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Research article

Constraints and economic impacts of COVID-19 on dairy farming in Chattogram, Bangladesh

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A B S T R A C T

The covid-19 pandemic is likely to have substantial effects not only on the human being in Bangladesh but also on smallholder dairy farmers who were more affected because of the perishability nature of the product. The study was carried out to examine the impact of covid-19 on the dairy farming sector at Karnafully upazila in the Chattogram district of Bangladesh from an economic standpoint. Primary data were collected using a random sampling technique from smallholder dairy farms in the study area. Descriptive statistics and econometric methods were used to measure the socioeconomic status and farm profitability of dairy farmers. To analyze farm milk productivity, a Cobb-Douglas production function was estimated. A significant association of feed cost, milk price, household income and return from dairy farming between after covid and before covid period was found using t-test results. The study revealed that net return was higher before covid (BDT7972.19) than after covid (BDT4869.41) period. The production functions exhibited increasing returns to scale in both periods but comparatively in the covid-19 period it declined. The results also showed that feed costs increased but milk price, household income and return from dairy farming decreased due to covid-19 and the results are statistically significant (P<.0001). Finally, our research revealed that the dairy farming industry was severely impacted by the COVID-19 pandemic in numerous issues as a result of the lockdown including a fall in milk price, high feed cost, spoilage of milk on the farm due to the unsalable, difficulty of milk transportation, drug unavailability and shortage, decreased demand for dairy products etc. For decreased the vulnerability of dairy farming, it is essential to reduce feed costs, stable milk prices and develop a proper marketing system in the whole country.

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1. INTRODUCTION

COVID-19 is an ongoing global pandemic of coronavirus disease 2019 caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). This pandemic continues to have an impact on numerous businesses, including

agriculture and the food chain, as well as many people's livelihoods (Hossain, 2020; Hashem et al., 2020; McNamara et al., 2020). COVID-19 has harmed food security, putting the world's poorest people in danger of starvation and food chain disruption. Chronic hunger impacted 820 million people worldwide, with acute severe insecurity affecting 113 million (Emadi and Rahmanian, 2020). The Organization for Economic Cooperation and Development (OECD) forecasts that economic growth would fall from 2.9 to 2.4 percent in 2020, with the possibility of falling to 1.5 percent if the pandemic continues (Interim report, 2020; Yamin, 2020). Bangladesh's dairy industry is a promising one that has contributed to the country's economic progress.

Dairy producers in Bangladesh are also unable to sell their milk and are experiencing bad economic conditions as a result of lockdowns. Every day, Bangladesh loses about 67 million US dollars owing to milk waste of 15 million liters. Furthermore, farmers were compelled to sell their milk at a low rate of around 0.14 US dollars per litter, which was nearly 0.6 US dollars less than the typical price (Siche, 2020). This pandemic produced severe worldwide socioeconomic issues, such as the fear of a supply deficit, which led to panic purchasing (WHO, 2020; Baldwin and Mauro, 2020); the epidemic affected 41% of global exports (Nicola et al., 2020). According to the International Labour Organization (ILO), 2.7 million employees have been affected by the pandemic's partial and total lockdown since this RNA virus may be spread from person to person by airborne particles and droplets (Interim report, 2020). The American Veterinary Medical Association (AVMA) expressed worry about veterinary medication scarcity from animal pharmaceutics owing to panic buying. Animal health and wellbeing may suffer as a result of such scarcity.

For the vast majority of the world's population, livestock is an essential source of high-value animal protein. Milk continues to have the beneficial effect of improving immunological homeostasis in the human upper respiratory system, including the oropharynx (Perdijk et al., 2018). Smallholder farmers in Bangladesh make up the majority of the dairy industry. According to estimates, there are 1.4 million dairy farms in the country with an average herd size of one to three cows (Hemme et al., 2014). These smallholders dairy farmers provide between 70 and 80 percent of the nation's total milk production (Uddin et at., 2021). As a result, greater attention must be devoted to the small holder dairy farms to continue producing and distributing safe products to consumers across the country. Currently, due to COVID-19 regulations, these vulnerable smallholder dairy farmers and producers experienced tremendous financial strain from market interruptions, just as other industries. No research has done yet on the impact of covid-19 on smallholder's dairy farming in Bangladesh. The main objective of our research was to discuss how covid-19 and the consequent lockdowns have impacted smallholder's dairy farming in economic point of view in Chattogram, Bangladesh.

