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bears out that there was no significant differences between the average input applications of large and small farmers.

To sum up, the analysis shows that the crucial factor determining the distribution of net profits was the pattern of land ownership. The fact that there were not significant differences in the pattern of input expenditure from that of land ownership follows from the fact that there were no serious constraints on input availability and use which could distort the distribution pattern of net profits.

Summary and Conclusion

The foregoing analysis clearly shows that the gains from the HYVP were not enjoyed by large farmers alone, but by farmers of all size-groups. In both the seasons the land ownership pattern determined the pattern of net profit distributions and was the cause if substantial inequity. Swenson[11] came to more or less the same conclusion when discussing about the distribution of benefits from increased rice production in Thanjavur district, Tamil Nadu. These findings bring out the importance of institutional reforms in such situations. Further, our analysis did show that with access to inputs available to all farmers, the inequality due to land ownership pattern need not be worsened and can be improved, only fractionally. Thus, to a greater extent, the distribution of benefits depends on the distribution of land ownership pattern. This suggests that the Government has to rely heavily on policy measures in relation to land reforms particularly which are conditional on the proper functioning of other factors such as easy and equal access to inputs and extensions, to improve income distribution among farmers. Thus, the distribution of benefits from the HYVP is indeed a problem of policy options on the part of Government. However, these policy measures in 'unsuccessful' HYV areas may not be as successful as in 'successful' HYV areas. So, as Dantwala argued, a reasonable approach is for the Government to bring about agricultural growth with social justice by giving priority to infrastructure investment and scientific research in areas with deficient endowments and to institutional reform in technologically advanced areas.[12]

K. KALIRAJAN*

PROSPECTS OF INCREASING FARM INCOMES ON SMALL FARMS OF AMBALA DISTRICT (HARYANA)

In Haryana, about 46 per cent of the total operational holdings are below five acres, accounting for only 4.79 per cent of the total cultivated area. The number of small farmers has increased manifold over the years with the imposi-

11. C. G. Swenson, "The Distribution of Benefits from Increased Rice Production in Thanjavur District, South India", *Indian Journal of Agricultural Economics*, Vol. XXXI, No. 1, January-March 1976, pp. 1-12.

12. M. L. Dantwala, "Future of Institutional Reform and Technological Change in Indian Agricultural Development", *Economic and Political Weekly*, Vol. XIII, Nos. 31, 32 and 33, August 1978, pp. 1299-1306.

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tion of legal ceiling on the ownership of land holding and sub-division of larger holdings due to break up of traditional joint families. It has been emphasized that under the existing farming practices in India, holdings less than five acres are uneconomic since they do not provide adequate employment to the available family labour, bullock labour and generate surpluses over and above farm family requirements. In this context, efficient resource reallocation on small farms can convert these uneconomic holdings into economic ones. Hence, the present study in Haryana State has been undertaken with a view to examining the prospects of increasing the income of small farmers by finding out an optimum cropping pattern at varying capital levels both at existing and improved levels of technology.

METHODOLOGY

Sampling Design and Collection of Data

Ambala district of Haryana State was purposively selected to represent a case study. However, this particular district was selected because of the predominance of small farmers and the operation of the Small Farmers' Development Agency (SFDA) which has been set up in the district for their unliftment. In order to select the ultimate unit of the sample, *i.e.*, farmers, multi-stage random sampling technique was adopted. Barara block was randomly selected amongst the blocks where both the predominance of small farmers and concentration of loans were higher. Amongst 126 villages in the Barara block, four villages representing three per cent of the total villages were randomly selected. In view of the small number of beneficiaries of the SFDA scheme in each village, it was decided to include all the beneficiaries in the sample. Amongst the total number of non-beneficiaries in each village, ten per cent of them was randomly selected to represent the sample. In all, 71 non-beneficiaries and 22 beneficiaries were selected to represent the sample. Cross-section data from these selected farmers were collected for the year 1976-77.

Analytical Technique

Linear Programming technique has been used to develop the following four optimum farm plans:

(*a*) Farm Plan I: It maximizes the farm business income of a typical small farm with existing resources and existing technology. This serves to indicate whether managerial efficiency alone could make improvements in the farmer's income, consequently making a non-viable small farmer as a viable one.

(*b*) Farm Plan II: It maximizes the farm business income of a typical small farm with existing resources but with the improved technology.* This serves to indicate whether managerial efficiency with the improved technology could make a non-viable small farmer as a viable farmer.

