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Impact of Dairy Cooperatives Model Farm (MF) on Milk Production, Cost Competitiveness and Rural Livelihood Improvement in Selected Regions of Bangladesh

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ABSTRACT

The aim of present study was to assess Dairy Cooperatives Model Farm (MF-an approach of the Department of Cooperatives) compared with traditional farms in terms of milk productivity and cost of milk production as a measure of cost competitiveness, farm resilience and rural livelihoods of the dairy farmers in four regions of Bangladesh. The holistic approach which combines with research and development agenda was used to handle the complexity of the current dairy farming system and scarcity of data on dairy farms. The International Farm Comparison Network (IFCN) methodology consisting of Typical Farm Approach (TFA), Technology Impact Policy Impact Calculations (TIPICAL) model and dairy networking approach were used. The four regions were selected namely Gopalganj, Tangail, Mymensingh, and Sirajganj purposively where the Dairy Co-operative Model Farm (DCMF) were operating. Data were collected using the IFCN panel approach which is considered as Modified Delphi Technique along with baseline survey, transect survey and panel help survey. Within the DCMF, the 2-cow model farm was selected where under each region first type of farm was Model Farm (MF) with support services where the second farm was Traditional Farm (TF) without any support services. The average milk productivity for MF for all region was higher (1660 kg per cow/year) than TF (1446 kg/cow/year) which is 14.8% higher in MF. The milk productivity has strong regional variations, highest milk production was observed in MF in Sirajganj while the lowest in Gopalganj. The cost of milk production is 7.5% lower in MF than TF where the average cost is 36.44 BDT/kg milk in MF and 39.40 BDT/kg in TF. In relation to cost competitiveness, Gopalganj MF has the lowest cost, implies that highly cost competitive among the regions. The buffer capacity is found to be higher in MF in Tangail and Gopalganj. The Model farms in all regions have increased land, higher income and more income sources than the TF. The study concludes that 2 -cow MF under cooperatives is highly competitive than TF, however, further study might be needed to identify which factors might affect this variation. The results are expected to be beneficial for the policy makers for identifying the suitable farm type and regions for increasing milk production.

Introduction

Bangladesh has achieved tremendous growth in milk production from 1.78 million ton in 2001 to 9.92 million ton in 2018 (DLS, 2019). In contrast, the Integrated Dairy Research Network (IDRN) dairy sector database showed the total milk production is8.14 million ton (IDRN, 2020). The average growth is 12.77% for DLS data and 10.77% for IDRN data; however, the DLS data has substantially higher variation (47% in 2012 versus -14% in 2008). Given with this plethora, research and extensive field experiences revealed that milk production in Bangladesh has been increased significantly although the reported milk production seems to be higher than the reality (Uddin *et al.,* 2020). This implies that intervention that is linked with the improvement of the dairy farmers is highly associated with dairy sector development. The number of dairy farms as defined having at least 1 cow with more than 33% income to the household income is estimated to be 1.44 million in 2019 (IDRN, 2020) which is also changing over time. Against the growth of milk,

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the number of cattle populations has not increased significantly from 23.20 million in 2011 to 24.28 million in 2018 (DLS, 2019). To boost milk production and to achieve the goal of self-sufficiency, dairy farming should be promoted in the rural areas of Bangladesh. The study done by Uddin *et al.* (2020) showed that Bangladesh will achieve self-sufficiency in 2030 if demand is considered as stable (deterministic approach) and can only achieve 66% self- sufficiency in 2030 if the demand is considered stochastic (Uddin *et al.,* 2020).

The current management system of the dairy farms has lack of good practices and lack of knowledge of the farm owner and manager. Within the managerial activity, feed and labour management is the most important component for efficient dairy production in Bangladesh. The feed cost of milk production is higher in Bangladesh compared with its neighboring countries (IFCN, 2019) among which, the feed costs represents the highest cost item ranging from 18 to 82% globally (Hemme *et al.,* 2014) while for the Bangladesh the feed cost ranges from 58 to 72% (Uddin *et al.,* 2010). Therefore, the feed cost optimization is one of the key management aspects which might help the famers to decrease the cost of milk production, thus increase profit and overall household income.

