Original Research

Crossbred Cattle Adoption and Market Participation Behaviour of Smallholder Dairy Farmers in Assam

Baban Bayan[1*] and Ram Pratim Deka[2]

[1]Department of Humanities and Social Sciences, I. I.T. Guwahati, Assam, INDIA
[2]International Livestock Research Institute, North-East India Regional Office, Six mile, Assam, INDIA

***Corresponding author:** babanbayan@gmail.com

Rec. Date:	Nov 22, 2017 05:14
Accept Date:	Mar 16, 2018 17:37
DOI	10.5455/ijlr.20171122051450

Abstract

Smallholder production system and informal milk marketing being predominant in Assam, the present study tries to understand the changing market participation behaviour of smallholder dairy farmers with adoption of high yielding crossbred cattle. The study is based on information collected from a sample size of 245 smallholder dairy farmers using structured and pre-tested interview schedule. The study has shown that with adoption of crossbred cattle, surplus milk is generated and thus larger number of farmers becomes market participant. Furthermore, the study points out that crossbred cattle adopters seem more commercially oriented as more than 70% of the marketed surplus is absorbed in selling self to the market and dairy cooperatives society together. While non-adopters' market participation is found to be minimal as many of them are found to dispose the surplus milk by selling retail to their nearby households. It is again found that marketed surplus of milk increased by 14.60% due to crossbred cattle adoption for the smallholder dairy farmers in the state. Thus, the study suggests that diffusion of crossbreeding technology is important in order to encourage farmers to increase their market participation.

Key words: Adoption, Assam, Crossbred Cattle, Milk Marketing, Multivariate Regression

How to cite: Bayan, B., & Deka, R. (2018). Crossbred Cattle Adoption and Market Participation Behaviour of Smallholder Dairy Farmers in Assam. International Journal of Livestock Research, 8(8), 1. doi: 10.5455/ijlr.20171122051450

Introduction

Dairying is an important sub-sector in the context of Assam as about 82% of rural households in the state keep cattle or buffalo in a singular or mixed-farm setting (ILRI, 2007; Kumar and Staal, 2010). However, the sub-sector is characterized mostly by rural smallholders' production using pre-dominantly the non-descript cattle with pockets of specialized dairy farms using high yielding crossbred cattle in the peri-urban areas and in certain rural zones with better market access (Sarker, 2002; Kumar *et al.*, 2010). Recent studies point out that adoption of crossbred cattle in the context of Assam is significantly rewarding in terms of

higher farm income and gain in nutrition from increased self-produced milk consumption (Bayan and Dutta, 2017). Given the right institutional incentives and market infrastructure, marginal and small landholders are capable of scaling up milk production by commercializing their dairy enterprise through adoption of high yielding crossbred cattle (Bardhan *et al.*, 2012). Again, while facilitating market infrastructure emphasis should be given on the type of markets that closely connects with the demand coming out from the transition (from traditional system of dairying to a modern commercial farming based on rearing of high yielding crossbred cattle). This may tend to redirect our focus towards understanding the farmers' market participation behaviour in the changing production system. Kumar and Staal (2010) are also of the view that while increasing farm level production and productivity will require more improved animals, smallholders' access to reliable markets to absorb more milk at remunerative prices remains a critical constraint in the state. In this backdrop, the present study is carried out with the objective of understanding the changing behaviour of market participation of the dairy farmers of Assam in the context of high yielding crossbred cattle adoption.

Materials and Methods

Data and Sampling Procedure

The study is carried out on a data set of 245 sample dairy farmers in three districts of Assam. The information relating to marketing and marketed surplus of milk are collected through primary survey method using structured and pre-tested questionnaire during December, 2015 to March, 2016. Multistage sampling techniques are employed in order to select the sample dairy farmers. In the first stage, districts are stratified in the order of high, medium and low density of cattle population per 100 hectares of geographical area. From each stratum one sample district is randomly selected. Thus, Barpeta, Sonitpur and Karbi Anglong districts are selected from high medium and low stratum respectively. In the second stage, two community development blocks are chosen keeping in mind that one block has higher density of cattle population and the other with relatively lesser density. However, comments from some key informants such as veterinary doctor of block veterinary dispensary and district veterinary officer (DVO) guided the selection process of sample blocks. In the third stage, three villages are purposefully selected from each block considering that the villages have sizable number of milch cattle. Finally, 20-30% of the total dairy farmers are interviewed from each village. Thus, a total of 245 sample dairy farmers (137 crossbred cattle adopters and 108 non-adopters) are interviewed in the state to elicit information relating to market participation behaviour of sample dairy farmers. Table 1 presents the break-up of sample respondents according to various herd size categories in the three sample districts of the state and according to crossbreeding technology adoption status. Standard Animal Unit (SAU) is derived from Kumbhare *et al.*

DOI 10.5455/ijlr.20171122051450

(1983) to standardize production characteristics of different farms with different species of animals. Different herd size category farms (small, medium and large) are post-stratified on the basis of milch SAUs using cumulative frequency of the square root technique. Farms with the herd size of 1-2.99 are categorized as small, 3-5.99 as medium and 6 and above as large farms in the context of the present study sample.

