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IMPACT OF YIELD INCREASING FOODGRAIN TECHNOLOGY ON THE CULTIVATION OF COMMERCIAL CROPS

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The interaction of semi-dwarf varieties of wheat, paddy, hybrid of maize and millets and their procurement prices have resulted in greater emphasis on the production of these crops. The area under paddy and wheat in the Punjab State increased from 3,14,000[1] and 17,90,000 hectares in 1967-68 to 3,90,000 and 22,99,000 hectares in 1970-71 respectively. Johl[2] reported that no other crop stood competition with 'rice-wheat' rotation at current level of production technology and prices, excepting vegetables. But vegetable crops by their nature and owing to market peculiarities, did not hold extensive scope for cultivation by the majority of the farmers. Since no such technological break-through occurred in the so-called traditional commercial crops, their acreage and production have either declined or remained almost stagnant. This imbalance in the Punjab agriculture has brought about perceptible changes in the production patterns of the State.

Recognizing that the country needs not only more of foodgrains but also more of cash crops, it is necessary to locate minimum prices at which other enterprises, which did not enter the production programme, would find a place in the optimum production patterns of the State. This would indicate the scope and the extent to which prices could be manipulated to make optimum production patterns possible.

This study was undertaken in the Punjab for two years (1971-72 to 1972-73) with the specific objective of developing normative production patterns for farms of various sizes, assuming various price levels for the commercial crops.

METHODOLOGY

The central plains of the Punjab were divided into two broad agro-climatic regions based on the cropping pattern. This area comprised paddy

1. Statistical Abstract of Punjab, Economic and Statistical Organisation, Government of Punjab, Chandigarh, 1971.
2. S. S. Johl: The Agricultural Economy of Punjab at a Cross-road—An Economic Analysis of Shifts in Production Patterns, Punjab Agricultural University, Ludhiana, August, 1972 (mimeo.).

and groundnut areas. All the districts, which had larger area under paddy relative to the area under groundnut, were included in the paddy zone and those districts, which had the larger area under groundnut were included in the groundnut zone.

Sampling Frame

The sampling design used was multi-stage stratified random technique. The blocks formed the primary and operational holding an ultimate unit of sampling. For the purpose of this study, two blocks from each zone were selected at random. A list of villages of each block was obtained from the concerned block development office. Two villages were selected randomly from each block. Thus eight villages were selected for study, which means four villages from each zone. A list of all the resident cultivators was prepared for each of eight villages selected in the State.

The operational holdings in all the four villages of each zone were pooled and arranged in an ascending order of the cultivated area. These holdings were divided into three categories in such a way that each stratum covered almost the same cultivated area. The distribution of operational holdings in the selected villages of each region was transformed to obtain small, medium and large holdings and six farmers were selected randomly (two from each farm size-group) from each selected village. The sample thus consisted of 48 holdings from the study area.

Resource Restrictions

Land and capital were the most limiting resources in farm production. There were certain periods in the year when family labour was inadequate to cope with farm operations. Therefore, the supply of labour during the critical periods was treated as restriction. The supply of bullock labour did not impose any restraint on the production of different enterprises, but the farm-yard manure did. The latter was, therefore, treated as a limited resource in the analysis.

The optimal production patterns for the small, medium and large holdings were worked out by developing one synthetic farm situation for each farm size-group of the two regions. These situations were developed by averaging out the information on resource mix and resource use potentialities of the selected holdings. The optimal plans were developed through linear programming analysis. The price structure used for commercial as well as food-grain crops related to the year 1971-72. The actual prices used are given in Appendix 1.

Level of Technology

Both divisible and indivisible components of the new technology were incorporated in the analysis. The divisible technology used was recommended

package of practices for different production enterprises and anticipated yield from them. The indivisible technology was treated as follows :

(*i*) *Small farms :* A pair of bullocks plus electric motor of 3 H.P. plus allied equipment.

