, 2002). Maharashtra State ranks first in area and production of jowar, tur and cotton but lags seventh, eighth and ninth position respectively as far as productivity of these crops concerned (GOI, 1998). The state had also gone through green revolution, but its impact is very less as compared to other states. Hence, the study on the impact of yield-rising new seed-fertilizer technology in Maharashtra merits careful analysis.

Data and Methodology

The state has a diversified cropping pattern in different regions depending upon agro-climatic conditions and hence all the important cereals, pulses, oilseeds and commercial crops were selected for the present study. Selected crops accounted for more than 80 per cent of the total cropped area. Minor pulses and oilseeds and other crops were not considered for lack of data on these crops. Thus, the study was restricted to principal crops with the assumption that the excluded crops do not affect the cropping pattern and in turn would not vitiate the main conclusions of the study. The selection of crops for the study was thus dictated by the availability of data. The selected crops for the study were kharif jowar, rabi jowar, bajra, wheat, paddy, total cereals, tur, gram, other pulses, total pulses, total foodgrains, oilseeds, cotton and sugarcane. The time series data on area, production and productivity of these selected crops and input use i.e. net irrigated area, gross irrigated area, fertilizer consumption and area under high yielding varieties were collected from the various Government Publications¹. The present study was conducted for Maharashtra State, pertains to the period 1961-62 to 1997-98. The entire study period was split into three sub periods to evaluate the impact of new production technology on agricultural development and assess the changes in relative contribution of different factors to the output growth over the period of time. The sub periods² are Period I: 1961-62 to 1970-71; Period II: 1971-72 to 1980-81; Period III: 1981-82 to 1997-98 and Overall Period: 1961-62 to 1997-98.

a) Estimation of Growth in Area, Production and Yield

Pace of agricultural development of a region can be ascertained through measuring growth in area, production and yield of crops in the region. In the present study, compound growth rates of area, production and yield for the selected crops for each period were estimated to study the growth in area, production and yield of these crops. Similarly compound growth rates of inputs were also worked out. Both linear and compound growth rates were estimated. However compound growth rates³ were used for the study. Compound growth rates were estimated with the following exponential model.

$$Y = a b^t$$

$$\text{C.G.R. (r)} = [b - 1] \times 100$$

The 't' test was applied to test the significance of 'b'.

b) Decomposition of Output Growth of Individual Crop

To measure the relative contribution of area and yield to the total output change for individual crop, Minhas (1964) component analysis model as given below was used. Sharma (1977) redeveloped the model and several research workers used this model and studied growth performance of crops on state level (*see* Narula and Vidysagar, 1973; Singh and Sissodia, 1989; Bastine and Palanisami, 1994; Bhatnagar and Nandal, 1994; Mundinamami et. al, 1995; Gupta and Saraswat, 1997; Singh and Ranjan, 1998; Singh and Ashokan, 2000 and Siju and Kombairaju, 2001).

$$\Delta P = A_o \Delta Y + Y_o \Delta A + \Delta A \Delta Y$$

Change in Production = Yield effect + Area effect + Interaction effect.

Thus, the total change in production can be decomposed into three effects viz. yield effect, area effect and the interaction effect due to change in yield and area.

c) Decomposition of Total Agricultural Output Growth

In recent years, attempts have been made to estimate the contribution of each element to the growth of output. Numbers of additive and multiplicative models have been developed for this purpose. Minhas and Vaidyanathan (1965) were the first to decompose and compute the influence of individual components. They used four factor model and later Minhas (1966) extended it to a seven factor decomposition model, considering the other interaction terms since the four-factor model is not useful when the interaction term is relatively larger. Prabha (1971) has slightly modified the model to convert the absolute growth in to relative growth. Besides this, Parikh (1966) and Shetty (1970) have developed the multiplicative decomposition model wherein the growth rate of output could be split into the contribution of area, yield, cropping pattern and interactions (Dharm Narain, 1977; Sarma and Subramanyam, 1984, and Narender et.al, 1989).

Studies conducted elsewhere in our country with regards to component analysis were Kaul and Sodhi (1971), Bhatia and Sinha (1975), Krishnaji (1975), Sarma (1975), Sarma and Subrahmanyam (1984), Sikka and Vaidhya (1985), Sharma and Singh (1986), Singh (1987), Lakshmi and Pal (1988), Naidu (1989), Narender *et.al.* (1989), Chandrakar and Kosta (1997) and Padmanaban *et.al.* (1999) at a state, as well as, country level. In these studies, the contribution of various components to the growth of agricultural output has been estimated by using a seven-factor decomposition model developed by Minhas (1966) and modified by Sarma (1975). The output growth for the purpose of decomposition analysis has been computed as the change in output of current period (taking average of the last three years) over the base period (taking average of first three years) for each time period. The changes in components have also been similarly computed on the basis of three year average of the base and current years. Constant price weights have been assigned to different crops based on the three year average of farm harvest prices (Singh, 1981) for 1990-91 to 1992-93. Consider,

$$P_o = A_o \sum_i W_i C_{io} Y_{io} \quad \text{-----} \quad \text{(I)}$$

$$P_t = A_t \sum_i W_i C_{it} Y_{it} \quad \text{-----} \quad \text{(II)}$$

From the identities (I) and (II) we can write

$$\begin{aligned} \frac{P_t - P_o}{P_o} &= \frac{A_t - A_o}{A_o} + \frac{\sum W_i C_{io} Y_{io} \left(\frac{Y_{it} - Y_{io}}{Y_{io}} \right)}{\sum W_i C_{io} Y_{io}} + \frac{\sum W_i C_{io} Y_{io} \left(\frac{C_{it} - C_{io}}{C_{io}} \right)}{\sum W_i C_{io} Y_{io}} \\ &+ \left(\frac{A_t - A_o}{A_o} \right) \frac{\sum W_i C_{io} Y_{io} \left(\frac{Y_{it} - Y_{io}}{Y_{io}} \right)}{\sum W_i C_{io} Y_{io}} + \left(\frac{A_t - A_o}{A_o} \right) \frac{\sum W_i C_{io} Y_{io} \left(\frac{C_{it} - C_{io}}{C_{io}} \right)}{\sum W_i C_{io} Y_{io}} \\ &+ \frac{\sum W_i C_{io} Y_{io} \left(\frac{C_{it} - C_{io}}{C_{io}} \right) \left(\frac{Y_{it} - Y_{io}}{Y_{io}} \right)}{\sum W_i C_{io} Y_{io}} + \left(\frac{A_t - A_o}{A_o} \right) \frac{\sum W_i C_{io} Y_{io} \left(\frac{C_{it} - C_{io}}{C_{io}} \right) \left(\frac{Y_{it} - Y_{io}}{Y_{io}} \right)}{\sum W_i C_{io} Y_{io}} \end{aligned}$$

