DAIRY BUFFALO PRODUCTION UNDER INTENSIVE SYSTEM IN SEMI ARID AREA OF BANGLADESH

S.M. Rajiur Rahman*, Md. Nurul Islam, Md Harun-ur-Rashid, Md. Sohel Rana Siddiki and Mohammad Ashiqul Islam

ABSTRACT

An attempt was made to know the management system of intensive buffalo farming and buffalo derived -problems under semi-arid area of Bangladesh. Direct interview with farmers, farm observation, community discussion and key informant interview (KII) had been followed over six months in Dinajpur district. It was observed that buffaloes were reared under two types of management system namely household yard intensive (HYI) and completely intensive (CI). In HYI system, farmers purchased heifer or pregnant buffalo from local market and sold mother with calf after one year. Buffaloes were kept shed at night and maintained feeding, showering and other activities in the household yard at day. Those were showered by once-two times/week in cool day, but most of them were showered in a day. On the other hand, in CI system, buffaloes were reared inside the shed all time and maintain feeding, showering and other activities in the shed. Buffaloes were showered twice in a day in winter period while three times in summer period. Average milk production for each buffalo was 5 to 8 liter/day. Major productive and reproductive traits e.g. lactation Length (day), average milk yield (L/day), dry period (day), age at first pregnancy (month) and age at first calving (month) were found better in CI system than that of HYI system and those were found highly significant ($P<0.001$). Significant difference were found on total solids, fat and protein content but no significance difference were observed on SNF, lactose and ash of buffalo milk between two farms. Insignificant difference ($P>0.05$) was found for the value of electric conductivity (ECms/cm) that showed both farms produced healthy milk (3.25±0.49 vs 3.09±0.89). Both systems showed as a profitable venture (BCR 1.33 vs 1.25). Problem matrix revealed that the top ranked order of problem were “inadequate knowledge on buffalo rearing”, “high price of feed” and “low milk price” mentioned as 1, 2 and 3. Shortage of feeds and fodder, high temperature and lack of cow boy were ranked as 4, 5 and 6. Limited breeder bull, lake of AI workers and inadequate quality semen and credit facilities mentioned as 7 ranked problem. It was concluded that ensuring training and marketing could help to improve intensive system of dairy buffalo that meet up the growing demand of milk in urban people. Simultaneously AI facilities with quality semen, HYV fodder cultivation and credit facilities should be promoted for sustainable dairy buffalo farming.

Keywords: *Bubalus bubalis*, buffalo, buffalo farming, feeding system, milk quality

Department of Dairy Science, Bangladesh Agricultural University, Bangladesh, *E-mail: smrajiurrahman@yahoo.com

INTRODUCTION

The rural farming system of animal agriculture consisting buffaloes (*Bubalus bubalis*) and other livestock resources in Bangladesh. Buffalo is a less prioritized dairy species in Bangladesh though it has potential health beneficial due to quality of milk and meat. The buffalo meat is of good quality as compared to the cattle beef because of the low cholesterol. Buffalo meat contains 40% less cholesterol, 55% less calories, 11% more protein and 10% more mineral in comparison to bovine meat (Nanda and Nakao, 2003). Buffalo milk has 43% less cholesterol than cow's milk on the basis of per gram butterfat and having 58% and 40% more calcium and protein than cow's milk respectively. In addition to the significant cholesterol and calcium benefits of buffalo milk, is also a rich source of iron, phosphorus, vitamin A and of course protein (Bilal *et al*., 2006). Considering its composition, it may be advisable over cattle beef for the cholesterol sanative people (Bilal *et al.*, 2006). It has been never addressed in before by policy level in Bangladesh despite their important role in the national economy. The buffaloes are 14.71 million heads (DLS 2016) in Bangladesh. Though the trend of buffalo population (2.20%) in recent year is relatively higher than cattle (0.44%) but buffalo milk production is not contributed significantly to national production in Bangladesh (Islam, 2017). Total milk production of Bangladesh is about 7.27 million metric tons per year (MMT) against the requirement of 14.69 MMT (DLS 2016). To address the gap of demand and availability of milk, another dairy species e.g. buffalo should be prioritised along with cattle.

Several production system based on management practices and feeding system are found in Bangladesh. At the village level production is usually based on a small herd of mixed ages and sexes generally for milk and breeding purposes. In a semi-intensive production system, buffaloes are kept mainly for specific purposes, i.e., either for milk or for meat production. In an extensive production system, a larger herd is kept for both meat and meat production (usually for sale or slaughter). In the village production systems, buffaloes and cattle are kept within the shed at night, and spend the daytime household yards for feeding and resting, together with other animals. Many buffaloes rear in saline coastal region under extensive farming in *Char areas*. In river basin areas, buffaloes are reared under semi-intensive system. In this system, buffaloes are kept within the shed at night and spend daytime for grassing in the *Bathan.* Besides, a few number of intensive buffalo farming also been seen in some institutional herd as well as farmer level as business purpose where buffaloes are kept in shed whole time. Household intensive system are very scattered and mainly seen at Northern part of Bangladesh, e.g. Dinajpur, Rangpur which is reared mainly under the intensive irrigated agriculture system. The national strategies for the irrigated intensive agricultural system in developing countries should focus upon producing less expensive milk from dairy buffaloes that, efficiently, utilize the limited expensive produced feed resources (Soliman, 2007). Milk production has a comparative advantage in agricultural resource use, in terms of net costs per 100 grams animal protein under irrigated intensive agricultural system in developing countries (Soliman, 2007). The total milk yield per lactation and lactation period varied among the systems due to availability of feed resources, management systems and genotypes of buffaloes. The buffalo raised under household / semi-intensive system produced higher milk than those raised under bathan /extensive system which

results household farming is more attractive as it gives milk and meat both. The lactation yield in the household farming/ semi-intensive system and bathan farming /extensive system were 712 to 799 and 435 litres, respectively (Faruque *et al*., 1990; Uddin *et al*., 2016).

There is several research works in Bangladesh which is demonstrated about productive, reproductive and management system of dairy buffalo under extensive and semi- intensive system, but there is very few information about intensive system of buffalo farming. Moreover India, Pakistan, Trinidad, Italy and some other country have been started intensive system buffalo farming to increase the national milk production in the country. Farmers of Bangladesh believe that extensive system is essential for buffalo farming due to its feeding and wallowing behaviours. This study is therefore undertaken to know the different information regarding feeding, breeding, management practice and associated problems under intensive system of dairy buffalo farming; so that policy makers could be given attention for development of milking buffalo farming which would lead to improve milk production in Bangladesh.

MATERIAL AND METHODS

Location of study areas

Dinajpur district was selected for the study as a semi-arid aria. Moreover greater Dinajpur and Rajshahi district are second buffalo concentrate areas holding 5.1 to 10 buffalo for 1000 people (Huque and Khan, 2017). Birganj, Kaharol and Dinajpur sadar upazilla under Dinajpur district were selected for the study.

Climate of Study area

Dinajpur experiences a hot, wet and humid tropical climate. Under the Köppen climate classification, Dinajpur has a tropical wet and dry climate. The district has a distinct monsoonal season, with an annual average temperature of 25°C (77°F) and monthly means varying between 18°C (64°F) in January and 29°C (84°F) in August. Paddy, Maize, wheat and potato are main crops (Wikipedia 2017).

Farmer selection

Based on the information of Upazila Livestock Office of Birganj, Kaharol and Dinajpur Sadar buffalo farmers were considered for the study. Farmers were randomly selected based on management system and on the experience of dairy buffalo farming having at list one milking buffalo and one calf.

Preparation of questioner

Structure questionnaire was developed according to variable of the objectives. Variables like productive, reproductive, feeding and management practice with related problem for buffalo farming were considered. Data was collected using standard procedure. The questionnaire was pre-tested in the selected area. Some addition and subtraction had been made in the preliminary schedule on the basis on experienced gained in pre-tasting and finalized the questionnaire. The schedule contains were both open and closed-ended question.

