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Comparative economic analysis of dairy characteristics focused on repeat breeding losses in selected milk pocket areas of Bangladesh

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Abstract

Dairy farming is an important approach for farmers to increase their incomes and which has a significant contribution to the economy of Bangladesh. The present study describes the dairy characteristics and estimates the financial profitability of dairy farming in selected milk pocket districts of Bangladesh. Following study areas- Sirajganj, Bogura, Rangpur, Satkhira and Munshiganj districts were selected based on the fastest growing dairying, abundant number of dairy farms and contribution in national milk production. Two hundred and sixty-five (265) dairy farms were selected across the study areas and data were collected through direct interview method. The study revealed that dairy herd sizes from the surveyed farms varied from 5 to 19 per farm. Average milk productivity was found 7 to 10 L per cow per day, in which Satkhira district cow's milk productivity per day (10 L/cow/d) and lactation (3,116 L/cow/lactation) was found the highest and Rangpur district was the lowest. On the contrary, significantly (p=0.000) highest milk production per farm per lactation was in the Rangpur district (33,697 L) and the lowest in the Bogura district (9,818 L). Results revealed that statistically (p=0.000) higher income generated in Munshiganj district in terms of per cow per year and/or per day compared to the other milk pocket districts. The study also indicated that repeat breeding cost and unavailable income per farm per year were higher in the Sirajganj district and lowers in the Bogura district. Repeat breeding problems increases the production cost of the animals significantly (p=0.000) and negatively affect the farm profitability of the milk pocket areas in Bangladesh. Annually gross margin and net return per cow were statistically (p=0.000) higher in Munshiganj district. Benefit-cost ratios were found more than one and indicated that benefit is much higher than the cost of production at Satkhira (annual BCR/farm=1.52) and Munshiganj districts (annual BCR/farm=1.50) compared to the other areas (0.27–0.35 units more). Dairy farming provides higher economic benefits to the farmers of Munshiganj and Satkhira districts compared to the other milk pocket districts. The research concludes that there is an ample scope and possibility for sustaining and developing dairy farming in the milk pocket districts of Bangladesh. Overall, it may be suggested that the causes of repeat breeding should be identified and corrected accordingly within the shortest possible time for the betterment of dairying. Also, milk prices should be similar across the milk pocket districts and essential inputs prices should be kept within the affordable purchase range of farmers for sustainable dairying.

Key words: dairy farms, milk production, variable cost, repeat breeding, BCR, profitability

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Introduction

Dairy farming is an important and potential agricultural sector in Bangladesh. The contribution of livestock and fisheries sub-sector is about 35-40% of the overall gross domestic product (GDP) of the agricultural sector. This contribution is about 7-8% of the total GDP, among which around 3.57% comes from fisheries sub-sector and 1.53% from the livestock (MOFL, 2019). More than 70% of the dairy farmers are smallholders and produce around 70-80% of the country's total milk (Uddin *et al*., 2012). The share of livestock in agricultural gross domestic product (GDP) is 13.46% and the contribution of livestock in GDP is 1.47% (DLS, 2019). Bangladesh has 24.08 and 1.485 million of cattle and buffalo, respectively. Cows are the dominating source of milk in Bangladesh and about 95% of the total milk comes from cows, 1% from goat and the remaining 4% from buffalo (DLS, 2019). Approximately 1.4 million dairy farms are in Bangladesh (Hemme *et al*., 2008). Dairying in Bangladesh is a mixed and profitable farming system that contributes as a potent tool

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for developing the micro-economy of villages (Saadullah, 2001). Traditional dairy animal production and farm management are being generally focused on feed and disease management, and artificial insemination adoption, etc. (Quddus, 2013). Besides traditional feeding management, some of the dairy farmers fed concentrates only on the lactating animals (Khan *et al*., 2009).

Analyzing dairy farming especially with a focus on economics is very decisive to assess the farm profitability or benefit-cost ratio. Dairy farming profitability varies across the dairy farms and several studies have already been conducted regarding the profitability of dairy cows (Datta *et al*., 2019; Uddin *et al*., 2012; Ghule *et al*., 2012 and Sikder *et al*., 2009). It was found that production management factors like farm size, high rate of milk production, use of parlors instead of stanchion milking systems and reproductive efficiency (Nebel and Jobst, 1998) had a positive impact on dairy farm profitability. The majority of the dairy farmers (75%) are not conscious about improved insemination for their cows and disease management. About 87% of the farmers adopted artificial insemination at some milk pocket areas of Bangladesh (Khan *et al*., 2013) but there exist repeat breeding problems in cows.

