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The Ripple Effect of COVID-19: Analyzing Challenges Faced by Smallholder Dairy Farmers in Cox's Bazar, Bangladesh

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Context: As an important subsector of agriculture, livestock sector significantly contributes to the national economy of Bangladesh. This subsector contributes 1.85% of national gross domestic product (GDP) whereas it shares 16.52% in agricultural GDP and provides 20% employment directly and 50% indirectly for the country population. Moreover, COVID-19 created a serious negative impact in all sectors worldwide. Around 0.3 million dairy farms suffered the bad luck that came with this circumstance in our country.

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Aims: The study aimed to show the socio-economic impact of COVID-19 on smallholder dairy farmers, estimate the comparative profitability of dairy farm owners before and during the pandemic along with identify the problems faced by dairy farmers during the COVID-19 pandemic period.

Methods: On the basis of available information, a total of 31 dairy farms were selected following convenient sampling technique from Cox's Bazar Sadar, Ukhia, Ramu and Moheshkhali upazila under Cox's Bazar district of Bangladesh through a pre-designed questionnaire. Descriptive, statistical and econometric analysis were carried out to achieve the objectives.

Results: This study identified a remarkable change in the selected farms' net return, gross margin, and BCR (Benefit Cost Ratio). The net return of the farms decreased from BDT (Bangladeshi taka) 27,796.36 to BDT 8,512.39, whereas the gross margin reduced from BDT 16,531.04 to BDT 4,463.76 as the post-COVID-19 impact. This result also revealed that the average difference in feed cost during and before the COVID-19 period was BDT 1,531.08, and the average reduction in monthly farm income due to COVID-19 was BDT 74,429.03 (*P*<.0001). This study also identified 12 major problems faced by the farmers due to COVID-19, which were ranked according to problem indices. Fall in milk price, constraints on dairy milk marketing, and high cost of concentrate feed were highlighted among the problems faced by the farmers. These changes had a direct health impact on farmers since disruptions in income and food supply chains resulted in decreased access to nutritious food, affecting farmers' physical health.

Conclusion: We recommend that the Government and other agencies should focus on multipurpose cash support to pandemic affected vulnerable dairy farmers to minimize their losses in future.

Keywords: BCR; COVID-19; dairy farming; net return; smallholder dairy farmers.

1. INTRODUCTION

Global pandemics emerged as the greatest threat to long-term human survival from time to time. Millions of people died throughout human history, and the global economy collapsed due to pandemics. The world has already experienced with a new pandemic, the Corona Virus Disease of 2019 (COVID-19). Severe Acute Respiratory Syndrome Coronavirus 2 causes COVID-19, an infectious disease (SARS-CoV-2) (Acter et al. 2020). The first verified case of COVID-19 was discovered in Wuhan (the capital of China's Hubei province), the epicenter of the coronavirus outbreak (Roosa et al. 2020). The disease was spreading rapidly among people due to the peculiarity of this virus strain. The World Health Organization (WHO) labeled the COVID-19 a global pandemic on March 11, 2020 (Cucinotta Vanelli 2020). COVID-19 and had an unpredictable threat on societies and economies. This pandemic has greatly impacted agricultural sectors worldwide (Barichello 2020). Widespread health crises severely affected the economy in various ways, e.g., production shortage (Keogh-Brown et al. 2020), panic buying and changes in consumer behavior (Siu and Wong 2004), contraction in producers' operative margins (Park et al. 2008) and unpredictable effects on national and international trade flows due to logistic rules and variability in exchange rates (Schmidhuber et al. 2020).

The dairy sector within agriculture in developing countries suffered the most for two basic reasons: Firstly, milk and dairy products are highly perishable. Secondly, as milk has a specific shelf life and is a good media for bacteria, it highly depends on an integrated and time-sensitive supply chain (Atkins 1992). Though the virus itself did not affect the dairy supply chain, the measures taken to contain it, e.g., lockdown, movement restrictions, and social distancing measures, did.

