Vol XXX
No. 3

ISSN 0019-5014

CONFERENCE
NUMBER

JULY-
SEPTEMBER
1975

INDIAN JOURNAL OF AGRICULTURAL ECONOMICS

INDIAN SOCIETY OF
AGRICULTURAL ECONOMICS,
BOMBAY

CAN SMALL-SCALE FARMING YIELD MORE INCOME

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With the introduction of high-yielding varieties, the possibilities for the farmers to improve farm productivity and income, has increased. Further, the continuously rising prices of farm products during the last few years have offered incentives to the farmers for increasing their farm production through the use of scientific methods of cultivation. The increase in farm productivity involves a manifold increase in capital requirements due to increased use of modern farm inputs. The farmers' owned resources are meagre and inadequate for adopting the improved agricultural farm practices and other innovations. The problem is more serious in the case of small-scale farms. It is, therefore, essential to study the production posssibilities with varying levels of capital input on the small-scale farms. The specific objectives of the study were : (*i*) to study the criteria for identifying the small farms. (*ii*) to find out optimum cropping pattern for the small farms under varying capital requirements with the existing and improved levels of technology, (*iii*) to study the prospects for increasing the income on the small farms with the existing and improved technology, and (*iv*) to study the marginal productivity of the factors of production.

METHODOLOGY

Definition of Small Farms

In identifying the small farms, the following criteria are mainly used :

1. *Size of holding :* The small farm is defined by the size of the operational holdings. This is the simplest and most commonly used criterion.

2. *Income :* This criterion recognizes that the size of holding is not the same for all the regions, *i.e.*, irrigated and unirrigated, plain and hilly regions, etc. Therefore, the small-scale farm is explained in terms of income generated from the farm.

3. *Organization of the farm :* A number of dimensions are used for farm classification, *e.g.*, the ratio of family labour to hired labour, the ratio of owned capital to borrowed capital, decision-making, etc.

4. *Degree of integration :* The criterion seeks to measure the extent of integration and interdependence of the farm with its environments such as the amount of production sold compared with the portion withheld for internal consumption.

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However, no single criterion was found adequately suitable for identifying the small farms. In the workshop on the marketing problems of small farmers held at the Michigan State University, the following definition for the farms was suggested : "Small farm agriculture comprises those farms where (*i*) the bulk of the labour force, management and capital come from the same household; (*ii*) production is either consumed on the farm and/or traded in local markets; (*iii*) the decision-making process is hampered by limited access to marketing and political institutions; and (*iv*) the farmers do not live much above culturally determined subsistence levels."[1]

In this study, this definition was used with some modifications with respect to capital availability and ignoring condition number three.

Data

Gurgaon district in Haryana was purposively selected because in this district, the number of small farms was more than in others and the SFDA (Small Farmers Development Agency) was operating. Gurgaon block was again purposively selected because the SFDA operations were intensive in this block. Two villages from the Gurgaon block were randomly selected for this study. A list of the small farms (based on the above criterion) of the selected villages was prepared and 35 per cent of the small farms from these villages were selected with probability proportional to the size of the farm by Lahiri's[2] method. From both the villages 49 farmers were selected for data collection.

Each of the selected farmers was interviewed and the data regarding farm inventory, cropping pattern, existing resources, financial situation, input-output relationships of different crops, prices received and paid by the farmers were collected for the agricultural year 1973-74. The data regarding improved technology were obtained from the package of practices prepared by the Directorate of Extension Education, Haryana Agricultural University. These recommendations were marginally modified in consultation with the District Extension Specialist (Farm Management). A synthetic farm situation was developed by pooling and averaging the data on existing resource use pattern and cropping pattern. This synthetic farm situation was considered as the representative farm for the block.

