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Farming Systems:
Income Potential and Credit Requirements of Non-Viable Farmers in Pithapuram Block, India

Satheesh V. Aradhyula*
and
B.M. Sharma

The present study deals with farmers who are a part of rural poor. Such farmers are termed as non-viable farmers. Using linear programming techniques the potentiality and adequacy of a liberal credit policy and a recommended level of technology in raising the incomes of the non-viable farmers above poverty line is evaluated under four different farming systems. Also, the minimum amount of credit needed to raise their income above poverty line is calculated. Incomes of some of these farmers increased above poverty levels when their resources are allocated optimally. Results also indicated that credit and technology are essential to raise the incomes of the other non-viable farmers above poverty line.

I. Background

The present study deals with farmers who are a part of the "rural poor." Such farmers are termed as nonviable farmers. Thus, a nonviable farmer is considered as one whose income falls short of the poverty line, implying his income is insufficient to maintain himself and his family at a reasonably good standard of living. The objectives of the study are:

* Research Associate, Department of Economics, Iowa State University and Scientist, Department of Agricultural Economics, Indian Agricultural Research Institute, respectively.

1. To explore the possibilities of raising farm incomes of non-viable farmers in Pithapuram Block above the poverty line through an optimal allocation of available resources under different farming systems.
2. To explore the capabilities of a liberal credit policy and a recommended level of technology as a means of raising incomes of these farmers beyond the poverty line.
3. To compute the credit requirements of these farmers.

Five villages from Pithapuram Block were selected to draw a sample of 80 nonviable farmers, 16 from each village. For the purpose of the present study, the poverty line was defined, in accordance with Rudra as an annual per capita income of Rs. 1,166.16 (at 1980-81 prices) from all sources. The data on input-output relationships of crops, dairy and sericulture activities were collected by survey methods from the selected sample of farmers for the year 1980-81 by interviewing them personally with the help of a specially designed questionnaire. Information regarding each recommended technology of various crop activities for this area was obtained from the recommendations of Andhra Pradesh Agricultural University. Recommended technology is the technology that is currently available but not diffused to the farm level fully. Parameters of the linear programming model used were derived from these two sets of information.

Four farming systems (viz. crop farming system, crop and dairy farming system, crop and sericulture farming system, and crop dairy and sericulture farming system) were identified for the present study. These are the farming systems recommended to this area by Andhra Pradesh Agricultural University. To see how effective the farming systems are in bringing the farmer above the poverty line, four different plans were worked out using a linear programming technique (one with a liberal credit policy, one with a recommended level of technology, one with both of these, and one with none of these) under each of the four farming systems. This enables us to evaluate the potentiality of farming systems to generate sufficient income under varied conditions of capital availability and technology. It may be noted here that this paper does not address questions like how a liberal credit policy, if feasible, can be implemented; where the credit comes from; how the recommended level of technology will be diffused to farm

level. The paper computes credit requirements and examines whether and how the liberal credit policy and recommended level of technology, if given, can raise the incomes of nonviable farmers beyond the poverty line under different farming systems. Also the study treats the demand side of outputs such as crop products, dairy products, and silk as exogenous. The farmer is assumed to be a price taker and knows the prices.

Using the median of per capita incomes of farm households as the cut-off point, the selected farmers were grouped into two groups (viz. Group I, representing the poorer 50 percent of the nonviable farmers and Group II, representing the upper 50 percent). Optimal plans were computed seperately for both these groups. Thus, in all, 32 different plans were computed — 16 for each of the two groups of farmers. Algebraically, the model used was:

$$(1)\ \text{Maximize } Z = \sum_{i=1}^{s} C_i X_i - \sum_{k=1}^{12} W_k B_k^* - \sum_{h=1}^{4} D_h B_h^* - R_m B_m^*$$

subject to:

Land constraints

$$(2)\ \sum_{i=1}^{s} a_{ij} X_{ij} \leqslant B_j \qquad j = 1, 2, \ldots, 8.$$

Human labor constraints

$$(3)\ \sum_{i=1}^{s} b_{ki} X_i - B_k^* \leqslant B_k \qquad k = 1, 2, \ldots, 12.$$

