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AN ANALYTICAL STUDY OF GROWTH OF PUNJAB AGRICULTURE

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The notable achievement in the production of foodgrains in the State of Punjab is reflected in the five-fold increase in the index of production of cereals during the period 1960-61 to 1982-83. The result is that the State with less than two per cent of the area in the country accounts for as much as 60 per cent of the total foodgrains procured for the central pool. This is indeed creditable but there is no reason for complacency. The future may not hold the production possibilities realised earlier. The growth process is not all permeating and, in fact, there are certain crops where the break-through has not been possible and in respect of major crops also, the rate of growth is expected to be rather slow. In this study, we have critically examined the growth pattern of agriculture in Punjab, particularly focusing on the factors associated with the growth process.

LAND USE PATTERN

The net area sown in the State was 4,210 thousand hectares during 1981-82 out of a total reporting area of 5,033 thousand hectares which means that about 84 per cent of the reporting area was already under cultivation and was the highest in the country. There was only negligible area available under 'current fallows' and 'other uncultivated land.' The net area sown has increased from 3,886 thousand hectares in 1966-67 to 4,210 thousand hectares in 1981-82, showing an average increase of 20 thousand hectares per annum. On the other hand, the total cropped area has increased by 1,757 thousand hectares during this period, giving an average increase of over one lakh hectares per year. It was apparent that there was very little scope to add to the net area sown. The only possibility was to add to the cropped area through increase in cropping intensity.

SHIFTS IN CROPPING PATTERN

The cropping pattern in the State is shown in Table I. The figures show that during 1982-83, 72.1 per cent of the area was under foodgrains, 15 per cent under cash crops, *i.e.*, cotton, sugarcane, oilseeds and potatoes, 0.8 per cent under fodders. The percentage of area under cereals increased from 50.9 to 69.1 during the period 1966-67 to 1982-83. The area under pulses declined from 13.4 per cent to only 3.0 per cent and under oilseeds from 6.2 per cent to 2.6 per cent and under sugarcane from 3 per cent to 1.5 per cent during the corresponding period. On the other hand, potatoes and cotton have registered a slight increase. The area under fruits and vegetables is almost static at 0.8 per cent.

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TABLE I—SHIFT IN CROPPING PATTERN IN PUNJAB, 1966-67 TO 1982-83

(per cent area under crops)

Year			Cereals	Pulses	Food-grains	Oilseeds	Sugar-cane	Potato	Cotton	Fruits and vegetables
1966-67	..	..	50.9	13.4	64.3	6.2	3.0	0.3	8.4	0.8
1967-68	..	..	54.3	11.0	65.1	7.3	2.5	0.3	7.7	0.8
1968-69	..	..	60.2	7.8	68.0	5.8	3.0	0.3	7.4	0.6
1969-70	..	..	60.2	7.9	68.8	5.3	2.3	0.3	7.4	0.8
1970-71	..	..	61.9	7.3	69.2	5.2	2.3	0.3	7.0	0.7
1971-72	..	..	61.9	6.7	68.6	5.6	1.8	0.8	8.5	0.8
1972-73	..	..	61.3	6.4	67.7	5.9	1.7	0.8	8.5	0.5
1973-74	..	..	60.8	7.1	67.9	5.9	1.8	0.4	8.7	0.8
1974-75	..	..	61.4	5.6	67.0	6.3	2.1	0.5	9.3	0.8
1975-76	..	..	62.2	7.0	69.2	5.0	1.8	0.4	9.3	0.7
1976-77	..	..	64.7	6.3	71.0	4.0	1.8	0.5	8.8	0.7
1977-78	..	..	63.8	6.3	70.1	4.5	1.8	0.6	9.5	0.8
1978-79	..	..	65.7	6.2	71.9	3.5	1.6	0.6	9.6	0.7
1979-80	..	..	68.4	4.5	72.9	3.0	1.2	0.6	9.6	0.8
1980-81	..	..	66.7	5.0	71.7	3.4	1.1	0.6	9.6	0.8
1981-82	..	..	67.2	4.6	71.8	3.2	1.5	0.5	9.9	0.8
1982-83	..	..	69.1	3.0	72.1	2.6	1.5	0.5	10.4	0.8

Source: Annual issues of Statistical Abstracts of Punjab, Government of Punjab (India), Chandigarh.

