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Research Article

Survey of Calf Management and Hygiene Practices Adopted in Commercial Dairy Farms in Chittagong, Bangladesh

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Abstract | A survey was conducted to characterize calf management and hygiene practices adopted by dairy farmers at Chittagong, in Bangladesh. A total of 210 dairy farms located in 3 geographically distinct regions in Chittagong division, namely coastal, hilly and plain area, were surveyed. Calf management and hygiene practice related data was collected through a standard questionnaire and all sampled farms were visited once by technical persons and administered the questionnaire by 'face to face' method during the period July, 2015 to May, 2016. Statistically significant variations were observed in distribution of different factors through different strata (herd size and region). Among larger farms (>50 cows), 10% had a poor hygiene score whereas 32% of the smaller farms (5-20 cows) belonged to this category. 97% of the large farms used tube well water as the source of drinking water for their calves; whereas 35% of the small farms used surface water. None of the large and medium farm owner said they never clean the calf pen; 47% small farm owners said yes to it. More than half of the smallholders (54%) were discovered with raising other domestic animals and birds within the same premises. Hygiene score and surrounding environment of the farms did not show any regional variation ($p>0.05$). Remarkably 65% farms of the hilly area used surface water for their calves to drink with. The relationship between management practices and calf mortality/morbidity is complex. Our study design did not allow us to draw conclusions about the management and hygiene practice responsible for calf mortality/morbidity, but knowing the management practices adopted on farms is valuable for bringing attention to herds with less optimal practices and for planning meaningful experiments to explore causal affects.

Keywords | Calf management, Farm hygiene, Calf mortality, Survey, Demography

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INTRODUCTION

Livestock is an inherent element of the compound farming system in Bangladesh as it besides a source of meat and milk protein, a prime source of farm power services as well as employment. The livestock sub-sector dispenses 20% and 50% of the total population a full time employment and part-time employment, respectively. The contribution of the livestock sector to total gross domestic product persisted steady within a range of 2.1–3.6% over the 1973–2008 periods. Despite a steady contribution to the Gross Domestic Product (GDP), budget allocation for this sector remained <1% of the total expenditure. Moreover, it was revealed that the growth in individual livestock products were mainly in minor products (*e.g.*, tails, bones, *etc.*) and hides and skins (a major export item) rather than in milk and milk products, meat and eggs might not be very motivating because such tendency will lead to less im-

provement in protein intake from animal origin. To fight with malnutrition problem we need to address growth in edible livestock products. A bunch of commingled factors such as *technical, institutional,* and *social,* are limiting the development of the livestock sector in Bangladesh. Previous studies (Islam and Shahidullah, 1989; Abdul-Rahman and Hailes, 2000) have identified many areas of concern that restrict the potential development of the livestock sector; outbreak of diseases being the most important one.

Among all other factors causing economic loses to Bangladeshi dairy industry, calf mortality is considered as the preeminent element. Infectious diseases are often considered as the principal cause of calf mortality, specially gastro-intestinal disorders (Svensson and Liberg, 2006; Torsein et al., 2011; Bähler et al., 2012; Daros et al., 2014) and respiratory problems (Gulliksen et al., 2009). Moreover, farms with high calf mortality are regarded as of having poor welfare at the farm level (Ortiz-Pelaez et al., 2008; Kelly, 2013). A high death rate renders an economic burden to the farm that needs to be addressed with utmost importance. It is well established that management practices influence morbidity and mortality in dairy calves (Kehoe et al., 2007). Such as management and feeding of high-quality colostrums can lessen calf mortality and fortify immunity (Quigley and Drewry, 1998). If the intake of colostrums is delayed it diminishes passive transfer of Ig and interrupts supply of vital nutrients that supplement the scanty reserves in the bovine neonate.

In Bangladesh, enteritis and pneumonia are regarded as the most important cause of calf death (Samad et al., 2004). Calves are more dependent on milk, milk replacer, and are incapable of digesting all kinds of food materials. Feeding related management practices including time of colostrums feeding, poor hygienic condition of feeding utensils, and calf barns hygiene might be the cause of death from enteritis. Pneumonia and enteritis are multi-factorial diseases and factors responsible for it often commingled (Debnath et al., 1990). It was hypothesized that common factors related to management techniques that lead to introduction and spread of specific agents make calves susceptible to both diseases.