Bullock labor constraints

$$(4)\ \sum_{i=1}^{s} c_{hi} X_i - B_h^* \leqslant B_h \qquad h = 1, 2, 3, 4.$$

Working capital constraint

$$(5)\ \sum_{i=1}^{s} d_{mi} X_i - B_m^* \leqslant B_m$$

Maximum animal number constraint

$$(6)\ \sum_{i=1}^{s} e_{ni} X_i \leqslant B_n$$

Maximum area constraints

$$(7)\ \sum_{i=1}^{s} f_{oi}X_i \leqslant B_o \qquad o = 1, 2, 3.$$

Minimum cereal constraint

$$(8)\ \sum_{i=1}^{s} g_{pi}X_i \geqslant B_p$$

and the usual nonnegativity restrictions.

where Z is the total net returns to the fixed resources; C_i is the net returns per unit of the ith activity; X_i is the number of units of ith activity; W_k is the wage rate of human labor used in the kth period; B_k^* is the quantity of human labor hired in kth period; D_h is the wage rate of bullock labor used in hth period; B_h^* is the quantity of bullock labor hired; R_m is the rate of interest at which capital can be borrowed; B_m^* is the amount of capital borrowed; a_{ij} is the amount of jth type land required to take up one unit ith activity; B_j is the amount of jth type land available; b_{ki} is the kth period human labor requirement per unit of ith activity; B_k is the amount of family human labor available in kth period; c_{hi} is the bullock labor requirement per unit of ith activity in the hth period; B_h is the amount of own bullock labor available in hth period; d_{mi} is the capital requirement per unit of ith activity; B_m is the amount of own capital available; e_{ni} is equal to one if ith activity is dairy activity, if not zero; B_n is the maximum number of dairy animals allowed in the plan; f_{oi} is equal to one if ith activity belong to oth group, if not zero; B_o is the maximum area allowed under oth group activities; g_{pi} is the grain (cereal) yield per unit of ith activity; B_p is the cereal requirement of the household; and s is the total number of crops, dairy, and sericulture activities included in the model. s took different values in different programming situations.

A few words are in order regarding constraints (7) and (8). In the area surveyed, cotton banana, and eggplant are considered profitable but highly risky crops. Constraint (7) imposes upper bounds on land allocated to these crops. These upper limits are obtained from the surveyed farmers. The constraint reflects the intent of the farmers to "limit" the risky activities. Constraint (8) ensures that the cereal requirement of the farm household is met from the farm itself, a concern expressed by the farmers surveyed. As explained later in Section V, the model is changed slightly

when calculating the credit requirements.

II. Results and Discussion

Existing farm plan: The average size of holding of Group I and Group II farmers was 2.74 acres and 3.61 acres, respectively. The average size of the households was 6.47 (members) for Group I farmers and 5.95 in case of Group II farmers. Thus, the per capita land availability was less than 0.43 acres in the case of Group I farmers and 0.61 acres in case of Group II farmers. The total net farm returns were Rs. 3,043.27 for Group I farmers and Rs. 4,551.45 for Group II farmers (Tables 1 and 2). The corresponding total nonfarm incomes were Rs. 128.01 and Rs. 107.04. Thus, per capita income (farm and nonfarm) was Rs. 489.77 in case of Group I farmers and Rs. 782.94 in case of Group II farmers, as against Rs. 1,116.16 of the poverty line. The meager per capita incomes of both the groups of farmers indicated that their standards of living were precariously low. Group I farmers were at destitution levels.

A. Crop Farming System

As the name suggests, this farming system includes crop activities only. More optimization of resource allocation at existing levels of technology and capital availability (Plan C) considerably increased (by 53.9 percent) the net returns of Group II farmers. The increase was dismal (a mere 4.6 percent) in the case of Group I farmers. The per capita income of Group II farmers reached above the poverty line when resources were allocated optimally under existing technology, while that of Group I farmers remained almost the same. Therefore, it appears that the poverty of Group II farmers is not necessarily because of poor endowments they have. This difference underlines the importance of managerial input and calls for mobilizing the services of extension institutions and, more particularly, that of agricultural extension economists.

