Journal of Development Economics 37 (1992) 327-350. North-Holland

Quality of livestock assets under selective credit schemes

Evidence from South Indian data

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Received October 1989, final version received January 1991

This paper examines the quality of livestock investments made by participants in India's Integrated Rural Development Programme in two villages in Southern India. Comparing the returns to livestock investment for IRDP participants against those for a control group of livestock purchasers who were not participants, it finds evidence of substantial price discrimination in the market for livestock. Participants in the scheme receive subsidised loans but purchase milch animals at inflated prices that are not compensated by higher livestock quality. Such imperfections in the markets for livestock assets may have serious adverse consequences for the efficacy of intervention to elleviate the credit market imperfections that are rightly believed to hamper the accumulation of capital by the poor.

1. Introduction

A potentially serious problem for the operation of credit-based poverty-alleviation programmes is the difficulty of identifying investments of adequate quality for beneficiaries to undertake.[1] In particular, programmes that concentrate upon rectifying the many undoubted market failures in credit

*Research for this study was funded by a grant (no. R3899) from ESCOR of the Overseas Development Administration. My thanks are due to them and also to All Souls College, Oxford, where I was Fellow at the time of the study, and who generously gave me leave of absence to undertake the research. The Madras Institute of Development Studies kindly welcomed me as a visiting scholar. All opinions expressed in this paper are strictly my own and should in no way be taken to represent the official views of the Overseas Development Administration or of any academic institution.

Many people have contributed to this research. Gilbert and Vasantha Rodrigo gave companionship and research assistance throughout the field study, and K. Kumar and S. Iyyampillai each spent several months with us in the field. Ian Alexander gave invaluable programming assistance in the U.K. Others whose advice has been important include Venkatesh Athreya, James Copestake, S. Guhan, Judith Heyer, V.K. Ramachandran, Amartya Sen, S. Subramanian, Madhura Swaminathan, Douglas Thornton and A. Vaidyanathan. Three anonymous referees made many constructive (and extremely prompt) comments. And as usual, Isabelle Daudy's support and help have been incalculable. None of the above is culpable.

[1]The literature on India's Integrated Rural Development Programme is now quite large: Drèze (1988) and Hanumantha Rao and Rangaswamy (1988) are two recent papers that explicitly address the question of the efficiency of investments in IRDP.

0304-3878/91/$03.50

markets may overlook those in the various markets for productive assets or their associated outputs and complementary inputs. In another paper [Seabright (1989)] I present evidence from two villages in Southern India that the operation of India's Integrated Rural Development Programme (IRDP) has been adversely affected by the poor quality of livestock investments made by programme participants. Overall, the net benefits to participants of undertaking credit-financed investment have been lower than the benefits to a control group who have made similar livestock investments – even after taking into account the substantial subsidy component of IRDP loans. Possible explanations fall into three broad categories. First, there is a degree of waste and corruption in the administration of the scheme, though the evidence suggests that this does not account for more than a fraction of the discrepancy in performance to be explained. Second, there is some evidence that the landless poor towards whom these loans are directed do not have the comparative advantage in the management of livestock that is sometimes attributed to them. This may partly be due to increasing returns to scale at low levels of production, and partly to complementarities between livestock and other forms of physical capital (notably land). Third, there appears to be substantial price discrimination in the markets for livestock assets, with the effect that IRDP participants pay higher prices for animals of comparable quality to those purchased by non-participants.

The purpose of this paper is to test these hypotheses. What is not in question is that IRDP-financed purchasers of livestock in the study villages paid higher prices than other purchasers. They also spent more on purchased feed for their animals, and the (imputed) cost of their labour time in livestock care was much higher per animal. Table 1 illustrates.

However, the evidence in the first column of table 1 that IRDP purchasers paid substantially more than the prices paid by non-IRDP purchasers (and more than double in one of the villages) does not in itself support the hypothesis of price discrimination. For that difference in price could have been compensated by a difference in mean livestock quality (indeed, the IRDP programme incorporates a system of veterinary inspections that is supposed to ensure that only relatively high quality animals are purchased). Similar considerations apply to the figures for feed and labour costs; these are no evidence for inefficiency in the quality or management of the investments unless the return to the higher expenditure fell significantly below the outlay. It is therefore necessary to estimate functions relating the value of livestock output to expenditure on the various inputs, in order to see whether IRDP purchasers have indeed been significantly disadvantaged, and if so why. The functions reported here provide some weak support for the hypothesis that the assetless poor lack a comparative advantage in the management of livestock, and much stronger support for the view that IRDP participants face systematic price discrimination in the market for livestock.

Table 1

Mean prices and upkeep costs of cattle in survey villages (rupees).[a]

	Purchase price	Feed cost	Full wage cost	Adj. wage cost
Village 1 (wet zone)	1,478	449	850	435
Buffaloes				
- IRDP	1,993	713	1,016	747
- Other	1,224	362	618	132
White cattle	595	163	833	282
Village 2 (dry zone)	1,441	394	647	365
Buffaloes				
- IRDP	2,394	849	911	573
- Other	1,117	130	338	189
White cattle	722	130	526	256
Total	1,243	421	749	400

[a]Full wage cost is time spent by household members caring for livestock, valued at the wage rate appropriate to the household member concerned, divided between animals in proportion to the length of time owned. Adjusted wage cost is the same figure adjusted for unemployment and underemployment: the labour of previously unemployed household members is valued at zero, while that of those employed part time is valued at half the market wage rate.

2. The survey data

The data analyzed here were collected by the author during the course of a field study of two villages in Tamil Nadu state from March to December 1985, further details of which are given in Seabright (1989). Information was collected from a stratified random sample of 82 IRDP participant and 128 non-participant households concerning, inter alia, all livestock that had been owned by the household at any time during the 3 years prior to the reference date of September 1985. Of the cattle studied in the survey, there were 379 adult females, divided (as it happened) almost exactly between the two villages, one of which was in a canal-irrigated paddy-growing zone and one in a region of almost entirely rainfed farming. For each animal in this sample of 379, data were collected regarding purchase and sale prices, milk yields and length of lactations, values of purchased feedstuffs[2] and details of

[2]A referee has raised the question why the analysis of feed restricts itself to *purchased* feed. Ideally feed grown by the household on its own land would also be included. But it proved impossible to obtain reliable quantitative data on this (households could not quantify amounts grown in the way they could quantify expenditures). This could be partly offset by the fact that households purchasing less feed would spend more time on grazing, an effect captured in the labour cost term. But it may leave unaccounted the inputs of households owning more land than the average, which might bias the results against the IRDP participants. This possibility is considered below (p. 341) where it is shown that feed purchases are in fact unrelated to (wet) land ownership. So the omission, though regrettable, does not appear to invalidate the paper's main findings.

credit arrangements; in addition, information was gathered on time spent by household members in livestock care, calves born to household livestock and benefits from the use or sale of manure. These data were used to construct a number of measures of the costs and benefits to the household of undertaking investment in the animal concerned. These left no doubt that the investments by IRDP participants had performed significantly worse than investments by the control group of non-participants, even after including the substantial elements of subsidy in the IRDP.

