SMALLHOLDER DAIRY FARMING IN BANGLADESH: A SOCIOECONOMIC ANALYSIS

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Abstract

The present study was undertaken to determine the factors affecting dairy income and labor utilization, compare the performance of crossbred and indigenous cows, and identify the constraints in smallholder dairy farming. Five different study sites were selected representatively from all over the Bangladesh and 280 cattle farmers were interviewed through a questionnaire. Multiple regression model was used for determining the effect of socioeconomic factors on dairy income and labor utilization in dairying. The Cobb-Douglas production function was used to explore the input-output relationship of milk production. The estimated factor share (EFS) and actual factor share (AFS) for the major inputs used were determined. Highly significant positive correlation (r = 0.465) between total income and dairy income was found. Men contributed more labor in peri-urban and hilly areas whereas women in coastal and northern plane areas. Crossbred cows were reared commercially in the peri-urban area mostly by utilizing hired labor. Farming experience and number of economically active person had positive and significant effect on time spent in dairy farming. The highest milk yield was recorded in the rainy season due to higher amount of food availability and intake. Green fodder, dry fodder, concentrate and labor contributed 58% for indigenous cow and 83.8% for crossbred cow in the milk production function and among them concentrate was the most important factor affecting the milk production. With the introduction of crossbred technology only the concentrates stood to little gain over indigenous cow. The socioeconomic constraints like high price of concentrates, lack of capital and credit facilities, ineffective extension services, low price of milk and inadequate milk marketing facilities were the top most ranking for smallholder dairy farming.

Keywords: Dairy farm, Smallholder, Labor utilization, Factor share, Socioeconomic constraints

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I. INTRODUCTION

Dairy development in developing countries has played a major role in increasing milk production, improving income level in rural areas, generating employment opportunities and improving the nutritional standards of the people, especially for small and marginal farmers. Dairy contributes 18.6% of the agricultural GDP and 2.41% of the national GDP; and it excludes livelihood contributions of the dairy farmers in the country (Huque, 2011). In Bangladesh, dairy is the most important livestock product produced by smallholder crop-livestock farmers where most of the rural household keep cow in order to cultivate and also to produce milk for family consumption. The dairy cow plays a significant role in maintaining a strong agricultural economy of Bangladesh. It can play a leading role to reduce malnutrition of the country's people, mostly the children. According to Rahman *et al.* (2003), dairy farming is a business, way of life and 365 days-a-year job. Dairy farming is marginally profitable and farmers have ample opportunities to increase output by using more of aggregate feed and hired labor inputs (Sikder et al., 2001). The priority of milk in the diet is widely recognized and it has a very high elasticity of demand as compared to other food item (Jabbar and Raha, 1984).

The economics of dairying can be made more profitable by improving the productivity of dairy cows. Development of this sub-sector may be considered as an important strategy for poverty alleviation which is a major objective of the Government. A greater number of family labors are used in dairy cows' care and milk marketing. It has been contributed to provide year-round working opportunities to utilize family labor effectively and provide a place of milk market. Milk production in Bangladesh increased from 1.29 million metric tons in 1987-88 to 2.82 million metric tons in 2011 (Uddin et al., 2011). However, current national production of milk is inadequate to meet country's protein demand. But adoption of crossbred cattle is associated with better milk yield and this type of improved dairying has a direct impact on income generation, poverty alleviation and availability of animal protein.

The prevailing gap in the knowledge of socio economic condition of dairy farmers has constrained for proper planning of new dairy development programs in Bangladesh. Many socio-economic studies revealed that socio-economic parameters are playing great role in development of dairy production and the study might help in understanding their social

parameters and subsequently formulating policy and programs for their development. In order to achieve a regular income and a more market-oriented production pattern in dairy farming, it is necessary to analyse the socioeconomic conditions of dairy farmers and their effects on dairy income in rural Bangladesh. Labor is the primary resource in dairy farming. The results of labor utilization study will help to incorporate the available scientific knowledge and makes the best use of available time in management of a dairy farm (Sreedhar and Ranganadham, 2009). The knowledge on the efficiency of the labor use can be increased to a considerable extent. Proper management of labor is a must for earning profits in dairy farming in the present day competitive market. The output of this study can also serve as an input for a large scale study on the evaluation of dairy policy in the country.

However, dairy farmers are still facing to take decisions on how best to produce milk and how much to produce within their limited resources. Thus, another objective of this study is to conduct production function analyses of small dairy farms focusing on the most important factors affecting milk production according to farm size and season, and to determine whether resources are optimally used. A number of socioeconomic and production constraints are seriously affecting small-scale dairy farming in Bangladesh. Constraints are the circumstances or the causes which prohibit the dairy farmers from adoption of the improved management practices. These constraints are the barriers coming in the way of successful dairy farming faced by the dairy farmers. Identification of constraints faced by them is very important to make necessary interventions and formulation of strategies for uplift of small holder dairy farming.

