Project ID: 557

Competitive Research Grant

Sub-Project Completion Report

on

Benchmarking cost of milk production in typical dairy farms in selected regions of Bangladesh: Implications for milk market price and livelihood improvement policy

Project Duration

May 2017 to September 2018

Department of Animal Nutrition
Bangladesh Agricultural University, Mymensingh

Submitted to

Project Implementation Unit-BARC, NATP 2
Bangladesh Agricultural Research Council
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Acronyms

SL. No.	Acronyms	Abbreviation
1	NATP	: National Agricultural Technological Project
2	IFCN	: International Farm Comparison Network
3	IDRN	: Integrated Dairy Research Network (IDRN)
4	TFA	: Typical Farm Approach
5	TIPICAL	: Technology Impact Policy Impact Calculation Model
6	COMPO	: Cost of milk production only
7	ECM	: Energy Corrected Milk
8	BAU	: Bangladesh Agricultural University
9	DLS	: Department of Livestock Services
10	BARC	: Bangladesh Agricultural Research Council
11	HF	: Holstein Friesian
12	LU	: Labour Unit

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Executive Summary

Bangladesh is at 36th position in the world milk production ranking; while, in the cost of milk production ranking Bangladesh is 46th (for small scale farms) and 21st (for large scale farms) among the highest cost countries. In both the cases of small and large scale farms, the cost of milk production is higher than neighboring countries, India and Pakistan that makes Bangladesh relatively less competitive. This situation instigated to undertake a detailed study on cost of milk production only (COMPO) and total cost of dairy enterprise to identify the major factors that affect the cost of milk production. It was expected that this study will further help to define and develop a specific benchmarking cost comparison tool so that farmers can see what is the cost level compared with his neighbor farms and regional farms. However, due to lack of real accounting data (e.g. Profit and Loss account of dairy farms) farmers are often confronted with the problem of understanding and separation of the cost of milk production only (COMPO) from the total cost of dairy enterprise This study, therefore, was carried out with the objective to benchmark the cost of milk production only so that farmers can compare the COMPO with milk price in order to see the real profit of the farms. This study used the International Farm Comparison Network (IFCN) methodology which is based on two pillars: 1) Typical Farm Approach (TFA) and 2) Technology Impact Policy Impact Calculations (TIPICAL) model. Three farm types were identified such as household farms, family farms and business farms. Each farm type was again divided into small and large-scale farms. Two regions were selected for setting up of typical farms. The data were collected using the Panel Approach. In total 12 typical farms (6 from Bogura and 6 from Sirajgonj) were selected. The average herd size was found for Sirajong to be relatively higher (3, 12 and 20 dairy cows/farm) compared with Bogura (1, 8 and 15 dairy cows/farm for household, family and business farms respectively) and dairying was highly linked with major income source for Sirajgonj. The average milk yield per day per cow was found for Bogura to be 3.88 kg/d/cow while that for Sirajgonj it was 5.11 kg/d/cow. However, the average milk production was found 1914 kg Energy Corrected Milk (ECM)/cow/year in Sirajgonj while that for Bogura was 1451 kg ECM/cow/year. The lowest amount of milk yield was found for household farms of Bogura with 1 cow (1005 kg/cow/year) while the highest was observed for Business farms in Sirajgonj with 20 cows (2410 kg/cow/year). The average cost of milk production only (COMPO) in all typical farms was found to be 34.30 BDT/kg ECM while that for Sirajgonj was higher (35.80 BDT/ kg ECM) than Bogura (32.80 BDT/kg ECM) indicating a regional competitiveness advantage for Bogura over Sirajgonj. On the other hand, the milk price in Sirajgonj and Bogura was 35.1 BDT /kg ECM and 32.1 BDT/kg ECM respectively which was lower than the production cost indicating an overall negative entrepreneur's profit (EP) in both the regions. This implies that current small scale household farming system is no more profitable and sustainable and they might need either to decrease the cost of milk production or increase milk production so that return from milk sale becomes higher than the cost of milk production. Looking into total cost of the dairy enterprise, Sirajonj has shown the highest average costs (45.02 BDT/ kg ECM) compared to Bogura (44.31 BDT/ kg ECM). The finding of this study is expected to help the farmers and processors to see the exact cost of milk production only (COMPO) to compare with milk price.

CRG Sub-Project Completion Report (PCR)

A. Sub-project Description

1. **Title of the CRG sub-project:**
   Benchmarking cost of milk production in typical dairy farms in selected regions of Bangladesh: Implications for milk market price and livelihood improvement policy

2. **Implementing organization:**
   Bangladesh Agricultural University Research System (BAURES)

3. **Name and full address with phone, cell and E-mail of PI/Co-PI (s):**

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4. **Sub-project budget (Tk):**
   4.1 Total: Tk. 10, 42015
   4.2 Revised (if any): Not applicable

5. **Duration of the sub-project:**
   5.1 Start date (based on LoA signed): 11 May 2017
   5.2 End date : 30 September 2018

6. **Justification of undertaking the sub-project:**

The economics of milk production is the major concern for sustainable dairy production in all over the world. The concept of estimation of cost of milk production only (COMPO) which is different than total cost of milk production is gaining importance in Bangladesh. At the eve of launching mega Livestock and Dairy Development Project (LDDP) by the Department of Livestock Services (DLS) with the financial support from World Bank, this type of study where the detail analysis of cost components and its relation with milk price, can provide significant management level information. The study was thus undertaken with the following justifications:

- The study results use the Global Economic Modeling based on the typical farm approach which determines not only the detailed cost components but also make it available to compare with different regional basis.
- The household income and the contribution of the dairy to the total household requirement are also possible to compute from this model.

- The milk price policy might be benefitted as this study results could show the cost of milk production only which can then be compared with milk price.
- Farmers can understand the reasons for high cost and that finally might help farmers in planning for minimizing those costs.

7. Sub-project goal:

The goal of this project was to provide all required information to develop an excel based tool (for cost modeling) to benchmark different types of dairy farms on the basis of cost of milk production only (an indicator of the competitiveness) in two regions after the end of the project.

8. Sub-project objective (s):

The major objective of this sub-project was to estimate the cost of milk production only (COMPO) within agricultural enterprises where the farmers are tied with the same inputs for crops, horticulture, milk, and beef production. The specific objectives were:

a) To estimate the "cost of milk production only (COMPO)" and total cost of dairy enterprise in order to benchmark the dairy farms with different farming systems and regional basis.
b) To determine the underlying factors that causes the variation in cost of milk production
c) To analyze the link among milk production cost, market price, and livelihood improvement policy

9. Implementing location (s):

The project was implemented in two major milk producing areas in Bangladesh of which one was at Sirajgonj and another one was at Bogura.

10. Methodology :

Approaches

This research project has applied the International Farm Comparison Network (IFCN) methodology. The IFCN method was built and validated based on two methodological pillars:

i) Typical Farm Approach (TFA)
ii) Technology Impact Policy Impact Calculations (TIPICAL)model

The IFCN is a global knowledge-creating network in milk production that connects different stakeholders (dairy farmers, researchers, dairy related companies, investors, policy makers, advisors and dairy institutions) in the global milk supply chain. The network concept is the unique characteristic of the IFCN method and it makes the IFCN method advantageous over others. The role of the network is to ensure the formal relationship among the researchers, dairy stakeholders and farmers that assures their commitment to deliver and validate typical farm data annually. In addition, country specific research project has been done to improve the method and model each year which is extra-ordinarily beneficial for ensuring high quality data and updating cost comparison results.

The application of its ability to produce results with minimal resources (Ndambi and Hemme, 2009; Uddin et al., 2010) are the main motivation to apply in the current study. However, the proposed study has intended to apply this approach with the aim to adjust the global model to the local

context and for the sustainable use by the farmers in collaboration with research/academic organization.