Mathematical Model

Variable capital programming technique was used for developing optimum farm plans at the existing and improved levels of technology. The predetermined data include the technical input-output coefficient

1. K. Harrison and Keneth Shwedel, "Marketing Problems Associated with Small Farm Agriculture," Report on an ADC/RTN Seminar held at Michigan State University, June 7-8, 1974, No. 5, November, 1974.
2. M. N. Murthy: Sampling Theory and Methods, Statistical Publishing Society, Calcutta, 1967, p. 202.

a_{ij}'s, return over variable cost c_j, real activities x_j and resource level b_i. The problem is to determine such that

$$Z = \sum_{j=1}^{n} C_j x_j \quad \text{(Maximum).}$$

Subject to

$$\sum_{j=1}^{n} a_{ij}x_j = \text{variable capital,}$$

$$\sum_{j=1}^{n} a_{ij}x_j = \text{irrigated land,}$$

$$\sum_{j=1}^{n} a_{ij}x_j \leqslant \text{unirrigated land,}$$

$$\sum_{j=1}^{n} a_{ij}x_j \leqslant \text{irrigation from January 15 to February 15 in acre-inch,}$$

$$\sum_{j=1}^{n} a_{ij}x_j \leqslant \text{irrigation from June 15 to July 15 in acre-inch,}$$

$$\sum_{j=1}^{n} a_{ij}x_j \leqslant \text{irrigation from October 15 to November 15 in acre-inch,}$$

$$\sum_{j=1}^{n} a_{ij}x_j \geqslant \text{minimum green fodder,}$$

$$\sum_{j=1}^{n} a_{ij}x_j \geqslant \text{minimum wheat } \textit{bhusa.}$$

$$x_j \geqslant 0, \quad a_{ij} \geqslant 0.$$

Since the availability of family labour was quite adequate on the small farms, labour restriction was not included in the model.

Economic Framework of the Problem

Figure 1 illustrates how a farmer whose main objective is to maximize profit could decide about the amount of capital use. Suppose capital is an input to be used in a production system. Axis-X indicates the capital used, and the Y-axis represents the marginal value products and cost of money spent, MVP X_1 curve represents the marginal value products of capital at the existing technology. If the cost of money, including interest rate, is at the level C_0 and he has unconstrained access to credit to borrow the

input (capital), the producer would maximize his return above the cost, if capital is used at level XE_1. At this level of input use, the returns above variable cost are represented by the area enclosed by C_0AE_1 ($OAE_1\ XE_1$-$OC_0\ E_1XE_1$). Such a view of optimization is not sufficient, however, if access to capital is restrained due to limited availability of credit so that he is able to spend capital upto XR. The effect of this is reduction in net earnings to the amount represented by the area enclosed $F_1\ F_2\ E_1$.