Table 1: Distribution of different herd size category sample households across groups and across districts

Herd Size Category	No. of Households		
	Barpeta	**Sonitpur**	**Karbi Anglong**
Adopter			
Small	29 (31.52)	23 (28.05)	6 (8.45)
Medium	20 (21.74)	18 (21.95)	11 (15.49)
Large	5 (5.43)	2 (2.44)	23 (32.39)
Overall	54 (58.70)	43 (52.44)	40 (56.34)
Non-Adopter			
Small	29 (31.52)	18 (21.95)	12 (16.90)
Medium	9 (9.78)	20 (24.39)	12 (16.90)
Large	0 (0.00)	1 (1.22)	7 (9.86)
Overall	38 (41.30)	39 (47.56)	31 (43.66)
Total	**92 (100)**	**82 (100)**	**71 (100)**

Source: Field survey, 2015-16; Figures in parentheses indicate percentage to column total

Specification of Empirical Model on Determinants of Marketed Surplus

Studies indicate that marketed surplus of agricultural output depends on various price and non-price factors (Sharma, 2016). Empirical studies show that farmers respond positively towards price change and the finding is consistent with economic theory. However, there are other non-price variables relating to socio-economic, institutional, technological and infrastructural factors that affect marketed surplus. In most cases, there remains a strong linear and in certain cases non-linear relationship between the quantity sold out and factors such as farm size, volume of production, household size, prices of output received and socio-economic and institutional factor such as access to credit, distance to market etc. Thus, the postulated multiple regression model (OLS) between the dependent and explanatory factors designed for the present study can be written as:

$$Y_i = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \mu \qquad (5.4)$$

Where, Y_i = marketed surplus as a percentage of total output per household; α = constant; β_1- β_7 = parameters to be estimated

X_1 = crossbred cattle adoption (dummy: 1=adopter; 0 otherwise)

X_2 = herd size (number of milch SAU); X_3 = family size (numbers)

X_4 = price received for the milk sold (Rs/litre); X_5 = distance to nearest market (kilometre)

X_6 = membership of DCS (dummy: 1=member; 0 otherwise)

X_7 = access to credit (dummy: 1=accessed credit; 0 otherwise)

μ = standard error term

DOI 10.5455/ijlr.20171122051450

It is hypothesized that with the increase in adoption of crossbred cattle and increase in herd size, family size, price received for the milk sold, membership of DCS and access to credit, the marketed surplus should increase. On the other hand, distance to market is expected to have a negative association with the marketed surplus of milk. It is also hypothesized that since crossbred cattle adopters may be more commercially oriented compared to non-adopters, crossbred cattle adoption variable should have highly significant relationship with the dependent variable and also have higher β coefficient.

Results and Discussion

Pattern of Market Participation

Table 2 presents the market participation behavior of the crossbred cattle adopter (or non-adopter) farm households. Subsistence farmers who produce smaller volume of milk for their domestic consumption apparently do not participate in the market. In contrast, rest of the farm households, apart from part of their produced milk consumed domestically, also produces a major proportion for market. Table 2 reveals that higher level of market participation is more explicit for crossbred adopters compared to non-adopters. In other words, adopters are commercially oriented to a higher extent in their milk production behavior. Of the 137 sample farmers with adoption of crossbred cattle, 98.54 per cent farmers are market participant that sells a part of their produce in market (or any other marketing agent) against 83.33 per cent of the non-adopters. However, producing for the market must be incentivized by availability of effective and economically remunerative marketing options for the farmers.