Estimation of the cost by IFCN method

The application of this method can help to overcome the shortcoming of the traditional cost analysis and it has the capacity to make input use and cost parameters comparable with global data. In this way very diverse farms can be used to build typical farms making it possible to benchmark the cost for all typical farms worldwide. As mentioned above, The TFA considers three specific methodological steps:

1. Establishing and maintaining the dairy network,
2. Defining typical farms, data collection and validation, and
3. Selection of typical farms

On the other hand, the data collected from the typical farms are analyzed by the TIPI-CAL model which is based on the concept of Farm Level Income and Policy Simulation (FLIPSIM) Model (Richardson et al., 1996). The key differences of TIPICAL over FLIPSIM is that TIPI-CAL focuses on farm comparison and less on simulation and it is an Excel software which is globally used. FLIPSIM, on the other hand, uses simulation of sector data to produce results. The detailed of the methodology is described below:

Typical Farm Approach (Uddin et al., 2010 and Hagemann et al., 2011)

1. Establishing and maintaining the dairy network

Applying this approach, the current study formed an expert body to establish the Integrated Dairy Research Network (IDRN) which would provide a formal link with different dairy stakeholders for data collection, data validation, result preparation as well as follow up for the effective use of outputs for improving the dairy farmers.

2. Defining typical farms, data collection and validation.

The key issue in creating high quality farm comparison results is to apply the same method to all farms in all regions. Therefore, this method used the Standard Operating Procedure, called "Typical farm approach" (TFA). The inception of using typical farms or representative farms in economic analysis occurred in 1928 when Elliot defined a typical farm as being “a modal farm” or “mode farm” in a frequency distribution of farms of the same universe; or it is representative of what a group of farmers are doing who are doing essentially the same thing”(Dillon and Skold, 1992; AFPC, 2010). In IFCN, a typical farm represents a certain production system, farm size, production technology used and the related milk volume in a country/dairy region. The technical and economic data to describe the typical farms are preferably neither individual farm data nor statistical averages but based on a consensus achieved in a panel meeting.

Applying the TFA approach, three different types of farming system were selected: a) household farm, b) family farms and c) business farms. Using this method, three typical farms from each region was built. This six typical farms was built and validated based on the transect study of 480 dairy farmers (240 from each region). This approach was able to evaluate the heterogeneity of farm structure, diversity of the production system, and size of the region and country thus making them comparable on a global, national and local scale. In this study, two regions such as Sirajgonj and Bogura were selected representing the reasonably higher amount of milk producing areas as well as

the dairy is considered as a major source of income in those areas. After selecting typical farms, the data pertaining to this study was collected by using the IFCN Panel Approach. IFCN Panel Approach was consists of successive meetings of 3-5 farmers, 1 national expert, 1 regional expert, 1 representative from the ministry of livestock and 1 external researcher. The objective was to obtain more reliable farm level data with a validation process with farmers, experts and researchers in the respective regions and production systems. The IFCN panel approach is similar to a modified Delphi technique (Custer et al. 1999). However, the application of TFA and panel approach is considered scientific, produces fast and in-depth results and requires minimal resources and costs.The quality of the data was ensured through the development of standard tools for cross comparison and validation of data and results using panel approach.

The next step after the data collection was to analyze and validate results. This is a very important step of the TFA. After including the data into the TIPICAL model, a cross check of the results is vital as an initial step to the data validation process. This was done by the following ways: a) a review with accounting statistics, b) a review with the same panel of farmers who were involved in collecting the data, c) a review with national experts, d) own review of results by farmers and e) other review methods adapted to the regional situation.

3. Selection of the typical farms

The selection process of the typical farms consisted of the following methodological steps:

i) A survey using Transect study in two regions. From Sirajgonj 240 farms and from Bogura 240 dairy farms (in total 480 dairy farms) were surveyed in order to know the overview of the regional dairy profiling
ii) A panel survey which is the shorter version of the IFCN Input sheet was used. A total of 60 Panel surveys which is a bigger version than transect study were done.
iii) A national panel body was formed consisting of academicians, dairy industry players, research organizations, other input suppliers, dairy farmers, national dairy expert and local dairy expert as well as government representative from the Department of Livestock Services (DLS)
iv) A pre panel study was done to arrive at consensus on average herd size of Household farm, family farm and business farm along with milk yield and land size
v) A full panel study was done to validate the typical farm consisting of 647 variables which provided detail overview of the study of dairy farming activities
vi) Using this approach, a total of 12 typical farms considering 6 from each region was surveyed but finally 6 typical farms were selected for detail analysis using IFCN TIPICAL Model

TIPICAL model

This model first of all standardizes input variable to enable their comparability across countries and then calculates various outputs. The estimation of cost of milk production in the TIPICAL model of IFCN method (Hemme, 2000) is described as

$$f(c) = f(x, w) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where, c = is the cost, x = the level of inputs, and w = prices for inputs.

This TIPICAL model is based on the principle of Farm Level Income and Policy Simulator Model (FLIPSIM) developed by Texas A & M (Richarsdson, 1989) which are based on the farm simulation.

An additional adjustment in the model was made to include factors that are not directly considered as physical inputs but affect the costs, for example, quota costs and opportunity costs for owned factors of production. The model runs through a number of indicators stepwise in order to estimate the costs. Two cost parameters were estimated in the model:

- Total cost of the dairy enterprise which takes into account all of the input costs, opportunity costs for factors of production, costs for raising heifers, beef cattle and dry cows and depreciation for buildings and machinery; and
- Cost of milk production only, which is based on the Profit and Loss accounts (P & L), e.g. cash costs, depreciation of factors of production and opportunity costs for farm owned factors (family labor, own land and capital)

The total cost of the dairy enterprise was estimated as:

$$C = (Wv, W_f) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Where W_v is the vector for inputs of variables and W_f represents the factors of production while C = w, y, xf and C is the cost

Thus, total costs of dairy enterprise (C_t)

$$Ct = w, y, xf \; = wvxv\,(w, y, xf) + wfxf \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

wvxv (w, y, xf) is the variable cost for different inputs, and wfxf is the cost of factors of production. Thus, the total cost of the dairy enterprise was estimated

$$C_{t\,=\sum X1\ldots\ldots n+\sum W1\ldots\ldots k} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

Where, *Ct* = total costs of dairy enterprise*, Xi….j*= costs *i*th inputs with *J*th price, *Wi….k* = costs for *i*th factors for *k*th price of production (land, labor and capital based on factor prices). In this study, the inputs (expressed as per 100 kg ECM) used to calculate the total cost of the dairy enterprise were: X1 = animal purchases; X2 = feed, machinery (maintenance, depreciation, contractor); X3 = fuel, energy, lubricants, water; X4 = buildings (maintenance, depreciation), X5 = veterinary and medicine, insemination; X6 = Insurance taxes, X7 = other inputs dairy enterprise (quota); X8 = VAT balance (if negative). The cost of factors was also expressed per 100 kg ECM and entered into the model, as: w1 = total land, w2 = capital and w3 = labor costs.

The second key variable calculated in this analysis is the cost of milk production only

The '*cost of milk production only (COMPO)'* refers to the cost related only to milk production. The estimation is modeled on the Profit and Loss (P&L) account. The cost is derived by subtracting the expenses for Non-milk returns from the P&L account. The P & L account is related to the total returns of the dairy enterprise including milk and non-milk returns (cattle returns and coupled direct payments). To indicate the effect of opportunity costs, they are shown separately from the other costs. In cases where the non-milk returns werehigher than the cash cost of the dairy enterprise, the cost bar could be negative which indicated that the farm had opportunity costs only. This method of estimating cost of milk production only makes the method unique and more powerful in comparing cost on a global scale, because all the cost associated to beef, heifers and other non-milk related costs was adjusted so that it is applicable all over the world.

Thus, the model calculates Cost of milk production only, as shown below:

$$C_{\text{milk}} = \sum \text{P\&}L\ account - \sum \text{Nmr} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ (3)$$

Where, C_{milk} is the cost of milk production only, *P & L is the profit and loss account taking into account all of the cash and non-cash cost and quota*, *Nmr* is the non-milk returns.

However, for estimations and calculations of opportunity costs, the following assumptions were made:

Labor costs: Cash labor cost currently incurred was used for hired labor and the average wage rate per hour in the region was used for unpaid family labor.

Land costs: Rents currently paid by the farmers. Regional rent prices provided by the farmers were used for owned land.

Capital costs: Own capital was defined as assets, without land, plus circulating capital. For borrowed funds, a real interest rate of 6 per cent was used; for owner's capital, the real interest was assumed to be 3 per cent (Isermeyer, 1998) which are applicable to global level when there is no country specific data available. If the data persist, then the model takes the real (nominal) interest rates for borrow money: 12% and for farm deposit money the interest rate is 6%.

