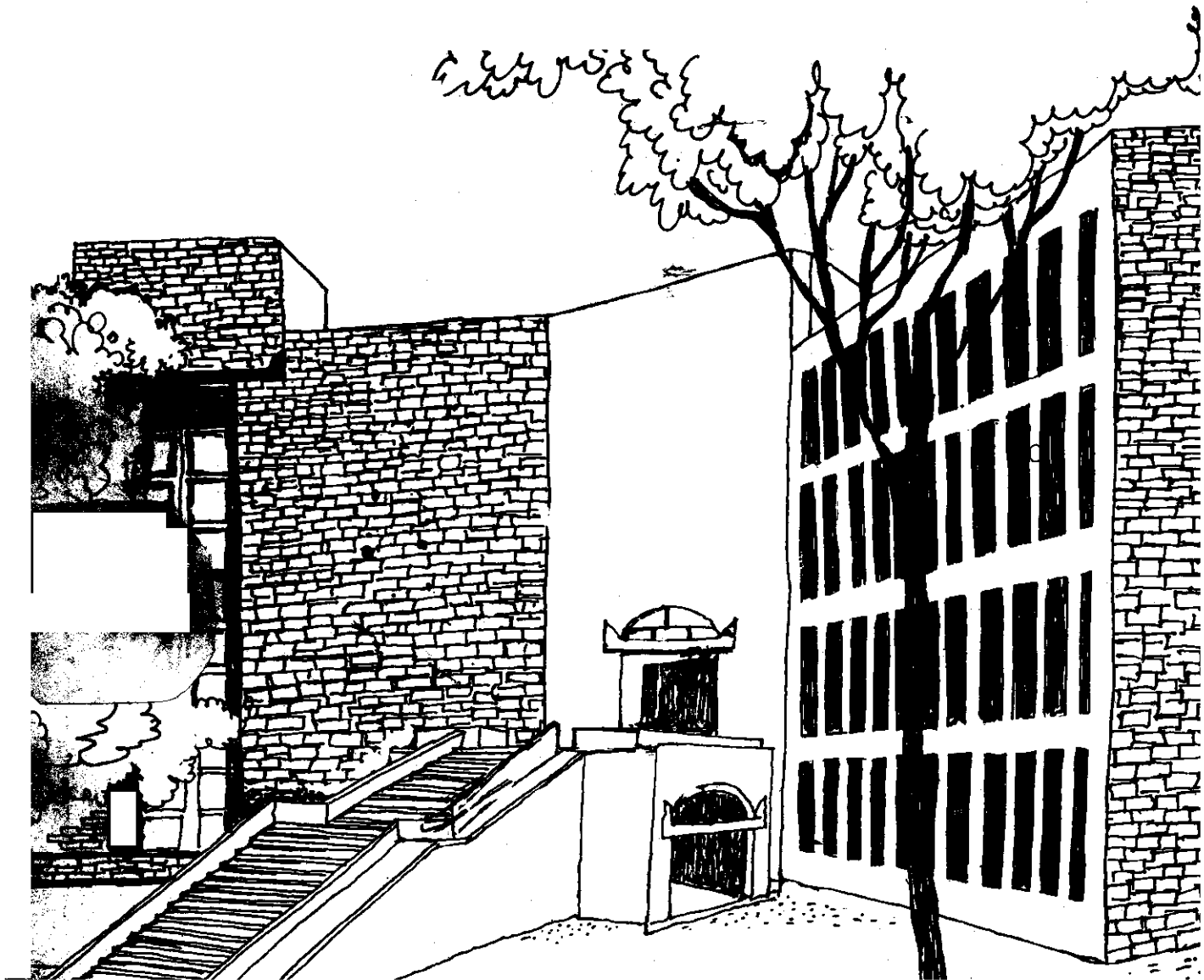




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Working Paper



GROWTH AND INSTABILITY IN
GUJARAT AGRICULTURE

By

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GROWTH AND INSTABILITY IN GUJARAT AGRICULTURE

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I INTRODUCTION

The agricultural development strategy followed in India during the various Five Year Plans laid emphasis on achieving growth and stability in agricultural production and equity in distribution of gains from increased production. However, it was pointed out by S.R. Sen, ^{1/} C.H. Hanumantha Rao ^{2/} and others that the measures adopted for achieving growth in agricultural production through extension of area under crops and intensive use of inputs, especially for high yielding varieties (HYV) have often resulted in increasing the annual fluctuations in production. Most of the empirical evidence available on growth and instability in agriculture are based on its performance during the fifties and sixties. Though the HYVs particularly of wheat, has been introduced during the sixties, it might have been too early to judge their impact of the new varieties based on the experience during the sixties alone. This paper summarizes the findings of a study based on the performance of growth and instability of Gujarat agriculture during 1953-54 to 1977-78.

^{1/} Hanumantha Rao, C.H., 'Technological Change and Distribution of Gains in Indian Agriculture', The Macmillan Company of India Ltd., Delhi, 1975.

^{2/} Sen, S.R., 'Growth and Instability in Indian Agriculture', Address delivered at the Twentieth Annual Conference of the Indian Society of Agricultural Statistics, January, 10-12, 1967.

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Section II explains the methodology followed in obtaining the growth rate, coefficient of variation and also the effect of component element on output growth of different crops. Section III analyses the growth rates and coefficient of variation in area, production, and productivity of important major crops and the effect of area and productivity on crop output. Section IV deals with the contribution of each component element viz., area, yield, interaction, and cropping pattern to crop output through decomposition analysis. Section V discusses about the factors responsible for increasing productivity. The last section contains the summary.

