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## ESSAY 4

# CREDIT AVAILABILITY AND THE GROWTH OF SMALL FARMS IN THE PAKISTAN PUNJAB\*

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In virtually all rural development programs designed to aid small farmers, questions arise regarding the minimum holding size that could be expected to generate an investible surplus. Perceptions differ about the precise meaning of "surplus"—within limits it is obviously a decision variable for the farm family. But what agricultural planners have in mind is knowledge about the size of holding that could potentially provide enough savings from current family income to permit modest investments in production facilities. Such information is particularly important where land reform is being contemplated or a credit program to facilitate the purchase of durable capital goods is being implemented.

The answer to the question varies considerably from one farming community to another. In part, these differences are traceable to such agroclimatic factors as soil, temperature, and moisture availability. Relevant also is the nature of the technology. If such indivisible inputs as tractors, wells, and engine-driven pumps are to be used efficiently, farm size must be well above the average of those dependent on traditional methods. The effect of technology on growth potential may, however, work the other way, i.e., highly divisible inputs like seeds and fertilizer may make it possible to generate surplus on holdings whose previous output was no more than sufficient only to meet the consumption requirements of the family.

This essay attempts to explore how the relationship between size, technological change, and the ability to accumulate is affected by government policies regarding agricultural credit, interest rates, and product prices. Because the element of time is involved, a multiperiod programming model was developed to facilitate the exercise. Its mechanism is based on the assumption that the variable costs of the seed-fertilizer technology and the cost of purchasing supplementary water represent outlays of cash that small farmers find difficult to obtain. By having access to credit they can be expected to increase output—which in turn becomes the source of increased savings. A sustained increase in net revenues is taken as the indicator of growth.

\* The views expressed in this article are those of the author and in no way reflect the views of the Department of Agriculture of the Punjab Government.

## STRUCTURE OF THE MODEL

The structure of the model used to investigate the relationship between credit, farm size, and the adoption of new technology contains many of the same ingredients found in the models examined in previous essays. The basic constraint set involves land, water, bullock power, and family labor, each described in terms of monthly time periods; however, there are two important differences in the exercises that follow. The first and most obvious of these is that the model extends over a period of eight crop seasons (four years) instead of the two crop seasons previously assumed.<sup>1</sup> Thus, the objective function becomes:

$$R = \sum_t \sum_i \frac{c_{i,t}}{(1+r)^t} X_{i,t} - \sum_t \sum_i \frac{d_{i,t}}{(1+r)^t} H_{i,t} - \sum_t \sum_i \frac{e_{i,t}}{(1+r)^t} P_{i,t} - \sum_t \frac{f_t}{(1+r)^t} L_t, \quad (1)$$

where  $c_{i,t}$  = net revenue per acre of the  $i^{\text{th}}$  crop activity in period  $t$   
 $X_{i,t}$  = acres of the  $i^{\text{th}}$  crop activity in period  $t$   
 $d_{i,t}$  = cost (wage) per hour of the  $i^{\text{th}}$  labor hiring activity in period  $t$   
 $H_{i,t}$  = hours of the  $i^{\text{th}}$  labor hiring activity in period  $t$   
 $e_{i,t}$  = cost per hour of the  $i^{\text{th}}$  water pumping activity in period  $t$   
 $P_{i,t}$  = hours of the  $i^{\text{th}}$  water pumping activity in period  $t$   
 $f_t$  = cost (interest) of the capital borrowing activity in period  $t$   
 $L_t$  = amount of capital (rupees) borrowed in period  $t$   
 $r$  = discount rate (rate of interest in the private capital market).

Because the model's solutions are to reflect the optimal allocation of a small farmer's resources over time, it is necessary to convert the parameters of the variables in the objection function to their present values. In addition to discounting the net revenues of crop activities, this also involves discounting the cost of hiring labor, buying water, and borrowing capital. The discount rate used for compressing the streams of revenues or costs to a single comparable figure is the interest rate prevailing in the private capital market.