Repeat breeding (RB) is defined as the failure to conceive from three or more regularly spaced services in the absence of detectable abnormalities. RB increases the number of services per conception and delaying conception of cows which influences negatively to calving intervals of animals. As a result, cows become a non-productive state for a period of a long time and economic losses arise (Bartlett *et al*., 1986; Lafi and Kaneene, 1992). Usually, about 9-12% of the cows are expected to be repeat breeders in a herd with normal fertility and with 50-55% conception rates (Zemjanis, 1980). Dairy farming economy largely depends on good conception rates after insemination whereas; RB has been identified as major limitations in profitable dairy farming in Bangladesh (Alam and Gosh, 1988; Islam *et al*., 2017). Recently, dairying is a faster-growing industry in Bangladesh but facing a good deal of challenges, especially due to high input and low output prices. Uddin *et al*. (2012) mentioned that disease, unpredictable milk market, higher prices of drugs, concentrates, and failure of AI were the main limitations to small scale dairy production in Bangladesh.

Milk producers wanted to scale up their milk production capacities through adopting dairy farming on a commercial scale to tap the market opportunities. As a result, many commercial dairy farms have come up in the country (Ghule *et al*., 2012). Investment pattern on a dairy farm largely depends on the returns obtained from them. The relationship between milk production cost and return is studied globally using various methods like cost-benefit analysis (Mburu *et al*., 2007). Reproductive performance is one of the most important factors that affecting dairy farm profitability and the development of the national economy as it is directly or indirectly influences the calf production, milk yield and culling rate (Walsh *et al*., 2011). Bangladesh has some milk pocket areas where farmers give more concentration on dairy animals rearing only (Chowdhury, 2005) but the majority of the farmers do not consider cost-benefit analysis for a repeat breeding. However, scientific literature is very limited regarding the dairy production characteristics, repeat breeding losses and farm profitability among the major milk pocket districts of Bangladesh. That's why current research work was undertaken to make a comparative scenario of different milk pocket districts of Bangladesh in terms of production parameters, feeding practices, cost, income, repeat breeding losses, and overall profits.

Materials and Methods

Study area and data collection

Few districts are known as milk pocket areas of Bangladesh *viz.* Sirajganj, Bogura, Rangpur, Satkhira, and Munshiganj due to the fastest-growing small scale dairying and a good number of dairy farms. This study defines dairy farm size based on the number of dairy cows in the herd such as small farm (1-5 cows), medium farm (6-15 cows) and large farm (more than 15 cows).

Primary data were collected through direct interview method from the dairy farm owners. Before the actual interview; the farmers were given short briefings regarding the nature and purpose of the study. The questions were asked systematically and explanations were made whenever it was felt necessary. The information supplied by the farmers were recorded directly on the interview schedule and checked carefully before leaving the farms. A total of 265 dairy farms having 3824 dairy cows were surveyed in the year 2018-19 from the five selected districts (Sirajganj, 58; Bogura, 48; Rangpur, 94; Satkhira, 40 and Munshiganj, 25 farms) of Bangladesh. Distribution pattern of dairy farms and genotype of cows among the studied areas are presented in Table 1 and 2.

Those cows failed to conceive after three or more services, had normal estrus cycle, free from palpable abnormalities, no abnormal vaginal discharges, delivered at least once before and had less than ten years old are to be considered as repeat breeder. The distribution pattern of repeat breeder dairy cows among the studied areas is shown in Table 3.

Table 1: Distribution pattern of dairy farms in the study areas

Selected districts	Farm Size			Total (No.)
	Small (No.)	Medium (No.)	Large (No.)	
Bogura	33	15	0	48
Sirajganj	2	15	41	58
Rangpur	19	35	40	94
Satkhira	3	30	7	40
Munshiganj	8	12	5	25
Total farms number	65	107	93	265
% of total farm	24.53	40.38	35.09	100.0

Small farm, 1-5 cows; medium farm, 6 -15 cows and large farm, >15 cows.

Calculation of farm profitability

This study considered feed, labor, housing, AI, veterinary and preventive care costs under the cost calculation category and sales value of milk, cow dung, empty gunny bags, and culled calves as a return from the dairy farm (Halder and Barua, 2003). The total cost of milk production consisted of total fixed cost (TFC) and total variable cost (TVC). In this study, TFC belongs to depreciation cost on housing that covering the interest cost and which was 10 percent per annum. Total variable cost includes the cost of roughage (green grass and straw), concentrates (wheat bran, rice polish, pulse bran, oil cakes, common salt, molasses, vitamin and mineral premix, etc.), labor (unpaid family labor also priced at the existing market wage rate), prevention and treatment (deworming and vaccinations, and medicine, respectively) and AI.