The net returns of both groups of farmers increased further with a liberal credit policy (Plan CK). The recommended technology (Plan CR) increased the net returns of both groups of farmers considerably. Yet, Group I farmers remained below the

Table 1

NET RETURNS AND PER CAPITA INCOME OF THE HOUSEHOLDS OF GROUP I FARMERS UNDER DIFFERENT PLANS

Name of the Situation/Plan	Net Returns (in Rupees) Per Farm		% Increase in Net Returns Over		Per Capita Income of the Household (Rupees)	% Increase in Net Returns due to a Shift in Farming System from Crop Farming System
	Total	Per Acre	Existing Plan	Plan C		
I. Existing Plan	3,043.27	1,111.44	—	—	489.77	—
II. Crop Farming System:						
Plan C	3,184.02	1,162.90	4.6	—	511.51	—
Plan CK	3,443.52	1,257.68	13.2	8.2	551.59	—
Plan CR	6,120.48	2,235.38	101.1	92.2	965.02	—
Plan CRK	9,013.58	3,292.03	196.0	23.2	1,411.83*	—
III. Crop and Dairy Farming System:						
Plan CD	3,482.26	1,271.83	14.4	9.4	551.57	9.4
Plan CDK	7,248.81	2,647.48	138.2	127.7	1,139.28	110.5
Plan CDR	6,120.48	2,235.38	101.1	92.2	965.02	0.0
Plan CDRK	13,399.60	4,893.94	340.3	320.8	2,089.21*	48.7

Table 1 (Continued)

Name of the Situation/Plan	Net Returns (in Rupees) Per Farm		% Increase in Net Returns Over		Per Capita Income of the Household (Rupees)	% Increase in Net Returns due to a Shift in Farming System from Crop Farming System
	Total	Per Acre	Existing Plan	Plan C		
IV. Crop and Sericulture Farming System:						
Plan CS	5,230.50	1,910.34	71.9	64.3	825.57	64.3
Plan CSK	7,021.44	2,564.44	130.0	120.5	1,104.16	103.9
Plan CSR	6,282.26	2,294.47	106.4	97.3	990.00	2.6
Plan CSRK	9,649.20	3,524.18	217.1	203.1	1,509.99*	7.1
V. Crop Dairy and Sericulture Farming System:						
Plan CDS	5,230.50	1,910.34	7.19	64.3	827.57	64.3
Plan CDSK	10,134.04	3,701.26	233.0	218.3	1,584.87*	194.3
Plan CDSR	6,282.26	2,294.47	106.4	97.3	990.00	2.6
Plan CDSRK	13,851.31	5,058.92	355.2	335.2	2,158.96*	53.7

*indicates a per capita income above poverty line.

Note: Letter K In the name of a Plan indicates that capital borrowing was allowed in that Plan(i.e., a Plan worked out assuming liberal credit policy)
Letter R Indicates that the Plan was worked out at recommanded level of technology
Letters C,D,S stand for crop activities, dairy activities and sericulture activity respectively

Table 2

NET RETURNS AND PER CAPITA INCOME OF THE HOUSEHOLDS OF GROUP II FARMERS UNDER DIFFERENT PLANS AND FARMING SYSTEMS

Name of the Situation/Plan	Net Returns (in Rupees) Per Farm		% Increase in Net Returns Over		Per Capita Income of the Household (Rupees)	% Increase in Net Returns due to a Shift in Farming System from Crop Farming System
	Total	Per Acre	Existing Plan	Plan C		
I. Existing Plan	4,551.45	1,259.39	—	—	782.94	—
II. Crop Farming System:						
Plan C	7,004.03	1,938.03	53.9	—	1,195.14*	—
Plan CK	7,868.95	2,177.35	72.9	12.4	1,340.50*	—
Plan CR	8,630.61	2,388.10	89.6	23.2	1,468.51*	—
Plan CRK	11,584.47	3,205.44	154.5	65.4	1,964.96*	—
III. Crop and Dairy Farming System:						
Plan CD	7,004.03	1,938.03	53.9	0.0	1,195.14*	0.0
Plan CDK	11,078.77	3,065.51	143.4	58.2	1,879.97*	40.8
Plan CDR	8,630.61	2,388.10	89.6	23.2	1,468.51*	0.0
Plan CDRK	15,323.94	4,240.10	236.7	118.8	2,593.44*	32.2

