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Gains from Crossbreeding of Dairy Cattle in the North East: Micro Evidence from Tripura

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I

INTRODUCTION

The North-Eastern states are among the most backward in the country in terms of development indices. The Tenth Five Year Plan, envisages bringing about a paradigm shift in development planning in the country, by focusing attention on the regions such as North-East that have largely been by-passed in the planning process in the last several years. Given the importance of agriculture sector in the economy, the strategies and programmes for the development of agriculture and its allied sectors should take the centrestage of planning for the welfare and well-being of the masses. The Working Group on Agricultural Development in Eastern and North-Eastern India constituted by the Planning Commission for the formulation of the Tenth Five Year Plan has categorically emphasised; *"Looking at the predominance of agriculture as the source of livelihood in the region, a breakthrough in the human development graph of the region can be achieved only by addressing the key issues of the agriculture and allied sectors"* (Government of India, 2001). In view of the available empirical evidence regarding the high potential of livestock in rural transformation and employment (Sharma and Jacob, 1997) it is essential that this sector receives greater focus in the coming years.

The predominant livestock species in the region is the bovines, comprising 11.48 million cattle, 0.8 million buffaloes and 0.27 million mithuns. The dairy animals primarily comprise low producing cattle, with average productivity of 1.34 litres/day in the region as against the all-India average daily milk yield of 2.77 litres (Government of India, 2004). The Government of India, through the Centrally Sponsored Schemes, has been supplementing the State Government's effort for livestock development. During the Ninth Plan, cattle breed improvement programmes like Extension of Frozen Semen Technology, National Bull Production Programme, Progeny Testing, and Integrated Dairy Development have been implemented.

Crossbreeding of indigenous cattle with exotic germplasm is an important component of dairy development strategy in India. The crossbreeding policy of

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Indian Government envisages that a shift in milk producing technology from local cows to crossbred cows will lead to a growth in milk output. Empirical studies from various other parts of the country report economic superiority of crossbred cows over local cattle and hence, accrual of sizeable gains from adoption of this technology (Kumar, 1994; Dixit, 1999; Singh, 2001; Pandit, 2002). However, there are very few research studies that examine the various economic aspects of dairy farming in the North-Eastern region. It is, therefore, desirable to estimate the extent to which the benefits from the crossbreeding technology have materialised in the North Eastern part of the country.

The study has been carried out in Tripura as there exists good potential for dairy farming in the state, signified by utilisation of 8 per cent of the operated land area in rural areas for rearing of animals (NSSO, 2006) which is the highest among all the North Eastern states. The assessment of gains from crossbreeding has been done by (1) looking at the relative economics of milk production from crossbred and indigenous cows; (2) estimating the contribution of "breed effect" (technological change) and "input effect" in increasing milk production and (3) working out the value of inputs saved due to adoption of crossbreeding cattle. The next section briefly outlines the methodology used, followed by discussion of results and the concluding section.

II

METHODOLOGY

The Data: The present investigation is based on primary data collected during the period February-March 2006 from the sample farmers in the South Tripura district of Tripura state. Two blocks, viz., Matabari and Kakraban and two villages from each (Pauramura and Joyanti from Matabari block and Murapara and Rajdhanagar from Kakraban block) were selected randomly for the study. A sample of 15 milk producer households who are keeping both, the crossbred and local cows was randomly selected from each village thus totalling 60 sample households for detailed data collection.

Analytical Approach: The cost and returns from milk production was estimated separately for local and crossbred cattle. The gross cost of maintenance was worked out as the sum of fixed and variable costs items (Bhowmik, 2006). The net cost was arrived at by deducting the value of dung from gross cost. In order to estimate the cost of milk production, the average maintenance cost per milch cattle per day was divided by the average milk yield per day of the respective breed. The net return was calculated by deducting gross cost from gross return (i.e., sum of value of milk and dung).

Decomposition of Output Gains from Crossbreeding Technology: For any production function, the total change in output is brought about by the shifts in the scale parameters (neutral technological change), change in slope parameters (non-neutral technological change) and by changes in the volume of inputs. The technological change or the "breed effect" comprises the first two components while the third is the "input effect". The increase in the level of milk yield with new production technology (crossbred cow) over the old production technology (local cow) has been decomposed into these components using the technique suggested by Bisaliah (1975). The Cobb-Douglas production function has been used in the study, with daily milk production as the output variable and quantity of dry fodder, green grasses, concentrate and labour as the input variables. Before decomposing growth in milk output Chow–test was carried out to test the hypothesis that production functions of crossbred and local cows are statistically different.