Small scale farming is decreasing in some regions of Bangladesh day by day. It was suggested that, adoption of contemporary management practices that are modified to the growing herd sizes is crucial to reduce calf mortality (Barkema et al., 2015). Torsein et al. (2014) suggested some management options most rewarding for calf survival in Swedish herds. Designing controlled experiments to establish management practices that benefit calf survival is difficult. Therefore, evaluating management practices on-farm based on previous studies could be an effective method to establish beneficial on-farm practices.

This survey was designed to characterize calf management and hygiene practices adopted by dairy farmers at Chittagong, in Bangladesh. It was hypothesized that calf management practices are not uniform across dairy farms, and potential difference exists at different herd size. In addition, we searched for the variation between three geographical regions of Chittagong consisting of hilly area, coast and plain land that might affect the calf management practices among dairy producers.

MATERIALS AND METHODS

Study Area and Period

Data collection for the present study was performed during the period July, 2015 to May, 2016. Three distinct geographical areas under Chittagong division of Bangladesh were sorted out to conduct this present study. Areas were selected to cover geographical variations like hilly regions, coast and plain land. We selected Chittagong metropolitan and Patiya upazilla (sub district) to address plain lands under Chittagong district, Rangamati sadar and Kowkhali upazilla were incorporated as hilly area under Rangamati district. Chakaria and Pakua upazilla were selected from the Coastal belt of the district Cox's bazar using probability sampling scheme.

Sampling Strategy and Study Population

Farms nested within sub-districts, and sub-districts nested within districts were selected using multi stage (three stages) random sampling strategy. At the beginning of the sampling, districts under the study area (Chittagong division) were divided into 3 geographical regions (hilly, coast and plain) to make sure all geographical variations are covered. By using simple random sampling technique, 1 district from each geographically distinct region was sorted (1st stage of sampling). However, Chittagong district was selected on the basis of research interest. Two sub-districts from each selected districts were selected using simple random sampling at the second stage of multistage sampling. Individual farms under each selected sub-districts were selected at the third stage of multistage sampling. At this stage, due to absence of sampling frame, simple random sampling could not be performed for all sub-districts. Sampling frame for Chittagong Metropolitan Area and Potiya was available (created by others under the project HEQEP CP: 3220); farms were selected using simple random sampling within these study areas. For Rangamati and Cox's Bazar district, we used convenience sampling strategy (non-probability sampling scheme) due to absence of sampling frame. However, to validate the selection of farms and to confirm reasonable representation of farms with all possible variation of the study area, before convenience sampling, local vets and dairy practitioners were contacted and were included in to the team during farm selection

and data collection. A total of 210 farms from the study area (101 farms from Chittagong district, 66 farms from Cox's Bazar district and 43 farms from Rangamati district) were selected for data collection. All calves with diarrhea (having loose motion or just have recovered from) within the selected farms were incorporated in to the study. In addition, a sample of healthy calves (without diarrhea) was selected. Altogether, 411 calves from 210 farms were sorted out as the study population at the end of the sampling. No biological samples from the study subjects were collected for this present study.

Study Design and Data Collection Tool

The survey followed a cross sectional design. Each farm was visited once during the study period. A standard questionnaire was used as data collection tool for the present study. Questions to be incorporated in to the questionnaire were identified through a standard procedure. Initially, a thorough literature review was done to identify management factors related to calf death in Bangladesh and in other countries. For expert opinion, these factors were further discussed with local vets and practitioners and the questions were corrected as suggested. The draft questionnaire was used to conduct a pilot study including a small number of farms around the center of the research station (CVASU, Bangladesh) and was amended when discrepancies found.

Data Management and Statistical Analysis

Scoring (good, moderate, poor) was applied to some variables; categorized as follows:

Hygiene score: Good, Cleaning of floor with disinfectants every day, un-authorized people and vehicle access in farm premises is prohibited, regular washing of udders with antiseptics before milking and washing of milker's hand with antiseptics before milking; moderate, Cleaning of floor with disinfectant once or twice per week (others similar as previous); poor, Cleaning of floor with only water regularly, un-authorized people and vehicle access is not prohibited, regular washing of udders with water before milking, washing of milker's hand with antiseptics before milking.

Surrounding environment: Good, at least fifty meter distance from roads and highways/industrial areas and residential areas; moderate, at least fifty meter distance from roads and highways/industrial areas but closed to residential areas; poor, less than fifty meter distance to roads and highways/industrial areas as well as residential areas.