*Capital in the Model*

A second major departure from the previous models is the assumption that capital is a constraint on the adoption of the so-called Green Revolution technology. Previously the major thrust of the programming exercise was to ascertain the effects of the technology on the economics of resource allocation; it was taken for granted that if the technology was profitable, farmers would somehow manage to finance it. In the multiperiod model, this assumption is dropped in favor of a formulation that specifies the need for capital to finance crop activities and that generates capital availability endogenously. Specifically, the farmer is assumed to have available a certain amount of his own capital at the beginning of the planting period in the first season and to be able to save more from the surpluses generated by his agricultural activities. He may also borrow each season up to a specified limit. The capital available (own plus borrowed) is used (1) to cover annual production costs, and (2) to provide for the replacement of a por-

<sup>1</sup> The handling of the multiperiod formulation follows (1).

tion of his durable capital inputs (bullocks, farm implements, sheds, etc.) each season.<sup>2</sup>

*Savings.*—Money available for investment in period  $t$  is assumed to be available either from previous activities (the initial conditions) or to be generated by the crop activities in the previous time period, i.e.,  $I_t = S_{t-1}$ . In the latter, it is assumed that money for investment is a linear function of net revenue:

$$I_t = \sum_i \Theta C_{i,t-1} X_{i,t-1} = S_{t-1} \quad (2)$$

where  $\Theta$  is the marginal propensity to save out of net revenue.

Relatively few data exist in Pakistan from which the magnitude of  $\Theta$  might be inferred. However, several surveys conducted by the Board of Economic Enquiry indicate that a likely estimate of the savings ratio would be .10 (3). Unfortunately, it is not clear from the definitions used exactly what elements were subtracted from gross revenue to obtain an estimate of "income."<sup>3</sup> For this reason, solutions were obtained using alternative values for the savings ratio,  $\Theta$ .

*Borrowing.*—The second source of capital is short-term borrowing. It is assumed that this option is limited, however, and that at the prevailing institutional interest rates severe credit rationing frequently exists. This assumption enters the model as a constraint on the borrowing activity:

$$L_t \leq K_t \quad (3)$$

where  $L_t$  = the capital borrowing activity in period  $t$   
 $K_t$  = borrowing limit in period  $t$ .

According to the farm survey, farmers in the size group of 12.5 acres take an average loan of Rs. 764 per year or approximately Rs. 284 for the winter season and Rs. 480 in the summer season. However, checking with local lending agencies indicates that credit availability is about double the survey figures on credit use. The basic solution, therefore, assumes Rs. 600 for winter and Rs. 1,000 in the summer as the limit beyond which credit is unavailable.

*Capital constraint.*—In the initial period ( $t = 1$ ), the capital constraint, takes the form:

$$\sum_i a_{i,1} X_{i,1} - L_1 \leq C \quad (4)$$

where  $C$  is assumed to be net capital available, i.e., savings from previous surpluses minus outstanding debts and minus the replacement of a portion of the durable capital for the preceding period.

A figure of Rs. 245, derived from the farm survey and assumptions about the traditional cropping pattern in the area, was used for the initial winter season.

Under the foregoing assumptions, the general statement linking capital needs in period  $t$  to capital availability is given by the following expression:

<sup>2</sup> The model does not, therefore, permit the farmer to obtain short-term resources by permitting his fixed capital to deteriorate. That is, it is assumed that at the beginning of each season, funds must be secured both to cover forthcoming costs of production and to replace a portion of the fixed assets assumed to have been depleted during the previous period.

<sup>3</sup> If all variable costs were not subtracted, use of .10 in equation (2) would provide an understatement of the funds available for investment. If, in addition to subtracting variable costs, some portion of a farmer's expenditures on durable capital was subtracted, it would overstate the availability of investment funds.

$$\sum_i a_{i,t} X_{i,t} + L_{t-1} + D_{t-1} - \Theta \sum_i b_{i,t-1} X_{i,t-1} - L_t \leq 0 \quad (5)$$

where  $a_{i,t}$  = short-term capital (variable cost) required to grow crop  $X_i$  in period  $t$   
 $L_{t-1}$  = capital borrowed in period  $t-1$   
 $D_{t-1}$  = replacement of durable capital depleted in period  $t-1$   
 $\Theta$  = marginal propensity to consume out of net revenues  
 $b_{i,t-1}$  = net revenue of crop  $X_i$  in period  $t-1$   
 $L_t$  = capital borrowed in period  $t$ .

