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IMPACT OF OPTIMUM AGRICULTURAL LAND ALLOCATION PATTERNS ON FARM INCOMES—A CASE STUDY OF TRANSITIONAL AGRICULTURAL ECONOMY*

L. N. Dahiya†

This paper attempts to examine with the aid of computerized field data, the impact of optimum agricultural land allocation patterns on farm incomes in the State of Haryana. Optimum allocation of land has been defined as one, which given physical, technical and resource conditions,[1] shows what crop activities to undertake and how much land to allocate to each crop activity so that net farm returns (farm incomes) are maximized in an annual cycle. The view has generally been held that in traditional[2] agriculture relatively few allocation errors would be possible inasmuch as the economy would have, after a long process of trial and error, settled down to some sort of equilibrium pattern. The view, originally propounded by T. W. Schultz, has repeatedly been put to test by many studies in India,[3] as also in other countries. While some of these studies do corroborate the view, others do not. Now that agriculture in the State is undergoing a transformation and has come out of the orbit of traditional agriculture—due, of course, to the substantial changes in the biological and economic environment consequent upon the advent of science and technology in this area—one may expect some allocative ineffi-

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† Lecturer in Economics, Sri Aurobindo College (University of Delhi), New Delhi-17.

1. See E. O. Heady: Economics of Agricultural Production and Resource Use, Prentice-Hall, Inc., Englewood Cliffs, N.J., U.S.A., 1952, p. 763, where he says, "Land, as a factor of production, has no unique characteristics which should cause it to be set aside by itself in economic analysis. The principles defining the optimum use of land are those drawn from the more general production economics principles"; and, again, p. 765, where he says, "Any attempt to single land out as a separate resource and to define optimum land use apart from other resources stands to lead to grave errors."

2. For the attributes of traditional agriculture, See T. W. Schultz: Transforming Traditional Agriculture, Yale University Press, New Haven, U.S.A., 1964, p. 3, where he says, "Farming based wholly upon the kinds of factors of production that have been used by farmers for generations can be called traditional agriculture."

3. See W. D. Hopper, "Allocation Efficiency in Traditional Indian Agriculture," *Journal of Farm Economics*, Vol. 47, No. 3, August, 1965; Stanislow Wellisz, with Bernard Munk, T. Peter Mayhew, and Care Hemmev, "Resource Allocation in Traditional Agriculture: A Study of Andhra Pradesh," *Journal of Political Economy*, Vol. LXXVIII, No. 4 (Part I), July-August, 1970; 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; D. K. Desai, "Increasing Income and Production on Indian Farms: Possibilities with Existing Resource Supplies on Individual Farms," *Indian Journal of Agricultural Economics*, Vol. XVI, No. 3, July-September, 1961; G. R. Saini, "Resource Use Efficiency in Agriculture," *Indian Journal of Agricultural Economics*, Vol. XXIV, No. 2, April-June, 1969; and Sulata Rudra, "Resource Allocation in Traditional Agriculture." *Arth aniti*, Vol. XIII, Nos. 1 and 2, January-July, 1970.

ciency in transitional agriculture.[4] The inefficiency may exist largely because of the fact that the farmers may not adjust quickly in accordance with changed conditions and may be increasingly confronted with new alternatives and problems which do not fit the experience-based decision frame. Thus an investigation of the issue is needed.

SURVEY

The analysis is based on the primary information collected through a comprehensive field survey. For the purpose of the study, the total cultivated land[5] of the State of Haryana has been classified on the basis of several physical and agricultural characteristics, into seven distinct farming regions. In evolving the classification, factors like rainfall, temperature, topography of land, cropping pattern, extent of cultivation, cropping intensity, human and animal labour, fertilizers, improved seeds, have been taken into account. It may be pertinent to mention that tehsil[6] or sub-tehsil has been taken as a unit of such classification as data below this level were generally not available. To avoid the annual abnormalities, triennial (1968-71) average of the above indicators was taken for each tehsil and sub-tehsil. After a prolonged exercise in shuffling and re-shuffling of the units into various combinations on the basis of their homogeneity[7] in terms of the conditions mentioned above, seven distinct regions emerged.

For the purpose of sampling, a three-stage stratification design was adopted, the regions being the strata, the blocks within the regions the first stage sample units, the villages within the blocks the second stage sample units and the holdings within the villages the third stage sample units. All the holdings in a village were arrayed in an ascending order of size. Then, on the basis of cumulative frequency distribution, the holdings were categorised into three groups, each group comprising approximately one-third of the total cultivated area of the village. Then, a random sample of 15 per cent of the holdings was taken ensuring a proportionate representation for all the three categories of operational holdings[8] within each village. This gave a total sample of

4. *cf.* For instance, Yukon Huang, "Allocation Efficiency in a Developing Agricultural Economy in Malaya," *American Journal of Agricultural Economics*, Vol. 53, No. 3, August, 1971, pp. 514-516, where it has been empirically shown that some degree of inefficiency in resource allocation characterizes the phase of transition from traditional agriculture to a modern one.

5. Cultivated land includes the area under crops and current fallows. The cultivated land as a percentage of the total cultivable land in the State is as high as 95 per cent, leaving little scope for expanding the extensive margin of agricultural land.