Features of Smallholder Dairy Farming

Smallholder dairy farmers are competitive and are likely to endure for many years to come, particularly where the opportunity costs of family labor and wages remain low, and play an important social role in developing counties (Holloway et al., 2000; Somda et al., 2005). One important features of the smallholder dairy production system is their rapid expansion in smallholder area, driven essentially by the urban demand, and the opportunity to generate income (Devendra, 2012). Smallholder farming has been characterized by low productivity which is partly attributed to lack of capital and uses poor farming technologies by

smallholder farmers, drought, and lack of market for the produce (Mwankemwa, 2004). Dairy farming in rural Bangladesh are constituted mainly from smallholder farming system (herd size is small 3.5 cattle per household, Saadullah and Hossain, 2000) being managed in traditional ways. Small and marginal dairy farmers rear milch cow in the homestead for income generating purposes. Smallholder dairy farming, usually 1 or 2 heads of cattle, has the highest economic returns compared to other cattle management systems (MAAIF, 2010). About 70-80% of national milk output is produced by smallholder owing an average 1 or 2 local cows giving 1-2 liters of milk per day (Pathan, 2011). Usually, in traditional smallholder farming systems are maintained mainly keeping local cows for milk. A large portion of smallholders rear indigenous cow in the homestead for own consumption and sometimes for income generating purposes. Bangladesh has 24 million cattle, out of which 6 million are dairy cattle of local and crossbreds (DLS, 2008) of which the majority of them are in the hands of smallholder dairy producers.

The extensive farming system is more common in Bangladesh where dairying is considered part of the mixed farming agricultural systems. Low productivity of indigenous cows is attributable to the fact that these cows are mostly subsist on crop residues and natural greenery without any note-worthy supplementation of concentrates produce low amount of milk yield. Housing of dairy cows is essential for controlling of animals and dairy production as well as for disease control. Most of this housing establishment requires a considerable cost to the farmer's investment and labor as such the smallholders built less expensive cowshed. Most of the small farmers provide tin shed and straw shed to house their cattle and a few farmers are found to use half building. Some of the households can not manage cowshed and they kept their cows in open yard. Cattle feed in Bangladesh is rice straw based with limited-availability of forages in certain seasons, and milling by-products are the only feed supplements (Shamsuddin et al., 2002). The small-scale dairying is followed as small-scale intensive, extensive and traditional farming systems (Uddin et al., 2010). A majority of the farmers do not provide concentrates and depend on natural grass. Forages for dairy animals are usually natural pastures from communal lands, river banks and road sides; and crop residues i.e. straws. In a few case, cows are also supplemented with concentrates such as maize crush, wheat bran and rice polish.

Scope of Smallholder Dairying in the Rural Economy

Small-scale dairy farmers are at the centre of concerns about globalization, and rightly so because they are the largest employment and small business group among the world's poor (von Braun, 2004). Potentially, therefore, small-scale dairying is a viable tool to spur economic growth and alleviate poverty and malnutrition. Among other reasons, low agricultural productivity, and high population growths not matching with the available resources to support them are associated with high incidences of poverty in many countries (Mwankemwa, 2004; Mason and Lee, 2005). Smallholder dairy production has thrived since independence in 1972 owing to supportive subsidized services, and guaranteed milk markets and prices for farmers. In order to take advantage of emerging market demands for reducing their poverty, smallholders have to face challenges to improve production costs and productivity (Uddin et al., 2009) and coupled with limited labor inputs. This practice has condemned smallholder dairy farmers to subsistence production, resulting to low income, low saving and low investment in the dairy sector, triggering vicious cycle of low inputs, low productivity, low technology applications and environmental degradation, which translate into abject poverty (Muia et al., 2011).

The livelihood of the land-poor rural farmers depends on their income sources other than the land, and dairy play a vital role here. About 52.3% of the total cattle owner has ≤1.0 acre land, and the household having even no homestead area or have but zero cultivable land keeps cattle, and their average number per household varied from 1.75 to 2.47 (Huque, 2011). Also dairying is a part of the mixed farming systems in Bangladesh (Saadullah, 2001) and a predominant source of income, nutrition and jobs (Miyan, 1996; Haque, 2009). Smallholder dairy supports family income, nutrition and women empowerment. Dairying is also considered a strong tool to develop a village micro economy of Bangladesh (Shamsuddin et al., 2007) in order to improve rural livelihoods and to alleviate rural poverty. Potentially, therefore, small-scale dairying is a viable tool to spur economic growth and alleviate poverty and malnutrition. Therefore, to bring improvement in dairy farming and rural life, self employment of rural family members could contribute to the improvement of dairy farming activities as well as rural life.