*Terminal conditions.*—Valuation of the terminal year investment poses well-known problems in finite-horizon planning models. Several approaches have been suggested in the literature.<sup>4</sup> These include: (1) inclusion of the terminal year capital stock in the objective function, (2) a constraint that precludes declines or increases of investment in the final years, (3) considering for planning purposes only the first few years of a model with a limited time horizon, or (4) treating terminal year investment as a function of terminal year output. None of these approaches is entirely satisfactory. In this essay, the simplest, i.e., the third, was adopted. The last two crop seasons were largely ignored in the interpretation of the model's behavior.

### *Links Between Time Periods*

The connecting link between the different seasons is in the capital row. Savings generated in one period are available for investment in the succeeding period.

The time periods correspond to cropping seasons, a summer season from May through October and a winter season from November through April. The assumption that all of the surplus generated by crops in one period is available for investment in the next is not strictly correct. For example, although the first picking of cotton may have been harvested by November, the last is frequently taken around the end of the year. Thus there may be no way that the entire net revenue can be used to finance fertilizer, pesticides, and water at the beginning of the winter season. Similarly, wheat harvesting and threshing are frequently not completed until after the cotton crop has been planted. Winter clover, winter oilseeds, and winter vegetables, on the other hand, are harvested well before the end of the winter season and provide cash that can be used to finance expenditures on late-maturing winter crops.

Moreover, in defense of the approximation that all savings become available at the end of a particular crop season it should also be remembered that not all expenses are payable at the beginning of the next season. Fertilizer, labor, and water are used, and usually paid for, throughout the growing season. Thus, if some receipts from the cotton crop are not available until January, they will still be in time to purchase pesticides for the oilseed crop.

There are a number of negative entries in the tableau. Those in the objective function of course indicate costs. The negative entries in the  $a_{ij}$  matrix add to resource availability in the rows in which they are found. In the right-hand side column, negative entries do not indicate resource availabilities but deficits that must be covered, e.g., fodder for bullocks, a certain amount of wheat for the family and the replacement of a certain portion of the capital stock.

<sup>4</sup> The literature is reviewed briefly in C. R. Porter (3).

TABLE 4.1.—OPTIMAL CROPPING PATTERNS AND CROPPING INTENSITIES  
IN THE BASE YEAR

Crops	Model		Farm survey <sup>a</sup>	
	Acres	Percent	Acres	Percent
Winter crops				
Wheat	1.16	8.4	5.06	35.4
Barley				
Oilseeds	2.88	20.9	.02	.1
Gram			.15	1.0
Fodder	1.26	9.1	1.65	11.5
Sugarcane			.57	4.0
Vegetables	.06	.4	.02	.1
Orchards				
Subtotal	5.36	38.8	7.47	52.2
Summer crops				
Rice			.52	3.8
Cotton	3.30	23.9	3.36	23.5
Maize	1.13	8.2	.12	.8
Fodder	1.23	8.9	2.15	15.1
Pulses	1.72	12.5	.08	.6
Sugarcane			.57	4.0
Vegetables	.05	.4	.01	.1
Tobacco	1.01	7.3		
Orchards				
Subtotal	8.44	61.2	6.81	47.8
Total	13.80	100.0	14.28	100.0
Cropping intensity		110		114

<sup>a</sup> Details of the farm survey are reported in (1).

#### MODEL RESULTS: THE BASIC SOLUTION

##### *One-Period Model*

Table 4.1 shows the cropping pattern of the optimal solution of the single-period model for the base year. Assumptions include a farm size of 12.5 acres, a credit supply of Rs. 1,600 per year, a discount rate of 7 percent and a saving rate of 10 percent of net revenue.

According to the results of the model, a profit-maximizing farmer should grow nearly 14 acres of crops, hire 84 hours of labor, and purchase 10 acre-inches of water. In the process of reaching the optimal allocation of land and water reported in Table 4.1, the entire stock of capital is used up and the "shadow price" on the capital constraint shows a high value.

Compared with the farm survey also shown in Table 4.1, the model's cropping intensity is similar to the average cropping intensity of the survey, although the allocation of fixed resources among crops is rather different.<sup>6</sup>

<sup>6</sup> In judging the significance of the difference, it should be remembered that when similar constraints are operating on two linear programming activities, slight differences in net revenues and technical coefficients can produce radical differences in the primal solution.