Where,

P_t = Value of agricultural output in the current year 't'

P_o = Value of agricultural crop output in base year 'O'

A_t = Gross cropped area of crops in year 't'

A_o = Gross cropped area of crops in year 'O'

Y_{it} = Yield per hectare of i^{th} crop in year 't'

Y_{io} = Yield per hectare of i^{th} crop in year 'O'

C_{it} = Proportion of area under i^{th} crop to the total cropped area in year 't'
 C_{io} = Proportion of area under i^{th} crop to the total cropped area in year 'O'
 W_i = Constant price weight represents the three year average of farm harvest price.

In this additive decomposition model, the first component on the right hand side is the area effect i.e., an increase in output of this magnitude could have taken place in the absence of any change in per hectare yield and cropping pattern. The second component is the yield effect on the total production. The third component reflects the impact of the cropping pattern changes during the current period compared to the base period in the absence of any change in per hectare yield. The first order interaction of area and yield, area and cropping pattern, yield and cropping pattern explains the effect of simultaneous change in respective factors. The second order interaction of area, yield and cropping pattern explains the effect of simultaneous change in area, yield and cropping pattern (*see*, Minhas and Vaidyanathan, 1965; Sarma and Subrahmanyam, 1984).

d) Crop Diversification

The level of diversification of crop enterprises affects the extent of economic development in the rural sector. The level of crop diversification varies among regions because of varied agro-climatic conditions and resource endowment of the farms. The introduction of new-seed-fertiliser technology has not only led to intensification of farming but also results in large scale diversification of crop farming and the benefits gradually accrued to the whole farming community (De, 2000). The approach used in this study for crop diversification is to utilize a variety of measures of crop diversification, which connote the extent of dispersion and concentration of activities in a given time and space by a single quantitative indicator (Shiyani and Pandva, 1998). Studies conducted elsewhere with regard to crop diversification are Gupta and Tewari, 1985; Singh *et. al.*, 1985; Chand, *et.al.*, 1986; Singh and Sisodia, 1989; Bhatia and Tiwari, 1990; and Singh, 1999. Following two measures of crop diversification are used in the empirical analysis.

- Herfindahl Index

Herfindahl index as given below was computed by taking the sum of square of area proportion of each crop in the total cropped area. Where N is total number of crops and P_i represents acreage proportion of the i^{th} crop in total cropped area. With the increase in diversification, the Herfindahl Index would decrease. This index takes a value one when there is a complete specialization and approaches zero as 'N' gets large i.e. if the diversification is perfect. Thus, the Herfindahl index is bounded by zero and one. It is a measure of concentration.

$$\text{Herfindahl Index} = \sum_{i=1}^N P_i^2$$

- Entropy index

Entropy index is regarded as an inverse measure of concentration having logarithmic character. The index would increase with the increase in diversification and it approaches zero when there is perfect concentration, i.e. when P_i equals one. The upper bound of the index is $\log N$. However, the base chosen for taking logarithms

and the number of crops determines the upper limit of Entropy Index. The upper value of the index can exceed one, when the number of crops is higher than the value of the logarithm's base, and it can be less than one when the number of crops is lower than the base of logarithm.

$$\text{Entropy index} = \sum_{i=1}^N P_i \text{Log} (1/P_i)$$

Results and Discussion

The results of the study are divided into five sections. Section I is devoted the growth in area, production and productivity of selected crops in the state. Section II represents growth in input use in the state over a period of time. In section III, decomposition of individual crops and aggregate crop out put in the state is presented, Section IV presents crop diversification in the state and few concluding observations and policy implications are made in Section V.

Section I

Growth Rates of Area, Production and Productivity of Principal Crops

The growth rates of area of principal crops in Maharashtra over three periods of time are presented in Table 1. Results of this analysis revealed a mixed trend in respect of growth in area under important crops in Maharashtra State. For overall period, except jowar, bajra and wheat all other crops recorded a growth in area. Growth rates of area of kharif jowar, paddy, wheat and sugarcane were higher for second period (1971-72 to 1980-81) than first (1961-62 to 1970-71) and third period (1981-82 to 1997-98). This is obviously due to high yielding varieties and increase in input use. Bajra recorded highest growth rate during first period. For, tur, gram, oilseeds and cotton growth rates for third period were higher. The cereal and oilseed crops recorded decline in area as evident from negative rate of growth, however, area under foodgrains was almost stagnant. A higher rate of increase in area for cereals during second period of study could be due to government policy of increasing production through expansion of area under cultivation. Moreover this period was

Table 1: Compound growth rates of area of principal crops in Maharashtra State
(per cent)

Crop	Period I	Period II	Period III	Overall Period
Kharif Jowar	0.0491	2.619**	-2.594**	-0.092
Paddy	0.0894	1.451**	0.183	0.507**
Bajra	2.944**	-1.966	0.770	-0.0027
Rabi Jowar	-1.739**	1.036	-0.864	-0.144
Wheat	-1.209**	4.028*	-1.917	-0.512*
Total Cereals	-0.161	1.269*	0.677**	0.013
Tur	1.773**	2.019*	3.657**	1.973**
Gram	-2.158*	3.526*	4.416**	2.168**
Other Pulses	2.244**	6.914	0.157	0.305*
Total Pulses	1.412**	1.536	1.867**	1.054**
Total Foodgrains	0.163	1.319	-0.142	0.231**
Oilseeds	-1.331**	0.597	3.375**	1.292**
Cotton	0.420	-0.411	0.962**	0.178
Sugarcane	1.534	6.335**	4.179**	4.057**