Table 2 (Continued)

Name of the Situation/Plan	Net Returns (in Rupees) Per Farm		% Increase in Net Returns Over		Per Capita Income of the Household (Rupees)	% Increase in Net Returns due to a Shift in Farming System from Crop Farming System
	Total	Per Acre	Existing Plan	Plan C		
IV. Crop and Sericulture Farming System:						
Plan CS	8,132.34	2,250.23	78.7	16.1	1,384.77*	16.1
Plan CSK	9,548.50	2,642.09	109.8	36.3	1,622.78*	21.3
Plan CSR	9,137.88	2,528.47	100.8	30.5	1,553.76*	5.9
Plan CSRK	12,274.78	3,396.45	169.7	75.3	2,080.98*	6.0
V. Crop Dairy and Sericulture Farming System:						
Plan CDS	8,132.34	2,250.23	78.7	16.1	1,384.77*	16.1
Plan CDSK	11,593.97	3,208.07	154.7	65.5	1,966.55*	47.8
Plan CDSR	9,137.88	2,528.47	100.8	30.5	1,553.76*	5.9
Plan CDSRK	15,487.38	4,285.38	240.3	121.1	2,620.91*	33.7

*indicates a per capita income above poverty line.

Note: Letter K In the name of a Plan indicates that capital borrowing was allowed in that Plan (i.e. a Plan worked out assuming liberal credit policy)
Letter R Indicates that the Plan was worked out at recommanded level of technology
Letters C,D,S stand for crop activities, dairy activities and sericulture activity respectively

poverty line. However, the optimal allocation of resources with a liberal credit policy along with recommended level of technology (Plan CRK) increased the incomes by about 196 percent for Group I farmers and 154 percent for Group II farmers. This farming system gave a per capita income (Rs. 1,411.83) above the poverty line for Group I farmers. Group II farmers also were better off with a per capita income of Rs. 1,964.96.

B. Crop and Dairy Farming System

As Tables 1 and 2 show, this system is a marginal improvement over a crop farming system when capital is a constraint. This is true for both groups of farmers at both levels of technology since dairy activities cannot enter the optimal plan (Plan CD and Plan CDR). When the capital constraint is relaxed this farming system is better than the crop farming system in generating net returns. This is true for both groups of farmers at both levels of technology (Plan CDK and Plan CDRK). The large increase in income came from the inclusion of dairy activities in the optimal plan. In this farming system, for Group I farmers, only Plan CDRK insured an income above the poverty line.

C. Crop and Sericulture Farming System

For both groups of farmers, this system has higher net returns than the crop farming system. This was true at both levels of technology and capital availability (all four plans). A comparison of Plan CS with Plan CD and Plan CSR with Plan CDR indicated that a crop and sericulture farming system generated higher net returns than a crop and dairy farming system when capital is a constraint. When capital borrowing is allowed, a crop and dairy farming system had a higher income than a crop and sericulture farming system. (Compare Plan CSK with Plan CDK and Plan CSRK with Plan CDRK.) In this farming system also, only the simultaneous provision of a liberal credit policy and a recommended level of technology (Plan CSRK) generated an income beyond the poverty line for Group I farmers. In the case of Group II farmers, all the plans insured incomes above the poverty line.

D. Crop Dairy and Sericulture Farming System

When adequate capital was not provided, in the case of both

groups of farmers, this farming system at both levels of technology failed to generate more income than the crop and sericulture farming system. (Compare Plan CDS with Plan CS and Plan CDSR with Plan CSR.) The reason again was that dairy activities could not enter the optimal plan. Thus, as long as capital is a constraint, at both levels of technology, none of the four farming systems generated an income beyond the poverty line for Group I farmers. The interesting feature was that even without the recommended level of technology, this farming system, given a liberal credit policy, ensured an income above the poverty line for Group I farmers (Plan CSDK). Hence, this system is superior to the other three. However, Plan CDSRK (simultaneous provision of recommended level of technology and liberal credit policy) recorded the highest net returns for both groups of farmers.

In summary, mixed farming systems generally generate more income than crop farming systems. When capital is a constraint, the crop and sericulture farming system gave the highest income. However, under a liberal credit policy, the crop-dairy and sericulture farming system was better.