This reveals that cereals have come to dominate the cropping pattern in the State in the wake of new technology and the axe has fallen mainly on pulses and oilseeds. This outcome is a consequence of much higher profitability of wheat and paddy crops. This, however, has some implications. Firstly, this has led to reduced availability of pulses. The average quantity of pulses consumed per farm family in Punjab has declined from 11.4 kg./head per annum in 1960-61 to only 7.13 kg. per annum in 1979-80.

There is another dimension of the problem. Pulses and oilseeds are legumes and are an important natural source for restoring the soil fertility. The decline in their area has resulted in reduced availability of natural sources of fertilisation of soils. Also, some soil scientists and agronomists have expressed concern over the long range effects of cereal dominated cropping pattern, particularly rice cultivation and also exploitative agriculture which could have deleterious effects on soil health. Indiscriminate and uncontrolled

use of underground water may not also be desirable in several areas of the State from the long run point of view of conserving this very scarce resource. In future we might have to think of regulating the cultivation of paddy by confining its cultivation to certain selected areas. Lastly, we may have to have a fresh look at the strategy of intensive agriculture from the point of view of matching the energy needs to the available source of energy in future.

PRODUCTION GROWTH RATES

Compound growth rates in respect of area, yield and production for important crops of the State through 1966-67 to 1981-82 are shown in Table II. A perusal of the figures shows that rice production has recorded an increase of 17.93 per cent per annum of which the contribution of area and yield was 11.24 and 6.0 per cent respectively. Wheat was the second crop to record a production growth rate of 5.37 per cent during the same period. The share of area in this was 2.84 and yield contributed 2.46 per cent. Potatoes and American cotton also recorded significant growth rates of 12.88 per cent and 6.80 per cent respectively in this period. In the case of potatoes whereas the contribution of yield was 3.92 per cent that of the area was 8.66 per cent. In the case of American cotton, however, the entire increase in production has occurred as a result of increase in area. The yield has rather declined. Sugarcane witnessed a zero growth rate in production in this period on account of decline in acreage, although productivity growth rate was quite

TABLE II—COMPOUND GROWTH RATES OF AREA, PRODUCTION AND YIELD OF IMPORTANT CROPS IN PUNJAB (1966-67 TO 1981-82)

Crop	Area	Yield	Production
Rice	11.24**	6.00**	17.93**
Wheat	2.84**	2.46**	5.37**
Maize	-2.53**	0.65	-1.90*
Barley	-3.16	4.77**	1.54
Bajra	-9.00**	0.05	-8.99**
Pulses	-2.57**	-1.53	-4.07*
Oilseeds	-3.47**	-0.17	-3.63**
Sugarcane	-3.48**	3.67**	-0.01
Potato	8.66**	3.92*	12.88**
Cotton (American)	7.69**	-0.89*	6.80*
Cotton (<i>desi</i>)	-2.00	-2.18**	-4.10**

**Significant at 1 per cent level.

*Significant at 5 per cent level.

high. All the other crops shown in the table, *viz.*, maize, barley, bajra, pulses, oilseeds and *desi* cotton have shown negative growth rates of production in the period under study. And this has primarily resulted from decrease in acreage. The area released from maize is largely going under paddy and that from pulses and oilseeds to wheat in *rabi*.

TRENDS IN PRODUCTION AND PRODUCTIVITY

(a) *Production*

Rice is the only crop in the State which has shown a consistent increase during the last one decade. Wheat production has also increased during this period although it has shown occasional drops. The production of other important crops has declined through time except sugarcane, potatoes and American cotton where production has shown significant increase.

(b) *Productivity*

In the case of wheat, productivity during the years 1971-72 to 1976-77 showed no improvement and stagnated around 24 quintals per hectare (Appendix). The later years have shown an improvement in productivity and much of this gain is attributed to the favourable weather. In the case of paddy, however, productivity has shown a consistent increase during this period and the yield level in the terminal year was almost double compared to the base period. The other crops where productivity improvement is visible are sugarcane and potatoes. In the case of all the remaining crops, namely, maize, barley, bajra, pulses, oilseeds, American cotton and *desi* cotton, there is absolutely no improvement in the productivity, rather the trend is towards some decline. This should be a cause for concern.