Data collection

Qualitative and quantitative information were collected from household yard intensive and full intensive farm. Data were collected directly from 30 household yard intensive (HYI) farms and visited by the researcher through face to face

interviews. Moreover more than 60 milking buffalo farmers were discussed for validate the information of household yard intensive system (HYI). Discussion was also conducted with the cowboys (hired labours) who were taken care of buffalo farm to confirm and recheck the information.

Information is collected from two completely intensive (CI) system buffalo farms (who were rearing buffaloes since three decade) over six months period through direct interview with a prescribed format which was kept in record book. Researcher also kept communication with the farm owners by over mobile phone during study period. Based on record book, different information/ variables were collected from individual farm e.g. gestation period, calving interval, lactation period, dry period, milk production, breeding system and profitability. Feeding and management practices were documented based on questioner. Problem associated to buffalo farming were collected and rechecked with cowboys, Veterinary Field Assistant (VFA) and Upazilla Livestock Officer (ULO). The study therefore follows the mixed methodology mode of Greene *et al.* (1989) focusing mainly on triangulation which can investigate the same issue with the same unit of analysis (Mitchell, 1986).

Period of study

Farm visit, farm observation, secondary review, community discussion were held in the period of six moths which was from October 2016 to March 2017.

Milk sample collection and analysis

Milk sample were collected from both type of intensive farm of Dinajpur district. Just after milking milk samples were collected by ice box and frize at minus twenty degree centigrade (-20^{o}C) due to bring the sample to Dairy Science Laboratory, Bangladesh Agricultural University, Mymensingh. Milk samples were analysed after reaching normal temperature. The milk compositions (TS, SNF, Fat, Protein, Lactose, Ash, P^{H}, Density and conductivity) were analyzed by using Lactoscan milk analyzer (Milktronic Ltd., 600 Stara Zagora, Bulgaria) in the Dairy Science Laboratory, Bangladesh Agricultural University.

Determine of the problem matrix of dairy buffalo farming

In order to understand local perceptions of the problem of dairy buffalo farming, a simple proportional pilling tool was used with two different groups of informant consisting sixteen buffalo farmers. The informants were asked to think about related problem that might have influenced the reduction of dairy buffalo production. Ten factors were identified and then recognized first five factors using 16 small stones.

Data analysis

After collecting data from field, these were edited and coded. The data was then transfer to MS Excel for processing and summarizing. The tabular technique mainly used to analyze the data and derived meaningful finding by using simple statistical measures like mean, percentage and ratio. Statistical analyses were carried out through SPSS version 16 computer package and analysis of variance of treatment (three locations) means was done by ANOVA in case of productive, reproductive and milk quality. Duncan Multiple Range Test (DMRT) was used to the level of significance the treatment means.

RESULT AND DISCUSSION

Dairy buffalo model

Dairy buffalo farm were very scattered in the study areas. Eighty-eight percent (88%) farmers reared dairy buffaloes that were purchased pregnant or heifer buffalo for business purpose. All of them reared buffalo under household yard. After calving, farmers sold buffalo with calf when age of calf became for two-three months. Among them, a total of 12% farmers maintained full cycle; they reared milking buffaloes with calf for selling milk as a means of family income. Buffalo were reared in shed at night and whole day in household yard allocation with feeds. On the contrary, a few number of intensive dairy buffalo herds were shown in study areas that were reared buffalo all time in the shed. They were rearing buffaloes since two-three decades. Herd size was consisting with 6 to 22 buffaloes by maintaining stall feeding with cooling fan and showering, called as completely intensive (CI) system.

Housing system

Most of the house made by muddy, bamboo and straw. At night farmer kept animal in house. During day, they kept animal in household yard (HYI) where animal took rest and fed to straw, grass, water and small amount of concentrate feed under HYI system. But buffaloes were passed day-night in brick and tin made shed under completely intensive system (CI). Uddin *et al.* (2016) observed that dairy buffaloes were kept under semi-intensive system in the wet season and only 15% farmers provided shed having only roof but no concrete floor. Akbar *et al.* (2009) mentioned that most of the dairy buffalo were not housed in extensive system of bathan areas but buffaloes which were in the plain land sometime had an enclosure, only roof made by straw or tin without wall and floor was always muddy. Seventy four percent respondents reported that the average housing facilities were unavailable for buffalo rearing (Siddiki, 2017) which was not agreed to present study as in Dinajpur both type of farm provided houses for buffaloes. According to Siddiki, 2017, 100% of the farmers didn't care about the housing for buffalo rearing in Subornochar upozila, followed by Trishal, Bagha and Lalpur were 80%, 70% and 45%, respectively and differed significantly ($P<0.01$) between the locations.

Feeding system

The main diet for the buffalo was roughage such as natural grass, and paddy straw. The roughage could be fed either fresh as pasture or in a cut-and-carry-system. The roughage was often complemented with grains, concentrate and agro-industrial by-products such as of wheat bran, oil cake and broken rice etc. Concentrate feed, paddy straw, local grass and water were provided in the manger in a household yard in day time under HYI system. But in night only straw and water kept in the shed where passed whole. Forage was found as insufficient during the dry season and abundant during the rainy season.

Different types of feed base identified under intensive household yard (HYI) system. Average rice gruel ready feed, broken maize, maize flower, rice bran, wheat bran , broken rice after cook, mustard oil cack, molasses, paddy straw green grass cultivated/cut and carry and fresh water were 1.71, 0.03, 0.14, 0.16, 0.14, 1.53, 0.86, 0.19, 0.09, 10.69, 6.22 and 25 to 60 kg/day/buffalo provided respectively. All farmers provided paddy straw and half of them were provided green grass. A total of 75% farmers provide wheat bran, 62.5% farmers provide cack, 62.5% farmers provide

broken rice after cooking and 50% farmers provide broken maize to milking buffalo (Table 1). Under completely intensive system (CI), supply of feed resources depend on season and available of feeds and fodders Table 2. Buffaloes were given more grass (10 to 14 kg/day/each) for three-five months (March to July) during flash period and less grass (1 to 6 kg/day/each) for seven months (August to February) during lean period. During that time paddy straws were also given at the rate of 7.5 to 9 and 11 to 14 kg/day respectively depending on the season. Allocation of concentrate feeds were 5 to 7 kg/milking buffalo. Broken maize, wheat bran, broken rice, and oil cake mainly were used for concentrate mixture. Ahmed (2006) showed that common concentrates of wheat bran, rice polish, pea bran, khesary bran, matikalai bran, lentil, sesame oil cake, coconut oil cake and mustard oil cake were available round the year for dairy animal which support our findings. In the rainy and winter season some legumes, green grasses were grown sporadically in some areas of the country and next six months availability of green grass was very limited, during this time rice straw alone contributes 87% of roughage portion of the dairy feed (Tareque, 1991) (Table 3).

The dry matter intake (DMI) (kg/d) of milking buffaloes in different locations was varies from 13 to 15 (kg/d) (Siddiki, 2017) but in our study dry matter supply (DMI) (kg/d) of milking buffaloes in study area was near to similar as dry matter basis (kg/day).

Watering

All farmers (100%) provided fresh drinking water to buffalo in three times a day under HYI and CI system. Average water intake was 26 to 60 litter under HYI. But 45 litters and 60 litters were found in winter and summer period respectively under CI system. Drinking water is the most important water source of buffalo for body functions, e.g. maintaining body temperature, milk production and maintaining blood plasma volume. A restricted water intake leads to a decrease in dry matter intake and thus affects milk production and growth negatively (Buffalopedia, 2018).

Wallowing

Due to keep cool body temperature and control of insect, buffaloes showed wallowing behavior. In case of absence of water or mud hole, the buffaloes behave more likely to cattle. They need shade and shower. Very few numbers of buffaloes were allowed for wallowing at pond or river in summer season under HYI system. Wallowing was done in river/pond for 1 to 2 h during July to October in this system. Buffaloes were showered once/two times during a week in high cool period (December to January) and other time, most of the farmers' showered buffalo at home once time in a day for both HYI and CI system. When buffaloes enter the water, they defecate and/or urinate to maintain temperature (buffalopedia, 2018). According to farmer reaction, without showering, buffalo feed intake was reduced, skin disease, delay heat and early abortion might be occurred.