The return from dairy farming was calculated in terms of gross return and net return. Gross return of dairy farming was considered as the sum of income from selling milk, cow dung, calves, and empty gunny bags. Information on return from milk sales is collected on a daily basis and then converted to a liter per cow per month and year. The net profit margin was calculated by deducting the total cost of production from gross return and then calculated on per farm and per cow basis. In addition, the benefit-cost ratio was also calculated by dividing the total return by the total cost. It is a relative measure that is to be used to compare the benefit of the per-unit cost of production.

Estimation of cost, income and losses from repeat breeding cow

The calculations of yearly unavailable income of repeat breeder (RB) cows were considered alike income of healthy breedable lactating dairy cows. Yearly losses of high yielding RB cows were the sum of the total rearing cost of the cow and total unavailable income of the RB cows. For calculating life losses of RB cows and farms, firstly calculated the yearly losses for RBC and then calculated yearly losses of farm-based on RB cows present per farm. Here, the life of cow means their average productive life which estimated from the average productive life of a cow which is considered eight years (Cooper, 1909). In this study, all the losses in the life of cows and farms were calculated in eight years of productive life.

Statistical analysis

The collected data were compiled, tabulated and analyzed based on the objectives of the study following one-way ANOVA with descriptive statistics by SPSS version-16 (SPSS Inc. Chicago, USA). Tukey's HSD test was also used to determine the significance of differences among the district means.

Results and Discussion

Comparative scenario of dairy production characteristics

Dairy characteristics in milk pocket areas of Bangladesh are presented in Table 4, which represent general information regarding the farm size, the number of lactating cows with their lactation length, productive and reproductive performance, value of farm inputs (price of concentrate mixture, green grass, and rice straw, etc.) and outputs (milk, calf, cow dung and gunny bags, etc.). This study indicates that average farm size (i.e., number of cow per farm) and lactating cow numbers were significantly ($p=0.000$) altered among the studied areas. Average cow numbers per farm were higher in the Sirajganj district and lowers in the Bogura district, and this variation is occurred due to the facts of lower numbers of small size farm (1-5

cows) at Sirajganj district and more numbers at Bogura district (Table 1). Farm size was found similar ($p>0.05$) in between Satkhira and Munshiganj districts. Though farm size was higher in the Sirajganj district but per farm lactating cow numbers was found numerically highest in the Rangpur district and the lowest in the Bogura district (Table 4). Very recently, Datta *et al*. (2019) carried out a study regarding the economic analysis of dairy farming in Bangladesh and found an average herd size of 6.77. In another study, Saadullah and Hossain (2000) stated that the smallholder dairy farms in Bangladesh owned on an average 2.9 cattle per farm, medium households own 3.7 cattle per farm, and the large households own 4.4 cattle per farm in Bangladesh. Average milch cow of small, medium and large dairy farms of Bangladesh were reported to be 1.34, 4.25 and 7.30, respectively (Datta *et al*., 2019).

The result revealed that average milk production per cow per day ranged from 7.06 to 10.33 L among the studied milk pocket areas of Bangladesh. Per day cow milk productivity was found statistically ($p=0.000$) higher in the Satkhira district and the lowest in the Rangpur district (Table 4). Similarly, lactation milk yield per cow was also found significantly ($p=0.000$) higher in Satkhira district (3116 L/cow/lactation) and lower in Rangpur district (2080 L/cow/lactation) which may be due to higher daily milk yield and seven day longer lactation period (302 days) of the dairy animals in the Satkhira district than that of the Rangpur district. It is noteworthy to mention that more percentages (99%) of high yielding crossbred cows were found in the Satkhira district which was 91% in the Rangpur district. Moreover, the proportions of the non-descriptive cows were more in the Rangpur district compared to the other districts (Table 2).