6. Tehsil = sub-division of a district with separate revenue staff.

7. It needs hardly to be pointed out that all the tehsils and sub-tehsils grouped together into each region, do not possess completely identical values of the indicators. Some degree of deviation has been unavoidable in this regard, but it may be mentioned that it has been rather insignificant.

The regions with their constituent tehsils and sub-tehsils are as follows : Ambala, Jagadhri, Naraingarh, Kalka (I) ; Safidon, Karnal, Panipat, Kaithal, Thanesar, Guhla (II) ; Jind, Rohtak Sonepat, Gohana (III) ; Gurgaon, Nuh, Ferozepur-Jhirka, Palwal, Ballabgarh (IV); Jhajjar, Mohendergarh, Dadri, Narnaul, Bhiwani, Rewari, Loharu (V); Narwana, Hissar, Fatehabad, Hansi (VI); and Sirsa, Dabwali (VII).

8. Operational holding is defined as one which includes the land owned and leased-in, but excludes such of the owned land as is leased out.

252 farms, falling in three size-groups of operational holdings, *viz.*, small, medium and large, from 14 sample villages representing the seven regions. Since it was difficult to work out the optimum plan for each of the 252 holdings individually, synthetic farm[9] situations were developed for each group, *viz.*, small, medium and large. The aggregate results in this study are thus obtained directly from such resultant 21 synthetic holdings in all the seven regions. The survey was conducted during May, 1971-January, 1972 and the data collected pertain to two agricultural seasons : *rabi* (November, 1970-April, 1971) and *kharif* (May-October, 1971).

LAND USE ALTERNATIVES

While examining the nature and problem of land utilization, we consider all the crops grown on the holdings. However, we assume that the area under fodder crops and the area under minor crops which cover less than 2 per cent of the total cropped area on these holdings under the optimum would be the same as under the actual plan. Thus, the following thirteen crops,[10] seven of them *rabi*, *viz.*, wheat, gram, barley, wheat-gram mix, mustard, rape and lentil and six of them *kharif*, *viz.*, bajra, cotton, rice, sugarcane,[11] maize and groundnut, were considered as major land use alternatives. Notably, the analysis has not been carried out in terms of these thirteen crops as such. Further differentiation was made in the case of each crop. Each crop was sub-classified into activities.[12] For instance, (*i*) a crop grown under irrigated conditions has been treated as being a different activity from that representing the same crop grown under unirrigated conditions, and (*ii*) high-yielding variety (HYV) of a crop has been consideed as a separate crop activity from raising of the indigenous (*desi*) variety of the same crop.

MODEL

The linear programming technique which maximizes farm returns from various crop activities subject to the various constraints has been used as an analytical tool. The model used was :

Maximize :

$$Z_0 = \sum_{j=1}^{k} C_j X_j$$

9. Admittedly, farm planning is a micro approach. But it will be a stupendous task to apply elaborate farm planning procedures to each and every farm situation. Thus, synthetic holdings were developed by pooling and averaging all resources constraints and input-output data of the selected holdings from different size-groups for each region. The relevant data for each synthetic holding are not reproduced here for want of space. The interested readers may write to the author directly.

10. It has been assumed that there is no complementarity among the different crops.

11. Sugarcane is a full year crop for *kharif* and *rabi*.

12. The crops, which are considered to be technically feasible and which are acceptable to the farmers concerned, have been termed crop activities.

Subject to

$$\sum_{j=1}^{k} a_{1j} X_j \leqslant b_1$$

$$\vdots$$

$$\sum_{j=1}^{k} a_{ij} X_j \leqslant b_i$$

$$\vdots$$

$$\sum_{j=1}^{k} a_{nj} X_j \leqslant b_n$$

and $X_j \geqslant 0$ where

Z_0 = the total net farm returns in rupees,
C_j = net return from one unit of jth activity,
X_j = the level of activity j (j=1, ...k),
a_{ij} = amount of ith input required per unit of jth activity,
b_i = the quantity available of the ith resource. (i=1,.....,n)

The final solution of the linear programming probem has been obtained through simplex method.[13]

Net Returns

The objective function in this case is to maximize net returns (profits)[14] on the farm in an annual cycle. Net returns have been obtained by deducting from the gross income realized by the farmer from his farm produce[15] (main products and by-products), the cash and kind expenditure (variable cost)[16] incurred in the cultivation of crops during the year. Our choice of

13. For details regarding simplex method, the following publications are referred to : E.O. Heady, "Simplified Presentation and Logical Aspects of Linear Programming Technique," *Journal of Farm Economics*, Vol. 36, No. 5, December, 1954; E.O. Heady and Wilfred Candler: Linear Programming Methods, Iowa State College Press, Ames, Iowa, U.S.A., 1958; E.O. Heady and John A. Hopkins: Farm Records and Accounting, Iowa State College Press, Ames, Iowa, U.S.A., 1962; Wilfred Candler, "A Modified Simplex Solution for Linear Programming with Variable Capital Restrictions," *Journal of Farm Economics*, Vol. 38, No. 4, November, 1956; and Robert Dorfman, Paul A. Samuelson, and Robert M. Solow : Linear Programming and Economic Analysis, McGraw-Hill Book Co., Inc., New York, 1958.