(*ii*) *Medium farms :* A pair of bullocks plus electric motor of 5 H.P. All the matching equipment which goes with electric motor for stationary jobs was assumed.

(*iii*) *Large farms :* 14 H.P. tractor plus allied equipment plus electric motor or diesel engine of 5 H.P. for stationary jobs.

Sensitivity Analysis

The parametric objective function[3] (variable price programming which is a modification of the standard simplex linear programming model,[4]) was used as an analytical tool for economic analysis in this study.

New technology has a great bearing on shifting production patterns of the farmers. Also, the changes in factor-product prices prompted shifts in the production patterns. The effect of price variation in different products on the production patterns was examined using the following model :

Maximize $Z=CX$

Subject to the conditions

$$AX \leqslant b$$

$$X \geqslant 0$$

When applied to farm, X is a vector of N market-oriented production activities, called the activity vector, b is a vector of scarce resources, and C is a vector of net price. In each column of M.N. matrix, A specified the amount of each of the M scarce resources required to produce one unit of a given production activity. The problem then is to choose a set of values for the elements of the column vector X, called optimal solution vector, which satisfies the given conditions and renders CX a maximum, better known as the optimal value of the objective function. It is assumed that the elements of the matrix and vectors b and c are exactly known without error.

To incorporate changes in prices of the activities, the following model was used.

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3. L. S. Thomas and S. I. Gass, "Parametric Objective Function," *Journal of Operational Research*, Vol. 2, 1954, pp. 316-319.
4. E. O. Heady and W. Candler: Linear Programming Methods, Iowa State College Press, Ames, 1958, Chapter VIII.

Maximize $Z=C'X$
under the conditions

$$AX \leqslant b$$
$$X \geqslant 0$$

where the subscript c′ denoted price after variation.

The problem was to examine the effect of price variation on the shifts in the production patterns of the farmers who had to allocate their fixed farm resources to various production activities. The following scheme was followed to analyse the effect of price variation of different products on the shifts in the production patterns. Price of an individual product was increased by 5, 10, 15, 20 and 25 per cent on the basis of the price used in developing optimal plans. This scheme was repeated for almost all the enterprises.

CENTRAL PLAINS OF THE PUNJAB (PADDY AREA)

Optimum Agricultural Production Patterns

Optimum agricultural production patterns were derived by applying the linear programming technique to a synthetic farm situation in each of the two zones of the central plains of the Punjab. In the existing enterprise-mix, Mexican wheat occupied the largest proportion of the cultivated area on all the synthetic farm situations during the *rabi* season, whereas paddy was the main crop in the *kharif* season. Dairy buffaloes were reared to meet the domestic needs of the family and this enterprise was raised on commercial basis only on a few farm situations, especially near the densely populated cities to supplement the income from the crop enterprises. The existing and optimal cropping plans of the synthetic farm situations are given in Table I.

Table I indicates that the farmers devoted about 75 per cent of the cropped area to foodgrains,[5] whereas commercial crops were limited to 5.93 to 10.11 per cent in the existing output-mix. This clearly showed that foodgrain crops were more profitable than commercial crops in the paddy area of the central plains of the Punjab. Table I further showed that the Punjab farmer put more area under miscellaneous crops such as fodders, *guara*, etc.

An optimum production plan of all the situations is also given in Table I which shows that even in the normative production plans foodgrains occupied 75 to 86 per cent of total cropped area and the area under commercial crops further decreased, although the area under miscellaneous crops remained almost the same.

Among the foodgrains, paddy occupied 14.36 to 18.11 per cent of the total cropped area in the existing output-mix, but its area was from 31.24 to

5. Most of the farmers, including small farmers, grow wheat and paddy mostly for the market. In that sense, these crops are a kind of commercial crops for the farmers but these are treated in this paper as foodgrains to conform with the definition of foodgrains used in the country.