Bangladesh dairy is dominated by small scale farms with an average of 2.7 Cows/farm which is lower than world average of 3.1 Cows/farm. Any kind of intervention that targets to the small-scale farm size would fit with the current dairy farming practices. To response to this, The Department of Cooperatives have established the concept of "2-Cow model farms" called "Dairy Cooperatives Model Farms (MF)" which leads to the research question, to what extent and how this type of model farm may help in increasing milk production and rural livelihoods. To test this, International Farm Comparison Network (IFCN) Typical Farm Approach and Technology Impact Policy Impact Calculations Model (IFCN) was used with the objective of assessment of the impact of Cooperatives Dairy Farm Model (DCFM) intervention on milk production, cost competitiveness, and improvement of rural livelihood in Bangladesh.

Methodology

Methodological approach and model

For dairy development in the country and increasing management skill at farm level, it is necessary to identify a suitable model dairy farm that are feasible to replicate to the wider context and also fit to the rural current socio-economic condition. To do this, it is incredibly important to apply appropriate methodological procedure that combines research and development which is unlike with traditional research systems. Therefore, this study applied the holistic approach considering the complexity of the dairy farming in Bangladesh (Uddin *et al.,* 2017), the acute scarcity of detailed economic and accounting data and data on the rural livelihood system. This limitation can be overcome by utilizing the International Farm Comparison Network (IFCN)which has the capacity to integrate multiple factors in the single research and can produce good scientific output from limited data and using less resources (Ndambi*et al*., 2008; Hemme*et al.,* 2014).

Based on the background information, objectives and the current need for increasing commercialization of the dairy farming systems, the analysis of cost might play an important role in both econometric and biological simulation models. However, the analysis of cost from theory of competitiveness imposes significant challenges in benchmarking Bangladesh dairy farms. To address the complexity of the dairy farming from the nutritional, economic and environmental as well as the rural livelihood improvement perspectives, this study has applied a combination of the both International Farm Comparison Network (IFCN) methodology and application of impact evaluation adaptive field research. The IFCN method is applied which is consisting of three pillars (Uddin *et al.,* 2012; Hemme *et al.,* 2014): (1) Typical Farm Approach (TFA), (2) Technology Impact Policy Impact Calculations Model (TIPICAL), and (3) The Concept of the dairy network

Typical Farm Comparison Network

The typical farm approaches (TFA) (Uddin *et al*., 2010) can handle those limitations and challenges mentioned above. The application of TFA in typical farm selection, data collection and validation have a strong scientific basis due to its ability to produce results with minimal resources (Ndambi and Hemme, 2008; Uddin *et al.,* 2010, Hagemann *et al.,* 2011). For this study, we select 8 typical farms, four from Model farms (MF) and four from Traditional Farm (TF). The TFA has three distinct steps:

Selection of study region: The study regions were selected based on the purposive sampling to align with the evaluation of dairy farming model. Since it is a priority to identify the suitable model based on the cooperative's principles, we selected the regions and farms model from the areas where this type of farming models is under operating. It is revealed that the Department of Cooperatives (DOC) have been implementing 2-cow dairy farming model targeting to enhance the dairy development and rural livelihood improvement in 65 Upazilas under 32 districts in 7 divisions (DOC, 2019). For this study we selected four Upazilas such as Tungipara, Dhanbari, Trishal and Shahjadpur which are belonging to Gopalganj, Tangail, Mymensingh and Sirajganj district, respectively.

Selection of the typical farms: Three different types of dairy farming system is available in the country such as: household farm, family farms, business farms. In our study we selected DCMF with 2 cows, here considered as household farm. The household farm is the most dominant farm type in the country which represent 82% of the total farms available in Bangladesh (IDRN, 2020). As a measure for comparison, our model farms are terms as Model Farm (MF) which is operated under the Department of Cooperatives (DOC) and the other type of farms from the same region was taken as Traditional Farm (TF).

Formation of Panel: To collect data from the selected farms type, a panel consisting of one national expert, one regional expert, one researcher and 5-7 farmers from each of the farm type was formed. The role of the expert panel members was to validate the data, results, and its implication.