Breeding

A total of 96.3% buffalo cow received natural breeding under HYI system whereas, AI was covered only 3.7% in semi-arid areas of Bangladesh. Most of the farmers were facing problem to breed their buffaloes during heat. As of notification of farmers buffaloes were missing heat several times due to lack of breeding bull and far distance of bull station from farm. Moreover farmers bring the heated buffalo far way by small van/track which was very costly (BDT 25000 to

Table 1. Location of study areas.

Name of the upazilla	Location in Bangladesh	Human population density	Type of farm
Birganj	26°0′0″N 88°35′0″E	560/km^2 (1,500/sq mi)	Full Intensive and Intensive household yard
Dinajpur sadar	25°38′N 88°39′E	520/km^2 (1,300/sq mi)	Full Intensive
Kaharole	25.7917°N 88.6000°E	576/km^2 (1,490/sq mi)	Intensive household yard

Source: Wikipedia, 2017.

Table 2. Available feed-base and Feed supply (kg/day) for dairy buffalo under HYI system.

Name of feed-base	Amount Kg/day/buffalo	Percent of farmer provided feed items
Rice gruel	1.71	12.5
Ready feed	0.03	25
Broken maize	0.14	50
Maize flower	0.16	25
Rice bran(kg)	0.14	25
Wheat bran (kg)	1.53	75
Broken rice after cook (kg)	0.86	62.5
Mustard oil cake (kg)	0.19	62.5
Molasses	0.09	25
Straw (kg)	10.69	100
Green grass cultivated/cut and carry	6.22	50
Fresh water	25-60	100

30000). On the other hand natural breeding were followed in CI system as breeding bull were kept in this farm (Table 4).

The natural mating system was practiced by the most farmers though few number of breeding bull having in the herd (about 1%) both in household and bathan farming in Bangladesh (Uddin *et al*., 2016) which agreed to our present finding. Sawarkar *et al.* (2001) reported that, most of the farmers preferred natural service with the expectation that it would increase the conception rate. More than half of the farmers used natural service to their buffalo in heat at the right time, while 42% of farmers were unable to inseminate their animals in time due to various reasons (Uddin *et al*., 2016).

Milk production and quality

Average milk production for first, second and third stage were 6.80, 4.30 and 2.00 litter/day/ buffalo respectively under HYI system and it was 11,6.5 and 2.5 litter/day/ buffalo respectively for CI system (Table 5).

Table 6 showed that chemical quality of buffalo milk for household intensive (HYI) and completely intensive (CI) farm in study areas. Significant difference were found on total solids, fat and protein content but no significance difference were observed on SNF, lactose and ash of buffalo milk between two farms. Insignificant difference ($P>0.05$) was found for the value of electric conductivity (ECms/cm) that showed both farms produced healthy milk (3.25±0.49 vs 3.09±0.89). Milk quality of buffalo agreed with the result of Xiao-YanLing *et al*., 2013 who found that the average milk yield per lactation in 305 day, average milk fat, protein, lactose, total solid and non-fat solid of dairy buffalo were 1162 kg ,7.52%, 4.32%, 5.19%, 17.81%, and 10.11%, respectively in Mang city of China.

Milk man was milking from buffalo cow and purchased milk but price was not well (40 to 42 Tk/L) in HYI system. Milk sold to local market and sweetmeat shop. Some time Milk man didn't come to collect milk and farmer became looser. They gave money to farm owner quarterly or monthly basis. Buffalo farmers therefore depend on middle man for pricing of milk. But in completely intensive system, farmer was sold milk directly to sweetmeat shop (50 to 55 Tk/L) and took relatively better price than HYI system.

Productive and reproductive characters

Productive and reproductive characters of dairy buffalo were exposed in Table 7 under household intensive (HYI) and completely intensive (CI) system. Lactation Length (day), average milk yield (L/day), dry period (day), age at first pregnancy (month) and age at first calving (month) were found highly significant ($P<0.001$) between the system. Service per conception (number), service per conception and post Partum heat (month) period of dairy buffalo were found as significant ($P<0.05$) different between household intensive (HYI) and completely intensive (CI) system. But insignificant different were shown in case of weaning age (days) and gestation length between those system (month). The average dry period (day), weaning age (day), service per conception (Number), age at first pregnancy (month), age at first caving (month), calving interval (month), gestation period (month), postpartum heat period (month) were 172.67±22.73 and 97.22±6.18, 199.33±19.28 and 190.56±8.81, 2.00±0.58 and 1.33±0.50, 35.42±3.48 and 29.33±0.86, 45.60±3.60 and 39.33±0.86, 14.00±1.30 and 12.89±1.16, 10.01±0.17 and 10.00±0.00 and 4.23±0.89 and 3.44±0.72 for HYI and CI system, respectively

Table 3. Average feed allocation(kg/day/buffalo) base on fodder availability under CI system.

Month	Rice gruel (kg)	Brokenmaize	wheat bran	Broken rice	Mustard oil Cake	Molsses	Straw (kg)	Green grass from own
March-July (Five months)	6	1.25	2.25	1	0.75	0.3	8.75	13.5
August-February (Seven months)	6	1.25	3	2	0.75	0.3	13.25	5.5

Table 4. Breeding system and time of heat showed by buffalo cows.

Variables	Semi-arid (Dinajpur)
Type of breeding	
Natural breeding (% of buffalo)	96.3
Artificial insemination (AI) (% of buffalo)	3.7
Time of signing heat	
Early morning (% of buffalo)	11
Noon (% of buffalo)	3.2
Afternoon (% of buffalo)	5.7
Evening (% of buffalo)	12.4
Early night (% of buffalo)	47
Late night (% of buffalo)	20.7

Table 5. Average milk production (L/day).

Management system	First stage (L/day)	Second stage (L/day)	Third stage (L/day)
HYI	6.80	4.30	2.00
CI	11	6.5	2.5

Table 6. Chemical quality of buffalo milk under Household Intensive (HYI) and Completely Intensive (CI) system.

Parameter (%)	Household intensive	Completely intensive	Level of significance
Total solid	16.43±1.03	18.20±0.98	**
Fat	6.86±0.65	8.62±0.97	***
SNF	9.42±0.70	9.49±0.29	NS
Lactose	4.54±0.18	4.66±0.14	NS
Ash	0.67±0.05	0.70±0.03	NS
Protein	4.32±0.35	3.86±0.22	**
pH	6.20±0.42	6.09±.30	NS
Conductivity	3.25±0.49	3.09±0.89	NS

(Table 7). Similar findings were also reported by other authors (Karim *et al*., 2013; Faruque *et al*., 1990; Shabede *et al*., 2003) which were more or less similar to our findings.

The lactation yield in the household farming/ semi-intensive system and bathan farming /extensive system were 712 to 799 and 435 litres, respectively (Faruque *et al*., 1990; Uddin *et al*., 2016) which are much lower than the Nili-Ravi buffaloes reported by Mudgal (1989); Khan (1995); ICAR (2000) and also lower than present finding. Lactation yield of our finding also more than the finding of Hussen (1990); Faruque and Amin (1995). Lactation yield of indigenous buffaloes were low in Khulna region (280 litres, Faruque and Amin, 1995) and Tangail district (830 litres, Hussen, 1990). Cross breed buffaloes were reared in HYI and CI system in Dinajpur district which were migrated from India.