14. See Heady and Candler: *op. cit.*, pp. 19-30, where they say, "Profit maximization or cost minimization is the supreme objective of a firm or a farm willing to operate at the optimum level;" and C. H. Hanumantha Rao : Agricultural Production Functions, Costs and Returns in India, Asia Publishing House, Bombay, 1965, 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."

15. The produce has been evaluated at the farm harvest prices in order to obtain uniformity.

16. The various items of variable cost are as follows: casual hired labour, seeds, manures, fertilizers, water, hired bullock, implements and machinery, insecticides and pesticides, fuel, oil, etc., interest on short-term cash borrowed, depreciaton and maintenance of some implements like cane-crusher, wheat thresher, which are specific for the use of certain crops.

the procedure for estimating net farm returns is in consonance with the usual practice followed by most studies relating to farm management.[17]

Input Coefficients

The input coefficients[18] for all the crop activities on all the selected farms were calculated on the basis of the actual quantities of different resources used for these crop activities.

RESOURCE SUPPLIES OR RESOURCE CONSTRAINTS

The resources on a farm consist of land, human labour, bullock and tractor power, implements, irrigation facilities, cash, manures, fertilizers and other scarce inputs. The constraints[19] or the availabilities for these resources have been explained below :

Land : Since the total supply of land with the farmers was both irrigable and unirrigable land, four categories of land constraints were considered, *viz.*, *rabi* irrigable, *rabi* unirrigable, *kharif* irrigable and *kharif* unirrigable. These four broad categories were further classified according to land use capability levels.[20]

Human labour : The total family labour availability (family plus permanent attached labour) was measured in total man-days[21] during the two peak periods, *viz.*, (*i*) April-May (period I), and (*ii*) October-November (period II). However, the man-days of labour utilized during these two periods, for purposes not directly impinging upon, or related to crop activities such as tending of cattle, social functions, ceremonies, and the man-days that could not be uti-

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17. Hanumantha Rao: *op cit.*, 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; E.O. Heady and Harold R. Jensen: Farm Management Economics, 1964, p. 131; J.M. Henderson, "The Utilization of Agricultural Land: A Theoretical and Empirical Inquiry," *Review of Economics and Statistics*, August, 1959, p. 251; S.S. Johl and A.S. Kahlon: Application of Programming Techniques to Indian Farming Conditions, Punjab Agricultural University, Ludhiana, 1967, p. 33; Raj Krishna, "The Optimality of Land Allocation—A Case Study of the Punjab," *Indian Journal of Agricultural Econimics*, Vol. XVIII, No. 1, January-March, 1963, pp. 63-73.

18. Input coefficients refer to the requirements of a crop activity in respect of the inputs of resources measured in terms of per unit of land, *i.e.*, per hectare.

19. The resources which are fixed or scarce in supply on the farm at levels which limit, or are likely to limit the scale of the crop activities, are termed resource constraints.

20. By land use capability is meant the specification of the land restriction for growing a particular crop/crops. Alternatively stated, there existed several qualities of land on the farms, each of which is suited for different crop/crops. So according to its suitability for crop/crops, the land available with the farmer was divided into several categories such as :

rabi irrigable land fit for wheat
rabi unirrigable land fit for barley
⋮ ⋮ ⋮
kharif irrigable land fit for cotton/maize
kharif unirrigable land fit for jowar/bajra.

21. For the purpose of measurement, a man-day and a bullock power pair day have been taken to be equal to eight hours of work.

lized due to natural factors such as rains, inclement weather, etc., were deducted to arrive at the net available days for crop production. However, the permanent labour constraint was appropriately relaxed to include the hiring in of casual labour as an activity in the simplex tableau on the basis of the extent to which the casual hired labour was actually used, during the two peak periods.

Bullock and tractor power : The availability of bullock power pair days was determined after deducting from the total available days used for other than crop production purposes. As in the case of human labour constraint, the bullock power constraint was also considered during the same two peak periods. But unlike in the case of human labour, hiring in bullock power as an activity has not been included in the matrix table because the practice is not in vogue in the State.

Similarly, the availability of tractor power in terms of hours was considered as a constraint during the same two peak periods. But unlike in the case of bullock power, tractor hiring which is a common practice in the State has been considered as an activity in the matrix table.

Irrigation : The irrigation facilities available on a farm have been expressed in terms of the number of hectares that can be irrigated in a week by drawing upon all the sources of irrigation within the reach of the holding. Irrigation constraint was considered for three periods, *viz.*, (*i*) September-October (period I) when water supply is needed for standing *kharif* crops like rice, maize, sugarcane and cotton, (*ii*) November-February (period II) when water is required for *rabi* crops like wheat, wheat-gram, sugarcane, and (*iii*) June (period III), the hottest and the driest pre-monsoon period when crops like sugarcane and cotton require watering after every short intervals.