Though Rangpur district had shorter lactation length and lower (3.3 L) daily milk yield than the Satkhira district but average production per lactation per farm was higher in Rangpur district. Probable causes of such variation may be due to farm size, lactating cow numbers and lactation length in the respective districts. In case of per farm productivity comparison, significantly ($p=0.000$) higher per day per farm milk yield was found in both Sirajganj and Rangpur districts (114 L) compared to the others, and lower found in Bogura district (33 L). This higher trend of milk yield per farm of respective districts may be due to high yielding genotypes (Holstein-Friesian and Jersey crossbred) of cows (Table 2). According to Hossain *et al*. (2005), milk yield per lactation for crossbred and indigenous cows of Rangpur district was 1210 and 358 L, respectively. There is a wide numerical variation from the current finding within the same district that might be due to changing of years and increasing good numbers of high yielding genotype of milch animals. Table 4 also showed that the average RB cow's number per farm was statistically higher in Sirajganj districts and lower in the Bogura and Munshiganj districts. But the ratio of several RB cows compared to the total number of lactating cows was found statistically higher in Satkhira (44%) and Sirajganj (35%) districts followed by Bogura (31%), Rangpur (20%) and Munshiganj district (16%).

Table 2: Distribution pattern of dairy cows in the study areas

Selected districts	**Total farms** (No.)	**HFX** (No.)	**JX** (No.)	**ShX** (No.)	**Non-descript** (No.)	**Total cows** (No.)
Bogura	48	192	41	10	2	245
Sirajganj	58	865	267	0	0	1132
Rangpur	94	980	558	67	84	1689
Satkhira	40	380	105	2	0	487
Munshiganj	25	190	57	14	10	271
Overall numbers	265	2607	1028	93	96	3824
% of total cows		68.18	26.88	2.43	2.51	100.0

HFX, Holstein-Friesian crossbred; JX, Jersey crossbred and ShX, Sahiwal crossbred.

Table 3: Distribution pattern of repeat breeder cows in the study areas

Selected districts	Total farms (No.)	HFX (No.)	JX (No.)	ShX (No.)	Non-descript (No.)	Total cows (No.)
Bogura	48	66	9	1	0	76
Sirajganj	58	304	91	0	0	395
Rangpur	94	195	106	14	22	337
Satkhira	40	173	42	1	0	216
Munshiganj	25	36	7	0	0	43
Overall numbers	265	774	255	16	22	1067
% of total respective genotype		29.69	24.80	17.20	22.92	27.90

HFX, Holstein-Friesian crossbred; JX, Jersey crossbred; ShX, Sahiwal crossbred.

Service per conception required a higher per cow level in almost all studied areas (>3.50) except Rangpur district (3.10) (Table 4). This finding is supported by Hossain *et al*. (2005) who studied crossbred and indigenous cows of Rangpur district and found 3.10 and 1.95 services per conception, respectively. Table 4 indicates that prices of farm inputs were lower and outputs were higher in Munshiganj district than other milk pocket areas of Bangladesh. It was noticed that milk prices ranged from 38 to 45 Tk. throughout the studied areas and prices of milk, calf and cow dung were significantly (p=0.000) highest in Munshiganj district. Green grass price was slightly higher in Munshiganj district (2.00 Tk./Kg) and, lowers in both Bogura and Rangpur districts (0.99 Tk./Kg). Again, rice straw price was 70% higher in Bogura and Sirajganj districts compared to the Satkhira and Munshiganj districts. As rice straw are being widely used as basal feed for livestock in Bangladesh (Khan *et al*., 2009) that's why the price of this straw fluctuated throughout the country depending on the season and paddy production in the area. In these studied areas, concentrate mixture price varied from 31 to 34 Tk. per Kg. According to Datta *et al*. (2019), concentrate feed and capital cost significantly influence the profitability of a farm and feed prices are more or less similar to the current findings.

Milk pocket area wise profitability of dairy farms regarding the cost and returns are worked out in Table 5. This analysis was done regarding the major milk pocket districts of the country to have a better insight into dairy production economics in Bangladesh. Fixed cost has differed among the selected districts of Bangladesh and significantly found higher in the Satkhira district. In this, the inclusion of depreciation or appreciation precision value of livestock and depreciation on farm machineries, utensils, and equipment could improve the precision of financial statements. However, the collection of these data depends on the practical challenges prevails in field condition.