Drainage system: Good, water runs out perfectly from the pen within 15 minutes during cleaning and rainy season and leaves the pen dry; moderate, water runs out perfectly from the pen within 15 minutes during cleaning but during heavy rain water stays for more than 15 minutes; poor, water does not run out perfectly within 15 minutes during cleaning or rain and the floor remains wet most the time.

Feed storage: good, locked separate feed store room with proper ventilation; moderate, locked separate feed store room without proper ventilation; poor, no separate feed store room, feed are stored within the burn.

Survey data were entered in to an Excel spreadsheet (Microsoft Office Excel 2007). Data distribution were examined across study strata; regions, districts etc. Intercooled STATA 9.2 for Windows (Stata Corp LP, College Station, Texas) was used to statistically compare results across study strata. Descriptive analysis was performed by means of frequency (N, %) of presence of different factors in different strata. Association between different factors with different geographically distinct areas and size of the farm (herd size) was determined using uni-variable statistical significance tests (chi square test or Fisher's exact test).

Table 1: Farm demographics of 210 dairy farms surveyed during July, 2015 to May, 2016 in Chittagong, Bangladesh

Variable	Level	Frequency	Percent
Farmers education	Illiterate	6	3
	Primary	97	46
	Eight	11	5
	Secondary	39	19
	Higher secondary	11	5
	BA/BSc	33	16
	MA	12	6
	MBBS	1	0.48
Herd size	5-20	126	60
	21-50	55	26
	>50	29	14
No. of calf (<6 month age)	1 to 5	138	66
	6 to 15	56	27
	16 to 37	16	8
Total area of farm (sq. feet)	100 - 450	87	41
	500-1500	61	29
	1800-3000	33	16
	3500-10000	29	14
Geographic region	Coastal	66	31
	Hilly	43	20
	Plain	101	48

RESULTS

Farm Demographics

Farm demographics are shown in Table 1. Only remarkable findings are discussed in text. Among 210 farms, 97 (46%) farm owners were educated up to primary level, 16% (n=33) completed graduation. 60% (n=126) of the sampled farms were raising 5 to 20 caws, only 14% (n=29) had a big

herd size of over 50 cows. Eight percent farms had 16 to 37 calves (<6 months age). However, most of the farms (66%) had 1 to 5 calves in their farm in the study area.

Table 2: Demographics of 411 calves from 210 dairy farms surveyed during July, 2015 to May, 2016 in Chittagong, Bangladesh

Variable	Level	Frequency	Percent
Age	<1 week	53	13
	>1 to 3 weeks	143	35
	>3 to 6 weeks	178	43
	>6 weeks	37	9
Sex	Female	214	52
	Male	197	48
Breed	Cross	324	79
	Local	87	21
History of calf scour	No	112	27
	Recovered	104	25
	Yes	195	47
Therapy	None	218	53
	Antibiotics	169	41
	Antiparasitic	19	5
	Other	5	1
Body weight (kg)	15 – 25	117	28
	26 - 40	227	55
	41 - 55	67	16
History of dystocia during birth	No	386	94
	Yes	24	6

Calf Demography

Detailed calf demographics are shown in Table 2. Male and female ratio among the claves was nearly similar in the sampled farms, 48% and 52%, respectively. 79% of the calves were cross breed. During the study period, 195 (47%) calves were discovered with loose motion and another 104 (25%) were identified recovered from the syndrome; 41% of the total calves were treated with antibiotics. 24 calves (6%) faced dystocia during birth in the study area.

Farm Level Calf Management and Hygiene Practices

Majority (47%) of the calf pen floors was slatted or was made of concrete and 86% of the pens were identified without bedding materials/litter. Some of the farmers used rubber pad (12%) or grass (2%) as bedding material. 23% of the farms used surface water (from pond, river, lake *etc.*) as the drinking water for their calves. 28% farmers said that they never cleans calf pen, 62% cleans with water only. 55% farms allows calf to drink colostrums within 30 minutes of birth and 72% farmers feed calves with waste milk. All farmers said that they do not use separate utensils (*e.g.* feeding utensils) for different calves and among them only 5% said they disinfect the utensils between calves. Less than a quarter of the farms (18%) had a good drainage system for the calf pen. 42% of the total study farms were raising other domestic animals and birds than cows within the same premise (Table 3).