Technology Impact Policy Impact Calculations Model (TIPICAL)

TIPI-CAL model which is based on the concept of Farm Level Income and Policy Simulation (FLIPSIM) Model developed by Texas A&M (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 based software which is globally used while the FLIPSIM, on the other hand, uses simulation of sector data to produce results. 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 and Hemme *et al.,* 2014) is described as

f (c) =f(x, w)……..(1)

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

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 and depreciation for buildings and machinery; and

Cost of milk production only (COMPO) 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) and quota costs.

The total cost of the dairy enterprise was estimated as:

$C = (Wv, W_f)$…… (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)

$Ct = w, y, xf = wvxv\,(w, y, xf)\; wfxf$…… (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

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

Where, C_t = 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: X_1 = animal purchases; X_2 = feed, machinery (maintenance, depreciation, contractor); X_3 = fuel, energy, lubricants, water; X_4 = buildings (maintenance, depreciation), X_5 = veterinary and medicine, insemination; X_6 = Insurance taxes, X_7 = other inputs dairy enterprise (quota); X_8 = VAT balance (if negative). The cost of factors was also expressed per 100 kg ECM and entered into the model, as: W_1 = total land, W_2 =capital and W_3 = 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 were higher 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 is associated to beef, heifers and other non-milk related costs is adjusted so that it is applicable all over the world.

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

$C_{milk} = \sum \text{P\&L account} - \sum \text{Nmr}$ …… (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).

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). For estimation of Solid Corrected Milk (SCM), it is calculated as: SCM = Milk yield * (Fat% + Protein%)/7.3 (IFCN, 2019)

The difference between 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.

Using the concept of the dairy network

The unique feature of this methodology is the use of the concept of dairy network in order to obtain the reliable data in a sustainable way and also make this available for future research and policy decisions. Following the principle of IFCN methodological networking approach which is the network of dairy researchers from 110 countries supported by 120 dairy companies and operated by IFCN Dairy Research Centre, we have taken the concept of the Integrated Dairy Research Network (IDRN) where the network is working under the Department of Animal Nutrition, Bangladesh Agricultural University. The IDRN is basically network of interdisciplinary researchers (dairy nutrition, economics, environment, and marketing) and database team as well as national panel experts. The research team coordinates the entire research focusing on the dairy supply chain which is guided by the panel of experts to ensure the quality of the data and work to serve the dairy industry (IDRN, 2020). The network also serves the real time data for monitoring dairy sector. The current study uses this network for generating the data and validation of the data and results before being accepted for dissemination.

Data collection

The study applied four different levels of data collection using the Panel Approach which is a modified Delphi Technique (Custer *et al.,* 199). The levels are (i) baseline data, (ii) transect survey among the selected farmers, (iii) panel help survey data, and (iv) panel data. Required data for running the model was collected in two stages: in the first phase, data was collected for baseline benchmark, transect survey and Panel Help Survey and in the second phase, data was collected using the panel approach. Field study were organized in cooperation with Department of Cooperatives and relevant other dairy stakeholders (researchers, experts and farmers). All collected data inserted in Input sheet (INP). Input sheet contains all the input variables (total 647 variables) covering dairy farm enterprise and whole farm enterprise. This sheet is the key to insert in the TIPICAL (Technology Impact Policy Impact Calculations Model).

Table 1. Overview of field survey and data collection

District	Collected numbers		
	Data	Panel	INP
Gopalganj (Tungipara)	16	1	16
Tangail (Dhanbari)	19	1	1
Mymensingh (Trishal)	57	1	18
Sirajganj (Shahjadpur)	35	1	19
Total	127	4	54
Grand total	185		

An overview of the sample dairy farms is depicted in Table 1. From each region and farm type where two groups of typical farm was selected: one is called beneficiary group who got financial support to purchase at least 2 cows (equivalent to100000-120000taka) and training on improvement management, called Model Farm (MF) while the other group of same herd size (2 cow) farm is operating using their own resources,

herewith called Traditional Farm (TF). This leads to us to make comparison between beneficiary and non-beneficiary farms types.

Data analysis

Data was entered into the TIPI-CAL model and run to produce the required output. The output was validated through comparing the existing literature or comparing by utilizing the experiences. For data analysis and producing results, IFCN method uses TIPICAL software (version 5.6).

Results and Discussion

Impact of MF on dairy competitiveness and dairy farm management

The section deals with the results of the TIPICAL model which was done by using the IFCN method. The results need to be interpreted with specific farm type and region.

