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OPTIMUM LAND USE PATTERN AND RESOURCE ALLOCATION IN A GROWING ECONOMY

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Optimum allocation of land and other resources is defined as to what crop activities to undertake, how much land to allocate to each crop activity and what method and combinations of inputs to use on each crop so that net farm returns are maximized.[1] Whereas in a traditional agriculture few allocative inefficiencies are reported,[2] in a growing economy maladjustments in resource allocation may be found. These inefficiencies arise mainly because of the lags in adjusting to the changing resource structure and their new allocation opportunities which do not fit into the experience-based decision frame of the farmers.[3] The significant changes in the biological and economic environment consequent upon the advent of improved technology in agriculture have provided new alternatives which, in turn, have brought up the need for various adjustments in allocating land and other resources among their competing uses.

This study makes an attempt to examine the optimum land use pattern in the Punjab. The planning was done at the micro level for farm-firms which were then aggregated to obtain the optimum cropping pattern for the State. The aggregated results regarding resource requirements and the scope of increasing net returns through optimum shifts in the cropping pattern were then related with the level of development and farm size. Finally, the relationship of the degree of maladjustment in the existing cropping pattern, at the aggregative level, with such macro policy variables as farm size distribution, tenancy, fragmentation, farm mechanization, etc., was examined.

SAMPLING TECHNIQUE AND DATA

The analysis was based on the primary data collected through a comprehensive field survey. Based on the tehsil level data for 1971-74, the Punjab State was divided into six distinct farming regions with respect to crop-climate complex (Appendix 1). A three-stage stratification design was adopted; the regions being the strata, the tehsils within the regions the first stage sample

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1. See, E. O. Heady and H. R. Jensen: Farm Management Economics, Prentice Hall of India (Private) Ltd., New Delhi, 1964, Chapter I, pp. 1-10; A. S. Kahlon: Farm Management, I.C.A.R. Technical Bulletin (Agri.) No. 39, 1972, pp. 1-3.

2. See, W. D. Hopper, "Allocation Efficiency in Traditional Indian Agriculture", *Journal of Farm Economics*, Vol. 47, No 3, August 1965; Venkareddy Chennareddy, "Production Efficiency in South Indian Agriculture", *Journal of Farm Economics*, Vol. 49, No. 4, November 1967; Gian S. Sahota, "Efficiency of Resource Allocation in Indian Agriculture", *American Journal of Agricultural Economics*, Vol. 50, No. 3, August 1968; G. R. Saini, "Resource Use Efficiency in Agriculture", *Indian Journal of Agricultural Economics*, Vol. XXIV, No. 2, April-June 1969; Karam Singh and A. S. Kahlon, "Resource Use Efficiency and Resource Adjustment Possibilities in Punjab Agriculture", *Agricultural Situation in India*, Vol. XXX, No. 1, April 1975.

3. L. N. Dahiya, "Impact of Optimum Agricultural Land Allocation Patterns on Farm Incomes—A Case Study of Transitional Agriculture", *Indian Journal of Agricultural Economics*, Vol. XXXI, No. 1, January-March 1976.

units, the village within the tehsil the second stage sample units and the holdings within the villages the third stage sample units. One tehsil from each region was selected at random, and four villages from the selected tehsil were selected with probability proportional to the cultivated area of the village. All the holdings in the selected villages were categorised into small, medium and large such that each group comprised approximately one-third of the total cultivated area. The medium and large holdings were further categorised into bullock and tractor operated holdings. Then 14 holdings from each of the small, medium and large categories from each region were selected randomly. The sample of medium and large holdings was proportionately drawn from bullock and tractor operated categories. This gave us a total sample of 251 holdings.[4] Since it would be a stupendous task to apply elaborate farm planning procedures to each of the 251 holdings individually, five synthetic farm situations were planned for each region. The aggregate results in this study were thus obtained by weighted average where weights for each farm category were the proportion of farmers of that category in the selected villages. The data pertain to agricultural year 1974-75.[5]

PLANNING TECHNIQUE

The profit maximization model of linear programming techniques was used to find out the normative solutions. The objective function was:

$$\text{Maximize } Z_0 = \sum_{i=1}^{n} P_i X_i$$

$$\text{Subject to } R_j \geqslant \sum_{i=1}^{n} a_{ij} X_i$$

$$X_i \geqslant 0$$

where

Z_0 = Net returns (returns to fixed farm resources),
P_i = Net returns from the ith activity,
X_i = The level of the ith activity,
R_j = Quantity available of the jth resource,
a_{ij} = Quantity of R_j input required per unit of ith activity.

The final optimum plans were given by the solution of the linear programing problem through simplex method.