The relevant data of area, production and yield of Gujarat state for this analysis were collected from official sources. ^{3/}

II METHODOLOGY

The agricultural output level in a given year is heavily influenced by weather conditions and it is sometimes considered important to remove the influence of weather before analyzing the growth rates. Attempts to make adjustments in the production levels to incorporate weather conditions have, in general, remained either unsuccessful or at best partially successful. In the absence of a satisfactory method of obtaining production levels adjusted for weather changes, it was considered that the

^{3/} Area, Production, and yield per hectare of Important food and non-food crops in Gujarat State (1949-50 to 1978-79) published from Department of Agriculture, Gujarat State, Ahmedabad-6

years of peak output represented best production condition in terms of weather. A comparison on outputs between the major peaks was expected to give an idea of output growth adjusted for weather changes between the two periods. Agricultural output levels in Gujarat between 1953-54 to 1977-78 indicated two major peaks during 1961-62 and 1970-71. Using these two peak periods, the entire period was divided into three sub periods which could be roughly approximated to three decades.

GROWTH RATE

The compound growth rate of each crop and for each period was worked by fitting exponential function with the help of last square Techniques.

Preference for exponential function over linear function has two important reasons. 1) In agriculture time series data, the output does not show a constant change over the year. This is because the factors affecting output of crops such as rainfall, temperature, all inputs, prices etc., generally show change in constant ratio, which is a characteristic of an exponential function. Secondly the use of logarithms function equalize the importance of fluctuations in regard to their relative rather than in regard to their absolute deviation from the trend. Hence the following exponential equation is used.

$$\text{Log } Y = a + bt$$

Where Y = represents dependent variable

a = represents constant

b = represents coefficient of regression (growth parameter)

t = represents time period

$$\text{Compound growth rate } 'r' = (\text{antilog } b - 1) \times 100$$

COEFFICIENT OF VARIATION

Fluctuations in area, productivity and output are measured by the coefficient of variation. Deviation of observed values for each year from the trend value, and the overall mean for the period were used for computing the coefficient of variation. Here it may be noted that deviation from trend value, instead of from the mean value, was used to make correction for the trend movements.

DECOMPOSITION ANALYSIS

Here, the growth of agricultural output was analysed to note the relative contribution of different component elements like area, yield, interaction, (between area growth & yield growth) and cropping pattern to the growth of crop output. The following additive model suggested by Minhas and Vaidyanathan ^{4/} was used. This analysis was carried out for

^{4/} Minhas, B.S. and Vaidyanathan, A. "Growth of Crop Output in India: 1951-54 to 1958-61 - An Analysis of Component Elements" Journal of the Indian Society of Agricultural Statistics, Vol. XVII No. 2, December 1965, pp. 230-52.

all the three sub periods separately to have comparative idea of the change in the effect of each component

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

Where

| | |
|----------|---|
| P_t | = Production at 't' period |
| P_o | = Production at 'o' period |
| A_t | = Area at 't' period |
| A_o | = Area at 'o' period |
| Y_{it} | = Yield of <u>ith crop</u> at 't' period |
| Y_{io} | = Yield of <u>ith crop</u> at 'o' period |
| C_{it} | = Crop pattern of <u>ith crop</u> at 't' period |
| C_{io} | = Crop pattern of <u>ith crop</u> at 'o' period |
| W_i | = Weight derived from the prices of 'i'th crop (Average farm harvest price of each period) |

Further, to analyse the effect of each component element on each crop output growth the following decomposition model was used.

$$\frac{\frac{1}{n} \sum \Delta P_i}{\bar{P}} = \frac{\frac{1}{n} \sum \Delta A_i}{\bar{A}} + \frac{\frac{1}{n} \sum \Delta Y_i}{\bar{Y}} + \frac{\sum \Delta A_i \Delta Y_i}{\sum A_i Y_i}$$

Where

| | |
|--------------|---|
| ΔA_i | = Total increase/ decrease in area in the 'i'th period of given crop |
| ΔY_i | = Total increase/ decrease in yield in the 'i'th period of given crop |

P_i = Total increase/decrease in output in the 'i'th period
of a given crop

A = Mean of area

Y = Mean of Yields

P = Mean of output

The above model does not explain contribution of cropping pattern to the output growth.

III GROWTH RATE AND COEFFICIENT OF VARIATION

3.1 OUTPUT GROWTH

Table 1 gives the compared rates of growth of cropped area, output and productivity of major crops during the three periods 1953-54 to 1961-62, 1961-62 to 1970-71, and 1970-71 to 1977-78. Rice, wheat, sugarcane, cotton and tobacco were the only crops which had positive growth rates in output during all the three periods. Among these ~~five~~ commodities the growth rate in output of rice and tobacco declined between the first and second periods and then increased between second and third period. While productivity per acre of both rice and tobacco showed continuous growth rate of increase during these periods, the fall in output can be explained by the fall in growth rates of area under these crops. The growth rate in output of wheat increased from 1.94% in the first period to

11.23% in the second period and then declined to 6.04% in the third period. The high growth rate in wheat output during the sixties had been the simultaneous effect of increased growth rates of cropped area and productivity. Though the growth rate in cropped area of wheat continued to increase during the seventies, the fall in the growth rate of productivity has resulted in a fall in the growth rate of wheat output. The growth rates in the output of sugarcane and cotton declined continuously over the three periods, and in both these cases a fall in the growth rate in cropped area accounted for the decline in the growth rate of output.

Total pulses and other cereals had a negative growth rate in output during all the three periods. The growth rate in area of pulses remained negative during all three periods and that of other cereals remained negative during the first and third periods. In both these ~~cases~~ the growth rate in productivity remained negative during the first two periods (1953-54 to 1961-62 and 1961-62 to 1970-71) with a positive growth rate in the third period (1970-71 to 1977-78).