Calf management

Most of the farmers fed colostrums and milk to new born buffalo calf. After one month letter, wheat bran, cake and newly grown soft grass were fed to calf (50 to 60 gm/day). Calves were kept in separate dry and clean place in same room of mother at night and kept at day time in raise pit under tree shed. Timely feeding of colostrums to calves is essential and it should be fed within 2 to 3 h after birth and delay in feeding of colostrums lead to lowered effectiveness of the colostrums in terms of providing immunity to calves (Sharma and Mishra, 1987). Tiwari *et al*. (2007) found that the disease incidence in India Diarrhoea, pneumonia, parasitic infestation, dysentery was found as common diseases in study areas. Tiwari *et al*. (2007) also found those type of disease incidence in India in buffalo calves which reveals that the most common and frequent occurring disease in calves

Table 7. Productive and reproductive traits of dairy buffalo under Household Intensive (HYI) and Completely Intensive (CI) system.

Parameters	Household Intensive (HYI) system	Completely Intensive(CI) system	Level of significant
Lactation Length (day)	188.67±13.06	217.22±6.18	***
Lactation yield (L)	1028±256.68	2001±332.97	***
Average milk yield (L/day)	5.46±1.33	9.22±1.56	***
Dry period (day)	172.67±22.73	97.22±6.18	***
Weaning age (days)	199.33±19.28	190.56±8.81	NS
Service per conception (number)	2.00±0.58	1.33±0.50	*
Age at first pregnancy (month)	35.42±3.48	29.33±0.86	***
Age at first calving (month)	45.60±3.60	39.33±0.86	***
Calving interval (month)	14.00±1.30	12.89±1.16	*
Gestation length (month)	10.01±0.17	10.00±0.00	NS
Postpartum heat (month)	4.23±0.89	3.44±0.72	*

*** = Significance at 0.1% level of probability; * = Significance at 5% level of probability;
NS = Non significant; ± = Standard deviation

was diarrhoea which was reported by 82.2% of the dairy farms followed by endoparasite infestation (80%), ectoparasite infestation (78.9%), naval ill (66.7%) and pneumonia in calves (26.7%). Calf mortality was found as 8% and 7% respectively for HYI and CI system.

Primary health care

A total of 31% farmers used anthelmintics drug for internal parasite for buffalo but 23% farmers followed vaccination practice under HYI system. In CI system farmers were used for controlling both external and internal parasite. Vermic injection which introduced two times in a year (1 ml/40 kg body weight). Deworming drug was used for all type of internal parasite. Vaccine was used for HS and FMD under CI system

Economics of buffalo farming

Yearly expenditure, gross income and net income were BDT 140000, BDT 200000 and BDT 60000 respectively and yearly Benefit Cost Ratio (BCR) was found as 1.33 for in HYI system. On the contrary, yearly expenditure, gross income and net income were BDT 968810, BDT 1220525 and BDT 251715 respectively in CI system farm. Yearly Benefit Cost Ratio (BCR) was found as 1.25. Moreover total remaining assets were BDT 1060000 which represents of present value of buffalo herd of CI system (Table 8). Hasan *et al*., 2016 found that buffalo rearing in the coastal areas of Bangladesh was highly profitable that was crucial pathway for poverty alleviation. Rahman *et al*., 2008 stated that the benefit cost ratio was 1.31, indicating that buffalo rearing was profitable in Bangladesh which is agreed with the findings of Islam *et al*., 2017; Siddique *et al*., 2017 and also support to present study.

Problems associated with dairy buffalo production

According to farmer reaction ten bellow problems had been identified for milking buffalo production system resulted reason for decreasing buffalo population.

Shortage of feeds and fodder

Lack of feed and fodders at January to February as during this time there was no fellow land for grassing. The situation of pasture land was aggravated day by day because of crops were occupied most of the land in those areas. Maize was cultivated most of the land for grain production but they could not fed maize leaf to their animal due to lack of awareness.

High price of feed

High cost of concentrate feed of animal. Farmer could not provide balance feed due to high price of feeds.

Low milk price

Most of the farmers did not get good price of milk (30 to 40BDT). In some cases a few number of farmer get good price (BDT 50 to 52) where milkman collects milk from several farmers and sold to district level sweat meat shop.

High temperature

High temperature was a hindrance for buffalo rearing. Temperature was gradually increased and reducing water source. During high temperature; buffalo could not to take feed as required and abortion might be happen if not showering properly done during hot summer season.

Table 8. Cost -benefit of intensive buffalo farming (1USD = BDT83).

Herd composition and items		**Unit price**	**Yearly total cost**	**Yearly Gross income**	**Yearly net income**	**Net income Monthly**	**Remaining asset (Unit Price)**	**Total Remaining asset**
Milking buffaloes	8	Total milk production 45 L/ day, BDT 53/L	-	870525	-	80000	640000	-
Dry buffaloes	4	-	-	-		70000	280000	-
Heifer	1	-	-	-	-	65000	65000	-
Bull	1	-	-	-	-	75000	75000	-
calf	7	50000	-	350000	-	-	-	-
Concentrate feed	-	18	643860	-	-	-	-	-
Straw	-	3	229950	-	-	-	-	-
Labour	1	7500	90000	-	-	-	-	-
Other	-	-	5000	-	-	-	-	-
Total	-	-	968810	1220525	251715	20976	-	1060000
BCR	1.25							

Decrease of buffalo ploughing

One decade ago, land was cultivated by buffalo ploughing but now day it is done by power tiller.

Limited breeder bull

Few number of breeder bull was main hindrance to bred the buffalo. Farmer could not reach to bull station to breed the buffalo cow in time.

Lake of AI workers and inadequate quality semen

Artificial Insemination (AI) facilities were not available, even yet not popularized because of insufficient AI worker as well as unavailable of buffalo semen and low conception rate.

Lack of financial institutes

There was NGO office but did not provision to disburse credit to purchase buffalo.

Lack of cow boy

Now a day cow boy was not found as before. Labor did not wanted to work in buffalo farm as a cow boy due to opportunities of several jobs.

Inadequate knowledge for buffalo rearing

Government/ NGOs/ private sector did not provide still training or awareness program on Buffalo rearing.Problem matrix represented total score and percentage of score to assess dairy buffalo-derived problems illustrated in Table 9. The top three problems were found "inadequate knowledge for buffalo rearing/no training facilities on buffalo farming", ''high price of feed'' and "low milk price" which were ranked as 1, 2 and 3. Shortage of feeds and fodder, high temperature and lack of cow boy were ranked as 4, 5 and 6. Limited breeder bull, lake of AI workers and inadequate quality semen and lack of financial facilities as credit were ranked for 7. Decrease of buffalo ploughing shown as 8 (Table 9).

Table 9. Problem matrix for assessing dairy buffalo-derived problems.

Name of the problem	% of the score	Ranked order
Inadequate knowledge for buffalo rearing/no training facilities on buffalo farming	18	1
High price of feed	15	2
Low milk price	14	3
Shortage of feeds and fodder	11	4
High temperature	10	5
Lack of cow boy	9	6
Limited breeder bull	7	7
Lack of AI workers and inadequate quality semen	7	7
Lack of financial facilities as credit	7	7
Decrease of buffalo ploughing	4	8
-	100	-

CONCLUSION

Social and technological transformation can boost up the milk production from this species. Development of management practise along genetic improvement and policy intervention could be enhanced the productivity of buffalo and it would be contribute significantly in national economy.

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Buffalo Milk Yield, Quality, and Marketing in Different Agro-Climatic Districts of Bangladesh

S.M. Rajiur Rahman[1], Md. Nurul Islam[1,*], Md. Harun-ur-Rashid[1], Nathu Ram Sarker[2], Mohammad Shohel Rana Siddiki[1], Md. Zakirul Islam[1] and Mohammad Ashiqul Islam[1]

[1]*Department of Dairy Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh*

[2]*Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka, Bangladesh*

Abstract: The study was aimed at assessing the productive performance of dairy buffalo and milk marketing approaches in different agro-climatic districts of Bangladesh. Three (03) districts of Bangladesh viz. *Bhola*, *Mymensingh*, and *Dinajpur* were chosen from the coastal, river basin and semi-arid region, respectively. A triangulation method of survey was used to collect the data and the components of the triangle were buffalo farms, buffalo farmers and buffalo herdsmen. The investigation duration was twelve (12) months. The study revealed that the highest milk yield (5 L/h/d; p=0.010) was found in the river basin and semi-arid region. Lactation yield was also recorded double in the river basin and semi-arid districts compared to coastal districts (p=0.000). In the case of lactation length, the river basin buffaloes possessed 33 and 36% longer than coastal and semi-arid districts, respectively. All the chemical components were found significantly different (p≤0.050) but fat. Among different agro-climatic districts, about 92% of milk was traded in the coastal region after meeting the household's need but it was noted that the farmers from the semi-arid region kept more than 21% of milk for family consumption (p=0.000). The highest unit price (BDT 72/L) of milk was observed in the river basin district (p=0.011). In conclusion, the current situations of buffalo farming and milk marketing approaches in Bangladesh, varies considerably.