III. Income under a Liberal Credit Policy

A liberal credit policy was defined as the provision of as much credit as needed at a constant rate of interest to maximize net income under each farming system. Unrealistic this policy may seem, but as results indicate, even this policy by itself, is inadequate to raise the incomes of these farmers above poverty line. The amount of credit borrowed under a liberal credit policy and the corresponding increase in net returns of both groups of farmers under different farming systems at two levels of technology are presented in Table 3.

The capital availability on the farms of both groups of farmers was low (Rs. 2,099.45 in the case of Group I farmers and Rs. 3,186.19 in the case of Group II farmers). Capital was a limiting resource to maximize the farm net returns. Hence, capital borrowing was used to augment the incomes when the capital borrowing activity was introduced in the plan.

As expected, the liberal credit policy increased the net returns under all farming systems at both levels of technology. In each

Table 3

CAPITAL BORROWING, PERCENTAGE INCREASE IN NET RETURNS UNDER DIFFERENT FARMING SYSTEMS DUE TO LIBERAL CREDIT POLICY, AND CREDIT REQUIREMENTS

Name of the Situation/Plan	Capital Borrowed under Liberal Credit Policy (in Rupees)		% Increase in Net Returns due to Liberal Credit Policy		Credit Requirements (in Rupees)	
	Group I	Group II	Group I	Group II	Group I	Group II
I. Crop Farming System:						
At existing technology (Plan CK)	603.94	1,002.24	8.2	12.4	α	0.0
At recommended technology (Plan CRK)	3,257.18	3,144.35	47.3	34.2	2,540.21	0.0
II. Crop and Dairy Farming System:						
At existing technology (Plan CDK)	4,181.37	5,007.75	108.2	58.2	α	0.0
At recommended technology (Plan CDRK)	6,741.97	7,585.35	118.9	77.6	2,536.79	0.0
III. Crop and Sericulture Farming System:						
At existing technology (Plan CSK)	2,088.64	3,549.52	34.2	17.4	α	0.0
At recommended technology (Plan CSRK)	2,902.42	3,000.05	53.6	34.3	2,160.82	0.0
IV. Crop, Dairy and Sericulture Farming System:						
At existing technology (Plan CDSK)	6,022.27	8,531.47	93.8	42.6	α	0.0
At recommended technology (Plan CDSRK)	6,733.20	7,655.25	120.5	69.5	2,041.49	0.0

Note: The percentage increase in net returns due to liberal credit policy was worked out by comparing the net returns of the two optimal plans worked out in the same farming system and at the same level of technology. For example, the figure 8.2 percent was arrived at by comparing the net returns of Plan CK with that of Plan C — both of Group I farmers.

farming system, the increase in net returns owing to the availability of additional funds was higher at the recommended level of technology than at the existing level of technology. This implied that adoption of recommended technology magnified the income increasing capacity of a liberal credit policy.

The increase in net returns due to a liberal credit policy was not uniform in all the farming systems. The response to capital borrowing was the highest in crop and dairy farming system, followed by crop dairy and sericulture farming system. Results also showed the general trend that the income of Group I farmers responded more to liberal credit policy than the income of Group II farmers.

The results further demonstrated that, for Group I farmers, a liberal credit facility is indispensable if they are to be moved above the poverty line. The results emphasize the need and urgency of a liberal credit policy for this group of farmers. However, Group II farmers also were better off after the implementation of liberal credit policy, but the need or urgency of such a policy was not as high as for Group I farmers.

IV. Impact of Recommended Technology

The results indicated that the income of nonviable farmers can be substantially increased by adopting recommended technology. An increase in net returns, owing to the adoption of a recommended technology, was indicated by comparing the plans computed for a recommended level of technology with those computed for an existing level of technology (see Table 4).