The linearised form of Cobb-Douglas production function is given by the following regression equations:

$$\text{Ln } Y_{i1} = \text{Ln } A_1 + a_1 \text{ Ln } D_{i1} + b_1 \text{ Ln } G_{i1} + c_1 \text{ Ln } C_{i1} + d_1 \text{ Ln } L_{i1} + u_{i1} \quad \text{[local cow]} \quad \ldots (1)$$

$$\text{Ln} Y_{i2} = \text{Ln } A_2 + a_2 \text{ Ln } D_{i2} + b_2 \text{ Ln } G_{i2} + c_2 \text{ Ln } C_{i2} + d_2 \text{ Ln } L_{i2} + u_{i2} \quad \text{[crossbred cow]} \quad \ldots (2)$$

Where, Y = daily milk yield per lactating animal (in litre),

D = quantity of dry fodder fed to lactating animal (kg/day),

G = quantity of green grasses fed to lactating animal (kg/day),

C = quantity of concentrates fed to lactating animal (kg/day),

L = daily labour time spent on lactating animal (hours),

i = 1,…., n (no. of observations), a_j, b_j, c_j and d_j represent output elasticities of the respective inputs (j = local cow: old technology and technology and crossbred cow: new technology).

The decomposition equation derived by deducting equation (1) from (2) is:

$$\text{Ln } (Y_2/Y_1) = [\text{Ln } (A_2/A_1)] + [(a_2-a_1) \text{ Ln } D_1 + (b_2-b_1) \text{ Ln} G_1 + (c_2-c_1) \text{ Ln} C_1 + (d_2-d_1) \text{ Ln} L_1] + [a_2 \text{Ln } (D_2/D_1) + b_2 \text{Ln } (G_2/G_1) + c_2 \text{Ln } (C_2/C_1) + d_2 \text{Ln } (L_2/L_1)] + (u_2-u_1) \quad \ldots (3)$$

In this decomposition equation, the first bracketed term on the right hand side of the equation measures the percentage change in milk output due to neutral variation of technological efficiency. The second bracketed expression measures the percentage change in the value of milk output due to non-neutral technological efficiency. The third expression in the bracket measures the percentage change in milk output due to increased use of inputs like feeds and labour necessitated by the crossbred milk production technology. The last expression is the difference in error terms.

The term on the left hand side measures approximately the percentage change in the value of milk output as a result of technological change. This measurement is true if the change in milk output is less than 100 per cent. Thus, when the milk yield in the case of new production technology increases more than 100 per cent compared to that of the old milk production technology, Ln(Y2/Y1) will very much under estimate the change in milk yield. To avoid this problem, Alshi (1981) proposed to multiply equation (3) by correction factor $\delta=(\Delta Y/Y_1)/Ln(Y_2/Y_1)$ where $\Delta Y= Y_2 - Y_1$.

The decomposition analysis has been carried out in the present study using both the methods and further the relative contribution of each component in total change has been worked out to facilitate comparison with other similar studies in different regions.

III

EMPIRICAL RESULTS

The average productivity of a crossbred cow in the sample households was 2.97 litres/day, about 2.8 times higher than 1.04 litres/day produced by local cows (Table 1). The milk yield of lactating animals was 3.21 litres/day and 1.32 litres/day for crossbred and local animals, respectively, which is close to the state average of 3.73 litres/day and 1.16 litres/day for crossbred and local cows.

TABLE 1. RELATIVE ECONOMICS OF CATTLE MILK PRODUCTION

Particulars (1)	Types of animal: Crossbred cow (2)	Types of animal: Local cow (3)
Milk yield per day (litres)	2.97 (3.21)	1.04 (1.32)
Maintenance cost per day per cow (Rs.)	27.95	20.08
Cost of milk production per litre (Rs.)	9.40	19.26
Net return per animal per day (Rs.)	24.54	-1.75
Income per rupee of variable expense	2.23	1.13

Figures in parentheses is milk yield for lactating animals.

The net maintenance cost of a crossbred cow worked out to be Rs. 27.95 per day; while the same was lower (Rs. 20.08) for local cattle. However, despite the lower net maintenance cost of local cow, the cost of milk production was very high, Rs. 19.26/litre, on account of low productivity of local cattle. The average cost of milk production from crossbred cow worked out to be Rs. 9.40/litre. The average price of milk realised by the farmers was about Rs. 17.60. The gross return from the crossbred animal is about 2.8 times higher than the local cattle, due to productivity differences.