2. MATERIALS AND METHODS

Study area and sample size

The study was conducted in Karnafully upazila (known as a dairy hub) of Chattogram, which is located in the southeastern part of Bangladesh. The study area purposively selected based on the density of smallholders crossbred dairy farms of these areas. A total of 30 smallholders crossbred dairy farms (who has minimum 5 crossbred dairy) were randomly selected for this study.

Data collection method and study period

A pre-structured questionnaire was designed to conduct the survey. The survey was carried out by visiting each sampled dairy farm and a practically experienced veterinarian interviewed farm owners and recorded their responses from 5 January to 15 March 2021. Data were collected in two periods, before COVID-19 situation (2019) and after covid-19 outbreaks (2020) for comparison.

Analytical technique

After collecting data, the questionnaires were rechecked for completeness, and then data were cleaned, organized, coded. MS-Excel and STATA (Stata 14, Stata Statistical Software, Stata Corporation, College Station, Texas 77845 USA) were used for data analysis. Both the descriptive statistics and econometric methods were used to achieve the objectives. Descriptive

statistics were used to estimate the socio-economic characteristics of dairy farm owners.

Profitability analysis

To determine the profitability of per dairy, the following algebraic equation was followed:

$$\sum TR = \sum (QyPy + QzPz) \text{ …… (1)}$$

$$\pi = \sum TR - \sum TC$$

$$= \sum (QyPy + QzPz) - \sum PXi.Xi - \text{TFC… (2)}$$

$$\sum GM = \sum TR - \sum TVC$$

$$= \sum (QyPy + QzPz) - \sum PXi.Xi \text{…… (3)}$$

BCR (Full cost basis) =

$$\frac{\sum TR}{\sum TC} \text{ … … … … … … … … … … … … … … … … … … (4)}$$

BCR (Cash cost basis) =

$$\frac{\sum TR}{\sum TVC} \text{ … … … … … … … … … … … … … … … … … … (5)}$$

Where,

TR = Total Return
TC = Total Cost
TVC= Total Variable Cost
GM = Gross Margin
BCR = Benefit Cost Ratio
π = Profit/Net return per dairy (Tk)
Q_y = Total quantity of milk yield (litre)
P_y = Per unit price of milk (Tk/litre)
Q_z = Total unit of calf selling
P_z = Per unit price of a calf
X_i = Quantity of the concerned i^{th} inputs
Px_i = Per unit price of the relevant i^{th} inputs
TFC = Total fixed cost involved in the production
i = 1, 2, 3...., n (number of inputs)

Cost estimation

Interest on operating capital and total variable cost

The Bank interest rates (4%) 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

TVC = Operating capital + Interest on operating capital

Fixed cost

Costs on poultry houses and equipment were included under fixed cost.

The cost of housing was calculated by taking into account the depreciation cost of housing. The cost of equipment was expressed as equipment cost, which was calculated by taking into account the depreciation cost of equipment. Depreciation cost on house and equipment was worked out as follows:

Depreciation =

$$\left[\frac{Original\ value - Salvage\ value}{Life\ \ of\ the\ house\ or\ equipment}\right]$$

Productivity analysis

The study assumes a Cobb-Douglas production function to estimate the input-output (milk production) relationship of a dairy farm. The double log form of the Cobb-Douglas production function proved to be a superior alternative on theoretical and econometric grounds (Rubin and Erickson, 1980). Thus, Cobb-Douglas function was selected for this study. The specification of the Cobb-Douglas function is as follows:

$$Y = AR^{b1}C^{b2}L^{b3}e^{ui}$$

The following equation describes the logarithmic transformation of the Cobb-Douglas production function, which enables us to apply the Ordinary Least Squares (OLS) method to estimate relative share of inputs (or, partial elasticity).

$$\ln Y = \ln A + b_1 \ln R + b_2 \ln C + b_3 \ln L + u_i$$

Where,

Y = Per day per cow milk yield (liter)
A = Intercept of the function;
R = Use of roughages per day per cow (kg)
C = Use of concentrates per day per cow (kg)
L = Use of labour per day per cow (hours)

b1, b2 and b3 = Coefficients/Slope of the respective inputs to be estimated and

u_i= The error term which is assumed to follow the assumptions of the linear stochastic regression model (Goldberger, 1964).

Paired t-test

Paired t-test was used to compare the mean value of feed cost, milk price, monthly income of dairy farm household and monthly income from per dairy cow before (2019) and after (2020) covid-19 effect.

