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production twice that of area, and 3 times that of productivity. The corresponding figures for jute are only 2 and 1. The ratio between the growth of productivity and area was less than 1 both for cotton and jute.

(e) Thus an analysis of time series data relating to acreage, production and productivity of food crops and non-food crops like jute and cotton reveals that (i) the growth of output was brought about more by the expansion of area through the extension of cultivation than by the use of productivity-raising factors. (ii) Among the food crops, wheat recorded highest growth of output and the major contribution to growth of production of wheat came from land. In the case of barley and gram which are substitute crops for wheat, not much effort has been made to increase their production; on the contrary, their production has tended to decline partly due to bad planning and wrong policy adopted by the government. (iii) As a result of a decline in the productivity of jute, its gross yield could not improve despite an expansion in the area under it.

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## VALUE PRODUCTIVITY GROWTH OF SOME IMPORTANT CROPS IN THE PUNJAB

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Punjab is one of the most progressive States in India. The general showings of Punjab after Independence are impressive. Divided Punjab opened with a deficit of 35,000 tons of foodgrains to feed 44 per cent of the population of united Punjab from only 38 per cent of lands which viewed from any angle whether of fertility or irrigation bore no comparison to the lands abandoned in West Punjab. Now this deficit area has been turned into a progressive surplus zone.

This article attempts at studying the growth of agricultural productivity in Punjab. Further, the contribution of different elements such as increase in yield, extension in area and changes in cropping patterns towards this growth has also been analysed.

### MATERIAL AND METHOD

The period under study extends from 1950-51 to 1964-65 covering thereby three plan periods. Data for the year 1965-66 are not as yet available. The data on yields per acre, production and acreage of six major crops, i.e., wheat, gram, maize, bajra, jowar and rice covering about 68 per cent of the total cropped area in the State were obtained from the Statistical Abstract of Punjab. Value

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productivity per acre of food crops covered under the study were worked out keeping the prices constant. (Prices used here were average prices over three years, i.e., 1950-53). Prices were kept constant because the objective here was to examine the effect of yield and shifts in cropping pattern. A rise or fall in prices over time would have concealed the effect of these factors. Value productivity at variable prices was also worked out for the sake of comparison. The analysis was extended to different districts of the State.

The value productivity per acre was worked out as under<sup>1</sup> :

$$\text{Value productivity per acre for the year} = \frac{\sum_i C_{ij} P_i}{A_j}$$

where  $C_{ij}$  is the production of the  $i$  th crop for the  $j$  th year,  $P_i$  is the price of the  $i$  th crop kept constant over years and  $A_j$  the net area sown in the district for the  $j$  th year. Growth rates of the value productivity per acre were calculated while fitting a simple linear function of the type  $Y = a + bt$  to the index of the value productivity per acre. The index was worked out with an average of three years productivity as base 100. It was further tested for its significance by 't' test.

The growth of agricultural production was analysed to see the contribution of change in area, yield and cropping pattern. The whole of this analysis was done at district level. The additive model<sup>2</sup>

$$P_t - P_o = (A_t - A_o) \sum W_i C_{io} Y_{io} + A_t \sum W_i C_{io} (Y_{it} - Y_{io}) + A_t \sum W_i (C_{it} - C_{io}) (Y_{io}) + A_t \sum W_i (C_{it} - C_{io}) (Y_{it} - Y_{io})$$

was used for this analysis

where	$P_t$	=	production at the period $t$ ,
	$P_o$	=	production at the period $o$ ,
	$A_t$	=	cropped acreage at time $t$ ,
	$A_o$	=	cropped acreage at time $o$ ,
	$C_{it}$	=	crop pattern at time $t$ ,
	$C_{io}$	=	crop pattern at time $o$ ,
	$Y_{it}$	=	yield of the crop $i$ at time $t$ ,
	$Y_{io}$	=	yield of the crop $i$ at time $o$ , and
	$W_i$	=	weights derived from the prices of $i$ th crop.

(Price is average of three years (1950-53).

1. This formula has been used in Growth Rate of Agriculture in Punjab by A. S. Kahlon, S. S. Johl and Ragbir Singh, Research Bulletin, Punjab Agricultural University, Ludhiana. (Unpublished.)