Livestock farming is an instance of joint production with durable capital, raising some complex issues of measurement and imputation. First, the output produced by an adult female in any time period consists not just of milk, but also of manure, and also sometimes of calves and rental services (such as in activities like ploughing).[3] Secondly, there are changes in the value of the animal itself which need to be taken into account; if the animal is still in the household's possession at the reference date (not having died or been sold), these changes in value require imputation. The procedure adopted here has been to construct a measure of gross output per animal during the 3-year reference period, where production is conceived as a one-period process employing labour, feed and capital (in the form of a purchased animal) as inputs, and yielding as joint outputs both the conventional outputs and the older animal.

Two points need to be made about this method of measurement. First, the fact that production is treated as a single-period process means that there is no distinction between stocks and flows; output is the undiscounted sum of benefits over the period. This might be a serious over-simplification if inflation had been significant over this time. However, general inflation was comfortably in single figures. And table 2 shows average purchase prices by year of purchase from 1980, revealing that IRDP prices showed no clear trend over the period and were well above those for non-IRDP animals.[4]

Secondly, it is necessary to allow for the fact that only some of the animals covered by the sample were still in the household's possession at the terminal date. If the animal died during the reference period its imputed value is zero, if it was sold the value was the sale price. For animals still in the household's possession a sale price was imputed based on a regression equation of sale

[3]Ploughing is an activity normally performed by bullocks, which were not included in the survey. However, during the survey it was realised that cows are occasionally used for ploughing in this region, in a way that the survey had not systematically inquired into. The output figures here do not include rental income; however, there is no evidence that this is more than a tiny component of income, and even then it occurs only for white cattle. Adult female buffaloes (the sub-sample on which the hypothesis of price discrimination is tested below) are not used for this purpose.

[4]In addition, the equations 9 onward below exclude all animals over 8 years of age, which removes from the sample used for hypothesis testing all adults purchased before 1980.

Table 2

Average purchase prices by year of purchase.ᵃ

	IDRP		Non-IDRP		Total
Year	%	Price	%	Price	Price
1980	0	–	8	295	295
1981	1	2,300	12	598	659
1982	32	1,959	5	686	1,713
1983	37	2,222	16	731	1,626
1984	10	2,093	20	925	1,202
1985	21	2,333	24	907	1,433

[a]Percentages do not add to 100 due to rounding, and because 16% of non-IRDP livestock were purchased prior to 1980 (these were excluded from equation 9 onwards).

prices [reported in Seabright (1991)]. The measure of gross output, then, is defined as follows:

(A) Gross output = Value of milk produced + Sale price of animal

+ Value of manure + Value of calves.

Both the value of manure and the value of calves are averages for the livestock in the household as a whole, owing to difficulties in allocating them to particular animals; this is less severe a simplification than might be feared, since households owned less than two animals each on average, and since IRDP participant households only rarely owned other livestock. In addition, the value of milk produced was, both in mean and variance, the dominant component of gross output, which is reassuring since it was the easiest component to measure with confidence.

The first thing to note about the value of livestock output is its variability. Livestock farming is a highly risky business (an important consideration for those advocating its promotion for poor households). The data here do not permit calculation of fluctuations in output over time, but for the 3-year period under consideration the intra-sample coefficient of variation in output per animal was 75.5%. This represented almost exactly the same degree of variation in the two survey villages. IRDP cattle, considered separately, displayed somewhat less variation, at 41.2% in the wet and 54.8% in the dry zone.[5] By comparison, the intra-village coefficient of variation in paddy yields per acre at the previous crop (in which there had been significant problems due to an attack of virus) was 51.0% in the wet zone. To these

[5]This was not due to the fact that non-IDRP animals included both buffaloes and white cattle. Confining attention to the sample of purchased buffaloes and excluding animals more than 8 years old (the same comparison as in equations 9 onward below) reveals a coefficient of variation of 45.9% for IRDP animals and 105.8% for non-IRDP animals.

observations may be added the fact that the intra-village yield variations in crops are more likely to be anticipated by the farmers concerned – since one of their main determinants, land quality, is a constant from year to year. By contrast, a farmer contemplating the purchase of livestock will not know its quality, though appropriate indicators may of course be observed at the time of purchase.[6]

The three basic inputs measured were costs of feed, labour time and capital expenditure on the purchase of the animal (expenditure on other equipment was negligible). The costs of feed were based on estimated monthly average expenditures (collected separately for periods when the animal was milking, dry and pregnant). Labour costs were based on estimated daily time spent in care of livestock by different members of the household. These were evaluated at the market wage rate appropriate for the household member who undertook the care (since men, women and children receive different wages in the market for agricultural labour), and divided among all livestock owned by the household in proportion to the length of time owned. Capital outlays are defined as the sum of the purchase price and incidental expenses of purchase (including bribes where reported); as tables 5 and 6 below demonstrate, it makes little difference whether these incidental expenses are included or not; the poor relative performance of IRDP investments is not primarily attributable to there being a greater inccidence of such expenses.[7]

The question of interest therefore is the extent to which the variability in gross output per animal is statistically explained by variations in capital outlays and the value of other inputs – and specifically, whether and to what extent the greater capital outlay of IRDP participants corresponds to a greater value of gross output. The basic equation of interest therefore is

$$\text{(B)} \quad GY=\alpha_1 . ICAP+\alpha_2 . NCAP+\alpha_3 . LABCOST+\alpha_4 . FDCOST + \alpha_5 . HC+u,$$

where

GY	= gross output,
$ICAP$	= capital outlay of IRDP participants (others = 0),
$NCAP$	= capital outlay of non-participants (others = 0),

[6]A referee points out that some of the variation is predictable at the time of purchase – some animals are too young to lactate and others are pregnant and it is the unpredictable component that counts. The figure cited here cannot distinguish between predictable and unpredictable components. They are used merely to give a general impression that livestock farming does not appear to be any less risky than growing crops – if anything, the reverse is true. This is important to bear in mind when devising programmes of livestock investment that are intended to assist the poor, a point that is taken up in section 4 below.