Note: * Significant at 5 % level and ** Significant at 1% level.

green revolution period i.e., spectacular growth in foodgrains production due to use of high yielding varieties supported by increased use of fertilizer and irrigation. The growth in area of pulses and oilseeds during third period was due to the fact that Government tried to increase the production of pulses and oilseeds through various measures such as National Pulse Development Programme (Khare, 1995), Technology Mission on Oilseeds (DOR, 1999) and Pilot Project on Oilseeds and Pulses crops (GOM, 1999) in the view of their shortage. Sugarcane crop recorded significant increase in area in subsequent periods. A high growth rate in sugarcane was evidently contributed by the high profitability from growing sugarcane (Venkataramanan and Prahladachar, 1980).

Growth in total agricultural production over a period of time gives an idea of the pace of agricultural development in the state. Results obtained are presented in Table 2, it could be seen from this table that the production of all the cereals and pulses and also total foodgrains increased substantially over the entire study period in the state. The growth in production of all these crops was visible in the second period and it remained so in the third period also. The rate of increase in total production was higher in second period for kharif jowar, paddy, tur, rabi jowar, wheat and sugarcane while bajra, oilseeds and cotton recorded higher growth in production in third period. This growth was obviously due to spread of HYV's of cereals and pulses during these periods.

Table 2: Compound Growth Rates of Production of Principal Crops in Maharashtra
(per cent)

Crop	Period I	Period II	Period III	Overall Period
Kharif Jowar	-2.446	15.069**	0.698	3.243**
Paddy	0.955	8.213*	1.474*	2.283**
Bajra	5.580*	4.054	6.605**	2.976**
Rabi Jowar	-6.547*	4.705	2.121	0.920
Wheat	0.239	12.208*	1.252	2.962**
Total Cereals	-1.163	10.624**	1.719	2.385**
Tur	-2.527	4.727	2.445	2.120**
Gram	-4.44*	6.908	8.147**	4.180**
Other Pulses	0.460	5.241	4.356**	2.450**
Total Pulses	-1.411	5.271	3.961**	2.544**
Total Foodgrains	-1.175	10.003*	1.988*	2.408**
Oilseeds	-2.383	3.406	7.044**	3.310**
Cotton	-4.723	2.66	4.897**	1.928**
Sugarcane	4.833**	7.528**	3.748**	4.428**

Note: Same as in Table 1.

Commercial crops like cotton, oilseeds and sugarcane also recorded increase in production. This leads to the conclusion that total foodgrains production in Maharashtra State increased during green revolution period and that too at high rate of growth. Adoption of high yielding varieties coupled with use of irrigation and chemical fertilizers increased foodgrains production during this period. Production of cotton increased at a higher rate during third period. This could be attributed to the adoption of hybrid seed cotton technology by the farmers, which had a high yield potential. Oilseeds also exhibited similar trend. Thus it could be inferred that it is the new production technology which was instrumental in bringing about a breakthrough

in agricultural production in Maharashtra State. The increased production of oilseed may be due to realizing the importance of oilseed crop and the role of edible oils to foreign exchange balances, the oilseeds were brought under *Technology Mission on Oilseed* (TMO) in May, 1986 by Central Government (DOR, 1999) with incentives and institutional support to oilseed growers to enhance oilseed production in the country.

The new production technology had its impact on per hectare yield of crop also. Table 3 represents the growth rates of productivity of principal crops in the state over a period of time. Growth rates of per hectare yield of most of the crops were higher during second period. Except for the first period, there is increase in per hectare yield of selected crops over the entire period of study in the state. During overall period, wheat crop recorded higher rate of increase in productivity. Inter-period comparison revealed that growth in productivity of almost all the selected crops was lower, infact negative in the first period of study, but increased substantially during second and then third period. Sugarcane recorded significant increase in productivity during first and second period and then declined during third period. Growth rates of cereals, pulses and total foodgrains were substantially higher in second period, obviously due to new seed fertiliser technology. Commercial crops like oilseeds and cotton recorded higher growth in productivity whereas sugarcane crop recorded decrease during the third period of study.

Table 3: Compound Growth Rates of Productivity of Principal Crops in Maharashtra (per cent)

Crop	Period I	Period II	Period III	Overall Period
Kharif Jowar	-2.469	12.120**	3.383	3.341**
Paddy	0.862	6.288	1.350*	1.770**
Bajra	2.543	6.428*	5.795**	2.983**
Rabi Jowar	-4.930	9.445*	2.566*	1.097*
Wheat	1.457	7.863*	3.244**	3.494**
Total Cereals	-1.000	9.237**	2.411**	2.370**
Tur	-4.203**	2.649	-1.162	0.145
Gram	-2.348	3.369	3.550**	1.970**
Other Pulses	-1.735	4.375	4.189**	2.138**
Total Pulses	-2.739*	3.693	2.081*	1.504**
Total Foodgrains	-1.135	8.413**	3.375**	2.163**
Oilseeds	-1.062	2.778	3.534**	1.991**
Cotton	-5.137	2.978	3.859*	1.737**
Sugarcane	3.249**	1.847	-0.927	0.357

Note: Same as in Table 1.

Section II

Growth in Inputs use

The growth and level of agricultural output to a large extent is determined by the pattern of resource structure or input mix in the agricultural sector. Technological developments shift the production function up and to the right enabling the farmers to make greater use of yield increasing inputs. As is well known, the pace of agricultural development in India was increased with the introduction of new production

technology. Irrigation, chemical fertilizers and high yielding variety seeds are the three important components of new production technology (Bhatia, 1979). It is therefore, imperative to study the growth in these inputs over a period of time to get an idea about the process of agricultural development.