Table 2: Number of sample farmers according to market participation status

Farm Category	Participant	Non-Participant	Total No. of Sample Farmers
Adopter	135 (98.54)	2 (1.46)	137 (100)
Non-adopter	90 (83.33)	18 (16.67)	108 (100)
Total	225 (91.84)	20 (8.16)	245 (100)

Source: Field survey, 2015-16; Figures in parentheses indicate percentage to total

Milk production, sales and retention for self-consumption on the sample households for the two different adoption groups are presented in Table 3. The table shows that average milk production, sales and retention for self-consumption are directly proportional to farm size. This indicates that production, sales and household retention for self-consumption increases with the increase in farm size for both the adoption groups. It is seen from Table 3 that production, sales and retention for consumption of milk per farm across farm size groups among adopters are 15.14, 13.43 and 1.72 (11.36%) litres respectively. Production of milk per farm for crossbred cattle adopter group is found to be 8.01 litres for small farms (<3 milch SAU) that increases to 11.99 and 34.07 litres per farm for medium (3<6 milch SAU) and large (≥6 milch SAU) category farmers respectively. Similar pattern of sales and retention for self-consumption is envisaged

 DOI 10.5455/ijlr.20171122051450

among the adopter group of the sample farmers. Again, among the non-adopter farmers overall production of milk per farm is found to be 3.12 litres of which 2.19 liters per farm is sold by the farm household and the remaining 0.93 litres (29.81 per cent) retained for consumption in liquid form and/or consumed as processed product. The retention for self-consumption for the small farm category (<3 milch SAU) of non-adopter households is as high as 37.83% of the total farm milk production. The reason for such high consumption proportion of this group is that a sizeable number of sample farmers in the non-adopter group are autarkic farmers who produce milk solely for self-consumption (see Table 2). It is, thus, seen that almost 30% of the farm milk production for sample farmers across groups of the non-adopter category is consumed domestically and the rest 70% is sold as marketed surplus. Thus, Table 3 explains that adopters have higher absolute consumption and sales of milk per farm commensurate with increased production in relation to the sales and consumption of non-adopters. This finding is consistent with the findings of Kumar and Shah (2016) which explain that consumption of milk is proportional to the volume of milk production and there exists also a notable difference in milk consumption level between producer and non-producer households. The next section presents the various marketing options farmers utilizes to sell their marketed surplus and their respective average prices of milk.

Table 3: Milk production, sales and retention for consumption pattern among sample household (litres/day)

Farm size	Adopter				Non-Adopter			
	Production	Sales	Retained for consumption	% consumption	Production	Sales	Retained for consumption	% consumption
Small	8.01	6.69	1.32	16.48	2.3	1.42	0.87	37.83
Medium	11.99	10.14	1.85	15.43	3.32	2.34	0.97	29.22
Large	34.07	31.82	2.25	6.6	8.19	7.13	1.06	12.94
Overall	15.14	13.43	1.72	11.36	3.12	2.19	0.93	29.81

Source: Field survey, 2015-16

Sale Pattern of Milk by Type of Buyer

The marketing of milk and milk products in Assam is on a small scale, partly because of the demand-side constraints and partly because of lack of effective marketing strategy to overcome the demand-side constraints (Sirohi *et al.*, 2009). An effective marketing system particularly for agricultural commodities can facilitate agricultural intensification resulting from higher accrual of farm profit. According to Sharma (2016), smallholder farmers face various marketing constraints that either raise marketing costs or market risks associated with market access and market information. Table 4 presents the percentage distribution of marketed surplus of milk produced by the crossbred cattle adopter and non-adopter farmers across various sources of marketing. It shows that when farmers rear high yielding crossbred cattle, dairy cooperative

DOI 10.5455/ijlr.20171122051450

society constitutes as the dominant source of milk sale (almost 39% across farm size) followed by farmers selling self to the market (31.45%). But, for farms based on rearing of pure indigenous breed selling the surplus milk to the cooperative is only 7.78% across farm size groups. Most dominant source of milk sale for the non-adopter farms is selling retail in the neighborhood (46.67% across farm size) which is significantly low in case of crossbred cattle adopter farms (almost 14%). Since, average marketed surplus of non-adopter farmers is only 2.19 litres/day against 13.43 litres/day for the adopter farmers, many of the non-adopter farmers try to dispose the surplus milk within their neighborhood through retail selling. Crossbred cattle adopters seem more commercially oriented as more than 70% of the marketed surplus is absorbed in market and cooperatives together. The cooperatives support the dairy farmers by regularly procuring milk from the member-producers even during a sudden declaration of *bandh* (due to political strikes) and extending non-market support such as providing help during the time of credit needs of the farmers, supplying quality concentrate, extension support and a dividend received by the members at the end of the year.