(*c*) Farm Plan III: It maximizes the farm business income of a typical small farm with the existing technology by relaxing the capital constraint. This indicates whether a small farmer could become viable even without modern technology, provided enough capital was available.

(*d*) Farm Plan IV: It maximizes the farm business income of a typical small farm with the improved technology and relaxed capital constraint. This serves to indicate what was the potential optimum performance even with a small land base.

The programming model of the following form was used to maximize the farm business income of a typical small farm.

$$\text{Max. } Z = \sum_{j=1}^{n} C_j X_j$$

Subject to

$$\sum_{j=1}^{n} a_{ij} x_j \leq b_i \text{ (Maximum)}$$

$$\sum_{j=1}^{n} a_{ij} x_j \geqslant b_i \text{ (Minimum)} \qquad (i = 1, 2, \ldots\ldots\ldots\ldots n)$$

$$b_i \geqslant 0 \quad x_j \geqslant 0 \quad a_{ij} \geqslant 0$$

where

C = returns over variable cost,

a_{ij} = technical input-output coefficients,

x_j = real activities, and

b_i = resource levels.

The details of the various types of restrictions used in the present study are as follows:

(*i*) *Working capital*:— Capital is one of the most important restricting resources on small farms. A constraint was introduced for capital implying the practical limit of capital restriction under which the farms were operated. The estimated cash expenditure in the period was taken up as a figure for available capital. In farm plans III and IV, capital restriction was relaxed by introducing different levels of capital in the plans.

(*ii*) *Land*:— The operational size of holding in the reference period was considered as land restriction. Further, land restriction was divided into two categories, *viz*., (*a*) irrigated land and (*b*) unirrigated land.

(*iii*) *Irrigation*:— Irrigation as a restriction was calculated in acre-inch for two peak periods. Farmers were asked to supply information on how many maximum hours of irrigation they would have used from owned or purchased sources

* Improved technology means the Package of Practices for different crops recommended by the Scientists of the Haryana Agricultural University, Hissar suitably adjusted for the region.

of irrigation during two peak periods. These two peak periods were from 20th to 30th July and from 1st to 10th October. The first peak period relates to the time just following the sowing of *kharif* crops while the second relates to the period when *kharif* crops are standing in the fields and for providing pre-sowing irrigation to *rabi* crops. The maximum irrigation water available during these peak periods was considered as irrigation constraint. The calculation of acre-inch from the collected data was made from the table "Catalogue of Pumps" available from Agricultural Engineering Department, Haryana Agricultural University, Hissar.

(*iv*) *Minimum food restriction*:— This constraint imposed the condition that in any chosen allocation, certain amount of minimum quantity of food (rice and wheat) would be met by a food crop combination. This constraint ensured the small farmers against market fluctuations, implying that the small farmers would at least produce some portion of their food requirements themselves. To include a minimum restriction of food equal to the desired quantity, a corresponding artificial activity was defined and it was priced minus m. In this case the level of the activities multiplied by their food yield coefficient must be equal to or greater than the minimum requirement.

(*v*) *Minimum fodder restriction*:— This restriction too imposed the condition that in any chosen allocation, certain minimum quantity of fodder would be met by a fodder crop combination. This constraint ensured that by meeting this minimum requirement a small farmer would be at least able to keep one cow and one buffalo. This restriction was divided into two categories: (*a*) minimum *kharif* fodder and (*b*) minimum *rabi* fodder. To include a minimum restriction of fodder equal to the desired quantity, a corresponding artificial activity was defined and it was priced minus m. In this case the level of the activities multiplied by their fodder yield coefficient must be equal to or greater than the minimum requirement.

Bullock labour and human labour were sufficiently available with the small farmers and these, therefore, have not been included as resource restrictions.

RESULTS AND DISCUSSION

The prospects of increasing net incomes on small farms through efficient resource reallocation using systematic farm planning approach have been examined by various synthetic situations.

(*i*) *Farm Plans I and II: Efficient Resource Reallocation with Existing Resources, Existing and Improved Levels of Technology*

Table I shows the existing and optimal plans I and II with existing resources, existing and improved levels of technology. It is evident from the table that net returns increased from Rs. 8,159.54 to Rs. 10,013.30 and to Rs. 10,777.12 in the optimal plans I and II respectively, representing an increase of 22.72 per cent and nearly 32.08 per cent over the existing plan and an increase of 7.63 per cent in the case of optimum plan II over the optimal plan I.