Depreciation: Machinery and buildings were depreciated using a straight-line schedule on purchase prices with a residual value of zero.

Adjustment of VAT: All cost components and returns are stated without value added tax (VAT).

Adjustment of milk to ECM: The milk output per farm was adjusted to ECM with 4% fat and 3.3% protein. ECM was obtained using the formula: ECM = Milk production / ((0.383* fat% +0.242 * protein% + 0.7832)/3.1138) (IDF, 2003).

The difference between the two cost estimation methods: i) total cost of the dairy enterprise and ii) cost of milk production only, lies in the fact that the first one shows the total cost of the dairy enterprise considering the whole farm approach, while the second one takes into account the cost of milk production only. Total cost includes all of the cost items related to producing milk, raising heifers and calves. On the other hand, cost of milk production only includes all the costs allocated specifically to milk production. Since the costs for raising heifers and calves are difficult to estimate, in our method, an assumption was made that the returns from heifers, and calves equal to their cost, thus we subtracted these returns from the total cost, to derive cost of milk production only. The returns from other components of the dairy enterprise except milk were called "non-milk returns (NMR)". This approach helps to standardize the IFCN method in order to benchmark all the dairy farms globally, independently from the farm type, whether it is a specialized dairy (100% dairy), a dual purpose (dairy and beef) or mixed farming (mostly in developing countries). Hence, in this study, we used cost of milk production only as a cost indicator to benchmark the farms in order to apply the same method to all farms worldwide.

Analysis of Household income and rural livelihoods

The farm household income (HI) was selected as indicator of the rural livelihoods and poverty status. The HI is calculated by the following functional form

$$HI = FP_d + FP_c + OI$$

Where, HI is the total household income, FP_d is the profit from dairy, FP_c is the profit from crop, and OI is the off-farm income. The FP_d is calculated from the TIPI-CAL model and the FP_c is calculated by subtracting all the costs related to crop production from the revenue for crop production and adjusting the non-cash components (depreciation for machinery and building, inventory changes).

11. Results and discussion:

11.1. Description of the typical farms

A total of 12 typical farms were identified initially form which 6 farms, 3 from Bogura and 3 from Sirajgonj districts were selected for the detail study. Those 6 typical farms were built and validated by collecting 480 questionnaires from two districts which were then cross checked and validated by National panel of experts from University, dairy processors, research organizations and dairy marketing. The typical farm size were classified into three categories: Household farm (HH), means additional income comes from dairy farm after fulfilling home requirement; Family farms (FF), means major income of the household comes from dairy farming and Business Farms (BF) those who get return based on ROI from dairy farm that means 100% commercially operated farm. The key results are presented in this section with a logical discussion. The description of the typical farms that were analyzed in this study is depicted in Table 1.

Table 1: An overview of typical farms analyzed in two milk regions (Bogura and Sirajgonj)

Farm Description	Unit	Typical farms					
		Bogura			Sirajgonj		
		BD-1BG-HH	BD-8BG-FF	BD-15BG-BF	BD-3SG-HH	BD-12SG-FF	BD-20SG-BF
Farm type	Text	Household	Family	Business	Household	Family	Business
Breed	Text	Indigenous	Cross with HF	Cross with HF	Indigenous	Cross with HF	Cross with HF
Land base	Ha/farm	0.2	0.8	1.1	0.7	1.5	2.1
Labour input	(1 LU = 2100 hrs/year)*						
Farmily labour	hrs/day	0.57	1.24	1.24	0.48	1.48	1.43
Hired labour	hrs/day	0.38	2.19	2.24	0.29	2.14	2.05
	*BD =Bangladesh; BG =Bogura, SG =Sirajgonj; HH =Household farm; FF =Family farm and BF =Business farm. The number with BD indicates the number of dry + lactating cows. Example BD-1BG-HH =Bangladesh 1 cow Bogura Household farm; *IFCN, 2018*						

The average herd size for three types of typical farms were found to consists of 1, 8 and 15 dairy cows/farm for Bogura while for Sirajgonj that were 3, 12 and 20 dairy cows/farm (Figure 1a).

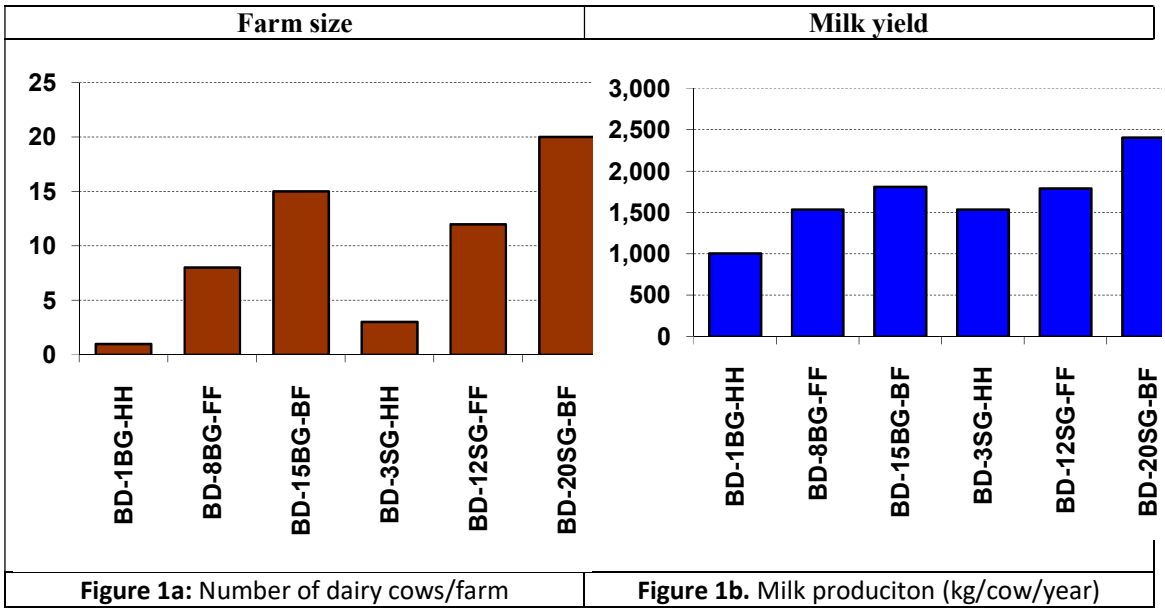


Figure 1a: Number of dairy cows/farm

Figure 1b. Milk produciton (kg/cow/year)

In terms of milk yield which is expressed as annul milk production in kg/cow/year is stated in Figure 1b. The milk production is expressed as Energy Corrected Milk (ECM) in order to standardize the fat and protein content of the milk from two different regions. Energy Corrected Milk (ECM) is defined as the milk that is corrected for 4.0% fat and 3.3% protein and is calculated as:

ECM = Milk production / ((0.383* fat in percent +0.242 * protein in percent + 0.7832)/3.1138)

Table 2. Milk yield of the typical farms analyzed in two milk regions (Bogura and Sirajgonj)

Milk yield/ production	Typical farms					
	Bogura			Sirajgonj		
	BD-1BG-HH	BD-8BG-FF	BD-15BG-BF	BD-3SG-HH	BD-12SG-FF	BD-20SG-BF
kg/cow/day	2.68	4.11	4.84	4.11	4.79	6.44
milk t/year/farm	1.00	12.30	27.15	4.61	21.53	48.19
kg/cow/ lacting day	3.21	4.92	5.79	4.92	5.74	7.70
kg /d/farm	2.68	32.88	72.53	12.33	57.53	128.77
	BD = Bangladesh; BG = Bogura, SG = Sirajgonj; *HH = Household farms ; FF = Family farms and BF = Business farms:* *The number with BD indicates the number of dry + lactating cows*					

As shown in Table 2 the average milk yield per cow/day was found better (6.44 kg/day/cow) in Sirajgonj (BD-20SGBF) than Bogura (BD-1BG-HH) which was the lowest (2.68 kg/day/cow). The Lactation yield and annual yield was also different substantially.