Despite low maintenance cost of local cows, the gross returns were lower than the gross cost and hence, net returns were negative. However, the returns from these animals were able to cover the variable cost component. The return of Rs. 1.13 over each rupee of variable expense includes the family labour expense as well.

Therefore, the return per rupee of out-of-pocket expenses of the farmers is even higher. Besides, the cow provides dung and draft animals which are essential inputs in agricultural operations.

The relative economics of crossbred and local animals presents a case for promoting crossbreeding as it provides handsome profit margin to the farmers. However, at the same time, efforts for increasing the productivity of the local non-descript breeds are also essential.

The regression results of the production function reveal that the feed inputs and labour, together explain 45 per cent of variation in milk yield (Table 2). The regression coefficients of green fodder and concentrate were positive and highly significant for both, crossbred cows and local cows. However, the milk output elasticity with respect to green fodder was very low, 0.035 and 0.049 for crossbred and local cows, respectively. This is hardly surprising as the farmers, that too, few of them, were feeding only grasses to the animals.

TABLE 2. ORDINARY LEAST SQUARES ESTIMATES OF MILK PRODUCTION FUNCTIONS

Sr.No. (1)	Explanatory variables (2)	Old technology (3)	New technology (4)
1.	Constant	0.1717 (0.7523)	0.5499 (0.3082)
2.	Dry fodder	0.1688 (0.3951)	0.2248 (0.2082)
3.	Green fodder	0.0495* (0.0125)	0.0353* (0.0062)
4.	Concentrate	0.6446* (0.1394)	0.4777* (0.1056)
5.	Labour	-0.2713 (0.5975)	-0.0535 (0.2021)
6.	R^2	0.45*	0.46*
7.	Number of observations	56	61
8.	Breusch-Pagan Statistics@	5.0884	15.4934*

Notes: Figures in parentheses are the standard errors.

* Significant at $p < 0.01$.

@ Breusch Pagan statistics showed for presence of heteroscadasticity in regression equation for new technology. Hence, heteroscadasicity consistent standard errors of regression parameters were estimated for this model.

The responsiveness of milk yield to concentrate feeding is quite high. A 1 per cent increase in concentrate feeding from its geometric mean level would increase milk yield by 0.48 per cent in crossbred and 0.64 per cent in local cows. The regression coefficient of dry fodder was also positive for all the functions, but it did not show significant effect on milk yield, perhaps because of low variation in its use across the sample households. The labour input showed negative though not significant. This may be due to over employment of family labour in dairy farming. The estimated parameters of the above two production functions were significantly different from each other hence; the contribution of technological and input components in the structural change was isolated through decomposition analysis (Table 3). The adoption of new dairy technology, i.e., crossbred cattle in the place of old dairy technology, i.e., indigenous cow led to higher per day milk yield.

Consequently, this shift in dairy technology, brought about a sizeable gain in milk yield, viz., total percentage gain of 96.26[1] per cent or 161.84[2] per cent in terms of percentage change in crossbred milk production over production from local cows. Out of the total change in milk production more than two-third occurred due to the difference in the levels of technological efficiency (both neutral and non-neutral) of crossbred cow vis-à-vis local cow and the remaining (nearly one-third) has been contributed by increased level of input use. Within this component, the maximum contribution is of concentrate input. In the technological component, the contribution of both, neutral (shift in the intercept term) and non-neutral (sum of the shift in slope elasticities) technical efficiency is positive.

TABLE 3. DECOMPOSITION OF TOTAL GAIN IN MILK YIELD OF CROSSBRED OVER LOCAL COW

Sources of change (1)	Percentage attributable: Method I (2)	Percentage attributable: Method II (3)	As ratio of total estimated change (4)
A. Technological	65.76	110.56	0.68
Neutral Technological Efficiency	37.81	63.57	0.39
Non-Neutral Technological Efficiency	27.95	46.99	0.29
B. Inputs	30.49	51.27	0.32
Dry fodder	2.63	4.42	0.02
Green fodder	9.42	15.85	0.09
Concentrate	20.07	33.75	0.20
Labour	-1.63	-2.75	-0.01
C. Total estimated change	96.25	161.83	
D. Total observed change	96.26	161.84	

This implies that with the present level of resource used by the old technology (local cow), productivity can be increased, and to a great extent if farmers could just switch over to new technology (crossbred cows). In other words, the adoption of crossbred milch cattle will bring about an immediate upward shift in the threshold level of milk yield, enabling farmers to get more milk at the existing levels of input use. If, however, farmers could simultaneously raise the input use level to the same level as on to the new technology (crossbred), the milk yield could further be raised.