Net Returns

The objective function was to maximize net returns on the farm in an annual cycle. The net returns were measured by deducting variable expenses

4. In region III, only 13 large holdings could be selected for want of sufficient number of large tractor holdings.

5. For further details on sampling, methodology and results, see, D. S. Sidhu, Karam Singh, G. S. Gill and Nirmal Singh: Economic Potentials of Grain Production in the Punjab, Punjab Agricultural University, Ludhiana, PL-480 Project, 1976.

from the gross income.[6] In order to maintain uniformity, the output prices were taken as the harvest prices and the input prices as the actual market prices at the time of application of inputs. The various items of variable cost were casual hired labour, seeds, manures, fertilizers, water, hired machinery, reccurring expenses on implements and machinery, electricity, insecticides and pesticides, fuel oil, etc.

Input Coefficients

The input coefficients refer to the requirements of a crop activity in respect of the inputs of different resources measured in terms of per unit of land, *i.e.*, per hectare. The input coefficients for all the crop activities on all the selected farms were calculated on the basis of the actual quantities of different resources used for those crop activities.

Resource Constraints or Resource Supplies

The resources on a farm consist of land, labour, bullock and tractor power, irrigation facilities, cash or working capital required to buy such inputs as seeds, fertilizers, insecticides, to hire labour and machinery, etc. The availabilities of these resources act as constraints within which the feasible planning needs to be optimized. Whereas some of these resources can be supplemented through borrowing/hiring, others cannot be. These constraints were: (*i*) land—its crop use capability classification, (*ii*) labour in three peak periods, *viz.*, sowing of *kharif* crops (period I), harvesting of *kharif* and sowing of *rabi* crop (period II) and harvesting of *rabi* crops (period III),[7] (*iii*) working capital during *kharif* and *rabi* seasons, (*iv*) irrigation, (*v*) crop maxima.

The details of these constraints are given in Appendix 2.

Resources like draft power, farm implements, availability of high-yielding variety (HYV) seeds, etc., were not found exerting a restrictive influence on crop production. Similarly, the family-food supply was not considered a constraint in land use planning because the production system in the State is no longer need-based but geared towards the market, that is, farmers view agriculture not as an impoverished way of life but as a profitable business occupation.

SHIFTS IN LAND USE PATTERN

An examination of the existing cropping pattern shows that HYV wheat was the only major *rabi* enterprise covering about 50 to 72 per cent of the cultivated area (Table I). The other crop that could

6. This is in consonance with the usual practice followed by most of the studies in farm management. See, C. H. Hanumantha Rao: Agricultural Production Functions, Costs and Returns in India, Asia Publishing House, Bombay, 1965, p. 72 ; Don Kanel and Walter C. Neale, "More Farm Planning with Arithmetic", *Economic and Political Weekly*, Vol. XIV, Nos. 4, 5 and 6, Annual Number, February 1962, pp. 247-250; Heady and Jensen: *op. cit.*, p. 131; Raj Krishna, "The Optimality of Land Allocation—A Case Study of the Punjab", *Indian Journal of Agricultural Economics*, Vol. XVIII, No. 1, January-March 1963, pp. 63-73; S. S. Johl and A. S. Kahlon: Application of Programming Techniques to Indian Farming Conditions, Punjab Agricultural University, Ludhiana, 1967.

7. The period differed in different zones in terms of their duration and start or end.

TABLE I—EXISTING CROPPING PATTERN: PUNJAB, 1974-75

(hectares)

Crop	Region I	II	III	IV	V	VI
Paddy HYV	1.94 (41.82)	2.27 (45.31)	0.08 (2.08)	0.08 (1.31)	0.05 (0.69)	0.07 (0.89)
Paddy local	0.18 (3.88)	0.71 (14.17)	0.29 (7.53)	— —	— —	— —
Cotton American	—	—	—	0.40 (6.57)	1.11 (15.45)	3.69 (49.49)
Cotton *desi*	0.09 (1.94)	0.01 (0.20)	0.01 (0.26)	0.15 (2.46)	1.00 (13.90)	0.05 (0.64)
Maize hybrid	0.01 (0.22)	0.05 (0.99)	— —	0.29 (4.76)	0.03 (.42)	0.01 (0.13)
Maize *desi*	0.29 (6.25)	0.60 (11.98)	2.14 (55.58)	1.94 (31.86)	0.27 (3.75)	—
Sugarcane	0.14 (3.00)	0.18 (3.59)	0.19 (4.94)	0.27 (4.43)	0.11 (1.53)	0.04 (0.51)
Groundnut	—	—	0.14 (3.64)	1.78 (29.23)	0.16 (2.22)	—
Bajra hybrid	—	—	—	—	0.82 (11.39)	—
Bajra *desi*	—	0.08 (1.60)	0.05 (1.30)	—	0.32 (4.44)	0.12 (1.53)
Fodders	0.82 (17.68)	0.61 (12.18)	0.26 (6.67)	0.73 (11.99)	1.15 (15.97)	1.07 (13.61)
Other crops	0.44 (9.49)	0.21 (4.19)	0.03 (0.76)	0.04 (0.66)	0.06 (0.83)	0.38 (4.85)
Sub-total	3.91 (84.29)	4.72 (94.21)	3.19 (82.86)	5.68 (93.27)	5.08 (70.56)	5.63 (71.63)
Wheat HYV	3.22 (69.41)	3.28 (65.43)	1.94 (50.39)	3.92 (64.37)	3.26 (45.56)	2.69 (34.22)
Wheat local	—	0.39 (7.78)	0.34 (8.83)	—	—	0.04 (0.51)
Barley	—	0.02 (0.40)	—	0.52 (8.54)	0.69 (9.58)	0.26 (93.31)
Gram	0.17 (3.66)	0.03 (0.60)	0.42 (10.91)	0.11 (1.61)	0.93 (12.92)	0.17 (2.16)
Oilseeds	0.01 (0.22)	0.01 (0.20)	0.09 (2.34)	0.04 (0.66)	0.90 (12.50)	0.90 (11.45)
Fodders	0.47 (10.13)	0.57 (11.38)	0.13 (3.38)	0.48 (7.88)	0.35 (4.86)	0.40 (5.00)
Other crops	0.05 (1.02)	0.03 (0.60)	0.06 (2.08)	0.11 (0.11)	0.01 (0.01)	0.05 (0.05)
Sub-total	3.92 (84.50)	4.33 (86.42)	3.00 (77.92)	5.18 (85.06)	6.16 (85.56)	4.51 (57.38)
Total cropped area	7.83 4.64	9.05 5.01	8.19 3.85	10.86 6.09	11.24 7.20	10.14 7.86
Cropping intensity	168.79	180.83	160.78	178.33	156.11	129.00