11.2. Economics of milk production

11.2.1. Cost of milk production only (COMPO)

The COMPO is the main indicators that are used to benchmark the region for competitiveness of the dairy production system. The COMPO is also important to compare with milk price as this excludes the cost of beef, heifers, breeding bulls and young stock. The total cost of dairy enterprise, on the other hand, is the full economic costs. The average cost of milk production only (COMPO) was found 3413.4 BDT/100 kg milk ECM (Figure 2a) while the total cost of milk production was found 4443.10 BDT/100 kg milk ECM (Figure 2b). The detail data on COMPO and total cost of dairy enterprise are provided as Table in the Annex 1.

Cost of milk production only

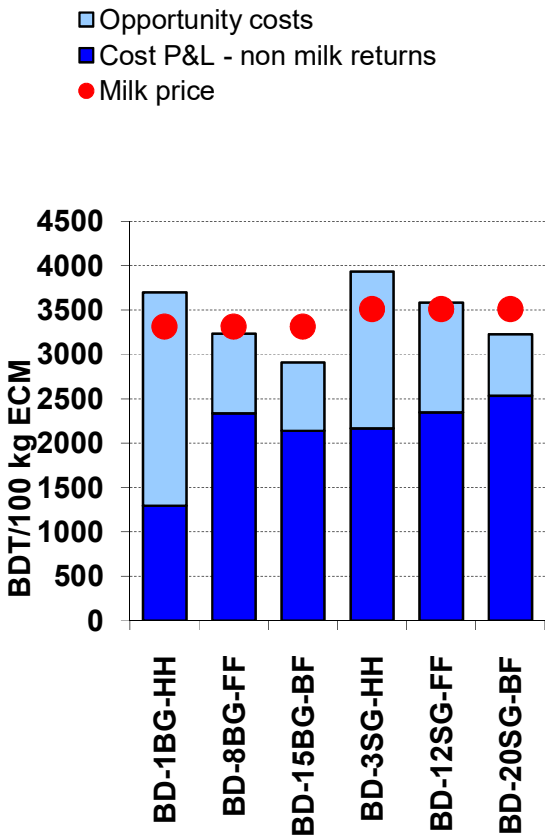


Figure 2a: Cost of milk production only in typical farms (BDT/kg milk production)

Total cost of the dairy enterprise

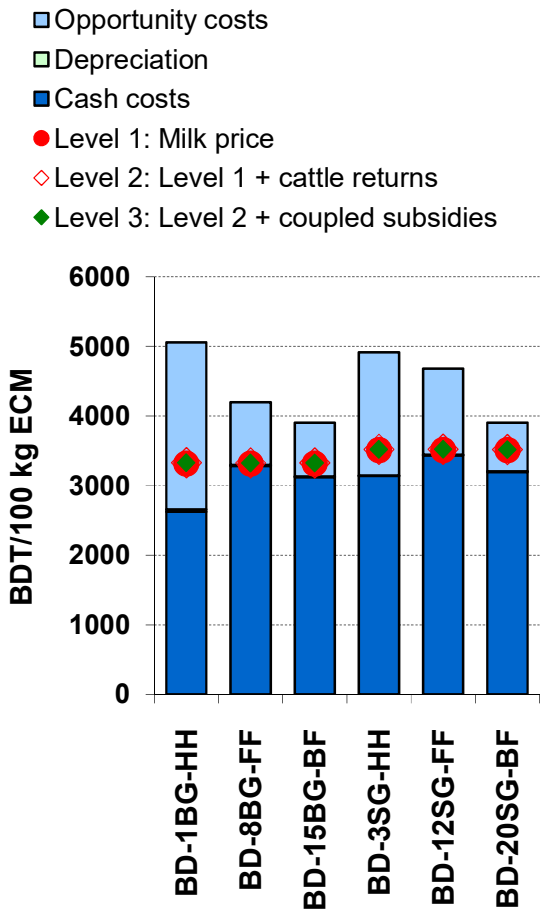


Figure 2b: Total cost in typical dairy enterprise (BDT/kg milk production)

However, the regional analysis of COMPO indicates that the farmers of Sirajgonj has higher cost (3510 BDT/100 kg milk ECM) than Bogura which has a COMPO of 3316 BDT/100 kg milk ECM. This implies that the farmers in Sirajonj has potential to decrease the cost and via that can increase the competitiveness.

The average milk price was found 3431.5 BDT/100 kg milk but the farmers of Sirajgonj received higher milk price (3582.10 BDT/100 kg milk ECM) while for Bogura that was 3431.5 BDT/100 kg.

Within the COMPO, the opportunity costs (for own land, labour and capital), marked as light blue,was the highest for household farms in Bogura (65%) and the lowest was found for business farms in Bogura (22%). This implies that farmers put substantial family labour input to the dairy farms as long as the farms stays smaller but once the farms starts to get bigger, the hired labour takes place. The cash costs (marked as dark blue) was found to be highest for business farms (78%) and the lowest in household farms (35%). While considering the total cost of the dairy enterprise, none of the farms could generate positive revenue (Figure 2b) as the return from milk price and cattle returns (beef, culled cows) and other returns (manure and biogas).

Non-milk returns	Return structure of the dairy enterprise

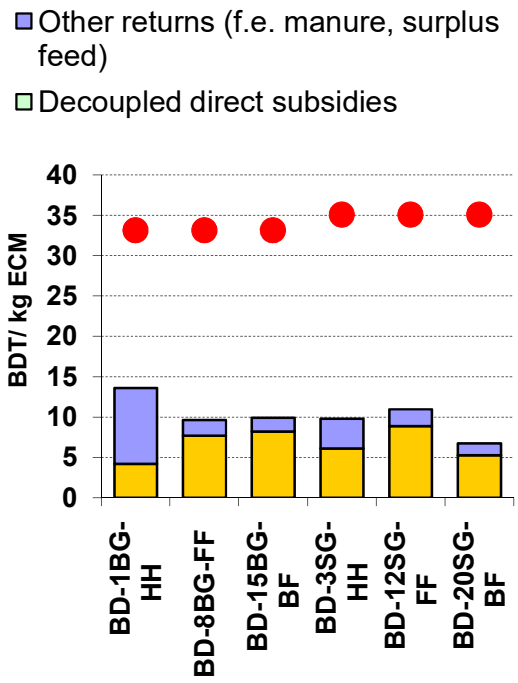
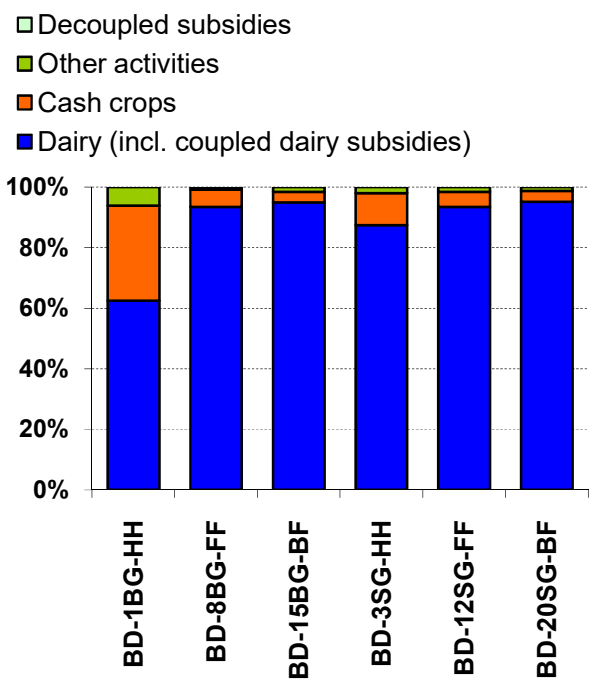

	

Figure 3a: Non-milk returns (BDT/100 kg ECM) in typical dairy farms	**Figure 3b**: Return structure of the dairy enterprise (%)

Considering the non-milk return (NMR), manure and other return was the highest for household farms in Bogura and the lowest was in business farms in Sirajgonj (Figure 3a). The return structure of the dairy farms shows that small farms in Bogura had the highest share from cash crops and the lowest from dairy (Figure 3b). It shows that as the intensification of the farm increased, the share of the return to the total return also increased.