A Case of Stagnation

The above analysis reveals that the break-through in productivity has been achieved only in four crops, *viz.*, rice, wheat, sugarcane and potatoes. It may be significant to point out here that Punjab could have achieved a revolution in the production of sugarcane and potatoes also but for the severe constraints on the marketing front of these crops. In the case of pulses, the productivity drop is significant which is also noticeable in the case of oilseeds, American cotton and *desi* cotton. This is a big challenge to the technology in these crops.

Overall Productivity Increase

The productivity figures given in the Appendix indicate a mixed evidence of productivity gains in the State. While there has been an increase in some of the major crops, the picture of stagnation or decline is evident in others. We have worked out an overall estimate of the increase in productivity over time by working out the productivity in value terms for all the crops taken

together.¹ The concept of value productivity would reflect the combined effect of several variables such as the differentials in the level of productivity, effects of cropping pattern, cropping intensity, etc. It is apparent from the data given in Table III that at current prices, there has been almost a three-fold increase in value productivity during the period 1970-71 to 1981-82. However, at constant prices (1970-71 level), the increase is rather moderate (47 per cent). The compound growth for productivity increase works out to 11 per cent at current prices and 3.3 per cent per annum at constant prices.

TABLE III—VALUE PRODUCTIVITY PER HECTARE OF CULTIVATED AREA IN THE PUNJAB—OVER TIME

Year	Value productivity (Rs.)	
	At current prices	At constant prices* (Base = 1970-71)
1970-71	1,695.1	1,695.1
1971-72	1,929.4	1,908.4
1972-73	1,882.9	1,691.7
1973-74	2,794.2	2,045.5
1974-75	2,990.8	1,737.8
1975-76	2,769.0	1,689.4
1976-77	3,241.0	2,086.9
1977-78	3,680.5	2,120.1
1978-79	3,945.6	2,288.6
1979-80	4,169.1	2,234.2
1980-81	4,778.0	2,298.2
1981-82	5,851.5	2,494.2
Compound growth rate (per cent)	11.01	3.28

* Deflated by wholesale price index for food articles.

Districtwise Analysis

It is interesting to point out that even in a relatively small State like Punjab, there are significant inter-district and inter-area differentials in value productivity (Table IV). Ludhiana district comes at the top with value productivity of Rs. 6,987 per hectare against only Rs. 4,015 for Bhatinda district. The other two districts next to Ludhiana are Jalandhar and Patiala with value

1. Total production of all crops for which recorded statistics were available, was evaluated in money terms and the aggregate value output of the State was divided by the cultivated area to arrive at per hectare value productivity.

TABLE IV—DISTRICTWISE VALUE PRODUCTIVITY IN RELATION TO IMPORTANT VARIABLES IN PUNJAB, 1981-82

District	Value productivity (Rs./culti- vated hecti- are) Aver- age 1980-81 and 1981-82	Share in value of output (per cent)	Share in cultivated area (per cent)	Fertilizer use (kg./ cultivated hectare)	Cropping intensity	Area irrigated (per cent)		Number of trac- tors per 1000 hecti- ares (1979-80)
						Overall	By tube- well	
Ludhiana	6,987	10.20	7.77	269	177	89	91.7	34.6
Jalandhar	6,557	8.71	7.10	216	161	91	88.7	36.5
Patiala	6,283	10.97	9.33	216	175	79	88.0	31.0
Sangrur	5,806	11.85	10.93	170	172	89	67.2	25.9
Kapurthala	5,753	3.77	3.51	254	148	87	97.2	35.7
Gurdaspur	5,501	6.35	6.18	213	165	68	60.1	14.6
Ferozepur	5,209	11.29	11.75	185	163	89	52.2	23.6
Faridkot	4,824	11.24	12.49	209	159	87	23.4	36.8
Rupnagar	4,804	2.85	3.06	128	150	43	92.3	13.2
Amritsar	4,680	8.97	9.93	195	168	97	40.5	17.9
Hoshiarpur	4,328	4.87	6.00	105	153	38	85.3	18.6
Bhatinda	4,015	8.93	11.95	109	161	71	13.7	21.3
State ..	5,362	100.00	100.00	188	165	81	58.0	26.0

productivity at Rs. 6,557 and Rs. 6,283 respectively. At the bottom, the district of Hoshiarpur has very low productivity (Rs. 4,328). The other districts fall in between these two extremes. The figures show that the top two districts of Ludhiana and Jalandhar have value productivity which is 62 per cent higher compared to the bottom two districts. Stated in different terms, the share of the top three districts works out to be about 30 per cent in the total value output of the State against their share of only 20 per cent in the cultivated area. The reverse is the position in the case of bottom districts.