Except for concentrate feed and labor costs, the majority of the variable costs per farm were found statistically higher in the Sirajganj district and the lowest in the Bogura district compared to the other studied areas. These higher variables cost may be due to scarcity of available feed ingredients, large farm size and intensive rearing of high yielding crossbred (HFX and JX) lactating animals (Table 2). Thus, variable costs influences significantly (p=0.000) to the total costs of each farm per year. It was recorded that yearly total farm feed cost comprises about 78, 86, 90, 85 and 76 percentages of total variable cost at Bogura, Sirajganj, Rangpur, Satkhira and Munshiganj districts, respectively (Table 5). This result is very similar to Shamsuddin *et al*. (2006) who mentioned that feed cost ranges from 52.5 to 92.1 percentages of the total cost. Other findings indicated that feed cost for the smallholder dairying was 59% (Hossain *et al*., 2005) and 50% (Alam *et al*., 1999), respectively. Labor cost was lower in Rangpur district which may be due to the availability of labourers within the cheapest cost. About 71% of treatments, medication, and AI costs are lower in the Bogura district than that of the Sirajganj district which might be due to good husbandry practices and indicated that animals were maintained at good hygienic environment.

Table 4: Comparison of dairy characteristics, milk, calf, cow dung and gunny bags prices in some selected milk pocket districts of Bangladesh

Parameters	Bogura (n=48)	Sirajganj (n=58)	Rangpur (n=94)	Satkhira (n=40)	Munshiganj (n=25)	p-value
Avg. farm size (No. of cow/farm)	5.10^{d}±2.50	19.52^{a}±7.46	17.96^{a}±5.73	12.18^{c}±6.41	10.84^{c}±10.80	0.000
Lactating cow (No./farm)	4.15^{c}±2.02	15.64^{a}±5.96	16.21^{a}±5.19	9.78^{b}±5.15	8.72^{b}±8.64	0.000
Lactation length (days)	297.08^{ab}±12.71	290.52^{b}±16.69	294.71^{ab}±14.33	301.75^{a}±6.36	300.00^{a}±0.00	0.000
Milk production (L/cow/d)	7.98^{c}±1.31	7.41^{d}±0.96	7.06^{d} ±0.61	10.33^{a}±1.33	9.20^{b}±0.65	0.000
Milk production (L/farm/d)	33.08^{c}±16.63	114.41^{a}±40.89	114.41^{a}±37.16	101.03^{a}±53.42	80.40^{b}±79.50	0.000
Milk production (L/cow/lactation)	2,365.20^{c}± 370.30	2,154.30^{d}± 312.80	2,080.00^{d}± 203.30	3,116.50^{a}± 415.90	2,760.00^{b}± 193.60	0.000
Milk production (L/farm/lactation)	9,818^{c}±5,025	33,219^{a}±12,221	33,697^{a}±1,106	30,483^{a}±16,066	24,132^{b}±23,839	0.000
Avg. repeat breeder cow (No./farm)	1.58^{bc}±0.69	6.81^{a} ±2.92	3.58^{b} ±0.81	5.53^{b} ±1.77	1.72^{b}±1.12	0.000
Avg. service per conception/cow	3.54^{b}±0.54	4.47^{a}±1.46	3.10^{c}±0.13	4.32^{a}±1.32	4.28^{a}±1.28	0.000
Avg. price of milk (Tk./L)	42.00^{c}±0.00	42.00^{b}±0.00	40.00^{d}±0.00	38.00^{e}±0.00	45.00^{a}±0.00	0.000
Avg. calf price (Tk./calf)	45,000^{a}±0.00	26,983^{d} ±3,827	30,157^{c}±3,184	38,975^{b}±3,893	46,840^{a}±3,997	0.000
Cow dung price (Tk./Kg)	1.00^{d}±0.00	1.25 ^{b}±0.00	1.17^{c}±0.21	1.00^{d}±0.00	1.50^{a}±0.00	0.000
Empty gunny bag price (Tk./Kg)	11.88±1.58	12.103±1.76	11.843±1.67	11.925±1.75	12.00±1.96	0.941
Green grass price (Tk./Kg)	0.99^{d} ±0.11	1.88^{b}±0.30	0.99^{d}±0.10	1.50^{c}±0.00	2.00^{a}±0.00	0.000
Straw price (Tk./Kg)	5.00^{b}±0.00	5.00^{a}±0.00	3.00^{c}±0.00	1.50^{e}±0.00	1.50^{d}±0.00	0.000
Concentrate mixture price (Tk./Kg)	33.00^{a}±1.95	31.55^{b}±1.49	33.40^{a}±1.8	33.20^{a}±1.94	32.60^{ab}±2.00	0.000

n= Number of farms.
^{abcd}Mean values in a row with uncommon superscript differed significantly.