Table 4: Sale pattern by type of buyers among selected households that are net sellers of milk

Farm size	Private Trader		Market		Cooperative		Sold retail in the neighborhood	
	Per cent	Price (Rs/litre)	Per cent	Price (Rs/litre)	Per cent	Price (Rs/litre)	Per cent	Price (Rs/litre)
	Adopter							
Small	11.69	33.86	38.6	40.23	37.77	34.09	10.94	38.57
Medium	10.42	24.6	20.69	40.69	49.81	33.64	19.2	40
Large	20	27	35.11	38.55	23.35	31.56	11.84	41.87
Overall	13.09	29	31.45	39.91	38.84	33.48	14.08	40.17
	Non-Adopter							
Small	10.64	26	39.36	39.72	8.51	33.75	42.55	38.4
Medium	14.28	28.4	20	38.14	8.57	33	57.14	38.25
Large	50	28.4	25	40	0	-	25	40
Overall	15.55	27.43	30.56	39.33	7.78	33.43	46.67	38.4

Source: Field survey, 2015-16

According to size classes of farmers, large farmers use private trader relatively more compared to small and medium farmers as the source of milk sale (see Table 4). This is for the reasons that these farmers being handicapped with manpower shortage and due to voluminous production resorts to private trader to collect the milk from the farmer's doorstep. However, a large part of the milk is also sold in the market by this group of farmers to fetch better prices. Table 4 further shows that small and medium farmers are the highest user of DCS to source the milk sale because of the advantages discussed above and price fetched by the

 DOI 10.5455/ijlr.20171122051450

farmers which is relatively better than the price offered by private trader (Rs. 33.48/litre against Rs. 28.31/litre).

Determinants of Marketed Surplus of Milk

The result of the multivariate regression analysis to examine the impact of various market and non-market factors on marketed surplus of milk is presented in Table 5.

Table 5: Factors influencing marketed surplus of milk

Factors	β - value	"t" Value	Relative rank
Constant	14.2908*** (5.3463)	2.67	-
Crossbred cattle adoption	14.6031*** (2.5046)	5.83	2
Herd size	0.5798*** (0.1736)	3.34	3
Family size	-0.6879 (0.4407)	-1.56	6
Price received for the milk sold	1.3339*** (0.1068)	12.49	1
Distance to market	1.3448* (0.6839)	1.97	4
Membership of DCS	4.7210** (2.6357)	1.79	5
Access to credit	2.4576 (3.0316)	0.81	7
F value	42.41***		
R^2	0.5561		
No. of observation	245		

*Source: Author's estimation based on field survey data; Figures in parentheses indicate standard error; *, ** and *** indicate significant at 10%, 5% and 1% probability level respectively*

It shows that the determinants of marketed surplus model has a significant F value of 42.41 (*p*-value = 0.000) and a R^2 value of 0.5561 indicating a good fit of the model. The independent variables are free from the problem of multicollinearity as the mean VIF value is less than 5 (See Appendix Table A1).

Appendix

Table A1: Variance inflation factors (VIF) of the explanatory variables

Variables	Collinearity Statistics	
	VIF	Tolerance
Crossbred cattle adoption	1.29	0.77
Herd size	1.23	0.81
Family size	1.1	0.9
Price received for the milk sold	1.07	0.93
Distance to market	1.06	0.94
Membership of DCS	1.04	0.96
Access to credit	1.04	0.96
Mean VIF	**1.12**	

Perusal of Table 5 shows that except family size and distance to market, the changes in the remaining variables bear positive influence on the marketed surplus. The existence of an inverse and significant (*p*-value < 0.10) relationship between distance to market and marketed surplus explains that higher the distance

DOI 10.5455/ijlr.20171122051450

to market, lower is the marketed surplus of milk. The possible explanation for the inverse relationship can be that use of other marketing channels (such as private trader, cooperatives and retail selling in the farmer's neighborhood) has stronger effect than selling directly to the market. As more than 65 per cent of the total produce is sold to cooperatives or picked up by professional vendors and buyers in the neighborhood. The negative relation between family size and marketed surplus of milk shows that higher the size of the family lower is the marketed surplus. One strong hypothesis behind postulating the model was that adoption of crossbred cattle has stronger and highly significant effect on increased marketed surplus due to adopter's milk production activity strongly guided by market participation. The result of the same is found as expected because it is found from Table 5 that crossbred cattle adoption is highly significant (*p* value = 0.000) and likely to induce a 14.60 per cent higher marketed surplus. Other explanatory variables such as herd size, price received for the milk sold and membership of DCS are positive and highly significant to influence increased marketed surplus. Price received on the sale of milk is an important signal in the study location to positively influence marketed surplus of milk. The elasticity of marketed surplus of milk to its price change is about 1.33, implying that increase in the price of milk fetched by one rupee likely to induce a 1.33 per cent higher marketed surplus. Similarly, one cattle head increase in the herd size and rise in the probability of becoming member of DCS respectively results in 0.58 and 4.34 per cent increase in the marketed surplus of milk. Family size matters and it has negative but statistically non-significant influence on marketed surplus of milk in the present study.