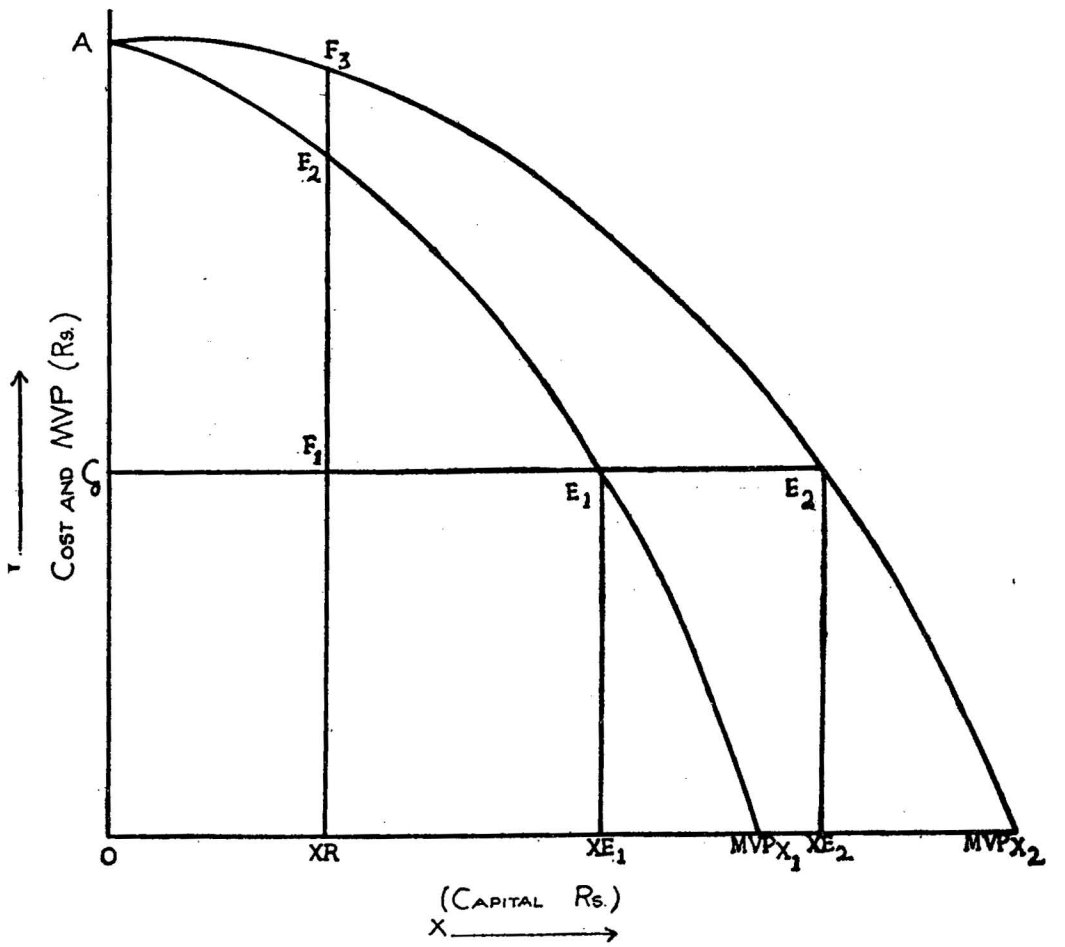

Figure 1 – Diagram Showing the Effect of Change in Capital Use at Existing and Improved Technology

Because of the introduction of new technology, the MVP curve would shift towards right (MVP X_2). If the per unit cost of the money remain unchanged and he has unconstrained access to credit to buy this input, the producer would maximize his return above the cost by borrowing the money

upto XE_2. The effect of this is an increase in the net earnings to the amount represented by the area enclosed by $E_1 AE_2$. If access to the capital is restrained at a previous level XR because of credit facilities not expanding at all after technological change, the net income of the farmer would increase only by the amount represented by the area enclosed by $F_2 AF_3$.

RESULTS AND DISCUSSION

Capital variable programming was used to have the continuous solution of capital required at the existing and improved levels of technology.

Optimum Farm Plans with Existing Technology

The results obtained by the programming are given in Table I. First plan represents the trivial "Optimum" plan where the farmers have zero capital and produce zero income.

TABLE I—OPTIMUM FARM PLAN WITH EXISTING TECHNOLOGY AT DIFFERENT LEVELS OF CAPITAL

Plan	Capital needed (Rs.)	Area (acres)					Net income (Rs.)
		Hybrid bajra-wheat	*Guara*-barley	Jowar(F)-berseem	Fallow-wheat	Buffalo (number)	
		(P_1)	(P_3)	(P_4)	(P_5)	(P_3)	
1.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2.	64.12	0.00	0.00	0.225	0.00	0.00	117.00
3.	380.12	0.00	0.00	0.225	2.00	0.00	571.00
4.	476.90	0.00	1.315	0.225	0.90	0.00	834.15
5.	598.73	1.375	0.00	0.165	0.62	0.00	1,123.04
6.	1,462.08	1.140	0.00	0.400	2.86	0.99	2,585.50

It is apparent from the above table that the working capital requirement for the optimum farm plans at the existing levels of technology was Rs. 1,462.08, generating an income of Rs. 2,585.50. Crop rotations included in the plan were hybrid bajra-wheat, *guara*-barley, jowar (fodder)-berseem, fallow-wheat (unirrigated) and one buffalo, whereas the irrigated crop rotations hybrid bajra-gram, *guara*-barley and the unirrigated crop rotations fallow-mustard, jowar (fodder)-gram and bajra-fallow could not enter the plan.