Keywords: Agro-climatic, dairy buffalo, milk yield, marketing.

INTRODUCTION

For years, buffaloes are extensively used for the agricultural production system in Bangladesh. Native buffaloes of Bangladesh belong to the *Bubalus bubalis* with most of the population are the riverine type with exception of some swamp type in the eastern part of the country. The crosses of Murrah, Nili-Ravi, Surti, and Jaffrabadi are frequently available around the Indian border of Bangladesh due to border migration [1,2]. However, the farmers keep buffaloes under extensive, semi-intensive and intensive management systems in coastal, river-basin and semi-arid areas in Bangladesh focus on the production of milk and meat along with drought power. Buffaloes are being considered as less prioritized dairy species in Bangladesh despite their important role in the national economy [3]. It is an important animal resource in the agricultural economy of many tropical and subtropical countries [4].

The world buffalo population (194.29 million) is dominated by Asia, representing 92.52% (179.75 million) of the total buffalo population [5,6]. South Asian countries represent about 79.74% of buffaloes and the rest of 20.26% in other countries. In Bangladesh, the total buffalo population is about 1.464 million of which coastal regions possess about 40% [1,7].

*Address correspondence to this author at the Department of Dairy Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh; Tel: +88-01712621079; Fax: +880 97 61510; E-mail: mnislamds@yahoo.com

Milk composition is considered as an important attribute for both dairy farmers and the dairy industries with regards to payment and processing quality of the milk, respectively [4]. Milk yield and quality are influenced by different feed regimes, breeds, and environments. Feeding unfavorably affects not only the productivity, health, and welfare of animals, but also the milk composition. According to [6], milk composition attributed to breed, physiology of animal, environment, and management system. It was stated by [7] that various non-genetic factors like stage of lactation, season and parity in Surti buffaloes influenced the milk components. Milk production and reproductive performances of buffaloes are negatively impacted by temperature rise during summer and also by sharp temperature decline in winter. The high temperature causes stress due to increased body heat leading to low heat dissipation from the body surface. High heat load in lactating buffaloes reduces their milk production and shorten the duration of lactation periods [5].

Economic returns from dairy buffaloes depend on its lifetime performance [8]. But the productive performance of buffaloes could not reach it' potential due to inadequate knowledge on husbandry practices, high feed cost and low milk price as those are regarded as first, second and third-ranked problems in Bangladesh with respect to buffalo milk production [9].

There are several investigations in Bangladesh demonstrated productive and reproductive

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performances, and management system of dairy buffalo under the extensive and semi-intensive system. However, to the best of our knowledge, there is very few information available about milk yield and quality under the different agro-climatic conditions as well as their marketing approach. Therefore, the present study was undertaken to envisage the productive performances of dairy buffalo and reveal the current marketing approaches of buffalo milk.

MATERIALS AND METHODS

Study Areas

Based on buffalo population density, three districts of Bangladesh *viz. Bhola*, *Mymensingh*, and *Dinajpur* were selected. These districts are from coastal, river basin and semi-arid agro-climatic region of Bangladesh, respectively. Geographical information of the study areas has been depicted in Table **1**.

Data Collection

A triangulation method of survey was used to collect the data. The components of the triangle were buffalo farms, buffalo farmers other than those farms and buffalo herdsmen. A predesigned questioner was used to collect data on milk yield, lactation yield, lactation length, household consumption as well as milk marketing approach from 30 buffalo farms of each selected district. These were cross-checked and validated by using the obtained information from the other two components, buffalo farmers and herdsmen.

Milk Sampling and Chemical Analysis

Morning milk samples (15, 16 and 18 individual buffalo samples from coastal, river basin and semi-arid area, respectively) were collected and transferred to the laboratory maintaining a cold chain and placed the samples at – 20 °C until analyzed. Only the samples from *Mymensingh* (river basin) were analyzed freshly. The milk composition was analyzed by using a Lactoscan milk analyzer (Milktronic Ltd., Bulgaria). All the samples were analyzed in triplicate.

Statistical Analysis

One way ANOVA was employed on milk yield, composition, price and use pattern to elucidate the regional variation. Data on milk marketing approach in different districts are presented by using descriptive statistics. For all these, SPSS (version 16) was used.

RESULTS AND DISCUSSION

Milk Yield

Variation in daily milk yield, lactation yield, lactation length stage of lactation, and lactation number, of the dairy buffaloes with regards to different agro-climatic districts (ACDs) of Bangladesh are summarized in Table **2**. The buffaloes in coastal districts significantly ($p=0.010$) produce (2 L/h/d) less than half of the milk produced daily by buffaloes in the river basin (5.4 L/h/d) and semi-arid district (5.3 L/h/d; $p\geq0.050$). Likewise, lactation yield of the river basin and semi-arid buffaloes ranged 1007 – 1085 L/h and differ non-significantly ($p>0.050$) but significantly ($p=0.000$) 2.3 times more than that of the coastal buffaloes. However, the lactation length of the buffaloes in the coastal and semi-arid area was statistically found similar (188 – 197 d; $p>0.050$), which was 96 - 105 days less than that of the buffaloes in river basin district ($p=0.021$). Milk yield in response to the stage of lactation also showed significant differences among the ACDs. The maximum yield was recorded in the river basin region in all three stages and at the third stage semi-arid area shares the ranking with river basin district. The peak milk yield was

Table 1: Agro-Climatic Information of the Study Areas

Items	*Bhola* (Coastal)	*Mymensingh* (River Basin)	*Dinajpur* (Semi-arid)
Location	22.6903°N 90.6525°E	24°34.5′N 90°23.5′E	26°0′0″N 88°35′0″E
Human population density	480/km^2	990/km^2	560/km^2
Type of farm	Extensive and Semi-intensive	Extensive and Semi-intensive	Intensive
Buffalo density* (% of total population)	40	30	25
Average Temperature (°C)	27.66	26.11	26.11
Relative humidity (%)	71	76	79
Climatic condition	Tropical wet and dry	Tropical wet and dry	Humid subtropical climate

*Indicates the buffalo density of coastal, river basin and semi-arid regions. Source: [1,7,31].

found in the second stage of lactation where the yield endured high from 90 to 180 days and then declines in the later stage of lactation. Notably, the average daily milk yield regarding the stage of lactation was recorded 4.28 L/h/d which is in agreement with the findings of [13]. It is evident that the lactation yield in the crossbred buffalo cows range of 800 to 1000 L [34]. It is worth to mention that similar results were obtained from the current investigation. Considering the number of lactation, the milk yield was varied among the ACDs. Milk production gradually increased as per the lactation number and the decreasing trend was noted for the advancement of lactation stages. Amongst the ACDs, the length of lactation varied from 188-197 days. The lactation length in dairy buffaloes is speckled from 279-282 days which was within the range of our findings (189-294) [9]. In addition, it was found that 286 days of lactation period in a similar type of buffaloes under extensive production system in *Mathbaria* and *Pirozpur* which was 290 days in *Pathorghata* and *Barguna* districts of Bangladesh [10]. The findings of this study are also supported by [11,12].

