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Improving Milk Yield Performance of Crossbred Cattle in North-Eastern States of India[§]

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Abstract

Crossbreds hold the solution to the milk-deficit problem of North-Eastern states of India. The proportion of crossbred cattle in the region is 7.54 per cent (3.46 per cent of the country) as against 13.33 per cent for the country as a whole. However, the productivity of crossbred cattle has been found considerably low (4.8 L/day) in the region as against the all-India average of 6.4 L/day of milk yield. Yield gap analysis has been applied to find out the intra-regional milk yield gaps and the factors that could be addressed in the short-run to make-up the deficit. Based on the analysis, it has been identified that the major factors affecting the milk yield of crossbred animals in the N-E states are the technological and socio-economic constraints, which could be addressed by adopting improved management practices, better feeding practices, controlling of diseases and amelioration of the socio-economic conditions of the farmers through training, education and enhancing access to the funds. Addressal of these constraints will increase actual milk yield by about 66 per cent, sufficient enough to meet the deficit of milk requirement in the region. Category-wise yield gap analysis has shown that the highest increase in milk yield will be obtained on medium category households. The factors significantly affecting the milk yield at the household level are allocation of humandays per animal, expenditure on concentrate, economic status of the farmer and availability of the green fodder in the surroundings. While no major breakthrough is expected immediately, improvement in these factors would meet the milk deficit in the region.

Introduction

The growth in dairy sector has been uneven in different regions of the country. The per capita availability of milk is highest in the northern region with 943 grams in Punjab and 628 grams in Haryana. In the western states like Gujarat and Rajasthan, the per capita availability of milk is the second highest, viz. 349 grams and 387 grams, respectively. In southern states like Andhra Pradesh and Karnataka, the per capita availability of milk is 260 grams and 197 grams,

respectively as against the national average of 246 g/capita/day. However, North-Eastern states (N-E states/region) reflect a completely contrast picture of milk production vis-à-vis rest of India. The per capita availability of milk at 81 g/capita/day is lowest in this region and is only one-third of the national average. People in this region prefer liquid milk and other milk products but due to unavailability of liquid milk round-the-year, they are to consume maximum amount of milk powder than any other region.

Animal husbandry, which is an integral part of the farming system in the region, is characterized by low producing cattle with average productivity of 1.34 L/day as against the all-India average of 2.77 L/day. During the past decade, milk output in the region has increased from 9.46 lakh tonnes in 1993-94 to 11.23 lakh tonnes in 2004-05, registering a growth rate of

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1.73 per cent per annum. But, there still exists a huge gap in the production and consumption of milk and other livestock products in the region.

Milk Production in N-E States

The N-E states could not get the benefit of either 'White Revolution' or 'Green Revolution', and probably it is one of the reasons that this area is among the most backward regions of the country in terms of development indices. Farming is predominantly rice-based with little exception in the state of Sikkim where maize is a dominating crop. Mixed farming system is the order as most of the farm households want to meet their food and nutritional needs without being dependent on outside sources. The production system is largely based on horticulture and animal husbandry, partly due to agro-climatic factors and partly due to preference for non-vegetarian food. With this system in place, the region produced 0.22 Mt meat, 1.06 Mt milk, 902 million eggs and 0.21 Mt fish in 2005 (Table 1) as against the requirement of 0.44 Mt meat, 2.15 Mt milk, 7027 million eggs and 0.38 Mt fish. The deficiency, therefore, ranges from about 45 per cent in fish to 87 per cent in egg. The gap between requirement and production of milk was around 51 per cent.

It is estimated that around Rs 1000 crore is annually drained out from the states' exchequer to meet the deficit in the requirement of livestock products, including milk. Therefore, it is very important to develop a strategic approach and implement the same for improving this sector, which will ultimately help in alleviating the rural poverty because livestock, especially the dairy animals are the major sources of income and insurance cover of poor people in the region.

The poor germplasm of dairy animals has been one of the main problems in the region. Being conscious of the problem, a grading-up programme is going on

through artificial insemination (AI). Most of the available crossbred animals are the upgraded breeds of Jersey and Holstein Friesian types. Presently, the proportion of crossbred cattle in the region is 7.54 per cent (3.46% of the country) as against 13.33 per cent for the country as a whole (Table 2).