Dairy accounts for about 12% of agricultural GDP and contributes to the livelihoods of many small-scale farmers in our country through income, employment and food (Bangladesh economic survey, 2009). Smallholder dairy farming system constitutes an important source of livelihoods to the majority of mixed crop-livestock farmers involved in agricultural production (Kibirizi, et al., 2006). Smallholder dairy farming generates more regular cash income, while dairy production, processing and marketing generate more employment per unit value added than do crops (Asaduzzaman, 2000; Omore et al., 2002). However, smallholder dairy production is becoming increasingly important and it contributes magnificently to the improvement of the livelihoods of rural people. Finally, it can be concluded that Smallholder dairy production was found to be an important and have the potential to poverty alleviation, food security, improved family nutrition and income and employment generation (Uddin et al. 2012).

Objectives

The main objective of the study is to know the socioeconomic conditions of the smallholder dairy farmers and constraints regarding dairying. The specific objectives were as (i) to know the farmer's socioeconomic conditions and their impact on dairy income and labor utilization, (ii) to compare the performance of crossbred and indigenous dairy cows with respect to milk production function and the factor shares and (iii) to identify the constraints faced by the farmers in dairy farming and their suggestions to improve dairy enterprise.

II. MEHODOLOGY

Study Design and Data Collection

Five different study sites were selected representatively from all over the Bangladesh in order to economize time and labor. These were (i) south-west region (Jessore district) (ii) northern hill sties (Sherpur district) (iii) industrial zone having high employment opportunity (Gazipur district) (iv) resource poor area and north-west region of the country (Bogra district) and (v) region between two extremes or mid-region of the country (Mymensingh district). These five regions were considered as the five strata of the whole sampling technique. For convenient mode of selection, an upazila from each of the regions

was selected using simple random sampling technique. Three adjacent villages from each upazila were selected purposively where small dairy farming was done. A complete listing of dairy farm households of each selected villages was carried out.

A total of 280 small dairy farm households (25% of aggregate 1120 households in 15 villages) were selected using simple random sampling technique through house to house visits. The distribution of total sample in different regions was as 30 households from coastal, 45 from northern hill sites, 45 from peri-urban, 90 from rural plain and 70 from northern plane areas. Data collection was done through oral interview of dairy farmers with the use of structured questionnaires. The questionnaire provided information on socioeconomic and farming characteristics of the farmers. Quantitative information regarding investment in dairying and milk output were collected.

To identify the constraints of smallholder dairy farming, an open ended schedule was developed. The respondents were asked to list out the problems faced by them in dairy farming and 12 important constraints were sorted. To know the extent of each of the problems, farmers were asked whether the problems were very serious, serious, or no serious. To aggregate the three types of response, weighted frequency for each of the problems was determined as (weighted frequency = 3 x very serious + 2 x serious + not serious). The highest frequency was ranked I, the second highest was ranked II and so on. Dairy farmers were asked to suggest measures for improving dairy farming. The suggestions were listed out, frequency and percentage were calculated.

Conceptual Framework

In order to examine the impact of dairy cattle farming on certain parameters, such as average milk yield per day, quantities of green fodder, dry fodder and concentrate and human labor use per milch cow was done according to cow type, farm size and season. Geometric mean was calculated as per day per cow data were used. In a few cases, there was no use of concentrate to the indigenous cow and hence no geometric mean was calculated for those cases. Factors included in the model are exogenous i.e. currently taken as given by the households. The model provides empirical estimates of how change in these

exogenous variables influences the probability of adoption of crossbred cows (Nkonya et al., 1997).

Feeds have been the primary inputs affecting milk production. The cost of milk production studies (Raut et al., 1975 and Madalia and Charan, 1975) had shown that feeds constitute three-fourths of the total cost of milk production. Feeds apart, labour and capital have often been used as independent variables. Labor may be varied over a certain range and is measurable but capital cost may relate to milk yield in fixed proportions and may therefore dominate all other variables in accounting for the total variation in the regression (Rao and Miller, 1972). For this reason, capital as an independent variable was dropped from the model. Feeds and milk yield were recorded in kilograms (kg). Cobb-Douglas production function for milk yield was done according to aggregate, farm size and seasons.

Econometric Models

To know the effect of socioeconomic factors of the households on dairy income in dairy farming following multiple regression models was used.