The period wise growth rates of net cropped area are presented in Table 4. From this table, it is observed that, net cropped area in Maharashtra State over the entire study period was almost constant as evident from non-significant growth rate. In first and second period of study, the net-cropped area in the state was almost constant. This indicates that there is no further scope to expand cultivated area in the state. Cultivated area as a means to increase agricultural production in the state, therefore has its own limitations.

The growth in area sown more than once is presented in Table 4. It is observed that for overall period, area sown more than once increased at the rate of 4.61 per cent per annum. This shows that area sown more than once increased significantly over a period of time. In first period, growth rate of area sown more than once was positive with a magnitude of 0.59 per cent, however, it was non-significant. During second period, growth rate was 7.73 per cent which was much higher than first (0.59 per cent) and third period (4.74 per cent). The increase in area sown more than once could be due to expansion of irrigation facilities. The area sown more than once is a good indicator of the level of agricultural development of a region. A positive and significant growth rate of this variable for the state indicates that agriculture in Maharashtra is making headway.

Increase in gross cropped area is also an important indicator of the pace of agricultural development of region. As evident from Table 4, growth rate of gross cropped area for the overall period was positive and significant with magnitude of 0.43 per cent indicating thereby that gross cropped area in the state increased significantly by 13 per cent over a period of time. During first period, growth rate of gross cropped area was positive but non-significant indicating no change in the gross cropped area in the state. The gross cropped area increased at the rate of 1.17 per cent and 0.52 per cent per annum during second and third period of study, respectively. During second period, there was higher growth in gross cropped area as compared to first and third period. The study thus indicates that the gross cropped area increased substantially during second period of study. This increase could be attributed to the various programs implemented by government through which irrigation facilities in the state were expanded and side by side also due to short duration HYV's.

Table 4: Compound Growth Rates of Area Cropped and Irrigated

Particulars	(per cent)			
	Period I	Period II	Period III	Overall Period
Net cropped area	0.07	0.69	-0.08	0.01
Area sown more than once	0.59	7.73**	4.74**	4.61**
Gross cropped area	0.09	1.17*	0.52**	0.43**
Net irrigated area	3.06**	4.59**	2.65**	2.07**
Gross irrigated area	3.16**	5.86**	2.74**	3.07**

Note: Same as in Table 1.

The new technology of production has resulted in bringing about agricultural growth in areas where, irrigation facilities are available. Acharya (1973), while discussing the scope for Green Revolution in Maharashtra observed that water supply is a critical factor in the “Green Revolution” particularly in Maharashtra, where improved management of water resources is badly needed to obtain higher yields over a wider area. There has been an increase in irrigated area in Maharashtra State. The proportion of net and gross irrigated area was increased from 5.8 and 6.7 per cent in 1961-64 to 11.8 and 15.41 per cent in 1995-98 respectively. As evident from Table 4, net irrigated area for the overall period increased at the rate of 2.07 per cent. During first period of study, net irrigated area increased at a higher rate of 3.06 per cent per annum whereas during second and third period, net irrigated area increased at the rate of 4.59 per cent and 2.65 per cent per annum. Growth rate of net irrigated area during second period was substantially higher than first and third period of study. In the third period the growth in net irrigated area was rather slow as compared to earlier periods. Table 4 further indicates that the growth rate of gross irrigated area for the overall period 3.07 per cent. This indicates that there was increase in gross irrigated area during entire period of study. Gross irrigated area increased during all sub periods under study. Second period recorded highest growth in gross irrigated area as compared to first and third period. Growth in gross irrigated area was much slow in third period as compared to earlier periods. The study thus reveals that there has been an increase in the irrigated area in the state. This increase in the irrigated area in the state could be attributed to the efforts put in by the government on expansion of this crucial input.

Table 5: Compound Growth Rates of Area under HYVs/Hybrids

Particulars	(per cent)			
	Period I	Period II	Period III	Overall Period
Kharif Jowar	N.A.	24.33**	0.49	6.12**
Paddy	N.A.	19.72**	2.35**	5.48**
Bajra	N.A.	-0.77**	5.94**	7.84**
Rabi Jowar	N.A.	28.09**	11.56**	23.76**
Wheat	N.A.	18.63**	-1.70**	1.13**
Cotton ^a	N.A.	N.A.	8.58**	8.58**
Total	N.A.	15.63**	3.56**	6.63**

Note: ^a for 1980-81 to 1997-98; N.A. - Not Available;

* Significant at 5 per cent level and ** Significant at 1 per cent level.

Area under high yielding varieties indicates the level of agricultural development of a region. High yielding seed is an important component of the new production technology in agriculture. As seen from the Table 5, total area under high yielding varieties over the entire study period increased significantly at the growth rate of 6.63 per cent per annum. In second period, the rate of growth was 15.63 per cent, which was higher than third period (3.56 per cent). This indicates that area under high yielding varieties increased substantially during the 1970's. But thereafter, actual rate of expansion slowed down (Sawant, *et. al.*, 1999). All the crops recorded positive growth rates of area under high yielding varieties for overall period. This shows that HYVs area for these crops increased over period of time. During second period of study, except bajra all other crops exhibited growth in area under high yielding varieties. The highest rate of growth during this period was observed for rabi jowar (28.09 per cent) followed by kharif jowar, paddy and wheat. In third period, there was

an increase in area under high yielding varieties in all the crops except wheat. The wheat recorded negative growth rate of 1.7 per cent annum. Among crops, the highest growth rate has been recorded for rabi jowar (11.56 per cent) followed by cotton, however the lowest growth rate of 0.49 per cent in case of kharif jowar. Comparison of growth rates during periods indicates that in general second period growth rates were higher than third period. Among the major cereals scope for accelerated expansion in the eighties was highest for rabi jowar followed by bajra. For the former area under hybrid seeds must be almost negligible till 1980-81 while, with regards to bajra crop coverage was only 41 per cent in 1980-81. For the remaining crops namely kharif jowar, rice and wheat, bulk of area was already covered by HYVs by 1980-81 (Sawant, et.al.,1999). The higher growth in case of rabi jowar and bajra may be due to early, high yielding and good quality, drought and pest tolerant varieties.