Bangladesh, the COVID-19 pandemic In confirmed on March 8, 2020 (Alam and Khatun 2021). Day by day, infection rates went up geometrically. After the outbreak began, the Government announced strict lockdown. movement restrictions, and social distancing measures to control the spread of the disease (Shammi et al. 2021). Such lockdown and restrictions had a direct and significant impact on the livestock sector. Interestingly, the disruptions came not only from the supply side but also the demand side due to economic contraction and loss of livelihoods. According to a recent study published by IMF (International Monetary Fund), though the lockdown was useful in preventing the spread of the disease, the average global economy fell by 5% in 2020 (Enserink and Kupferschmidt 2020). Such a reduction in income forced the consumers to shift towards cheaper and less nutritious foods, (Laborde et al. 2020)

and as a result, the dairy sector became vulnerable.

In Bangladesh, the dairy sector is dominated by smallholder producers. There is an estimation that there are about 1.4 million dairy farms with an average herd size of 1-3 cows (Hemme et al. 2014). and these smallholders produce around 70-80% of the country's total milk (Uddin et al. 2021) However, these vulnerable smallholder dairy producers/farmers faced severe financial pressure from market disruptions. likewise other sectors. due to COVID-19 restrictions. Consequently, the livelihoods of the smallholders got affected (Uddin et al. 2021) and the ripple impact resulted in the rise in poverty, food insecurity, and malnutrition to a serious level.

This research was carried out in Cox's Bazar, a coastal district of Bangladesh. It is a densely populated city and the most prominent tourist destination in Bangladesh (Fatema et al. 2018) and that's why it would represent the scenario of whole country in less or great extent. COVID-19 prevalence was very high in this city due to overpopulation, and that's why, the lockdown method was strictly enforced. This stringent movement restriction had a significant effect on Cox's Bazar's economy, particularly the dairy industry, since there are a huge number of dairy farms in this coastal area. Due to the movement restriction, the unsold milk, the feed expense, and the transportation risks rose to a higher level. As a result, the smallholder dairy farmers' vulnerability took a new shape during the pandemic in the coastal area of Cox's Bazar.

A few studies have been done to determine the effects of the pandemic on dairy farmers (Rahman and Das 2021, Uddin et al. 2012, Uddin et al. 2012). But no research has been performed on smallholder dairy farmers in the coastal region (Cox's Bazar) of Bangladesh. So, this study was designed to fill up this research gap to expand the existing knowledge about the effects of the pandemic on the dairy sector in Bangladesh. The study aimed to show the socio-economic impact of COVID-19 on smallholder dairy farmers and to estimate the comparative profitability of dairy farm owners before and during the pandemic. The study also identified the problems faced by dairy farmers during the COVID-19 pandemic period.

2. METHODOLOGY

2.1 Study Area and Sample Size

The study was conducted in mainly four upazilas named Cox's Bazar Sadar, Ramu, Ukhiya and

Moheshkhali under Cox's Bazar district. Bangladesh (Fig. 1). All the smallholder dairy farmers located in Cox's Bazar district were classified as the population of this study. A suggestion of (Casley and Kumar 1988) was, the sample should have minimum sampling and standard error which could be obtained by unlimited resources. But the sample size also depends on some issues like finance, time, and data management (Poate and Daplyn 1993). Here, a total of 31 dairy farms were selected by convenient sampling from Cox's Bazar district due to a short study period. In each farm, there were at least 4 dairy cows.

2.2 Data Collection

A pilot survey schedule was prepared to record desired information and confirm the study objectives. Then the survey was modified and rearranged based on experience gathered in the pilot test. The data were collected through an appropriate pre-designed questionnaire from 5 February 2021 to 9 May 2021. Information regarding socio-demographics, livestock assets, feed cost, housing cost, treatment cost, labor cost, and major problems faced during the pandemic were collected from the farmers in person using questionnaire.