Nearly 3 lakh crossbred cattle (35%) are in milk every year in this region. Across different N-E states, Assam has the maximum number of crossbred animals in milk. Nevertheless, crossbreds have not served the very purpose for which it was introduced in the region. The reason being that the productivity of crossbred cattle is considerably low (4.8 L/day) in the region as against the all-India average of 6.4 L/day milk yield. At the country level, the share of milk produced from the crossbred cattle has increased from 14 per cent in 1992 to 20 per cent in 2006.

To improve the productivity of the crossbred animals, the present study has estimated the milk yield gaps and has identified the factors contributing to the level of milk yield.

Database and Methodology

Three states of N-E region, namely Assam, Tripura and Manipur, were purposively selected on the basis of highest milk production and number of crossbred animals. A multistage random sampling technique was followed to select the districts (one from each state), blocks (one from each district), villages (two from each block) and dairy farmers (proportionate to population of the village). In total, 90 households comprising 50 small (1-2 crossbred cattle), 31 medium (3-8 persons) and 9 large (9-20 persons), were selected with the pre-imposed condition of having at least one crossbred cattle in-milk per household. Cross-sectional data were collected from these households on pre-tested schedules designed for the purpose during the agriculture year 2007-08.

Table 1. Production and requirement of livestock products in North-Eastern states: 2005

Sectors	Production (Mt)	Requirement (Mt)	Deficit (%)
Meat	0.22	0.44	50.00
Milk	1.06	2.15	50.63
Egg (million No.)	902	7027	87.16
Fish	0.21	0.38	44.74

Source: DONER, 2006 & GOI (2005)

Table 2. Population of crossbred cattle in N-E states

Sl No.	States	Cattle			Buffaloes
		Crossbred	Indigenous	Total	
1.	Assam	440	7999	8440	678
2.	Tripura	57	702	759	14
3.	Manipur	69	349	418	77
4.	Meghalaya	23	744	767	18
5.	Nagaland	243	208	451	34
6.	Arunachal	13	445	458	11
7.	Mizoram	9	27	36	6
8.	Total N-E states	854	10474	11329	838
		(7.54%)	(92.46%)	(100%)	
9.	All-India	24686	160495	185181	97922
		(13.33%)	(86.66%)	(100%)	
10.	Total N-E state as % of all-India	3.46	5.66	6.12	0.86

Source: GOI (2003 and 2006)

Note: Figures within the parentheses are percentages of the total

Yield Gap Analysis

This analytical tool as developed by the International Rice Research Institute (IRRI) and modified by Gomez (1977) was used. It has been used by a number of researchers to analyze similar objectives (Madhavswamy and Sheshareddy, 1987; Joshi *et al.*, 2003; Liang *et al.*, 2006; Job, 2006). The strategy of bridging the yield can bring in additional production with lesser efforts at the local level and can improve the efficiency of production. While efforts are being made to raise the yield ceiling, there is even a more pressing need to address the problem of yield gaps (Duwayri *et al.*, 1998).

As per the methodology of the yield gap analysis, the total yield gap is the sum of Yield Gap I (YG I) and Yield Gap II (YG II), i.e.

Total Yield Gap (TYG) = Yield Gap I + Yield Gap II

where,

Yield Gaps I = Experiment Station Yield (Yr) – Potential Farm Yield (Yp)

and

Yield Gap II = Potential Farm Yield (Yp) – Actual Farm Yield (Yf).

Different parameters included in yield gap analysis of milk from crossbred cattle in the N-E states were estimated in the following manner:

Experimental Station Yield (Yr)

It was the wet average obtained from the crossbred cattle on experimental stations in the three selected states in the year ending January, 2008. The research stations from where data were collected are: Guwahati Veterinary College, Assam; College of Agriculture, Central Agricultural University, Manipur; and R.K. Nagar Cattle Breeding Farm, Tripura. It was assumed that these farms were being managed on scientific lines using latest technology and reflected the maximum possible level of milk yield that could be obtained from the crossbred in the region.