[7]This does not seem to have been due to an unwillingness to report bribes. Almost all households did so, and often complained vociferously about them, but the magnitude of the sums involved was small compared to the discrepancies in purchase price paid.

LABCOST = labour cost,
FDCOST = cost of purchased feed,
HC = vector of variables capturing differences in household circumstances (such as land ownership).

Equation (B) is not a production function: it does not capture a technical relationship between inputs and outputs, but simply a statistical relation between expenditures on these items. However, economic theory has implications for the values of the coefficients: in a world of certainty, efficient optimisation by the household and an efficient livestock market would imply that $\alpha_1=\alpha_2=\alpha_3=\alpha_4=1$. A marginal increase in labour or feedcost inputs should just be compensated by an increase in gross output (the household optimisation hypothesis), and any intramarginal gains to ownership of the animal should be precisely captured in the capital outlay needed to acquire it (the efficient livestock market hypothesis). Likewise, in the absence of economies of scale or scope, $\alpha_5=0$. Indeed, when $\alpha_1=\alpha_2=\alpha_3=\alpha_4=1$ and $\alpha_5=0$, equation (B) can be simply rewritten as a pair of asset price valuation equations:[8]

(B′) $ICAP=GY-FDCOST-LABCOST$ for IRDP participants,
$NCAP=GY-FDCOST-LABCOST$ for others.

A more realistic view of the conditions in the survey villages would modify these expectations in two main ways. First, in the presence of involuntary unemployment one might expect the estimated value of α_3 to be less than unity, reflecting the fact that the expected opportunity cost of household members' time is less than their market wage rate, since they are not certain of being able to obtain employment.[9] Second, in the presence of uncertainty about output values, and risk aversion on the part of farmers, the estimated values of the coefficients α_1 to α_4 would tend to be somewhat greater than unity, to reflect a risk premium.[10] If IRDP participants and

[8]It should be noted that these are undiscounted valuations, because (as explained above) data on the timing of the various flows proved impossible to obtain accurately, and the production process has therefore been modelled as a single period. This regrettable simplification introduces some upward bias into the parameter estimates of α_1 and α_2, which may help explain the values of α_2 substantially above unity, while making the low values of α_1 even more surprising. But there is no reason to think that the absence of discounting biases one coefficient more than the other.

[9]This assumes that *LABCOST* is measured without adjustment for unemployment. An alternative would be to use the variable referred to in table 1 as the adjusted wage cost. This possibility is considered in the equations in table 7 below.

[10]One referee has argued that these coefficients could be expected 'to be *much above* unity, as in the study of Bliss and Stern (1982)'. It is hard to know how to evaluate this claim, since the high values of coefficients in the Bliss and Stern study are an anomaly for which risk aversion is only one possible explanation. However, I share the referee's intuition that the returns to livestock investment revealed by these equations are not high given the risks involved.

others were identically risk averse, then the hypotheses of household optimisation and efficient livestock markets would imply that $\alpha_1 = \alpha_2 > 1$. It is the rejection of this null hypothesis that will be the main focus of this paper.

In fact, the evidence reported above that the variability of gross output is lower for IRDP than for non-IRDP livestock, suggests that IRDP and non-IRDP participants may not be identically risk averse, a possibility that will be considered in section 5 below.

3. Results

Table 3 reports some basic descriptive regressions, which are used to suggest hypotheses for subsequent testing. Equations 1–4 do not consider whether IRDP and non-IRDP investments yield different returns to outlay, but consider the determinants of gross output for the sample as a whole, with dummy variables for IRDP participation. They are therefore versions not of equation (B) but of the related equation

$$\text{(C)} \quad GY = \alpha_0 CAP + \alpha_3 . LABCOST + \alpha_4 . FDCOST + \alpha_5 . HC + v,$$

where CAP is capital outlay (all participants), and the vector HC contains an IRDP participation dummy. It will be seen that the use of a participation dummy to capture IRDP effects does not, in fact, prove to be a satisfactory specification.

Equation 1 was estimated for the whole sample of 379 animals by weighted least squares. Ordinary Least Squares estimation (shown in equation 2 for comparison) is inappropriate because of heteroskedasticity, since the residuals fail the Glejser test.[11] The weighting procedure for each reported equation is a two-step one: first, OLS estimation is used and the absolute values of the residuals $\hat{v}_i$ regressed on the fitted values $\hat{g}_i$ of GY;[12] then the weights w_i were derived as the squared reciprocal of the predicted absolute values of the residuals. Comparison of equation 1 with equation 2 shows that appreciable proportionate changes in the values of the coefficients under weighted least squares as compared with OLS occurred only (as one would expect) for the most poorly identified coefficients. With the improved specification of equation 7 onward the difference between OLS and WLS results became quite insufficient to make any difference to the hypothesis testing.

[11] See Maddala (1977, p. 262).

[12] The square and the square root of $\hat{g}$ were also used as regressors. The equation used for deriving weights retained only those regressors that were significant at the 5% level.

Table 3

Determinants of gross output.

Independent variable	Equation 1 (WLS)	Equation 2 (OLS)	Equation 3 (WLS; dry zone)	Equation 4 (WLS; wet zone)	Equation 5 (dry zone)	Equation 6 (wet zone)
	$R^2=0.60$	$R^2=0.70$	$R^2=0.71$	$R^2=0.69$	$R^2=0.68$	$R^2=0.67$
Outlay	0.743 (0.18)	0.900 (0.18)	0.717 (0.23)	0.898 (0.20)	0.968 (0.12)	1.178 (0.14)
Labour cost	1.019 (0.14)	0.927 (0.12)	0.695 (0.20)	1.088 (0.20)	1.570 (0.20)	1.800 (0.24)
Feed cost	0.142 (0.17)	0.142 (0.14)	0.383 (0.23)	0.076 (0.21)	0.728 (0.21)	1.225 (0.23)
Irrigated land operated	203.8 (70.6)	182.7 (63.4)	82.0 (192.0)	144.8 (84.9)	0.454 (0.24)	-
Number of cattle owned	179.2 (58.5)	172.8 (62.3)	162.4 (77.2)	301.5 (84.9)		
Dummy variables						
IRDP	383.0 (432)	9.9 (411)	241.4 (638)	481.7 (554)		
White cattle	250.5 (238)	99.8 (277)	148.0 (292)	819.0 (373)		
Scheduled caste	−349.2 (199)	−290.1 (211)	−59.5 (266)	−1,100.3 (310)		
Female-headed household	706.2 (305)	472.7 (327)	−626.2 (494)	1,113.1 (366)		
Young animal	−12.2 (335)	−29.3 (422)	192.3 (457)	−116.5 (407)		
Old animal	850.8 (315)	769.0 (321)	1,231.3 (317)	184.6 (614)		