TABLE 4.2.—ACTIVITY LEVELS OF THE MULTIPERIOD MODEL  
(Base solution)

Crop and technology		Time period		Time period		Time period		Time period	
		W-1	S-2	W-3	S-4	W-5	S-6	W-7	S-8
Crop Activities									
Winter crops ( <i>acres</i> )									
Wheat	Advanced	1.25		1.31		1.47		1.53	
	Traditional	0.32		0.38					
Oilseeds	Intermediate	2.88		2.86		3.43		3.78	
Gram	Intermediate			0.13		0.11		0.41	
Fodder	Advanced	0.58		1.04		1.04		1.04	
	Traditional	0.68							
Vegetables	Intermediate	0.06		0.06		0.06		0.06	
Summer crops ( <i>acres</i> )									
Cotton	Advanced		2.89		2.83		3.63		3.53
Maize	Intermediate		0.54						
	Traditional		0.59		0.52				.55
Fodder	Advanced		1.23		1.23		1.23		1.85
	Traditional								
Pulses	Intermediate		1.72		1.72		1.32		2.63
Tobacco	Intermediate		1.01		1.06		0.77		
Vegetables	Intermediate		0.05		0.05		0.05		0.05
Seasonal total (winter)		5.77		5.78		6.11		6.82	
(summer)			8.03		7.41		7.00		8.61
Annual total			13.80		13.19		13.11		15.42
Cropping intensity ( <i>percent</i> )			110		106		105		123
Resource Augmenting Activities									
Labor hiring (May I) ( <i>hours</i> )			84.24		70.66		99.64		22.00
Water buying ( <i>acre-inches</i> )									
(Oct I)				7.21		5.66		6.85	
(Oct II)				6.42		5.41		7.11	
(Nov I)		4.17		5.05		5.15		6.18	
(Nov II)		0.19							
(May I)			5.63		6.05		7.51		3.01
(July)							0.59		
(Sep)							1.47		
Borrowing ( <i>rupees</i> )		600	1,000	600	1,000	600	1,000	600	1,000
Net Revenue									
Annual total			5,204		5,038		5,187		5,214

### *Multiperiod Model*

The eight-season, multiperiod model gives results (Table 4.2) similar to the single-period model for each of the four years. There is a small substitution of advanced for traditional technology in wheat, although total output is still constant at the subsistence level. This has freed some additional area in the winter season for oilseeds and gram. During the summer season, cotton has increased slightly over time while maize has declined. The main gainer in terms of acreage has been the area under mung beans, a summer pulse. Mung beans are a relatively low-value crop whose water requirements are modest. As a result of its increased acreage, the last period shows a significant rise in cropping intensity with virtually no improvement in net revenue.

Some labor is hired and water bought, but capital is borrowed up to the maxi-

mum. The dual solution shows that shadow prices for canal water, capital, and the limit on borrowing are very high, with scarcity values for family and bullock labor somewhat lower. This supports the hypotheses that the shortage of operating capital is a serious handicap to the growth of farm income and to the adoption of new technology by small farms in the study area.

#### SENSITIVITY ANALYSIS OF THE BASIC MODEL

The results of the basic model indicated a stable situation over time in the sense that the cultivator of a 12.5-acre farm was unable, at prevailing prices and the capital restrictions imposed, to generate the internal surpluses that were required to move systematically toward a higher level of technology. In the following sections, a number of parameters in the model are varied to provide a better picture of the relationship between credit, technological change, and growth on small farms in the wheat-cotton area.

##### *Varying the Availability of Credit*

In this exercise, credit is scaled upward and downward in increments of one-half the availability assumed in the base year solution, i.e., by Rs. 300 in winter and Rs. 500 in summer.

*Single-period model.*—A summary of these results for the “static,” one-period model are shown in Table 4.3. According to the model, net cash returns increase from Rs. 5,200 to Rs. 6,900 when the credit constraint is raised from Rs. 1,600 to Rs. 4,800. The scarcity value of credit falls from an average of Rs. 2.44 at Rs. 1,600 to zero in winter and Rs. 0.21 in summer when credit availability is set at Rs. 4,800. This indicates that even at 3 times the initial credit availability, the farmer should still be willing to pay substantially more than the prevailing institutional interest rate for summer credit.

Two trends are noticeable in the cropping patterns as credit availability is increased. First, there is a shift from traditional to improved technology in the production of wheat and clover. This reflects larger purchases of inputs, chiefly fertilizer, for crops whose acreage has also increased. Second, the acreage of several high-value crops has been increased while the technology remains unchanged. Sugarcane plantings were entirely absent from the base solution but took up nearly 15 percent of the total cropped acreage when more credit was available.