Note:—Figures in parentheses are the percentages to the cultivated area (farm size).

be rated as of some significance was gram in region III and gram and oilseeds in region V, each covering around 10 per cent of the cultivated area. But using *kharif* crops as the basis, the regions could be clearly distinguished from each other. Thus, region I could be referred to as paddy zone as this crop covered about 45 per cent of the cultivated area in this region. In region II, paddy and maize covered 59 and 13 per cent of the cultivated area respectively. In region III, maize alone dominated the scene covering about 60 per cent of the cultivated area whereas in region IV maize and groundnut covered 36 and 29 per cent of the cultivated area respectively. Regions V and VI were basically cotton regions but whereas in region VI American cotton dominated covering about 50 per cent of cultivated area, in region V the importance was equally shared by American cotton, *desi* cotton and bajra covering 15, 14 and 16 per cent of the cultivated area respectively.

The optimum land use pattern requires some significant changes from the existing land use pattern (Table II). In regions I and II, the area under HYV paddy increased from 42 and 45 per cent in the existing plan to 71 and 62 per cent in the optimum plan. Paddy local was eliminated altogether. Likewise, hybrid maize did not find any place in the optimum plan whereas the area under *desi* maize in region II increased from 12 to 17 per cent from the existing to the optimum plan. Sugarcane accounted for about 10 per cent of the cultivated area in both the zones. In region III, which was primarily a maize region, the optimum crop plan demanded HYV paddy to be as important (40 per cent) as maize *desi* (38 per cent). The area under paddy local also remained at 5 per cent in the optimum plan. In region IV, American cotton was completely substituted by *desi* cotton. Even in this region, hybrid maize could not find any place in the optimum plan whereas the area under *desi* maize increased from 32 to 64 per cent and that under groundnut decreased from 29 to 9 per cent. Hybrid maize not featuring in the optimum plan in any of the areas is in consonance with its very low adoption in the State in spite of the fact that its HYVs appeared on the scene much earlier than those of other crops. In regions V and VI, which were cotton+bajra and cotton regions respectively, the area under cotton declined from 29 and 50 per cent in the existing plan to 26 and 40 per cent in the optimum plan respectively. But hybrid bajra appeared to be very dominating covering about 46 and 43 per cent of the cultivated area in regions V and VI respectively.

Again, during *rabi* season, in the optimum plan HYV wheat was the most dominating enterprise. Wheat local did not appear in the optimum plan in any region except region III where its area increased from 9 per cent in the existing plan to 40 per cent in the optimum plan. This was mainly because of the higher proportion of unirrigated area in this region which was about 50 per cent as compared to less than 20 per cent in the other regions. Wheat local unirrigated being relatively more profitable than gram unirrigated in the same season and maize *desi* and bajra *desi* in the *kharif* season

TABLE II—NORMATIVE CROPPING PATTERN: PUNJAB, 1974-75

(hectares)

