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## **Profitability and Factors Affecting Milk Supply: An Empirical Study on Dairy Farms in Chittagong District of Bangladesh**

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### **Authors' contributions**

*The work has been derived from author SB master's thesis and carried out in collaboration with supervisor MJA, co-supervisor SAS and other authors. Author SB designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author SB, MMR and OCD managed the analyses of the study. All authors managed the literature searches, edited the manuscript, read and approved the final manuscript.*

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### **ABSTRACT**

It was an attempt to examine the profitability and factors affecting milk supply of dairy farms in selected areas in Chittagong District. Primary data were collected from both milk producers and traders during the months of August to September 2015. Simple descriptive methods and stepwise multiple regression models were used to analyze the data. The return over investment indicated that dairy farming is a profitable business in Chittagong District. Stepwise multiple regression models were specified and estimated to identify the factors affecting milk supply of dairy farmers. Regression analysis revealed that three variables i.e., number of milking cows, the age of

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household head and experience of dairy farming, as important factors affecting sale volume of milk. The survey result identified that the supply of milk trading was predominantly traditional, fragmented and only one cooling plant which has limited capacity but no other formal agreement either collectors or farmers. As a result, most of the surplus milk absorbed by the sweetmeat shops.

*Keywords: Profitability; marketing costs; margin; milk supply.*

## 1. INTRODUCTION

Dairy farming is an integral farming system in Bangladesh. It is an activity involving investment for milk production and marketing. Dairying plays a vital role in respect to nutrient, generation of income and employment. It is more efficient and intensive system in terms of nutrient and protein supply for human consumption from a given quantity of resources than beef or sheep farming. Dairy farming also supports substantial employment in production, processing, and marketing [1]. Bangladesh is a country of rural based subsistence agriculture. About 47.6% of total labour force is engaged in this sector [2]. Livestock sector contributes 1.78% of GDP out of the 16.33% contribution of the agriculture sector in the economy [3]. The total production of milk in Bangladesh in 2006-07 was 2.28 million tons which were increased to 6.09 million tons in 2013-14 [2]. In this context dairy farming stands a profitable business everywhere in the world, so dairying in the recent decades has been considered a vital component in the diversification in Bangladesh economy.

Dairying in Bangladesh has been practiced for a long time at small scale. Some noticeable developments has also taken place in breed improvement. In Bangladesh cross-breeding of local cows with Australian, Sahiwal, Holstein-Friesian, Jersey, etc. are often seen in the rural areas. These cross breeds are found as higher in terms of milk and meat production. Milk is considered as an ideal and a complete food for the people of the whole world. There is no more complete food that milk yet known to mankind. Moreover, milk today is a rare commodity for many children. Both population growth and rising income are contributing to rapid expansion in the demand for milk and its products as it has the high-income elasticity of demand [4]. As a result of the development of modern civilization and culture, particularly the emergence of high-income urban population group has changed the pattern of milk consumption. They prefer packaged milk over ordinary raw milk. With the alarming growth of population, the demand for milk and dairy products rises faster than the

demand for crops both in developing and developed countries. There are some milk pocket areas in the country where dairy farming has been traditionally an important and major component as mixed farming system. These areas are particularly located in Pabna, Sirajgonj, Manikganj, Faridpur, Kishoreganj, Rangpur, Tangail districts and now it is extended to Chittagong district, as one of the dairy producing emerged areas. The numbers of cross breed private dairy farms have been increasing in the study area over the last few years. As it is labour intensive farming and support employment in production, processing, and marketing, development of a dairy enterprise is essential to create the employment opportunity of the people in the country in general and Chittagong region in particular. Development of this sub-sector may be considered as an important strategy for poverty alleviation which is an objective of the government of Bangladesh. Several studies conducted by researchers [5-11] influenced to analyze the profitability and factors affecting of milk supply on dairy farms in Chittagong District. Given this backdrop, the present study was undertaken with the specific objectives of examining the profitability of dairy farms, estimating the marketing cost and margin of milk traders and analyzing the factors affecting of milk supply to the markets.