The description of the typical farm

Dairy production systems can vary considerably in different regions. In this study, the selected typical farms GL-2-MF, GL-2-TF, TG-2-MF, TG-2-TF, MM-2-MF, MM-2-TF, SG-2-MF and SG-2-TF representing the small scale household farms in the regions. The difference between all the farming systems are mainly driven by the differences in inputs and outputs. An overview of all those selected dairy farming systems is depicted in Table 2. The highest milk production is found in SG-2-MF (2256 kg ECM/cow/year) and the lowest in GL-2-TF (980 kg ECM/cow/year) and MM-2-TF (980 kg ECM/cow/year). the opposite is found for land size where the GL-2-TF has more land than the highest producing region. This might imply that low producing regions are relatively less efficient in land use compare with high producing region. In relation to labour input, TG-2-TF is using highest labour input per farm (2.2 LU/farm) which is the double than the highest milk producing region of SG-2-MF (1.1). This once again reflects the less efficiency of labour in dairy production. The higher labour use in the medium milk producing region (TF-2-MF) might be explained either the age of the farmers is relatively higher which cause inefficiency (Lips *et al.,* 2013) and labour is allocated for off-farm job.

Milk production among different farm types and regions

The milk production is the main source of income for the dairy farms in Bangladesh. Increase in milk production is considered as the key successful factor of any intervention or project. The milk productivity at cow level for daily, per lactation and per year in the study areas between MF and TF has been depicted in Table 3. The Table 3 also reports milk production in natural content (without any adjustment of fat and protein content), ECM (4% fat and 3.3% protein) and SCM (4% and 3.3% protein). The SCM is more implies for the processing level and ECM is more applicable for farmers and consumers level (IFCN, 2019). The milk production is the highest in Sirajganj for MF and the lowest is found for Mymensingh in TF. The main reason is that the farmers from Sirajganj is well experienced and have long history of dairy farming, have good genetic base and have good feeding base. On the other hand, the farmers from Mymensingh has started their dairy farming relatively new. The TF from Tangail and Gopalganj could be the good option to provide more intervention in future. The district of Sirajganj might not need such intervention as this district is more or less saturated in terms of technology and other management skill.

Estimation of cost competitiveness

The cost of milk production is the key indicator for measuring the competitiveness of the dairy farms and dairy profitability. The cost of milk production only and total cost of the dairy enterprise are depicted in Figure 1a and 1b. The average cost of milk production only (COMPO) in the study areas was 3644 BDT/100 kg milk in MF and 3940 BDT/100 kg in TF which implies that the COMPO for TF is 7.5% lower than TF. The typical farm from Gopalganj (GL-2 MF) shows the lowest cost compared with other study areas as well as the regional average which is 2888 BDT/100kg ECM. However, the COMPO is the highest in Mymensingh TF (MM-2TF) which corresponds to 5020 BDT/100 kg ECM. This implies that farmers from Gopalganj is highly competitive in relation to cost of milk production compared with other regions and other model farms. However, the milk production is lowest which indicates that MF in Gopalganj (GL-2-MF) is the low input and low output farm type which could be improved upon exposing the suitable intervention.

Buffer capacity of the MF in the study areas

The buffer capacity which is expressed as resilience that is again as a function of % liquidity, % operating profit margin and % financial performance for both MF and TF are depicted in Figure 2a, 2b and 2c. The MF shows higher liquidity, operating profit margin and financial performance compared with TF. However, for liquidity, it is 120% is the benchmark, implies that farms having more than 120% liquidity is able to respond to the financial crisis. From Figure 3a, it is revealed that only the MF from Gopalganj and Tangail has the liquidity >120%.