Crop	Region					
	I	II	III	IV	V	VI
Paddy HYV	3.30 (71.12)	3.10 (61.87)	1.54 (40.00)	—	—	—
Paddy local	—	—	0.20 (5.19)	—	—	—
Cotton American	—	—	—	—	1.43 (19.86)	3.13 (39.82)
Cotton *desi*	0.05 (1.08)	—	—	0.53 (8.70)	0.44 (6.11)	—
Maize hybrid	—	—	—	—	—	—
Maize *desi*	—	0.86 (17.77)	1.47 (38.18)	3.93 (64.53)	—	—
Sugarcane	0.47 (10.13)	0.47 (9.38)	—	0.32 (5.25)	0.32 (4.44)	0.24 (3.05)
Groundnut	—	—	—	0.52 (8.54)	0.41 (5.69)	—
Bajra hybrid	—	—	—	—	3.28 (45.55)	3.41 (43.25)
Bajra *desi*	—	—	—	—	0.16 (2.22)	—
Fodders	0.82 (17.68)	0.61 (12.18)	0.25 (6.49)	0.72 (11.82)	1.16 (16.11)	1.09 (13.87)
Sub-total ..	4.64 (100.00)	5.04 (100.60)	3.46 (89.97)	6.02 (98.85)	7.20 (100.00)	7.86 (100.00)
Wheat HYV	3.08 (66.40)	4.28 (85.43)	1.67 (43.38)	4.75 (78.00)	3.92 (54.44)	4.20 (62.34)
Wheat local	—	—	1.55 (40.26)	—	—	—
Barley	—	—	—	—	0.12 (1.67)	—
Gram	0.67 (14.44)	—	0.09 (2.34)	—	0.03 (0.42)	0.23 (2.93)
Oilseeds	—	—	—	—	0.81 (11.25)	0.61 (7.76)
Fodders	0.47 (10.13)	0.53 (10.58)	0.14 (3.64)	0.43 (7.06)	0.36 (5.00)	0.45 (5.72)
Sub-total ..	4.22 (90.97)	4.81 (96.01)	3.45 (89.61)	5.18 (85.06)	5.24 (72.78)	6.19 (78.75)
Total cropped area ..	8.89	9.85	6.91	11.20	12.47	14.05
Cropping intensity ..	190.97	196.61	179.58	183.91	172.79	178.75

Note:— Figures in parentheses are the percentages to the cultivated area (farm size).

warranted shifts from these crops to wheat local.[8] Thus the area under gram decreased from 11 to 2 per cent in region III whereas in region I, it increased from 4 to 14 per cent. In region V, oilseeds maintained their area at 11 per cent compared to 12 per cent in the existing plan but the area under gram decreased from 13 per cent to less than 1 per cent. Likewise, in region VI, oilseeds commanded 8 per cent of the cultivated area in the optimum plan compared to 11 per cent in the existing plan.

The increase in the cropping intensity in the optimum plan over the existing plan was around 20 per cent for regions I, II, III and V. It was 6 per cent for region IV and 60 per cent for region VI. The major source of increase in the cropping intensity was from *rabi* season when in the existing plan cropped area was less than in the *kharif* season in all the areas except in region V where it was opposite and in region I where cropped area in both the seasons was about the same. In region VI, where American cotton was the major *kharif* crop in the existing plan which acted as a constraint to increasing the cropping intensity by delaying the sowing of wheat crop, the increase in the cropping intensity in the optimum plan was made possible through hybrid bajra also emerging as an important *kharif* crop which did not delay the sowing of wheat. Thus, in this region, the total cropped area during the *kharif* season increased from 72 to 100 per cent and that during the *rabi* season from 57 to 79 per cent.

RESOURCE REQUIREMENTS OF EXISTING AND OPTIMUM PLANS

The requirements of labour during different peak periods and those of fertilizers during the *kharif* and *rabi* seasons for the existing and optimum plans are given in Table III. It was found that the labour requirements during all the periods increased in all the areas but for region III there was a decline of 34, 24 and 26 per cent over the existing plan during periods I, II and III respectively. As would be discussed later, region III is the most backward one. Thus it indicates that in the relatively backward areas, existing cropping pattern is unnecessarily labour intensive and that there is a possibility of MVP of labour being negative (even in the peak periods). In other regions, the increased labour requirements were to the tune of 17 to 39 per cent in period I, 8 to 27 per cent in period II and 7 to 33 per cent in period III except in period I in region IV where there was only a little change in the labour requirements. This indicates that, on the whole, the optimum plans would be more labour intensive and thus more desirable from economic as well as social point of view for an over-populated economy like that of India.

As regards fertilizers, their aggregate use, on the whole, increased by 12 to 37 per cent in region III and II respectively. Seasonwise, there was more use of fertilizers in *rabi* than in *kharif* except in region III in the existing plans and region I in the optimum plan. Accordingly, the percentage increase in fertilizers required for the optimum plan was in general higher in the *kharif*