Fertilizer is an important input in crop production. It is one of the important components of the new production technology. It could be seen from Table 5 that the state exhibited positive and significant growth in total fertilizer consumption during the overall period. The consumption of total fertilizer increased at the rate of 8.55 per cent per annum during overall period. Growth rate of total fertilizer during second period was 9.43 per cent, which was higher than third period. It is also observed that consumption of all these nutrients increased substantially over the period under study. At overall level the rate of increase of P was higher than N and K. The consumption of N and K nutrients increased during second period while consumption of P increased during third period. Out of total fertilizer consumption use of nitrogen has increased by 6.35 per cent whereas use of phosphorus and potash decreased or remained nearly stable. This is because soil in the state is rich in potash and deficit in nitrogen and crop requires more nitrogen for growth. Increase in the total fertilizer consumption can also take place due to the expansion of area under cultivation.

Table 6: Compound Growth Rates of Fertiliser Consumption.

Particulars	(per cent)			
	Period I	Period II	Period III	Overall Period
Nitrogenous (N)	N.A.	10.75	8.41**	8.85**
Phosphate (P)	N.A.	8.14*	8.55**	9.46**
Potash (K)	N.A.	7.60*	4.75**	6.22**
Total	N.A.	9.43**	7.95**	8.55**
<i>Per Hectare</i>				
Nitrogenous (N)	N.A.	9.42**	7.84**	8.21**
Phosphate (P)	N.A.	6.83*	7.98**	8.82**
Potash (K)	N.A.	6.38	4.20**	5.60**
Total	N.A.	8.13**	7.38**	7.91**

Note: N. A.- Not Available;

* Significant at 5 per cent level and ** Significant at 1per cent level.

To get an idea about the growth in chemical fertilizer use as a component of new technology, growth rates of per hectare fertilizer consumption were also worked out. The results are presented in Table 6. It could be seen from this table that during overall period of study, per hectare fertilizer consumption increased at the growth rate of 7.91 per cent per annum. Second period recorded growth rate of 8.13 per cent, which was higher than third period. Per hectare consumption of all nutrients increased during the overall period under study. The rate of increase of P was higher

than N and K. The rate of increase of per hectare consumption of N and K was higher during second period and that of P during third period. The results presented in the above section thus reveal that there has been increase in use of total and per hectare use of fertilizer over the period of time.

The foregoing discussion, thus, reveals that there has been growth in the use of crucial inputs like irrigation, chemical fertilizer and high yielding variety seeds. This increase could be attributed to the policies adopted by the Government from time to time. The observed growth in the agricultural production after sixties i.e. green – revolution period can be therefore be attributed to the increase in use of these crucial inputs.

Section III

Decomposition of Output Growth for Individual Crop

The pervious section presented an analysis of growth in area, production and productivity of selected crops in the state. An analysis of growth in area, production and productivity of these crops indicated the general pattern of growth and the direction of changes in area and productivity. But this does not evaluate the contribution of area and productivity to the production growth. For that, it is necessary to examine the sources of output growth. The growth in output of selected crops was therefore apportioned to the various sources by breaking the change in production into three effects i.e., area effect, yield effect and interaction effect.

The relative contribution of area, yield and their interaction to change in production of individual crops is presented in Table 7. The decomposition analysis of output growth of major crops in Maharashtra revealed that growth in production of kharif jowar, paddy, bajra, rabi jowar, wheat and cotton was mainly on account of change in yield. About 75.46 to 191.65 per cent growth in crop out put was due to yield effect. Production of gram, tur and sugarcane, however, increased due to expansion of area. Therefore, the scope for increasing production of these crops lies in increasing their yields. There has been little or even negative contribution of area and yield factors to change in production, hence, the interaction effects were also negative. During pre-green revolution period, decrease in output was noticed incase of kharif jowar, rabi jowar, gram and cotton which was mainly due to decline in yield and area. The yield effect was the major force of output growth of bajra whereas yield and area had almost equal contribution to total change in sugarcane and bajra. During green revolution period i.e. Period II, yield effect turned out to be the most powerful factor for increasing production of all the crops except sugarcane in which area expansion was responsible factor to output growth (Same results recorded by Panda, 2002). Yield effect continued to be the most powerful factor in increasing the production of all the crops except gram and sugarcane during third period of study. The expansion of area was mainly responsible for growth of output of gram and sugarcane. Kharif jowar, rabi jowar, wheat recorded decline in area while tur and sugarcane crop recorded decline in productivity as we have seen in the earlier section. Kharif jowar registered decline in output due to negative effect of area and interaction. The foregoing discussion thus, reveals that the productivity growth was responsible for change in production of kharif jowar, paddy, bajra, rabi jowar and wheat; production of gram, tur and sugarcane, however, increased due to expansion of area.