TABLE I—EXISTING AND OPTIMUM PRODUCTION PATTERNS, SYNTHETIC FARM SITUATIONS IN CENTRAL PLAINS OF THE PUNJAB : 1972-73

(area in acres)

Enterprise	Existing plans			Optimum plans		
	Farm situations			Farm situations		
	Small	Medium	Large	Small	Medium	Large
Paddy (IR 8)	2.38 (18.11)	3.16 (16.04)	6.73 (14.36)	5.94 (38.12)	9.06 (39.34)	20.50 (31.24)
Green gram	0	0	0.50 (1.06)	0.38 (2.44)	0.85 (3.69)	3.00 (4.59)
Toria	0.25 (1.90)	1.06 (5.56)	2.50 (5.31)	0.38 (2.44)	0.85 (3.69)	3.00 (4.59)
Maize (local)	1.06 (8.07)	1.97 (10.33)	3.31 (7.04)	0	0	0
Milch animal*	2	3	4	0	0	20 (15.24)
Sugarcane	0.34 (2.59)	0.59 (3.09)	0.78 (1.65)	0	0	0
Desi cotton	0.19 (1.44)	0.28 (1.46)	1.38 (2.94)	0	0	0
Black gram	0	0.28 (1.46)	0.38 (0.80)	0	0	0
Wheat (K-227)	6.37 (48.47)	9.38 (49.18)	25.15 (53.51)	6.32 (40.56)	9.91 (43.03)	23.50 (39.46)
Foodgrains	74.65	77.01	76.77	81.12	86.03	75.29
Commercial crops	5.93	10.11	9.90	2.44	3.69	4.59
Miscellaneous	19.42	12.88	13.33	16.44	10.25	19.22

Figures in parentheses are percentages.
*These figures are in numbers.

38.12 per cent in the optimal production programmes. In the *rabi* season, wheat covered about 50 per cent of the total cropped area in the existing product-mix and about 40 per cent in the normative plans. The percentage of the total cropped acreage under wheat was lower in the normative plans than in the existing ones. This was because some acreage was left fallow during the *kharif* season in the existing plans, which inflated the percentage of the total cropped area under wheat in the *rabi* season. All the other crops in the foodgrains category occupied an insignificant proportion of the cropped area.

The main objective of the further analysis was to locate optimum farm organization with different sets of prices of commercial crops. It was observed from the foregoing analysis that some commercial enterprises did not figure in the optimal farm organization operated at the improved level of technology, because they were not paying enterprises in comparison with the foodgrain crops which appeared in the optimum programmes. The question, therefore, arose how much price incentive was required to incorporate these less paying commercial crops in the farmers' production programmes. For this purpose, the prices of commercial crops were varied by 5, 10, 15, 20 and 25 per cent of the prices used in the original analysis.

Impact of Variation in the Price of Gur

The effect of variation in the price of *gur* on production schemes was worked out in Table II. An examination of optimal programmes showed that the sugarcane activity did not get any place in the optimal plans, whereas this crop occupied 2.59, 3.09 and 1.65 per cent of the total cropped area in the existing production plans on the small, medium and large farms respectively. When the price of *gur* was raised by 5 per cent (to Rs. 131.20 per quintal) no adjustment possibilities were noticed in the optimal output-mix of all sizes of holding.

Again, no change was observed in the product-mix of the small and medium farms, when the price of *gur* was increased by 10 per cent (to Rs. 136.50 per quintal) but many shifts occurred in the programme of the large holding. The area under sugarcane increased from zero to 19.44 acres, which comprised 42.30 per cent of the total cropped area.

When the price of *gur* was further raised by 15 per cent (to Rs. 141.75 per quintal), no further change in the output-mix of the large farm was observed. But as will be seen from Table II, the output-mix of the small and medium farms was changed. The area under sugarcane increased from zero to 3.63 and 8.44 acres on the small and medium situations, thus constituting 30.38 and 54.43 per cent of the total cropped acreage respectively.