8. The picture would change again when some HYV of wheat for the unirrigated areas would be released.

TABLE III—RESOURCE REQUIREMENTS OF THE EXISTING AND OPTIMUM PLANS FOR THE AVERAGE FARM: PUNJAB, 1974-75

Resource	Region I		Region II		Region III		Region IV		Region V		Region VI	
	Existing	Optimum	Existing	Optimum	Existing	Optimum	Existing	Optimum	Existing	Optimum	Existing	Optimum
Labour (man-hours)												
Period I	1035	1215 (17.39)	946	1187 (25.47)	822	545 (—33.70)	1310	1303 (—0.54)	1209	1550 (28.20)	1793	2486 (38.65)
Period II	1035	1117 (7.92)	996	1223 (22.79)	822	621 (—24.46)	1310	1411 (7.70)	1125	1377 (22.40)	1833	2332 (27.22)
Period III	1524	1631 (7.02)	1564	1998 (27.74)	1371	1020 (—25.61)	2183	2781 (27.39)	2511	3349 (33.37)	3728	4342 (16.46)
Fertilizer (Rs.)												
Kharif	846	1,266 (49.64)	1,275	1,831 (43.60)	348	366 (5.17)	668	1,068 (59.88)	612	878 (43.46)	1,947	1,984 (1.90)
Rabi	1,094	1,089 (—0.46)	1,706	2,257 (32.29)	289	347 (20.06)	3,306	3,725 (12.67)	1,580	1,828 (15.69)	2,370	3,586 (51.30)
Total	1,940	2,355 (21.39)	2,981	4,088 (37.13)	637	713 (11.93)	3,974	4,793 (20.60)	2,192	2,706 (23.44)	4,317	5,570 (29.02)

Note:—Figures in parentheses are the percentage increase or decrease in the optimum plan over the existing plan.

season than in the *rabi* season. The relatively lower use of fertilizers in the *kharif* was due to (*i*) the prevalent practices followed by the farmers,[9] (*ii*) the existing cropping pattern which is less fertilizer demanding in *kharif* than in *rabi*,[10] and (*iii*) the technology available at the moment for the State which suggests a reduction in the use of such fertilizers as phosphorus on *kharif* crops provided enough was used on the *rabi* crops particularly HYV wheat.[11]

CASH INPUTS AND NET RETURNS

The short-term demand for credit is to meet the requirements of cash variable inputs. The variable expenses and net returns per hectare from the existing and optimum plans are given in Table IV. It was found that the optimum plan required variable inputs by 20 to 24 per cent more than the existing plan in regions II to VI. Only in region I, the requirement of the optimum plan was 32 per cent more than that of the existing plan. Thus the scope of additional demand for credit was almost the same in all the regions but for region I.

TABLE IV—RELATIVE SCOPE OF INCREASING CASH INPUTS AND NET RETURNS: PUNJAB, 1974-75

Region	Variable expenses per hectare (Rs.)			Net returns per hectare (Rs.)		
	Existing	Optimum	Percentage increase	Existing	Optimum	Percentage increase
I ..	575.42	757.34	31.62	3,185.42	4,252.16	33.49
II ..	1,046.51	1,297.65	23.99	3,259.96	3,957.80	21.41
III ..	445.58	536.04	20.30	2,580.13	3,701.47	43.46
IV ..	1,033.04	1,257.26	21.70	3,979.34	4,706.86	18.28
V ..	711.25	881.12	23.88	2,684.54	3,376.70	25.78
VI ..	1,135.84	1,400.94	23.34	2,988.08	3,648.96	28.12

The net returns per unit of land inputs, which is a binding constraint, can be taken as a measure of efficiency[12] and development. The net returns per hectare from the existing plans were the minimum in region III (Rs. 2,580) and maximum in region IV (Rs. 3,979). Accordingly, these regions can be termed as relatively the least and the most developed ones respectively. On the same criterion, the rankings of other regions in the descending order of development was II, I, VI and V having net returns of Rs. 3,260, Rs. 3,185, Rs. 2,988 and Rs. 2,684 per hectare respectively.

9. K. S. Gill and S. S. Johl: Distribution of Fertilizers in the Punjab, Punjab Agricultural University, Ludhiana, 1973, pp. 14-15.

10. Karam Singh and Kuldip Grewal, "Unexploited Potential of Fertilizer Use in Punjab Agriculture", *Agro-Industrialist*, Vol. 4, No. 11, February 1973, pp. 15-22.

11. See, Package of Practices for Kharif Crops, 1976, Punjab Agricultural University, Ludhiana, 1976.

12. See, Hanumantha Rao: *op. cit.*, p. 41 where he says, "From the point of view of efficiency, net income per acre should be more meaningful than gross output for, in the ultimate analysis, the objective of land-use policy is to maximize net farm income of the community. We are, therefore, taking net income per acre from crop output as an index of land-use efficiency".

The percentage increase in the net returns from the optimum plan over the existing plan was the highest (43 per cent) in region III which was relatively the least developed and it was the minimum in region IV (18 per cent) which was relatively the most developed. Thus the more developed the region, the less is the scope of increasing farm incomes. Since the demand for additional credit was the same in all the regions, it may be concluded that the extension effort in the less developed regions is the most required (or rewarded) activity.