## 2. METHODOLOGY

On the basis of specific objectives of the study and taking into consideration with associated limitations, two Upazila (Patiya and Banshkhali) and Chittagong metropolitan city in Chittagong District were purposively selected as the study areas because of higher concentration of high yielding cross breed dairy cow. A sample of 55 milk producers and 35 milk traders were selected by using simple random and convenience sampling technique respectively. Required data were collected through the direct personal interview during the month from August to September 2015. The collected raw data was carefully checked to detect errors and omissions and to avoid irrelevant information. In order to

achieve the objectives, descriptive statistics and the following analytical techniques were used.

## 2.1 Net Profit of Milk Producer

To analyze the costs and revenue of the milk producers or dairy farms by tabular analysis following profit equation was used.

$$\pi = (P_m \times Q_m) + P_c + V_{bp} - \sum (P_{xi} \times X_i) - TFC$$

Where,

- $\Pi$  = Profit of milk producer per cow per year  
 $P_m$  = Per unit price of milk (Tk. /litre)  
 $Q_m$  = Quantity of milk (Litre /year)  
 $P_c$  = Price of calf (Tk. /year)  
 $V_{bp}$  = Value of by-product( cow-dung) (Tk. /year)  
 $TFC$  = Total fixed cost of milk producer per cow per year  
 $P_{xi}$  = Per unit price of i-th inputs (Tk. /kg)  
 $X_i$  = Quantity of the i-th inputs per cow per year (kg)  
 $i$  = 1, 2, 3.....n (number of input)

The BCR (undiscounted measure) was calculated by using the following formula:

$$\text{Benefit cost ratio (BCR)} = \frac{\text{Gross revenue}}{\text{Gross cost}}$$

The Marketing Margin and Net Margins of milk traders were estimated by using following formula:

- i) Gross marketing margin (Tk. /litre) = Sale price (Tk. /litre) – purchase price (Tk. /litre).
- ii) Net margin (Tk. /litre) = Gross marketing margin (Tk. /litre) - marketing cost (Tk. /litre)

## 2.2 Market Supply Model

Following multiple regression models was used to analyze the factors affecting farm level milk supply [12].

$$Y = X'\beta + U$$

Where,

- $Y$  = quantity of milk supplied/marketed volume to market  
 $X'$  = vector of explanatory variables (number of milking cows, age of household head, gender of household head, education of household head, family size, experience,

distance to market, market information, price of milk, veterinary training and off-farm income.)

- $\beta$  = vector of parameters to be estimated,  
 $U$  = disturbance term.

## 2.3 Hypothesis, Variable Selection, and Definition

The marketable surplus may differ from region to region, within the same region, and even from commodity to commodity. In order to identify determinants or factors influencing milk marketable supply both continuous and discrete variables were hypothesized based on economic theories and the findings of different empirical studies. Accordingly, in order to investigate the determinants of milk supply, the following variables were constructed.

## 2.4 Dependent Variable

### 2.4.1 Total volume of milk sales (litres)

It is a continuous variable that represents the marketable supply of milk by individual farm-households, which is measured in litres per day per farm.

## 2.5 Independent/Explanatory Variable

The explanatory variables expected to influence the dependent variable are the following;

### 2.5.1 Age of household head (age of HHH)

It is a continuous variable and measured in years. Age of household head is believed to be wise in resource use, on the other hand, young household heads have long investment horizon and it is expected to have either positive or negative effect on the volume of milk sales.

### 2.5.2 Sex of the household head (sex of HHH)

A dummy variable taking value zero if female and one if male is considered. It is expected to have either positive or negative effect on the volume of milk sales.