As the price of *gur* was further raised to Rs. 152.25 per quintal, no more change in the optimal plans occurred. Since the whole land for sugarcane was cropped, no further scope to increase the area under sugarcane existed. The total increase in the price of sugarcane resulted in an increase of the area under commercial crops from 2.44 to 36.22 per cent, from 3.69 to 68.96 per cent and from 4.59 to 59.42 per cent of the total cropped area on the small, medium and large situations respectively.

Impact of Price Variation in Oilseeds

A close perusal of Table I showed that *toria* was the only crop which figured in the optimal product-mix of all sizes of holding. The area under *toria* increased from 1.90 to 2.44 per cent in the optimal plan over the existing plan of the small farm. However, the area under this crop declined from 5.56 to 3.69 per cent and from 5.31 to 4.59 per cent on the medium and large farms respectively. It was also observed that the rise in the price of oilseeds upto 25 per cent did not bring any change in the optimal plans of all the farm situations.

Thus it could be concluded that more than 25 per cent increase in the price of oilseeds was required to induce some area under oilseed crops in the optimal plans of all the farm situations. Although the price of oilseed crops was high, yet their profitability was low compared to the foodgrain crops

TABLE II—IMPACT OF PRICE VARIATION IN *Gur* ON PRODUCTION PATTERNS IN CENTRAL PLAINS (PADDY AREA) OF THE PUNJAB : 1972-73

(*area in acres*)

Percentage price variation	Absolute price per quintal (Rs.)	Small farm					Medium farm				
		Paddy IR 8	Green gram	*Toria*	Wheat K-227	Sugar-cane	Paddy IR 8	Green gram	*Toria*	Wheat K-227	Sugar-cane
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
0 ..	125.00	5.94 (38.12)	0.38 (2.44)	0.38 (2.44)	6.32 (40.56)	0	9.06 (39.34)	0.85 (3.69)	0.85 (3.69)	9.91 (43.03)	0
5	131.25	5.94	0.38	0.38	6.32	0	9.06	0.85	0.85	9.91	0
10	136.50	5.94	0.38	0.38	6.32	0	9.06	0.85	0.85	9.91	0
15	141.75	2.31 (19.33)	0.38	0.38	2.69	3.63 (30.38)	0.60	0.85	0.85	1.45	8.44 (54.49)
20	147.00	2.31	0.38	0.38	2.69	3.63	0.60	0.85	0.85	1.45	8.44
25	152.25	2.31	0.38	0.38	2.69	3.63	0.60	0.85	0.85	1.45	8.44

Percentage price variation	Absolute price per quintal (Rs.)	Large farm						
		Paddy IR 8	*Toria*	Green gram	Wheat K-227	Dairy*	Sugar-cane	Poultry
		(11)	(12)	(13)	(14)	(15)	(16)	(17)
0	125.00	20.50 (31.24)	3.00 (4.57)	3.00 (4.57)	23.50 (35.80)	20* (15.24)**	0	0
5	131.25	20.50	3.00	3.00	23.50	20*	0	
10	136.50	3.37	3.00	3.00	6.37	8*	19.44 (42.30)	120† (2.52)‡
15	141.75	3.37	3.00	3.00	6.37	8*	19.44	120
20	147.00	3.37	4.00	4.00	6.37	3*	20.44	172
25	152.25	3.37	4.00	4.00	6.37	3*	20.44	172

Figures in parentheses are percentages.
* These figures are numbers.
** Percentages of total cropped area under fodder for dairy buffaloes.
† Indicates numbers of poultry layers.
‡ Percentage area under maize to feed poultry layers.

because at present there was no yield increasing technology in oilseed crops of the kind that occurred in wheat in the Punjab.

CENTRAL PLAINS (GROUNDNUT AREA) OF THE PUNJAB

The existing and optimal production plans of the groundnut zone are given in Table III. This table indicates that Mexican wheat in the *rabi* season and *desi* maize, *desi* cotton and groundnut in the *kharif* season, were the major crops grown in this region under the existing production programmes. All the other enterprises were raised on a small area.