Figure 2 is a graphical representation of the data in Table I. The X-axis refers to the amount of capital required while the Y-axis shows the marginal productivity of capital, the total income and level of real activities cor-

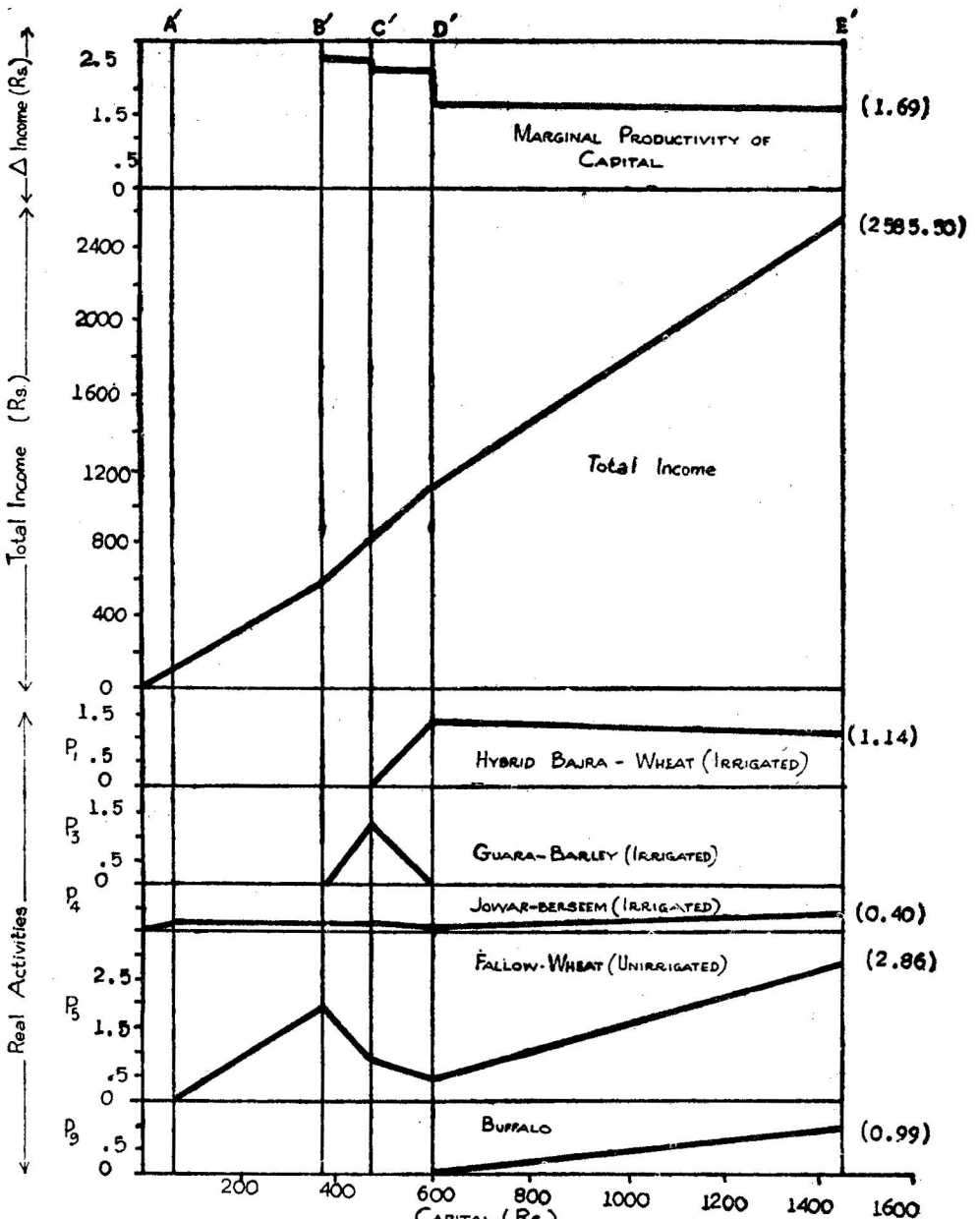

FIGURE 2- GRAPHIC REPRESENTATION OF TABLE I

responding to Re. 0.00, Rs. 64.12, Rs. 380.12, Rs. 476.90, Rs. 598.73 and Rs. 1,462.08. The income and level of real activities corresponding to Rs. 64.12 of capital shown by the line AA' was Rs. 117.00 and the level of P_4 (jowar (fodder)-berseem) was 0.225 acre. Similarly, the lines BB', CC', DD', and EE' correspond to the appropriate plans for Rs. 380.12, Rs. 476.90,