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + U_i$$

Where, Y = Monthly income from dairy farming

X_1 = Age of household head (year)

X_2 = Experience of household head in dairy farming (year)

X_3 = Year of schooling of household head

X_4 = Farm size based on cultivated land

X_5 = Total number of large ruminants in animal units

X_6 = Total number of small ruminants in animal units

X_7 = Time spent (hour) in dairy farming

b_1, b_2,----, b_3 are the coefficients of respective variables

U_i = Error term

To know the effect of socioeconomic factors of the households on labor utilization in dairy farming following multiple regression models was used.

$$L = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + U_i$$

Where, L = Labor used in hour per day by all members of the households including hired labor

X_1 = Age of household head (year)

X_2 = Experience of household head in dairy farming (year)

X_3 = Year of schooling of household head

X_4 = Number of economically dependent person in the family

X_5 = Number of economically active person in dairy activities

X_6 = Total number of large ruminants in animal units

X_7 = Total number of small ruminants in animal units

b_1, b_2,----, b_3 are the coefficients of respective variables

U_i = Error term

The following Cobb-Douglas production function was used to explore the input-output relationship of milk production.

$$Y_{ij} = A_j \; G_{ij}^{a_j} \; D_{ij}^{b_j} \; C_{ij}^{k_j} \; L_{ij}^{r_j} \; e^{u_{ij}}$$

Where, Y_{ij} is the per day per cow milk yield (liter)

G_{ij} is the use of green fodder per day per cow (kg)

D_{ij} is the use of dry fodder per day per cow (kg)

C_{ij} is the use of dry concentrate per day per cow (kg)

L_{ij} is the use of labour per day per cow (hours)

a_j, b_j, k_j and r_j - denote respectively the partial output elasticities with respect to feeding levels of green fodder, dry fodder, concentrate and labour.

A_j denotes the intercept term, and

u_{ij} denotes the error term which is assumed to follow the assumptions of linear stochastic regression model (Goldberger, 1964)

Factor Share Analysis

Estimated factor share (EFS) and actual factor share (AFS) were determined using the following equations:

$$EFS = b_j / \sum_{j=1}^{n} b_j$$

$$AFS = X_{ij} / Y_i$$

Where, Y_i is the total income for the ith cow breed

X_{ij} is the expenditure of jth input for ith breed

b_j is the regression coefficient of jth input estimated from Cobb-Douglas milk production function

Deviation of EFS from AFS was calculates as, Deviation = (AFS – EFS) / EFS

Significant/ difference of the deviations were tested with the comparison of observed deviation minus standardized deviation.

Standardized deviation = $\frac{AFS_j - EFS_j}{s.e.(EFS_j)}$, j = 1, 2, 3, 4 (inputs)

Change in AFS_j = (AFS_{crosj} - AFS_{indj}) / AFS_{indj}

III. RESULTS AND DISCUSSION

Socioeconomic Conditions of the Dairy Farmers and Their Effect on Dairy Income

The information regarding personal characteristics of the respondents such as age, experience in dairy farming, education and other socioeconomic characteristics help to understand the actual situation related to social set up of the dairy owners and potential contribution to the milk yield. The age of respondents ranged from 25 to 72 years with an average age of 40.8 years (SD = 9.6). Experience in cattle farming ranged from 4 to 57 years with an average experience of 17 years (SD = 9.6) and 56 percent of the respondents were experienced from 11 years to 20 years (Table 1). One-fourth of the surveyed

respondents were illiterate and about 45.7 percent of them had primary education. Quddus et al. (2010) found same results. The years of schooling had negative correlation with the dairy income because people with higher level education (high school and above) often seek other employment rather than dairy farming. Most of the dairy farm holder's family size was 2 to 7 persons with an average family size of 5.1 (SD = 5.1) and active family member in dairying ranged from 1-5 and average 2.4 persons. Farm size per household ranged from 0 to 6.7 hectares (ha) with an average farm size of 0.4 ha (SD = 0.7) which means that most of the studied respondents had marginal and small land holdings. Significant negative correlation between crop lands and dairy income interpret that people having small crop lands used to rear dairy cow. Highly significant positive correlation between total income and dairy income interpret that income from dairy had significant contribution to the cattle owner's family expenditure.

Table 1. Socioeconomic characteristics of smallholder dairy farmers

Respondents characteristics	**Range**	**Mean**	**Standard deviation**	**Correlation coefficient between characteristics and dairy income**
Age (years)	25-72	40.8	9.58	0.065
Experience in dairy farming (years)	4-57	10.7	9.61	0.114*
Education (years of schooling)	0-12	4.5	3.63	-0.053
Family size (number)	2-18	5.1	2.02	0.035
No. of family member active in dairy farming	1-5	2.4	0.70	-0.085
Farm size (crop land in ha)	0-6.7	0.4	0.70	-0.112*
Large ruminant (number)	1-15	4.2	1.95	0.551***
Small ruminant (number)	0-13	1.2	1.82	-0.041
Poultry (number)	0-25	8.7	5.15	0.138**
Total income (thousand taka per year)	4.2-314.4	65.3	50.18	0.465***
Income from dairy (thousand taka per year)	4.0-252.0	23.6	26.58	-