The growth rates in the output of bajri, total cereals, and total foodgrains remained negative during the first and third periods, with a positive rate of growth during the second period. In all these three cases, the growth rates in area indicated exactly the same pattern as the growth rates

Table 1: Growth Rates of Cropped Area, Output, and Productivity per Cropped Area

| Crops | Cropped Area | | | Output | | | Productivity per Cropped Area | | |
|-------------------|---------------|---------------|-------------|-------------|-------------|-------------|-------------------------------|-------------|-------------|
| | 1953-54 | 1961-62 | 70-71 | 53-54 | 61-62 | 70-71 | 53-54 | 61-62 | 70-71 |
| | to 1961-62 | to 1970-71 | to 77-78 | to 61-62 | to 70-71 | to 77-78 | to 61-62 | to 70-71 | to 77-78 |
| Rice | 1.83 | -1.58 | -1.40 | 2.76 | 0.69 | 2.54 | 0.92 | 2.31 | 4.48 |
| Wheat | -0.51 | 3.86 | 4.19 | 1.94 | 11.23 | 6.04 | 2.44 | 7.08 | 1.78 |
| Jowar | -1.97 | -0.25 | -2.45 | -3.43 | 2.06 | 3.50 | -1.48 | 2.30 | 5.42 |
| Bajra | -5.78 | 5.02 | -4.80 | -2.90 | 11.74 | -5.39 | 3.07 | 6.52 | -1.11 |
| Maize | 1.44 | 2.27 | 0.81 | 3.81 | -0.11 | -11.44 | 2.34 | -2.38 | -11.87 |
| Other cereals | -5.64 | 0.38 | -0.48 | -5.80 | -2.21 | -7.63 | -0.17 | -2.68 | 2.04 |
| Total cereals | -2.80 | 2.12 | -2.26 | -0.32 | 5.76 | -0.46 | 2.55 | 3.56 | 1.85 |
| Pulses | -0.34 | -1.30 | -1.43 | -0.50 | 2.58 | -1.15 | -0.16 | -1.30 | 0.25 |
| Total Food-grains | -2.59 | 1.78 | -2.19 | -0.59 | 5.24 | -0.49 | 2.05 | 3.40 | 1.73 |
| Sugarcane | 11.22 | 8.09 | 4.10 | 10.16 | 8.76 | 3.99 | -0.95 | 0.53 | 0.27 |
| Groundnut | 14.53 | -2.92 | -0.21 | 16.36 | -0.68 | 4.72 | 1.59 | 2.63 | 4.90 |
| Oilseeds | 10.18 | -2.47 | 0.10 | 14.26 | -0.35 | 4.71 | 3.59 | 2.19 | 4.54 |
| Cotton | 2.44 | -0.17 | -1.88 | 2.45 | 2.16 | 0.25 | 0 | 2.39 | 1.62 |
| Tabacco | 5.51 | 0.24 | -0.91 | 7.51 | 2.84 | 3.14 | 1.89 | 2.59 | 3.47 |

in output, even though the growth rates in productivity remained positive in all cases, except for bajri during the third period. The growth rates in output of groundnut and total oilseeds indicated a trend opposite to that of bajri, total cereals and total foodgrains with positive growth rates during the first and the third periods and negative growth rate during the second period. While the productivity of groundnut and oilseeds remained positive during all the three periods, the negative growth rate in output during the second period was the result of a negative growth rate in the cropped area.

Jowar had a negative growth rate in output during the first period and positive rates of growth during the second and third periods. The rate of growth in jowar output was mainly influenced by the rate of growth in its productivity. The rate of growth in output of maize indicated the opposite pattern of jowar output, with a positive growth rate during the first period and negative growth rates in the second and third periods. Here again, the changes in the growth rate of maize output was influenced by changes in rate of growth of its productivity.

3.2 FLUCTUATIONS IN OUTPUT

The estimated values of the coefficient of variation are available in Table 2.

An analysis of the fluctuations in output over the three periods indicated that the annual fluctuations in output showed an increasing tendency for rice, wheat, jowar, total cereals, pulses, total foodgrains, groundnut, and oilseeds. In all these cases the coefficients of variation in output during 1970-71 to 1977-78 were higher than the coefficients of variation during 1953-54 to 1961-62 and the coefficients for 1961-62 to 1970-71. The coefficient of variation in the output of sugarcane increased between the first and second periods, and declined between the second and third periods. For bajri, maize, and tobacco, the coefficients of variation increased between the second and third periods. The coefficients of variation in the output of other cereals and cotton showed a declining tendency over the three periods.

An analysis of the coefficients of variation in area under different crops indicated that the fluctuations in area declined between the first and second periods, and increased between the second and third periods for rice, wheat, bajri, maize, total cereals, pulses, total foodgrains, groundnut, oilseeds, cotton, and tobacco. The behaviour of the coefficients of variation for jowar and sugarcane indicated a reverse tendency where the fluctuations increased between the first and second periods, and decreased between the second and third periods. Other cereals was the only category where fluctuations in area showed a continuous decline.

Table 2: Coefficient of Variation In Area, Output and Productivity

| | <u>Cropped Area</u> | | | <u>Output</u> | | | <u>Productivity</u> | | |
|-----------------|---------------------|-------|-------|---------------|-------|-------|---------------------|-------|-------|
| | 53-54 | 61-62 | 70-71 | 53-54 | 61-62 | 70-71 | 53-54 | 61-62 | 70-71 |
| | to | to | to | to | to | to | to | to | to |
| | 61-62 | 70-71 | 77-78 | 61-62 | 70-71 | 77-78 | 61-62 | 70-71 | 77-78 |
| Rice | 5.90 | 2.56 | 6.89 | 23.36 | 23.60 | 31.68 | 21.06 | 22.62 | 22.51 |
| Wheat | 18.55 | 11.38 | 21.08 | 14.87 | 18.19 | 20.15 | 15.09 | 6.30 | 6.04 |
| Jowar | 4.60 | 5.59 | 5.46 | 14.34 | 17.88 | 25.75 | 14.52 | 18.95 | 23.12 |
| Bajri | 7.03 | 3.37 | 18.37 | 25.23 | 21.24 | 29.00 | 22.26 | 18.89 | 26.59 |
| Maize | 5.60 | 2.62 | 3.12 | 33.59 | 27.97 | 34.26 | 30.94 | 28.22 | 39.69 |
| Other Cereals | 20.84 | 12.94 | 11.97 | 38.43 | 28.63 | 9.71 | 20.71 | 16.39 | 14.40 |
| Total Cereals | 3.58 | 2.27 | 6.95 | 15.16 | 18.88 | 24.92 | 13.64 | 16.73 | 20.97 |
| Pulses | 10.94 | 9.07 | 9.40 | 16.09 | 18.15 | 19.49 | 9.30 | 12.22 | 13.17 |
| Total Foodgrain | 3.07 | 2.67 | 7.03 | 16.14 | 18.76 | 24.63 | 12.89 | 16.32 | 20.41 |
| Sugar cane | 14.89 | 19.89 | 14.05 | 11.91 | 21.21 | 14.49 | 5.53 | 3.40 | 9.06 |
| Groundnut | 7.86 | 5.82 | 7.75 | 19.05 | 25.41 | 41.84 | 19.61 | 26.22 | 42.36 |
| Oil seeds | 5.81 | 5.15 | 6.90 | 18.08 | 25.21 | 39.29 | 18.36 | 25.66 | 40.00 |
| Cotton | 10.38 | 2.81 | 8.36 | 19.38 | 7.73 | 6.86 | 17.62 | 6.72 | 13.82 |
| Tobacco | 9.65 | 6.14 | 14.32 | 21.00 | 7.13 | 15.67 | 21.59 | 7.21 | 4.80 |