Table 2. General descriptions of the typical farms

Farm description	Farming system							
	GL-2- MF	GL-2-TF	TG-2- MF	TG-2- TF	MM-2- MF	MM-2- TF	SG-2- MF	SG-2- TF
Farming system	MF	TF	MF	TF	MF	TF	MF	TF
Cows number	2	2	2	2	2	2	2	2
Milk yield (kg CM/ cow/ year)	1050	980	1850	1650	1484	980	2256	2172
Land base (ha/animal)	0.9	1.0	0.4	0.8	0.4	0.4	0.5	0.6
Labour input (LU)	1.3	1.3	2.1	2.2	1.1	1.1	1.1	1.3

H = household, MF = model farm, TF = traditional farm; LU= Labour Unit (1 LU=2100 hours); The number associated with the code indicates the number of cows; GF-2-MF: Gopalganj-2 cow-Model farms, GL-2-TF: Gopalganj-2 cow-Traditional farms; TG-2-MF: Tangail-2 cow-Model farms, TG-2-TF: Tangail-2 cow- Traditional farms; MM-2-MF: Mymensingh-2 cow-Model farms, MM-2-TF: Mymensingh-2 cow-Traditional farms; SG-2-MF: Sirajganj-2 cow-Model farms, SG-2-TF: Sirajganj-2 cow- Traditional farms

Table 3. Milk productivity at cow level (daily, lactation and year wise)

Farm description	Farming system							
	GL-2- MF	GL-2-TF	TG-2- MF	TG-2- TF	MM-2- MF	MM-2- TF	SG-2- MF	SG-2- TF
Milk yield in Natural content								
kg milk/day/cow	2.88	2.68	5.07	4.52	4.07	2.68	6.18	5.95
kg milk/lactation/cow	777	725	1368	1221	1098	725	1669	1606
kg milk/year/cow	1050	980	1850	1650	1484	980	2256	2172
Milk yield in ECM*								
kg milk/day/cow	2.95	2.75	5.19	4.63	4.17	2.75	6.33	6.10
kg milk/lactation/cow	796	743	1402	1251	1125	743	1710	1646
kg milk/year/cow	1076	1004	1896	1691	1521	1004	2311	2225
Milk yield in SCM**								
kg milk/day/cow	2.96	2.75	5.21	4.64	4.18	2.75	6.35	6.11
kg milk/lactation/cow	798	745	1405	1254	1128	745	1714	1650
kg milk/year/cow	1078	1007	1900	1695	1524	1007	2317	2231

*ECM =Energy Corrected Milk; **SCM = Solid Corrected Milk; GL = Gopalganj, TG = Tangail; MM = Mymensingh; SG = Sirajganj; MF = Model farmers; TF = Traditional farmers

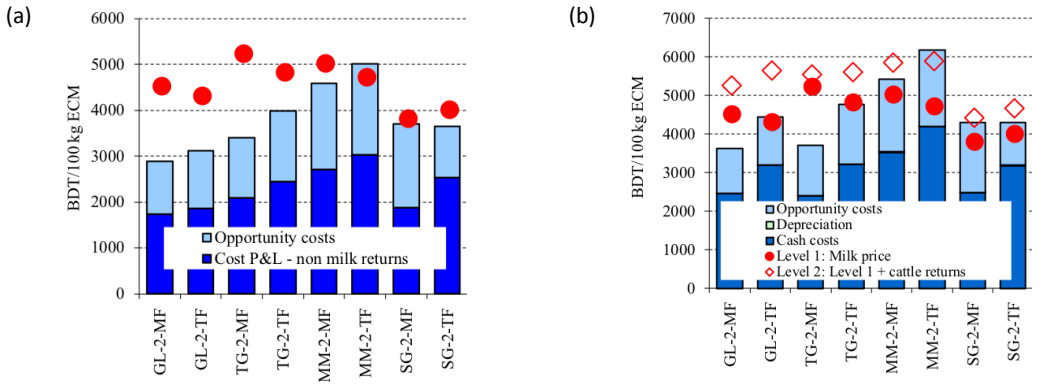

Figure 1. (a) Cost of milk production only (COMPO), and (b) Total cost and return of the dairy enterprise