FACTORS ASSOCIATED WITH VALUE PRODUCTIVITY

Irrigation

It is a well-known fact that irrigation is the key variable which explains the variation in value productivity because it determines the use of other associated inputs such as fertilizer use, index of mechanization as well as the cropping intensity. This seems to be true in this case also. It may be noted from the figures given in Table IV that, in general, the districts with higher percentage of area under irrigation as well as having higher percentage of area irrigated through tubewells, have higher proportion of area irrigated through tubewells, have higher value productivity and vice versa. For better appraisal, we have rearranged the data into three groups of districts (Table V). The first group containing districts of Ludhiana, Jalandhar, Patiala and Sangrur has the highest average value productivity (Rs. 6,408/hectare). The second group (districts of Kapurthala, Gurdaspur, Ferozepur and Faridkot) has medium level of value productivity (Rs. 5,322) and the third group including the districts of Ropar, Hoshiarpur, Amritsar and Bhatinda is at the bottom with value productivity of Rs. 4,457 per hectare. Irrigation

TABLE V—VALUE PRODUCTIVITY AND OTHER RELATED VARIABLES ACCORDING TO GROUPS

Group	Districts	Average value producti- vity (Rs./ hectare)	Fertili- zer use (kg./ cul- tivated hectare)	Crop- ping in- tensity	Per cent irrigated area			Index of mechani- zation (Num- ber of tractors per 1000 hectares)
					Total	By tube- wells	By ca- nals	
I.	Ludhiana, Jalandhar, Pati- ala and Sangrur	6,408	218	171	87	84	16	32.0
II.	Kapurthala, Gurdaspur, Ferozepur and Faridkot ..	5,322	215	159	83	58	42	25.2
III.	Rupnagar, Amritsar, Ho- shiarpur and Bhatinda ..	4,457	134	158	62	58	42	17.8
IV.	State	5,362	188	165	81	58	42	26.0

status, fertilizer use, index of mechanization as well as cropping intensity are positively correlated with value productivity.

At the level of individual districts, however, Amritsar district which has good irrigation facilities is among the bottom group. The most probable reason for this is the stagnation in productivity both of wheat and paddy; it being a traditional paddy growing area. Also, there is no other significant high value crop in the district. We would hypothesize here that the rate of growth of productivity and its level is lower in traditional paddy growing districts like Amritsar and Gurdaspur.²

To conclude, it can be said that the single most important factor responsible for differentials in value productivity is irrigation.

Micro Constraints

The above analysis has indicated that the inter-district differentials in productivity are primarily explained by the irrigation variable. The use of associated inputs like fertilizers and machinery largely goes with irrigation. As such, this calls for adding to the irrigation facilities in the sub-mountainous districts of the State. This, however, does not mean that in areas having assured irrigation facilities already, there is no scope to enhance the productivity. Table VI gives an analysis of 159 holdings mostly from

TABLE VI—FERTILIZER ADOPTION LEVEL FOR WHEAT ON INDIVIDUAL HOLDINGS, 1981-82

Yield range (quintals)					Number of holdings	Per cent to total holdings	Cumulative percentages	Per hectare fertilizer use (NPK nutri- ents) (kg.)
Upto 10	..	..	..	..	1	0.63	0.63	99.5
10-14	..	..	..	..	10	6.29	6.92	88.8
14-18	..	..	..	..	8	5.03	11.95	104.0
18-22	..	..	..	..	25	15.72	27.67	103.9
22-26	..	..	..	..	31	19.50	47.17	140.7
26-30	..	..	..	..	22	13.84	61.01	128.8
30-34	..	..	..	..	12	7.55	68.56	131.5
34-38	..	..	..	..	26	16.35	84.91	175.6
38-42	..	..	..	..	6	3.77	88.68	181.9
42 and above	..	..	..	..	18	11.32	100.00	238.7
Total	..	..	..	..	159	100.00	—	149.4

Source: Department of Economics and Sociology, Punjab Agricultural University, Ludhiana.