Equations 3 and 4 compare these results for the whole sample with those for the two villages considered separately, since these sub-samples display importantly different characteristics. The coefficients on outlay are a little below unity, though not significantly so. However, the specification of the equation is unsatisfactory in a number of respects: many of the explanatory variables are poorly identified, including the IRDP dummies, which is almost certainly due to the high correlation of outlay with IRDP participation. Furthermore, the sample contains a number of animals that have been bred from others in the household's possession rather than purchased; these will tend to involve larger outlays of labour and feed to compensate for the absence of capital investments, and will bias upward the coefficients on the former and bias downward the coefficients on outlay compared to the true value for IRDP participants. Equations 5 and 6 are therefore estimated on the sub-sample of 309 purchased animals (as are all remaining equations in this paper); they revert to the form of equation (B) and exclude the insignificant dummy variables. What do these equations show?

In both sub-samples the returns to outlay are lower for IRDP participants than for non-participants. Also, the returns to labour are lower in the dry zone (this might be thought to reflect the fewer alternative employment opportunities available, but as will be seen below the use of adjusted labour cost measures does not lead to parameter estimates closer to unity). The most striking departure from optimality concerns feed costs, the returns to which are a long way below unity and negligibly different from zero in the wet zone. It is possible that this is evidence of overinvestment in purchased feed, particularly by recipients of loans who perhaps lack experience in the management of cattle. Alternatively, it might be that owners treat the provision of feed as a fixed cost that is necessary to keep the animal alive (and whose urgency therefore increases the more expensive is the animal, but contributes relatively little at the margin to its actual milk output).

If true, this would be compatible with household optimisation and market efficiency (and therefore with $\alpha_1=\alpha_2=\alpha_3=\alpha_4=1$ in the true underlying equation). But estimates of equation (B) would then yield downward biased estimates of α_4, because higher than average values of *FDCOST* would be correlated, not just with higher than average values of *GY*, but with lower than average values of *ICAP* and *NCAP*. Equation (B) can be estimated with an imposed value of $\alpha_4=1$, which is equivalent to estimating an equation for output net of *FDCOST*. The same could be done for *LABCOST*. Essentially this is the procedure in equations 7–10 below.

Equation 4 has significant positive coefficients on the number of animals owned by the household and the acreage of irrigated land operated. It is possible that this is indicative, first, of mild scale economies, and secondly, of a degree of complementarity between land and livestock, in the sense that ownership of land raises the productivity of livestock (perhaps by making available grazing and feedstuffs as a by-product of cultivation). However, both variables yielded insignificant (though positive) parameter estimates when added to equation 6. There may nevertheless be significant dynamic scale economies in livestock management (especially of the learning-by doing variety, such as in ensuring successful breeding); however, the present data set is unsuited to testing for them. On balance it seems best to conclude that static scale economies may exist, but are not (on present evidence) very great.

The dummy variable for owners' membership of the scheduled castes is not only significantly negative but very large in equation 4, and still large if insignificant at 5% when added to equation 6. This differs strikingly from the dry zone, where there are in any case fewer members of the scheduled castes. What this suggests is the possibility of price discrimination between categories of buyers, affecting mainly (in the wet zone) members of these castes. Two ways suggest themselves in which this might happen. IRDP cattle tend (in this region and at the time of the study, at least) to be bought by groups of beneficiaries in company with officials of the sponsoring bank, in markets that are not so large as necessarily to be proof against price-rigging. It may be that in the *purchase* of the animals there is discrimination against scheduled castes. This would probably be because large groups of scheduled castes would be identifiable as such, and their caste status might be correlated with signs, or might itself be taken as a sign, of the fact that they were beneficiaries of the IRDP scheme (by contrast, scheduled castes in the dry zone tend to mix inconspicuously with the higher caste groups, and might be less identifiable among purchasers of cattle). Alternatively, there could be discrimination against these castes in the *distribution* of the animals after they have been purchased by the groups of beneficiaries and officials. The evidence in table 8 (to be discussed below) suggests that the former is a more plausible account than the latter, but that its operation is not confined to the IRDP. Further discussion of the institutional context in which price discrimination might take place will be undertaken in section 4 below.

A dummy is also included for female-headed households, since women are a particular target group of the IRDP. This has a large and significantly positive coefficient in equation 4 (only in the wet zone where there are female-headed households in significant numbers), but the coefficient, though positive, is not significant when the dummy is added to equation 6. It is commonly believed that female-headed households tend to benefit considerably from the IRDP, not so much because they make the investment more profitable but because their other economic opportunities are by comparison severely limited; whereas the cow has not yet been bred that yields less milk to a woman than to a man. If so, one would expect such an effect to be observed in equations in which output net of the opportunity cost of labour is the dependent variable (as in table 5 below). In fact the female-headed household dummy variable has a positive but insignificant coefficient in those equations, so such an effect does not appear to have been very marked in this sample. However, it is quite possible that IRDP participation is nevertheless beneficial to women,[13] even if these women are not especially concentrated in households with female heads.

The hypotheses suggested by the equations in table 3 fall into two broad categories:

(1) Those implying price discrimination between otherwise identical groups of purchaser, in that IRDP participants (or some identifiable sub-group such as the scheduled castes) pay higher prices or receive lower quality animals than non-participants. This means that $\alpha_1 < \alpha_2$ but is consistent with $\alpha_3 = \alpha_4 = 1$ and $\alpha_5 = 0$.
(2) Those implying that IRDP participants are less well equipped to manage the investments than are non-participants, whether because of lower skill levels or lower access to complementary inputs such as land. This means that either α_3 or α_4 is different from unity or α_5 is different from zero, but is consistent with $\alpha_1 = \alpha_2$.

In practice, discriminating between these hypotheses is not entirely straightforward. In what follows I shall first test the joint null hypothesis that there is no price discrimination and no difference in capacity to manage the investments between participants and non-participants (hereafter to be called the hypothesis of equal quality of investments). This is equivalent (in the absence of risk aversion) to the hypothesis that $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = 1$ and $\alpha_5 = 0$, and is therefore a test of the asset pricing equations (B′). Then I shall test particular versions of the price discrimination hypothesis separately.