Problem index

For constructing the problem index of the dairy farmers during the 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 report a problem in dairy farming. Ranking of 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 they were added together to get the total score for each specific activity for their ranking (Sailaja and Reddy, 2003).

The problem faced by each respondent was calculated by using the following formula:

$$\textbf{Problem Indices (PI)} = \mathbf{4 \times H + 3 \times M + 2 \times L + 1 \times VL}$$

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

3. RESULTS

Demographic and socio-economic status of dairy farmers

The demographic and socioeconomic status of dairy farmers was presented in Table 1. All the farm owners were male, and 50% (n=15) of them were belonging to the adult age group (41 and above). In this study majority of the farmers had 10 to 20 years of farming experience (n=21). The education level of dairy farmers can also be extremely important for efficient management and operation, which is vital for profitable dairy production. Table 1 shows the majority (63.33%) of respondents having a secondary education, while just 10% reported having an SSC and above (Table 1). This can be an indication of farmers' realization about the importance of formal education in their social development. The findings of the present study found that the majority (57%) of the farm owners relied on dairy farming as their main income source. Nearly half (43%) of the sample dairy farmers had small family size (up to 5 members). About 87% farm owners had access to credit. Moreover, most of the farm owners (n=20) had been given government allowances (SSN) to help themselves recover from damages caused by COVID-19 pandemic.

Profitability of dairy farming

Cost and return analysis for operating dairy farms in the studied area before and after Covid-19 period are shown in Table 2. The two major cost components in total variable cost are the feed cost and labour cost for dairy farming. The feed cost accounted for BDT 5620.71 in 2019 and BDT 6237.71 in 2020. In 2020, the labour cost represented 8% of total variable cost, which was higher than the pre-covid-19 situation. Prior to COVID-19, the average monthly revenue of a dairy farm was around BDT 15511.80 per cow, while this figure considerably fell after the pandemic (Table 3). The study finds that milk sales accounted for 50% of the monthly revenue in 2019, but due to COVID-19 pandemic, they only made up 30% in 2020. According to survey result, dairy farms could generate more revenue before COVID-19 (BDT15511.80) than after (BDT13701.40). Monthly net return and gross margin of per dairy cow also shown in Table 3. Net return from per dairy was higher in before Covid-19 period (BDT 7972.19) than after Covid-19 (BDT4869.41). The result of BCR shown that before Covid-19 period if a dairy farm owner invested BDT 1, then he got the return of BDT 2.11 in full cost basis and BDT 2.29 in cash cost basis. But after Covid-19, if a dairy farm owner invested BDT 1, then he got the return of BDT 1.60 in full cost basis and BDT 1.77 in cash cost basis (Figure 1). So dairy farm owner earn more profit in before Covid-19 than after Covid-19 period.

Table 1. Socio-economic characteristics of dairy farm owners

Parameter	Category	Frequency	Percentage	Mean	Std dev.
Age(years)	Young age up to 30	05	16.67		
	Middle aged(30-40)	10	33.33	42	12.36
	Adult aged (41and above)	15	50.00		
Marital status	Married	26	86.67		
	Unmarried	4	13.33		
Education	Primary	8	26.67		
	Secondary	19	63.33		
	SSC and above	3	10.00		
Occupation	Dairy farming	17	56.67		
	Business	9	30.00		
	Service	3	10.00		
	Student	1	3.33		
Household size(no)	Small family(up to 5)	13	43.33	7	3.22
	Medium family(6-8)	12	40.00		
	Large family(>8)	05	16.67		
Farm size (acre)				1.91	1.139
Experience(years)	Below 10 years	6	20.00	13	5.96
	10 -20 years	21	70.00		
	21-30 years	3	10.00		
Credit	With credit	26	86.67	1.13	0.346
	Without credit	4	13.33		
Social Safety Net Programme(SSN)	Yes	20	66.67		
	No	10	33.33		