*Multiperiod model.*—The single-period model demonstrated that credit was a significant constraint in attaining fuller exploitation of fixed resources. That larger credit inflows can, in turn, generate growth is evident from a comparison of net revenues over time (Table 4.4). For example, in Period IV, credit of Rs. 2,400 annually has made it possible to reach a net cash revenue of Rs. 6,249, only slightly less than that attained in a single-period model with credit set at Rs. 3,200. With somewhat more credit, growth is even more pronounced. An increment of Rs. 3,200 produces, in Period IV, cash income approximately equal to that achieved in the single-period model with credit set at Rs. 4,800. Based on these model estimates, even modest increases in credit above the no-growth base solution would initiate growth on a 12.5-acre farm, and this would generate a slightly larger surplus each season to be used to meet the following season's capital requirements.



TABLE 4.3.—OPTIMAL CROPPING PATTERNS AND TOTAL REVENUES FOR A RANGE OF CREDIT AVAILABILITIES  
(Base year solution)

Crop and technology		Annual credit availability ( <i>rupees</i> )					
		800	1,600	2,400	3,200	4,000	4,800
Winter crops ( <i>acres</i> )							
Wheat	Advanced		1.25	1.21	1.53	1.68	1.90
	Traditional		0.32	0.25			
Oilseeds	Intermediate		2.88	2.47	1.13	0.35	0.63
Gram	Intermediate						
Fodder	Advanced		0.58	1.56	2.51	3.14	3.09
	Traditional		0.68				
Sugarcane	Advanced			0.11	0.39	0.71	1.20
Vegetables	Intermediate		0.06	0.06	0.06	0.06	0.06
Summer crops ( <i>acres</i> )							
Cotton	Advanced	Infeasible solution	2.89	2.92	2.58	2.42	2.20
Maize	Intermediate		0.54	0.61	0.25	0.11	0.25
	Traditional		0.59	0.58	0.61	1.01	0.92
Fodder	Advanced		1.23	1.23	1.23	1.23	1.23
	Traditional						
Pulses	Intermediate		1.72	1.70	1.73	1.70	1.87
Sugarcane	Advanced			0.11	0.39	0.71	1.20
Tobacco	Intermediate		1.01	2.28	2.83	2.97	2.74
Vegetables	Intermediate		0.05	0.05	0.05	0.05	0.05
Total cropped acreage			13.80	15.14	15.29	16.14	17.34
Cropping intensity			110	121	122	129	139
Net cash returns ( <i>rupees</i> )			5,204	6,089	6,379	6,656	6,923
“Shadow prices” of credit:							
	Winter		3.22	.27	.12	0	0
	Summer		1.66	.32	.35	.28	.21

Relaxing credit constraints further increases the acreage under high value crops. Sugarcane now covers approximately 40 percent of the cropped area. Because it is a perennial crop, this has been at the expense of the acreage of all other crops, although "advanced" wheat, winter fodder for sale, and tobacco have suffered less.

The rapidity with which capital is accumulated depends in part on the family's savings and consumption decisions. The following section analyzes the impact on the model's behavior of an alternative assumption about the rate of savings from net revenue.

#### *Varying the Savings Rate*

In this exercise, the assumed savings rate of the small farmer is increased from 10 to 15 percent of net cash revenue. A comparison of the model's results is given in Table 4.5.

The base solution states that a farm of 12.5 acres with an internal savings rate of 10 percent and access to credit equal to Rs. 1,600 per annum is able only to maintain a constant output level. However, if the internal savings rate increases

TABLE 4.4.—OPTIMAL CROPPING INTENSITIES AND NET CASH RETURNS FOR A RANGE OF CREDIT AVAILABILITIES

Credit availability ( <i>rupees</i> )		Cropping intensity ( <i>percent</i> )				Net cash returns ( <i>rupees</i> )			
Annual	Seasonal	Period I	Period II	Period III	Period IV	Period I	Period II	Period III	Period IV
800	Rabi: 300 Kharif: 500	Infeasible solution				Infeasible solution			
1,600 <sup>a</sup>	Rabi: 600 Kharif: 1,000	110	106	105	123	5,204	5,038	5,187	5,214
2,400	Rabi: 900 Kharif: 1,500	121	129	124	147	6,089	6,163	6,218	6,249
3,200	Rabi: 1,200 Kharif: 2,000	122	140	140	152	6,379	6,590	6,705	6,802
4,000	Rabi: 1,500 Kharif: 2,500	129	149	154	160	6,656	6,784	6,887	7,279
4,800	Rabi: 1,800 Kharif: 3,000	139	163	174	172	6,923	7,171	7,305	7,516

<sup>a</sup> Base solution.