### 2.5.3 Education of the household head (EDU of HHH)

It is a dummy variable measured in terms of whether the household has a formal education (literate) or not (illiterate) which takes a value one if a household has formal education and

zero otherwise. Education broadens farmers' intelligence and enables them to perform the farming activities intelligently, accurately and efficiently. Moreover, better-educated farmers tend to be more innovative and therefore more likely to adopt the marketing systems. Formal education enhances the information acquisition and adjustment abilities of the farmer, thereby improving the quality of decision making [13]. Therefore, this variable is hypothesized to influence the volume of milk sales positively.

#### **2.5.4 Total milk production (TMP)**

It is a continuous variable that represents the production of milk by individual farm-households, which is measured in litres per day per farm.

#### **2.5.5 Family size**

Family size is a continuous variable measured in terms of a number of family members in the household. As dairying is labour intensive activities, dairy production in general and marketable surplus of dairy products, in particular, is a function of labour. It is expected to have either positive or negative effect on the volume of milk sales.

#### **2.5.6 Dairy farming experience (DFEXP)**

It is the total number of years a farmer stays in the production of milk. A household with a better experience in dairy farming is expected to produce more amounts of milk and, as a result, farmers expected to supply more amounts of milk to market. Farmers with longer farming experience are expected to be more knowledgeable and skillful [14]. Therefore, this variable is hypothesized to positively influence milk marketable surplus.

#### **2.5.7 Number of milking cows/herd size (NMC)**

This variable is continuous and is measured as number of milking cows owned. The marketable milk volume of dairy farming is assumed to be positively influenced by the number of milking cows owned.

#### **2.5.8 Access to extension training (ACEXT)**

This variable is measured as a dummy variable taking a value of one if the dairy household has

access to dairy production extension service and zero otherwise. It is expected that extension service widens the household's knowledge with regard to the use of improved dairy production technologies and has positive impact on milk market participation decision and sale volume of milk. A number of extension visits improve the household's intellectual capitals, which improves milk production and divert dairy production resources. Therefore, a number of extension visits are hypothesized to impact dairy household milk market entry decision and marketed volume of milk positively.

#### **2.5.9 Distance to market (DMKT)**

This is the location of the dairy household from the nearest milk market and is measured in a kilometer. The closer the dairy market to the dairy household, the lesser would be the transportation charges, loss due to spoilage and better access to market information and facilities. This improves return to labour and capital; increases farm gate price and the incentives to participate in the economic transaction. In that case, distance from nearest milk market is hypothesized to be negatively related to market participation decision and marketable milk surplus. On the other hand, distance from the dairy household to market might be positive that indicates a direct relation of distance with a marketed surplus. In a sense that, when lucrative prices are offered by some of the agencies than farmers are ready to travel longer distances in order to sell their surplus. So, it is expected to have either positive or negative effect on the volume of milk sales.

#### **2.5.10 Market information (MIF)**

Farmers, marketing decisions are based on market information, and poorly integrated markets that may convey inaccurate information, leading to inefficient product movement. Therefore, it is hypothesized that market information is positively related to the marketable surplus.

#### **2.5.11 Off-farm income (OFFI)**

It is a continuous variable and measured in taka. This variable is hypothesized to be positively related to sale volume of milk.

**Table 1. Descriptions of the dependent and independent variable**

Variables	Types	Values
Total Milk Marketed /Sales Volume (TMMV)	Continuous	liters
Age of Household Head (AHH)	Continuous	Number of years
Sex/Gender of Household Head (SHH)	Dummy	Male=1, Female=0
Education of Household Head (EHH)	Dummy	Literate=1, illiterate=0
Total Milk Production (TMP)	Continuous	Liters
Family Size (FS)	Continuous	Number of family member
Experience (EXP)	Continuous	Number of years
Number of Milking Cows (NMC)	Continuous	Number of cows
Veterinary Training (VT)	Dummy	Yes=1, No= 0
Price of Milk (PM)	Continuous	Taka per liter
Distance to Market (DMT)	Continuous	Kilometer
Market Information (MIF)	Dummy	Yes=1, No=0
Off-farm Income (OFFI)	Continuous	Taka