Table 3: Farm management and hygiene practices for calf pen in 210 dairy farms surveyed during July, 2015 to May, 2016 in Chittagong, Bangladesh

Variable	Level	Frequency	Percent
Type of barn	Open	74	35
	Partially open	68	33
	Closed	68	33
Hygiene score	Good	29	14
	Moderate	129	61
	Poor	52	25
Type of floor	Concrete/slatted	98	47
	Brick	54	25
	Grass/muddy	58	28
Type of litter	No litter	180	86
	Robber pad	25	12
	Grass	5	2
Drinking water for calf	Tube well	157	75
	Municipal supply	4	2
	Surface water	49	23
Pen cleaning	No cleaning	59	28
	Water cleaning	130	62
	Water with disinfectant	21	10
Separation of calf	Immediately after birth	23	11
	<24 hours	46	22
	>24 hours	139	66
First colostrums	Within 30 minutes	115	55
	Within 2 hours	90	46
	More than 2 hours	4	2
Waste milk feeding	No	58	28
	Yes	152	72
Sucking as feeding regime	No	85	40
	Yes	125	60
Confinement of calf after birth	Single	6	3
	Group	204	97
Maximum age difference between calves in a pen	<4 weeks	17	8
	4 to 8 weeks	65	31
	>8 weeks	128	61
Calf utensils	Shared and disinfected	10	5
	Shared and rinsed with water	200	95
Surrounding environment	Poor	57	27
	Moderate	102	49
	Good	51	24
Drainage system	Poor	80	38
	Moderate	92	44
	Good	38	18
Feed storage	Poor	76	36
	Moderate	101	48
	Good	32	15
Other animals in farm	No	122	58
	Yes	88	42

Table 4: Frequency of adoption of farm management and hygiene practice in calf pen in small (5-20), medium (21-50) and large (>50) sized farms as assessed in a survey of 210 dairy farms in Chittagong, Bangladesh

Variable	Level	5 to 20	20 to 50	>50	P-value
		N (%)	N (%)	N (%)	0.004
Type of barn	Open	41 (33)	16 (29)	17 (59)	
	Partially open	35 (28)	24 (44)	9 (31)	
	Closed	50 (40)	15 (27)	3 (10)	
Hygiene score	Poor	40 (32)	9 (16)	3 (10)	0.001
	Moderate	76 (60)	37 (67)	16 (55)	
	Good	10 (8)	9 (16)	10 (34)	
Flooring	Concrete/slatted	29 (23)	43 (78)	26 (90)	<0.0001
	Brick	39 (31)	12 (22)	3 (10)	
	Grass/muddy	58 (46)	0	0	
Type of litter	No litter	116 (92)	41 (75)	23 (79)	0.003
	Rubber pad	6 (5)	13 (24)	6 (21)	
	Grass	4 (3)	1 (2)	0	
Drinking water	Tube well	82 (65)	47 (85)	28 (97)	<0.0001
	Municipal supply	0	4 (7)	0	
	Surface water	44 (35)	4 (7)	1 (3)	
Pen cleaning	No cleaning	59 (47)	0	0	<0.0001
	Water cleaning	67 (53)	45 (82)	18 (62)	
	Water with disinfectant	0	10 (18)	11 (38)	
Separation of calf	Immediately after birth	107 (85)	23 (43)	9 (32)	<0.0001
	<24 hours	11 (9)	20 (37)	15 (54)	
	>24 hours	8 (6)	11 (20)	4 (14)	
First colostrums	Within 30 minutes	68 (54)	31 (57)	16 (55)	0.12
	Within 2 hours	58 (46)	20 (37)	12 (41)	
	More than 2 hours	0	3 (6)	1 (3)	
Waste milk feeding	No	42 (33)	12 (22)	4 (14)	0.05
	Yes	84 (67)	43 (78)	25 (86)	
Sucking as feeding regime	No	64 (51)	17 (31)	4 (14)	<0.0001
	Yes	62 (49)	38 (69)	25 (86)	
Confinement of calf after birth	Single	1 (0.79)	4 (7)	1 (3)	0.05
	Group	125 (99)	51 (93)	28 (97)	
Maximum age difference between calves in a pen	<4 weeks	4 (3)	8 (15)	5 (17)	<0.0001
	4 to 8 weeks	24 (19)	24 (44)	17 (59)	
	>8 weeks	98 (78)	23 (42)	7 (24)	
Calf utensils	Shared and disinfected	0	5 (9)	5 (17)	0.0001
	Shared and rinsed with water	126 (100)	50 (91)	24 (83)	
Surrounding environment	Poor	42 (33)	12 (22)	3 (10)	0.03
	Moderate	61 (48)	26 (47)	15 (52)	
	Good	23 (18)	17 (31)	11 (38)	
Drainage system	Poor	64 (51)	13 (24)	3 (10)	<0.0001
	Moderate	54 (43)	26 (47)	12 (41)	
	Good	8 (6)	16 (29)	14 (48)	
Feed storage	Poor	60 (48)	12 (22)	4 (14)	<0.0001
	Moderate	57 (46)	28 (51)	16 (55)	
	Good	8 (6)	15 (27)	9 (31)	
Other animals in farm	No	58 (46)	44 (80)	20 (67)	<0.0001
	Yes	68 (54)	11 (20)	9 (31)	