2. The share of Amritsar and Gurdaspur districts in paddy area of the State was 45 per cent in 1967-68 which dropped to 26.3 per cent in 1982-83.

irrigated areas of the State in the matter of wheat yields and fertilizers used. The yield of sample farmers ranged from 10 quintals to over 42 quintals per hectare. It was apparent that about 12 per cent of the farmers obtained a yield level of less than 18 quintals and, at the other extreme, about 11 per cent of the farmers obtained above 42 quintals. The reason for such wide variations were ascertained and these were found to be due to: (i) differential fertilizer use; (ii) variation in timeliness of operations, the timeliness factor itself was largely associated with the extent of mechanization; (iii) differences in the use of weedicides and other plant protection material; (iv) financial position of the farmers; and (v) general attitudes towards work.

The above analysis highlights the need for micro planning and gearing the extension efforts towards the needs of individual farmers as far as possible.

FUTURE POSSIBILITIES

A question is often raised that Punjab may not be able to add much to its agricultural production since it is already near the saturation point so far as the exploitation of new areas is concerned. We demonstrate here by examining the case of two most important crops of the State, *i.e.*, wheat and paddy, that even with the present level of technology, there is still scope to increase the production. The increase in total production can come about through increase in area under these crops along with increases in productivity. First of all, we examine the position in respect of increases in area. The examination of data reveals that the area under wheat and paddy has increased primarily due to increase in cropped area, which itself was influenced by growth in gross irrigated area in the State. To a limited extent, these crops have gained area at the cost of other competing crops like maize and groundnut in the case of paddy, and gram and barley in the case of wheat. During the last five years ending 1981-82, the gross irrigated area, cropped area, area under wheat and paddy have shown an average annual increase of 1.53, 1.0, 0.58 and 0.75 lakh hectares respectively. We expect these trends to continue during the next five years but in the succeeding five years, the increase is expected to slow down to 75 per cent of this level. The estimated area under wheat and paddy and other related information is shown in Table VII.

Productivity Increase: Response to Fertilizer Use

It has been discussed above that productivity increase is largely the outcome of increased irrigation and fertilizer use. We have examined the relationship between fertilizer use and productivity for wheat crop for the State of Punjab. It was further evident that at low level of fertilizer use, in the earlier years the response was higher compared to the later period when fertilizer use has increased. It was estimated that one kilogram of fertilizer nutrients yielded about 8 kg. of wheat grains during the period 1967-68 to 1976-77 when the average use of fertilizer for wheat crop was about one-third of the recommended dose. During the succeeding period ending 1981-82, this response was only 5.6 kg. of wheat per kg. of fertilizer nutrients applied. This

TABLE VII—ESTIMATED INCREASE IN PRODUCTION OF WHEAT AND PADDY FOR PUNJAB, 1991-92

Year					Gross irrigated area	Total cropped area	Wheat	Paddy
A Area (lakh hectares)								
(i) Position in 1981-82	..	..	..	..	59.7	69.3	29.1	12.8
(ii) Expected increase between 1981-82 to 1991-92	..	..	..	..	13.3	8.8	5.1	6.6
(iii) Position in 1991-92	..	..	..	..	73.0	78.1	34.1	19.4
B Productivity (quintals/hectare)								
(i) Position in 1981-82	..	..	..	..	—	—	29.32	29.57
(ii) Expected in 1991-92	..	..	..	..	—	—	33.00	35.00
C. Production (lakh tonnes)								
(i) Position in 1981-82	..	..	..	..	—	—	88.5	37.6
(ii) Estimated for 1991-92	..	..	..	..	—	—	112.9	67.9
(iii) Per cent increase	..	..	..	..			27.6	79.0