Table 7: Decomposition of Output Growth in Selected Crops

(per cent)					
Crop	Effect	Period-I	Period- II	Period-III	Overall
Kharif Jowar	Area	28.80	10.79	-1663.09	-15.32
	Yield	-127.95	74.21	2327.32	140.97
	Interaction	-0.85	15.00	-764.23	-25.65
Paddy	Area	-12.90	15.63	5.85	14.99
	Yield	113.10	76.29	93.56	76.27
	Interaction	-0.20	8.08	0.59	8.74
Bajra	Area	44.89	-16.76	9.24	2.46
	Yield	45.12	125.12	84.03	93.66
	Interaction	9.99	-8.36	6.73	3.88
Tur	Area	80.97	41.08	146.49	127.44
	Yield	-161.81	48.45	-29.18	-14.84
	Interaction	-19.16	10.47	-17.31	-12.60
Rabi Jowar	Area	-37.93	6.89	-22.97	-71.00
	Yield	-70.94	89.86	132.28	191.65
	Interaction	8.87	3.25	-9.32	-20.65
Wheat	Area	-356.24	22.43	-286.93	-12.82
	Yield	490.72	61.53	501.73	134.30
	Interaction	-34.48	16.04	-114.80	-21.48
Gram	Area	-48.98	47.80	53.59	46.23
	Yield	-58.08	42.87	24.98	28.24
	Interaction	7.06	9.32	21.43	25.23
Cotton	Area	8.50	5.88	19.30	14.05
	Yield	-106.96	93.08	67.47	75.46
	Interaction	-1.54	1.04	13.23	10.49
Sugarcane	Area	40.01	78.42	148.76	80.44
	Yield	50.93	13.45	-27.85	5.35
	Interaction	9.06	8.13	-20.91	14.21

Decomposition of Total Agricultural Output Growth

As explained earlier, the selected crops in the state have shown a substantial growth in output. The principal factor contributing to this phenomenon in general is yield, which however slowed down at later stage. The three and four factor model is not useful when the interaction term is relatively larger (Narender, et.al., 1989). Therefore, in order to clearly visualize the contribution of different factors such as change in yield, cropping pattern and acreage along with their first and second order interactions towards the changes in crop output of State, the data were subjected to analysis by components. The results are presented in Table 8.

Results of seven factor additive decomposition analysis, revealed that the productivity growth and change in cropping pattern was the major factor which accounted for the growth of crop output in the state during the overall period of 1961-62 to 1997-98. Out of the total growth in crop output in the state during overall period as high as 54.55 per cent is attributed to the change in productivity, 34.20 per cent to the change in cropping pattern and 4.72 per cent to the acreage expansion. The high cropping pattern effect indicates that shift in favour of high initial productivity crops

(Vidyasagar, 1980). The interaction between area, yield and area cropping pattern had a positive contribution in output. During first period, growth of agricultural output in the state was negative which was evidenced by negative contribution of area and yield. Declining yield rates and area brought about most of the decline in the output in the state. Results of decomposition analysis of individual crop presented in earlier section also confirm this finding. As revealed from these results the contribution of yield to the out put growth in the first period was negative for major crops viz. kharif jowar, rabi jowar, tur, gram and cotton. It is observed that improvement in cropping pattern (118.65 per cent) became the most important source of growth, which reflects shift in area from inferior or low value crop to superior or high value crops like pulses, oilseeds and sugarcane. Venkataramanan and Prahladachar (1980) recorded the same findings. The change in cropping pattern contributed positively and as mention earlier it shows shift in favour of high initial productivity crops, but it could not offset the negative effect of area and yield. The first order interaction between yield, cropping pattern and area yield had a positive contribution in output growth. The contribution of area cropping pattern and the second order interaction effect between area, yield and crop pattern was found to be negative and small in the state.

Table 8: Relative Contribution of Various Components to Aggregate Growth of Crop Output in the State

	(per cent)			
Component element	Period I	Period II	Period III	Overall
Area effect	-12.59	12.85	1.95	4.72
Yield effect	-237.20	61.17	57.16	54.55
Cropping Pattern effect	118.65	15.20	49.31	34.20
Interaction between cropping pattern & yield	30.86	3.50	-9.21	1.31
Interaction between area & yield	0.79	5.57	0.47	3.16
Interaction between area and cropping pattern	-0.39	1.39	0.41	1.98
Interaction between area, yield and cropping pattern	-0.10	0.32	-0.08	0.08

The results of decomposition analysis for second period revealed that most of the increase in output in this period was brought about by the growth in crop yield. The productivity growth was the main factor in output growth in the state, accounting 61.17 per cent, which was highest as compared to earlier periods. The contribution of shift in cropping pattern (15.20 per cent) and area (12.85 per cent) were very low. The first and second order interaction contributed positively. The interaction terms (i.e. first and second order interactions), which accounted for 31.16 per cent in increased production during sixties decreased to 10.78 per cent in seventies. The analysis, thus, revealed that the major contribution to increased output in the second period was mainly due to productivity growth. The other factors, i.e. area, cropping pattern and all first and second order interaction also contributed positively showing balanced growth of aggregate agriculture output in the state during green revolution period. It could further be seen from Table 7 that per hectare yield has been largely responsible for the growth in total crop output in the state during third period too, accounting for 57.16 per cent followed by shift in cropping pattern (49.31 per cent) and area (1.95 per cent). The high contribution of cropping pattern again indicates that

shift in high initial productivity crops like sugarcane, oilseeds. First order interaction between area yield and area cropping pattern effect contributed positively whereas yield and cropping pattern contributed negatively (9.21 per cent) to the output indicating that the yield rate of crops declined where shift in cropping pattern has taken place (Sarma and Subrahmanyam, 1984 and Dharm Narain, 1977). Thus, the area did not have impact in increasing output in the state. The contribution of the second order interaction was found to be contributing positively in output growth.

The productivity growth and shift in cropping pattern was the major factor accounting for large proportion of the total output growth in the state. This is an indication of the revolution in yield rate brought about by high yielding varieties. The second period was the period of green revolution characterized by the use of high yielding varieties of various crops along with the use of complimentary inputs like chemical fertilizer and irrigation. The introduction of high yielding varieties increased crop output many fold. The green revolution initiated during the second period became stable in the third period. In this period the farmers were convinced about the yield potential of HYVs of various crops and therefore they started using these HYV seeds on large scale. This resulted in further increasing crop productivity to the output growth. The contribution of area was not significant. It is noted that during third period, where there has been shift in the cropping pattern, the yield rates of crops declined. However, on aggregate basis, the yield rates in general were increased. This interaction term would have been positive had there been increase in yield of those crops in which the shift in the cropping pattern took place. One thing that is clear from analysis that both first and second order interactions, except yield and cropping pattern, had a very small (positive or negative) effect on output. Despite variations in relative contribution of various components the fact remains that a large portion of output growth in the state is brought about by increase in yield while area expansion did not play vital role. Analysis, thus, indicated that the future scope for increasing output in the state through expansion of area is limited. As such, efforts have to be direct towards further increasing the productivity of various crops and changes in crop pattern towards optimum for which, there is a scope in the state.