TABLE III—EXISTING AND OPTIMUM PRODUCTION PATTERNS, SYNTHETIC FARM SITUATIONS IN CENTRAL PLAINS OF THE PUNJAB: 1972-73

(area in acres)

Enterprises	Existing Plans			Optimum plans		
	Farm situations			Farm situations		
	Small	Medium	Large	Small	Medium	Large
Groundnut	0.55 (5.58)	1.56 (7.05)	2.75 (7.21)	2.00 (18.07)	4.76 (15.22)	10.00 (18.78)
Maize	2.35 (23.88)	3.56 (16.09)	4.38 (11.48)			
Dairy buffaloes*	2.00	3.00	3.00	0	2.44 (7.81)	0
Sugarcane	0.38 (3.86)	0.46 (2.07)	1.42 (3.72)	0	0	15 (14.08)
Paddy (IR 8)	0.09 (0.91)	0.50 (2.26)	0.13 (0.30)	1.00 (9.04)	0	10.38 (19.40)
Desi cotton	0.88 (8.94)	1.31 (5.92)	2.94 (7.70)	1.97 (18.00)	3.38 (10.81)	0
Toria	0	0.75 (3.39)	0.03 (0.08)	0	2.99 (9.56)	0
Fodder	0.98 (9.95)	2.75 (12.42)	4.78 (12.53)	0	0	0
Wheat	4.19 (42.58)	10.12 (45.75)	16.06 (42.10)	4.97 (45.06)	13.57 (43.40)	20.83 (38.88)
Foodgrains**	67.37	63.81	52.84	54.10	62.80	58.28
Commercial crops	18.38	18.62	18.71	36.07	24.18	18.78
Miscellaneous crops	14.25	17.57	28.45	9.83	13.12	22.94

Figures in parentheses are percentages.
* These are in numbers.
** These figures are in percentages.

Table III further showed that the farmers devoted 18 per cent of the total cropped area to the commercial crops, whereas the foodgrains occupied 52.84 to 67.37 per cent of the area in the existing product-mix. However, it was observed that all the farm size-groups allocated about the same proportion

of the area to the commercial crops. This analysis clearly brought out that the foodgrains paid more than the commercial crops under the prevailing set of technology and prices.

To test the rationality on the part of the farmers to allocate the acreage under different crops, the optimal production plans were developed, which are given in Table III. As will be seen from the table, foodgrains occupied 54.10 to 62.80 per cent of the total cropped area, which was almost the same as it was in the existing production plans. This analysis showed that the Punjab farmers allocated land resource quite rationally.

Among the foodgrain crops, paddy was the main crop in the *kharif* and wheat in the *rabi* season. Although maize occupied 11.48 to 23.88 per cent of the total cropped area on different size of holdings, yet it did not figure in the optimal plans. This crop was replaced by *desi* cotton.

Impact of Variation in Gur Price

The effect of variation in the price of *gur* on the production patterns is given in Table IV. A detailed examination of this table showed that the sugarcane crop could not get any place in the optimal plans of all sizes of holding even though it occupied 2.07 to 3.86 per cent of the total cropped area in the existing production patterns. It was, therefore, concluded that the price of Rs. 125 per quintal of *gur* was not sufficient for its inclusion in the optimal plans.

When the price of *gur* was raised by five per cent (to Rs. 131.25 per quintal) the sugarcane crop figured in the optimal programmes of all the farms. The area under sugarcane increased from zero to 1.97, 2.99 and 4.48 acres on the small, medium and large farms respectively, which accounted for 21.74, 10.57 and 8.92 per cent of the total cropped acreage. This crop was included in the optimal plans of the small and medium farms at the cost of *desi* cotton which was completely eliminated. This showed that even the commercial crops competed among themselves for the use of limited resources. This indirectly implies that the increase in the price of one commercial crop did not necessarily increase the total area under commercial crops.

