DEMAND FOR BORROWING ON IRRIGATED SMALL FARMS UNDER TRADITIONAL AND MODERN TECHNOLOGY—A CASE STUDY IN HOOGLY DISTRICT OF WEST BENGAL

By

A.K. RAY AND C.C. MAJI

I.A.R.I., New Delhi-12

(Received : January, 1979)

One of the important factors responsible for the backwardness of Indian Agriculture is the inadequacy or even absence of credit facilities to support various form activities, particularly those associated with high-yielding technology. The demand for credit in farming arises mainly from the need for purchased inputs such as fertilizers, seeds, irrigation, hired labour and the like. The role of credit in agricultural production has assumed greater significance with the introduction of high-yielding agricultural production technology in the recent past. It is well known that, unlike the traditional technology, the modern technology is relatively capital intensive in that it depends heavily, for its success, on the level of purchased capital inputs which form the major part of the total expenditure. Furthermore, lack of adequate credit supply often acts as an impediment to optimal allocation of farmer's own resources, *viz.*, land, family labour, irrigation, etc.

The problem of inadequacy of credit supply is most acute on small farms. Attempts to relax the credit constraint on these farms have taken various forms. The small Farmers Development Agency, nationalized banks and cooperatives have been commissioned to help the small farmers financially or otherwise. In order to serve the small farmers effectively it is imperative that the credit institutions should take into account the demand for borrowing on small farms which depends on the opportunity of investing the borrowed capital on these farms in an optimal manner. Furthermore, increase in productivity of variable inputs consequent upon the modern technology is believed to have shifted the demand for borrowing upward, It is, therefore, important not only to estimate the normative demand for borrowed capital but also to quantify its shift, if any, brought about by the new and more productive agricultural technology.

The present study is an attempt at estimating the normative demand for borrowing under both traditional and modern technologies on tube-well irrigated small farms and evaluating the impact of modern technology on the demand for borrowing on these farms. Besides, the average returns to total working capital (both borrowed and owned) under optimal resource allocation in traditional as well as modern technology was computed and compared.

METHODOLOGY

A sample of 60 small farms in the tube-well irrigated villages of Mithapurkur, Digsui and Purusottampur in Hoogly district of west Bengal were selected for this study. A sample farm, on an average, possessed 3.28 acres of cultivated land (of which 1.14 acres were irrigated), two man-months of family labour per month and Rs. 1157.00 of own working capital per year.

The demand for borrowing in farming depends, among other things, on the interest rate, the opportunity for investing the borrowed capital in the farm and constraints on the availability of purchasable and own inputs. Traditionally, production function and profit function approaches have been used to derive the normative demand for variable inputs inculding borrowed capital. But these approaches, being too often aggregative to be computationally manageable, fail to take account of the realities of farming situations, specifically the possibility of substitution between crop enterprises and limited supplies of resources on the farm. Parametric Linear Programming (PLP), on the other hand, used to derive the demand for an input (including credit) or the supply of an output is a more inclusive technique which takes explicit cognizance of the substitution possibility beween crop activities and also the restricted supplies of farm resources. Considering the relative merits and demerits of the available techniques the Parametric Linear Programming was used in this study to derive the step demand function for borrowing under restricted supply of land, family Labour, irrigation and own capital*. No restriction was imposed on the amount of borrowing, a decision variable in our PLP model.

* For detailed discussion on Parametric Programming, see Method and Application of Linear Programming by Leon Cooper and David Steinberg, W.B. Saunders Company, Philadelphia, 1974.

The detailed mathematical model actually used in this paper is not presented here for the sake of brevity. The model included crop activities, irrigation activities, fertilizer and pesticide buying activities, labour hiring, fodder selling activities, and dairy activities as decision variables and land, family labour, irrigation, own working capital, etc., as constraints. A month was taken to represent a decision period and the planning horizon consisted of a typical agricultural year.

The step-demand function for borrowing was derived by allowing the price of borrowing (interest rate) to vary continuously in a systematic manner. The model used in this study is briefly reproduced in matrix notation.

$$\underset{x}{\text{Max}}\ Z = c'x + \lambda d'x$$

subject to:

$$Ax \begin{Bmatrix} \leqslant \\ = \\ \geqslant \end{Bmatrix} b \qquad \ldots(1)$$

and $x \geqslant o$

where : $c' = (c_1, c_2, \ldots\ldots c_n)$, $d' = (d_1, d_2 \ldots\ldots d_n)$,

$$x = \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{bmatrix};\ A = \begin{bmatrix} a_{11}\ a_{12} \ldots\ldots a_{1n} \\ a_{21}\ a_{22} \ldots\ldots a_{2n} \\ \vdots \\ a_{m1} \ldots\ldots\ldots a_{mn} \end{bmatrix};\ b = \begin{bmatrix} b_1 \\ b_2 \\ \vdots \\ b_m \end{bmatrix} \text{ and}$$

λ is a scalar parameter.