Cash : Cash is needed to meet the day-to-day expenses on the farm. Besides, cash may be used by the farmer for consumption purposes as well, making it difficult to ascertain the cash availability exclusively for the purpose of crop production. To obviate this difficulty, the simple device of taking the actual cash expenditure made by the farmer for crop production purposes as being equivalent to the level of cash availability[22] for him, has been adopted.

Fertilizer : In view of the tight supply position[23] of this input, we have taken the actual use of fertilizer (in quantity) as being equivalent to its availability.

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22. For detailed discussion on cash availability, see L.N. Dahiya, "Impact of Cash Availability on Farm Income and Demand for Cash under Restricted and Unrestricted Fertilizers Conditions in the Farming Regions of the State of Haryana," *The Asian Economic Review*, Vol. 17, 1975.

23. See L.N. Dahiya, "A Note on Impact of Fertilizer Availability in the Farming Regions of the State of Haryana," *The Indian Journal of Economics*, January, 1975.

Resources like farm implements,[24] availability of HYV seeds, were not found exerting a restrictive influence on crop production. Likewise, transportation constraint in the Thunenian sense and family food supply,[25] the other possible constraint in land use planning, were not found to be of significant character in this developing economy and thus could easily be ignored.

RESULTS

EXISTING SITUATION

Land Use Pattern

Table I reveals that the land use pattern on the holdings is quite diversified and complex, involving several food and non-food crops which compete among themselves for space and other farm resources. In terms of the percentage of total cropped area under each crop, the selected crops can be arranged in a descending order of importance on these synthetic holdings, as follows: wheat, gram, bajra, rice, cotton, sugarcane, barley, wheat-gram mix, mustard and rape seeds, maize, groundnut and lentil. But the number of crops grown as well as the above order differs appreciably in various regions mainly due to the differences in agro-climatic conditions which make some regions more suitable for particular crops than others. The area brought under the HYVs[26] works out to be 15.6 per cent of the total cropped area on these holdings taken together. It would appear that the adoption rate is not uniform in all the regions, ranging as it does from 7.1 per cent of the total cropped area in region V to 32.4 per cent in region II. As among size-groups of holdings, the HYVs are adopted by all the sizes, but larger holdings have been, as indeed, one would expect them to be, relatively more active and quicker in adopting the new varieties of crops.[27]

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24. One may tend to think the crushing capacity of sugarcane as constraint at the farm level in terms of the available stock of crushers and accessories. But it was found ineffective since a large proportion of the sugarcane produce is sold to sugar factories leaving a little with the farmers where the available stock of machinery and equipment ensured its timely and efficient crushing.

25. Because of the consideration of the objective function (profit maximization) this consideration (to allocate a specific proportion of land for food crops to meet farm family food requirement) has to be relegated to a minor position and if the food availability on the farm falls, the farmer could not be handicapped by food scarcity, for he can always purchase food from outside. The production system in the State is no longer subsistence or need-based but geared towards the market, that is, the farmers (even small) view agriculture not as an impoverished way of life but as a profitable business occupation. In support of the above statement, see the author's Ph. D. thesis, p. 78.

26. High-yielding variety of seeds which appeared on the agriculture seene in 1965, are available for only five crops, *viz.*, wheat, rice, bajra, maize, and jowar.

27. *cf.* G.S. Bhalla: Changing Structure of Agriculture in Haryana (A Study of the Impact of Green Revolution), 1970; and L.N. Dahiya and A.K. Jain, "High-Yielding Variety Programme in Rohtak and Thanesar Blocks," Discussion Paper No. 31, Department of Economics, Kurukshetra University (Haryana).

TABLE I—LAND ALLOCATION PATTERN : PERCENTAGE OF CROPPED ACREAGE UNDER DIFFERENT CROPS IN DIFFERENT REGIONS UNDER EXISTING AND OPTIMUM SITUATIONS

Region	Resource situation	Wheat	Wheat +gram	Gram	Barley	Mustard and rape	Lentil	Bajra	Rice	Maize	Sugar-cane	Cotton	Gro-und-nut	Others*	Total
I	E.S.	21·0	12·0	12·0	0·0	0·0	3·0	0·0	9·5	11·0	8·0	0·0	4·0	19·5	100
	O.S.	16·6	17·9	0·7	0·0	0·0	7·0	0·0	0·0	17·9	12·2	0·0	8·8	18·9	
II	E.S.	40·0	0·0	9·5	3·0	2·5	0·0	4·0	21·0	3·0	5·0	0·0	0·0	12·0	100
	O.S.	36·5	0·0	8·6	3·8	0·0	0·0	11·1	13·9	8·5	6·6	0·0	0·0	11·0	
III	E.S.	33·0	0·0	18·6	0·0	0·0	0·0	13·4	3·3	0·0	8·0	3·8	0·0	19·9	100
	O.S.	35·7	0·0	14·5	0·0	0·0	0·0	17·0	4·8	0·0	0·0	11·2	0·0	16·8	
IV	E.S.	24·0	8·5	14·0	9·5	3·0	0·0	20·0	0·0	0·0	3·0	0·0	0·0	18·0	100
	O.S.	22·1	23·2	0·0	0·0	5·9	0·0	35·2	0·0	0·0	0·1	0·0	0·0	13·5	
V	E.S.	5·0	0·0	25·0	6·0	3·0	0·0	45·0	0·0	0·0	0·0	0·0	0·0	16·0	100
	O.S.	3·3	0·0	16·3	0·0	15·0	0·0	51·8	0·0	0·0	0·1	0·0	0·0	13·6	
VI	E.S.	17·0	0·0	23·0	2·5	2·3	0·0	25·3	0·0	0·0	3·5	11·0	0·0	15·4	100
	O.S.	20·2	0·0	21·8	0·0	5·8	0·0	29·5	0·0	0·0	0·0	15·1	0·0	7·6	
VII	E.S.	18·8	0·0	30·0	3·0	3·7	0·0	16·0	0·0	0·0	0·0	15·0	0·0	14·3	100
	O.S.	18·5	0·0	31·3	0·0	10·3	0·0	11·5	0·0	0·0	0·0	15·9	0·0	12·5	
Average	E.S.	22·6	2·9	18·9	3·4	2·4	0·4	17·7	4·8	2·0	3·9	4·3	0·6	16·1	100
	O.S.	21·7	5·9	13·3	0·5	5·3	1·0	22·2	2·7	2·8	2·7	6·0	1·3	13·6	