To test the hypothesis of equal quality of investments, I first calculate a measure of net output [the left-hand side of equation (B′)]. Estimating net output as a function of outlay for participants and non-participants is therefore equivalent to imposing the restrictions that $\alpha_3 = \alpha_4 = 1$ and $\alpha_5 = 0$, and testing for the validity of the hypothesis that $\alpha_1 = \alpha_2$. Rejection of the null implies that either α_1 is not equal to α_2 or the restrictions on the remaining coefficients are invalid.

The absence of price discrimination implies that any differential in price paid for an animal must be compensated by a differential in output net of necessary production costs; identical management capacity implies that any differential in production costs between the two groups of purchasers must reflect differences in necessary costs of managing different qualities of animal. The measure, net output, is therefore defined as

[13] It may be beneficial to them by giving women greater control over the income generated, regardless of whether it generates greater income absolutely than alternative opportunities for the household as a whole.

Table 4

Outlay, prices and livestock output in survey villages (rupees).

	Number of animals	Outlay	Purchase price	Gross output	Net output
Village 1 (wet zone)	191	1,554 (65)	1,478 (62)	3,121 (169)	2,003 (176)
Buffaloes					
- IRDP	80	2,136 (32)	1,993 (39)	3,522 (163)	2,063 (195)
- Other	53	1,235 (117)	1,224 (116)	3,010 (420)	2,516 (447)
White cattle	58	595 (88)	595 (88)	2,669 (332)	2,224 (320)
Village 2 (dry zone)	188	1,524 (75)	1,441 (69)	2,524 (137)	1,765 (131)
Buffaloes					
- IRDP	69	2,589 (24)	2,394 (33)	3,579 (240)	2,158 (252)
- Other	21	1,134 (200)	1,117 (199)	2,704 (497)	2,386 (512)
White cattle	98	727 (40)	722 (39)	1,742 (131)	1,355 (133)

[a]Figures in parentheses are standard errors.

(D) Net output = Gross output − Cost of purchased feed − Cost of labour,

where the cost of labour is not that used in equations 1–6, but rather the labour cost adjusted for the unemployment or underemployment of household members (it represents in effect the opportunity cost of labour actually withdrawn from other economic tasks). This is the more appropriate measure to use if we are testing the hypothesis of equal investment quality (irrespective of the reasons for any discrepancy). It corresponds to the measure in the fourth column of table 1, which (in comparison with the third column) revealed that IRDP participants were more likely than non-participants to have had to withdraw labour from other tasks. Table 4 compares outlay and purchase price in different categories with both Gross and Net output, for those animals that had been purchased (as opposed to being bred by the household).

In both villages, participants paid more than non-participants (the differences are significant at 5%) but obtained net outputs that were on average lower (though not significantly at 5%). This makes it unsurprising that, when regressing net output on outlay and the relevant dummies we can reject the null hypothesis that the coefficients on outlay are the same for participants and non-participants. Table 5 illustrates. Four equations are reported. In

Table 5

Determinants of net output[a]

Independent variable	Equation 7 (whole sample)	Equation 8	Equation 9 (excl. old animals)	Equation 10 (buffaloes only)
	$R^2=0.43$ $T=4.50$	$R^2=0.43$ $T=4.17$	$R^2=0.43$ $T=5.01$	$R^2=0.46$ $T=3.87$
Outlay (IRDP)	0.845 (0.078)	–	0.847 (0.078)	0.850 (0.082)
Outlay (non-IRDP)	1.713 (0.180)	–	1.887 (0.193)	1.921 (0.264)
Purchase price (IRDP)	–	0.922 (0.084)	–	–
Purchase price (non-IRDP)	–	1.773 (0.187)	–	–
Old animal	1,100.7 (371.2)	1,162.8 (377.2)	–	

[a] T is the value of the T-statistic for the null hypothesis that the coefficient on outlay (IRDP) equals the coefficient on outlay (non-IRDP), or that the coefficient on purchase price (IRDP) equals the coefficient on purchase price (non-IRDP), as appropriate. Figures in parentheses are standard errors.

equation 7 Net output is regressed on outlay for participants and non-participants respectively, as well as on a dummy for animals above 6 years old. Equation 8 uses purchase price as a regressor instead of outlay, with very similar results.

In equations 8 onwards T represents the value of the T-statistics for the hypothesis that $\alpha_1=\alpha_2$. In equations 7 and 8 we can reject with overwhelming (greater than 99.99%) confidence the hypothesis that the true coefficients on outlay or purchase price are the same for the two groups.[14]

It may be noted that the coefficient on the dummy for old animals is very high (and that old animals can be expected to be outliers). So equation 9 performs the same estimation on a sample from which the approximately 10% of animals over 8 years old have been excluded. Equation 10 tries to make the basis of comparison between the two groups more precise by estimating only for buffaloes (and again excluding old animals). Excluding old animals makes even more dramatic the disparity between the returns to outlay for the two groups; confining the comparison to buffaloes diminishes the disparity somewhat. But in all four equations the returns to outlay for

[14] This is equivalent to the T-value for the hypothesis that $\alpha_7=0$ in the equation:

(D) $NY=\alpha_6 . CAP+\alpha_7 . NCAP+\alpha_5 . HC+u$,

where NY = Net output, CAP = Capital outlay (all livestock), and $NCAP$ is Capital outlay (non-IRDP only). $NCAP$ therefore functions as a slope dummy variable.

non-participants are very significantly above unity; for IRDP participants they are below unity, significantly so at 5% in equations 7 and 9 and almost so in equation 10. The T-statistics are significant at tiny fractions of 1 percent. We can clearly reject the hypothesis of equal investment quality.

Deciding the relative importance of price discrimination and disparity in management capacity between households is considerably more difficult. Differences in labour cost between households almost certainly arise because of differences in household circumstances rather than the different requirements of particular animals. Differences in the cost of purchased feed are harder to interpret. They seem a priori more likely to be due to differences in household circumstances (such as availability of land). But a simple (unweighted) OLS regression of feedcost yields the following results:

$$\text{(E)} \quad \text{Feedcost} = \underset{(0.78)}{161.0} + \underset{(0.36)}{0.047PP} - \underset{(-0.22)}{13.8WL} + \underset{(4.27)}{0.332LC} + \underset{(1.20)}{229.1IRDP},$$

where PP = Purchase price; WL = acres of wetland operated; LC = labour cost; $IRDP$ = participation dummy and the figures in parentheses are T-statistics. The only coefficient significant at 5% is LC, which is positive. If differences in feedcost were due to differences in household circumstances (rather than differences in animals owned), one would expect negative coefficients on land ownership (the more land owned, the less need to purchase feed) and on labour cost (the more household labour available to gather fodder or to supervise grazing, the less need for feed). So on balance it seems more probable that the higher costs of feed for IRDP animals were either due to these animals being inherently more expensive to maintain (being either larger or less healthy than the average), or represented a misallocation of resources by households who lacked experience in livestock management.