TABLE 4.5.—OPTIMAL CROPPING INTENSITIES AND ANNUAL NET REVENUES FOR A RANGE OF CREDIT VARIATIONS AND ALTERNATIVE SAVINGS RATIOS

Credit supply (rupees)	Savings ratio (percent)	Cropping intensities (percent)				Net revenue (rupees)			
		Year I	Year II	Year III	Year IV	Year I	Year II	Year III	Year IV
Downward scaling									
800	.15	94	86	85	69	3,719	3,514	3,449	3,262
	.10		Infeasible solution				Infeasible solution		
Base solution									
1,600	.15	112	121	120	138	5,551	5,704	5,844	5,812
	.10	110	106	105	123	5,204	5,038	5,187	5,214
Upward scaling									
2,400	.15	117	134	126	152	6,120	6,399	6,317	6,643
	.10	120	128	123	146	6,089	6,163	6,218	6,249
3,200	.15	121	141	140	155	6,459	6,676	6,695	7,152
	.10	119	136	136	149	6,379	6,590	6,705	6,802
4,000	.15	124	145	152	158	6,680	6,857	7,001	7,460
	.10	124	142	146	152	6,656	6,784	6,887	7,279

to 15 percent, external credit supply remaining the same, then possibilities for growth emerge, although the results are not as dramatic as those accompanying an infusion of outside capital.

The cropping patterns are almost the same as at a savings ratio of 10 percent except that the acreages in oilseeds, cotton, and tobacco have expanded while the acreage of a low-value crop like summer pulses has declined. Net revenue has also increased because the additional savings have made it possible for the farmer to purchase the inputs required by the improved varieties of wheat and maize.

Varying credit availability at the higher savings rate underscores the cumulative interaction between internal savings and external credit. For example, at a 10 percent saving ratio, the growth process starts when the credit supply reaches Rs. 2,400, but at a 15 percent saving ratio, the firm starts growing even at an initial credit supply of Rs. 1,600. With each increase in credit, the rate of firm growth at 15 percent saving ratio is more pronounced than at 10 percent saving ratio. This general phenomenon is also reflected in the shadow price of capital. It declines as credit is increased, but when the savings rate is 15 percent, the decrease is not significant and at no time does the shadow price approach zero.

#### *Varying the Interest Rate*

Another relevant parameter in determining the growth potential of the firm is the rate of interest paid on borrowed capital. Since the interest rate in the private capital market is generally higher than that charged by government institutions such as the Agricultural Development Bank, an attempt was made to isolate its effects. With credit availability at the original Rs. 1,600 and the savings ratio at 10 percent, the interest rate is set at 10 percent. Once again, credit availability is varied parametrically (Table 4.6).

Examination of the base solution shows that at an interest rate of 10 percent, the net revenue of the farm declines slightly over time. Rates charged by private money lenders may be well in excess of this figure, and there is a strong suggestion that unless more government credit is provided, small farmers could well find themselves slipping ever deeper in debt. Indeed, at 10 percent interest the total credit constraint would have to be raised to Rs. 3,200 before a consistent upward trend in net revenue would appear.

#### *Varying Product Prices*

It has frequently been argued in Pakistan that higher prices for such important commodities as wheat can be justified on the grounds that they increase the surplus available to farmers for investment purposes. To test this claim, wheat prices were raised from Rs. 17 per maund, their value in the base solution, to Rs. 19 and Rs. 21.