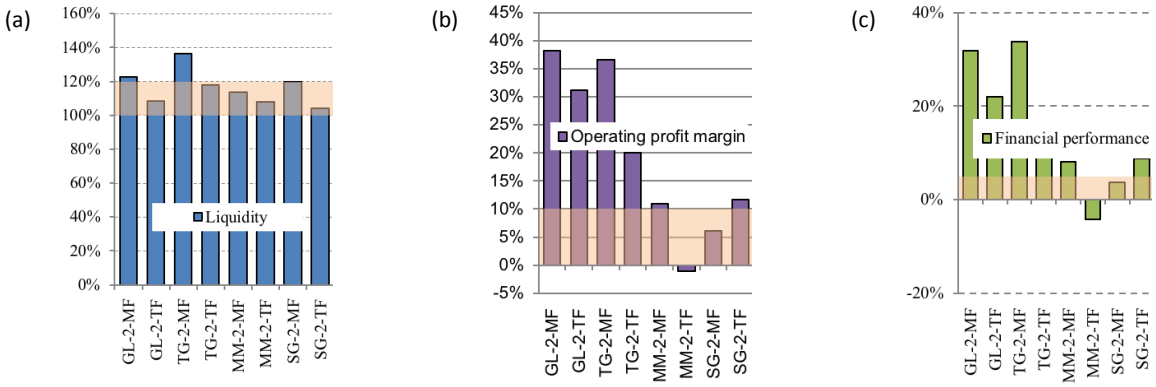

Figure 2. (a) Farm resillience capacity: liquidty, (b) Farm resillience capacity: operating profit margin, and (c) Farm resillience capacity: Financial performance

Table 4. Profitability analysis: Farm income and Entrepreneurs' profit

Profitability	GL-2- MF	GL-2-TF	TG-2- MF	TG-2- TF	MM-2- MF	MM-2- TF	SG-2- MF	SG-2- TF
Entrepreneur's profit (BDT/100 kg ECM)	1679.5	1245.6	1880.8	892.5	479.7	-249.5	161.5	417.8
ROI total (%)	6.1%	1.6%	25.6%	5.7%	5.8%	-2.6%	2.4%	4.5%
Farm income (BDT/farm)	58707	48177	116321	78855	69165	33606	87653	65445

Table 5. Dairy status quo based on baseline study areas, Regional and National level

Parameter		Regional*	National**	MF***	TF***
Farm type	Household Farm (HF)	42.6%	35.1%	33%	46%
Milk yield	Reginal Average (kg/cow/d)	6.95	6.04	4.25	3.96
Land base	Total land (ha)	0.43	1.1	0.55	0.70
	Land for dairy (ha)	0.07	0.11	0.06	-
Lactation length	Days	247	243	233	209

*Regional means: average of four districts: Gopalganj, Tangail, Mymensingh and Sirajganj; **National means: average of 20 districts; ***MF and TF indicates the selected model farms from four upaziall as:Tungipara (Gopalganj), Dhanbari (Tangail), Trishal (Mymensingh), and Shajadpur (Sirajganj); Data source: Field survey 2019 and IDRN national dairy database 2019

Table 6. Comparison of rural livelihood improvement between MF and TF

Major Parameter Studied	Survey region	TF /Baseline farms	MF
Land base (Ha)	Gopalganj	0.49	0.51
	Tangail	0.75	0.81
	Mymensingh	0.40	0.44
	Sirajganj	0.24	0.29
Income (BDT/month): Household	Gopalganj	12000	16000
	Tangail	20000	30000
	Mymensingh	13000	16000
	Sirajganj	19037	30703
Source of income*	Gopalganj	1,2,3,5	1,2,3,5
	Tangail	1,2,3,4,5	1,2,3,4,5
	Mymensingh	1,2,3,5	1,2,3,5
	Sirajganj	1,2,3,5	1,2,3,4,5

* 1=Agriculture, 2=Dairy, 3=Poultry, 4=Business, 5=others

In relation to operating profit margin, Figure 2b shows that all farms except TF from Mymensingh have the margin which is higher than 10%. A profit margin of >10% is considered as the positive buffering capacity respond to any crisis. The same is reflecting for financial performance where it is found that TF from Mymensingh has negative financial performance (-4%). A financial performance >5% is considered as the positive buffering capacity. The resilience capacity of the DCMF compared with traditional farm have been considered as the key indicator for responding to the financial crisis arises from any kind of unexpected and confounding factors (both endogenous and exogenous). The pandemic coronavirus infection (COVID-19) is one of the most devasting exogenous factors and complete unknown which has cause financial loss in the dairy farms as it is revealed by the study done by Uddin *et al*. (2020). However, this study results are not intended to link with the impact of COVID-19, but it might guide the dairy farmers for potential operating and managerial sustainability in the near future.