E. S. =Existing situation. O. S. = Optimum situation.

* 'Others' include fodder and minor crops, the latter covering less than 2 per cent of the total cropped area.

TABLE II (A AND B)—RESOURCE AVAILABILITY LEVELS AND THEIR UTILIZATION UNDER EXISTING AND OPTIMUM SITUATIONS ON PER AVERAGE HOLDING BASIS FOR DIFFERENT REGIONS

(A) Resource availability levels

Region	Land (hectares)	Permanent labour (man-days)		Bullock labour (pair days)		Tractor power (hours)		Irrigation (hectares)			Cash (Rs.)	Fertilizer (kg.)
		P. I	P. II	P. I	P. II	P. I	P. II	P. I	P. II	P. III		
I	8·0	139	139	74	74	41	41	3·3	4·6	1·9	4,152	618
II	8·3	147	147	81	81	65	65	13·0	21·0	3·4	5,954	956
III	7·4	153	153	59	59	50	50	4·0	9·3	2·5	3,348	262
IV	6·6	139	139	82	82	38	38	2·3	4·4	1·1	2,775	282
V	6·0	123	123	47	47	(—)	(—)	0·6	1·9	0·3	1,278	124
VI	8·2	146	146	53	53	35	35	4·6	7·7	2·0	3,036	286
VII	6·9	133	133	55	55	28	28	3·7	6·7	2·8	2,407	212
Average	7·4	140	140	65	65	37	37	4·5	7·9	2·0	3,279	391
S	3·1	108	108	40	40	(—)	(—)	2·6	3·8	1·0	1,116	128
M	6·6	136	136	61	61	(—)	(—)	3·6	6·9	1·9	2,896	352
L	12·5	176	176	94	94	37	37	7·3	12·8	3·1	6,024	694

(*Contd.*)

Notes: (*a*) Resource availability levels on the basis of per average holding has been reckoned by adding the resources on all size categories of holdings. *viz.*, small, medium and large in a region and dividing it by the number of holdings.
(*b*) (—)Indicates non-availability of the resource.
(*c*) P means period.
(*d*) S, M and L mean small, medium and large holdings respectively.

TABLE II (B)—*(Concld.)*

Region	Resource situation	(B) Resource utilization under existing and optimum situations *(per cent)*											
		Land	Permanent labour (man-days)		Bullock labour (pair days)		Tractor power (hours)		Irrigation (hectares)			Cash (Rs.)	Fertilizer (kg)
			P. I	P. II	P. I	P. II	P. I	P. II	P. I	P. II	P. III		
I	E.S.	74	76	89	59	77	48	53	68	70	35	100	100
	O.S.	79	83	92	63	91	68	63	72	65	75		
II	E.S.	75	87	87	62	82	66	80	66	80	48	100	100
	O.S.	84	97	100	73	89	68	86	56	82	68		
III	E.S.	74	79	80	58	94	81	86	80	83	59	100	100
	O.S.	83	97	92	78	83	100	94	90	83	83		
IV	E.S.	67	83	87	63	74	44	55	61	87	36	100	100
	O.S.	87	88	97	78	96	50	50	77	83	30		
V	E.S.	63	49	78	44	65	—	—	19	68	0	100	100
	O.S.	74	36	94	37	73	—	—	22	32	0		
VI	E.S.	71	69	91	64	78	40	45	80	64	79	100	100
	O.S.	80	83	97	83	89	40	50	94	75	91	88	
VII	E.S.	61	74	88	62	52	57	60	73	61	72	100	100
	O.S.	70	87	91	78	60	60	60	83	67	100		
Average	E.S.	69	74	86	59	75	48	54	64	73	47	100	100
	O.S.	80	82	95	70	83	55	58	71	70	64		
S	E.S.	72	63	75	54	70	—	—	63	75	50	100	100
	O.S.	82	68	84	59	73	—	—	86	78	68		
M	E.S.	70	76	88	62	80	—	—	60	75	49	100	100
	O.S.	81	86	100	68	87	—	—	69	70	70		
L	E.S.	64	83	95	60	74	48	54	67	70	42	100	100
	O.S.	75	92	100	84	90	55	58	57	61	55		

E.S.=Existing situation. O. S. = Optimum situation.