### 3. RESULTS AND DISCUSSION

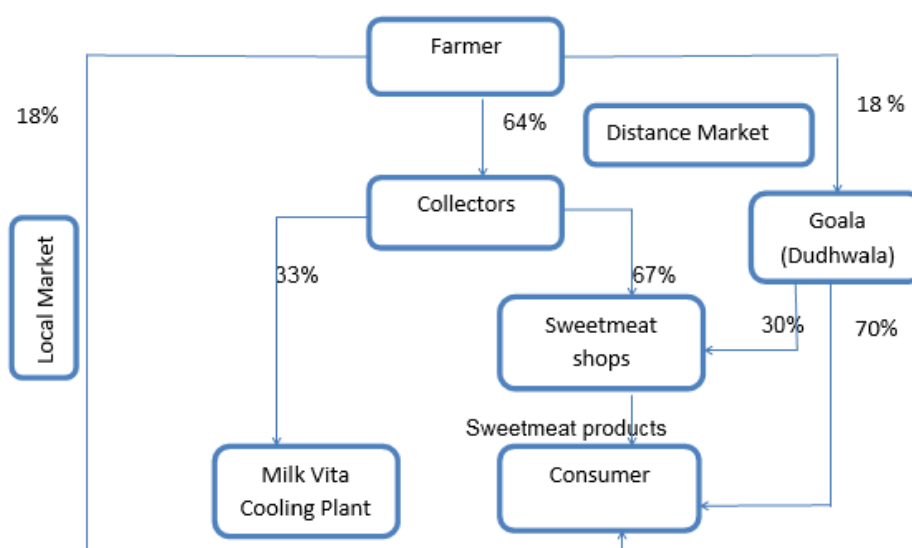
#### 3.1 Costs and Revenue of Rearing Cross-breed Dairy Farm

The gross annual costs and revenue per cow per year of rearing cross-breed milching cows are presented in Table 2. The gross cost per cow per year was estimated at Tk.74, 209. The feed was one of the major cost items (60 percent) of rearing cross-breed milching cows. The cost of feed included expenses on paddy straw, green grass, rice bran, salt, vitamin, maize bran, pulse bran, molasses, oil cake, and wheat bran and others. The total feed cost per year per farm was estimated at Tk. 44,658. The gross revenue of dairy farm consisted of revenue from milk

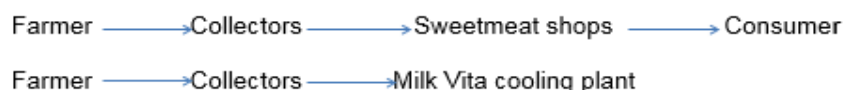
production, cow dung, and calf. The gross revenue was Tk. 1, 04,471 and the net margins per cow per year was Tk. 30,262. The BCR (undiscounted) is a relative measure is used to compare benefits per unit of cost. The table shows that benefit-cost ratio of the dairy farm was 1.41 (this result conformity with the reference number 8), which indicates that investment in dairy farming was profitable for individual producers' point of view (Table 2).

#### 3.2 Milk Marketing Channels

In the study areas, a number of marketing channels were observed. A sketch of overall milk marketing channels for the study area is shown in the following figure;

**Fig. 1. Marketing channels of raw milk**

Marketing channels of raw milk in the study areas moves from the producer to the ultimate consumer through direct and indirect marketing channels. The main and most important two marketing channel, which accounts for 64% of total milk marketed. This reason was that these two channels can absorb a large amount of surplus milk in the region while the local demand for milk is much less than supply in the study area. The study found that most of the surplus milk was absorbed by the sweetmeat shops because Milk Vita has only one cooling plant which has limited capacity (5,000 litres). The percentage of total supplied milk to the sweetmeat shops was varied during the month of May to August because of summer. So, the main and most important two marketing channels are shown in below;