2.3 Data Analysis

After data collection, the questionnaires were checked for completeness, cleaned, organized, coded and then entered into MS-Excel and STATA (Stata 14, Stata Statistical Software, Stata Corporation, College Station, Texas 77845 USA) for analysis. To attain the study goals, descriptive, statistical, and econometric analysis was performed. Descriptive method was used to identify the socio-economic characteristics of dairy farm owners.

2.3.1 Cost estimation

Operating cost: Feed cost, labor cost, medicine and treatment cost, electricity, gas, etc. were included under operating cost.

Interest on operating capital and total variable cost: The bank interest rates (4%) (Bangladesh 2021) were used to estimate the cost of capital which was provided by them and used as working capital.

Interest on operating capital= (Operating capital*0.04)/2

Total variable cost (TVC) =Operating capital + Interest on operating capital.

Fixed cost: Depreciation cost of house and equipment were included under fixed cost.

Cost of housing and equipment: The cost of housing and equipment was calculated by considering the depreciation cost of both housing and equipment. Depreciation cost on house and equipment was worked out as follows:

$$Depreciation = \left[\frac{Original \quad value - Salvage \quad value}{Life \quad of \ the \ house \ or \ equipment} \right]$$
(1)

2.3.2 Return estimation

To determine the profitability of per dairy cow, we followed the following algebraic equations

$$\Sigma \operatorname{GR} = \Sigma(QyPy + QzPz) \tag{2}$$

$$\Sigma GM = \Sigma (QyPy + QzPz) - \Sigma PxiXi$$
(3)

Profit (π) = Σ GR- Σ GM

$$= \Sigma(QyPy + QzPz) - \Sigma PxiXi - TFC$$
 (4)

BCR (Full cost basis) =
$$GR / GC$$
 (5)

BCR (Cash cost basis) =
$$GR / TVC$$
 (6)

Where,

GR and GM represent, Gross Return and Gross Margin, respectively.

π= Profit/Net return per dairy cow (BDT);
Qy= Total quantity of milk yield (liter)
Py= Per unit price of milk (BDT/liter);
Qz=Total unit of calf selling;
Pz=Per unit price of a calf;
Xi= Quantity of the concerned ith inputs;
Pxi= Per unit price of the relevant ith inputs;
TFC= Total fixed cost involved in production;

TVC= Total variable cost;

- BCR= Benefit- cost ratio;
- i= 1,2, 3.... n (number of inputs).



Fig. 1. Study area

2.4 Paired T-test

Paired t-test was used to compare the means of two samples when each observation in one sample could be paired with an observation in the other sample. In this study, Paired t-test was used to compare the means of feed cost and milk price of per cow, and monthly income of dairy farm household before (2019) and during (2020) covid-19 effect. To calculate the test statistics hypotheses mentioned below were followed.

 H_0 : There is no difference in means before and during COVID-19 effect.

H₁: There is a difference in means before and during COVID-19 effect.

The test value t formula is with d.f. (n-1).

$$t = \frac{\mu_D}{S_D / \sqrt{n}} \tag{7}$$

n= Sample size μ_D =Mean differences $S_{D=}$ the standard deviation of the difference

The expected value μ_D is zero if the hypothesis is $\mu_D = 0$. The confidence interval of the difference in the paired mean difference.

2.5 Likert Scale

For measuring the problem indices of the dairy farmers during COVID-19 situation, a 4-point Likert Scale was used. The scales were weighted in order of importance from; high=4, moderate=3, low=2 and very low=1. The respondents were asked to identify problems in dairy farming. Ranking different problems faced by dairy farmers, the frequency of responses from each of the four-point continuum of a specific activity under major activity was tabulated and multiplied by the concerned score. Then, for ranking, they were totaled together to generate the total score for each individual activity (Ansari and Sunetha 2014).

Problem faced by each respondent was calculated by using the following formula,

Problem Indices (PI) = $4 \times H + 3 \times M + 2 \times L + 1 \times VL$ (8)

Where, H= High, M=Moderate, L= Low, VL=Very low

3. RESULTS AND DISCUSSION

This section reports the impact of COVID-19 on the smallholder dairy farmers of Cox's Bazar district in Bangladesh.