Variations in Management and Hygiene Practices According to Herd Size and Regions

Association between different management and hygiene practices with herd size and different regions are shown in Table 4 and 5. All variables except 'feeding of first colostrums' showed a statistically significant ($p<0.05$) variation across different herd size. Among larger farms (>50 cows), 10% had a poor hygiene score whereas 32% of

Table 5: Frequency of adoption of farm management and hygiene practice in calf pen in Hilly, Coastal and plain land farms as assessed in a survey of 210 dairy farms in Chittagong, Bangladesh

Variable	Level	Coastal	Hilly	Plain	**P-value**
		N (%)	N (%)	N (%)	0.002
Type of barn	Open	21 (32)	17 (40)	36 (36)	
	Partially open	14 (21)	10 (23)	44 (44)	
	Closed	31 (47)	16 (37)	21 (21)	
Hygiene score	Poor	16 (24)	12 (28)	24 (24)	0.18
	Moderate	45 (68)	27 (63)	57 (56)	
	Good	5 (8)	4 (9)	20 (20)	
Flooring	Concrete/slatted	18 (27)	9 (21)	71 (70)	<0.0001
	Brick	17 (26)	7 (16)	30 (30)	
	Grass/muddy	31 (47)	27 (63)	0	
Type of litter	No litter	59 (89)	38 (88)	83 (82)	0.003
	Rubber pad	7 (11)	0	18 (18)	
	Grass	0	5 (12)	0	
Drinking water	Tube well	53 (80)	15 (35)	89 (88)	<0.0001
	Municipal supply	0	0	4 (4)	
	Surface water	13 (20)	28 (65)	8 (8)	
Pen cleaning	No cleaning	36 (55)	23 (53)	0	<0.0001
	Water cleaning	30 (45)	20 (47)	80 (79)	
	Water with disinfectant	0	0	21 (21)	
Separation of calf	Immediately after birth	65 (98)	43 (100)	31 (31)	<0.0001
	<24 hours	1 (2)	0	45 (45)	
	>24 hours	0	0	23 (23)	
First colostrums	Within 30 minutes	27 (41)	32 (74)	56 (56)	0.002
	Within 2 hours	39 (59)	11 (26)	40 (40)	
	More than 2 hours	0	0	4 (4)	
Waste milk feeding	No	32 (48)	7 (16)	19 (19)	<0.0001
	Yes	34 (52)	36 (84)	82 (81)	
Sucking as feeding regime	No	28 (42)	24 (56)	33 (33)	<0.03
	Yes	38 (58)	19 (44)	68 (67)	
Confinement of calf after birth	Single	0	0	6 (6)	0.03
	Group	66 (100)	43 (100)	95 (94)	
Maximum age difference between calves in a pen	<4 weeks	0	0	17 (17)	<0.0001
	4 to 8 weeks	13 (20)	6 (14)	46 (46)	
	>8 weeks	53 (80)	37 (86)	38 (38)	
Calf utensils	Shared and disinfected	0	0	10 (10)	<0.0001
	Shared and rinsed with water	66 (100)	43 (100)	91 (90)	
Surrounding environment	Poor	16 (24)	16 (37)	25 (25)	0.35
	Moderate	32 (48)	21 (49)	49 (49)	
	Good	18 (27)	6 (14)	27 (27)	
Drainage system	Poor	36 (56)	16 (37)	28 (28)	<0.0001
	Moderate	25 (38)	23 (53)	44 (44)	
	Good	5 (8)	4 (9)	29 (29)	
Feed storage	Poor	22 (33)	28 (65)	26 (26)	<0.0001
	Moderate	37 (56)	15 (35)	49 (49)	
	Good	7 (11)	0	25 (25)	
Other animals in farm	No	28 (42)	12 (28)	82 (81)	<0.0001
	Yes	38 (58)	31 (72)	19 (19)	
Herd size	5-20	61 (92)	39 (91)	26 (26)	<0.0001
	21-50	5 (8)	3 (7)	47 (47)	
	>50	0	1 (2)	28 (28)	