Chemical Composition of Milk

The proximate components of buffalo milk in different agro-climatic districts are presented in Table **3**. The results revealed that the total solids (TS), solids-not-fat (SNF), lactose, protein and ash content significantly differed ($p<0.05$) among the Agro-Climatic districts (ACDs). The highest TS (17%) was found in the semi-arid region compared to others. Fat content was found non-significant ($p>0.05$) among the ACDs and recorded within the range of 6.5 to 7.5%. A higher fraction of SNF was noted for the semi-arid region and river basin districts which were 1% higher than the coastal districts. But lactose and ash were found higher in the river basin (4.92% and 0.7%, respectively) region. The highest mean value for protein was found in the semi-arid area (4%) followed by others (3.64-3.72%. The present investigation regarding fat per cent was agreed with [14]. They recorded the fat content of buffalo milk within the range of 7.18 to 8.16% in *Noakhali Sirajgang, Potuakhali* and *Bagerhat* districts which were similar to our results. The protein, lactose, SNF and ash content of buffalo milk collected from different agro-climatic districts might be varied due to different feed regimes, breeds, and environments [13]. On feeding a balanced ration, milk fat increased by 6.3% to 6.6% in buffaloes [15]. Besides, the supplementation of minerals to the diet of lactating cows and buffaloes has been reported to enhance milk production and milk composition [16].

Buffalo Milk Marketing Approach and Household Consumption

The results relevant to milk marketing approach and household consumption were stated in Tables **4** and **5**. The data obtained from milk trading, household consumption and unit price of milk were found significantly different ($p<0.05$). The highest share of milk trading (92%) was found in the coastal region and the second highest in the river basin region. Therefore,

Table 2: Buffalo Milk Yield under Different Agro-Climatic Districts of Bangladesh

Variables	Coastal (n = 38)	River basin (n = 33)	Semi-arid (n = 35)	p-value
Daily milk yield (L/h/d)	2.18±0.63^{b}	5.41±1.92^{a}	5.25±1.33^{a}	0.010
Lactation yield (L/h/lactation)	428.91±124.28^{b}	1085.16±568.53^{a}	1007.28±252.36^{a}	0.000
Lactation Length(day)	197.44±29.06^{a}	293.93±18.22^{b}	188.67±13.06^{a}	0.020
Stage of lactation				
First stage (1 to 90 days)	2.38±0.68^{c}	5.53±1.24^{a}	5.29±1.69^{b}	0.000
Second stage (91 to 180 days)	2.60±0.93^{c}	7.23±1.71^{a}	6.85±2.11^{b}	0.001
Third stage (181 to 270 days)	1.57±0.70^{b}	3.47±0.93^{a}	3.62±1.30^{a}	0.001
Number of lactation				
First	2.10±0.71^{c}	3.27±1.95^{b}	4.80±1.69^{a}	0.021
Second	2.22±0.37^{c}	3.32±1.89^{b}	5.40±1.40^{a}	0.031
Third	2.02±0.47^{c}	4.08±2.00^{b}	5.40±1.25^{a}	0.012
Fourth	2.35±0.65^{c}	3.84±2.08^{b}	4.76±1.13^{a}	0.020

Means with different superscripts are significantly different. n, number of observations.

Table 3: Effect of Different Agro-Climatic Districts of Bangladesh on Buffalo Milk Composition

Variables (%)	Coastal area (n=45)	River basin (n=48)	Semi-arid (n=54)	p-value
TS	15.60^{c} ±2.55	15.91^{bc} ±1.47	17.08^{a} ±1.22	0.050
Fat	7.30±2.66	6.55±1.53	7.55±1.10	0.100
SNF	8.30^{b} ±0.54	9.35^{a} ±0.57	9.43^{a} ±0.32	0.011
Lactose	4.03^{b} ±0.32	4.92^{a} ±0.48	4.60^{ab} ±0.20	0.000
Protein	3.64^{b} ±0.41	3.72^{b} ±0.26	4.12^{a} ±0.37	0.051
Ash	0.62^{b} ±0.06	0.70^{a} ±0.07	0.69^{a} ±0.02	0.021

Mean with different superscripts are significantly different. n, number of observations.

Table 4: Buffalo Milk Prices and Farmers Household Consumption in Different Agro-Climatic Districts of Bangladesh

Parameters	Coastal (n=45)	River basin (n=45)	Semi-arid (n=55)	p-value
Milk trading (%)	92.00^{b} ±9.73	90.77^{b} ±5.78	78.60^{a} ±12.11	0.021
Household consumption (%)	8.00^{a} ±9.73	8.23^{a} ±5.41	21.43^{b} ±12.15	0.001
Unit price (BDT/L)	55.00^{b} ±9.71	71.96^{c} ±2.83	41.10^{a} ±5.16	0.011

The data represented as Mean±SD. n, number of observations.

Table 5: Milk Marketing Approach in Different Agro-Climatic Districts of Bangladesh

Parameters	Coastal (n=45)	River basin (n=45)	Semi-arid (n=455)
Milk buyer (%)	*Ghosh** (100)	Local market (35) and *Ghosh* (65)	Local market (100)
Milking method (%)	Hand milking (100)	Hand milking (100)	Hand milking (100)
Product manufacturing (%)	None	11	None
Advanced payment (%)	57.89	None	None
On-site payment (%)	42.11	None	None
Advanced amount (Tk.,000)	3-10,	None	None

**Ghosh*, local term means sweetmeat makers.

rightly, significantly highest household consumption was recorded in semi-arid districts (21%). However, maximum milk price (Tk.72.0) was found in the river basin region. All of the farmers sold milk directly to *Ghosh* in coastal areas. In river basin areas producers sold milk both to the local market and sweetmeat shops but for semi-arid areas it was only the local market. Among the study area, hand milking was found as the sole milking method. As far the milk processing is concerned, the farmers didn't produce milk products in coastal and semi-arid district but 11% of farmers produced milk products in river basin district. About 58% of farmers received advance money (BDT 3000-10000) every month from the *Ghosh* and 42% farmer practised on-site payment. The higher milk selling price was BDT 72/L for the farmer who didn't take advanced money from *Ghosh* but the selling price was relatively low (BDT 55/L) who had taken advanced payment in coastal areas. Milk price was comparably low in the case of advanced payment in coastal areas. Milk market was more volatile concerning the farmers who didn't take advanced from *Ghosh* in coastal areas. The current finding is in agreement with [25] and reported that the price of milk was set below by BDT 55/L in advanced payment. Buffalo rearing in the coastal areas of Bangladesh is highly profitable which a crucial pathway for poverty alleviation [26]. However, even more lower price (BDT 41/L) was found in semi-arid area indicating a poor marketing system there. The cost-benefit ratio was 1.31 [27], indicating that buffalo rearing was profitable in Bangladesh [9,28]. A total of 25% of the cow milk consumed by the household [29] but in our study, home consumption of buffalo milk was varied from 8-21% of total milk yield. It was reported by

[30] that milk supply chain in Bangladesh had a mixed picture as milk is not consumed by farm household and maily supplied to the traditional local market (>80%). It was also mentioned that farmers sold about 95% of the milk produced directly to *Ghosh,* the local market and local sweetmeat shop as well but none to the formal distribution channel [30].

CONCLUSION

It can be concluded that a considerable variation is prevailing among the selected districts from different agro-climatic regions with regards to milk yield (daily, total lactation, according to stage of lactation and number of lactation) and composition. Milk yield and quality in the different agro-climatic districts varied owe to several factors that could not be altered only by farm management practices. The milk marketing approach, milk price and mode of using milk were also found different among the agro-climatic districts. The amount of milk selling was more than the household consumption in the coastal region. It indicates that buffalo farming was highly emphasized for household income for farmer's livelihoods..