2. B. S. Minhas and A. Vaidyanathan, "The Growth of Agricultural Output in India—An Analysis by Component Elements," *Journal of Indian Society of Agricultural Statistics*, December, 1965.

## RESULTS AND DISCUSSIONS

The growth rates of the value productivity per acre at constant prices and at variable prices are presented in Table I. The table showed that the productivity per acre at constant prices for all the districts were showing a significant upward trend except for the districts of Kangra, Kapurthala and Ferozepur where this increase in growth rate was not significant. The districts are arrayed in order of the rate of growth (per cent). Only three districts, *i.e.*, Amritsar, Rohtak and Bhatinda recorded a low growth rate compared to the State rate of growth which worked out to be 3.2 per cent.

TABLE I—DISTRICTWISE GROWTH RATES OF VALUE PRODUCTIVITY PER ACRE AND THEIR LEVEL OF SIGNIFICANCE IN PUNJAB

Rank order	Value productivity at constant prices		Value productivity at variable prices	
	Districts	Growth rate (per cent)	Districts	Growth rate (per cent)
1.	Patiala	5.84**	Patiala	7.92**
2.	Hissar	4.54**	Hissar	7.20**
3.	Sangrur	4.22**	Sangrur	6.72**
4.	Ludhiana	4.13**	Gurgaon	6.68**
5.	Hoshiarpur	3.92**	Ludhiana	6.51**
6.	Ambala	3.75**	Hoshiarpur	6.29**
7.	Karnal	3.68**	Karnal	6.15**
8.	Gurgaon	3.63*	Ambala	6.05**
9.	Jullundur	3.55**	Jullundur	5.82**
10.	Gurdaspur	3.45**	State	5.76**
	State	3.24**	Amritsar	5.75**
11.	Amritsar	3.18**	Gurdaspur	5.72**
12.	Rohtak	2.96*	Rohtak	5.45**
13.	Bhatinda	2.70*	Bhatinda	5.26**
14.	Kangra	1.49 N.S.	Ferozepur	3.83**
15.	Kapurthala	0.66 N.S.	Kangra	3.70**
16.	Ferozepur	0.15 N.S.	Kapurthala	3.08**

\*Significant at 5 per cent level.

\*\*Significant at 1 per cent level.

N.S. Not significant.

Value productivity at the variable prices for all the districts of the State increased significantly. The effect of rise in prices of the crops was evident because the value productivity at variable prices was found significant even for those districts which did not show significant rate of growth when prices were kept constant.

Value productivity per acre worked out with constant and variable prices did not change the order of the districts so far as the rate of growth was concerned. This was tested through rank correlation<sup>3</sup> which worked out to be 0.96 (significant at 1 per cent level).

RELATIVE CONTRIBUTION OF VARIOUS COMPONENTS TOWARDS THE  
AGRICULTURAL GROWTH

In order to visualize clearly the contribution of different factors such as change in yield, cropping pattern and acreage towards agricultural production of the State in general and districts in particular, the data were subjected to the analysis by component elements. The districtwise analysis of agricultural output brought out some interesting features that helped in visualizing and interpreting some of the results found out earlier. The results of the additive model analysis are given in Table II. The districts in the table have been arrayed in order of their contribution to the additional foodgrain production of the State since 1950-51.