As the price of *gur* was further raised by ten per cent (to Rs. 136.50 per quintal) no more change was observed in the preceding plans of the small and medium farms, but on the large farm, adjustment took place in the area of different enterprises. The area under sugarcane increased to 8.80 acres, thus accounting for 19.17 per cent of the total cropped acreage. When the price of *gur* was raised to Rs. 147 per quintal, no further change in the preceding plans of all sizes of holding was noticed. Thus it was concluded that greater price incentive was required to increase the acreage under sugarcane, because a 25 per cent rise in the price of *gur* could not bring the whole area

TABLE IV—IMPACT OF PRICE VARIATION IN *Gur* ON PRODUCTION PATTERNS IN THE GROUNDNUT AREA OF THE PUNJAB: 1972-73

Percentage change in prices	Absolute price per quintal (Rs.)	Small farm					Medium farm					
		Paddy IR 8	*Desi* cotton	Ground-nut	Wheat K-227	Sugar-cane	Paddy IR 8	*Desi* cotton	Black gram	Wheat	Sugar-cane	Ground-nut
0	125.00	1.00 (9.07)	1.97 (17.85)	2.00 (18.12)	4.97 (45.03)	0	3.38 (10.81)	2.99 (9.56)	2.44 (7.81)	13.57 (43.40)	0	4.76 (15.22)
5	131.25	1.00 (11.04)	0	2.00 (22.08)	3.00 (33.12)	1.97 (21.74)	3.38 (11.95)	0	2.44 (8.63)	10.58 (37.41)	2.99 (10.57)	4.76 (16.83)
10	136.50	1.00	0	2.00	2.47 (28.96)	1.97	3.32	0	2.44	10.58	2.99	4.76
15	141.75	0.47 (5.51)	0	2.00	2.47	2.50 (29.31)	3.38	0	2.44	10.58	2.99	4.76
20	147.00	0.47	0	2.00	2.47	2.50	3.38	0	2.44	10.58	2.99	4.76
25	152.50	0.47	0	2.00	2.47	2.50	3.38	0	2.44	10.58	2.99	4.76

		Large farm				
		Paddy IR 8	Wheat	Sugarcane	Ground-nut	Buffaloes*
0	125.00	10.33 (19.40)	20.33 (38.18)	0	10.00 (18.78)	15
5	131.25	10.33 (20.56)	20.33 (40.47)	4.48 (8.92)	10.00 (19.01)	0
10	136.50	6.01	16.01	8.80 (19.17)	10.00	0
15	141.75	6.01	16.01	8.80	10.00	0
20	147.00	6.01	16.01	8.80	10.00	0
25	152.50	6.01	16.01	8.80	10.00	0

Figures in parentheses are percentages. * Indicates number of buffaloes.

under sugarcane, though some acreage fit for sugarcane was left uncropped. This indicated that sugarcane was relatively low paying proposition compared with wheat-paddy rotation.

Impact of Price Variation in Desi Cotton

The impact of price variation in *desi* cotton on the production patterns was examined in Table V. It shows that *desi* cotton occupied 1.97 and 2.99 acres in the optimal plans of the small and medium holdings, which comprised 17.85 and 9.56 per cent of the total cropped area respectively. It was observed that there was an increase in the percentage area of *desi* cotton over the existing plans but this crop could not figure in the optimal programme of the large holding, where *desi* cotton occupied 7.76 per cent in the existing plans. It

TABLE V—IMPACT OF PRICE VARIATION IN *Desi* COTTON ON PRODUCTION PATTERNS IN THE GROUNDNUT AREA OF THE PUNJAB: 1972-73.