11.2.2. Return to labour and whole farm agricultural income

The return to labour was estimated in terms of the amount of BDT earned per hour from dairy. The Figure 4a shows that the business farms could generate the higher income BDT/hr than the income from the regional alternative jobs. This implies that as long as the regional alternative job opportunity remains low, the dairy can be profitable otherwise dairy will be under threat and next generation will not practice dairy as their means of living.

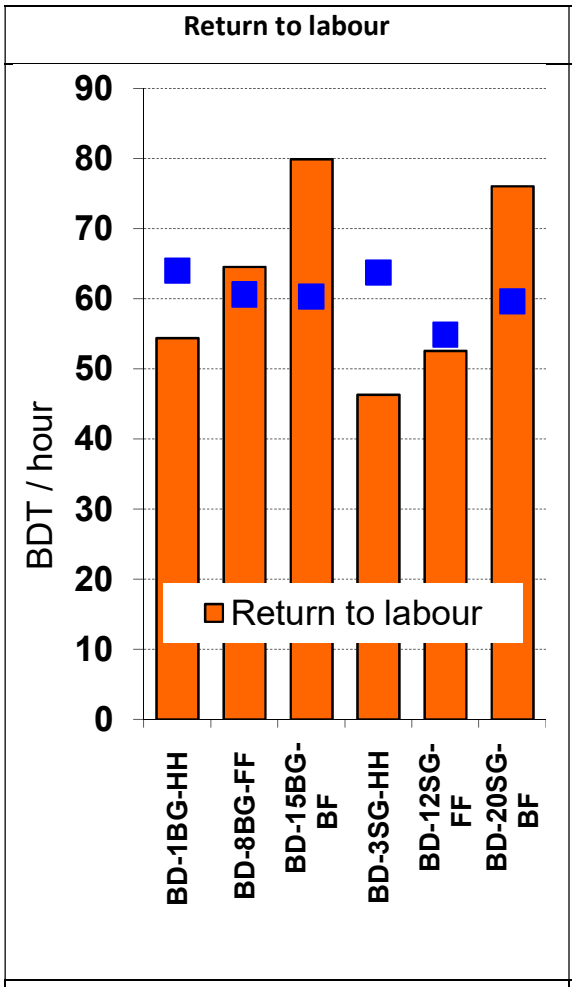


Figure 4a. Return to labour (BDT/hr)

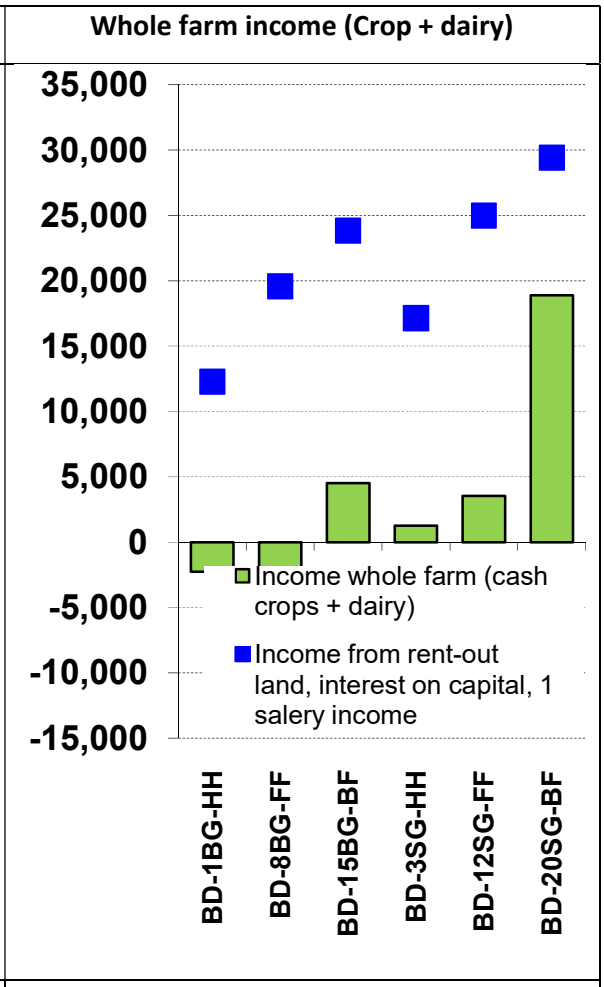


Figure 4b. Whole farm income (dairy + crop) BDT/100 kg ECM

Looking at the total income from dairy and crop, the situation became worsen as none of the farms could generate the income higher than the alternative income (Figure 4b). This dark blue squares represent the amount of income that could be earned if the farms keep the money in the bank by selling their cows, rent their all land and sell all of their assets.

11.2.3 Labour costs and labour productivity of the farms analyzed

The Figure 5a indicates the total costs of labour, both family labour and hired labour, e.g. paid wages and the Figure 5b indicates the labour productivity (kg ECM/hr).

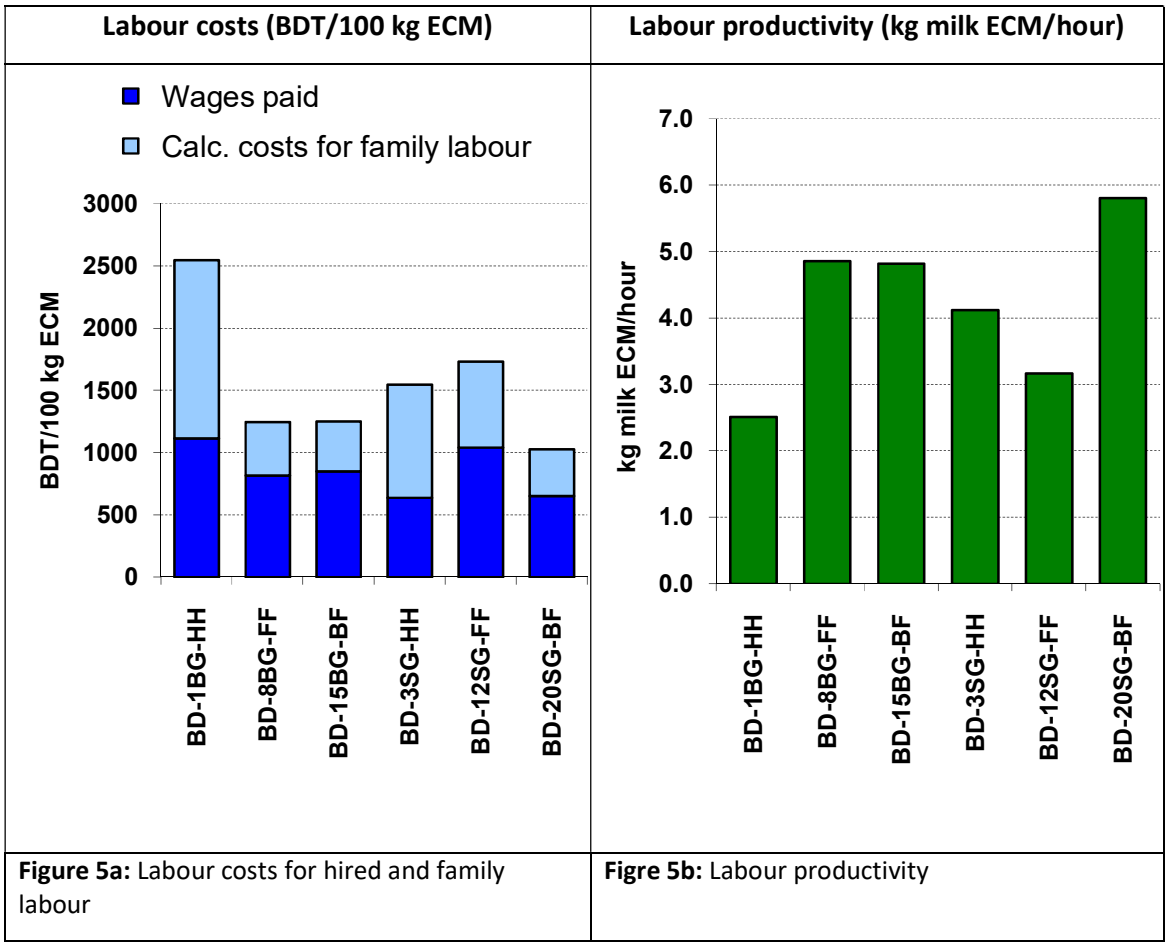


Figure 5a: Labour costs for hired and family labour

Figre 5b: Labour productivity

The figure 5a shows that small farms in Bogura had the highest labour costs while the lowest was obtained from business farms in Sirajgonj. The family farm in Sirajonj had the highest paid wages (for part time, contract and hired permanent labour) and the cost for opportunity costs (family labour) was the highest for Bogura small farms. Regarding labour productivity, the business farms in Bogura (BD-20SG BF) had the highest productivity (5.81 kg milk ECM/hr) while the lowest in household farms in Bogura (2.51 kg ECM/hr). The labour inefficiency, therefore, might become the key factor for increasing dairy productivity.