Earlier studies (Kumar and Singh, 1980; Lalwani, 1989; Gaddi and Kunnal, 1996; Kumar, 1999) from other parts of the country indicated that the contribution of pure breed effect (technological change) ranges from 25 to 47 per cent. In other words, this implies that a major portion of the estimated increase in milk production from crossbred cows was in fact, due to improved inputs and management factors. But, this study suggests that the contribution of crossbreeding technology in increasing milk production was much higher than that of increased level of input use in the study region. A plausible explanation for these results lies in the fact that, the difference in the average level of feed and labour input provided to crossbred and local cows in the study region is of lower magnitude compared to reports from the other regions of the country where similar type of studies have been carried out. As

Tripura is a milk scarce region with predominant milch animal population of local animals of an average herd size of two or so, the difference in input allocation to crossbred and local cows is, obviously, less profound. Hence, the contribution of input component in increasing milk yield would be less dominant.

Implications for Returns to Development Expenditure

The costing analysis and estimation of production function provides the basis for working out the value of inputs saved from crossbreeding. As the promotion of crossbreeding programme involves sizeable allocation of public funds, it is relevant to take a look at the expected returns from the same. The value of input saved approach from the adoption of new technology without altering the input level is popularly used in the literature for assessing the returns to investment in new technology. This involves computation of difference between IRc and IRo where

IR_c = value of resources required to produce MYc (i.e., daily milk yield of crossbred animal) and

$IR_0 = (1+[R/100]) \times IR_c$ wehre R = percentage increase in output per cow per day under crossbred milk production technology using inputs at the level of local cow milk production technology.

The results of this exercise (Table 4) show that, without crossbreeding technology, for getting milk yield of 2.97 litres/day from local cow, the farmers have to spend Rs. 46.40 as against Rs. 27.95 with the implementation of crossbreeding. Hence, the value of input saved (IR_c-IR_0) is Rs. 18.45/day from each crossbred animal. This amount may appear to be very small at the farm level, but for the population size of 6.5 thousand crossbred milch animals in South Tripura (as per 2003 Livestock Census), this transforms to annual aggregate savings of Rs. 4.4 crores. This amount is 87 per cent of the cumulative state expenditure on dairy development made by Tripura during 2000/01-2003/04, indicating that the gains from crossbreeding technology have the potential to more than recover the development expenditure on it.

TABLE 4. VALUE OF INPUTS SAVED FROM ADOPTION OF CROSSBREEDING

Particulars (1)	Value (2)
MYc (litres)	2.97
MY_0 (litres)	1.04
R (per cent)	67
IRc (Rs.)	27.95
IR_0 (Rs.)	46.40
VIS (Rs.)	18.45

MY_0 = Daily milk yield of local animals.
IR_0 = Value of resources required to produce MYc using existing input level of local cow.
VIS = Value of input saved.

IV

CONCLUSIONS

The net cost of milk production from crossbred cows is nearly half of the same from local cow, thus, in the economic interest of the farmers, strategies aimed at crossing nondescript cattle with superior germplasm should be intensified by the concerned state department. The contribution of technological component in higher milk production for crossbred cows is about 68 per cent, thus, propagation of crossbreeding in the region has the potential to ensure reasonable returns on investment. The annual value of inputs saved in one district alone, covers 87 per cent of the expenditure on dairy development made by the state in four years. Therefore, from the planners' perspective also, it is a winsome proposition.

Notwithstanding the distinct economic superiority over the local animals in the region as far as milk production is concerned, the breeding policy in the region should not be excessively biased towards crossbreeding. Instead, in order to cater to the dairy and draught power requirements of the farmers, both, promotion of crossbreeding and development of dual purpose local breeds should be taken up simultaneously.

NOTES

1. Geometric mean of crossbred milk yield (Y_2) = 2.99 litres, Geometric mean of local cow milk yield (Y_1) = 1.14 litres. Ln (Y_2-Y_1)*100 = 96.26 per cent.
2. {(Y_2-Y_1)/Y_1}*100 = 161.84 per cent.

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