the smaller farms (5-20 cows) had a poor score. Majority of the large and medium (20-50 cows) sized farms had a concrete/slatted floor at the calf pen, 90% and 78% respectively. On the other hand, nearly half (46%) of the small farms had a muddy or grass floor for the claves. 97% of the large farms used tube well as the source of drinking water for their calves, on the other hand 35% of the small farms used surface water. None of the large and medium farm owner said they never clean the calf pen; 47% small farm owners said yes to it. Zero, 9% and 17% of the small, medium and large sized farms practiced disinfectant to clean calf utensils, respectively. 41% and 48% of the large farms had a moderate and good drainage system in their calf pen, respectively. More than half of the small farms (54%) were discovered with raising other domestic animals and birds within the same premises.

Hygiene score and surrounding environment of the farms did not show any regional variation ($p>0.05$). 70% of the farms in plain land had concrete/slatted floor in the calf pen, on the other hand 63% and 47% of the farms in hilly and costal region, respectively had muddy/grass floor. Remarkably 65% farms of the hilly area used surface water for their calves to drink with. 55% and 53% of the farmers in coastal and hilly region, respectively, said they never clean calf pen, whereas 100% of the plain land farmers said they clean pens either with water or disinfectant. Other than 6 farms in the plain land, all other farms from different regions were practicing group confinement for the calves. All 10 farms practiced disinfectant to clean shared calf utensils between calves were from plain land. A noticeable number (81%) of the plain land farmers do not practice mixed farming system, which is 28% and 42% for the farms in hilly and coastal regions, respectively.

Table 5 shows the distribution of herd size according to different regions. 92% and 91% farms in the coastal region and hilly area respectively were small sized farm. Overall, 100 out of 126 (79%) small sized farms were situated in these 2 areas. Plain land farms were a mixture of all 3 types of herd size; however, among 29 large sized farms surveyed in the study, 28 were situated in the plain land region.

DISCUSSION

The present survey was carried out to characterize, and evaluate variations in, management and hygiene related practices at calf pens adopted by dairy farms across different strata of the survey; herd size and regions. Statistically significant variations were observed in different factors through different strata that might influence in-farm calf mortality from different infectious diseases. It was revealed from the present survey that majority of the farms in the study area are small sized rearing only 5 to 20 cows, and 14% of the sampled farms were rearing more than 50 cows. Many studies discovered the relationship between herd size and calf mortality (Del Río et al., 2007; Gulliksen et al., 2009; Mellado et al., 2014). Majority of the studies suggested that small or medium sized farms are beneficial for calf survival (Seppä-Lassila et al., 2016) perhaps due to increased chance for pathogens to trade among increased number of animals in large sized farms. It could also be because of increased care to the fewer, relatively more precious, calves, in smaller herds. For example, colostrums management practices were found associated with herd size in previous studies (Kehoe et al., 2007). In addition, larger farm size was found associated with respiratory tract infections (Svensson and Liberg, 2006). There are chances for more courses of transmission of pathogens within larger herds. Moreover, adult cow mortality was found significantly associated with larger herd size (Raboisson et al., 2011; Alvåsen et al., 2012). However, in the present survey, we observed that only 8% of the small sized farms are practicing a good hygiene practice, none of them uses disinfectant with water to clean calf pen; 47% never cleans calf pens not even with water, a remarkable number of them serves surface water to calves for drinking purpose, none of them disinfects shared calf utensils before using between calves, only 6% has a good drainage system and feed storage system. It indicates that the calf management system in small sized farms in the study area might not be similar to other countries. Hygiene practices recorded in small and medium sized farms were very different than the large sized farms in the present study area. Specifically, insufficient cleaning of calf pen and feeding utensils might increase the chance of spread of different diarrheal and respiratory disease pathogens among calves. Moreover, giving surface water for drinking might increase several fold the risk of introduction of many water borne diseases in to the farm. Since 60% of the farms in the study area were small sized farms, insufficient hygienic measures practicing by the mentioned group might be a major concern for the dairy industry of the area. Awareness through training among the smallholders might be necessary to improve the hygiene level of the farms, hence to improve the herd health. However, good hygiene practice involves costs that might be an utmost concern among small holder owner. Implementation of government incentives might be necessary to uplift this potential sector of the area.