Source: Field survey data, 2021

Table 2. Cost, return of per dairy per month in the study area

Cost Items	Before covid-19(2019)		After covid-19(2020)	
	BDT	%	BDT	%
A. Variable Cost	6936.63	92.00	7994.97	90.52
Feed cost	5620.71	74.55	6237.71	70.63
Roughages	2080.46		2537.87	
concentrate	3540.25		3699.84	
Labour cost	525.96	6.98	714.48	8.09
Biosecurity cost	86.66	1.15	117.83	1.33
Treatment and medicine cost	395.50	5.25	512.57	5.80
Electricity, water cost	118.01	1.57	170.40	1.93
Transport and other cost	53.77	0.71	85.20	0.96
Operating cost	6800.61	90.20	7838.21	88.75
Interest on Operating cost	136.01	1.80	156.76	1.77
B. Fixed cost	602.98	8.00	836.98	9.48
Depreciation of House	518.43	6.88	722.6	8.18
Depreciation of Equipment	84.54	1.12	114.38	1.30
Total cost (A+B)	7539.60	100	8831.96	100
C. Return from milk sale	7811.90	50.36	4237.61	30.93
D. Return from calf sale	7699.90	49.64	9463.77	69.07
Total Return (C+D)	15511.80	100	13701.40	100

Source: Field survey data, 2021

Table 3. Profitability of per dairy per month in the study area

Particulars	Before covid-19(2019)	After covid-19(2020)
Total Return (BDT)	15511.80	13701.4
Total cost	7539.6	8831.96
Total Variable Cost	6936.63	7994.97
Net Return (A-B)	7972.19	4869.41
Gross Margin (A-C)	8575.17	5706.4

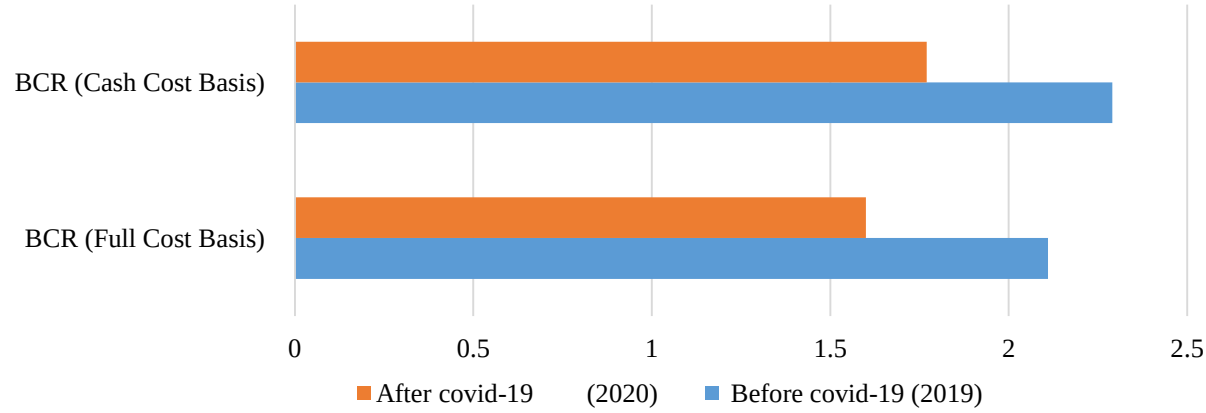

Figure 1. Comparison of BCR between two periods

Estimation of milk productivity and profitability

Table 4 presents regression results measuring the impacts of different inputs on dairy production before and after COVID pandemic. The regression results suggest that the explanatory variables (roughages, concentrate and labour) are responsible for only about 32% variation in response variable (milk production) in pre-COVID 19 situations, while, in the post-COVID situation, they can explain about 42% of total variation in the response variable. The findings show that the significance of variables alters across regression specifications. In the regression specification before COVID 19, the coefficient of roughages appeared to be positive and statistically significant (P<0.01), implying that a 1% increase in roughage foodstuff causes dairy production to increase by 0.8237%, where it was 0.271% in after covid-19, other factors remaining the same. Surprisingly, however, the variable is not found significant in 'after COVID 19'.

In addition to individual significance, one important finding here is worth noting. In a Cobb-Douglas type of function, summation of coefficients is indicative of returns to scale. The results show that both of these sums exceed one, implying that the production functions exhibit increasing returns to scale. However, the return to scale slightly bigger in before COVID-19 than after covid-19 period.