**Table 2. Profitability analysis of raising cross-breed dairy farms (per cow per year)**

Items	Tk./year
<b>Variable costs</b>	
Feed cost	44,658 (60)
Labour cost	14,180 (19)
Electricity charge	796 (1)
Veterinary cost	1,553 (2)
Miscellaneous cost	269 (1)
<b>Fixed costs</b>	
Housing cost	5,258 (7)
Costs of capital	4,462 (6)
Interest on operating capital	3,033 (4)
<b>Gross cost</b>	74,209 (100)
<b>Gross revenue</b>	
Milk	91,531
Cow dung	1,409
Calf	11,536
Gross revenue	1,04,471
Net profit	30,262
BCR	1.41

Source: Field survey (2015)

Note: Figures within parenthesis indicate percentage of total costs

1 USD = BDT 81 (Bangladesh Bank, July 15, 2017)

### 3.3 Marketing Cost and Margin of Milk Traders (Collectors)

Marketing cost of milk collectors (i.e., that middleman who purchase the large quantities of milk from the producers and maintain their good relationship with the dairy plant and sweetmeat shops.) includes labour, transportation, milk container, spoilage, rent, electricity, personal expenses etc. The average estimated marketing cost per litre of milk incurred by the milk collector was Tk. 3.39. The gross margin was Tk. 6. So the net margin was Tk. 3 per litre (Table 3).The

total marketing cost of milk collectors was low because of that, per day raw milk transaction of collectors was 1371 litres (on average) and market concentration ratio of milk collector was highest in the sampled areas.

**Table 3. Marketing costs and margin of milk traders (Collectors)**

Particulars	Tk./litre
Labour	2.28
Transportation	0.56
Milk container	0.02
Spoilage	0.01
Rent	0.12
Electricity	0.17
Mobile costs	0.09
Personal expenses	0.14
<b>Total marketing cost</b>	<b>3.39</b>
Average purchase price	45
Average sales price	51
<b>Gross margin</b>	<b>6</b>
<b>Net margin</b>	<b>3.00</b>
<b>Volume of milk trading per day (liters on an average)</b>	<b>1371</b>

Source: Field survey (2015)

### 3.4 Marketing Cost and Margin of Goala (Dudhwalla)

Marketing cost of Goala (locally called dudhwalla i.e., that middleman who purchase the small quantities of milk from the producers and sells to consumer and sweetmeat shops.) includes labour, transportation, milk container and personal expenses etc. the average estimated marketing cost per litre of milk incurred by the milk traders was Tk. 12.39. The gross margin was Tk. 18. So the net margin was Tk. 6 per litre (Table 4).

**Table 4. Marketing costs and margin of milk traders (Goala)**

Particulars	Tk./litre
Labour	6.52
Transportation	3.64
Milk container	0.13
Spoilage	0.59
Personal expenses	1.51
<b>Total marketing cost</b>	<b>12.39</b>
Average purchase price	46
Average sales price	64
Gross margin	18
<b>Net margin</b>	<b>6.00</b>

Source: Field survey (2015)

### 3.5 Econometric Analysis

Before estimating the regression model, the correlation was calculated to find out the relationship between total production of milk and number of milking cows for the best-fitted model. Correlation coefficient shows that these two variable are strongly positively correlated and statistically significant ( $r = 0.94$ ,  $P=0.00$ ) and reject the null hypothesis. According to the result and review the several studies [15-18] the study used the number of milking cows for avoiding the multicollinearity problem and autocorrelation.