To test directly the hypothesis that there is no price discrimination I abandon the restrictions on the coefficients α_3 to α_5 and estimate the unrestricted equation (B). In other words, gross output is regressed on outlay (and, alternatively, on purchase price[15]). to ensure that the test is not affected by differences in the breed of cattle purchased, attention is restricted to the sub-sample consisting only of purchased buffaloes (the most direct control group for IRDP investments). In effect this allows the values of the coefficients α_3, α_4 and α_5 to be determined by the data, and ensures that the test of $\alpha_1 = \alpha_2$ is not affected by possibly invalid restrictions on the remaining

[15]It is not necessarily the purchase price that is the more appropriate regressor: if the incidental expenses of purchase (such as payments to a broker) are designed to raise the quality or lower the price of the animal being bought, they ought properly to count as part of the cost of purchase. In the results reported here the choice of regressor makes no important difference.

Table 6

Determinants of gross output.[a]

Independent variable	Equation 11	Equation 12	Equation 13	Equation 14
	$R^2=0.75$ $T=3.43$	$R^2=0.75$ $T=3.02$	$R^2=0.75$ $T=3.36$	$R^2=0.76$ $T=3.74$
Outlay (IRDP)	1.139 (0.095)	–	1.176 (0.090)	1.279 (0.098)
Outlay (non-IRDP)	1.813 (0.193)	–	1.832 (0.191)	1.982 (0.200)
Purchase price (IRDP)	–	1.225 (0.102)	–	–
Purchase price (non-IRDP)	–	1.832 (0.195)	–	–
Labour cost	0.851 (0.200)	0.847 (0.200)	0.858 (0.189)	0.835 (0.177)
Feed cost	0.108 (0.152)	0.132 (0.152)	–	–
Scheduled caste	–	–	–	−379.6 (173.9)

[a]T is the value of the T-statistic for the null hypothesis that the coefficient on outlay (IRDP) equals the coefficient on outlay (non-IRDP), or that the coefficient on purchase price (IRDP) equals the coefficient on purchase price (non-IRDP), as appropriate. Figures in parentheses are standard errors.

coefficients.[16] Table 6 illustrates. Equation 10 regresses gross output on outlay for the two groups as well as on labour cost and feed cost. Equation 11 checks whether the results are affected by using purchase price as a regressor instead of outlay (they are not), and equations 13 and 14 compare the effect of dropping the insignificant regressor *FDCOST* and adding a dummy variable for scheduled caste membership. The conclusion that there is price discrimination is robust to all these alternative specifications. In all four of equations 11–14 the hypothesis that the coefficients for IRDP participants are the same as those for non-participants can be rejected at well below the 1% level.

Provided difference in gross output between households are due to differences in livestock quality and not to omitted differences in household circumstances, then the null hypothesis that there exists no price discrimination between participants and non-participants in the IRDP can be rejected. A number of independent variables representing possibly important

[16]Of course, as noted above, if *FDCOST* and *LABCOST* are fixed costs, then the parameter restrictions may be valid even if their estimated values in the unrestricted equation are significantly below unity. This biases the significance test of $\alpha_1=\alpha_2$ in the unrestricted equation in favour of the null, so the fact that the null is rejected strengthens rather than weakens the present argument.

household circumstances (land ownership, number of animals owned, sex of household head) were tried in the estimations of equations 11–14 and proved entirely insignificant. There may of course be household circumstances whose effect has not been captured in the present data set. But unless these circumstances can be identified, to salvage the null hypothesis by appealing to (unspecified) advantages that non-participants possess over participants is very unsatisfactory. It also provides no more grounds for optimism about the workings of the IRDP scheme than does acceptance of the presence of price discrimination, which at least suggests ways to think about improving the workings of the scheme. I conclude, then, that a major reason for the difference in investment quality between participants and non-participants in the IRDP is the presence of price discrimination in the market for livestock. However, the fact that the coefficient on feedcost is a long way below unity, and that on labour cost some way below, coupled with the fact that the values of these two variables are much higher for participants than non-participants, suggests (though not conclusively) that IRDP households may *also* be at a disadvantage due to their circumstances: either their lower endowments of underemployed labour, or their lack of experience in livestock managment.

The possibility of disadvantageous circumstances affecting IRDP households is further investigated in table 7. In equation 15 adjusted labour costs are used as a regressor in place of the unadjusted variable *LABCOST*. The hypothesis that $\alpha_1=\alpha_2$ is still rejected, with a T-value greater than 3. The coefficient on adjusted costs is lower than that on unadjusted costs in the previous equations, and is highly significantly below unity. So the fact that some households appear to have been investing excessive amounts of labour in livestock management does not appear straightforwardly to be due to the failure to adjust labour cost measures for unemployment; on the contrary, those households whose opportunity cost of labour was lowest (non-IRDP households) appear to have enjoyed higher returns at the margin to livestock management. This finding is confirmed in equation 16, where IRDP slope dummies are added to the variables representing feedcost and labour cost as they appeared in equation 11. IRDP participants receive very significantly lower returns to their (unadjusted) labour input; non-participants receive returns respectably above unity. By contrast, slope dummies are insignificant if added to equation 15 where the labour cost measure has been adjusted for unemployment. This implies that IRDP participants do not necessarily face lower absolute returns to their labour at the margin; their disadvantage lies in the fact that their opportunity cost of labour is higher. The fact that they do not reduce their labour input accordingly may be due to a comparative lack of experience in livestock management. Alternatively, it may reflect the fixed cost nature of labour inputs. Either way, however, it appears that since IRDP households are more likely to have had to withdraw labour from

Table 7

Determinants of gross output.[a]

Independent variable	Equation 15	Equation 16	Equation 17
	$R^2=0.72$ $T=3.12$	$R^2=0.80$ $T=2.24$	$R^2=0.79$ $T=2.52$
Outlay (IRDP)	1.261 (0.103)	1.150 (0.091)	1.379 (0.107)
Outlay (non-IRDP)	1.905 (0.192)	1.568 (0.163)	1.602 (0.175)
Labour cost (unadjusted)	–	1.507 (0.521)	1.583 (0.451)
Labout cost (adjusted)	0.299 (0.199)	–	–
Feed cost	0.291 (0.169)	−0.323 (0.244)	–
Scheduled caste	–	–	−530.2 (218.2)
IRDP slope dummy (feed cost)	–	0.766 (0.301)	–
IRDP slope dummy (labour cost)	–	−1.030 (0.552)	−0.925 (0.482)

[a] T is the value of the T-statistic for the null hypothesis that the coefficient on outlay (IRDP) equals the coefficient on outlay (non-IRDP), or that the coefficient on purchase price (IRDP) equals the coefficient on purchase price (non-IRDP), as appropriate. Figures in parentheses are standard errors.

other occupations, the fact that this labour has low marginal returns is particularly to their disadvantage.