Rs. 598.73 and Rs. 1,462.08 of capital, respectively. The income was Rs. 571, Rs. 834.15, Rs. 1,123.04 and Rs. 2,585.50, respectively. The straight lines drawn between the points corresponding to the successive plans of continuous solution provide the optimum programmes for intermediate capital levels, at which the optimum combination of activities happened to change. Having inserted the appropriate lines in the figure, there is no difficulty in finding the optimum plan for any level of capital supply.

Figure 2 also enables us to follow easily the successive steps of the continuous solution. At the initial level when the capital requirement was zero, the level of real activities and income was also zero. The first Rs. 64.12 of capital permits 0.225 acre of jowar (fodder)-berseem to be produced, to meet the minimum restriction of green fodder. Another minimum requirement of *bhusa* was also fulfilled with the introduction of 2 acres of wheat, the capital required at this stage being Rs. 380.12. It is also observed from Figure 2 that after each change in the investment opportunities, the upward slope of the income curve decreased. The slope of this line indicates the change in income with a unit change in investment. It corresponds to the MVP of capital, the declining slope indicating decline in the MVP of capital. It has not been possible to represent the MVP of capital in the second and third plan because the price of artificial activities was arbitrary. The minimum MVP of capital was Rs. 1.69.

Optimum Farm Plans with Improved Technology

The optimum plans with improved technology are presented in Table II. It is apparent from Table II that working capital requirement for an optimum plan for generating an income of Rs. 6,958.84 was Rs. 2,801.80. The income from capital varying from Re. 0.00 to Rs. 2,801.80 can be calculated which will be between Re. 0.00 and Rs. 6,958.84.

TABLE II—OPTIMUM FARM PLAN WITH IMPROVED TECHNOLOGY AT DIFFERENT LEVELS OF CAPITAL

Plan	Capital needed (Rs.)	Area (acres)							Net income (Rs.)
		Hybrid bajra-wheat	*Guara*-wheat	Jowar(F)-berseem	Tomato-potato	*Moong*-gram	Jowar(F)-gram	Fallow-wheat	
		(P_1)	(P_4)	(P_6)	(P_8)	(P_{10})	(P_{12})	(P_{13})	
1.	0	0	0	0	0	0	0	0	0
2.	72.00	0	0	0.18	0	0	0	0	176.40
3.	872.80	0	0	0.18	0	0	0	2.86	1,892.40
4.	924.80	0	0.1	0.18	0	0	0	2.86	2,014.90
5.	1,048.00	0	1.36	0.18	0	0	0.60	0.96	2,418.40
6.	1,110.40	0	1.54	0	0	0	0.60	0.57	2,618.50
7.	1,414.80	0	1.54	0	0	2.11	0.39	0.15	3,527.00
8.	1,649.10	1.54	0	0	0	2.34	0.39	0.13	4,187.32
9.	2,801.80	0.38	0	0	1.16	0	0.54	2.32	6,958.84

Figure 3 is a graphic representation of Table II. The total income and level of real activities corresponding to Re. 0.00 to Rs. 2,801.80 of capital could be obtained from Table II or Figure 3. The total income and level of