The fluctuations in productivity indicated a continuous increase over the three periods for jowar, total cereals, pulses, total foodgrains, groundnut, and oilseeds. For rice, there was an increase in the fluctuations in productivity between the first and second and there was a very marginal change between the second and third periods. The annual fluctuations in the productivity of bajri, maize, sugarcane, and cotton declined between the first and second periods, and increased between the second and third periods. Wheat, other cereals, and tobacco showed a declining tendency in the annual fluctuations over the three periods.

A comparison of the fluctuations in area and productivity during the different periods indicate that fluctuations in productivity per acre were greater than those in area for rice, jowar, bajri, maize, other cereals, total cereals, total foodgrains, groundnut, oilseeds, and cotton. This was also true for pulses in the second and third periods, and for tobacco in the first and second periods. The fluctuations in area were greater than those in productivity per acre for wheat and sugarcane during all the periods, for pulses in the first period, and for tobacco in the third period.

A summary of the directions of change in growth rate and fluctuations in area, output, and productivity per acre, given in Table 3, provides the following conclusions.

1) The changes in growth rates in output for rice, bajri, other cereals, total cereals, total foodgrains, groundnut, sugarcane, and cotton had been consistent with the changes in growth rates of area, indicating that for these commodities the output changes were mainly influenced by changes in area..

2) The changes in growth rates in output for wheat, jowar, maize, pulses, and oilseeds had been consistent with the changes in growth rates of productivity had a predominant influence of the growth rates of outputs of these commodities.

3) The change in the growth rates in output of tobacco between the first and second periods was consistent with the change in the growth rates of area. However, the change in the growth rates of output of tobacco between the second and third periods was consistent with the change in the growth rates of productivity.

4) The changes in the coefficient of variation between the first and second periods and between the second and third periods, in area, output, and productivity per acre of bajri, maize, and other cereals were in the same direction. However, for jowar, total cereals, pulses, total foodgrains, groundnut, and oilseeds, the changes in the fluctuations in output were consistent with those in productivity. For

Table 3: Summary of Changes in Growth Rates and Coefficients of Variation in Area, Output and Productivity

| Nature of changes | Area | | Output | | Productivity | |
|--|------------------|---------------|------------------|---------------|------------------|------------------|
| | Growth Rate | C.V. | Growth Rate | C.V. | Growth Rate | C.V. |
| Increase Between Period I & II Increase Between Period II & III (+,+) | Wheat | | Jowar | Rice | Rice | Jowar |
| | | | | Wheat | Jowar | Total Cereals |
| | | | | Jowar | Groundnut | Pulses |
| | | | | Total-Cereals | Tobacco | Total foodgrains |
| | | | | Pulses | | Groundnut |
| Increase between Period I & II Decrease Between Period I & III (+,-) | Bajri | Jowar | Wheat | Oilseeds | Wheat | Rice |
| | Maize | Sugarcane | Bajri | Sugarcane | Total Cereals | |
| | Other Cereals | | Other Cereals | | Total Foodgrains | |
| | Total Cereals | | Total Cereals | | Sugarcane | |
| | Total Foodgrains | | Total Foodgrains | | Cotton | |
| Decrease between Period I & II, Increase Between Period II & III (-,+) | Rice | Rice | Rice | Bajri | Other Cereals | Bajri |
| | Groundnut | wheat | Pulses | Maize | Pulses | Maize |
| | Oilseeds | Bajri | Oilseeds | Tobacco | Oilseeds | Sugarcane |
| | | Maize | Tobacco | | Bajri | Cotton |
| | | Total Cereals | Groundnut | | | |
| | | Groundnut | | | | |
| | | Oilseeds | | | | |
| | | Cotton | | | | |
| | | Tobacco | | | | |
| | | Pulses | | | | |
| | Total Food- | | | | | |

Table-3: (Continued)

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| Name of Changes | Area | | Output | | Productivity | |
|------------------|-------------|---------------|-------------|---------------|--------------|---------------|
| | Growth Rate | C.V. | Growth rate | C.V. | Growth Rate | C.V. |
| Decrease between | Jowar | Other Cereals | Maize | Other Cereals | Maize | Wheat |
| Period I & II | Pulses | | Sugarcane | Cotton | | Other Cereals |
| Decrease between | Sugarcane | | Cotton | | | Tobacco |
| Period II & III | Cotton | | | | | |
| (-, -) | Tobacco | | | | | |

sugarcane and tobacco, the output fluctuations were consistent with the fluctuations in area. The pattern of changes over the three periods in the movements of fluctuations in area, output, and productivity of rice, wheat, and cotton has undergone some changes.

5) The simultaneous changes in growth rates and fluctuation indicated that growth rates in output and output fluctuations were consistent for only three commodities -- jowar, tobacco and cotton. The fluctuations in area under rice, groundnut and oilseeds were influenced by the growth rates in area. The fluctuations in productivity of jowar, bajri and groundnut were consistent with their growth rates in productivity.