Total production cost per cow per day was found 27% higher at Bogura district compared to the Sirajganj district (Table 5). In Sirajganj district, the density of dairy animals is much higher and per cow per year and/or per day costs were significantly lower compared to other districts of Bangladesh. Such lowering costs might be due to the availability of green grass in *bathan* areas and poorly fed concentrate mixture to the dairy cows. It is proved that feed cost is about 65-70% of the total cost of dairy animal rearing (Khan *et al*., 2009) but dairy animals of Sirajganj district are generally managed by *bathan* feeding system where concentrate mixture supplied little amount that might reduce the total cost of dairy animal production. On the contrary, yearly total production cost per farm was found highest in Sirajganj districts followed by other districts which may be due to variation of farm size, rearing of high yielding crossbred cows, cost items, the occurrence of repeat breeding, treatment, medication and AI cost. The income of the dairy farms is generally generated from the selling of farm outputs like milk, calves, gunny bags and cow dung (Table 5). It was found that yearly total income per farm was significantly ($p<0.05$) higher in Sirajganj district compared to the other districts and lower found in Bogura district which due to selling higher amount of milk, gunny bags, calves and cow dung (Table 5).

Table 5: Variations in fixed cost, variable cost, total cost, income, repeat breeding loss, profit and BCR of dairy farms in some selected milk pocket districts of Bangladesh