In the above formulation c_j $(j=1,2,\ldots\ldots n)$, is the net return from activity x_j, b_i $(i=1,2,\ldots\ldots m)$, is the level of restricted resource or constraint constant, a_j is the input-output coefficient and d_j denotes the rate at which c_j is varied.

For the purpose of this study only the interest rate (cost of borrowing) was varied while the other c_j's were held constant. Specifically, $d' = (0, 0, \ldots 0, = .0_1, 0, \ldots\ldots 0)$ where .01 denotes the rate at which interest rate was increased.

The model was first solved with $\lambda = 0$ and an interest rate of zero per cent (*i.e.*, c_j for borrowing activity is zero) to obtain the optimal level of borrowing. Then λ was successively increased to 1,2,3 and so on and the model was resolved for the optimal level of borrowing with interest rate increasing by one per cent at each solution. The critical rate of interest at which the optimal level of borrowing changed and the corresponding level of borrowing and the optimand (the optional value of the objective function) were noted. The step demand function for borrowing was obtained by plotting the optimal levels of borrowing against the relevant ranges of the interest rate. The above procedure was followed for both traditional and modern technologies.

It is important to note that the PLP model for the traditional technology differs from that for modern technology only in respect of the number of crop activities. Specifically, the high-yielding varieties included as alternative crop activities in the PLP model for the modern technology are excluded from the model for the traditional technologies. The total number of crop activities (including intermediate fodder production activities) in the model for the modern technologies is 44 which include 12 high-yielding rice activities and four high-yielding wheat activities. Deleting these 16 high-yielding crop activities from the PLP model for the traditional technologies the number of crop activities is reduced to 28.

The step demand function constituted a set of range of interest rates as continuous series of interst interval within the amount of borrowing remained constant. Following Burt's method* which takes into account the variable lengths of the vertical segments of the steps through a weighting procedure the step demand functions were approximated by a smooth linear curve.

Results and Discussion

The step demand schedules for borrowing and their linear approximations for both the traditional and modern technologies are presented in Tables 1 and 2. These demand functions are shown graphically in Fig. 1. It may be seen that even with the traditional crop activities the amount of credit demanded on a small farm to ensure the optimal use of the limited resources was Rs. 450.60 which remained invariant with the interest rate in the range of 10 per cent to 32 per cent per annum. The demand fell to Rs. 400 per farm at the interest rates ranging from 33 per cent to 83 per cent.

It is evident from Tables 1 and 2 that, given the interest rate, the demand for borrowing on the small farm more than doubled in the realistic ranges of interest rate as a result of the introduction of high-yielding technology. It should be noted that there was no appreciable decrease in the amount of credit demanded even when

* Burt, O.R., 'Curve Fitting to Steep Function' Journal of Farm Economics, 39 (2) : pp, 409-28, 1957,

the interest rate was as high as about 90 per cent or so. Both the demand functions remained inelastic until the interest rate rose to about 103 per cent and 160 per cent under the traditional and modern technologics respectively. However, for a given rate of interest, the demand for borrowing under high-yielding technology was found to be more inelastic than under traditional technology implying that the necessity of credit was more in the former than in the latter technology. This also confirms the capital intensive nature of the modern technology.