Profitability of the dairy farms (including the opportunity costs)

The profitability including Entrepreneur's profit (EP), Farm income and return on investment is depicted in Table 4. Profitability analysis is used as a measure of the sustainable dairy farming system as higher the profit and the higher the sustainability (Van Chalker *et al.,* 2005) but this does not include the opportunity costs. Analysis of profit including opportunity costs is termed as EP (Return – (Costs for input + costs for opportunity costs for land, labour and capital). The EP is found highest for Gopalganj in MF (GL-2MF) which corresponds to 1680 BDT/100 kg ECM and the lowest is in Mymensingh (MM-2-TF) which is even negative. This implies that any development intervention for dairy that might apply to Gopalganj has a probability of higher chance for increasing profit compared to other region. In terms of Return over Investment (ROI) also shows the highest (6.1%) in Gopalganj. This is higher than normal bank interest as deposit of money in the bank only provide less than 5.5% interest.

Therefore, investment in dairy is profitable as long as the ROI stays greater than bank interest. The operating profit margin is also higher for Gopalganj (38%) which also supports that Gopalganj dairy farms are more prone to dairy development.

Benchmarking the FM compared with regional and national level

The results from the transect study showed that DCMF intervention has strong link with household farms (small scale farms). The IDRN database shows that household farm is dominant farm type in Bangladesh as the household farm represent 82%farm type prevailing in Bangladesh. The status quo of the regional farm types and milk production is depicted in Table 5. The MF in the selected areas represent 33% household farms which is close to national average (35%) however, lower than regional average (42.6%). However, milk yield per cow is lower in MF farms compared to regional and national average but this is since some of the MF are quite new and need some time to increase their productivity. The land area in the MF is also similar with regional average. The lactation days (233) of the MF is somehow slightly lower than regional and national average. This is again due to the fact that new farms might need some more time to increase their skill which entails that MF might think on extending similar type of project intervention to the similar days. This result implies that MF has still scope to make improvement in farm input and output which might be helpful for increasing the sustainability of the dairy farmers in the regional level.

Rural livelihood improvement of the MF

The improvement in farmer's condition in terms of total land base, income of the household and source of income is depicted in the following Table 6. It is revealed that the condition of the farmers has been improved. There is a remarkable difference in farmer's conditions between MF and TF before starting the projects and after competition of the project. Along with the indicators stated in Table 5 and the other conditions of the farmers as stated in Table 6 have been improved. The Department of Cooperatives has made tremendous effort to establish the model dairy farm and its extension to other regions by providing financial and managerial support services. Based on the findings of this study, it is clear that MF has better performance than TF. This is also reflected from other study done by Uddin *et al.* (2012) who found that the improvement of support services on dairy farm has positive impact on milk productivity and rural livelihood improvement. At the same pace, the support services were also helpful in decreasing the cost of milk production where the access to credit, nutrition and feeding and access to market plays key role (Uddin *et al.,* 2017).

Conclusion

The application of the International Farm Comparison Network (IFCN) to benchmark the MF with TF has been considered a time being approach in the context of Bangladesh dairy sector development. The impact of Cooperatives Dairy Farm Modelling for identifying the suitable and better performing farm in relation to cost competitiveness and farm resilience clearly showed that MF has positive impact on increasing competitiveness compared with TF in terms of milk production, cost of milk production, entrepreneur's profit, income per household, income diversification, and overall rural livelihood. The GL-2-MF is the cost competitive as it has the lowest cost compared with all other regions, but the total milk production is lower compared with other regions. This implies that low input-and low-output dairy farming might be considered a suitable farm as this small household farms are the most dominant farm type in the country. In relation to buffer capacity as a measure of farm resilience to respond to financial crisis management arises from any exogenous factors showed that MF from Gopalganj (GL-2-MF) and Tangail (TG-2-MF) has better resilience capacity than other regions as well as TF. This study concludes that MF which is the representative of DCMF might be extended to other region for increasing milk production and improvement of rural livelihood.

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Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

References

Custer, R.L., Scarcella, J.A. and Stewart, B.R. 1999. The modified Delphi Technique – A rotational modification. *Journal of vocational and technical education*, 15(2). https://doi.org/10.21061/jcte.v15i2.702

DLS, Department of Livestock Services, 2019. Livestock Economy at a glance. Ministry of Fisheries and Livestock, Dhaka, Bangladesh. www.dl.gov.org

DOC, Department of Cooperatives, 2019. Smallholder dairy development projects under the Ministry of Local Government, Rural development and Cooperatives, Dhaka.