11.2.4 Profitability analysis

The profit and return on investment are depicted in Figures 6a and 6b, respectively. The estimation of the entrepreneur's profit was found to be negative for all farms except the business farms both in Bogura and Sirajgonj (green round dot in the Figure 6a). The household farms in both regions were not competitive and made a loss of approximately BDT 4 /kg milk they produced. This implies that farmers need to be efficient for reducing the cost of milk production. On the other hand, the business farms from Bogura and Sirajgonj had entrepreneurs profit of BDT 4 and 3/kg milk production, respectively. The analysis considered the similar inputs for all kind of farms and region; therefore, the regional differences are need to be addressed, where and how to increase the profitability. At the same time, the return on investment in absolute term (without considering the inflation rate) shows that none of the farms could get higher return than 6% (6% is the Bank interest rate). If the inflation rate of 6% is added, it is obvious that farms has to generate a Return on investment (ROI)>12% if the farms has to stay in business which was not found in any case.

Entrepreneur's profit	Return over investment

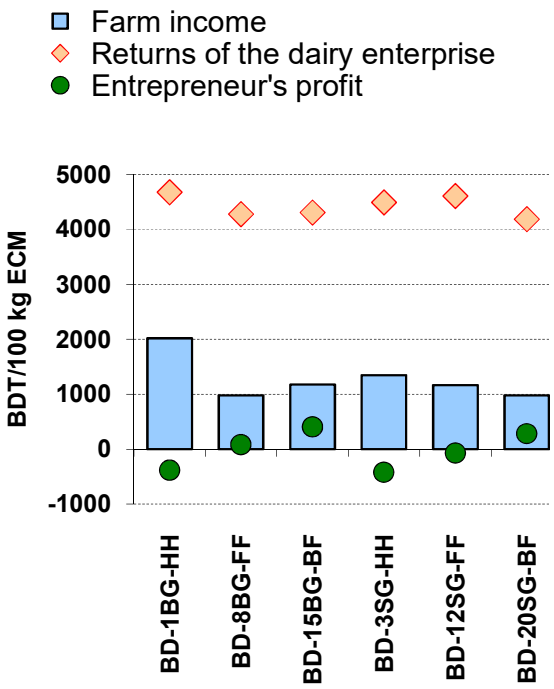
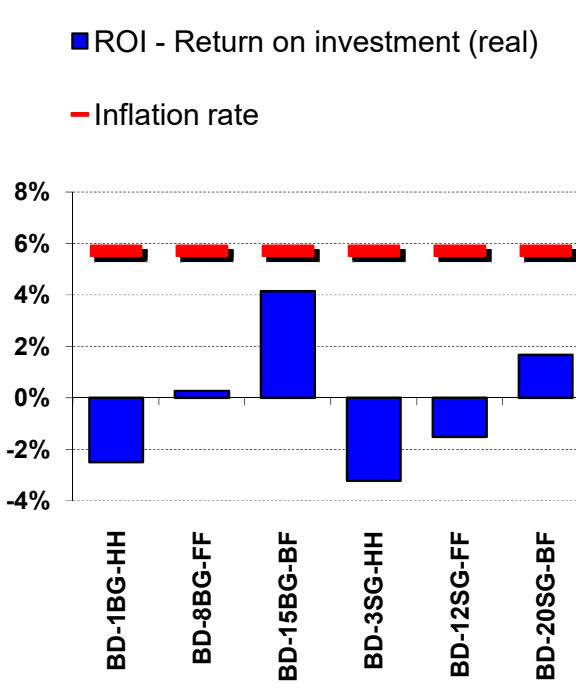
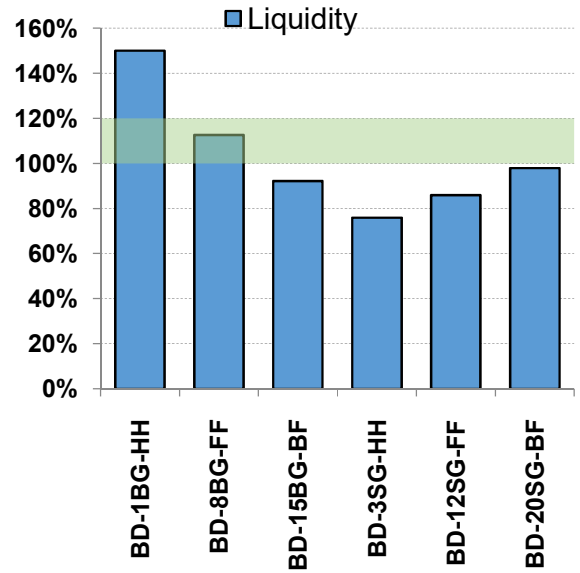
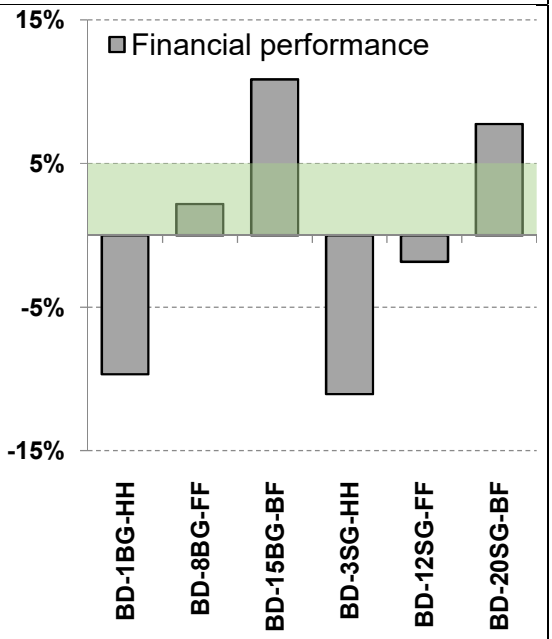

	

Figure 6a: Entrepreneurs profit of typical farms	**Figure 6b:** Return on Investment (ROI) of the typical farms

11.2.5. Farm Resilience to cope with adverse situation

The Figures 7a and 7b show that liquidity, which is expressed as the proportion of the total cash receipts and cash expenses and financial performance (expressed as the proportion of dairy receipt and entrepreneurs' profit). It is generally assumed that farms having 120% liquidity (means that with 20% extra cash flow) could make investment for the next year for increasing farm size. The Figure 7a shows that small farms in Bogura (BD-2BG-HH) had 150% Liquidity which might be interpreted as the fact that small farms had mostly unpaid family labours. As the family and business farms had higher cash costs and had to pay cash at the rate much higher than the small farms, indicating that there is a good opportunity for the household farmers but still it is a matter of policy decision whether this small farms having lower contribution to the total income can be supported by the government.

While looking at the financial performance in the Figure 7b, it is seen that only the small scale household farms had negative performance. It is assumed that farm needs at least 5% financial performance as a resilience capacity. The results indicates that only business farms from both region had the financial performance >5% while that for family or small scale farm are -10% and -11% for Bogura and Sirajgonj, respectively.

Liquidity (% cash receipts and expenses)	Financial performance (% of dairy receipt/entrepreneurs profit)
	
7a: Liquidity of the typical farms (% cash receipts and expenses)	**7b:** Financial performance (% of dairy receipt/entrepreneurs' profit)

11.3. Factors affecting the variation of cost and link among milk price and rural livelihood improvement

The TIPICAL simulation model farms were applied to identify the factors that cause variation in cost of milk production which is depicted in Figures 8a and 8b. From the simulation model it was revealed that except household farms, family and business farms become more responsive to decrease the cost of milk production. This was due to increasing milk yield. The other factor that affects directly to increase the profit is the milk price. Increasing milk price is a major way to increase profit and decrease the cost of milk production but it is not always be expected to increase the milk price.