The relative scope of increasing cash variable inputs and net returns on different sizes of farms is given in Table V. It can be seen from the table that in the paddy regions (regions I and II) the increase in variable expenses due to the optimum plan was less on the small farms than on the large ones but the proportionate increase in the net returns as compared to the proportionate increase in variable expenses was greater on the small farms. This

TABLE V—RELATIVE SCOPE OF INCREASING CASH VARIABLE INPUTS AND NET RETURNS ON DIFFERENT SIZES OF FARMS IN DIFFERENT REGIONS: PUNJAB, 1974-75

(per cent)

Farm category	Region I		Region II		Region III	
	VE	NR	VE	NR	VE	NR
1. Small	13.02	31.40	8.01	11.24	22.17	47.00
2. Medium	56.21	27.06	54.43	54.34	19.52	36.34
3. Large	38.36	28.08	36.74	25.68	17.17	27.47

Farm category	Region IV		Region V		Region VI	
	VE	NR	VE	NR	VE	NR
1. Small	31.44	24.74	26.31	17.60	21.93	21.81
2. Medium	7.90	12.68	10.63	47.72	29.87	14.17
3. Large	23.62	13.04	43.95	25.87	27.11	31.86

VE=Variable expenses.
NR=Net returns.

indicates the relatively more significant shifts in the existing resource use pattern with their augmentation to a relatively small degree on the small farms and thus the scope for extension agency on these farms. Again in region VI, the increase in variable expenses was less on the small (22 per cent) as compared to the large (27 per cent) farms and the scope of increasing returns was 22 and 32 per cent on these holdings respectively. This was due to the relatively larger holdings in this area and the relatively greater scope of increasing cropping intensity on larger holdings in this area.

The scope of increasing net returns in regions III and IV was almost two-fold on the small as compared to the large holdings and the additional credit requirements (increase in variable expenses) were relatively more but

far less than double on the small than on the large holdings. These two regions were the widest apart in terms of development, region III being the least developed and region IV being the most developed. Thus considering all the regions together, it could be concluded that the small farms are at a relatively greater disadvantage in the less developed areas and as development catches momentum, they start joining the race, (or are given a lift in the initial stages of development), but in the long run, they (small farmers), again, are the maximum disadvantaged lot because the resource structure of the large farmers enables them to make warranted adjustments at a relatively greater speed. This belies the common notion that the small farmers need only an initial stimulus and thereafter can be left on their own. Rather it suggests that the special institutional services for small farmers should be made a permanent feature, which in turn requires that efforts should be made to make such services economically viable so that these can sustain in the long run.

FACTORS AFFECTING SHIFTS IN OPTIMUM CROPPING PATTERN

Having discussed the optimum shifts in the cropping pattern, the changes in the resource requirements or for that matter the scope of additional demand for some resources like fertilizers, credit, etc., the possibilities of increasing incomes and relating these variables with the general economic development of the area, it is important to correlate the degree of sub-optimality in the existing cropping pattern in different areas with some important economic characteristics of these areas. The degree of sub-optimality indicates the extent of maladjustments in the existing cropping pattern and is defined as absolute mean deviation in the percentage area under different crops in the existing cropping pattern from the optimum cropping pattern. It is hereafter referred to as the Intensity of Adjustment. Its determinants are taken as farm size distribution in the area expressed as a proportion of the small holdings, extent of tenancy measured as a proportion of the leased in area in the operational holdings, fragmentation of holdings measured as area per fragment and machinery measured as a proportion of tractor operated holdings. The relevant data are given in Table VI.

TABLE VI—CORRELATES OF MALADJUSTMENTS IN CROPPING PATTERN

Region	Intensity of adjustment	Proportion of small holdings	Tenancy (proportion of leased in area) (per cent)	Area per fragment (hectares)	Machinery (per cent of tractor holdings)
I	5.55	65.40	12.54	2.38	11.67
II	4.94	54.95	18.68	1.32	10.43
III	8.03	83.55	8.87	0.75	1.57
IV	6.73	47.19	15.31	1.90	18.82
V	5.39	65.47	12.73	1.19	6.28
VI	6.76	52.47	9.17	2.75	16.16

It was found that in region III which had the highest proportion of small holdings (83 per cent), the intensity of adjustment was also the highest (8.03).

As the proportion of small holdings scaled down to 65 per cent both in regions V and I, so did the intensity of adjustment to 5.39 and 5.55 respectively. Again, in Region II, as the proportion of small holdings declined to 55 per cent, it was associated with a decline in the intensity of adjustment to 4.94. But a further decline in the proportion of small farmers was not found associated with a decline in the intensity of adjustment which rather jumped to 6.73 and 6.76 in regions IV and VI respectively. It shows that the existing cropping pattern is relatively more sub-optimal in areas dominated by the small farmers. The level of sub-optimality declines as the proportion of small farmers decreases in the area but only upto some extent beyond which the two variables do not stand correlated.