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DAIRY BUFFALO PRODUCTION SYSTEM UNDER SEMI-INTENSIVE MANAGEMENT IN THE COASTAL AREA OF BANGLADESH

S.M.R. Rahman*, M.N. Islam, M.H. Rashid, M.S.R. Siddiki and M.A. Islam

Department of Dairy Science , Bangladesh Agricultural University, Mymensingh 2202, Bangladesh

ABSTRACT

This study was conducted to evaluate the present status of production system of dairy buffalo under semi-intensive management in coastal area of Bangladesh. The data were collected during farm visit and recorded in prepared questionnaire and check list. The findings of the study revealed that very minimum housing facilities were provided to the buffaloes. Both the grazing and confinement time were found similar (around 6 hrs in a day) and they spent almost 3 hrs in a day for wallowing. The majority of the lactating buffaloes were not being adequately fed. Farmers usually supplied local grass (4.98±2.89 kg DM/day) and rice straw (10.90 ±2.85 kg DM/day) with one or two concentrate feed separately as supplement (1.51±0.80 kg DM/day). The daily average DCP and TDN supply were 0.365 and 6.417 kg/d respectively which were undersupplied as compared to standard requirement. The productive and reproductive performance of indigenous dairy buffalo was not similar to high producing dairy buffaloes. The average lactation yields (litre/lactation) were found as 469.52±163.71. The EC value (2.73±3.53) of milk indicated as healthy milk production. Milk consumption pattern (8%) was not satisfactory. Milk market was volatile. Natural breeding (95.7%) was more prominent practice than artificial insemination (AI) (4.3%). The most of the buffalo cows showed heat from early night to early morning (22.2-54.2%). Technology adaptation for buffalo rearing was very much poor. Technology adaptation index for the use of concentrate feed, artificial insemination, de-worming and vitamin-mineral premix were 16.34, 13.46, 23.07 and 6.25 respectively. It therefore be concluded that technological transformation could be boost up to national milk production by developing of the management practise of dairy buffalo under semi-intensive system in Bangladesh.

Keywords: Dairy buffalo, semi-intensive, management practice, coastal area, technology

* Corresponding author: smrajiurrahman@yahoo.com

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INTRODUCTION

The dynamics of buffalo production systems in South Asia Region is transforming day by day due to increasing the population more rapidly specially in Asia for its emerging role in economic development (Dhanda, 2013). Buffalo production system varies widely in accordance with climate, soil and socio economic opportunities in Bangladesh (Saadullah, 2012). Buffalos graze in natural pasture in coastal areas. A total of 11, 5 and 84% farmers reared buffalo for milk purpose, meat purpose and milk and meat purpose, respectively in coastal areas (Nahar et al., 2014). According to Saadullah (2012) buffaloes are kept mainly for specific purposes, i.e. either for milk or for meat production in Bangladesh under semi intensive system. It is an important livestock resource in several countries of South Asia and the Mediterranean regions. Buffalo is playing a leading role in the national economy by producing milk, meat and draught power in India and Pakistan. Buffalo contributes about 57% and 68% of total milk production of India and Pakistan, respectively (FAO, 2010). Due to high fat content of buffalo milk, it is the most preferred species and called Black gold of Pakistan (Bilal et al., 2006). Climatic condition of Bangladesh is nearly similar to India and has many rivers and marshy lands that favour for raising buffaloes. Recently Government of Bangladesh, private sector and research organization has given emphasis on Buffalo production. The availability of milk in Bangladesh is only about 158.19 ml h^{-1} d^{-1} of about 63.27% (DLS, 2018) whereas, the availability of milk in India and Pakistan is about 290 ml, 525 ml, h^{-1} d^{-1}, respectively (Hamid et al.,2016). This figure indicates that Bangladesh need to give more emphasis on the milk production to fulfil the national demand. The indigenous dairy cows are low producers and the crossbred cow has the limitation regarding disease resistance, repeat breeding etc. Use of other mammalian livestock species for milk production could help to improve the scenario (Siddiki, 2017) and the success of India and Pakistan dairy industry based on buffalo might be a good example for Bangladesh. However, buffaloes are low producers in Bangladesh, because of poor genetic potentialities, poor nutrition, longer puberty age, seasonality of breeding, longer calving interval, high calf mortality and poor management practices (Nahar, 2015;Amin et al.,2015; Sarker et al., 2013; Faruque and Amin, 1995; Shamsuddin et al., 2001). Faruque and Amin (1995), Uddin et al., (2016) and Amin et al., (2017) reported the management and production performances of buffaloes of Noakhali district of Bangladesh. However, there is no report on the management and production performances of buffaloes of Bhola district in Bangladesh which possesses the highest number of buffaloes of the country. Moreover different management system e.g. extensive and semi-intensive systems were followed in this area. Semi-intensive system introduces very recently for emphasised lactating buffaloes. Therefore, the present study was designed to investigate the existing management system along with reproduction and production characteristics of dairy buffalo in Bhola district of Bangladesh under semi-intensive system.

MATERIALS AND METHODS

Location of study areas

The study area was Vhalu Miar Char, Sub-district: Bhola sadar, District: Bhola (AEZ-18, coastal area), Bangladesh. This is a coastal area of Bangladesh having high buffalo concentration (10.1-32.3 buffaloes/1000 people (Huque and Khan, 2017).Under the Köppen Climate Classification, Bhola is under Tropical Monsoon Climate (Wikipedia, 2017). General information of study area demonstrated in Table 1.

Table 1. General information and satellite image of study area

The Köppen Climate Classification	Tropical wet climate (Aw)
Location Vhalu Miar Char, Bhola sadar in Bangladesh	22.6903°N& 90.6525°E
Temperature (Min-Max)	19-29°C
Humidity (%)	71
Average yearly rain fall(mm)	2424
Human population density	480/km2
Management system	Semi-intensive
Breed type	Indigenous

Map and satellite image of study area
(Map Source: http://www.banglapedia.org and image source: Google map)

Source: https://en.wikipedia.org; https://www.timeanddate.com/weather/@1336136/climate ;https://www.banglapedia.org

Farmer selection

Buffalo farmers were randomly selected from three villages. Farmers had at least one milking buffalo with calf and reared buffalo under semi-intensive management system. Farm visit, farm observation, secondary review, community discussion were held in the from January to July 2017.

Preparation of questioner

Structured questionnaire was developed according to variable of the objectives. Variables like productive and reproductive performances, feeding and management practices with related problem for buffalo farming were considered. The questionnaire was pre-tested in the selected area. The preliminary schedule was edited on the basis of experience gained in pre-testing and then the questionnaire was finalized. The schedule contains both open and closed-ended question.

Data collection

Qualitative and quantitative information were collected from semi-intensive farm. Data were collected directly from 30 farms by the experience enumerators. Researcher monitored the enumerators and support as required by direct visit and mobile communication. Moreover, more than 40 milking buffalo farmers were directly contacted by the researcher for validation of the information. Discussion was also conducted with the cowboys (hired labours) who are responsible for the care and management of the buffalo and the farm as a whole, to confirm and recheck the information that were collected from the household buffalo farms which fulfil the triangulation methods.

Period of Study

Farm visit, farm observation, secondary review, community discussion were held in the period of six moths which was from January to July 2017.

Sample collection and analysis

Information regarding the amount and types of feeds and fodders being offered randomly to thirty the lactating buffaloes. The quantity of dry matter (DM), digestible crud protein (DCP) and total digestible nutrient (TDN) available to dairy buffaloes were calculated from the records of feeds and fodder using value as given by Kearl (1982) and Feedipidia.org (2018). Their requirements for DCP and TDN were worked out according to Kearl (1982).

During this visit, 15 individual milk samples (50 ml/sample) were also collected from study area. The milk samples were immediately placed in a home freezer, transported in a cool box and again placed in a regular freezer in the Dairy Chemistry Laboratory, Department of Dairy Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh until further analyses. Milk samples were analyzed for fat, protein, lactose, SNF, ash content and Electric Conductivity (EC) by auto-milk analyzer (Lactoscan, Ultrasonic Milk Analyzer; Model MIA-SLP-60, S/N-70148; MILKOTONIC Ltd., Bulgaria 6000. Stara zagora).

Data Analysis

After collecting data from field, these were edited and coded. The data was then transfer to MS Excel 2007 for processing and summarizing. The tabular technique mainly used to analyze the data and derived meaningful finding by using simple statistical measures like mean, percentage and ratio by using SPSS16 version.