3.1 Demographic and Socio-Economic Status of the Respondents

The information on household sociodemographic and economic factors can be used to define the study boundaries, allowing any findings or outcomes to be stated within the scope of this profile (Alam and Khatun 2021).

In this study it was found that, the majority of the farmers (42%) were adults (41 years aged and up), who were married (83.87%) and had completed their education beyond the SSC level (45.16%). The majority of the farmers (54.84%) relied solely on dairy farming to support their medium-sized (6-8) family (48.39%) which is larger than national family size (BBS 2017). Almost 52% of the farmers had a family income ranging from 51000 to 100000 BDT. Most farmers (41.94%) had little or no farming experience and 67.74% of the farmers had no training in dairy production. Interestingly, 77.42% of the farmers started their farms with their own money (Table 1).

3.2 Cost and Return Measurement Per Dairy Cow Per Month in the Study Areas

In dairy farms, production cost consists of variable cost and fixed cost of the farms. The cost of various inputs such as feed cost (concentrate and roughage), labor cost, medicine and treatment cost, transportation, electricity, water cost and interest on operating cost are considered as variable cost. Fixed cost includes depreciation cost of house and equipment (Samad 2020).

Feed costs accounted for the majority of the cost of the farms in the study area. The major cost heads included concentrate costs (28.61%), roughage (23.62%), and labor (17.12%) before the COVID-19 epidemic. However, due to the outbreak of COVID-19, all of these costs changed, such as concentrate (27.10%), roughage (29.17%), labor (15.38%), medicine and treatment (3.46%), electricity, transportation, and other costs (5.47%). Here cost of roughage and transportation increased due to COVID-19 restrictions whereas cost of concentrate. labour and medicine-treatment decreased slightly. As restricted movement during COVID-19 increased unsold milk and concentrates increased amount of milk production, farmers allowed lesser amount of concentrates to their cows to lessen milk production as well as unsold milk. This farmers' behavioral change might have led to lesser concentrate costs during COVID-19. Similiarly, respondants claimed that, unavailability of labour and vets during COVID-19 which is also found in other research (Rahman and Das 2021) decreased cost of labour cost along with treatment and medicine costs.

Total cost per cow per month was BDT 14076.65 before COVID-19 which increased into BDT 15787.48 due to COVID-19 (Table 2). Total cost increased due to high roughage and transportation cost and these cost increased due to movement restriction imposed by the Government, effective from 26 March, 2020, (Kamruzzaman and Sakib 2020). Another study revealed a similar conclusion, indicating that the average cost of milk production, i.e. the cost per cow per month, increased 10.09% for family farming (Uddin et al. 2012).

But most destructive change was found in the case of farm return due to increase in unsold milk

and lesser milk price. The return per cow per month was BDT 27796.36 before COVID-19, which decreased to BDT 8512.39 during COVID-19 (Table 2).

After the declaration of lockdown, transportation was interrupted causing a shortage of animal feed supply, labor supply, and veterinary services, in one hand (Hashem et al. 2020). On the other hand, food outlets, restaurants, and social and cultural programs were closed, lowering the market demand for dairy milk (Rahman and Das 2021). Additionally, some unverified social networks circulated that SARS-CoV-2 could transmit via domestic animals to humans, which was also responsible for reducing the demand for dairy products (Enserink and Kupferschmidt 2020, Öreshkova et al. 2020, Manes et al. 2020, Molenaar et al. 2020, Schlottau et al. 2020, Gaudreault et al. 2020, Di et al. 2021). All these uncertain Teodoro situations created financial pressure for the farmers as well as decreased the profit of the farms.