IV AGGREGATE DECOMPOSITION ANALYSIS

The results of the decomposition analysis are presented in Table 4. A perusal of table 4 reveals that among the three sub-periods, the period-2 (61-62-70-71) registered the highest growth in output of the order of 4.70 per cent followed by the first period (53-54-61-62) 4.00 percent. A negative output growth -0.37 per cent was exhibited by third period (70-71-77-78). Table further reveals that the relative contribution of each component element was varying in different periods. The highest growth in output in second period was

mainly due to the growth of the yield levels which accounted for 97.62 per cent contribution followed by area (5.09%).

Cropping pattern, however, showed a negative contribution to the output growth during this period. In the first period, the highest contribution of 97.34 per cent to the output growth was made by the changes in the cropping pattern. The other contributing factors were yield levels (27.71%) and area (14.62%) and interaction (.01%). The period-3 showed negative trend in output growth. Change in cropping pattern was noted to be the principal factor affecting output growth. It was followed by area and yield level respectively. Thus, it can be concluded that in the periods, first and second the contribution of yield to output growth was in increasing order thereafter it decreased. Contribution of Cropping pattern to output growth was highest in the period-1. In the third period, however, the change in the cropping pattern contributed most to a negative output growth.

CROPWISE DECOMPOSITION ANALYSIS

The contributions of growth in area, yield and interaction effect on each crop output growth have important significance in providing an idea of the effect of new technology on different crops. The relevant results of the analysis in this effect are summarised the Table 5.

Table 4: Relative Contributions of Different Component Elements to the agricultural Output Growth; Gujarat: 1953-78.

| Periods | Percentage increase attributed to | | | | | Overall Rate of Growth (%) |
|----------------------|-----------------------------------|-----------------|------------------|-----------------|---------|----------------------------|
| | Area | Yield | Crop Pattern | Inter-action | Total | |
| 53-54 to 61-62 | 14.62 (.59) | 27.71 (1.11) | 57.34 (2.29) | 0.33 (0.01) | 100.00 | (4.00) |
| 61-62 to 70-71 | 5.09 (.24) | 97.62 (4.59) | -3.20 (-0.15) | 2.49 (0.02) | 100.00 | (4.70) |
| 70-71 to 77-78 | -17.39 (-.06) | -7.16 (-.03) | -72.60 (-.27) | -2.85 (-.01) | -100.00 | (-0.37) |

Notes:- Figures in Parentheses are the respective contribution of different Component element in the overall output growth rate.

Table 5: Cropwise Contribution of Component Elements to Output Growth, Gujarat: 1953-78

| | 53-54 to 61-62 | | | | 61-62 to 70-71 | | | | 70-71 to 77-78 | | | |
|------------------|----------------|---------|--------------|---------------|----------------|----------|--------------|---------------|----------------|---------|--------------|---------------|
| | Area | Yield | Inter-action | Output Growth | Area | Yield | Inter-action | Output Growth | Area | Yield | Inter-action | Output Growth |
| Rice | 66.30 | 33.30 | 0.40 | 2.76 | -229.00 | 334.80 | -5.80 | 0.69 | -55.12 | 176.37 | -21.25 | 2.54 |
| Wheat | -26.28 | 125.77 | 0.51 | 1.94 | 34.37 | 63.05 | 2.58 | 11.23 | 69.37 | 29.48 | 1.15 | 6.04 |
| Jowar | -57.43 | -43.15 | 0.58 | -3.43 | -12.13 | 111.65 | 0.48 | 2.06 | -70.00 | 154.85 | 15.15 | 3.50 |
| Bajra | -199.31 | 105.86 | -6.55 | -2.90 | 42.75 | 55.53 | 1.72 | 11.74 | -89.05 | -20.59 | 9.64 | -5.39 |
| Maize | 37.79 | 61.41 | 0.80 | 3.80 | 2063.64 | -2163.64 | - | -0.11 | 7.08 | -103.75 | -3.33 | -11.44 |
| Uragi | 132.18 | -31.04 | -1.14 | 1.74 | -44.80 | -56.00 | 0.80 | -5.00 | -36.31 | -66.87 | 3.18 | -1.57 |
| Kodra | -107.78 | 12.31 | -4.53 | -3.98 | 14.70 | -113.93 | -0.77 | -5.17 | -106.38 | 6.99 | -0.61 | -3.29 |
| Barley | -72.39 | -29.89 | 2.28 | -10.47 | 123.69 | -26.48 | 2.79 | 2.87 | 89.69 | 9.69 | 0.62 | 4.85 |
| Other Cereals | -97.24 | -2.93 | 0.17 | -5.80 | 17.19 | -116.74 | -0.45 | -2.21 | -124.24 | 26.73 | -2.49 | -7.63 |
| Total Cereals | -875.00 | 795.87 | -21.87 | -0.32 | 36.81 | 61.81 | 1.38 | 5.76 | -491.30 | 402.17 | -10.87 | -0.46 |
| Gram | -172.38 | 74.58 | -2.20 | -1.81 | -149.65 | 54.52 | -4.87 | -5.74 | 405.26 | -431.58 | -73.68 | -0.76 |
| Other Pulses | 36.66 | -120.00 | -16.66 | -0.90 | 28.00 | -122.67 | -5.33 | -0.75 | 88.39 | 11.61 | - | 2.93 |
| Total Pulses | 108.33 | -212.50 | 4.17 | -0.24 | 63.63 | 36.37 | - | 0.11 | -86.59 | -13.91 | 0.50 | -5.97 |
| Total Foodgrains | -68.00 | -32.00 | - | -0.50 | -50.38 | -50.39 | 0.77 | -2.58 | -124.34 | 21.73 | 2.61 | -1.15 |
| Sugarcane | -438.98 | -347.45 | -8.47 | -0.59 | 33.97 | 64.89 | 1.14 | 5.24 | -446.93 | 353.06 | -6.13 | -0.49 |
| Oilseeds | 110.43 | -9.35 | -1.08 | 10.16 | 92.36 | 6.05 | 1.59 | 8.76 | 102.76 | -6.76 | 4.00 | 3.99 |
| Chickpeas | 10.59 | 88.33 | 1.08 | 12.93 | -18.06 | -86.34 | 4.40 | -2.27 | -99.57 | -0.57 | 0.14 | -6.93 |
| Potato | 53.92 | -150.25 | -3.67 | -5.99 | -6.79 | 108.34 | -1.55 | 11.03 | 101.37 | -0.23 | -1.14 | 17.48 |
| Groundnut | 88.75 | 9.71 | 1.54 | 16.36 | -429.41 | 347.05 | -17.64 | -0.68 | -4.44 | 103.81 | 0.63 | 4.72 |
| Other | -75.41 | -25.69 | 1.10 | -7.16 | -60.45 | 165.91 | -5.46 | 5.31 | 77.60 | 43.69 | -21.29 | 11.74 |