As regards the impact of tenancy on maladjustments in the existing cropping pattern, one would postulate that the higher the extent of tenancy, the greater the sub-optimality in the existing cropping pattern. But the data in Table VI does not support this clearly. Regions III and VI are the areas where the degree of maladjustment is the highest but tenancy, measured as a proportion of leased-in area, is the lowest at less than 10 per cent. Also, the average size of holdings was the lowest in region III and the highest in region VI. This shows that areas burdened with an abundance of small holdings or gifted with large holdings are mostly the owner operated. In the former case, every owner likes to earn his bread through self-cultivation and in the latter case, every owner (being a viable or large farm size holder) likes to maintain his standard better through self-cultivation. For other regions also where the leased-in area formed more than 10 per cent of the operational holdings, no clear-cut relationship between the extent of tenancy and the degree of maladjustment could be established. Although this is some indication of the phenomenon that the spirit of tenancy in the Punjab is something unique so as not to be an important constraint to making adjustments in the farm organization,[13] this is only a part of the explanation. The alternative explanation is that the percentage of leased in area in a region is not a sufficient measure to identify tenancy as a constraint. In the Punjab, most of the tenants are landed farmers who enhance the size of their farms by leasing-in some land and the landless tenants are rather a rare phenomenon.[14] And it is not only the small farmer who leases in land but the medium and large farmers lease in some land. The data in Table VII corroborate not only this fact but also show that in some of the regions as I, IV and V a higher percentage of medium and large farmers leased in land than did the small farmers. And to the extent the owned land base of the medium and large farmers along with their relatively more capital investment indicates their greater risk bearing ability and more bargaining power,[15] the leased-in land

13. A. S. Kahlon, *et al.*: The Dynamics of Punjab Agriculture, Punjab Agricultural University, Ludhiana, 1972, pp. 54-55.

14. There were only 10 pure tenants out of the total operational holdings of 2,163 in the selected villages, distributed as 1, 3 and 6 in regions I, V and VI respectively. Also see Kahlon, *et al.*: *op. cit.*

15. Pranab Bardhan, "Variations in Extent and Forms of Agricultural Tenancy-I: Analysis of Indian Data Across Regions and Over Time", *Economic and Political Weekly*, Vol. XI, No. 37, September 11, 1976.

or to be a (landed) tenant does not in any way act as a constraint to making allocative adjustment on these farms. Thus only the small landed tenants are affected by tenancy as a constraint and are hereafter called as "constrained tenants". It can also be seen from Table VII that the proportion of cons-

TABLE VII—PROPORTION OF LANDED TENANTS AMONG DIFFERENT CATEGORIES OF FARMERS AND EXTENT OF CONSTRAINED TENANTS AND TENANCY

Region	Percentage of landed tenants amongst			Proportion of constrained tenants to all tenants	Proportion of constrained tenancy to total leased-in area
	Small farmers	Medium farmers	Large farmers		
I	10.35	15.52	21.05	54.39	51.01
II	24.00	14.29	12.12	58.57	44.10
III	17.81	12.50	0	92.86	87.60
IV	11.89	32.41	25.00	26.15	20.36
V	58.78	71.30	59.57	62.37	55.18
VI	15.58	8.97	3.19	71.67	56.29

trained tenants was the highest in region III (93 per cent) followed by in region VI (72 per cent) where the degree of maladjustment was also the highest (see Table VI). In regions V and I, where the constrained tenants were 62 and 54 per cent respectively, the degree of maladjustment was relatively lower. Thus, it shows that the higher the proportion of "constrained tenants", the greater the degree of allocative maladjustments. In region IV, although the degree of adjustment needed was high (6.73), the proportion of constrained tenants in this region was rather low (26 per cent) as to have any significant effect on allocative adjustments. Thus, the only exception is region II where the percentage of small landed (constrained) tenants is more than that in region I and the intensity of adjustment is the lowest. But a further refinement in the measure by taking it as the percentage of total leased-in land with the constrained tenants, to be called as "constrained tenancy", results in shifting the co-ordinate for region II also down on to the line of relationship. Thus, the degree of constrained tenancy holds a strong positive association with the degree of maladjustments.

In relation to fragmentation, the smaller the size of each fragment (or conversely, the larger the number of fragments per unit of area) the more will be the difficulty in making adjustments, *i.e.*, more are the adjustments needed in the cropping patterns. Thus for regions III, V and II, the area commanded per fragment was 0.75, 1.19 and 1.32 hectares and the intensity of adjust-

ment was 8.03, 5.39 and 4.94 respectively. But for other regions, no trend was indicated. Incidentally, the size of each fragment increased to about 2 hectares or more. Thus extreme fragmentation is a constraint to making needed adjustments but once a reasonable size of each fragment is achieved, the needed adjustments assume the functional relationship with some other variables.

Agricultural mechanization in the area also has a U-type relationship with the intensity of adjustment. Thus in areas where mechanization is very low as in region III (1.57) it means that it is in the initial stage of modernization and thus many adjustments are needed (intensity of adjustment was the highest at 8.03). As mechanization proceeds, more and more adjustments are made leaving few inefficiencies, as in regions V and II with mechanization at 6.28 and 10.43 and the intensity of adjustment at 5.39 and 4.94 respectively. A further increase in mechanization is accompanied with the development of custom-hiring services to the small farmers, which introduces the scope of making adjustments on small holdings also and thereby the aggregate picture of land use efficiency again becomes dismal. Thus in regions IV and VI where mechanization was high at 18.82 and 16.16, the intensity of adjustment was again high at 6.73 and 6.76 respectively. This, however, should not discredit mechanization, rather it suggests that the development of custom-services be encouraged to enable the small farmers to make needed adjustments and push the cropping pattern of the area towards the optimum one.