Raising wheat prices produced no significant change in the growth pattern exhibited by the 12.5-acre farm, primarily because it produced only minor changes in the cropping pattern. Although the new wheat technology that is one of the options in the model is exceedingly profitable, the substantial costs associated with the purchased inputs required to grow the crop make it sensitive to the availability of funds. Thus it is impossible for the savings and investment process to gain

TABLE 4.6.—OPTIMAL CROPPING INTENSITIES AND NET CASH RETURNS FOR A RANGE OF CREDIT VARIATIONS AND ALTERNATIVE INTEREST RATES

Credit supply (rupees)	Interest rate (percent)	Cropping intensities (percent)				Net revenue (rupees)			
		Year I	Year II	Year III	Year IV	Year I	Year II	Year III	Year IV
Downward scaling									
800	.10	Infeasible solution				Infeasible solution			
Base solution									
1,600	.10	111	106	106	123	5,198	4,986	5,158	5,185
	.07	110	106	105	123	5,204	5,038	5,187	5,214
Upward scaling									
2,400	.10	120	128	115	146	6,121	6,119	5,891	6,216
	.07	120	128	123	146	6,089	6,163	6,218	6,249
3,200	.10	120	137	136	149	6,348	6,561	6,594	6,748
	.07	119	136	136	148	6,379	6,590	6,705	6,802
4,000	.10	123	143	148	150	6,591	6,679	6,884	7,098
	.07	124	142	146	152	6,656	6,784	6,887	7,279

momentum when the increase in revenue available for reinvestment is less than Rs. 100.

If more credit were available, the story would be somewhat different. Relaxing the credit constraint would make the introduction of the new technology more sensitive to relative prices, which in turn would mean proportionately greater net revenues as wheat prices went up. However, for small farmers at least, the total additional income obtained through higher wheat prices would increase the net surplus available for investment so little that higher prices cannot be considered as an alternative to increased credit.

### *Varying Farm Size*

Investigating the effect of changing the size of holding requires proportional changes in other resources as well. For example, the allotment of canal water is directly related to the amount of land commanded by irrigation. Similarly, by assumption, the level of credit availability is related to the amount of land that can be given as collateral. Only family labor and bullock labor are left unchanged throughout the exercise.

A summary of the results is presented in Table 4.7. It shows that net revenue per acre declines with increasing farm size as bullock labor constraints become binding and wage labor is hired to meet manpower demands. However, the impact of farm size on the growth prospects of the firm is erratic. For the smallest sizes, i.e., 7.5 acres and below, comparison of the first and final periods show no significant growth in net revenue per acre. At 10 acres, however, a substantial increase is registered, but this result is reversed in the 12.5-acre where the growth is again negligible. The larger farm sizes also fail to show a consistent pattern in the relationships between periods, leading to the conclusion that so long as credit availability is proportional to farm size, the effect of the change in the scarcity values of family and bullock labor are not a significant determinant of the capacity for growth.

The estimates presented in Chart 4.1 develop a more interesting theme, the nature of the trade-off between capital availability and land in providing a given level of income. Even with the limited number of points available, it is apparent that small farmers, with only modest inputs of credit, can expect to achieve increases in net revenue that put them on a par, in terms of net revenue, with their larger neighbors. This is consistent with the general expectation that where the technology is divisible, and where high-valued crops are also labor intensive, there is considerable growth potential even in situations where the land-holding would have traditionally been considered to be too small to support a family.