Table 5: Continued

| | 53-54 to 61-62 | | | | 61-62 to 70-71 | | | | 70-71 to 77-78 | | | |
|----------------|----------------|-------|------------------|------------------|----------------|--------|------------------|------------------|----------------|--------|------------------|------------------|
| | Area | Yield | inter- action | Output Growth | Area | Yield | Inter- action | Output Growth | Area | Yield | Inter- action | Output Growth |
| mum | -99.71 | -0.06 | -0.32 | -10.62 | 30.93 | 67.77 | 1.30 | 8.47 | -23.57 | -77.71 | 1.28 | -7.00 |
| seed & Mustard | 68.59 | 31.05 | 0.36 | 2.77 | 147.69 | -60.51 | 12.82 | -1.95 | 101.27 | 1.26 | -2.53 | 7.89 |
| l Oilseeds | 71.38 | 25.17 | 3.45 | 14.26 | -705.71 | 625.71 | -20.00 | -0.35 | 2.13 | 96.39 | 1.48 | 4.71 |
| on | 99.60 | 0.40 | - | 2.45 | -7.87 | 110.64 | -2.77 | 2.16 | -752.00 | 648.00 | 204.00 | 0.25 |
| ico | 73.36 | 25.17 | 1.47 | 7.51 | 8.45 | 91.19 | 0.36 | -2.84 | -9.87 | 110.50 | -10.63 | 3.14 |

In the first period among all the crops, groundnut indicated the highest output growth (16.36%). It was followed by total oilseeds (14.26%) chillies (12.93%), and sugarcane (10.16%). The lowest output growth was noted in case of sesamum, castor, barley etc., which showed less than 10 per cent decrease in the output growth. The crops which witnessed highest growth in the second period were bajri (11.74%) followed by potato (11.03%), sesamum (8.47%) etc. Gram, Kodra, and ragi, however, indicated negative five per cent in the output growth in the same period. In the third period, only potato and castor crops accounted for more than 10 per cent growth in the output. Potato accounted for highest output growth (17.18%) and maize accounted for lowest output growth (-11.44%) in the third period respectively.

Looking in to the relative contribution of each component element (area, yield, and interaction) to the output growth rate it was noted that contribution of each component varied from crop to crop as well as from period to period. In the first period, there were 9 crops whose yield growth contributed more than 50 per cent to their respective output growth. These were wheat, bajri, maize, kodra, total cereals, gram, tur, total foodgrains and chillies. In this, the yield growth of total cereals accounted for the highest contribution to output growth i.e. 796.87 per cent. In the second period, the crops

whose yield growth contributed for more than 50 per cent change in the output growth were rice, wheat, jowar, bajri, total cereals, gram, total foodgrains, potato, groundnut, castor, sesamum, total oilseeds, cotton and tobacco. In this period the yield growth of total oilseeds (625.71%) contributed highest to its output growth followed by rice (334.8%) etc. The last period showed further change in the effect of yield growth of a crop to output growth of a crop. The yield growth of rice, jowar, kodra other cereals, total cereals, total pulses, groundnut, total oilseeds, cotton and tobacco contributed more than 50 per cent to their respective output growth. Here, yield growth of cotton crop (648.00%) contributed highest to its output growth followed by total cereals (402.17%), total foodgrains (353.06%), rice (176.37%) etc.

It is further evident from the table that the contribution of area growth to output growth of crops were found to be more than 50 per cent for rice, ragi, other pulses, sugarcane, potato, groundnut, sesamum, rapeseeds and mustard, total oilseeds, cotton, and tobacco in the first period; maize, kodra, barley, other cereals, other pulses, sugarcane, rapeseeds and mustard in the second period; and wheat, maize, barley, gram, total pulses, total foodgrains, sugarcane, potato, castor, rapeseeds and mustard in the third period.

the third period made the highest contribution to their respective output growth. The interaction effect of area and yield showed insignificant contribution to the output growth of different crops in all the three periods.

EFFECT OF CROPPING PATTERN ON OUTPUT GROWTH-CROPWISE ANALYSIS

It is evident from different studies that cropping pattern plays an important role in accelerating or decelerating the pace of output growth of a crop. Very few studies have been conducted this analysis on cropwise basis. In the present study, in order to study the effect of cropping pattern on output of an individual crop, the growth rates of different crops were classified. The changes in the growth rates of yield and area of different crops from the first to second period and from the second to the third period were worked out. The results of this analysis are presented in Table 6.

A perusal of the table 6 shows that out of 25 crops there were eleven crops in the first period, seven crops in the second period, and ten crops in the third period whose area growth rate were more than yield growth rate. The crops whose area growth rate showed negative trend and were less than yield growth rate were jowar, barley, other cereals, castor seeds and total pulses in the first period; and bajri, other pulses, and chillies in the third period. The second period, however, does not show such changes.