Parameters	Bogura (n=48)	Sirajganj (n=58)	Rangpur (n=94)	Satkhira (n=40)	Munshiganj (n=25)	p-value
A) Fixed cost						
Depreciation on housing (Tk./farm/yr.)	680.30^{c} ± 220.40	8,321^{a} ± 2,784	5,338^{b} ± 1,773	9,783^{a} ± 17,492	5,396^{ab} ± 3,936	0.000
B) Variable cost						
Concentrate mixture (Tk./farm/yr.)	3,11,626^{d} ± 1,72,913	10,36,455^{ab} ± 39,860	11,05,297^{a} ± 3,81,639	7,13,931^{c} ± 3,79,366	7,10,713^{c} ± 6,71,529	0.000
Rice straw (Tk./farm/yr.)	90,451^{bc} ± 45,273	3,16,745^{a} ± 1,37,651	1,88,713^{ab}± 56,986	1,00,192^{b} ± 60,243	70,165^{bc} ± 65,853	0.000
Green grass (Tk./farm/yr.)	17,683^{c} ± 8,100	39,615^{b} ± 19,870	64,758^{a} ± 22,687	71,770^{a} ± 36,668	28,205^{c} ± 25,447	0.000
Total feed cost (Tk./farm/yr.)	4,19,760^{cd} ± 2,24,546	13,92,815^{a} ± 5,34,107	13,58,765^{ab} ± 45,017	8,85,893^{ac} ± 4,66,927	8,04,771^{acd} ± 7,63,690	0.000
Treatment and AI cost (Tk./farm/yr.)	13,650^{b} ± 7,079	46,318^{a} ± 18,851	45,666^{a} ± 18,590	35,970^{a} ± 19,532	31,200^{a} ± 28,068	0.000
Labor (Tk./farm/yr.)	1,06,000^{bc} ± 10,527	1,70,379^{b} ± 71,736	1,00,978^{b} ± 34,361	1,21,350^{b} ± 37,247	2,22,720^{a} ± 1,58,899	0.000
Total variable cost (Tk./farm/yr.)	5,39,410^{c} ± 2,31,543	16,09,513^{a} ± 6,04,309	15,05,410^{a} ± 4,82,411	10,43,213^{b} ± 4,91,571	10,58,691^{b} ± 9,40,501	0.000
Total cost (A+B)						
Total cost (Tk./farm/yr.)	5,40,090^{c} ± 2,31,464	16,17,834^{a} ± 6,05,622	15,10,749^{a} ± 4,83,276	10,52,996^{b} ± 4,93,178	10,64,087^{b} ± 9,44,262	0.000
Total cost (Tk./cow/yr.)	1,05,900^{a}± 45,385	83,635^{b} ± 9,301	84,270^{b} ± 6,776	88,423^{ab} ± 8,938	98,163^{ab} ± 87,109	0.012
Total cost (Tk./cow/d)	290.10^{a} ± 124.30	229.14^{b} ± 25.48	230.88^{b} ± 18.56	242.25^{ab} ± 24.49	268.90^{ab} ± 238.70	0.012
Income						
Milk sale (Tk./farm/yr.)	4,12,324^{b} ± 2,11,082	13,95,189^{a}± 5,13,283	13,47,906^{a} ± 4,42,752	11,58,335^{a} ± 6,10,507	10,85,940^{a} ± 10,72,748	0.000
Calves sale (Tk./farm/yr.)	1,86,563^{b} ± 90,947	4,13,638^{a} ± 160,557	4,85,585^{a} ± 1,51,172	3,79,425^{a} ± 2,05,146	4,00,080^{a} ± 3,86,535	0.000
Gunny bag (Tk./farm/yr.)	3,083^{c} ± 1,449	12,964^{a} ± 5,905	11,250^{a} ± 5,048	6,405^{b} ± 3,422	5,574^{b} ± 5,293	0.000
Cow dung (Tk./farm/yr.)	21,102^{cd} ± 11,167	1,03,844^{a} ± 39,325	86,307^{ab}± 30,990	52,733^{bc} ± 32,301	2,06,475^{a} ± 1,04,478	0.000
Total Income (Tk./farm/yr.)	6,23,071^{b}± 3,10,741	19,25,635^{a} ± 6,89,125	19,31,049^{a} ± 6,06,213	15,96,898^{a} ± 8,36,689	15,96,072^{a}± 15,53,662	0.000
Total Income (Tk./cow/yr.)	1,24,566^{b} ± 25,256	1,00,042^{c} ± 11,000	1,07,751^{c} ± 7,547	1,31,237^{b} ± 12,986	1,46,007^{a} ± 16,157	0.000
Total Income (Tk./cow/d)	341.28^{b} ± 69.20	274.09^{c} ± 30.14	295.21^{c} ± 20.68	359.55^{b} ± 35.58	400.02^{a} ± 44.26	0.000
Repeat breeding loss						
a) Cost (Tk./RBC/d)	291.56^{a} ± 51.56	229.00^{b} ± 25.56	230.65^{b} ± 18.57	240.88^{b} ± 24.98	285.04^{a} ± 28.16	0.000
b) Cost (Tk./farm/yr.)	24,701^{c} ± 9,896	1,43,041^{a} ± 64,305	47,016^{b} ± 11,367	91,886^{a} ± 39,629	1,00,122^{a} ± 34,476	0.000
c) †Unavailable income (Tk./RBC/d)	345.52^{b} ± 65.31	275.62^{c} ± 30.16	295.04^{c} ± 20.63	359.40^{b} ± 35.55	399.88^{a} ± 44.24	0.000
d) †Unavailable income (Tk./farm/yr.)	29,402^{c} ± 12,410	1,68,304^{a} ± 72,598	60,054^{b} ± 14,275	1,37,963^{a} ± 60,587	1,48,995^{a} ± 51,953	0.000
a+c) Loss (Tk./RBC/d)	637.10^{b} ± 107.90	504.62^{c}± 53.19	525.69^{c} ± 34.76	600.27^{b} ± 46.09	684.92^{a} ± 42.57	0.000
Loss (Tk./farm/d)	1,053.10^{d}± 442.80	4,384^{a} ± 1,137	2,584^{bc} ± 448	3,308^{ab}± 1055	1,205^{d} ± 6,83	0.000
b+d) Total loss (Tk./farm/yr.)	54,102^{d} ± 21,972	3,11,344^{a} ± 1,31,692	1,07,070^{c} ± 25,370	2,29,848^{b}± 9,90,09	2,49, 117^{b} ± 84,683	0.000
Total loss (Tk./farm/ life)	4,32,819^{d} ± 175779	24,90,754^{a} ± 10,53,534	8,56,564^{c} ± 2,02,968	18,38,786^{b} ± 7,92,070	19,92,940^{b} ± 6,77,465	0.000
Profit						
Gross margin (Tk./farm/yr.)	1,22,798 ± 83,661^{d}	3,16,123^{bc} ± 1,28,745	4,25,638^{ab} ± 3,295	5,53,685^{a} ± 3,76,233	5,37,381^{a} ± 6,56,789	0.000
Gross margin (Tk./cow/yr.)	16,404^{b} ± 24,078	16,195^{b} ± 6,596	23,687^{b} ± 9,354	45,459^{a} ± 30,889	49,574^{a} ± 60,589	0.000
Net return (Tk./farm/yr.)	82,981^{d} ± 122,828	3,07,801^{bc} ± 1,27,595	4,20,300^{ab} ± 1,67,530	5,43,902^{a} ± 3,74,550	6,53,343^{a} ± 5,31,985	0.000
Net return (Tk./cow/yr.)	16,271^{b} ± 24,084	15,769^{b} ± 6,537	23,390^{b} ± 9,323	44,655^{a} ± 30,751	60,272^{a} ± 49,076	0.000
Benefit cost ratio (BCR)						
BCR per farm per yr.	1.15	1.19	1.27	1.52	1.50	-
BCR per cow per yr.	1.18	1.20	1.27	1.48	1.49	-
BCR per cow per day	1.17	1.19	1.28	1.48	1.49	-

n, Number of farms; BCR, benefit-cost ratio. ^{abcd} Mean values in a row with uncommon superscript differed significantly. †Unavailable income calculated considering the cow generates equal amount of income alike sound breedable cow but cannot be attained due to repeat breeding problem.