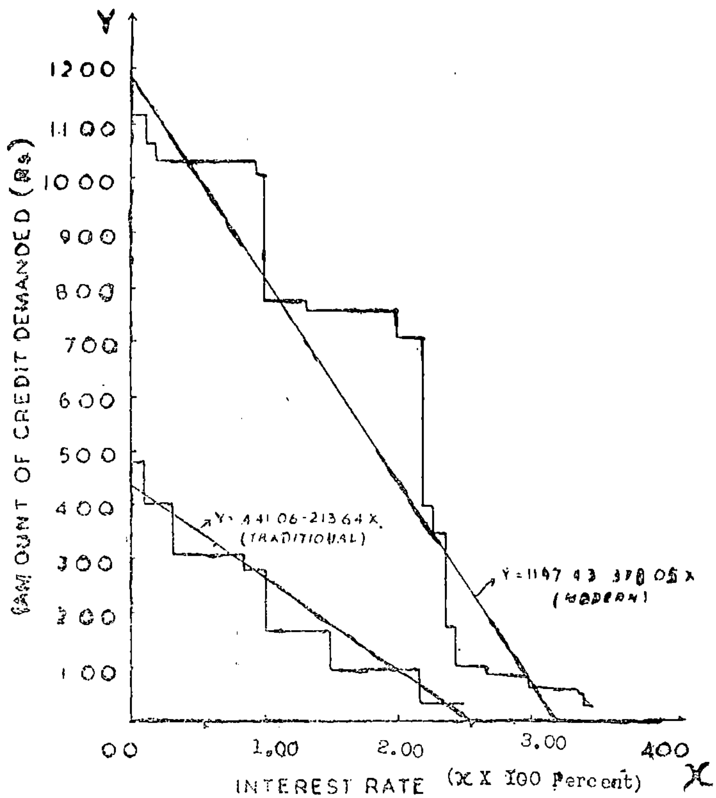

Fig. 1.

TABLE 1

Normative Step Demand Schedules for Borrowing on Small Farms under Traditional and Modern Technologies, Hoogly District, (West Bengal)

Traditional Technology		*Modern Technology*	
Interest range (%)	*Credit Demanded* (*Rs.*)	*Interest range* (%)	*Credit Demanded* (*Rs.*)
0.0-0.10	480.00	0.0-0.11	1120.00
0.10-0.33	450.60	0.11-0.15	1072.12
0.33-0.84	400.00	0.15-0.93	1037.88
0.84-1.00	310.00	0.93-0.99	0010.66
1.00-1.50	270.00	0.99-1.27	771.54
1.50-1.70	181.00	1.27-1.95	756.96
1.70-2.16	95.50	1.95-2.17	702.05
2.16-2.51	15.40	2.17-2.25	397.27
		2.25-2.31	345.29
		2.31-2.41	176.32
		2.41-2.65	100.18
		2.65-2.95	95.65
		2.95-3.35	65.71
		3.35-3.37	64.07
		3.37-3.49	34.64

TABLE 2

Normative Demand Function for Borrowing on Small Farms, Hoogly District (West Bengal)

Type of function	*Technology*	*Estimated unction*	R^2
Linear	Traditional	$Y = 441.06 - 213.64X$	0.95
Linear	Modern	$Y = 1197.43 - 378.05X$	0.93

X=Interest rate,
Y=Amount of credit demanded (Rupees).

An important implication for the interest rate policy is that, as long as the rate of interest is less than 103 per cent and 160 per cent respectively under traditional and modern technologies, a rise (fall) in interest rate will result in a less than proportional fall (rise) in the normative demand for credit. Stated differently, a one per cent rise (fall) in interest rate is associated with a less than one per cent fall (rise) in the demand for borrowing until the interest rate reaches 103 per cent and 160 per cent for traditional and modern technologies respectively. It should, however, be noted that the percentage of fall (rise) in demand for credit consequent upon a one per cent rise (fall) in interest rate depends on the interest rate itself. In particular, higher the interest rate, greater is the fall in the percentage of credit demanded. Furthermore, the inelastic nature of demand for farm credit coupled with an inadequate supply of institutional credit has an obvious impact on the unofficial credit market in the rural areas. Specifically, it explains why a high interest is charged for the loan advanced by the village money lenders and traders.

It is worth-mentioning that the existing supply of credit from all sources to a small farmer was nearly adequate to meet his demand at the going rate of interest under the traditional technology of agricultural production.* However, the existing credit supply fell short of the amount demanded under the high-yielding technology. In order to increase emploment and income on small farms through the application of modern technology and efficient use of limited resources it is imperative that the existing level of credit supply should be substantially increased. So long the credit supply remains at its existing inadequate level an increase in interest rate appears justified in bridging the gap between the existing and the equilibrium rates of interest and thereby making the efficient use of not only credit but also other farm resources under modern technology in the tube-well irrigated areas under study. Continuance of an interest rate lower than the equilibrium rate tends to be associated with the misuses of what is known as liberalized credit.

The average net returns per rupee of working capital (both borrowed and own) under the traditional technology were found to rise from Rs. 2.46 to Rs. 3.09 (Table 3) as borrowed capital became increasingly scarce, *i.e.*, as interest rate increases. These returns increased further from Rs. 3.95 to 6.47 (Table 3) under the high-

* The data obtained from a primary survey of the sample farms revealed that the amount of credit advanced to a small farm from all sources was, on an average, Rs. 400.00 during the year 1975-76.