was the case when fertilizer use was two-thirds of the recommended level. One can, therefore, expect that further use of fertilizer will add still less to wheat productivity. Apart from this average picture for the State, the response function was fitted separately for the districts of Ludhiana, Jalandhar, Patiala, Kapurthala and Sangrur taken together which had more assured irrigation and made more intensive use of fertilizers (using 78 per cent of the recommended level of fertilizers). Here again, the marginal physical product was about 4.9 kg. of wheat per kg. of fertilizer nutrients. At this stage, it may be interesting to examine the case of Ludhiana district in this respect which is rated as one of the leading districts in the matter of wheat productivity in the world. It was noted that although fertilizer use between 1970-71 and 1981-82 almost doubled (from 85 kg. to 167 kg./hectare), wheat yield, however, has hovered around 33 quintals per hectare. It means that some other factors have become more limiting—the most important being the time of sowing, larger incidence of weeds as well as deficiency of micro-nutrients.

The above exercise was further extended by fitting the quadratic function to the State level wheat production data to know the expected level of wheat yield in case the adoption of fertilizer was hundred per cent of the recommended level. This yielded a figure of about 3,260 kg. per hectare against the yield level of 2,932 kg. realised in 1981-82. If we go by these figures, we cannot hope to add much to wheat productivity through increased fertilizer use alone. Discussions with the agronomists and soil scientists, however, reveal that there is still scope for enhancing productivity of wheat by concentrating on the removal of the deficiency in micro-nutrients, control of weeds which are becoming a serious problem particularly in the case of wheat and paddy and above all timeliness of operations can go a long way in increasing the productivity of these crops. The latter obviously calls for more mechanized operations. It is estimated that in case these limiting factors are given due care, the State average yield of wheat at the known level of technology, *i.e.*, with the present

genetic stock can be improved to 33 quintals per hectare by the year 1991-92. The case is almost parallel for paddy crop where the present adoption level of fertilizers is even higher (85 per cent) than wheat. The per hectare paddy yield in the State realised in 1981-82 (29.6 quintals) is expected to go upto 35 quintals per hectare by the year 1991-92.

The estimated production for wheat and paddy calculated on the above basis is given in Table VII. The estimates show that the production of wheat and paddy in the State can be increased by 27.6 per cent and 79 per cent respectively at the end of 1991-92 compared to the level of 1981-82 provided vigorous extension efforts are made to ensure full adoption of known package of technology. This will give an average annual increase of 2.76 per cent in wheat production and 7.9 per cent for paddy in the coming decade compared to the compound growth rates of 5.4 and 17.9 per cent for wheat and paddy respectively realised during the period 1966-67 to 1981-82.

APPENDIX
AVERAGE YIELD OF MAJOR CROPS IN PUNJAB

Year	Wheat	Maize	Rice	Barley	Bajra	Pulses	Oilseeds	Sugarcane	Potato	Cotton American	Cotton <i>dest</i>
											(kg./hectare)
1969-70	..	2,245	1,469	1,123	1,117	1,033	845	4,146	12,096	380	322
1970-71	..	2,238	1,555	1,022	1,176	797	970	4,117	12,752	399	339
1971-72	..	2,406	1,564	1,144	1,180	841	1,056	3,912	13,443	407	326
1972-73	..	2,233	1,612	1,075	836	837	858	4,602	12,819	407	322
1973-74	..	2,216	1,348	855	982	896	970	5,289	13,720	430	303
1974-75	..	2,396	1,720	1,155	886	813	861	4,997	15,496	416	301
1975-76	..	2,373	1,467	1,267	1,038	987	1,050	5,374	16,648	404	292
1976-77	..	2,430	1,157	1,206	924	843	828	5,371	21,306	379	282
1977-78	..	2,538	1,527	1,391	1,141	856	728	5,612	19,946	374	263
1978-79	..	2,716	1,625	1,454	983	762	774	5,668	19,320	387	263
1979-80	..	2,797	1,723	1,546	1,032	648	789	5,099	18,060	357	241
1980-81	..	2,730	1,602	1,656	1,244	589	772	5,526	19,287	328	240
1981-82	..	2,932	1,839	1,999	1,008	565	762	5,772	18,856	334	248
1982-83	..	3,007	1,778	1,575	1,198	582	785	6,098	N.A.	373	176

Source: Statistical Abstracts of Punjab. N.A. = Not available.