Generally, the income of the dairy farms depends upon herd size, animal productivity like daily milk yield and lactation length, and prices of all output items. In this study, numerically higher income was found in Munshiganj district considering per cow in both per year and per day whereas, significantly lower income was derived from Sirajganj district that due to more RB cows in Sirajganj district (Table 3).

Economic losses due to repeat breeding are also presented in Table 5 and the result revealed that daily losses per RB cow was found statistically (p=0.000) higher in Munshiganj district and, the lowest in both the Sirajganj and Rangpur areas that might be due to higher amount of unavailable income per day. Yearly cost and unavailable income per farm were much higher in the Sirajganj district which might be due to more numbers of RB cow (avg. 6.8) per farm (Table 4).

Cost and unavailable income per RB cow per day were significantly (p=0.000) higher at Munshiganj district compared to the other milk pocket areas. In the case of per farm per year and per life of cow comparison, it can be seen that higher monetary value losses occurred in the Sirajganj district and lower in the Bogura district (Table 5). As RB cows consume alike sound breedable cow, takes more service per conception, prolonged calving interval, treatment and medication; so, repeat breeding negatively affected the lifetime milk production of cows and income of a dairy farm. Similar evidence was given by Shah *et al*. (1991) who reported that income of any farm could be maximized through shorting of calving intervals and its vice-versa.

Generally, gross margin and net return positively correlated with the herd size of dairy farm (Datta *et al*., 2019) because large herd size reduces the per-unit cost of production. In this study, the average herd size of Bogura, Sirajganj, Rangpur, Satkhira, and Munshiganj areas was 5.10, 19.52, 17.96, 12.18 and 10.84, respectively (Table 4). Again, the milk pocket district-wise analysis of the current study depicted that yearly gross margin was significantly higher (p=0.000) in both Satkhira and Munshiganj districts compared to the other district and lowers in the Bogura district. Similarly, net return per farm per year and per cow per year was higher in the Munshiganj district (Table 5). Though herd size is more in Sirajganj and Rangpur districts but found lower gross margin and net return per farm in these areas that due to more number of RB cows (Table 3). Production cost is closely related to the net return of farm and minimum production costs can be achieved through intensive grazing, lower supplemental grain feeding, less labor for feeding and barn cleaning, lower treatment and medication cost (Hanson *et al*., 1998; Jackson-Smith *et al*., 1997).

Benefit-cost ratio (per farm per yr.) for Bogura, Sirajganj, Rangpur, Satkhira and Munshiganj districts were 1.15, 1.19, 1.27, 1.52 and 1.50, respectively; which indicated that dairy farming was profitable. Again, BCR per cow per year or day comparison indicated that dairy farms of the Munshiganj and Satkhira districts were more profitable than the other districts. Similarly, Sikder *et al*. (2009) studying the economics of community dairy farming in the Satkhira district and found benefit-cost ratios were 1.80, 1.62 and 1.71 for community member farmers, non-members and all categories of dairy farmers, respectively.

Conclusion

The productivity of cattle in terms of milk production per milch cattle per day was found higher in the Satkhira district followed by Munshiganj, Bogura, Sirajganj and Rangpur districts. The benefit-cost ratio, gross profit margin, and net profit return indicated that dairy farming is more profitable in both Munshiganj and Satkhira areas. Both the Bogura and Sirajganj districts are in poorest conditions in terms of profitability of dairying and that arises due to the incidence of more repeat breeding. Repeat breeding negatively affects the farm profitability and losses due to repeat breeding are greater in Sirajganj district compared to the other milk pocket district in Bangladesh. It can be recommended from the study that causes of repeat breeding should be identified and interventions need to be adopted to overcome such problems from the study areas. Besides these, the price of milk should be homogeneous over the milk pocket districts and the government should take appropriate measures for the dairy farmers; so that they are afforded to manage the essential inputs (e.g.: feed, medication, and treatment) for sustainable dairy animal production.

Conflict of interest

The authors have no conflict of interest to declare.

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