Parameter	Category	Frequency	Percentage	Mean	Std. dev.
Age	Young age up to 30	8	26.00		
	Middle aged (30-40)	10	32.26		
	Adult aged (41 and above)	13	41.94	42	12.84
Marital status	Married	26	83.87		
	Unmarried	5	16.13		
Education	Primary	8	25.81		
	Secondary	9	29.03		
	Above SSC	14	45.16		
Occupation	Only Dairy Farming	17	54.84		
	Business + Dairy Farming	7	22.58		
	Service + Dairy Farming	6	19.35		
	Student + Dairy Farming	1	3.23		
Household	Small family (up to 5)	15	48.39		
size(no)	Medium family (6-8)	15	48.39		
	Large family (>8)	1	3.23	5.9	1.35
Monthly Family	20000-50000	8	25.81	25719.35	
Income (BDT)	51000-100000	16	51.61		
	Above 100000	7	22.58		
Experience(years)	Below 5 years	13	41.94		
	5-10 years	12	38.71	7.3	5.6
	Above 10 years	6	19.35		
Source of credit	Own	24	77.42		
	Own + Loan	4	12.90		
	Loan	3	9.68		
Training	Yes	10	32.26		
-	No	21	67.74		

 Table 1. Socio-economic characteristics of dairy farm owners

Source: Field survey, 2021.

Cost and Return		Before COVID-1	9 (2019)	During COVID-19 (2020)		
		Amount (BDT)	Percentages	Amount (BDT)	Percentages	
Cost Items						
Feed Cost	Roughages	3325.41	23.62	4605.65	29.17	
	Concentrate	4027.67	28.61	4278.51	27.10	
Labor		2410.37	17.12	2427.88	15.38	
Medicine and	Treatment	476.80	3.39	546.43	3.46	
Electricity, Tra	ansportation	804.18	5.71	863.25	5.47	
and Others						
Operating Capital		11044.43		12721.71		
Int. on Operating Capital		220.89		254.43		
Total Variable Cost (TVC)		11265.32	80.03	12976.15	82.19	
Depreciation of House		1575.50		1575.50		
Depreciation of	of Equipment	1235.83		1235.83		
Total Fixed C	ost (TFC)	2811.33	19.97	2811.33	17.81	
Total Cost (TVC+TFC)		14076.65	100.00	15787.48	100.00	
Total Return I	tem					
From Milk Sel	ling	27796.36	100.00	8512.39	100.00	
Total Return		27796.36	100.00	8512.39	100.00	
		0 5:11	0.00.4			

Table 2. Cost and return of per dairy cow per month in the study areas

Source: Field survey, 2021.

Due to the absence of transportation facilities, the farmers could not distribute farms' products duly, which caused deterioration of the product quality and a severe fall in farmgate price. As milk is a highly perishable item, interruption in distribution results in an immediate loss. During the pandemic, different media reported that many farmers threw their milk on the street out of frustration, finding no alternative ways to sell their product (Rahman and Das 2021). Bangladesh Dairy Farmers' association claimed that, about 12-15 million liters milk remained unsold which caused an estimated daily loss of 570 million (The Financial Express 2023).

3.3 Comparison of Profitability of the Dairy Farm Owners

It is very important to check a farm's profitability to determine the farm progress level. The total cost and cash cost increased from BDT 14076.65 to 15787.48 and BDT 11265.32 to 12976.15, respectively. During COVID-19, net loss per dairy cow per month was calculated BDT 7282.85. Consequently, the net return and gross margin per dairy cow per month went down by BDT 7275.09 and 4463.76, respectively during the COVID-19 period compared to the pre-COVID period (Fig. 2).