(*area in acres*)

Percentage price variation	Absolute price per quintal (Rs.)	Small farm				Medium farm				
		Paddy IR 8	*Desi* cotton	Groundnut	Wheat K-227	Paddy IR 8	*Desi* cotton	Black gram	Wheat K-227	Groundnut
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
0	150.00	1.00 (9.07)	1.97 (17.85)	2.00 (18.14)	4.97 (45.03)	3.38 (10.81)	2.99 (9.56)	2.44 (7.81)	13.57 (43.40)	4.76 (15.22)
5	157.50	1.00	1.97	2.00	4.97	3.38	2.99	2.44	13.57	4.76
10	165.00	1.00	1.97	2.00	4.97	3.38	2.99	2.44	13.57	4.76
15	172.50	1.00	1.97	2.00	4.97	3.38	2.99	2.44	13.57	4.76
20	180.00	1.00	1.97	2.00	4.97	3.38	2.99	2.44	13.57	4.76
25	187.00	0	2.97 (26.87)	2.00	4.97	3.38	2.99	2.44	13.57	4.76

		Large farm				
		Paddy IR 8	Groundnut	Wheat K-227	Buffaloes*	*Desi* cotton
		(10)	(11)	(12)	(13)	(14)
0	150.00	10.33 (19.40)	10.00 (18.78)	20.33 (38.18)	15 (14.06)	0
5	157.50	10.33	10.00	20.33	15	0
10	165.00	10.33	10.00	20.33	15	0
15	172.50	10.33	10.00	20.33	15	0
20	180.00	10.33	10.00	20.00	15	0
25	187.00	10.33	10.00	24.59	0	4.26 (7.85)

Figures in parentheses indicate the percentages of total cropped area.
* These figures are in numbers.

was noted that 20 per cent increase (to Rs. 180 per quintal) in the price of *desi* cotton did not bring any change in the product-mix of any farm situations. When the price of *desi* cotton was raised by 25 per cent (to Rs. 187 per quintal), some changes in the product-mix of the small and large farms were observed but the product-mix of the medium farm remained undisturbed. The area under the crop increased from 1.97 to 2.97 acres and from zero to 4.2 acres on the small and large situations respectively and comprised 26.86 and 7.85 per cent of the total cropped acreage respectively. It could thus be concluded that greater price incentive was required to induce more area under *desi* cotton, because a 25 per cent increase in its price could not bring all the suitable area under *desi* cotton. *Desi* cotton entered the plans at the cost of milch enterprise which was eliminated from the plan. With 25 per cent increase in the price of *desi* cotton, even this crop could not compete with the paddy enterprise on the large size holding. When *desi* cotton was incorporated in the plans, the commercial crops occupied 44.59 and 26.28 per cent of the total cropped area on the small and large holdings respectively.

CONCLUSIONS AND SUGGESTIONS

The analysis of the existing cropping pattern showed that with the existing structure of technology and yield levels together with their price structure, the foodgrains occupied more than 50 per cent of the total cropped area. This indicated that with the development of high-yielding varieties of paddy and wheat, the cropping pattern was skewed in favour of foodgrains and the acreage under commercial crops, therefore, declined. The analysis further indicated that the setback to the production of commercial crops was greater in the paddy zone than that in the groundnut zone. This is because no foodgrain crop was developed, which could compete out groundnut which required a special type of soil. The degree of setback to the production of commercial crops will be seen from Tables I and III, where the commercial crops occupied 5.93 to 10.11 per cent of the total cropped area in the paddy zone, but more than 18 per cent in the groundnut zone.

The analysis of the optimal plans showed the rationality of the decision on the part of the farmers in allocating more acreage to foodgrains. It was important to note that an increase in the price of a single commercial crop could not induce more acreage under commercial crops owing to the fact that competition for the use of limited resources existed among commercial crops themselves. When the price of one commercial crop was raised, it replaced the same acreage under other commercial crops. This means that relative profitability of the commercial crop compared unfavourably with such foodgrain rotations as paddy-wheat and adjustment in the price of commercial crops in the practical range could not improve the position of acreage that would come under the commercial crops.