Notes: (*a*) P means period.

(*b*) S, M and L mean small, medium and large holdings respectively.

The figures for both resource availability levels and resource utilization levels have been given here in abridged form. For size-holdingwise details, see the author's Ph. D. thesis.

Resource Use Levels

Examining the position of resource use levels on the sample holdings, the data thrown up by the survey demonstrate that varous farm resources are not fully utilized (Table II (B)). For instance, of the total land available during both the seasons, *rabi* and *kharif*, nearly seven-tenth is utilized and the rest goes unutilized. As between *rabi* and *kharif* seasons, as much as 21 per cent and 40 per cent, respectively, of the land remains idle. Also, unutilization is relatively greater in the case of unirrigable land, due primarily to its lower remunerativeness. Among regions, utilization during the two seasons taken together is the highest (75 per cent) in region II and the lowest (61 per cent) in region VII. The highest utilization of land in region II may largely be attributed to adequate irrigation facilities accompanied by fairly good rainfall whereas the lowest utilization of land in region VII, among other factors, is also due to its taking up long duration crop such as cotton on a much larger scale leaving little chance for the next crop to grow during the same year. As among the size-groups of holdings, small holdings make relatively better use of this scarce resource than either the medium or the large holdings. As regards the intensity[28] of cropping, the overall average of the sample holdings works out to be 139 per cent. Among regions, it is the highest (151 per cent) in region II and the lowest (123 per cent) in region VII. The intensity seems to be more favourable (though not as a general rule) in the regions with high rainfall or assured irrigation or both. Inter-size comparison of holdings clearly exhibits the tendency for intensity of cropping to decline with the increase in holding size.

An examination of the utilization of permanent labour reveals that during the two peak periods, April-May and October-November, 26 per cent and nearly 14 per cent, respectively, of the available permanent labour stock exceeds the farm requirements at the existing level of technology. One may tend to consider this figure of 14 per cent as an index of the magnitude of withdrawable surplus in the agricultural sector of the State of Haryana, that is, the redundant labour can be removed from farming without any diminutive effect on agricultural production. However, this need not be the case when the agricultural sector turns from traditional to a technological dynamic form, a part of this labour may be absorbed within the sector itself.[29] Inter-size comparison in this regard reveals that small holdings, which in fact bear the brunt of unutilized labour stock, are the largest contributors to this pool of surplus labour. On the other hand, the surplus on several large holdings would be found to be conspicuous by its absence.

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28. Intensity of cropping $= \frac{\text{Total cropped area} \times 100.}{\text{Total cultivated area.}}$

It may be mentioned that sugarcane crop being an annual crop, the area under it has been considered as double cropped for arriving at the gross cropped area.

29. As we shall see below, the quantum of surplus labour is much less in optimum situation.

As regards the bullock power, the overall utilization figures work out to be a little less than three-fifths and three-fourths of its availability during two peak periods, respectively. The inter-size comparison reveals that the utilization is the maximum on medium holdings and the minimum on small ones. Large holdings, unlike in the case of permanent human labour, do not maintain this position. Tractor utilization (measured in terms of hours) as a percentage of availability works out to be 56 per cent and 63 per cent during the two peak periods respectively.

In the case of irrigation, it may be noted that the farmers do not make full use of irrigation facilities they have. On an average, 36 per cent, 27 per cent and 53 per cent of the irrigation potential remains unutilized[30] during the three periods respectively. The seasonal variations in utilization figures are, of course, due to the greater or lower watering requirements of the different types of crops grown in the different periods. Inter-size differentials in the matter of irrigation utilization would, however, not appear to be very wide in all the three relevant periods, though small-sized holdings have an edge over the other two size-groups of holdings.

As regards the utilization of cash and fertilizer, it is estimated that the overall cash is utilized to the tune of Rs. 3,279 per average holding (Rs. 443.10 per hectare) though variations around this average among regions and among size-groups of holdings are marked. As regards fertilizer, the dose for chemical fertilizers works out to be 391 kg. per average holding (52.8 kg. per hectare) which like cash differs from region to region, and understandably, from size-group to size-group.

Farm Incomes[31]

It may be derived from Table III that the average income on per hectare basis of the area held by all the holdings taken together under the existing situation is Rs. 1,120 but the dispersion around this average among regions and among size-groups is fairly wide. The order of difference in terms of per hectare income in the 'best' region (II) and the 'worst' region (V) is nearly three and half times. Such differences in income levels among regions are largely accounted for by the variations in farming followed, and by the Green Revolu-

30. The finding with respect to under-utilization of irrigation which is a scarce and costly input is quite surprising and alarming. Indeed, we face an apparently conflicting situation. The conflict arises because it seems there is large potential demand for irrigation though in fact the available irrigation water is not fully utilized. The under-utilization of water is caused by several factors, *viz.*, (*i*) improper field channels to carry water from canal, etc., to the fields; (*ii*) frequent break down of electricity making the electric operated tubewells inoperative; (*iii*) expensiveness of irrigation and lack of capital specially in the case of small farmers; and (*iv*) favouring dry or lightly irrigated crops in irrigation scarcity areas so that even the meagre irrigation availability is not fully utilized. For instance, it is customary in region V to grow gram and bajra crops which do not use water.