Table 4 indicates that in all the farming systems and at both levels of capital availability, Group I farmers benefited more than Group II farmers by adopting the recommended technology. This is because there was a wider gap between existing levels of technology and recommended level of technology for Group I farmers than for Group II farmers. Under each farming system and for both groups of farmers, the percentage increase in net returns due to the recommended technology was higher when it was for the liberal credit policy. However, without the liberal credit policy, recommended technology failed to bring the desired

Table 4

PERCENTAGE INCREASE IN NET RETURNS DUE TO TECHNOLOGY UNDER DIFFERENT FARMING SYSTEMS

Name of the Situation/Plan	Net Returns: Existing Technology		Net Returns: Recommended Technology		% Increase in Net Returns due to Technology	
	Group I	Group II	Group I	Group II	Group I	Group II
1	2	3	4	5	6	7
I. Crop Farming System:					@	#
With limited capital	3,184.02	7,004.03*	6,120.48	8,630.61*	92.2	23.2
With unlimited capital	3,443.52	7,868.95*	9,013.58*	11,584.47*	161.8	47.2
II. Crop and Dairy Farming System:						
With limited capital	3,482.26	7,004.03*	6,120.48*	8,630.61	75.8	23.2
With unlimited capital	7,248.81	11,078.77*	13,399.60*	15,323.94*	84.9	38.3
III. Crop and Sericulture Farming System:						
With limited capital	5,230.50	8,132.34*	6,282.26	9,137.88*	20.1	12.4
With unlimited capital	7,021.44	9,548.50*	9,649.21*	12,274.78*	37.4	28.6
IV. Crop, Dairy, and Sericulture Farming System:						
With limited capital	5,320.50	8,132.34*	6,282.26	9,137.88*	20.1	12.4
With unlimited capital	10,134.04*	11,593.97*	13,851.31*	15,487.38*	36.7	33.6

$$@ \frac{\text{Column 4} - \text{Column 2}}{\text{Column 2}} \times 100 \qquad \# \frac{\text{Column 5} - \text{Column 3}}{\text{Column 3}} \times 100$$

*Corresponds to an income above poverty line.

impact of generating enough income to push Group I farmers out of poverty.

V. Credit Requirements

So far, we have examined whether a liberal credit policy and a recommended level of technology are adequate in raising the incomes of nonviable farmers above poverty levels. Even more interesting is the question, what is the minimum amount of credit needed to raise the incomes of nonviable farmer above the poverty line. Thus we define credit requirement as the minimum amount of credit needed to borrow at a given rate of interest to raise the income of the non viable farmer to the poverty line.[1] To answer this question equations (1) and (5) of the model are modified as follows:

$$(9)\ \widetilde{B} = \sum_{i=1}^{s} d_{mi} X_i - B_m$$

$$(10)\ \sum_{i=1}^{s} C_i X_i - \sum_{k=1}^{12} W_k B_k^* = \sum_{h=1}^{4} D_h B_h^* - R_m \left[\sum_{i=1}^{s} d_{mi} X_i - B_m\right] \geqslant P$$

where P is the minimum income desired (poverty line, Rs. 1,166.16). This modified model consists of minimizing (9), subject to constraints (2)-(4), (6)-(8), and (10). A non-positive $\widetilde{B}$ indicates that no credit need be borrowed to achieve an income of P, the poverty line. In these cases credit requirements are reported as zero. Credit requirements are calculated separately for both groups of farmers under the four different farming systems and under the two levels of technology. These are presented in Table 3 (last two columns). The results indicate that Group II farmers need not borrow any credit to achieve an income above or equal to poverty line. This is not surprising in view of our earlier results. For Group I farmers it is not possible to achieve an income above or equal to poverty line with any level of credit requirement, under the existing level of technology ($\widetilde{B}$ is infinite). Under the recommended level of technology, credit requirements are

[1] It may be noted here that we are considering "production" capital only i.e., the model implicitly assumes that the money borrowed is used for production purposes only. The assumption is --- what farmers borrow is "production capital."

lower in mixed farming systems. These results again emphasize the need of credit and technology.

In conclusion, the benefits of recommended technology can be exploited better when associated with credit borrowing. Similarly, a full utilization of credit was possible only when it was associated with recommended technology. Therefore, the nonviable farmers' economic lot can be more substantially improved if, instead of providing piecemeal credit for crop production, a package approach suitably combining the recommended technology and adequate capital be provided. This emphasizes the need for strengthening the close coordination between credit and extension institutions and streamlining the flow of credit and extension services so as to revitalize the economy of the nonviable farmers.

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