TABLE II—CONTRIBUTION OF DIFFERENT COMPONENTS TO THE INCREASED FOODGRAIN PRODUCTION: 1950-53 to 1962-65

Districts	Yield	Area	Crop pattern	Interaction	Increase in production ('000 metric tons)
Karnal .. ..	9.26 (15.30)*	32.25 (53.29)	16.99 (28.08)	2.01 (3.32)	60.51
Hissar .. ..	35.19 (69.32)	45.82 (90.26)	-24.91 (49.07)	-5.34 (10.51)	50.76
Bhatinda .. ..	17.67 (43.16)	18.29 (44.68)	2.22 (5.42)	2.76 (6.74)	40.94
Ferozepur .. ..	32.51 (84.82)	12.53 (32.69)	3.08 (8.03)	-9.79 (-25.44)	38.33
Patiala .. ..	14.83 (40.08)	8.71 (23.54)	6.06 (16.38)	7.40 (20.00)	37.00
Sangrur .. ..	18.46 (50.38)	11.64 (31.77)	11.54 (31.49)	5.00 (13.64)	36.64
Ludhiana .. ..	19.75 (61.39)	10.07 (31.31)	1.31 (4.07)	1.04 (3.23)	32.17
Rohtak .. ..	6.21 (23.17)	8.08 (30.15)	9.81 (36.60)	2.70 (10.07)	26.80
Amritsar .. ..	10.91 (41.12)	7.08 (26.69)	10.88 (41.01)	-2.30 (-8.82)	26.53
Ambala .. ..	8.83 (41.57)	10.24 (48.21)	-1.38 (-6.49)	3.55 (16.71)	21.24
Hoshiarpur .. ..	11.30 (56.44)	2.43 (12.14)	25.31 (26.52)	0.98 (4.90)	20.02
Jullundur .. ..	6.68 (34.50)	6.42 (33.16)	5.48 (28.31)	0.78 (4.03)	19.36
Gurgaon .. ..	1.44 (9.64)	3.76 (25.17)	10.38 (69.47)	-0.64 (-4.28)	14.94
Gurdaspur .. ..	4.61 (31.77)	3.99 (27.50)	5.19 (35.77)	0.72 (4.96)	14.51
Mohindergarh .. ..	6.67 (54.63)	2.19 (17.94)	2.41 (19.74)	0.94 (7.69)	12.21
Kapurthala .. ..	0.63 (7.70)	7.05 (86.19)	-1.28 (-15.28)	1.75 (21.39)	8.18

\* Figures in parenthesis are percentage increase through these respective components.

$$3. \text{ Rank correlation} = 1 - \frac{6 \sum_i d_i^2}{n(n^2-1)}$$

The district Karnal recorded the highest growth in production. The extension of acreage was responsible for 53.29 per cent of it followed by 28.08 per cent due to change in cropping pattern and 15.30 per cent due to increase in yield of the crops. Additional growth in the production of the district Bhatinda came almost equally from extension of acreages (44.68 per cent) and yield (43.16 per cent). Cropping pattern contributed very little, *i.e.*, 5.42 per cent towards this increase in production since 1950-51.

Change in yield per acre was mainly responsible for the change in production. It was 84.62 per cent in the district of Ferozepur, 61.39 per cent in Ludhiana, 56.44 per cent in Hoshiarpur, 54.63 per cent in Mohindergarh, 50.38 per cent in Sangrur, 40.08 per cent in Patiala and 41.72 per cent in Amritsar. The change in yield in these districts was followed by the extension of acreages under these crops. It accounted for 32.69 per cent in the Ferozepur district, 23.64 per cent in Patiala, 31.77 per cent in Sangrur and 31.31 per cent in Ludhiana.

In the districts of Mahindergarh, Hoshiarpur and Amritsar changes in crop patterns figured next to yield so far as its contribution to growth of agricultural output was concerned. However, in the Sangrur district acreage expansion and the change in crop pattern contributed equally and were next to yield only. The growth of production in the Jullundur district came almost equally from change in yield from the expansion in acreage and changing the crop pattern. As much as 86.19 per cent of the additional growth in agricultural output in the Kapurthala district came from changes in acreage. Very little (7.7 per cent) was the contribution of yield. Change in cropping pattern did not contribute to increase in production; on the contrary, it was responsible for a decline in crop production to the tune of 15.28 per cent. Ambala and Hissar districts behaved alike so far as the contribution of yield and acreages was concerned. Extension in acreage was responsible for 45.80 per cent of the additional growth of output in Hissar followed by yield which accounted for 35.19 per cent. Acreage and yield contributed 48.21 per cent and 41.57 per cent respectively to the growth of agricultural production in the Ambala district.

While discussing the results of value productivity it was mentioned that the increase can either be attributed to the increase in yield or multiple cropping. Both these factors are themselves dependent on the available irrigation or the timely rainfall, the fertilizer application and the adoption of other improved techniques in the agricultural field. A study of the behaviour of these components (Table II) indicated that assured irrigation in the districts of Amritsar, Ferozepur, Ludhiana, Jullundur, Sangrur and Bhatinda was responsible for increase in yield, which contributed the highest towards the additional output as compared to other components. In the rest of the districts, acreage expansion was mainly responsible for increased production.