Potential Farm Yield (Yp)

The milk yield level of households in a category was arranged in the descending order and the wet average realized by top 10 per cent of the sample households was considered as 'Potential Farm Yield'. It is the level of milk yield that could be attained by other households of the same locality, and sets target for other farmers if they also adopt the same package of practices as being adopted by the progressive farmers.

Actual Farm Yield (Yf)

It was the wet average of the remaining 90 per cent of the households of a category which could be

increased with little effort made in adoption of improved package of practices and by addressing the technical and socio-economic constraints.

The YG I and YG II are caused by different factors/constraints. The major factors responsible for YG I include the environment, physical and non-transferable components of technology. It is very difficult to overcome these factors and R&D has to be carried out to evolve alternative solutions. The YG II is caused by technical and socio-economic factors, which could be addressed through either applied research or transfer of technology. Therefore, YG II is more important because it signifies the quantum of increase in total milk production that could be achieved in the short-run by managing the factors causing it.

To determine the quantum of increase in milk yield by managing these yield gaps, yield gap percentages were calculated over the actual farm yield (Y_f) in the following manner:

$$\text{Yield gap (\%)} = (\text{Yield gap/actual farm yield}) \times 100$$

Household Factors Determining Level of Milk Yield

Milk yield production is a complex variable dependent on the interplay of various quantitative and qualitative household factors. The quantitative factors were agricultural land, education level of the family-head and expenditure on concentrate, and the qualitative factors were economic status of the household and availability of green fodder in the surroundings. The qualitative factors were used as dummy variables. To identify the factors contributing significantly to the level of milk yield from the crossbred cattle, the average milk yield per household was regressed against these variables using log linear form of Cobb-Douglas function as given below:

$$\ln Y = \ln b_0 + \sum_{i=1}^4 b_i \ln X_i + \sum_{k=5}^6 b_k D_k$$

where,

Y = Average milk yield/animal/day of a household (in litres),

X_1 = Agricultural land/head of standard animal units (in ha)

X_2 = Educational level of the family-head (in years),

X_3 = Expenditure of concentrate/ animal in-milk /day (in Rs),

X_4 = Humandays allocated/ head of milch animal/day (in days),

D_5 = Economic status of dairy farmers (Economically sound = 1; otherwise 0), and

D_6 = Availability of green fodder in the surroundings (Easily available = 1; otherwise 0).

Results and Discussion

Milk Yield Gaps in Crossbred Cattle

The yield gaps of crossbred cattle in the N-E states across different categories of households, given in Table 3, revealed a sizeable gap in the productivity of crossbred cattle across experimental stations, progressive farmers and sample households. The average milk yield realized on experimental stations was 8.39 L/day, which was the maximum yield level to be achieved by the farmers in the region. The potential farm yield was 7.65 L/day and the actual milk yield realized by the average household was 4.62 L/day. Thus, there existed a total yield gap (TYG) of 3.78 L/day. The total yield gap was comprised of YG I (0.75 L/day) and YG II (3.03 L/day). Thus, YG II was higher than YG I in the region. The lower component of YG I indicates that the environmental and physical factors were the minor constraints. The major factors affecting the milk yield of crossbred animals in the N-E states were the technological and socio-economic constraints, which could be addressed by adopting better management practices, feeding practices, controlling of diseases and amelioration of the socio-economic conditions of the farmers through training, education and enhancing access to the funds.

The percentage of TYG with respect to actual farm yield was worked out to be 81.60 per cent, comprising YG I as 16.02 per cent and YG II as 65.58 per cent. Thus, the percentage of YG II accounted for two-thirds of the total increase in actual milk yield. This indicated the need to concentrate efforts on addressing the constraints causing YG II to increase milk yield by about 66 per cent in the short-run. It will increase milk production sufficiently to meet the deficit of 50.63 per cent, as mentioned in Table 1.