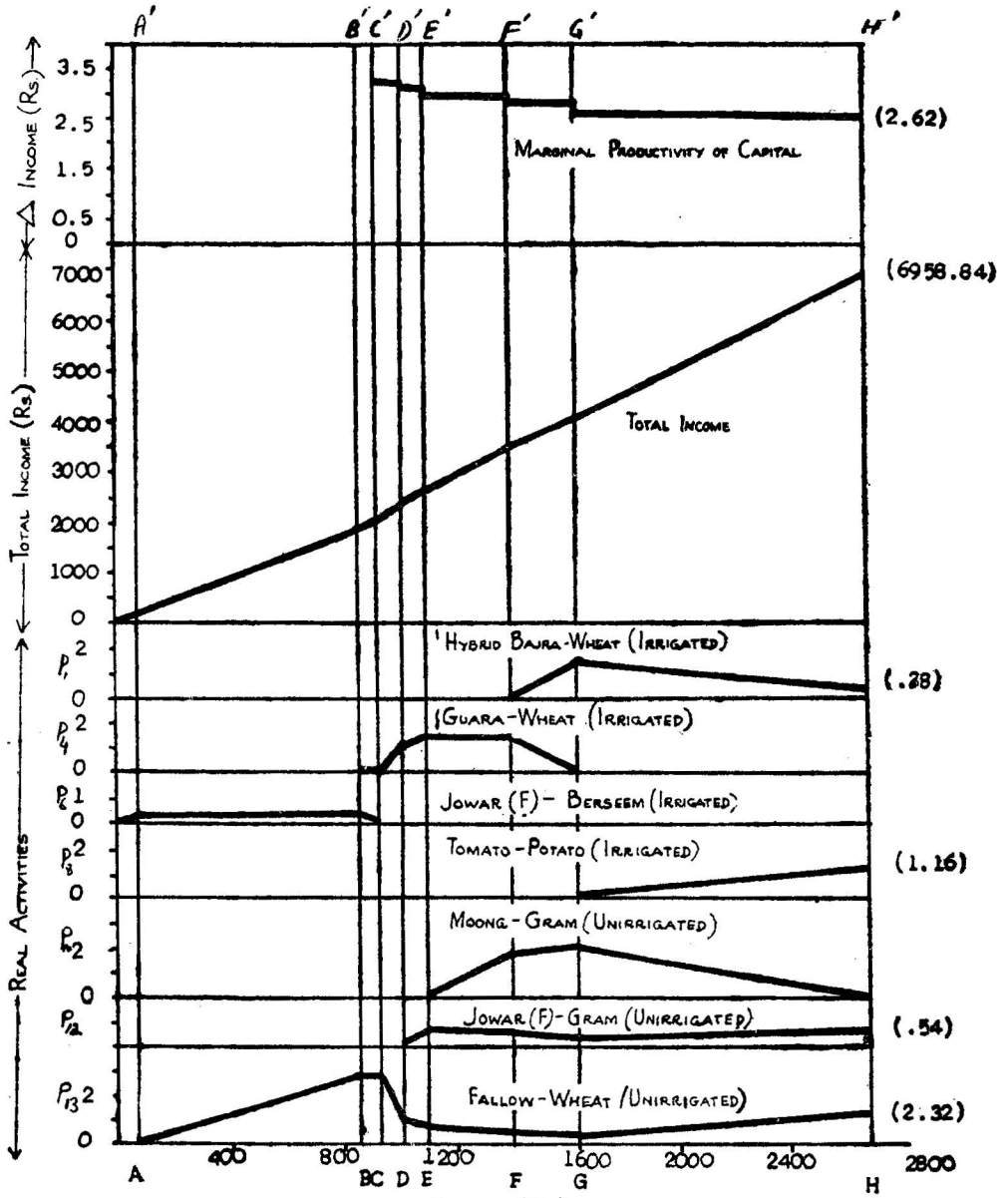

FIGURE 3— GRAPHIC REPRESENTATION OF TABLE II

real activities corresponding to Rs. 72.00 of capital have been shown by the line AA' which indicates an income of Rs. 176.40 with the production of 0.18 acre of P_6 (jowar(fodder)-berseem). Similarly, the lines BB', CC', DD', EE', FF', GG' and HH' correspond respectively to the appropriate plans for Rs. 872.90, Rs. 924.80, Rs. 1,048.00 Rs. 1,110.40, Rs. 1,414.80, Rs. 1,649.10, and Rs. 2,801.80 of capital; the incomes generated were

Rs. 1,892.40, Rs. 2,014.90, Rs. 2,418.40, Rs. 2,618.50, Rs. 3,527.00, Rs. 4,187.32, and Rs. 6,958.84 respectively. From Figure 3, for any level of capital input, the optimum plan could be obtained. The figure also shows all the critical plans at which the investment opportunity changes as the availability of capital increases. The slope of the line indicates the change in income with a per unit change in investment. The minimum MVP of capital was found to be Rs. 2.62. The irrigated crop rotations maize-wheat, jowar (fodder)-mustard, *guara*-wheat, hybrid bajra-gram, jowar (fodder)-berseem, chillies-potato, sugarcane and the unirrigated crop rotations *moong*-gram, hybrid bajra-fallow, fallow-mustard and buffalo could not enter the plan.