In the cropping pattern, an allocation specifying the minimum quantity of food crops, *i.e.*, 2 quintals of rice and 8 quintals of wheat was imposed. Similarly, an allocation specifying the minimum quantity of fodder, *i.e.*, 52 quintals of *kharif* fodder and 68 quintals of *rabi* fodder was imposed. In the optimal plan I, the levels of cash crops such as sugarcane and paddy increased from their existing levels while the area under wheat crop was to the extent of the imposed minimum restriction. One unit of both cow and buffalo in the existing situation was replaced by two units of buffaloes in the optimal plan I. The increased levels of cash crops as well as buffalo units in the optimal plan I have increased the net returns which ultimately affect the viability of the small farmers. Similarly, there also existed a shift in the levels of cash crops such as sugarcane and paddy in the optimal farm plan II over the existing plan, while the area under the wheat crop was at the level of imposed restriction. In optimum plan II, the area under sugarcane was more as compared to the optimum plan I while dairy activity did not enter into the optimum plan II. In this case the crop enterprise such as sugarcane was more profitable as compared to the dairy enterprise with the existing resource base. Besides this, the dairy enterprise has not entered into the optimal plan II which might be due to the scarcity of capital especially when improved technology has been adopted. It was economically profitable to adopt the improved technology under the existing resource base as evidenced by an increase in the net returns by Rs. 763.82 over the existing plan. In general, there was significant scope for increasing the farm income. Through a rationalised use of capital and correct choice of cropping pattern, the income could be substantially increased above the existing level on the small farms both under the existing and improved levels of technology.

(ii) Farm Plan III: Efficient Resource Reallocation with Existing Technology and Relaxed Capital Constraint

The results obtained from the analysis of the data with the existing technology but relaxed capital constraint are presented in Table II. The table summarises the five optimum plans with the various capital levels. The initial plan requires zero capital and generates zero income which clearly indicates that a minimum capital is essential for generating income. This plan has been designated as a trivial plan. It is evident from the table that with the existing technology the additional capital requirement is Rs. 890.20 which generates an additional income of Rs. 3,114.55 over the existing plan. Besides this, there is an increase in the net incomes by Rs. 1,260.79 and Rs. 496.97 over the optimal plans I and II respectively. This reveals that even with the existing technology there is scope for increasing the farm income provided additional resources are made available.

Thus Table II gives us all the critical plans at which the investment opportunity changes as the supply of capital increases from zero to Rs. 4,385.20. It is also observed from the table that after each change in the investment opportunity, the upward slope of the income curve decreases. The slope of this line indi-

TABLE I—EXISTING AND OPTIMAL PLANS WITH EXISTING RESOURCES, EXISTING AND IMPROVED LEVELS OF TECHNOLOGY

Plan	Area (acres)													Cows	Buffa-loes	Net returns
	Paddy	Sugar-cane	Jowar fodder	Maize grain	Maize fodder	Wheat	Oats	Ber-seem	Potato	Gram	Jowar grain	Sarson	*Toria*			
	(P_1)	(P_2)	(P_3)	(P_4)	(P_5)	(P_6)	(P_7)	(P_8)	(P_9)	(P_{10})	(P_{11})	(P_{12})	(P_{13})	(P_{14})	(P_{15})	(Rs.)
I. Existing	1.00	0.45	0.72	0.44	0.40	1.05	0.10	0.55	0.30	0.50	1.00	0.50	0.12	1.00	1.00	8.159.54
II. Optimum																
(*a*) Plan I	1.71	1.77	0.58	—	—	0.61	—	0.68	—	—	1.26	1.26	—	—	2.00	10,013.30
(*b*) Plan II	0.75	1.99	0.27	—	—	0.38	0.64	—	—	—	1.26	1.26	—	—	—	10,777.12

TABLE II—OPTIMAL PLAN III WITH EXISTING TECHNOLOGY AND DIFFERENT LEVELS OF CAPITAL

Plan	Capital needed	Area (acres)											Cows	Buffaloes	Net income
		Paddy	Sugar-cane	Jowar fodder	Maize grain	Maize fodder	Wheat	Oats	Berseem	Jowar grain	Sarson	*Toria*			
		(P_1)	(P_2)	(P_3)	(P_4)	(P_5)	(P_6)	(P_7)	(P_8)	(P_{11})	(P_{12})	(P_{13})	(P_{14})	(P_{15})	
I.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
II.	1,398.0	0.83	0	0	1.78	0	0.62	0	0.68	0.80	0	0	0	0	3,432.20
III.	2,796.0	0.78	1.93	0.30	0	0	0.62	0	0.47	1.26	1.26	0	0	0.63	8,627.02
IV.	3,145.5	0.83	1.78	0.40	0	0	0.62	0.11	0.41	1.26	1.26	0	0.49	1.00	9,258.34
V.	3,495.0	0.71	1.76	0.52	0	0	0.62	0	0.62	1.26	1.26	0	0	1.78	10,013.30
VI.	4,385.2	0.66	1.85	0.12	0	0.46	0.62	0	0.74	1.26	0	1.26	1	2	11,274.09