TABLE 3

Average Net return per rupee of working capital on small farms under traditional and modern technologies, Hoogly District West Bengal)

Traditional				*Modern*			
Interest range (%)	*Net returns* (*Rs.*)	*Tatal working capital* (*Rs.*)	*Net return per rupee of working capital* (*Rs.*)	*Interest range* (%)	*Net retnrns* (*Rs.*)	*Total working capital* (*Rs.*)	*Net retrun per rupee of working capital* (*Rs.*)
0.0-0.10	4022.00	1637.40	2.46	0.0-0.11	8990.10	2277.41	3.95
0.10-0.33	3971.79	1608.00	2.47	0.11-0.15	8918.12	2229.53	4.00
0.33-0.84	3940.25	1557.40	2.53	0.15-0.93	8803.10	2195.29	4.01
0.84-1.00	3800.59	1467.40	2.59	0.93-0.99	8766.50	2168.07	4.04
1.00-1.50	3796.91	1427.40	2.66	0.99-1.27	8538.00	1928.95	4.43
1.50-1.70	3720.78	1338.40	2.78	1.27-1.95	8500.00	1914.37	4.44
1.70-2.16	3658.50	1252.90	2.90	1.95-2.17	8273.58	1859.46	4.45
2.16-2.51	3623.98	1172.80	3.09	2.17-2.25	7940.05	1554.68	5.11
				2.25-2.31	7849.27	1502.70	5.22
				2.31-2.41	7823.46	1333.70	5.87
				2.41-2.65	7805.66	1257.59	6.20
				2.65-2.95	7776.95	1253.06	6.20
				2.95-3.35	7731.34	1223.12	6.32
				3.35-3.37	7718.37	1221.48	6.32
				3.37-3.47	7716.15	1192.05	6.47

yielding production technology. The findings clearly indicate that the modern technology is truly an improvement over the traditional technology in as much as it helps increase the net return for the given levels of the available resources.

CONCLUSION

The study reveals that the demand for borrowing on the tube-well irrigated small farms in Hooghly district of West Bengal has increased two-fold after the introduction of high-yielding technology. This, in turn, has increased the burden on the credit institutions, *viz.*, banks and cooperatives in the recent past. The existing level of credit supply from all sources is inadequate for optimal allocation of limited farm resources under modern technology. An important economic implication of this result is that in order to increase the allocative efficiency and to make the best use of the modern techonology on the small farms in the area studied the supply of credit has to increase almost twice the existing level. Failure to supply adequate institutional credit will lead either to slower adoption of high-yielding modern technology or to increased dependence of the small farmers on the unscrupulous private money-lenders. An increase in interest rate seems justified to bring the existing rate closer to the equilibrium rate and to prevent inefficient use of credit as well as other farm resources. Furthermore, the results clearly indicate that the modern technology is superior to the traditional one in as much as the former results in a higher return to working capital than the latter for a given level of other resources.

SUMMARY

The study was conducted with a view to deriving the normative demand for borrowing on irrigated small farms under both traditional and modern agricultural technologies. The study also aimed at estimating the change in the demand for borrowing brought about by the high-yielding technology. A sample of 60 small farms from the tube-well commanded villages of Mithapukur, Digsui and Purasottampur in the district of Hoogly, West Bengal, were selected for the purpose of this study. Data were collected from each sample farm for the year 1975-76 by survey method.

Parametric linear programming technique was used to derive the step demand functions for borrowing. Only the interest rate was varied continuously by one per cent while the net returns (costs) of other decision variables were held constant. The step demand functions were then approximated by linear functions using Burt's

method. Average net return per rupee of working capital was computed by dividing the optimal net return by the total working capital (borrowed *plus* own).

The findings of the study clearly indicate a rise in the demand for credit on small farms as a result of the introduction of high-yielding technology. Given the interest rate, the credit demanded was found to be more than double under modern technology as compared to that under traditional technology. Furthermore, the introduction of new technology in agricultural production resulted in a more inelastic demand for borrowing implying that the necessity of credit in modern farming and increased in the recent years.

The actual supply of credit to an average small farm in the area studied was not even a half of the amount demanded at the existing rate of interest. This necessitates a substantial increase in the supply of institutional credit without which efficient use of limited resources on small farms cannot be achieved. The average net return per rupee of working capital was found to be significantly higher in the modern technology than in the traditional one. Thus an increase in credit supply to match the higher demand is a prerequisite for increase in income on small farms in the study area.