Table 6: Change in the Growth Rate of Crops and Cropping Pattern Changes

| Period | Crops whose Yield Growth is Positive & more than Area Growth | Crops whose Area Growth is Positive and more than Yield Growth | Crops whose Yield Growth is Negative and more than Area Growth | Crops whose Area Growth is Negative & More than Yield Growth | Change in Growth Rate of Crops | | | | |
|------------------|--|--|--|--|---|---|-------------------------------------|-------------------------------------|---------------|
| | | | | | Decrease in yield growth & increase in area | Decrease in Area Growth & increase in Yield | Decrease in Area Growth from + to - | Increase in Area Growth from - to + | |
| P ₁ | Wheat | Rice | | Jowar | | | | | |
| | Bajri | Ragi | | Barley | | | | | |
| | Maize | Other Pulses | | Other Cereals | | | | | |
| | Kodra | Sugarcane | | Castorseeds | | | | | |
| | Total Cereals | Potato | | Total Pulses | | | | | |
| | Grains | Groundnut | | | | | | | |
| | Tur Pulse | Sesamum | | | | | | | |
| | Total Foodgrains | Rapeseed & Mustard | | | | | | | |
| | Chillies | Total Oilseeds | | | | | | | |
| | | Cotton | | | | | | | |
| | | Tobacco | | | | | | | |
| | P ₂ | Rice | | Ragi | | Maize | Rice | | Barley |
| | | Wheat | Maize | Total Pulses | | Kodra | Potato | | Other Cereals |
| Jowar | | Kodra | Chillies | | | Sesamum | | | |
| Bajri | | Barley | | | | Total Oilseeds | | | |
| Total Cereals | | Other Cereals | | | | Cotton | | | |
| Gram | | Other Pulses | | | | Groundnut | | | |
| Total Foodgrains | | Sugarcane | | | | | | | |
| Potato | | Rapeseed & Mustard | | | | | | | |
| Groundnut | | | | | | | | | |
| Castorseeds | | | | | | | | | |
| Sesamum | | | | | | | | | |
| Total Oilseeds | | | | | | | | | |
| Cotton | | | | | | | | | |
| Tobacco | | | | | | | | | |
| P ₃ | Rice | Wheat | Ragi | Bajri | Wheat | Kodra | | Other Pulses | |
| | Jowar | Maize | Sesamum | Other Pulses | Gram | Other Cereals | | | |
| | Kodra | Barley | | Chillies | Total | | | | |
| | Other Cereals | Gram | | | Foodgrains | | | | |
| | Total Cereals | Total Pulses | | | Potato | | | | |
| | Total Pulses | Total Foodgrains | | | Castorseeds | | | | |
| | Groundnut | Sugarcane | | | | | | | |
| | Total Oilseeds | Potato | | | | | | | |
| | Cotton | Castorseeds | | | | | | | |
| | Tobacco | Rapeseed & Mustard | | | | | | | |

Among the three periods only two crops (sugarcane, and rapeseeds and mustard) were such whose area growth rates were found more than the yield growth rate. Thus, changes in the area growth of the crops over the three periods showed changes in cropping pattern.

The table further reveals that the ten out of 25 crops viz; maize, kodra, rice, potato, sesamum, Total oilseeds, cotton, Groundnut, Barley and other cereals there was a change in the **dominant** contributing factor from the first to second period while such a pronounced **change** was noticed in eight out of 25 crops (wheat, gram, total foodgrain, potato, castorseeds, kodra, other-cereals and other pulses) from the **second** to third period. These changes reflected the changes in the cropping pattern over the study period.

V FACTORS RESULTING PRODUCTIVITY INCREASES

This section deals with the effect of different inputs on output of various crops. This quantitative assessment of the contribution of different input factors to the output growth of the crops may help in restructuring the agricultural development programmes to enhance production. The input factors to be studied which effect production are area shown, proportion of total area under HYV, proportion of total area under irrigation, effect of HYV seed, fertilizer, rainfall, improve agronomic practices, and mechanisation. The present analysis is, however, limited to study the contribution of

only two input factors viz., proportionate area under irrigation, and that area under HYV over total area. In the absence of required time series data other factors would not be considered. Further, due to non-availability of complete time series data for the period 1953-54 to 1977-78 of irrigated area and area under HYV for certain crops, the present analysis is limited to only a few crops for the periods 1966-67 to 1977-78.

For comparing the impact of the different input factors on productivity, the regression analysis was carried out for each crop for two different periods viz., 1966-67 to 1977-78 and 1970-71 to 1977-78 separately. Double log linear regression model was fitted with the help of Least Square Technique to calculate regression coefficient of each input factor. Here, one might argue that as irrigation is very essential for HYV crops, to get higher production, there is a possibility of multicollinearity existing between the proportionate area under irrigation to total area, and proportionate area under HYV to total area. To assess this, correlation coefficient was worked out. The results are presented in Table 7. It reveals that except in rice (70-71 to 77-78) and Jowar (66-67 to 77-78) multicollinearity for the other crops does not exist as their values of co-efficient correlation are found to be very less.

Table 7: Correlation Coefficient of Different Crops.

| Crops | Correlation Coefficient between Irrigated Area and Area under HYV Crops | |
|-------|---|----------------|
| | 66-6 to 77-78 | 70-71 to 77-78 |
| Rice | .47 | .66 |
| Wheat | -.23 | -.38 |
| Jowar | .52 | .37 |
| Bajri | .18 | -.31 |
| Maize | -.12 | -.35 |

The result of the analysis are presented in Table 8.

Table 8: Regression Coefficients of Productivity for Gujarat State for the period 1966-67 to 1977-78

| | 1966-67 to 1977-78 | | | | 1970-71 to 1977-78 | | | |
|-------|-------------------------|------------------|------------------|----------------|-------------------------|------------------|------------------|----------------|
| | Irrigation ² | HYV ³ | Constant | R ² | Irrigation ² | HYV ³ | Constant | R ² |
| Rice | 2.61** (2.22) | 0.23 (1.30) | -2.11 (0.52) | .53 | 2.10** (2.85) | 0.03 (0.85) | -0.20 (-0.07) | .59 |
| Wheat | -0.76 (-0.21) | -0.14 (-0.57) | 9.84* (0.53) | .42 | -0.11 (-0.02) | -2.14 (-0.91) | 10.55 (0.53) | .15 |
| Jowar | -0.27 (-0.53) | 0.14** (2.56) | 6.55* (10.78) | .43 | -1.11 (-1.42) | 0.18 (1.95) | 7.67* (7.63) | .46 |
| Bajri | -0.32 (-0.86) | 0.17 (1.12) | 6.75* (14.71) | .12 | -0.20 (-0.26) | -0.14 (-0.17) | 7.05* (9.61) | .11 |
| Maize | -0.21 (-0.45) | -0.06 (-0.38) | 7.07* (10.45) | .55 | 0.55 (0.81) | -0.38 (-1.58) | 6.12* (7.06) | .34 |

1. Figures in parentheses are t-value.

2. Proportion of area irrigated over total area under crop.

3. Proportion of area under HYV over total area under crop.

* Significant at 1 per cent level.