Marginal Value Products

A linear programming problem has a dual solution. The development of the optimum farm plans and marginal value productivity of resources were used as restraints. The MVP of working capital was found to be zero in both the cases because capital was assumed as a variable resource. The MVP of the irrigated land was Rs. 617.71 and Rs. 3,205.90 at the existing and improved levels of technology respectively. The MVP of the unirrigated land with the existing and improved levels of technology was found to be Rs. 274.00 and 609.44 respectively. This indicates that the MVP of the irrigated land at the improved technology was highest. In the case of unirrigated land it was also quite different with the level of technology. The MVP of irrigation under both the situations was found to be zero, the reason being that the land of farmers having irrigation facilities, on an average, was able to fulfil their requirements completely, *i.e.*, irrigated land was less and this could be fully irrigated with the existing supply at the existing and improved levels of technology. Thus, for all practical purpose, after allowing for more availability of the capital on the small farms, land is the only scarce resource. The MVP of minimum green fodders and *bhusa* was Rs. 19.95 and Rs. 11.02 respectively with the existing level of technology. With the improved technology, the MVP of minimum green fodders and *bhusa* was Rs. 4.26 and Rs. 2.96 respectively.

CONCLUSION

Various criteria, *i.e.*, size of holding, income, organization of the farm and degree of integration, etc., are used to define the small farms. However, no single criterion is well suited for the empirical studies. A small farm can be defined as one where the bulk of the labour force comes from the same household, production is consumed on the farm and/or traded in the local markets and the farmers do not live much above culturally determined subsistence levels. If adequate working capital is made available to these farmers, they have the potential for increasing farm incomes even at the existing levels of technology. The farmer's income could be further enhanced

manifold if suitable guidance and assistance is provided for the adoption of improved technology. The MVP of the irrigated and unirrigated land at the existing levels of technology was found to be Rs. 617.17 and Rs. 274 respectively. The MVP of the irrigated and unirrigated land was found to be Rs. 3,205.90 and Rs. 609.44 at the improved levels of technology.

ADOPTION OF NEW TECHNOLOGY ON SMALL FARMS : THE ROLE OF CREDIT AND ITS REQUIREMENTS

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Much of the advantages of the high-yielding varieties (HYVs) as a factor in the uplift of the economic condition of the small farms lies in their scale neutrality. This scale neutrality was exhibited by a number of people through their studies.[1] However, it was soon realised that the changed factor proportions required by the HYVs were not favourable to the small farms. This was due to the fact that the factor substitution permitted by it, *viz.*, capital for land rather than labour for land, was not conducive to the small farms, as the small farms are not only deficient in land area but particularly deficient in capital in the form of fertilizers, pesticides, etc., which are crucial to reap the full benefits of the new technology. This capital bottleneck places the small farms in a disadvantageous position regarding access to the supposedly scale neutral technology.

Several measures to alleviate the capital constraints have been suggested such as the supply of scarce resources like credit, etc. These are based on the assumption that once these facilities are made available, the small farmers will gain from the new technology The present study is an attempt to evaluate the likelihood that such measures will succeed in alleviating capital constraints. In particular, the two main objectives of the present study are: (*i*) to investigate how far credit will help the small farmer in the adoption of new HYVs of paddy; (*ii*) to assess the credit requirements of the small farmers.

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1. See for example, Surjit S. Sidhu, "Relative Efficiency in Wheat Production in the Indian Punjab," *The American Economic Review*, Vol. LXIV, No. 4, September, 1974, p. 746 and also P. K. Bardhan and T. N. Srinivasan, "Income Distribution: Patterns, Trends and Policies," *Economic and Political Weekly*, Vol. VI, No. 17, April 24, 1971, pp. 877-882, where they write "There was some agreement that though the new agricultural technology might be neutral to the size of holding and..... .....", p. 881.