31. Our concept of farm income is equivalent to the concept of net farm returns (profits) as has already been explained.

tion which has been more favourable to some regions than it has been to others. As among different categories of holdings, it is significant enough to note that on per hectare basis income is inversely related to size, being Rs. 1,208 per hectare on small, Rs. 1,151 per hectare on medium and Rs. 1,081 per hectare on large holdings. This is largely because of the fact that land is more intensively utilized on small holdings resulting in greater productivity going on well wih lower per hectare cost (paid-out cost) of cultivation on them.

TABLE III—FARM INCOMES, INTENSITY OF CROPPING AND AREA UNDER HIGH-YIELDING VARIETIES UNDER EXISTING AND OPTIMUM SITUATIONS ON PER AVERAGE HOLDING BASIS IN DIFFERENT REGIONS

Region	Farm incomes (Rs.)			Intensity of croppping (per cent)		HVV (percentage of total cropped area)	
	Existing	Optimum		Existing	Optimum	Existing	Optimum
I	8,651	10,555	(21·7)	148	159	11·2	12·4
II	14,651	16,233	(12·3)	151	168	32·4	46·7
III	9,913	11,780	(21·5)	148	166	14·4	8·2
IV	6,199	8,457	(36·6)	134	174	17·3	18·1
V	3,070	4,279	(38·6)	127	150	7·1	39·5
VI	8,402	11,153	(37·4)	141	173	14.1	14·6
VII	7,118	8,785	(26·8)	123	141	12·3	4·3
Average	8,286	10,177	(24·4)	139	161	15·6	20·5
S	3,745	4,838	(29·2)	143	170	13·7	16·7
M	7,602	9,347	(23·2)	141	163	16·2	22·2
L	13,512	16,347	(21·0)	133	151	16·8	22·7

Notes : (*a*) Figures in brackets show the percentage increase in income levels over existing situation.
(*b*) S, M and L denote small, medium and large holdings respectively.

OPTIMUM SITUATION

Land Use Pattern

The optimum solution envisages significant changes in the land use pattern. It may be observed from Table I that for the entire sample a shift of acreage from gram and barley, economically the less paying crops, to cotton, groundnut, mustard and lentil, economically the more paying crops, would be a

movement towards an optimal allocation of land. Significantly enough, wheat, however, does not show any appreciable deviation in acreage under this situation, showing that the allocation of land under wheat, on the whole, is optimal. Regionwise, rice, a *kharif* crop, in region I, has been completely eliminated in favour of sugarcane. Groundnut, relatively a more profitable crop, has markedly enhanced its status in the land use planning, and its cultivation is, indeed, extended to its full land availability levels on all size-groups of holdings. In region II, sugarcane appears to be elbowing out rice. However, barley, in this region, despite its being relatively a less profitable crop, maintains its percentage share in the total cropped area. This is because of its low irrigation and fertilizer requirements and due to land specificity. In region III sugarcane is completely eliminated from the plan, yielding its area principally to rice, American cotton and wheat. And thus the solution shows that sugarcane, contrary to the belief commonly held by the farmers of this area, is not really income promoting. And if at all sugarcane is to continue in this region, where it is needed to feed the sugar factories located therein, either an adequate provision of irrigation facility must be made or adequate pressure must be brought to bear on the government to alter the price structure in favour of sugarcane so as to make it relatively more remunerative and competitive. However, wheat is found to be the favourite of the programming solution for this region, increasing almost to the full limit of land capability levels on both the irrigable and unirrigable components of land, on all synthetic holdings. In region IV, sugarcane experiences a distinct decline and figures only marginally in the programming solution. This decline may be attributed to its heavy requirements of cash and fertilizers. In region V, bajra and mustard show substantial increase. Barley does not appear to be congenial to the economic objective of maximization of profit, with the result that it is discontinued from the optimum plan. In region VI, the acreage under American cotton and wheat expands, the former at the expense of *desi* cotton and the latter at the cost of barley irrigated. In region VII, too, *desi* cotton seems to have lost ground to American cotton.

The area under HYV registers an increase to 20.5 per cent of the total cropped area under the optimum situation as against 15.6 per cent in the existing situation (Table III). And of the total area under the crops which have HYVs, the HYV segment constitutes about 49 per cent as against 35 per cent under the existing situation. Generally, the gains made by HYVs have been through the displacement of *desi* varieties of the same crops. Among regions, the acreage under HYV crops increases in all the regions except regions III and VII, where it declines. The fact that optimum solution suggests a decline in area under HYVs in these two regions clearly brings out that the HYV programme is based on a shaky foundation and cannot succeed unless backed sufficiently by the availability of complementary inputs, such as fertilizers, irrigation and cash, in adequate proportions. Thus, the HYV programme in these regions is irrational and unrealistic, implying that it carried no chance of success under present circumstances.