Interestingly, equation 16 shows also that IRDP participants receive higher returns to investment in purchased feed, but still not nearly enough to bring the coefficient close to unity.[17] It remains puzzling, therefore, why their expenditure on feed remains so much higher than that of non-participants. As in the case of labour inputs, this might be due either to lack of experience or to the fixed cost nature of the inputs. It is not possible to discriminate here between these hypotheses – but either of them implies that IRDP participants are at a disadvantage relative to others in livestock management.

Equation 14 in table 6 showed that a dummy for schedules caste membership is significant at the 5% level. Tables 8 and 9 explore this phenomenon in greater detail. Table 8 shows the average purchase price, gross and net output realised for buffaloes in the wet zone (where the scheduled castes were both more numerous and less integrated into the life of the other castes).

[17] The fact that the coefficient on feed cost for non-participants in equation 16 is now negative (though insignificant at 5%) is puzzling. My guess is that this indicates that feed operates rather like a fixed cost.

Table 8

Comparison of prices and output between scheduled and other castes (buffaloes only, wet village).

	Purchase price	Gross output	Net output
Non-scheduled castes	1,558	3,862	3,303
(no. of animals = 51)	(98)	(411)	(418)
Scheduled castes	1,819	2,975	1,577
(no. of animals = 82)	(70)	(187)	(205)
Total	1,727	3,316	2,241

Table 9

Determinants of gross output.[a]

Independent variable	Equation 17	Equation 18
	$R^2 = 0.79$ $T = 2.52$	$R^2 = 0.76$
Outlay (IRDP)	1.379 (0.107)	1.368 (0.136)
Outlay (non-IRDP)	1.602 (0.175)	2.124 (0.320)
Labour cost (unadjusted)	1.583 (0.451)	0.861 (0.195)
Feedcost	–	0.083 (0.150)
Scheduled caste	−530.2 (218.2)	–
IRDP slope dummy (labour cost)	−0.925 (0.482)	–
Scheduled caste outlay slope dummy (IRDP)	–	−0.353 (0.146)
Scheduled caste outlay slope dummy (non-IRDP)	–	−0.933 (0.381)

[a] T is the value of the T-statistic for the null hypothesis that the coefficient on outlay (IRDP) equals the coefficient on outlay (non-IRDP), or that the coefficient on purchase price (IRDP) equals the coefficient on purchase price (non-IRDP), as appropriate. Figures in parentheses are standard errors.

While the scheduled castes paid higher prices they received lower output in both gross and net terms (the latter strikingly so, with net output less than half of that achieved by the higher castes). Table 9 tests these differences econometrically. Equation 17 confirms that the discrimination revealed in equation 14 is robust to the addition of the slope dummy for IRDP labour costs (indeed the coefficient increases). The equation shows that the scheduled castes (whose animals number 47% of the sample) do unmistakably worse than others, even controlling for IRDP participation. It would be tempting, but mistaken to conclude from this that it is the IRDP scheme itself which enables price discrimination to take place against scheduled castes. But equation 18 adds slope dummies for scheduled caste membership to the outlay terms in the basic specification reported in equation 11. Its findings are striking: the scheduled castes do indeed face price discrimination under IRDP, but they face grave discrimination already even as non-participants. In fact, the net price discrimination faced by scheduled caste members who are also participants in the IRDP is only slightly greater than that faced by scheduled caste members who are not.[18]

4. How is price discrimination possible?

Taken together, these results apppear to indicate that in the fragmented and oligopolistic markets for livestock characteristic of the area of the survey, significant price discrimination is possible between categories of purchaser. The failing of the IRDP has been, not that it made price discrimination possible where none existed before – but rather, that by failing to take account of the possiblity of price discrimination in the livestock market it has left participants in the scheme with comparatively low quality assets.

How is this price discrimination possible? First of all, markets in this area tend to be dominated by rings of brokers. Although there may perhaps be a score or more of these at any one market, they meet repeatedly and may therefore be able to enforce collusive agreements to the detriment of IRDP purchasers (and also of other groups such as the scheduled castes). Secondly (and just as important) there is undoubtedly a degree of at least passive collusion by bank and society officials in this price discrimination. By this I mean that negotiations for the purchase of cattle in a group may not be conducted as vigorously on behalf of the IRDP participants as they would be if the officials concerned were negotiating with their own resources.[19] This may not be with malign intent (and in particular, this study found no evidence that officials received bribes from cattle brokers, though such bribes may nevertheless have occurred); negotiation is a tiring business, and officials may well believe that they can afford to be relaxed about it because of the substantial subsidy component the participants are receiving. Indeed, it is quite possible that IRDP participants and officials are unaware quite how

[18]In fact, estimating equation 11 separately for scheduled caste members (not reported here) yields insignificantly different coefficients on outlay for participants and non-participants.

[19]Although individuals are free to conduct their own negotiations they are not free to choose to go to the market at a place and time to suit themselves. Since IRDP participants often have little experience of livestock markets many of them tend, once in the company of bank and society officials, to leave much of the negotiation to them or at least to seek substantial advice from them.

much of a premium they are paying. A number of villagers reported their belief that the cattle purchased under the IRDP were of low quality; the reasons conjectured for this varied, but were most commonly ascribed to a general tendency of everything associated with government schemes to be of low quality, rather than to any more specific cause.[20] However, it is doubtful whether either participants or officials are aware of the magnitude of the phenomenon: officials do not have to live with the consequences, and are inclined to dismiss reports of poor quality with remarks like 'people are never satisfied'; participants have difficulty in generalising from their own individual case because of the highly variable nature of livestock farming.