POLICY IMPLICATIONS

The existing land use pattern was found to be sub-optimal, more so in the relatively less developed areas, thereby indicating more scope of farm management extension in these areas.

The optimum resource use, in addition to increasing farm incomes, was also more labour intensive. The development efforts which will encourage needed adjustments in the cropping pattern should be taken up. This will also help to create more employment in the economy.

The optimum cropping pattern involved fewer crops, thereby indicating the trend towards specialisation. This is in conflict with the current emphasis on diversification of agriculture. Hence, incentives should be devised for the relatively less paying minor crops especially grams and other pulses and oilseeds.

There is lot of scope to channel more credit in agriculture. The institutional services for the small farmers should be made a permanent feature to cater to their changing resource needs at various stages of development. This is important because small farmers are a major section of the society and sub-optimality in their cropping pattern is a major determinant of the overall sub-optimality of land use of the region.

APPENDIX 1

DEMARCATION OF DIFFERENT FARMING REGIONS OF THE PUNJAB STATE

Region		Tehsils (Districts)
I	Paddy and Wheat	Amritsar,* Patti, Tarn Taran, Ajnala (Amritsar); Zira, Ferozepur (Ferozepur); Samana, Patiala (Patiala); Sultanpur (Kapurthala).
II	Paddy, Maize and Wheat	Gurdaspur, Pathankot, Batala (Gurdaspur); Sirhind, Rajpura (Patiala); Dasuya* (Hoshiarpur); Kapurthala (Kapurthala).
III	Maize and Wheat	Hoshiarpur, Garhshankar, Balachaur (Hoshiarpur); Phillaur, Nawan Shehar (Jullundur); Anandpur Sahib* (Ropar); Phagwara (Kapurthala).
IV	Maize, Groundnut and Wheat	Ludhiana,* Samrala, Jagraon (Ludhiana); Ropar, Kharar (Ropar); Jullundur, Nakodar, (Jullundur); Nabha (Patiala); Malerkotla (Sangrur).
V	American Cotton and Wheat	Sangrur, Sunam, Barnala, (Sangrur); Mansa,* Rampura Phul (Bhatinda); Faridkot, Moga (Faridkot).
VI	American Cotton, *Desi* Cotton, Bajra and Wheat	Mukatsar* (Faridkot); Fazilka (Ferozepur); Bhatinda (Bhatinda).

*Indicates the tehsil selected.

APPENDIX 2

RESOURCE CONSTRAINTS OR RESOURCE SUPPLIES

Land: The operational holding was basically categorised into four categories based on two crop seasons, *viz.*, *kharif* and *rabi*, and irrigation status, *viz.*, irrigated or unirrigated. Since certain groups have specific land requirements which cannot be grown on all the available land, the four broad categories of land were further classified according to land use capability classification, such as, paddy land, maize, cotton and *toria* land; groundnut land; berseem and sugarcane land, etc.

Human labour: The permanent human labour availability for farm work comes from family members working on the farms and permanently attached workers. The labour is not a constraint throughout the year, there are certain peak labour requirements periods when the permanent labour acts as a constraint and casual labour has to be hired on the economic rationale of equating MVP with the acquisition cost. Three such peak labour requirements periods as *kharif* sowing season, harvesting of *kharif* crops and sowing of *rabi* crops, and harvesting of *rabi* crops were identified. The labour utilized during these periods, for purposes not directly impinging upon, or related to crop activities such as tending of cattle, social functions, ceremonies, and that which could not be used due to natural factors such as rains, inclement weather, etc., were deducted to arrive at net availability of labour for crop production. The hiring in activity of labour was introduced for all the periods.

Working capital: Another important resource which acts as a constraint on the farm production activities is the capital. Since the direct estimation of capital availability was not possible due to the insufficient records available with the farmers and the difficulty in sorting out the family farm expenditures, so the availability of capital at the farm level was estimated as the variable expenses incurred during the season excluding the loans taken by farmers. The borrowing activity for capital during both the crop seasons was introduced to augment the capital available with the farmers.

Irrigation: The main sources of irrigation were tubewells operated by electric motor or diesel engines and canal. The irrigation capacity acted as a constraint during the sowing months of *kharif* crops (mid-June to mid-July) because of high temperature. The irrigation constraint was expressed as the number of hectares that could be irrigated per week.

Crop maxima: In addition to land use and other general resource constraints, certain crops cannot be grown beyond a certain limit because of every crop-specific constraints. Thus, in areas where sugarcane had to be crushed because of absence of any sugar mill in the area, sugarcane was constrained by the crushing capacity available with the farmer, including that which he could hire from neighbouring farmers. Similarly, the area under *toria* (an oilseed) and cotton which were more risky enterprises in some zones were kept limited because farmers would not like to place all their eggs in one basket.