cates the change in income due to the per unit change in investment. It corresponds to the marginal productivity of capital, the declining slope indicates declining marginal productivity of capital. The marginal productivity of capital in the last plan is 1.62.

(iii) Farm Plan IV: Efficient Resource Reallocation with Improved Technology and Relaxed Capital Constraint

Table III summarises the optimal plan IV with the various levels of capital and improved technology. It is evident from the table that the optimal plan with the improved technology requires working capital of Rs. 6,291.00 as against Rs. 4,385.20 with the existing technology. The net returns with the improved technology were Rs. 14,366.12 as compared to Rs. 11,274.09 in the optimal plan III with the existing technology. Besides this, the net returns in optimal plan IV has increased by Rs. 3,589.09 as compared to the optimal plan II which clearly shows that there exists scope for increasing the income provided additional capital is made available on the small farms. The level of income in the optimal plan IV ranges between zero and Rs. 14,366.21 with the range in capital between zero and Rs. 6,291. It clearly indicates that improved technology absorbs the additional capital over the existing plan by Rs. 2,796 which provides an additional income of Rs. 6206.67. Thus, with the introduction of improved technology and the additional borrowings, the income of the small farmers can be increased substantially.

Table III gives us all the critical plans at which the investment opportunity changes as the capital supply increases from zero to Rs. 6,291. It is also observed from the table that after each change in the investment opportunity, the upward slope of this curve decreases. The slope of this line indicates the change in income with the per unit change in investment, *i.e.*, marginal productivity of capital. The marginal productivity of capital has increased with the introduction of improved technology (1.84) as compared with the existing technology (1.62).

(iv) Marginal Value Productivities of Resources

The development of optimum plans in all the situations provided marginal value productivities (MVPs) of resources which were used as constraints in the programming matrices. The comparison of MVPs of resources with their factor costs would provide useful information for making proper resource adjustments and decisions. The marginal value productivity of a resource would indicate the direction in which rational adjustment should take place. Table IV shows the MPVs of different resources in various optimum plans. It is evident from the table that on the whole the MVPs of the existing resources have increased with the adoption of modern technology. The higher MVP of working capital under the improved technology (plan II) indicates that the marginal unit of the existing resource can generate greater incomes with the adoption of improved technology. The MVPs of working capital were zero in the optimum plans III and

TABLE III—OPTIMAL PLAN IV WITH IMPROVED TECHNOLOGY AND DIFFERENT LEVELS OF CAPITAL

Plan	Capital needed (Rs.)	Area (acres)									Cows	Buffaloes	Net income (Rs.)
		Paddy (P_1)	Sugarcane (P_2)	Jowar (P_3)	Wheat (P_6)	Oats (P_7)	Berseem (P_8)	Potato (P_9)	Jowar grain (P_{11})	Sarson (P_{12})	(P_{14})	(P_{15})	
I.	0	0	0	0	0	0	0	0	0	0	0	0	0
II.	2,796.00	1.10	1.04	0	0.38	0	0.66	0	0.90	0	0	0	8,930.71
III.	3,145.50	0.79	1.87	0	0.38	0	0.48	0	0.90	0	0	0	9,830.71
IV.	3,495.00	0.75	1.98	0.26	0.38	0.64	0	0	1.26	1.26	0	0	10,777.12
V.	3,844.00	0.66	2.23	0.11	0.38	0	0.39	0	1.26	1.26	0	0.10	11,204.55
VI.	4,194.00	0.66	2.23	0.11	0.38	0	0.39	0	1.26	1.26	0	0.66	11,909.19
VII.	4,893.00	0.75	1.91	0.27	0.57	0	0.45	0	1.26	1.26	0.77	1	13,124.75
VIII.	6,291.00	1.50	0	1.51	2.05	0	0.82	0.57	1.26	1.26	1	2	14,366.21