Table 4. Estimated value of Cobb-Douglas milk production function

Milk yield(Y)	Before COVID-19 (2019)		After COVID-19 (2020)	
	Coefficients	Std. Error	Coefficient	Std. Error
Intercept	-0.884	0.887	0.048	0.619
Roughages (R)	0.824***	0.271	0.238	0.358
Concentrates (C)	0.499	0.704	0.805**	0.460
Labour use (L)	0.038	0.117	0.066	0.118
F-value	4.07		6.18	
R^2	0.319		0.416	
Return to scale	1.36		1.16	

Note: ***= Significant at 1% level; **= Significant at 5% level
Source: Field survey data, 2021

Table 5. Impact of covid-19 in smallholder dairy farm

Variable Pair (BDT)	Mean difference	Std. Error	Std. deviation	95% Confidence Intervals		t	d.f.	Sig(2-tailed)
				Lower	Upper			
Feed cost'20- Feed cost'19	617.01	139.54	764.32	331.60	902.41	4.42	29	0.000
Milk price'20- Milk price'19	-22.3	1.39	7.59	-25.13	-19.47	-16.09	29	0.000
Monthly household income'20- Monthly household income'19	-10960	2051.65	11237.36	- 15156.52	-6764.33	-5.34	29	0.000
Per cow monthly income'20- Per cow monthly income'19	-1810.42	653.86	3581.34	-3147.72	-473.13	-2.76	29	0.009

Source: Field survey data, 2021

Effect of covid -19 on dairy farming

The effect of covid-19 on feed cost, milk price, household income of dairy farm owner and monthly income from per dairy cow of before (2019) and after (2020) Covid-19 has shown in Table 5. Feed cost is found more in after (2020) than before (2019) Covid-19 situation and the differences is statistically significant ($P<0.001$). The average difference in feed costs between 2020 and 2019 is BDT 617.01. While milk price is found to have significant negative impact on profitability. The mean value of milk price between 2020 and 2019 is -BDT22.3 indicating lower milk price after the Covid-19 scenario. Monthly family income and monthly revenue from per cow have a significantly negative influence on farm profitability, and both mean values are lower in 2020 than in 2019.

Problem faced by the farmer

Table 6 presents the problems that dairy farmers encountered during Covid-19. With the incidence of COVID-19, the dairy industry has suffered significantly due to the reduced overall demand of about 25-30% in the country, at least the first several months of lockdown. Above 90 percent dairy farm owners' claim that milk price fall due to COVID-19, high cost of feeding and spoilage of unsalable milk are major problem in pandemic period.

4. DISCUSSION

Socio-economic status of dairy farmers

In the study area, about half of the total farm owners belong to adult age group (≥ 41). This result is consistent with the findings of Sabapara et al. (2014). They mentioned that the 41 to 50 age group had better expertise and enthusiasm, and as a result they were always ready to adopt innovations without taking into account how others might react. Knowledge about the age structure of farm owners is important in estimating potential productivity of human resources (Rahman et. al., 2018).

The study also found that dairy farming is the main income source of majority of the respondents which supports the findings of Akila and Senthilvel et al. (2012). The result of the study demonstrated that about 70% dairy farm owners had 10 to 20 years of experience in dairy farming. The level of farming experience also plays an important role in affecting the sustainability of dairy production (Rahman et. al., 2018).

Profitability of dairy farming

In this study, monthly total cost incurred for per diary was BDT 7540 and BDT 8832 in before and after covid-19 period, respectively where feed cost accounted about 91% of total for both periods. The results are in line with the findings

Table 6. Indentified problems faced by the dairy farmers

Problems	**Extent of Problem**				**Problem indices**	**Rank**
	Very low	**Low**	**Moderate**	**High**		
Milk price fall due to Covid- 19	2 (6.67)	3 (10)	10 (33.33)	15 (50)	98	1
High cost of feeding	0 (0)	1 (3.33)	22 (73.33)	7 (23.33)	96	2
Spoilage of milk in farm due to unsaleable	4 (13.33)	3 (10)	7 (23.33)	16 (53.33)	95	3
Difficulty of milk transportation due to lockdown	1 (3.33)	5 (16.67)	17 (56.67)	7 (23.33)	90	4
Fall down monthly income of the family members	3 (10)	5 (16.67)	12 (40)	10 (33.33)	89	5
Constraint on marketing of the milk	2 (6.67)	4 (13.33)	17 (56.67)	7 (23.33)	89	5
Reduced sales of milk to processors	1 (3.33)	8 (26.67)	12 (40)	9 (30)	89	5
Decline in the consumption of milk, dairy products and meat	2 (6.67)	8 (26.67)	14 (46.67)	6 (20)	84	8
Decreased the market demand for milk and meat	4 (13.33)	10 (33.33)	13 (43.33)	3 (10)	75	9
Decrease of milk demand (close of hotel, restaurants, university etc)	6 (20)	9 (30)	14 (46.67)	1 (3.33)	70	10
Lack of credit facility due to pandemic situation	4 (13.33)	17 (56.67)	7 (23.33)	2 (6.67)	67	11
Household members lose their job	14 (46.67)	10 (33.33)	5 (16.67)	1 (3.33)	53	12
Increase labour cost	22 (73.33)	1 (3.33)	4 (13.33)	3 (10)	48	13
High disease prevalence	20 (66.67)	6 (20)	2 (6.67)	2 (6.67)	46	14
Lack of government assistance	21 (70)	4 (13.33)	3 (10)	2 (6.67)	46	14
Restrictions of movement and social distancing have led to an absence of labour	23 (76.67)	4 (13.33)	3 (10)	0 (0)	40	16
Insufficient/ Inadequate Veterinary services	25 (83.33)	2 (6.67)	3 (10)	0 (0)	38	17
Lack of Vaccination, and Deworming facilities2	25 (83.33)	3 (10)	1 (3.33)	1 (3.33)	38	17
High treatment cost	26 (86.67)	2 (6.67)	2 (6.67)	0 (0)	36	19
Fall down of production	28 (93.33)	0 (0)	1 (3.33)	1 (3.33)	35	20
Lack of storage facilities of feed	27 (90)	2 (6.67)	1 (3.33)	0 (0)	34	21
Unavailability of green fodder at the surrounding region	28 (93.33)	2 (6.67)	0 (0)	0 (0)	32	22