Cost of milk production only (with changes in milk yield and milk price)	Return to laboour (with changes in milk yield and milk price)

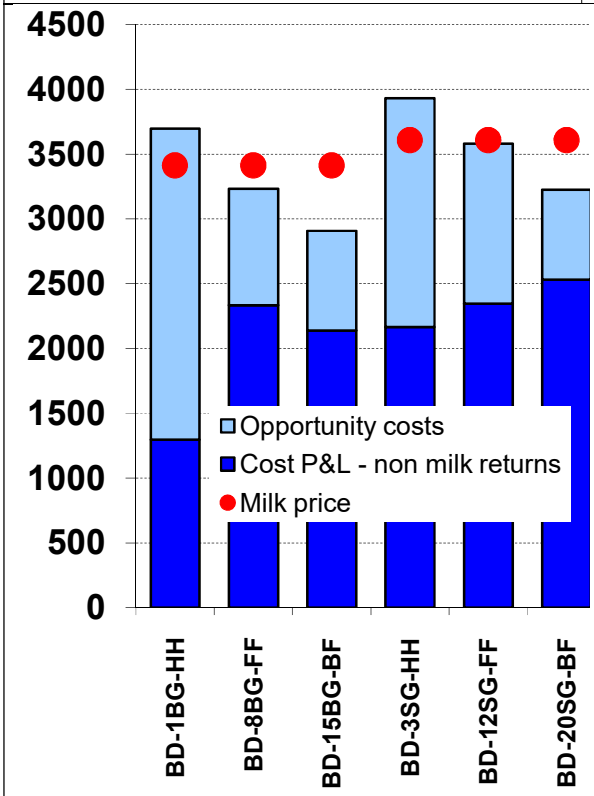
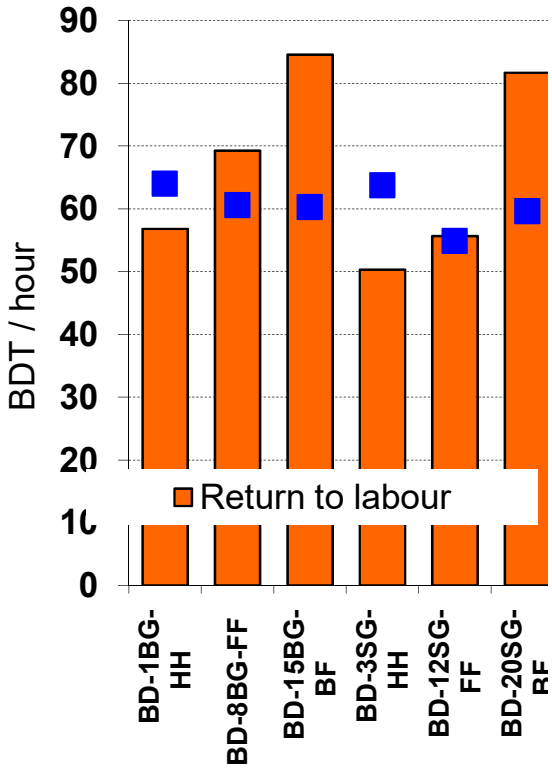

	

Figure 8a: Cost of milk production after simulation using the base typical farms	**Figure 8b:** Return to labouor after simulation using the base typical farms

The dairy farmers of Bangladesh are already getting +37% higher milk price than global average milk price. Therefore, there is relatively less probability of success to increase milk price further in the country. The return to labour is also highly responsive due to increase in milk yield and milk price increase. The rural livelihood improvement could be possible if the milk productivity and milk price can be increased.

11.4. Summary of the results of the farms analyzed for all the three categories

A short summary of all the major key variables that are used as "Key Performance Indicator (KPI)" are depicted in Table 3 for providing an overview of the results.

Table 3: The farm Key Performance Indicators (KPI) of the typical farms analyzed

The KPIs - Key Performance Indicators

		2017 BD-1BG-HH	2017 BD-8BG-FF	2017 BD-15BG-BF	2017 BD-3SG-HH	2017 BD-12SG-FF	2017 BD-20SG-BF
Profitability							
Enterpreneur's profit	BDT/100 kg ECM	-382.8	81.3	406.3	-423.5	-72.8	282.8
ROI total	%	3.2%	6.0%	9.9%	2.5%	4.2%	7.4%
Income							
Farm income	BDT/farm	20279	120608	318897	62035	250632	471419
Risk							
Operating profit margin	%	13%	13%	18%	10%	10%	15%
Feed cost on total cost	%	17%	46%	50%	44%	40%	34%
Proportion of subsidies on farm income	%	0%	0%	0%	0%	0%	0%
Competitiveness on the product market							
Milk price	BDT/100 kg ECM	3316	3316	3316	3511	3511	3511
Cost of milk production only	BDT/100 kg ECM	3699	3235	2910	3934	3584	3228
Competitiveness on the factor market							
Return to labour compared to general wage level	%	85%	107%	132%	73%	96%	128%
Return to land compared to rent price	%	-31%	174%	623%	-50%	61%	364%
ROI total minus interest rate for loans in the country	%	-7%	-4%	-1%	-7%	-6%	-3%
Productivity							
Land productivity	t ECM/ha arable &pasture land for dairy	10	12	38	11	18	27
Labour productivity	kg ECM/h	3	5	5	4	3	6
Feed							
Concentrate feed intensity	concentrate DM /kg milk	1.03	1.01	0.71	52.93	0.81	0.43
Herd							
Milk yield	kg ECM/year	1005	1538	1810	1538	1794	2410
Number of calvings per cow per year	no	0.99	0.99	1.05	1.01	1.05	0.99
Number of calvings per cow remaining in the herd	no	0.87	0.89	0.94	0.91	0.96	0.99
Replacement rate	%	29%	26%	29%	24%	23%	27%
Environment							
Stocking rate per ha land	LU/ha	15.6	17.5	33.3	11.1	15.3	9.8
Stocking rate per ha land (standard LU=650 kg cow)	LU-650/ha	6.0	8.1	17.9	4.8	8.0	5.3

12. Research highlight/findings:

- Six typical farms in three categories (household farm-2, family farm-2 and business farm-2) one each from two regions (Bogura-3 and Sirajgonj-3) were studied. Sirajgonj was found to have relatively higher herd size (3, 12 and 20 dairy cows/farm) compared with Bogura (1, 8

and 15 dairy cows/farm) for household, family and business farms respectively and dairying was found to be highly linked with major income source for Sirajgonj.

- The average milk yield per day per cow was found for Bogura to be 3.88 kg/d/cow while for Sirajgonj it was 5.11 kg/d/cow. However, the average milk production (kg ECM/cow/year) was found to be 1914 kg ECM/cow/year in Sirajgonj while for Bogura it was 1451 kg ECM/cow/year. The lowest amount of milk yield was found for household farms of Bogura (1005 kg/cow/year) while the highest was observed for Business farms in Sirajgonj (2410 kg/cow/year).
- The average cost of milk production only (COMPO) in all typical farms was found to be BDT 34.30/kg ECM while the average for Sirajgonj it was higher (BDT 35.80/ kg ECM) than Bogura (BDT 32.80/ kg ECM) which indicates a regional competitiveness advantage for Sirajgonj over Bogura. However, the milk price in Sirajgonj and Bogura was 35.1 BDT /kg ECM and 32.1 BDT/kg ECM respectively which was lower than the production cost indicating an overall negative entrepreneur's profit (EP) in both the regions.
- Looking into total cost of the dairy enterprise, Sirajonj has shown the highest average costs (BDT45.02/kg ECM) compared to BDT44.31/kg ECM for Bogura.
- The differences between COMPO and Total costs were found to be highly significant that needs to be taken into account as Bangladesh dairy enterprise is highly complex with beef production and other agricultural activities where the separation of the cost from the total cost to the cost of milk production is necessary in order to compare with milk price. This shows the reality, but farmers have no knowledge on this. Therefore, application of the IFCN method to the case of Bangladesh dairy is highly relevant to make decision on the milk price setting by the processors.
- From the social sustainability and job creation point of view, the return to labour (BDT/hr) reveals that both household and family farms are under risk as they are not generating any income at the level which is higher than the regional average. Therefore, if there is any alternative job option, this type of farmers will not continue dairy farming.
- Household farms from both regions were found to have negative Entrepreneur's Profit (BDT/kg ECM). This implies that current household and family farms might need either to decrease the cost of milk production or increase milk production so that return from milk sale becomes higher than the cost of milk production.
- Financial performance (EP/asset of the farm) was found to be positive only for the business farms from both the regions.