Fig. 2. Profitability of farm before and during COVID-19

3.4 Comparison of Benefit Cost Analysis (BCR)

Before the COVID-19 period, BCR were 2.47 and 1.9, indicating that if a dairy farm owner invested BDT 1, he would get a return of BDT 2.47 and 1.9, for cash cost basis and full cost basis, respectively. On the other hand, during COVID-19 period, BCR were 0.66 and 0.54, which meant that if a dairy farm owner invested BDT 1, he would lose BDT 0.34 and BDT 0.46 for cash cost basis and full cost basis, respectively, due to negative impact of COVID-19 (Fig. 3). Changes in farm income indicated the impact of the COVID-19 pandemic in the dairy industry due to greater costs, lower milk price, and higher feed prices. As milk sales are the primary source of income for dairy farms in Bangladesh and around the world (Hemme et al. 2014, Uddin et al. 2012), A higher percentage of unsold milk lowers farm income and, eventually, farm profit. A study by (Uddin et al. 2021) also found that cash costs increased due to COVID-19 by 4% (from 58 to 62 percent).

3.5 Impact of Covid-19 on Dairy Farmers

Paired t test was performed to compare the different aspects of the farm such as feed cost, milk price and per cow monthly income between the period before COVID-19 and during COVID-19.

It was shown that there was a significant difference in feed cost, milk price, and monthly household income between before COVID-19 periods and during COVID-19 period. The

average feed cost increased BDT 1531.08 during COVID-19 which was statistically significant (P<.0001) (Table 3).

As people could not move, feed delivery became impossible. Consequently, feed transportation cost increased which eventually raised feed supply cost as well as feed cost (Rahman and Das 2021). In some cases, imported feeds were not available due to import and border restrictions. Similar findings also found in India where farmers faced more problem to get cattle feed. This thing happened because the cattle feed industry had shut down their production temporarily due to irregular supply of raw materials, labor shortage and transportation issues. Hence, feed supply decreased and feed cost increased in different parts of India (Bhandari and Ravishankar 2020).

There were statistically significant differences in milk price and total return of the farm between before COVID-19 periods and during COVID-19 period and the difference was BDT 30.32 and 74429.03, respectively (*P*<.0001) (Table 3). Similar findings were also found in Ethiopia where 64% of the dairy farmers reported that milk sales volume decreased during the pandemic period. The surplus milk was used for home consumption by the majority of dairy producers (74%) (Meseret et al. 2021).

These changes had a direct health impact on farmers since disruptions in income and food supply chains resulted in decreased access to nutritious food, affecting farmers' physical health.



Fig. 3. Comparison of benefit Cost Analysis (BCR)

Variable pair	Mean	Std. Error	Std. deviation	95% confidence interval		Т	d.f	Sig
				Lower	Upper			(2- tailed)
Feed cost'during -feed cost'before COVID-19	1531.08	208.48	1160.76	1105.30	1956.84	7.34	30	0.0001
Milk Price/L during- Milk price/kg' before COVID-19	-30.32	1.87	12.40	-34.14	-26.51	-16.23	30	0.0001
Per Farm monthly income' during – Per farm monthly income' before COVID-19	-74429.03	16453.61	91609.85	-108031.8	-40826.27	-4.52	30	0.0001

Table 3. Paired sample test

Source: Field survey, 2021

Table 4. Problems faced by dairy farmers during COVID-19 situation

Problems	Extent of Problem				Problem	Rank
	Very low	Low	Moderate	High	indices	
Milk price fall due to COVID-19	1 (3.23)	2 (6.45)	8 (25.81)	20 (64.52)	109	1
Constraints on marketing of	1 (3.23)	3 (9.68)	7 (22.58)	20 (64.52)	108	2
the products						
High cost of concentrate feeds	2 (6.45)	3 (9.68)	6 (19.35)	20 (64.52)	106	3
Unavailability of green fodder at the surrounding	4 (12.90)	2 (6.45)	3 (9.68)	22 (70.97)	105	4
region						
Decline in the consumption of milk and other dairy products	5 (16.13)	3 (9.68)	2 (6.45)	21 (67.74)	101	5
Economic constraint of the farmer	6 (19.35)	3 (9.68)	10 (32.26)	12 (38.71)	90	6
Management problem	9 (29.03)	3 (9.68)	4 (12.90)	15 (48.39)	87	7
Insufficient/Inadequate veterinary services	15 (48.39)	4 (12.90)	3 (9.68)	9 (29.03)	68	8
High disease prevalence	(18 (58.06)	7 (22.58)	2 (6.45)	4 (12.90)	54	9
Insufficient pasture land	20 (64.52)	5 (16.13)	3 (9.68)	3 (9.68)	51	10
Shortage of space for housing and rearing	22 (70.97)	2 (6.45)	3 (9.68)	4 (12.90)	51	10
Fall down of production	22 (70.97)	5 (16.13)	2 (6.45)	2 (6.45)	46	11