Section IV

Crop Diversification

As is well known, agricultural development and crop diversification go hand in hand. The level of diversification of crop enterprises effects the extent of economic development in the rural sector. It is thus necessary to study the extent of diversification.

The shift in cropping pattern of the state is shown in Table 9. It is observed that during 1995-98, about 61.93 per cent area was under foodgrains, about 29 per cent under cash crops i.e. cotton, sugarcane, tobacco, oilseed and 2.78 per cent was occupied by fruits and vegetables. The percentage area of rice, kharif jowar, bajra, ragi, kodra, rabi jowar and wheat declined over a period of time. The area under cereals decreased by 8.23 per cent, however, pulses area increased by 2.72 per cent over 38 years. Percentage area of foodgrains declined from 67.69 per cent to 61.93 per cent during the corresponding years. However, the area under fruits and vegetables, sugarcane, pulses, oilseeds and cotton increased by 1.96, 1.66, 2.72, 2.11 and 0.1 per cent, respectively, during the corresponding years giving some evidence of diversification in this direction. Thus, increase in area under fruits and vegetable,

sugarcane, oilseeds, cotton and pulses indicate shift in cropping pattern to the commercial crops which was supported by following indices.

Table 9: Shift in Cropping Pattern in Maharashtra

Crops	TE 1963-64	TE 1973-74	TE1983-84	TE1993-94	TE1997-98
Rice	7.01	7.37	7.40	7.54	6.91
Kharif Jowar	13.11	13.81	15.23	12.94	9.48
Bajra	8.86	9.08	8.15	8.98	8.16
Ragi	1.18	1.06	1.03	0.89	0.70
Maize	0.15	0.23	0.27	0.66	1.15
Kodra	0.24	0.17	0.12	0.06	0.06
Tur	2.92	2.98	3.23	4.86	4.78
Rabi Jowar	19.10	18.43	17.49	15.09	15.07
Wheat	4.68	4.86	4.86	3.33	3.47
Gram	2.01	1.91	1.96	2.70	3.37
Total Cereals	55.11	55.87	55.26	50.06	46.88
Total Pulses	12.57	13.13	13.07	15.85	15.29
<i>Total Foodgrains</i>	<i>67.69</i>	<i>69.00</i>	<i>68.34</i>	<i>65.91</i>	<i>61.93</i>
Cotton	14.25	13.70	12.94	12.49	14.35
Sugarcane	0.74	1.13	1.48	1.95	2.40
Oilseeds	9.92	9.33	8.06	12.18	12.03
Fruits & Vegetables	0.82	1.09	1.42	2.46	2.78
Other Crops	6.47	5.69	7.72	4.97	6.47

Note: TE-Triennium Endings and Figures are as percentage area under crop to GCA.

Source: GOM (various issues).

It could be observed from the Table 10 that there has been relatively more diversification in the recent years of the study as compared to the initial years. However the extent of diversification was too small. Decrease in Herfindahl index (or increase in transfer H.I.⁴) showed continuous increase in diversification over the years. A gradual increase in Entropy indices over the years also confirms the steady increase in diversification. Herfindahl index declined by 12.16 per cent and entropy index increased by 5.27 per cent over 1961-64 to 1995-98. The diversification in cropping pattern has taken place towards fruits and vegetables, sugarcane and maize at the cost of food grain crops. It may, thus, be concluded that farmers have shifted their cropping pattern from subsistence crop to the commercial crops.

Table 10: Crop Diversification Indices

Indices	Year					% change in 1995-98 over 1961-64
	TE 1963-64	TE 1973-74	TE 1983-84	TE 1993-94	TE 1997-98	
Herfindahl Index	0.1225 (0.8775)	0.1201 (0.8799)	0.1200 (0.8800)	0.1081 (0.8919)	0.1076 (0.8924)	-12.16 (1.70)
Entropy Index	0.9809	0.9886	0.9921	1.0247	1.0325	5.26

Note: Figures in parentheses indicate transfer values of Herfindahl Index i.e. 1- H.I.

During the last 40 years the gross cropped area in Maharashtra increased by 25 lakh hectares from 190.7 lakh hectares in 1961-64 to 215.8 lakh hectares in 1995-98. The

bulk of this increase was due to the expansion of area sown more than once. The crops, which benefited by the increase in the gross cropped area in the state during reference period, were maize, tur, gram, oilseeds, sugarcane, cotton and fruits and vegetables. The diversification towards these crops could be utilized in a positive manner through the emphasis on processing of these commodities for their value addition. This would create more jobs in the non-agricultural sectors and strengthen the linkages of the secondary activities with the agricultural stratum. The diversification of cropping pattern towards specific crops also suggests that the intensive research efforts should be made by research institutions on the crops most suited to different agro-climatic conditions in the state.

Section VI

Conclusions and Policy Implications

From the foregoing discussion, it emerges that the growth in area of major crops in the state revealed mixed trend. Except jowar, bajra and wheat all other crops recorded a growth in area during overall period of study. The growth in production and productivity of all these crops was visible in the second period whereas commercial crops recorded remarkable increase during third period of study. There has been growth in the use of crucial inputs like irrigation, chemical fertilizer and high yielding variety seeds. The growth in production of kharif jowar, paddy, bajra, rabi jowar, wheat and cotton is mainly on account of change in yield, production of gram, tur and sugarcane however increased due to expansion of area. The productivity growth and shift in cropping pattern were major factor that accounted for the growth of crop output in the state.