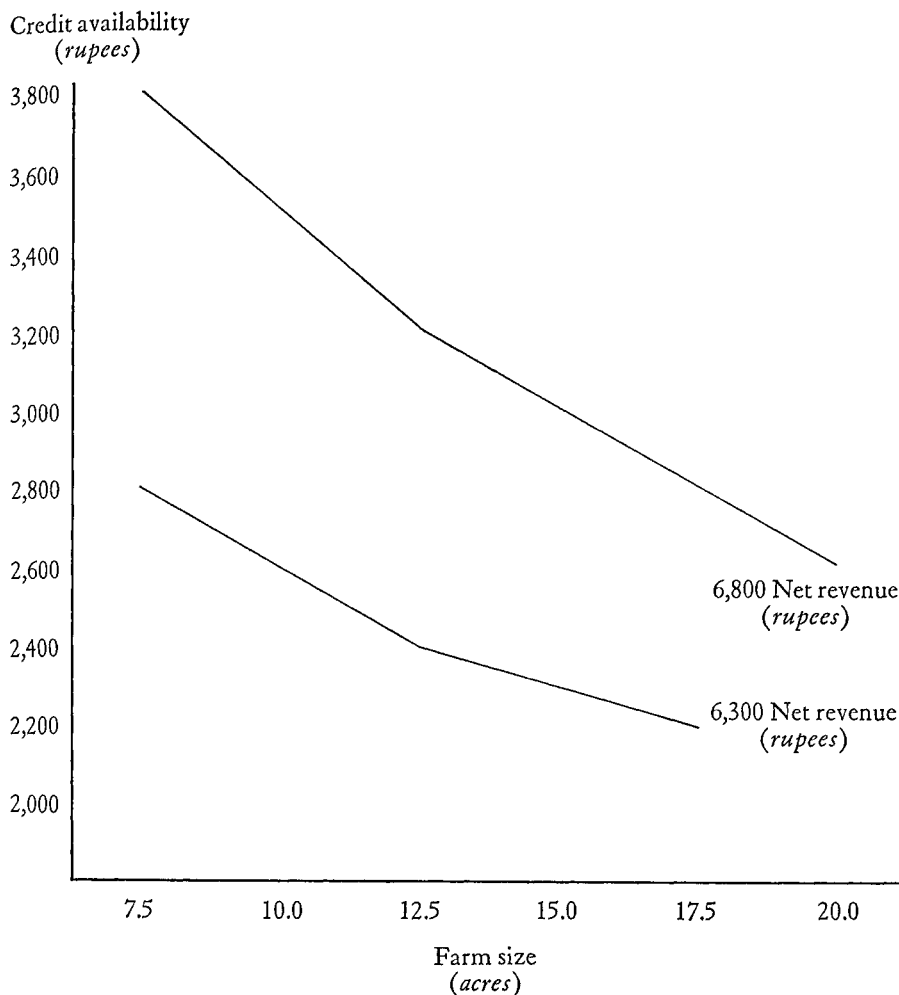
### CONCLUSIONS

The foregoing exercises have been devoted to a simulation of the conditions of small farmers in the Punjab under a variety of assumptions about the availability of credit, the rate of interest, the size of holding and general agricultural price policy. The results suggest that a substantial trade-off between land and borrowed capital exists and must be taken into account in determining the size of a minimum economic holding. This is further affected, but substantially less so, by

TABLE 4.7.—OPTIMAL CROPPING INTENSITIES AND NET REVENUES PER ACRE FOR VARIOUS FARM SIZES

Farm size ( <i>acres</i> )	Cropping intensity ( <i>percent</i> )				Net revenue/acre ( <i>rupees</i> )			
	Year I	Year II	Year III	Year IV	Year I	Year II	Year III	Year IV
5.0	124	114	91	115	471	433	376	473
7.5	123	113	92	115	471	431	378	474
10.0	112	109	109	132	442	417	421	463
12.5 <sup>a</sup>	110	106	105	123	416	403	415	417
15.0	107	102	97	119	393	378	378	395
17.5	103	98	94	110	368	352	340	362
20.0	100	96	87	102	344	322	314	319

<sup>a</sup> Base solution.

CHART 4.1.—NET REVENUE FROM  
SELECTED FARM SIZES AND CREDIT AVAILABILITIES

the savings ratio of the individual farmer and by assumptions about interest rates and product prices.

Using data drawn from a sample of small farms in Sahiwal District, it would appear that the minimum viable unit is in the range of 5 to 7 acres *provided* enough credit is available to permit the farmer to increase the area under advanced technology or to grow those high-valued crops that are demanding of purchased inputs. Even under adverse assumptions about product pricing, savings ratios, and rates of time preference, this conclusion holds; the model is relatively insensitive to the latter parameters.

Access to capital is clearly important in improving the well-being of small farmers. However, before the results of the model are taken too literally and translated into policy recommendations, several caveats are in order. First, it was



assumed in the calculations that funds must be available each year for replacing a portion of the farmer's fixed capital. While some such expenditures are undoubtedly necessary, permitting the capital stock to deteriorate and cutting back on personal consumption are sensible strategies when the payoff period for short term investment is on the order of six months. The effect of relaxing the assumption would be to lower the shadow price of credit considerably and thus reduce the significance of government programs aimed at increasing the availability of short-term funds.

A second point regarding policy relates to the size of a government lending program. As the model shows, at low levels of credit availability, each rupee invested by the farmer has an extremely high rate of return and indicates the rationality of borrowing from local moneylenders even though the interests charged are high. Except for distributive concerns, there is no need for the government to try to duplicate these funds; rather its calculations ought to be based on providing capital where private and social interests diverge. Such a program, based on removing institutional constraints to capital availability as well as reflecting society's view toward risk, would be substantially smaller than one which provided the major portion of the working capital needed by small farmers.

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