B. Implementation Position

1. Procurement:

Description of equipment and capital items	PP Target		Achievement		Remarks
	Phy (#)	Fin (Tk)	Phy (#)	Fin (Tk)	Procurement was completed on time and with 100% success
Desktop Computer	1	40000	1	43900	
UPS	1	10000	1	7300	
Laser Printer	1	20000	1	18700	

2. Establishment/renovation facilities: Not Applicable

Description of facilities	Newly established		Upgraded/refurbished		Remarks
	PP Target	Achievement	PP Target	Achievement	

3. Training/study tour/ seminar/workshop/conference organized: Not Applicable

Description	Number of participants			Duration (Days/weeks/ months)	Remarks
	Male	Female	Total		
(a) Training					
(b) Workshop					

C. Financial and physical progress

Fig in Tk

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
A. Contractual staff salary	160755	160755	160755	00	100%	-
B. Field research/lab expenses and supplies	438760	438760	438760	00	100%	-
C. Operating expenses	122400	122400	122400	00	100%	-
D. Vehicle hire and fuel, oil & maintenance	135000	135000	135000	00	100%	-
E. Training/workshop/ seminar etc.	00	00	00	00	100%	00
F. Publications and printing	60000	00	00	00	0%	No fund received
G. Miscellaneous	54000	54000	54000	00	100%	-
H. Capital expenses	70000	70000	70000	00	100%	-

D. Achievement of Sub-project by objectives: (Tangible form)

Specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output (i.e. product obtained, visible, measurable)	Outcome (short term effect of the research)
To estimate the "cost of milk production only (COMPO)" and total cost of dairy enterprise	-The typical dairy farms selected -transect study -assessment of the dairy profile of the region -formation of national expert team and expert validation -Data collection -Data validation -Data insertion and Typical Model application -Data analysis -Result analysis and validation	-Six typical farms in three categories (household farm-2, family farm-2 and business farm-2) one each from two regions (Bogura-3 and Sirajgonj-3) were studied. Sirajgonj was found to have relatively higher herd size (3, 12 and 20 dairy cows/farm) compared with Bogura (1, 8 and 15 dairy cows/farm) for household, family and business farms respectively and dairying was found to be highly linked with major income source for Sirajgonj. -The average milk yield per day per cow was found for Bogura to be 3.88 kg/d/cow while for Sirajgonj it was 5.11 kg/d/cow. However, the average milk production was found to be 1914 kg ECM/cow/year in Sirajgonj while for Bogura it was 1451 kg ECM/cow/year. The lowest amount of milk yield was found for household farms of Bogura (1005 kg/cow/year) while the highest was observed for Business farms in Sirajgonj (2410 kg/cow/year).	Detailed cost components were identified which could be used for setting milk price by the processors

To determine the underlying factors that causes the variation in cost of milk production	-Selection of key variables that might affect the cost. -Out of a number of variables three key variables such as milk price, milk yield and salary/wage change were selected -With the selected variables, the TIPICAL Farm Simulation Model was applied to understand to what extent the factors affect the cost of milk production -The simulation model was a bit different from the classical "Monte-Carlo Simulation model" in a sense that in the model under study typical version of simulation that is linked with real farm economic situation was used	-The average "cost of milk production only" (COMPO) in all typical farms was found to be BDT 34.30/kg ECM while the average for Sirajgonj was higher (BDT 35.80/ kg ECM) than Bogura (BDT 32.80/kg ECM) which indicates a regional competitiveness advantage for Sirajgonj over Bogura. However, the milk price in Sirajgonj and Bogura was 35.1 BDT /kg ECM and 32.1 BDT/kg ECM respectively which was lower than the production cost indicating an overall negative entrepreneur's profit (EP) in both the regions. -Looking into total cost of the dairy enterprise, Sirajonj has shown the highest average costs (BDT 45.02/kg ECM) compared to Bogura (BDT 44.31/kg ECM). -There was significant difference between COMPO and Total cost that needs to be taken into account as Bangladesh dairy enterprise is highly complex with beef production and other agricultural activities where the separation of the cost from the total cost to the cost of milk production is necessary in order to compare with milk price. This shows the reality, but farmers have no knowledge on this. Therefore, application of the IFCN method to the case of Bangladesh dairy is highly relevant to make decision on the milk price setting by the processors. -From the social sustainability and job creation point of view, the return to labour (BDT/hr) reveals that both household and family farms are under risk as they are not generating any income at the level higher than the regional average. Therefore, if there is any alternative job option, this type of farmers will not continue dairy farming. -Household farms from both regions were found to have negative Entrepreneur's Profit (BDT/kg ECM). This implies that current household and family farms might need either to decrease the cost of milk production or increase milk production so that return from milk sale becomes higher than the cost of milk production. -Financial performance (EP/asset of the farm) was found to be positive only for the business farms from both the regions	
To analyze the link among milk production cost, market price, and livelihood improvement policy	-Use of "What if" analysis to see how they link among milk production, milk price, cost of milk production and household income -TIPICAL model was extended to include the factors that cause those links		

E. Materials Development/Publication made under the Sub-project:

Publication	Number of publications		Remarks (e.g. paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Technology bulletin/ booklet/leaflet/flyer etc.			Establishment of "Integrated Dairy Research Network (IDRN)
Journal publication			
Information development	Preparation of the excel tool for the farmers cost of milk production		
Other publications, if any			

F. Technology/Knowledge generation/Policy Support (as applied):

i. Generation of technology (Commodity & Non-commodity)

None

ii. **Generation of new knowledge that help in developing more technology in future**

Establishment of Integrated Dairy Research Network using some of the resources and results of this study

iii. Technology transferred that help increased agricultural productivity and farmers' income

By using the production tool farmers can benchmark to reduce the cost of milk production, increase productivity and increase farm income

iv. Policy Support

Milk price policy strategy can be based on the cost of milk production in order to make the far setting of milk price

G. Information regarding Desk and Field Monitoring

i) **Desk Monitoring**:

Monitoring (Desk) was done two times during February and April, 2018. The feedback from monitoring team was addressed properly.

ii) Field Monitoring (time& No. of visit, Team visit and output):

No Field Monitoring was done as the project involved data collection and analysis using different data processing tools.

H. Lesson Learned (if any)

The project duration was too short for successfully achieving the objectives.

I. Challenges (if any)

To keep pace with time was a big challenge

Signature of the Principal Investigator
Date ……
Seal

Counter signature of the Head of the organization/authorized representative
Date ……..
Seal

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Annex 1

Detail on Cost of Milk production only (COMPO) and the total cost of dairy enterprise

Cost of milk production only (BDT/100 kg ECM)

Cost of milk production only	BD-1BG-HH	BD-8BG-FF	BD-15BG-BF	BD-1SG-HH	BD-12BG-FF	BD-20BG-BF
Cost P&L - non milk returns	1,298	2,336	2,141	2,166	2,347	2,533
Opportunity costs	2,401	899	768	1,768	1,237	695
Milk price	3,316	3,316	3,316	3,511	3,511	3,511
Total	3,699	3,235	2,910	3,934	3,584	3,228

Total cost of the Dairy Enterprise (BDT/100 kg ECM)

Total dairy eteterprise costs	BD-1BG-HH	BD-8BG-FF	BD-15BG-BF	BD-1SG-HH	BD-12BG-FF	BD-20BG-BF
Cash costs	2,624	3,286	3,123	3,137	3,436	3,193
Depreciation	35	13	10	10	8	16
Opportunity costs	2,401	899	768	1,768	1,237	695
Total dairy enterprise costs	5,059	4,197	3,901	4,915	4,681	3,905