Although *desi* cotton appeared in some of the optimal plans, yet to increase further production by enlarging area under this crop at least 20 per cent increase in the price of cotton was required.

The analysis of price variation in *gur* showed that a marginal increase in the price of *gur* was required to incorporate this crop in the groundnut zone, whereas more than 25 per cent increase in the price of *gur* was needed to bring all the suitable area under this crop in the paddy zone. In the paddy zone, sugarcane had to compete out high-yielding paddy enterprise, whereas in the groundnut zone, it had to compete out *desi* cotton which was relatively a low paying crop than paddy.

The overall analysis of production schemes and price differential in the central plains of the Punjab showed that under the present set of policies (prices, yield and available technology) the farmers will continue to put more acreage under foodgrains relative to the commercial crops. No commercial crop replaced wheat in the *rabi* season and the area under sugarcane, cotton and oilseeds may be further reduced in the study area, except coarse groundnut which required special soil type for cultivation. The analysis also revealed that some area might be shifted to fodder production to feed milch animals, because the price of milk was increasing faster with the increase in the money income of the people and consequently dairy enterprise was more paying at Re. 1 per litre price of milk. This phenomenon would have further adverse effect on the production of commercial crops in the Punjab.

APPENDIX 1

PRODUCT PRICES USED FOR THE DEVELOPMENT OF INPUT-OUTPUT MATRICES: 1971-72

Sr. No.	Item		Unit	Rupees
1.	*Desi* maize	(Main product)	Per quintal	55.00
2.	*Desi* maize	(By-product)	,,	5.00
3.	Hybrid maize	(Main product)	,,	54.00
4.	Hybrid maize	(By-product)	,,	5.00
5.	*Sathi* maize	(Main product)	,,	55.00
6.	Green gram	(Main products)	,,	150.00
7.	Green gram	(By-product)	,,	5.00
8.	Black gram	(Main product)	,,	200.00
9.	Black gram	(By-product)	,,	5.00
10.	Soybean	(Main product)	,,	100.00
11.	*Desi* bajra	(Main product)	,,	55.00
12.	Hybrid bajra	(Main product)	,,	65.00
13.	Bajra stalk	(By-product)	,,	5.00
14.	Paddy (Basmati)	(Main product)	,,	100.00
15.	Paddy (Jhona)	(Main product)	,,	55.00

(Contd.)

APPENDIX—(*Concld.*)

Sr. No.	Item		Unit	Rupees
16.	Paddy (IR 8)	(Main product)	Per quintal	55.00
17.	Groundnut	(Main product)	,,	125.00
18.	Paddy *bhusa*	(By-product)	,,	2.00
19.	Groundnut	(By-product)	,,	5.00
20.	*Desi* Cotton	(Main product)	,,	150.00
21.	American J. 34, ISS	(Main product)	,,	225.00
22.	Cotton sticks	(By-product)	,,	5.00
23.	*Gur*	(Main product)	,,	125.00
24.	Sesamum	(Main product	,,	200.00
25.	Wheat C-273	(Main Product)	,,	100.00
26.	Wheat K-227	(Main product)	,,	76.00
27.	Wheat *bhusa*	(By-product)	,,	55.00
28.	Barley	(Main product)	,,	2.00
29.	Barley *bhusa*	(By-product)	,,	100.00
30.	*Desi* gram	(Main product)	,,	5.00
31.	Gram straw	(By-product)	,,	175.00
32.	*Sarson*	(Main product)	,,	150.00
33.	*Toria*	(Main product)	,,	150.00
34.	Linseed	(Main product)	,,	150.00
35.	*Taramira*	(Main product)	,,	100.00
36.	Buffalo milk	(Main product)	,,	100.00
37.	Cow milk	(Main product)	,,	90.00
38.	Eggs	(Main product)	Per hundred	22.00