#### 3.5.1 Regression results of factors affecting milk supply

The results of the econometric analysis (stepwise multiple regression models) examined the characteristics of milk producers and its impact on marketed supply of milk to the market. Different variables were expected to influence the volume of marketed surplus of milk these are age of household head, sex of household head, education level of household head, family size, experience of dairy farming, number of milking cows, access to extension services (veterinary training), market information, price of milk, off-farm income and distance from the market. Stepwise multiple regression models were employed to analyze the factors that affect the supply of milk. A VIF for continuous variables and contingency coefficient values for discrete variables were computed to check the existence of multicollinearity problem. The results revealed that no significant problems of multicollinearity and the high degree of association among continuous and discrete variables were detected. Durbin-Watson (2.17) test was used to detect the autocorrelation. The result revealed that there is

no autocorrelation problem. Among the eleven hypothesized factors affecting marketed surplus of milk, three variables (number of milking cows, age of household head and experience of dairy farming) were found significant. The coefficient of multiple determination ( $R^2$ ) was 0.91 and adjusted  $R^2$  was 0.90. This means that 91% of the variation in the dependent variable is explained by the explanatory variables. Furthermore, the adjusted  $R^2$  of 90% which is significant has further consolidated the goodness of the model, hence, its econometrics significance and reliability (Table 5).

**Table 5. Stepwise regression results of factors affecting of marketed surplus of milk**

Independent variable	Coefficients	t	Sig	VIF
Constant	-6.67	-3.42	0.001	
Number of milking cows	6.24***	15.29	0.000	1.88
Age of house hold head	0.08**	2.34	0.024	1.02
Experience of dairy farming	0.21**	2.14	0.037	1.90
F-statistics	180.33***			
R Square	0.91			
Adjusted R Square	0.90			
Durbin-Watson	2.17			

Dependent Variable: Total volume of milk supplied per day per dairy farms (litres)

\*\*, \*\*\* indicates significant at the level of 5% and 1% respectively

As hypothesized number of milking cows (MCO) has a positive effect on marketed milk volume and is significant at 1% probability level. The model output predicts that the addition of one dairy milk cow causes the marketable cow milk surplus of the dairy farms to rise by 6.24 liters per day per farm. This result is plausible and suggests that marketable milk surplus of the household in the study areas is more responsive to a number of milking cows. Furthermore, this result illustrates that marketable milk surplus per day increases in responses to the increase in a number of a milching cow. In addition to that, the age of household head had a positive and significant impact on milk marketed volume of sampled dairy farms. The positive and statistically significant relationship between two variables indicates that older dairy household head could have more milking cows increasing the possibility of household milk marketed



volume. The result also elaborates that when the household age increases by one year, the probability of milk marketable volume increases by 0.08 litres per day per farm.

The experience of dairy farming has a positive effect on milk sales volume per household and is statistically significant at 5% probability level. The result suggests that as farmers have high dairy farming experience the amount of milk supplied to the market increased through its effect on milk production. The model also confirms that every one year of experience in dairy production leads to a rise in daily milk sales volume by 0.21 litres per day per farm.

#### 4. CONCLUSION

Dairy farming is an economic activity involving investment for milk production and marketing. The study aimed to determine the profitability and factors affecting milk supply of dairy farmers. The calculated net profit and the benefit-cost ratio (BCR) indicate that dairy farming is a profitable business in Chittagong District. Econometric result also indicate that number of milking cows, age of household head and experience of dairy farming, significantly associated with marketed supply of milk. Dairy farming is a profitable business although it has been facing problems in relation to the production and supply of milk. Though the study areas only one cooling plant which has limited capacity but has no formal contract with either collectors or dairy farmers. As a result, most of the surplus milk absorbed by the sweetmeat shops.

If proper remedial measures could be taken and formal institutional arrangements could have been established, then milk production and supply would be a viable in commercial enterprise which in turn would play a vital role to overcome the problems of low income, unemployment, undernutrition and unfavorable balance of payment situation of the country. Therefore, the government should provide necessary assistance for the establishment of feed mills in the private sector for making the quality feed available. The DLS (Department of Livestock Services) and NGOs (Non-Government Organizations) should strengthen their programs to train the dairy farmers on dairy management, animal health care, sanitation, and marketing techniques of milk on a priority basis. In order to improve preservation facilities provision should be made

for the supply of isolated containers to the farm owners at an affordable price.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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