Thirdly, IRDP participants are particularly hamstrung in the negotiation process by their inability credibly to threaten to withdraw from the market altogether. The rules governing the release of IRDP loan funds are somewhat inflexible,[21] and (at the time of the survey at least) participants faced the prospect of losing their entitlement to a loan altogether if they did not make a purchase on the date agreed with the bank officials. These rules have been framed with the intent of ensuring that individuals genuinely make the livestock purchases that they claim they will make, and do not divert the loan to other purposes. But the findings of this study suggests that this form of loan tying may have considerable hidden costs.

It is worth observing that analysis of the resale prices of livestock is compatible with the finding of price discrimination. The resale price equation reported in Seabright (1991) reveals that IRDP purchasers do worse than others on resale. This is revealed partly by the fact that an IRDP participation dummy is negative (though not significant at the 5% level). But more importantly, a 1% increase in the price paid at purchase is associated with less than half a percentage point increase in the resale price, so that IRDP purchasers (who pay higher prices) do not see these proportionately reflected in higher resale values. However, other discrepancies revealed in the purchase price data do not necessarily imply price discrimination. For example, the fact that IRDP buffaloes in the dry village were purchased for an average of 20% more than those in the wet shows up in resale values: other things equal, dry village resale prices were 26% higher.

Finally, it is worth remarking that the circumstances in which subsidised credit may lead to price discrimination may be of considerably more general application than the narrow context of livestock markets considered here. Whenever there is imperfect competition in markets for productive assets, sellers will have a degree of bargaining power that enables them to capture some of the rent embodied in the credit subsidy. This imperfect competition

[20]A common parallel drawn was with subsidised rice, which was of notoriously lower quality than open market rice.

[21]They have more recently been streamlined to allow more initiative for individual purchasers, though it is hard to know what effects the changes can be expected to have.

need not be due only to small numbers of sellers protected by barriers to entry: buyers may have relationship-specific investments with certain sellers, for instance, even if the total number of sellers is very large. For example, tenants of property have usually sunk costs in their rental of a specific property, even though there are many properties on the market; in these circumstances one would expect landlords to be able to capture a significant proportion of the rent implicit in a subsidy ostensibly aimed at tenants. The possibility of this form of rent dissipation suggests that the use of credit subsidies as a means of reaching poor and disadvantaged groups needs to be undertaken with a good deal of skepticism.

5. Risk aversion

To interpret the rejection of the hypothesis that $\alpha_1 = \alpha_2$ as implying price discrimination depends, as was noted above, on the assumption that there is no difference in the risk aversion of the participant and non-participant groups. The fact that the variability of gross output was lower for IRDP than non-IRDP animals suggests this may not be an accurate assumption. It is possible that IRDP purchasers, being more risk averse than others, choose to make less risky investments. The higher prices paid by them for their livestock could represent a risk premium.

It is difficult to know how to evaluate this possibility. In particular, the relevant measure of the riskiness of livestock investments is not the unconditional variability of livestock output; it is the variability of output conditional on whatever information the farmer may have at the time of purchase. It is possible that the greater variability of non-IRDP output reflects simply a greater variety in the anticipated quality of livestock chosen by these purchasers (which would not require them to be compensated by a greater risk premium than IRDP participants). Indeed, such a possibility is suggested by the fact that the coefficient of variation of prices paid for buffaloes by non-IRDP purchasers, at 62.7%, was nearly four times that of prices paid by IRDP purchasers (16.3%). This may indicate a greater variety in age or in whether the animals were lactating, for instance – though since the possibility of price discrimination is in question, purchase prices cannot be used straightforwardly as indicators of quality anticipated at time of purchase.[22]

It is doubtful whether such a hypothesis could be satisfactorily tested on

[22]Alternatively, since IRDP animals were usually purchased in groups, the prices for these 'bunched' purchases might be less dispersed without indicating any lesser variation in quality. If so, the bunched demand could itself be partly responsible for somewhat higher prices in a thin market (I am grateful to a referee for this point). However, the magnitude of this latter effect is unlikely to be large, since many hundreds of animals typically change hands in livestock markets, and no more than 20 or 30 IRDP purchases are made at a time.

the present data set, and in any case developing a model to determine the magnitude of the differences in risk aversion required to explain the discrepancy is beyond the scope of this paper. However, *even if true*, this possibility would give no comfort to proponents of selective credit interventions in the present form. From the point of view of the participants of the scheme, it is irrelevant whether the higher prices they pay for their investments are due to price discrimination or to the fact that, given their degree of risk aversion, they choose to spend much of their subsidy reducing the risk of the investment. In the former case, the scheme is wasteful since it induces price discrimination against its intended beneficiaries; in the latter case, it is wasteful because it forces a highly risk averse group to purchase highly risky assets.

6. Conclusions

The main conclusions of this paper can be simply stated:

(1) The quality of livestock investments undertaken by participants in the IRDP was significantly lower than that of investments undertaken by a control group of non-participants.
(2) The most probable principal reason for this was the presence of pervasive price discrimination between IRDP participants and non-participants in the livestock markets. But the possibility of substantial differences in risk aversion between the two groups cannot be ruled out.
(3) This price discrimination seems to have been exacerbated by the presence of a scheme of subsidised credit, but was present even among non-participants in the scheme, particularly in the form of price discrimination against members of the scheduled castes.
(4) There is some evidence that IRDP participants may be less well equipped to manage livestock investments than are non-participants, due to the possible presence of scale economies, complementarities between livestock and land, and a higher opportunity cost of labour. This evidence is not strong, but should at least prompt caution before acceptance of a judgment (common among implementers of the IRDP and similar schemes) that the poor have a comparative advantage in the management of livestock. Apart from anything else, livestock farming is a highly risky activity, which may need to be carried out at a significant scale in order to enable the risks to be spread.

It would be more than usually unwise to generalize from the experience of the two survey villages to the operation of the IRDP or other credit schemes. This is particularly true because the relatively small and fragmented livestock markets characteristic of the survey region are not found everywhere in India; in the north of the country, livestock markets tend to be much larger, and it may be that price discrimination of the kind observed here is much less likely. However, there has been a marked discrepancy between the relatively optimistic findings of the large-scale evaluations of the IRDP and the more gloomy findings of micro-studies.[23] The possibility of price discrimination affecting the quality of IRDP investments has not to date been given sufficient attention. And the substantially risky nature of these investments deserves greater emphasis.

In any event, the evidence presented here should warn against the presumption that a scheme of public intervention to alleviate poverty by remedying the undoubted market failures in the credit markets can afford to overlook the possibility of market failures elsewhere (such as in the markets for productive assets).

[23]See especially Drèze (1988, 1990).

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