The relative importance of factors influencing marketed surplus as measured by standardized regression coefficient implies that price fetched for the milk sold is the most important factor, followed by crossbred cattle adoption, herd size, distance to market, membership of DCS and family size. Access to credit is the least important factor to affect marketed surplus of milk. The findings are in similar line with the findings of Sharma (2016).

Conclusion and Policy Implications

The present study was carried out based on the primary information collected from 245 smallholder dairy farmers in three districts of Assam namely Barpeta, Sonitpur and Karbi Anglong. The study has shown that adopters are commercially oriented in their milk production behavior as 98.54 per cent of the adopter farmers produce milk for market against the non-adopters of whom almost 17 per cent of the farmers produce milk for self-consumption. The study has shown that adopter of crossbred cattle has higher absolute consumption and sales of milk per farm commensurate with increased production in relation to the sales and consumption of non-adopters suggesting that crossbred cattle adoption may lead to better commercialization and nutritional gain due to higher milk consumption. The study has also discussed the available sources of milk sale for the sample farmers that generate marketed surplus and their prevailing

DOI 10.5455/ijlr.20171122051450

prices of milk for each source. It highlights that increased use of dairy cooperative society and market by the crossbred cattle adopters may encourage policy makers to emphasize on milk market development and strengthening farmer-cooperative network. The study finally focused on identification of market and non-market factors determining the marketed surplus of milk. It shows that crossbred cattle adoption significantly leads to 14.60 per cent higher marketed surplus. Other factors such as herd size, price received for the milk sold and membership of DCS are positive and highly significant to influence marketed surplus. Overall, the study suggests that diffusion of crossbreeding technology in a state like Assam under the condition that there is absence of recognized indigenous breed in the state is important to raise smallholder dairy farmers' market participation.

Acknowledgement

The authors wish to thank Dr. Ripunjoy N. Choudhury of Assam Livestock Development Agency (ALDA) for providing necessary logistical support during the field survey of the study and for furnishing the authors with the secondary information on crossbreeding technology diffusion in Assam.

References

1. Bardhan, D., Sharma, M.L., & Saxena, R. (2012). Market participation behaviour of smallholder dairy farmers in Uttarakhand: A disaggregated analysis. *Agricultural Economics Research Review*, *25*(2), 243-254.
2. Bayan, B., & Dutta, M.K. (2017). Crossbred cattle adoption and its impact on income and household milk consumption among dairy farmers: Empirical evidence from Assam. *Indian Journal of Agricultural Economics*, *72*(2), 153-165.
3. ILRI. (2007). *Comprehensive Study of the Assam Dairy Sector: Action Plan for Pro Poor Dairy Development*, International Livestock Research Institute, Nairobi, Kenya
4. Kumar, A., & Shah, J. (2016). Dairying as an instrument for ensuring socio-economic and nutritional security in rural India. *Indian Journal of Agricultural Economics*, *71*(1), 78-89
5. Kumar, A., & Staal, S.J. (2010). Is traditional milk marketing and processing viable and efficient? An empirical evidence from Assam, India. *Quarterly Journal of International Agriculture*, *49*(3), 213-225.
6. Kumar, A., Staal, S.J., Baltenweck, I. & Lapar, L.L. (2010). Traditional milk market in Assam: Potential for income and employment generation. *Indian Journal of Agricultural Economics*, *65*(4), 747-759
7. Kumbhare, S.L., Sharma, K.N.S. & Patel, R.K. (1983). Standardization of bovine units. *Indian Journal of Animal Science*, *53*, 547-551
8. Sarker, A. B. 2002. Livestock activity in Assam and research priorities. In: Proceedings of the Seminar, Agriculture in 21st Century, Assam Science Society, Guwahati, Assam
9. Sharma, V.P. 2016. Marketable and marketed surplus of rice and wheat in India: distribution and determinants. *Indian Journal of Agricultural Economics*, 71(2):137-159
10. Sirohi, S., Kumar, A., & Staal, S.J. (2009). Formal milk processing sector in Assam: Lessons to be learnt from institutional failure. *Agricultural Economics Research Review*, *22*(2), 245-254.

 DOI 10.5455/ijlr.20171122051450