From the results it may be concluded that the future scope for increasing output in the state through expansion of area is limited. As such, efforts have to be directed towards further increasing the productivity of various crops and changes in crop pattern towards optimum for which, there is a scope in the state. The future strategy of agricultural development of the state will have to be centered on the expansion of area under HYVs. For the majority of the crops, the growth rates of area during second period (1971-72 to 1980-81) followed by third period (1981-82 to 1997-98) were higher than first period (1961-62 to 1970-71). That means the policy makers should not depend upon expansion of area for increasing agricultural production in the state. There is an urgent need to increase crop production, particularly the foodgrain production which will become inevitable in view of population growth and for that adoption of new technology in the form of HYVs and chemical fertilizers on large scale is necessary. Government should implement drives for this purpose. Production of oilseeds and cotton increased at a slow rate during second period and grew at a higher rate in third period. These two crops are of commercial importance, therefore, steps need to be taken to increase their production and productivity. Per hectare yield of cereals, pulses and total foodgrain increased at a higher rate during the second period of study.

The soil and climate conditions in Maharashtra State are such that they contribute to an inferior crop pattern and relatively low yields in most of the important crops. A major part of the state consists of the plateau region where rainfall is low and highly variable. Besides, the percentage of net area irrigated is low, about 16.4 per cent. It is quite clear that agriculture in the state cannot register progress unless irrigation is

provided over much wider areas and new seed are suitable and economical for adoption under unirrigated condition (Rath, 1977; Venkataramanan and Prahladachar, 1980). Same time water management is badly needed to obtain higher yield over a wider area (Acharya, 1973). Efforts need to be intensified by the government to increase the irrigation and efforts should be made by the extension agencies to convince the farmers to intensify the use of modern inputs. Use of HYV's has different impact on productivity of crops. Large proportion of area of different crops already is being covered by HYV. Need of the hour, therefore, is to stabilize the yield of the crops. Research efforts of the university should therefore be directed to stabilize the yield of various crops. Yield effect has been pronounced in the output growth. Research efforts therefore need to be intensified further to develop high yielding varieties of the crops suitable to agro-climatic conditions of the region. In more recent years, shift in cropping pattern in favour of high value crops like oilseed, sugarcane, fruits and vegetable and pulses have also made noticeable contribution to growth of crop output. These findings are also confirmed by long period study of agricultural growth in Maharashtra State by Venkataramanan and Prahladachar (1980). Changes in cropping pattern through appropriate crop planning with high value crops and steady improvement in crop yield through scientific management is necessary to introduce an element of dynamism in the state agriculture for maximizing the crop output.

It may be alarming to note that the growth rates of yield, which were highest during the second period, exhibited a steep decline during the subsequent period. This is somewhat disturbing, when all efforts are directed to increase yields through new technology, which is essential. The tempo of crop shift may have to be continued in the future also. This warrants the need and necessity of undertaking constraint analysis research to identify factors responsible for lower yields. Agricultural development in the state has to be promoted through enhancement of productivity of the farms. Since there is little scope for increasing arable land in the state, productivity gains alone can contribute to enhanced production.

Endnotes

1. Sources of data: The sources of data used for the purpose of the empirical study are as follows. Figures of area, production and productivity of major crops, area under HYVs, cropped and irrigated area collected from Epitome of Agriculture: Part I, Statistical Abstracts of Maharashtra State and Economic Survey of Maharashtra published by Government of Maharashtra. Data on fertiliser use was collected from Fertiliser Statistics, Fertiliser Association in India, New Delhi and data regarding farm harvest prices was collected from Agricultural Situation in India, published by Ministry of Agriculture, Government of India, New Delhi.
2. It is true that the high-yielding varieties were introduced in 1965, but even in 1966-67 they accounted for only 1.64 per cent of the area under foodgrains in India. In 1967-68, wheat crop alone accounted for 50 per cent of the total area covered under HYVs under foodgrains. Thus in the early period of the introduction of new technology even a shift of 10 per cent of wheat area from other irrigated category to Irrigated High-Yielding' category would have increased the output through the years only by 8.5 per cent. Therefore, the impact of HVY area is felt on foodgrains output, a maximum amount of coverage is necessary (Alagh and Sharma, 1980).

Initially impact of green revolution was confined to wheat and rice only and regions with good irrigation facilities. As a consequence, much of the growth, which took place after introduction of the HYVs, was confined to a limited number of states like Punjab, Haryana, Uttar Pradesh and coastal Andhra Pradesh (Dantwala,1986). Though the new seed fertilizer technology was introduced in Maharashtra in mid-sixties but it has arrived in full swing in the early part of seventies. In 1966-67, the per cent area under HYVs of foodgrain crops was only 0.75 per cent in Maharashtra. Therefore, 1970-71 year chosen as end of first period after which the coverage of HYV increased to around 10 per cent of area under foodgrains. The production of foodgrains in 1964-65 was 67.50 lakh tonnes. It crossed this level in 1968-69. Similarly, fertiliser consumption crossed 10 kg per ha only in 1970-71. Therefore in order to get real impacts of yield rising new seed-fertilizer technology in Maharashtra, the data is analysed by taking 1971-72 onward as green revolution period. Several research workers studied growth in agriculture at state as well as country level by taking same period (1968-69/1970-71 onwards) as green revolution period (see Alagh and Sharma, 1980; Sharma and Singh, 1986; Singh and Baleka, 1998; Raju and Rao, 1988; and Kaushik, 1993). Many researchers have taken 1980-81/1981-82 onward as a post green revolution period (*see* Sawant, 1999). Bifurcation of the period at 1980-81 coincides with the optimal point of break in the time trend for Indian agriculture (Dholkia and Dholkia, 1993).

3. Linear rates of growth are found not very convenient for any comparison of growth between two period and two crops. It seems more appreciable to analyze the movement of agricultural output in terms of compound rather than linear growth rate (Dandekar, 1980).
4. It is a measure of concentration, it was transformed by subtracting it from 1 i.e., $1 - H.I$. The transformed value of $H. I$. will avoid confusion to compare it with other indices , i.e., $E.I$

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