* Significant at 10% level of significance, **significant at 5% level of significance, ***significant at 1% level of significance

The coefficients of multiple determinations (R^2) for three groups of dairy holders were 0.757, 0.920, and 0.722 respectively (Table 2) which indicated that included variables in the model explained higher variability in case of medium dairy income group. Age of dairy owners had negative effect on dairy income for lower income group and all groups interpret that low aged people preferred dairy farming i.e. young dairy farmers tend to attain higher dairy outputs. This result is consistent with Gale (1994), who suggests that producers of older age may reduce farm work load as their health declines or to accommodate reduced income needs. On the other hand, farm size (crop land) of lower income group had significant positive effect and farm size of all groups had insignificant positive impact on dairy income because dairy holders having higher lands were given more preference to dairy farming. The coefficient of experience in dairy farming (0.219) was positive and significant at 0.05 levels. This result agrees with Sultana et al. (2016). This indicates that gaining experience might enhance efficient management decision on dairy management which is possible through receiving formal education, training, learning by doing and interaction with an informal network. The coefficient of year of schooling of farmers was -0.031 and it was statistically insignificant at 0.05 levels mainly due to the fact that educated farmers are motivated to other services and illiterate or low educated farmers usually adopt milk production activities.

Negative value of coefficient of small ruminant for all the groups interpret that this variable had no positive impact on dairy income. But positive value of coefficient of large ruminant for all groups interpret that large ruminant had positive impact to increase dairy income. The coefficient of number of large ruminant (0.382) was positive and significant at 0.01 levels in case of all farmers indicated that increase of 1 unit of large ruminant keeping other factors constant per month dairy income would be increased by Tk.0.38. The coefficient for time spent in dairy farming was statistically significant at 0.01 levels for both low income and higher income dairy holders (Table 2). In fact, the value of the coefficient (1.013) for time spent indicated that if the time spent in dairy farming increases by 1 hour per day other factors constant, dairy income would be increased by Tk.1.01 per month.

Table 2. Estimated values of coefficients of dairy income

Independent variables	Income < Tk.1500 N = 170	Income >= Tk.1500 N = 110	Overall N = 280
Intercept	7.804***	5.261	7.336
	(0.632)	(3.408)	(1.021)
Age (XI)	-0.897***	0.814	-0.774
	(0.192)	(1.160)	(0.318)
Experience in livestock farming (X2)	0.450***	-0.559	0.219*
	(0.084)	(0.510)	(0.127)
Year of schooling of household head (X3)	-0.055	0.305**	-0.031
	(0.069)	(0.105)	(0.098)
Farming size based on cultivated land (X4)	0.093**	-0.152	0.004
	(0.044)	(0.154)	(0.058)
Number of large ruminant (X5)	0.104	0.159	0.382***
	(0.098)	(0.266)	(0.133)
Number small ruminant (X6)	-0.249***	-0.028	-0.207**
	(0.064)	(0.113)	(0.091)
Time devoted in livestock farming (X7)	0.301***	0.565**	1.013***
	(0.095)	(0.221)	(0.110)
R^2	0.757	0.920	0.772

* Significant at 10% level of significance, **significant at 5% level of significance, ***significant at 1% level of significance

Factors Affecting Labor Utilization in Dairy Farming

Among the agriculture-allied activities, dairy farming is the prominent one which provided a major source of employment to the family labor. Across the farm size categories, small and marginal farmers devoted comparatively more time to livestock raring. However, there were disparity in level of labor contribution between male, female and children for dairy farming activities. In hill sites and peri-urban areas on average, male contributed more labor (1.88 and 5.42 hours per day, respectively) than women (1.45 and 4.76 hours per day, respectively). Women's labor activities were highest in coastal and northern plane areas compared to other groups of people (Table 3). The labor activities for children were lowest (0.15 hour per day) compared to other groups. Atuhaire et al. (2014) reported similar result,

12%, 5.5% and 3.1% respectively compared to total labor activities in three districts of Uganda. The highest labor contribution (11.18 hours per day) was observed in Peri-urban area because crossbred cows were reared commercially. Hired labors were found in middle plane and peri-urban areas only because the farmers of these areas had other jobs and they used to commercial farming.