IV. In both these cases the working capital was assumed to be a variable resource, therefore, its MVP at every stage was zero. As expected, the MVP of irrigated land was higher as compared to the unirrigated land. Further the MVP at improved levels of technology was higher as compared to the MVP at the existing levels of technology. Among all the situations, the MVP of irrigated land with the improved technology was the highest. The MVP of per acre-inch of irrigation water was zero for peak periods I and II in the optimum plans I and II respectively. But the MVP of this resource in both the periods was zero in the optimum plans III and IV. The reason being that on an average farmers were able to fulfil their irrigation requirements completely during these periods. The MVP per quintal of rice was zero in all the plans indicating that the minimum quantity of rice was met. But the minimum quantity of wheat was met only in the optimum plan III. Similarly, the MVP per quintal of *kharif* fodder was zero in all the optimum plans indicating that the minimum requirement of *kharif* fodder has been adequately met. However, the minimum requirement of *rabi* fodder was not met in any plan.

TABLE IV—MARGINAL VALUE PRODUCTIVITIES OF RESOURCES IN DIFFERENT OPTIMUM PLANS

Sr. No.	Resources	Marginal value productivities (Rs.)			
		Optimum plan I	Optimum plan II	Optimum plan III	Optimum plan IV
1.	Capital	1.85	1.95	0	0
2.	Land				
	(*i*) *Kharif* irrigated land	226.75	433.26	670.20	1,000.00
	(*ii*) *Kharif* unirrigated land	174.61	280.53	361.00	475.00
	(*iii*) *Rabi* irrigated land	692.08	724.65	1,062.18	1.973.00
	(*iv*) *Rabi* unirrigated land	162.56	301.94	360.00	702.00
3.	Irrigation acre-inch)				
	(*i*) Irrigation (20th-30th July)	0	35.53	0	0
	(*ii*) Irrigation (1st to 10th Oct.)	44.45	0	0	0
4.	Food				
	(*i*) Minimum quantity of rice	0	0	0	0
	(*ii*) Minimum quantity of wheat	33.87	2.62	0	6.86
5.	Fodder				
	(*i*) Minimum *kharif* fodder	0	0	0	0
	(*ii*) Minimum *rabi* fodder	5.43	3.64	6.28	2.29

Note:— 0 implies surplus.

The MVPs in the final iteration serve as a guideline for hiring and purchasing of farm resources. All zero MVP values of the resources indicate that these resources are surplus in supply. Positive MVPs indicate that the resources can be hired or purchased, but should not cost more than the MVPs of the respective resource.

CONCLUSIONS AND POLICY IMPLICATIONS

The above analyses indicated that systematic farm planning is a paying proposition under the existing technology and with the existing resource base on the small farms. There exists the possibility of increasing the net returns with the adoption of modern technology even under the existing resource constraints. With the additional capital borrowing the net returns increase even under the existing technology. The adoption of modern technology along with additional capital borrowings increased net incomes to a considerable extent. Hence, credit and improved technology are the major operative bottlenecks on the small farms.

The policy implications of the above findings are that the extension agencies involved in the region have to play an active role in providing the necessary input supplies and in preparing the farm plans. In order to convert the uneconomic holdings into economic ones, not only credit facilities should be extended to them but also the adoption of improved technology must be encouraged. Besides this, the various credit institutions located in the region have also to play a major role in meeting the capital requirements of small farmers adequately.

U. K. PANDEY AND A. K. KAUSHAL*

A MATHEMATICAL MODEL FOR THE PRICE ELASTICITY OF MARKETED SURPLUS OF A FOOD CROP: A COMMENT

The analysis contained in section II of Pushpangadan's article[1] is incomplete and is based on certain implicit assumptions which are not clearly spelt out therein. The author has derived the relationship among the price elasticities of total marketed surplus and its constituents, commercial and distress surplus as:

$$e = m_1 e_L + m_2 e_D \qquad \ldots\ldots (1)$$

where e : the price elasticity of total surplus,

e_L : the price elasticity of commercial surplus,

e_D : the price elasticity of distress surplus,

m_1 : the ratio of commercial surplus to total surplus,

m_2 : the ratio of distress surplus to total surplus.

m_1 and m_2 are by hypothesis positive.

The author implicitly assumes $e_D > 0$ and then derives the condition for $e < 0$ as:

$$e_L/e_D + m_2/m_1 < 0 \qquad \ldots\ldots(2),$$

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1. K. Pushpangadan, "A Mathematical Model for the Price Elasticity of Marketed Surplus of a Food Crop", *Indian Journal of Agricultural Economics*, Vol. XXXIV, No. 2, April-June 1979.