On the other hand, hygiene score did not show any significant association with the region of the study area. However, it was noticeable that 65% of the farms in the hilly area provide surface water as drinking water to the calves. This trend might be explained as unavailability of tube well and municipal supply and availability of lake water in the hilly area. Awareness towards treated surface water could be a good choice for the policy makers for the farmers of this region. Nearly half of the farmers in hilly and coast areas said that they never cleans the calf pen and all 21

farms used disinfectant with water to clean their farm were from plain land. The relationship between cleaning of calf pen across different regions might be confounded by herd size. It was observed that all those 21 farms were medium and large sized farms and situated in plain land. In the present study, plain land includes Chittagong city that consists some of the largest farms of the study area rearing more than 150 cows and practicing good hygiene measures. For example, in the present study only 10 farms used disinfectant with water to clean calves feeding utensils, are from plain land. It was noticeable that 72% and 58% farms of the hilly and coastal area, respectively are practicing mixed farming system, might also be influenced by farm size (79% small sized farms are situated in these two regions) as smallholders tend to raise different species together compared to large scale farms.

A remarkable number (46%) of farmers of the present study completed only primary level of education. Kabir (1995) reported that the average literacy rate of farm households in all farm categories was higher than the national average; more than 76% in all the farm categories had above primary level of education. Khan et al. (2013) reported that 60% of the farmers had higher secondary level education and no illiterate and under secondary education level farmers were found in a different study area which does not agree with our survey. However, both surveys were conducted in separate regions and the sample size (30 farms *vs.* 210 farms in the current study) could be an influencing factor here. Education and training intensify farmer's capability and desire to make successful modification to their management practice. Training program generally influence participants to make alterations to their practice following the program (Bartel and Lichtenberg, 1987). Therefore, implementation of effective training program to provide technical education to the farmers about farm management practice could make a difference in the study area.

Only 2 farms out of 210 sampled farms provided the calves with colostrums after 2 hours of birth. No significant difference among farm size or regions in colostrums management practice was observed. It can be concluded form this result that nearly all farmers of the study area had a fair knowledge about timing of colostrums feeding. However, it was observed that if calves receive colostrums by suckling than those fed using other methods, have a higher mortality rate (Gulliksen et al., 2009) and a delay in colostrums feeding increases calf mortality (Zucali et al., 2013). Moreover, the odds of having diarrhea was higher in calves <3 months of age that was provided colostrums by suckling (Svensson et al., 2003). In the present study 60% of the farmers used suckling as feeding regime for the calves, might have incorporated some risks in their colostrums feeding management.

We collected demographic data from 411 calves during the present survey. 195 calves were diagnosed with having some form of diarrhea (by physical examination of feces) and another 104 calves were identified as recovered according to the farmer's opinion. However, calculation of prevalence of diarrhea was beyond the scope of this survey as we did not include all calves in to the survey from each selected farm and diagnosis of diarrhea was based on physical examination and history. Although, 195 diarrheal cases and 104 recovered cases from 210 farms is a big enough number to be concerned about. A statistically designed extended study might be necessary to identify the pathogens responsible for this situation, relative attribution of pathogens in the study area and to evaluate the risk factors to formulate area specific recommendations.

CONCLUSION

It can be concluded from the present survey that the small herd sized dairy farm owners in the study area adopted some established risky calf management and hygiene practice that might lead to high calf morbidity/mortality in the farm. Considering the fact that majority of the dairy farms in the study area is small scale, high risk management practices by them could cause high economic losses through increased calf morbidity/mortality. This phenomenon might have had reduced the interest among farmers about dairy farming in the study area.

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CONFLICT OF INTEREST

There exists no conflict of interest.

AUTHORS' CONTRIBUTIONS

SC, SRB and TMR conducted the research and actively prepared the manuscript. TF, MM and MMR designed the work and provided the information. TMR, SC, MSI and MAH participated in the manuscript preparation and advice during the research work. All the authors read and approved the final manuscript.

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