Table 3. Labor utilization pattern of dairy enterprise

Region	Sample size	Labor involved (hour per day)				
		Male	Female	Children	Hired	Total
Coastal	30	1.36	1.78	0.30	00	3.44
Hill sites	45	1.88	1.45	0.07	00	3.40
Northern plane	70	1.19	1.58	0.17	00	2.94
Middle plane	90	1.64	1.61	0.17	0.44	3.86
Peri-urban	45	5.42	4.76	0.09	0.91	11.18
Over all	280	2.11	2.06	0.15	0.28	4.60

Source: Calculation of survey data

The coefficients of multiple determinations (R^2) for the dairy holders were 0.31 (Table 4) which indicated that included variables in the model explained not higher variability in labor utilization in dairy farming. Age of dairy owners had positive but insignificant effect on time utilization in dairy farming. The coefficient of experience (0.091) in dairy farming was positive and significant at 0.05 levels which indicated that increase of one year of experience keeping other factors constant 0.09 hour time spent would be increased. The coefficient of year of schooling of farmers was -0.020 which indicated that no positive effect of year of schooling on time spent in dairy farming. But positive value of coefficient of number of dairy animals interpret that this variable had positive and highly significant effect to increase labor utilization in dairy farming indicated that increase of 1 unit of dairy animal keeping other factors constant 1.1 hour of time spent would be increased. Number of economically dependent person in the family had no significant effect but number of economically active person had positive and significant effect on time spent in dairy farming. In fact, the value of the coefficient (0.784) indicated that if a single active person in dairy farming increases other factor constant, 0.78 hour labor would be increased.

Table 4. Estimated values of coefficients of labor utilization in dairy farming

Independent variable	Coefficients of Regression	Standard error
Constant	1.645	1.232
Age of household head (X_1)	0.028	0.032
Experience in dairy farming (X_2)	0.091	0.033
Year of schooling of household head (X_3)	-0.020	0.061
Number of economically dependent person (X_4)	0.426	0.278
Number of active person in dairy activities (X_5)	0.784	0.256
Number of dairy animals (X_6)	1.096	0.110
Value of R^2	0.31	

Source: Analysis of survey data

Milk Production Function

The average daily milk yield of crossbred cow was higher than that of indigenous cow in all the cases (Table 5). In the case of aggregate data crossbred cow produced 5.04 liters of milk per day, which was more than three times higher than indigenous cow. Average milk yield of landless farmers was higher (5.32 liter) compared to other farmers, because they gave more emphasis on crossbred cattle farming as a source of income. The highest milk yield was in the rainy season both for indigenous (1.87 liters) and crossbred (5.52 liters) cattle due to food availability and intake of higher amount of green and dry fodder in this period. The average daily feed intake and the human labor use per animal were also higher for the crossbred cattle.

In all the cases of farm size, season and breed type, the calculated value of F-ratio was highly significant implying the overall significance of the equation (Table 6). Low values for the adjusted coefficient of multiple determinations (R^2) for all of the cases of indigenous cattle were observed compared to crossbred cattle. This may largely be due to the omission of milch cattle as an explanatory variable from per cattle milk production functions. The R^2 value was 0.580 for aggregate indigenous cattle implying that the induced variables (green fodder, dry fodder, concentrate and labor) explained 58 percent contribution of milk

production whereas for aggregate crossbred cattle these variables explained 83.8 percent contribution. Among the different inputs, the coefficients of green fodder, dry fodder, concentrate and labor were positive in all the equations fitted and highly significant in most of the equations. The coefficient of concentrates was maximum in most of the cases compared to other inputs except rainy season implying the concentrate was the most important factor affecting the milk production in all the breeds of cows. Similar findings were reported by Rai and Gangwar (1976) and Sharma and Singh (1993). The coefficient of labor was significant in all the cases of indigenous cow and in a few cases of crossbred cow.

Table 5. Geometric mean of the per cow per day input used and milk output

Farm size/ Season/ Cow type	Input used				Output	Sample size
	Green fodder (kg)	Dry fodder (kg)	Concentrate (kg)	Labor (Hour/day)	Milk yield (Liter)	
Aggregate						
Indigenous	8.55	5.71	-	2.91	1.66	114
crossbred	15.60	10.95	2.12	4.56	5.04	66
Landless						
Indigenous	8.63	5.35	-	2.96	1.63	95
Crossbred	16.30	11.00	2.34	4.85	5.32	49
Small						
Indigenous	8.51	5.96	-	2.85	1.60	101
Crossbred	3.4	5.63	1.48	1.23	4.20	12
Large						
Indigenous	1.38	2.04	0.45	0.58	0.82	18
Crossbred	2.51	3.74	0.38	0.57	4.65	5
Winter						
Indigenous	8.31	5.80	-	2.83	1.63	101
Crossbred	12.81	8.05	1.62	3.97	3.52	15
Summer						
Indigenous	8.34	5.04	-	2.99	1.60	77
Crossbred	14.80	7.75	2.03	4.44	4.66	4
Rainy						
Indigenous	8.62	7.16	-	2.93	1.87	36
Crossbred	16.50	12.27	2.22	4.76	5.52	47

* Figures in the parentheses are the percentages of total
Estimated at prices: Interest of fixed capital = (Total cost x 16%) 365; green fodder @Tk. 2 per kg; dry fodder @ Tk. 3 per kg; concentrates @ Tk. 20 per kg; labor @ Tk. 10 per hour.