Source: Field survey, 2021

3.6 Problems and Policy Recommendation

3.6.1 Major constraints faced by farmers during COVID-19 situation

Major problems faced by the farmers during COVID-19 situation were discussed in two different ways. At first, percentages of farms facing each problem in different level was shown. Then, the problems were brought into different ranks based on problem indices (Table 4).

Ranking of different problems faced by dairy farm owners of Cox's Bazar district during COVID-19 period were specified based on problem indices (PI). In ranking, 'milk price fall due to COVID-19' was faced highly by the majority respondents (64.52%). Similar number of respondents mentioned about 'constraints on marketing of the products' (2nd) and 'High cost of concentrate feed' (3rd) which might be caused by movement restriction and consequent supply failure of concentrate feed during the pandemic period. Unavailability of green fodder was ranked 4th rank where, 70.97% respondents faced this issue, 'Decline in the consumption of milk' ranked fifth followed by 'Economic constraints of the farmers'. The least important problem was 'fall down of production' which was ranked 11th on the list and only 6.45 % of the farmers reported this problem (Table 4).

To address these problems, the Government might prepare a database of the needy smallholder dairy farmers and provide them with subsidies and relaxed agricultural loans to adapt to the situation within a short time. If the Government and non-government organizations, private companies, and academic institutions could collaborate to include the smallholder farmer in the mainstream market, it would greatly support the affected farmers to minimize the financial loss. Moreover, the farmers might be given training on 'value addition' which could help them to get better price under extreme market condition. By creating proper network among stakeholders and rapid sharing of information as well as utilization of other agricultural technologies and cost-effective farm management techniques might help the dairy farmers to overcome the impacts of any future disasters like COVID-19. Finally, the Government should introduce evidence-based strategies and implement dairy and livestock development projects to build resilience capacity to tackle future challenges.

4. CONCLUSION

The study found that, the major impacts of COVID-19 on the small-scale dairy farms were in four major areas. Firstly, the pandemic significantly increased the price of feed which reduced feed supply. Cost of concentrate feed increased and milk price decreased during COVID-19 period than before COVID-19 period which reduced per cow monthly income. Secondly, the pandemic condition resulted in a reduced worker supply and higher labor costs. Thirdly, the COVID-19 situation increased transportation cost due to COVID-19 movement restriction. Finally, the COVID-19 had a negative impact on the farms' return due to increased costs and amount of unsold milk. Average monthly income per farm was significantly reduced for COVID-19 situation. Though the Government took some measures to mitigate the arising issues, it was guite tough for the farmers to minimize their losses by utilizing the given subsidy. If the Government and non-government organizations, private companies, and academic institutions could collaborate to include the smallholder dairy farmers in the mainstream market, it would greatly support the affected farmers to minimize the already incurred financial loss.

DECLARATION

The study's ethical concerns were upheld by making sure the dairy farmers were fully informed about the research's goals, procedures, and implications before giving their consent: avoiding biases in the selection of participants; making sure the study represents a range of socioeconomic backgrounds in the sampled area; accurately representing the farmers' voices and experiences in the research findings; keeping in mind Cox's Bazar's cultural norms and practices during the interview and data collection processes; and, lastlv. avoiding any manipulation or misrepresentation of the data to support desired conclusions.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

CONSENT

As per international standards or university standards, Participants' written consent has been collected and preserved by the author(s).

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COMPETING INTEREST

Authors have declared that no competing interests exist.

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