** Significant at 5 per cent level.

In almost all the crops, 40 per cent or less variation in the crop productivity is explained by the independent variables included in both the periods (66-67 to 77-78 and 70-71 to 77-78). Only in maize crop (66-67 to 77-78), and rice (in both periods) more than 50 per cent variation in productivity of the crops were explained by the independent variables.

The cropwise analysis of coefficient regression of both the independent variables indicates that only in rice, (in both the periods) and jowar (in 66-67 to 77-78), the value of regression coefficients of proportionate areas under irrigation to total area was significant at 5 per cent level. In the rest of the crops, the regression coefficients of neither proportionate area under irrigation to total area nor proportionate area under HYV to total area showed significant contribution to productivity.

The above analysis therefore suggests that negative but insignificant coefficient of proportionate area under irrigation to total area may be treated as zero. It seems that the effect of irrigation is distributed among those of area shown, fertilizer, technical improvement etc. Further the insignificant effect of proportionate area under HYV to total area to productivity of the crops could be treated with area. Plausible

explanation for negative effect of HYV of crop to its productivity may be because of wrong application of modern agricultural practices, less doses of fertilizers to the crop in the top and ~~and~~ ~~bessel~~ dressing, lack of timely irrigation to the crops etc.

VI SUMMARY

The forgoing analysis indicates an accelerated growth rate of output of rice, pulses, oilseeds, tobacco, and groundnut during the seventies compared to the sixties when these commodities had experienced a decelerated growth rate compared to the fifties. At the same time wheat, bajri, other cereals, total cereals and total foodgrains which had experienced an accelerated growth rate during the sixties, as compared to the fifties, have experienced a decelerated growth rate during the seventies, as compared to the sixties. In spite of technological change, growth rate in output of a number of commodities are still dependent upon the growth rates of area under the crop. There is evidence that the increased fluctuation in the output of many commodities during the sixties is further aggravated during the seventies. While the sixties had experienced some decline in fluctuation in area under many crops, during the seventies fluctuation has widened. The fluctuation in productivity per acre experienced during the sixties also does not show any declining tendency.

The periodwise comparison of the effect of each component element viz., area effect, Yield effect, and cropping pattern effect on the output growth of the crops in Gujarat State enables us to identify the factors affecting the output growth. Analysis indicates that cropping pattern contributed more than fifty per cent change in output growth in fifties followed by yield effect and area effect. In sixties, yield effect accounted for more than ninety per cent contribution in output growth. However, in seventies, all the component elements contributed negatively to output growth. One can, therefore, argue that overall area and cropping pattern showed continuously decreasing effect to output growth in all the periods. Contribution of yield effect to output growth, however, witnessed acceleration till sixties and thereafter showed decreasing tendency. Thus, increase in overall growth rate of output from fifties to sixties can be attributed to increase in yield effect, whereas decrease in overall output growth from sixties to seventies was mainly because of the change in cropping pattern and fluctuation in area allocation.

The cropwise relative contribution of area effect, yield effect and interaction effect to their respective output growth showed a varying behaviour. In the first period the crops whose yield growth responded to more than 50 per cent contribution to their respective output growth are wheat, bajra maize, kodra, total cereals, gram, tur pulse, total foodgrains and chillies, whereas the crops whose area growth contributed to more

than 50 per cent change in the output growth of respective crops are rice, ragi, other cereals, sugarcane, potato, groundnut, sesamum, rapeseeds and mustard, total oilseeds, cotton and tobacco. Area and yield growth together did not contribute significantly to the output growth of respective crops. As far as changes in the area effect and yield effect in all the three periods are concerned, except wheat, bajra, total cereals, total foodgrains, and gram, in fifties and rice, jowar, total cereals, groundnut, total oilseeds, and cotton in sixties, all the other crops in fifties whose yield effect contributed more than 50 per cent to their respective output growth showed decline in yield effect to less than 50 per cent or negatively to output growth in the sixties. Similarly, in case of other cereals, sugarcane, and rapeseeds and mustard in fifties and maize, barley, sugarcane, and rapeseeds in sixties whose area effect contributed more than 50 per cent to their respective output growth, the remaining crops showed deceleration in the contribution of area growth to less than 50 per cent to output growth from fifties to sixties and from sixties to seventies respectively. Only two crops were found whose yield effect (Total cereals) and area effect (sugarcane) had been contributed more than 50 per cent to their respective output growth from fifties to seventies. Above analysis, therefore, suggest that even after vast agricultural advancement, the increase in the production of about 50 per cent crops still depend upon increase in area allocation.

Regarding the effect of cropping pattern to output growth, it was found that cropping pattern does affect the production. This was explained by noting down the change in the area allocation in different crops in different periods (refer table 6). There were ten crops from the first to second period and eight crops from the second to third period which had exhibited change in the growth rate of area and yield. This change in area growth indicate change in cropping pattern. At this stage quantitative measurement of cropping pattern effect to output growth of respective crops are not possible due to lack of suitable method.

Lastly, regression analysis carried out in section V of this paper suggested that neither the proportionate area under irrigation to total area nor proportionate area under HVV to total area of different crops showed a significant effect on productivity except in rice where coefficient of regression of proportionate area under irrigation to total area responded significantly in both the periods.