Resource Use Levels

Table II (B) shows that programming analysis has a significant positive effect on the resource use index. In the optimum plan, the extent of land utilization works out to be four-fifths of its availability against a little less than seven-tenths under the existing situation. In other words, the fallow area declines considerably under the optimum situation and consequently the overall intensity of cropping increases from 139 per cent in the existing situation to 161 per cent in the optimum situation. This increase is observed in all the regions and also on all size categories.

With respect to the utilization of permanent family labour, the overall utilization increases by 10 per cent over the existing situation in both the peak periods, due to the changed cropping pattern and intensive use of land, implying that most of the surplus labour in the existing situation was due to sub-optimal cropping patterns. The increase in labour utilization is noticed in all the regions, except in region V, which may partly be attributed to the elimination from the plan for this region, of barley which is input-heavy regarding human labour. As among different size categories of holdings, the surplus vanishes completely on the medium and large holdings in peak period II. However, a substantial surplus (16 per cent) continues to remain on the small holdings, suggesting the need for further intensification of land use by making available to small holdings the needed resources.

The utilization of bullock power, on an average, during each of the two peak periods increases under the optimum situation, the reason being the same as in the case of farm labour, that is, more intensive use of land. As between the different size categories, the maximum surplus again is on the small holdings. Thus, given the other constraints, the small holdings can, even if all the resources are put to their best uses, provide employment to bullocks only for about three-fifths of the available bullock power capacity. But on the other hand, on several large holdings, bullock labour turns out to be an effective constraint, the complementary availability of tractor power notwithstanding. This brings out clearly the need for accelerating labour-saving devices on these holdings.

The extent of utilization of the existing irrigation potential increases, though only slightly, during period I and period III, but declines during period II. Among size categories, small holdings continue to occupy the top position in this respect.

In the optimum plan cash and fertilizers are completely used up in all the regions and, obviously, on all size categories of holdings.

Farm Incomes

On juxtaposing this situation against the existing situation, it will be noted that the programming results in 24.4 per cent higher income for the synthetic

holdings as a whole. This amply demonstrates the favourable impact of optimum land and non-land resource allocation on the farm incomes. However, the optimum solution affects the different regions differently for reasons of inter-regional differentials in resource endowments and in socio-economic infrastructure. Thus, the maximum (38.6 per cent) improvement in income level is observed in the case of region V, which is on the lowest rung of the ladder in terms of agricultural resource endowments and income levels, and the minimum (12.3 per cent) in region II, which stands at the highest in these respects. A two-layered inference may be drawn from this: (1) that the regions with relatively worse resource endowments are also relatively the less efficient regions, *i.e.*, they have a relatively greater misallocation of farm resources, while regions with relatively better resource endowments are relatively the more efficient regions, *i.e.*, they have relatively less misallocation of resources; and following from the above, (2) that the former conceals relatively a greater potential for further improvement through a more judicious use of land and non-land farm resources than the latter.

Examined in terms of size categories, the increase in income level in the optimum situation over the existing level, subject to physical constraints and availability of inputs and knowledge, is the maximum (29.2 per cent) on the small, and the minimum (21 per cent) on the large holdings. This would seem to support the generally held notion that the small farmers may be the least efficient resource allocators in changing agriculture.

CONCLUSIONS AND POLICY IMPLICATIONS

(1) There is a divergence between the actually realized incomes on the farms and those which would have been realized if the given resources were allocated optimally. This proves the contention that there is always sub-optimal use of resources in a transitional agriculture. And, at any rate, the fact that Haryana has one of the highest rates of agricultural growth and spearheads the green revolution in the country should not be allowed to conceal the fact that the existing land use pattern in the State is anything but optimal.

(2) There exists regional imbalances in terms of the degree of agricultural development. Not only that, the regions with relatively weaker resource endowments are also relatively the less efficient in the sense that misallocation of resources is most acute in these regions. A meaningful strategy must lay relatively greater emphasis on improving the agricultural efficiency of the relatively lesser endowed and the most backward regions; otherwise, the disparity between the advanced and the backward regions would be accentuated in the face of rapid technological break-through in the State's agriculture.

(3) In view of the finding that the small farmers are not only inadequately provided with modern inputs, like cash and fertilizer, but are also the least efficient allocator of resources, State agencies, like the Small Farmers

Development Agency (SFDA) should go in for two-pronged action, *viz.*, (*i*) strengthening the revenue position of the small farmers; and (*ii*) helping them in rationally allocating their resources.

(4) In view of the fact that the factors responsible for keeping the land and other farm resources at sub-optimal level are found in an intertwined set of forces which vary from region to region, yet apart from the physical constraints, the farmers' managerial inefficiency and incapability to appraise adequately the more suitable combination and rotation of crops combined with the shortage of cash, fertilizer and irrigation, appear to be the factors responsible for the phenomenon.

(5) A very neat and effective solution for the twin problems of surplus of non-land fixed resources (like family labour, and animal labour) on the small, and of their paucity on the large holdings would be to impose a ceiling on the large holdings and to transfer the resulting surplus of land to the small holdings, for this would improve the factor proportion on both and thus help them perform better.