of Khan et al. (2013) who reported that the average monthly cost of a dairy cow in the country was BDT 2025, with feed costs accounting for approximately 58.7% of that total. In this study it was observed that total return from per dairy cows was higher in before covid-19 than after covid-19. These findings are in similar with Datta et al. (2019).

Estimation of milk productivity

In this analysis R^2 value was less than 50 for both before and after covid-19 period. The small R^2 value is an indication that there are more other factors, which are thought to have influences on milk production, such as age, environment, and weather and climate, but not included in the model due to inadequacy of data (Budiraharjo et al., 2020; Tanwar et al., 2018).

Effect of COVID -19 on dairy farming

Milk price is found to have lower after the COVID-19 scenario. The mean value of milk price between after covid (2020) and before covid (2019) is -BDT22.3 in the study area which supports the finding of Nicola, et al. (2020). They found that due to closure of restaurants and transport restrictions reduced the demand of fresh dairy products, affecting producers and suppliers and reduce milk price. In this study it was observed that monthly income from per dairy cow per farm was lower in after covid (2020) than before covid (2019). This finding was consistent with Sabbir et al. (2020). They reported that dairy farmers also faced economic losses due to a decrease in milk production and limitations in selling milk. As milk production is the basic source of income for these dairy farmers.

Problem faced by the farmer

Above 80% of dairy farm owners claim that milk price fall due to COVID- 19, high cost of feeding, spoilage of milk in farm due to unsalable, difficulty of milk transportation due to lockdown, fall down monthly income of the family members, constraint on marketing of the milk, reduced sales of milk to processors, and decline in the consumption of milk, dairy products and meat are the major problems for dairy production in covid-19 period in the study area. Biswal et al. (2020) reported that with the immediate declaration of lockdown, a good number of consumers undertook the bulk purchase of milk to meet their requirements for about 5-7 days. This had led to a surge 15-20% demand for milk during the initial 2 days, which however shown a drastic slowdown in subsequent days (Biswal et al., 2020, Hussain et al., 2020). With the closer of the street vending , roadside cafeteria, restaurant, and so on during lockdown, a share of about 15% of the total milk consumption in the country were almost at complete halt (Biswal et al., 2020). There have been reports of farmers selling their milk at a loss, sometimes by as much as 50%, in a number of rural locations where there are no milk cooperatives or private marketing agencies. Due to the country being under a state of lockdown, which forbade vehicular movement, the transfer of milk to consumers was hampered (Biswal et al., 2020; Udiin, 2020; Chandel et al., 2020).

5. CONCLUSION

COVID-19 had a substantial negative impact on the availability of dairy products for daily consumption by the general population and all those who rely on this sector for a living. Transport obstacles due to the lockdown created barriers in the milk supply chain. The study found that smallholder dairy farmer owner's monthly income reduces due to covid-19. As income from milk sales is the main source of income for smallholder dairy farmers, therefore the pandemic had a significant impact on their way of life and other sectors of the dairy food chain. In this context, it is expected that the government will take every possible measure to alleviate the distressing situations, including effective governance, necessary financial support, and the creation of a conducive environment for reviving the sector and ensuring the livelihood of the associated workers.

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