Source: Calculation of survey data

Effect of Crossbred Cow on Actual Factor Shares

The results of the estimated factor share (EFS) and actual factor share (AFS) of the different input factors under indigenous and crossbred farms, the deviations of EFS from AFS and the direction and magnitude of change in AFS of different inputs are presented in Table 7. The actual factor shares (AFS) of dry fodder and human labor under indigenous and only human labor under crossbred cattle were significantly different from their respective estimated factor shares. The results interpret that no any of the four input factors had sufficient gained shares in milk production on crossbred cattle over indigenous cattle. Thus, the actual factor share on dairy farm adopting crossbred technology had no significant contribution to the total milk output. With the introduction of crossbred technology only the concentrates stood to gain and all remaining inputs were found to loose. It means that the share accrued to green fodder, dry fodder and human labor decreased and concentrate increased as a result of rearing high yielding crossbred cattle. This result contradicts with the result of Kunnal et al. (2002) who determined that herd size and dry fodder stood to gain with the introduction of crossbred cow.

Table 6. Estimates of Cobb-Douglass milk production function according to farm size and season

Farm size/ Season/ Cow type	Intercept	Green fodder	Dry fodder	Concentrate	Labour	F-value	R^{2}-value
Aggregate							
Indigenous	-0.781	0.301**	0.217**	0.410**	0.370**	69.34	0.580
Crossbred	-0.873	0.408**	0.325**	0.408**	0.187	84.97	0.838
Landless							
Indigenous	-0.649	0.290*	0.164**	0.440**	0.355**	25.85	0.530
Crossbred	-1.202	0.431**	0.406**	0.366**	0.240	64.70	0.841
Small							
Indigenous	-1.040	0.329**	0.281**	0.297**	0.414**	31.32	0.571
Crossbred	-7.300	0.942*	0.003	0.656	0.114	34.14	0.923
Large							
Indigenous	-0.596	0.243	0.126	0.879**	0.325	12.21	0.725
Crossbred	0.118	0.344	0.014	0.481	0.082	2.85	0.825

Winter							
Indigenous	-0.350	0.187	0.199**	0.498**	0.254*	38.11	0.612
Crossbred	0.363	0.051	0.116	0.996**	0.032	21.05	0.861
Summer							
Indigenous	-1.026	0.245*	0.199**	0.370**	.711**	29.72	0.621
Crossbred	-0.357	0.344*	0.008	0.363*	0.416*	40.56	0.940
Rainy							
Indigenous	-2.140	0.835**	0.181	0.301**	0.486*	6.37	0.402
Crossbred	-1.326	0.491**	0.414**	0.337**	0.205	67.68	0.850

*Significant at 5% level of significance, **significant at 1% level of significance

Table 7. Estimated and actual factor shares and impact of technical change in milk production

Particulars	Indigenous			Crossbred			Change in AFS
	EFS	AFS	Deviation	EFS	AFS	Deviation	
Green fodder	0.232	0.233	0.004	0.307	0.121	0.606	-0.48
Dry fodder	0.167	0.417	1.497*	0.245	0.219	0.106	-0.47
Concentrates	0.316	0.295	0.066	0.307	0.310	0.001	0.05
Labor	0.285	0.766	1.688*	0.141	0.402	1.851*	-0.48

EFS: Estimated Factor Share and AFS: Actual Factor Share
* indicate significant at 5% level

Socioeconomic Constraints Faced by the Farmers and Their Specific Suggestions

A number of socioeconomic constraints are affecting smallholder dairy farming in Bangladesh. The major socioeconomic constraints were mainly capital, high price of feeds (specially concentrate feeds), marketing (inadequate facilities and low price of milk), non-availability of breeding and veterinary services, lack of educational knowledge and access to technology, labor crisis, and extension services. Smallholder farming has been characterized by low productivity that is partly attributed to lack of capital and use of poor farming technologies by smallholder farmers, drought, and lack of market for the produce (Mwankemwa, 2004). In order to take advantage of emerging market demands for reducing their poverty, smallholders have to face challenges to improve production costs and productivity (Uddin et al., 2009). High price of concentrates was ranked one constraint in

dairy farming. About 170 farmers (60.1%) opined this problem of which 105 farmers faced serious and 29 farmers faced very serious problem. Also, lack of availability of fodder or concentrate feeds was a moderate problem according to 16.8% farmers but other 16.8% farmers claimed that it was a serious or very serious problem. Similar result was also reported by Rathod et al. (2011).