Household category-wise analysis for the N-E states showed that the highest percentage of TYG was on the medium (89.82%), followed by large (78.13%) and small (74.43%) households. The YG II percentage

Table 3. Milk yield gaps across different categories of households in North-Eastern states

Sl No.	Particulars	Categories of household			Overall
		Small	Medium	Large	
1.	Experimental station yield (L/ day/animal)	8.39	8.39	8.39	8.39
2.	Potential farm yield (L/ day/ animal)	7.80	6.81	7.88	7.65
3.	Actual farm yield (L/ day/animal)	4.81	4.42	4.71	4.62
4.	YG I (Sl Nos 1–2)	0.59	1.58	0.52	0.75
5.	YG II (Sl Nos 2–3)	2.99	2.39	3.17	3.03
6.	Total yield gap (TYG) (I+II)	3.58	3.97	3.69	3.78
7.	TYG (%)	74.43	89.82	78.13	81.60
8.	YG II (%)	62.16	54.07	67.30	65.58
9.	YG I (%)	12.27	35.75	10.83	16.02

Table 4. Estimated coefficients of independent variables effecting level of milk yield in N-E states

Sl No.	Estimated parameters	Category of households			Overall
		Small	Medium	Large	
1	Constant (a)	2.48 (0.407)	1.67 (0.529)	0.05 (0.925)	2.18 (0.26)
2	Agricultural land/head of animal (X_1)	-0.004 (0.005)	0.015 (0.011)	0.124 (0.046)	-0.008 (0.005)
3	Educational level of family-head (X_2)	-0.008 (0.010)	-0.010 (0.01126)	0.171 (0.187)	-0.008 (0.007)
4	Huhumandays allocated/ head of animal (X_3)	0.142 (0.097)	0.060 (0.1099)	-0.593*** (0.187)	0.096** (0.041)
5	Expenditure on concentrate/ animal/day (X_4)	0.347*** (0.094)	0.37*** (0.127)	0.56 (0.268)	0.357*** (0.068)
6	Economic status of dairy farmer (D_5)	0.034*** (0.010)	0.001 (0.012)	0.0089 (0.012)	0.013 (0.007)
7	Availability of green fodder in the surrounding (D_6)	0.018 (0.012)	0.049*** (0.012)	0.042*** (0.009)	0.037*** (0.004)
8	R ² (%)	75	67	94	67
9	No. Of observations	50	31	9	90

Notes: Figures within the parentheses are standard errors of the coefficients.

, * denote significance at 5 per cent and 1 per cent levels of probability, respectively.

was found maximum among large (67.30%), followed by small (62.16%) and medium (54.07%) dairy farmers. Since the households were classified on the basis of number of milch animals, the medium and large households were the target groups where maximum milk yield gain could be attained and accordingly efforts need to be directed towards them. If all the households adopt the recommended package of practices and technologies that were used by the progressive farmers, the realized increase in milk yield (percentage of TYGs) would be 62.16 per cent, 54.07 per cent and 67.30 per cent, respectively from the present level.

Factors Determining Level of Milk Yield

As observed in Yield Gap Analysis, different households were obtaining different levels of milk yield. Even in the same village, some households were getting higher milk yield than the other households. To identify the factors affecting milk yield, regression analysis was carried out with five independent factors, keeping the level of milk yield as the dependent variable. The results of regression analysis are presented in Table 4.

The value of coefficient of multiple determination (R²) ranged from 67 per cent to 94 per cent, exhibiting

exactness of the factors included in the regression in determining the milk yield at the household level. Overall, three variables, namely humandays per animal (X_3), expenditure on concentrate (X_4) and dummy variable of availability of green fodder (D_6) were found to be significantly contributing to the level of milk yield. It was observed that one per cent increase in humandays per head of animal in the N-E states will increase milk yield by 0.096 per cent. However, it is very difficult to increase the availability of labour since above 90 per cent of the labour in dairy activity is only family labour. One of the reasons for the allocation of labour per animal coming to be significant was that in the N-E states dairy activities draw lot of inputs from out of the farm, which require additional labour. Another variable, namely expenditure on concentrate per head of animal per day was significant due to its direct effect on milk production from high-yielding animals. Due to high cost of concentrate and lack of availability of good quality concentrate, most of the farmers were feeding their animals with the field-grown rice bran or broken rice. The availability of green fodder within the surroundings was also found to be a significant factor for increasing the milk yield.

Household category-wise results of regression analysis were not much different than the overall situation, except that the coefficient of allocation of humandays (X_3) had the negative sign in the case of large households, showing a decrease in milk yield with increase in allocation of humandays. The interpretation of this observation was ignored due to its contradiction with *a priori* economic criterion of having the positive sign. This variable had a positive sign in small and medium categories of households, but it was non-significant.