Hagemann, M., Hemme, T., Ndambi, O.A., Alqaisi, O.S., and Sultanan, M.N. 2011. Benchmarking greenhouse gas emissions of bovine milk production systems for 38 countries. *Animal Feed Science and Technology*, 166(167): 46-58. https://doi.org/10.1016/j.anifeedsci.2011.04.002

Hemme, T. 2000. Ein Konzept zur international vergleichnden Analyse von Politik-und Technikfolgen in der Landwirtschaft. LandbauforshungVölkernode, Sonderheft 215 (2000).

Hemme T., Uddin M.M. and Ndambi, O.A. 2014. Benchmarking cost of milk production in 46 countries. *Journal of Reviews on Global Economics*, 3: 254 -270. https://doi.org/10.6000/1929-7092.2014.03.20

IDRN, Integrated Dairy Research Network, 2020. Monthly update of dairy market and dairy sector. Department of Animal Nutrition, Bangladesh Agricultural University, Mymensingh. www.idrn-dairy.org

IFCN, International Farm Comparison Network, 2019. IFCN Dairy Report 2019. University of Kiel, Germany. www.ifcndairy.org

Isermeyer, F., Hemme, T. and Holzner, J. 2003. Analysis of international competitiveness of milk production in the framework of IFCN. *Agricultural Economics-Czech*, 49(2): 94-100. https://doi.org/10.17221/5271-AGRICECON

Lips, M, Schmid, D and Jan P. 2013. Labour-use pattern on Swiss dairy farms. Agric. Econ. -Czech, 59(4): 149-159. https://doi.org/10.17221/121/2012-AGRICECON

Ndambi, O.A. and Hemme, T. 2008. An economic comparison of typical dairy farming systems in South Africa, Morocco, Uganda and Cameroon. *Tropical Animal Health and Production*, 41(6): 979-994. https://doi.org/10.1007/s11250-008-9288-1

Richardson, J.W. 1998. Simulation: A tool for decision making. Department of Agricultural Economics, Texas A&M University, Education paper for simulation class.

Sultana, M. N., Uddin, M. M., Riddout, B. G. and Peters, K. J. 2014. Comparison of water use in global milk production for different typical farms. *Agricultural Systems*, 129: 9-21. https://doi.org/10.1016/j.agsy.2014.05.002

Uddin, M.M. and Palash, S.U. 2018. Feeding strategies and optimization of feed costs in different typical dairy farms in Bangladesh. A project report submitted to University Grant Commission.

Uddin, M.M., Akter, A., Khaleduzzaman, A.B.M. and Sultana, M.N. 2020. Forecasting milk production in Bangladesh toward achieving self-sufficiency. *Livestock Research for Rural Development,* 32(5). http://www.lrrd.org/lrrd32/5/moham32081.html

Uddin, M.M., Sultana, M.N., and Khan, M.J. 2017 Impact of dairy support services and strategies on reduction of cost of milk production in different dairy production systems in Bangladesh: Implications for rural livelihood improvement. *Asian Journal of Poverty Studies*, 3(2): 95 – 104

Uddin, M.M., Sultana, M.N., Brümmer, B. and Peters, K.J. 2012. Assessing the impact of dairy policies on farm-level profits in dairy farms in Bangladesh: Benchmarking for rural livelihoods improvement policy. *Journal of Reviews on Global Economics*, 1, 124-138. https://doi.org/10.6000/1929-7092.2012.01.11

Uddin, M.M., Sultana, M.N., Ndambi, O.A., Hemme, T. and Peters, K.J. 2010. A Farm Economic Analysis in different Dairy Production Systems in Bangladesh. *Livestock Research for Rural Development*, 22(7). http://www.lrrd.org/lrrd22/7/uddi22122.htm

Van Chalker, K.J., Berentsen, P.B.M., Giesen, G.W.J. and Huirne, R.B.M. 2005. Identifying and ranking attributes that determine sustainability in Dutch dairy farming. *Agriculture and Human Values*, 22, 53-63. http://dx.doi.org/10.1007/s10460-004-7230-3