The second highest farming constraint was lack of capital and credit facilities (37.5%). Out of 105 farmers 23% claimed that it was serious problem and 9% farmers faced very serious problem. Lack of capital (47.2%) and lack of credit facilities and high rate of interest (42.2%) were reported by Quddus (2012). About 39.2% farmers opined that effective extension services was the next constraint for improved dairy production of which 20.4% stated that it was not serious problem. The next constraint was low price of dairy milk where most of them stated no serious problem but 9.6% farmers claimed that it was a serious and 7.9% clamed a very serious problem as reported earlier by Jayalaxmi et al. (1997). Also, inadequate milk marketing facilities is another socioeconomic problem (19% farmers faced serious problem) in dairying. Shortage of land and housing facilities are also the constraints in dairying but not serious and similar result (31%) reported by Dhindsa et al. (2014).

Table 8. Distribution of dairy farmers according to extent of socioeconomic and production constraints in dairy farming

Constraints	**Extent of problems**			
	Very serious	**Serious**	**Not serious**	**Rank**
Lack of capital and credit facilities	26	64	15	II
Lack of education and inadequate knowledge for technology use	5	35	46	X
Limited source of information and access to technology	7	15	33	XI
Lack of availability of fodder or concentrate feeds	15	32	47	VI
High price of concentrates	29	105	36	I
Shortage of land and housing facilities	0	13	43	XII
Unavailability of labor and higher rate of wages	10	21`	61	IX
Low price of milk	22	27	41	IV

Non-availability of breeding / AI services	23	17	36	VIII
Lack of vaccine facilities / veterinary services	9	23	75	VII
Inadequate milk marketing facilities	9	53	26	V
Ineffective extension services	8	45	57	III

The respondents were requested to provide suggestions for improving the dairy farming. The most important suggestions were prioritized by using frequency and percentage and presented in Table 9. About half of the respondents suggested that availability and low price of concentrate feeds (51.8%) and timely and adequate supply of inputs at affordable costs (47.5%) would improve the dairy enterprise. Availability of reliable and continuous technical assistance (26.1%), increased and timely provision of medicine and potent vaccine (31.1%), and AI facilities should be increased and provision of pure breed (24.6%) were the next significant suggestions for dairy improvement. A few numbers of farmers provided some important suggestions for development of smallholder dairy farming e.g. establish milk and meat marketing linkage through cooperatives, facilitate knowledge on improved technologies through training, encourage to set up milk collection centers and to organize animal show / mela / competition / telecast.

Table 9. Distribution of dairy farmers according to their suggestions

SL. No.	Suggestions	Frequency*	Percentage
1	Need more knowledge on improved technologies through aining	53	18.9
2	Availability of reliable and continuous technical assistance	73	26.1
3	Availability and low price of concentrate feeds	145	51.8
4	Timely and adequate supply of inputs at affordable costs	133	47.5
5	Increased and timely provision of medicine and potent accine	87	31.1
6	AI facilities should be increased and provision of pure breed	69	24.6
7	Milk collection centers should be encouraged	37	13.2
8	Milk and meat marketing linkage through cooperatives	62	22.1
9	Organizing animal show / mela / competition / telecast	48	17.1

*Multiple responses

Conclusion and Policy Recommendations:

Manpower training in dairy activities and credit facilities for smallholders should be improved. Extension services should be extended to encourage small farmers to rearing crossbred cows as it is profitable than indigenous cow. The concentrate is the most important input affecting milk production indicating that the farmers can increase their milk output by feeding more concentrates to their dairy cow. Thus, an attempt should be taken for raising milk production by readjustment of feed inputs in all the seasons. More feed mills should be established by government and private entrepreneurs for supplying quality concentrate feeds with a reasonable price as well as feed marketing policy should be adopted and farmers should be motivated to use concentrates to their cows.

Action plans based on the approved public policy is essential for the development of domestic smallholder dairy for addressing growing milk demand in the present changing and challenging socioeconomic conditions. Given suitable government policy support and access to market and services, there is a great potential to develop small-scale dairy farmers through introducing dairy schemes. Fixation of price for milk is a policy decision, so the government may fix the price of milk by considering the cost of production. Milk marketing facilities may be improved either by establishing milk processing plant or by making provision for collection of milk through well organized marketing bodies. Extension services should be increased and strengthened, especially, by introducing mass media/ telecast program to motivate the farmers in enriching their knowledge of improved farming practices. The constraints encountered in this study were due to the weak economic position of the small-scale dairy farmers and there has no provision of subsidies from government. Therefore, it could be recommended that in order to improve small-scale householders' life style by the way of improving dairy production, there is a need for technical and institutional intervention to alleviate the identified constraints of smallholder dairy farmers. A further research may be undertaken with consideration of whole country and all the possible measures for sustainable development of smallholder dairy farming in Bangladesh.

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