The coefficient of expenditure on concentrate per head of animal per day (X_4) was found significant at 1 per cent level in small and medium households and with its one per cent increase, the milk yield could increase by 0.35 per cent and 0.37 per cent on small and medium households, respectively in the N-E states. On the large category, the variable of expenditure on concentrate was not affecting milk yield because of non-significant technical coefficient. It may be due to the fact that there was not much variation in the amount of concentrate fed and level of milk yield.

The dummy variable, economic soundness of dairy farmers (D_5) was significantly (at 1% level of

probability) contributing towards the level of milk yield of crossbred on small farms in the region. With better economic conditions, farmers were able to provide better sheds and veterinary services. Assuming that the herd size commensurates with economic status, the variable D_5 did not significantly affect the milk yield on medium and large households. Another dummy variable of availability of green fodder (D_6) was significant at 1 per cent level of probability in medium and large categories of farmers, indicating that availability of green fodder in the surrounding significantly contributed to the level of milk yield attained by these households.

Summary and Conclusions

The crossbred animals constitute 7.54 per cent population of the cattle in the N-E region as against 13.33 per cent for the country as a whole. Yield gap analysis has revealed a considerable difference in the average milk yield of crossbred-cow recorded at the experimental station (8.39 L/day) and at the farmers' field (4.62 L/day), the potential yield being 7.64 L/day. The total yield gap (TYG) has been found to be 81.60 per cent of the actual farm yield, which signifies that if all the constraints related with milk production are addressed, milk yield in the region will increase by about 82 per cent. The TYG has been found to comprise a higher magnitude of YG II (65.58%) than YG I (16.02%), indicating that the environmental and physical factors are the minor constraints in achieving a higher milk yield.

Household category-wise yield gap analysis for the N-E states has shown that in the event of addressal of the constraints, the highest increase in milk yield will be obtained on medium category households because TYG is 89.82 per cent of the actual farm yield. The smallest magnitude has been noticed on the small category of households (74.43%). The percentage of YG II has been noticed highest on large category of households (67.30%) and the smallest on medium category (54.07%) in the region.

Overall, the percentage of YG II alone has accounted for about 66 per cent of the total milk yield gap. With concentrated efforts on addressing the constraints causing YG II, the resultant increase in milk yield will be sufficient enough to meet the shortfall in milk requirement (50.63%) in the region. The major factors affecting the milk yield (causing YG II) of the crossbred animals in the N-E states have been identified

as technological and socio-economic constraints which could be addressed by following better management practices, feeding practices, controlling of diseases and amelioration of the socio-economic conditions of the farmers through training, education and enhanced access to funds.

Regression of various household factors against milk yield has indicated that milk productivity could be increased by allocating more humandays per head of animal to take proper care and better management. Expenditure on concentrate contributes significantly towards milk yield on small and medium categories of households. Provision of low-cost good quality concentrate round-the-year would help increase milk production in the N-E states. Economic status, especially among small households, affects significantly the milk yield level through improving capability to provide better cattle sheds and healthcare services. The general dependence in the region on public lands for the supply of green fodder affects the milk productivity significantly. Therefore, regular availability of green fodder in the surroundings round-the-year would help increase milk production in the N-E region.

Policy Implications

Based on the study, following policy implications need immediate attention:

- The present huge gap in milk yield between the progressive and other farmers could be managed through either extension or providing necessary facilities. Technologies being adopted by some of the progressive farmers should be transferred with demonstration of benefits to other farmer.
- Feed concentrate being a significant factor for milk yield, availability of low-cost good quality concentrate to the farmers will help increase the average milk yield in the region. Farmers may be provided training on the preparation of such concentrates from the locally available materials.
- Due to dependence on out of the farm supply of green fodder, there is a need to develop a detailed programme for increasing the availability of green fodder on farmers' fields, community lands and forests. Re-emphasis on Watershed Development

Programmes, planting of fodder trees and grasses on wastelands, promotion of silvi-pastoral system and agro-forestry systems in this region will help the availability of green fodder round-the-year.

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