RESULTS AND DISCUSSION

Buffalo herd composition

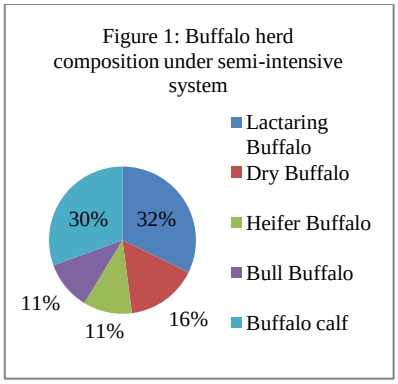
Farmers kept different type of buffalo in the herd. The average herd size was found to be 1.80±0.12. The herd was composed mainly of lactating buffalo, dry buffalo, buffalo heifer, buffalo bull and buffalo calf. The average number of lactating

buffalo, dry buffalo, buffalo heifer, buffalo bull and buffalo calf were 1.01±1.01, 0.78±1.72, 0.89±1.85, 1.06±1.62 and 1.02±1.94, respectively under semi-intensive system (Table 2 and Figure 1). This result supports to the findings of Uddin et al., (2016) who reported that 82% of the farmers having 1 to 3 buffalo reared under semi intensive system in coastal areas of Bangladesh. However Huque and Borghese (2013) found that average herd size in household subsistence farming (HF) and semi-intensive farming (SIF) buffaloes were about 1-3 and 4-15, respectively. Faruque (2000) found that the percentage of milking buffaloes, dry buffaloes, heifer buffaloes, bulls and calves were 35, 15, 16, 2 and 32, respectively in the upper part of coastal area reared under semi intensive management system which is very similar of our finding though number of bulls were relatively few in his study. But Akbar et al., (2009) mentioned that there was sufficient number of bull for breeding purpose in coastal areas.

Table 2. Average number of buffalo holding under semi-intensive system in Bhola district

Type of buffalo	Mean±SD (N)	Min	Max
Lactating Buffalo (No/HH)	1.85±1.01 (39)	1	4
Dry Buffalo(No/HH)	1.72±0.78 (19)	1	3
Heifer Buffalo(No/HH)	1.8±0.89 (13)	1	3
Buffalo Bull (No/HH)	1.62±1.06 (13)	1	4
Buffalo calf (No/HH)	1.94±1.02 (37)	1	4
Overall	1.80±0.12		

N= Number of observation; SD= Standard Deviation



Housing system of buffalo

Different types of housing were seen in the study area. Some farmers' constructed floor by brick, some sheds have roofs using tin or golpata (Nipa fruticans). Most of the house had no boundary wall and roof. Many buffaloes were kept on raised place in the open yard at day-night. Uddin et al., (2016) observed that dairy buffaloes were kept under semi-intensive system in the wet season and only 15% farmers provided shed having only roof but no concrete floor. Akbar et al., (2009) mentioned that most of the dairy buffalo were not housed in extensive system of bathan areas but buffaloes which were in the plain land sometime had an enclosure with only roof

made by straw or tin without wall and floor was always muddy. The average grazing time of buffalo was 6.04±1.52 hour in a day and rest of the time (5.91±1.70 hour/day) it was kept in confinement shed situated in household yard (Table 3). The average wallowing time of buffalo was found 2.78±1.34 hour/day (Table 3). Saadullah (2012) described that the buffalo farmers had their own wallowing place, but sometimes the whole village herd down together in mud wallows. Siddiki (2017) noted that majority (85%) of the buffalo farmers followed average grazing period of 6-8 h in a day and lowest grazing period (<6h) was found in Trishal and Lalpur Upozila (10%) which was similar to our findings.

Table 3. Average scavenges confinement and wallowing time (hrs/day)

Variable	Mean±SD	Minimum	Maximum
Grazing duration(hrs day^{-1})	6.04±1.52	2	8
Confinement (hrs day^{-1})	5.91±1.70	3	10
Wallowing (hrs day^{-1})	2.78±1.34	1	6

Feeding system

The available feed stuff were straw e.g. paddy straw (Oryza sativa); local green grass e.g. Dol (Saccrolepsis indica), Dubla (Cynodon dactylon), Halancha (Enhydra fluctuens), Sesbania, Water hyacinth (Eichhornia Crassipes) and kheshari (Lathyrus sativus); Concentrate feed e.g. oil cakes, wheat bran, rice polish, soybean meal and broken maize in the study area. Islam et al., (2002) identified more than fifty different types of local green grasses from different Agro Ecological Zones (AEZs) in Bangladesh among which most of those were same found in the present study. They noticed that baksha, lota, poa, khesari, beju, matikalai, kolmi, gamma, badam, durba, chailla, helencha, shama were mostly common and more potential native grasses. 89%, 100% and 57 % farmers provided dry roughage (straw), green roughage (local grass) and concentrate feed respectively to lactating buffaloes under this system. Among those, the average dry roughage, green roughage and concentrate feed supply were 10.90 ±2.85, 4.98±2.89 and 1.51±0.80 Kg DM day^{-1} head^{-1}, respectively. Nahar et al., (2015) found that 22 - 23% farmers supplied only straw, 95.55% farmers supplied straw with roughages, 8.89% farmers supplied only concentrate under extensive system in Bhola district. In the Ganges-Brahmaputra flood plain, dairy buffaloes were reared in semi-intensive system in which farmer raised buffaloes with minimum inputs. They were allowed to graze on natural pasture or road side in day time and were corralled at night (Akbar et al., 2009). The household subsistence farming (HF) buffaloes were reared under stall feeding with 6-7 hours grazing around backyard or public land with very little feed supply. The semi-intensive farming (SIF) buffaloes were raised in combination of seasonal based

household during rice cultivation and free range system during common land free which was mostly upper part of coastal areas (Huque and Borghese, 2013). According to investigation of Uddin et al., (2016), in the household farming, after morning milking, buffaloes were allowed to graze in fallow or road side land up to evening that covers approximately 8-9 hours per day. From the evening to next morning, buffaloes were tied up in homestead and they were offered mainly rice straw with little concentrate mixtures (wheat bran, rice bran, rice polish etc). The findings of the present study do not agree with the findings of Uddin et al., (2016) who mentioned the natural grass is the main source of feed in contrast to straw. This transforming perhaps to happen for newly introduces of semi-intensive system for lactating buffaloes in upper land of the coastal areas. Besides different crops were occupied most of the fellow land.

Table 5. Average feed supply (DM $kg^{-1}day^{-1}head^{-1}$) of lactating buffalo under semi-intensive system in Bhola district

Items	Mean±SD	Minimum	Maximum
Concentrate feed	1.51±0.80 (57)	0.44	2.64
Straw	10.90 ±2.85 (89)	4.50	16.0
Green grass (cut and carry)	4.98±2.89 (100)	1.6	11.30
Total supply	16.16±3.28	6.4	20.3

Figure parenthesis in the bracket indicates percentage of farmers

Nutritional status

Feeding practice deprives the potential high milk producers and also overburdens the low producers with nutrients (Habib et al., 2007). The average estimated levels of nutrients supplied to lactating buffaloes in coastal (Bhola) area of Bangladesh presented in Table 6.

Table 6. Average estimated levels of nutrients supplied to lactating buffaloes in coastal area in Bangladesh

Name of the feed resources	Amount DM ($kg\ d^{-1}$)	DCP($kg\ d^{-1}$)	TDN($kg\ d^{-1}$)
Coastal area: Bhola			
i. Broken Maize(Zea mays)	0.750	0.040	0.563
ii. Soybean meal(Glycine maximum)	0.560	0.228	0.459
iii. Rice bran (Oryza sativa)	0.200	0.015	0.120

Name of the feed resources	Amount DM (kg d-1)	DCP(kg d-1)	TDN(kg d-1)
A. Total concentrate mixture (i+ii+iii)	1.510	0.283	1.142
B. Straw (Oryza sativa)	10.900	0.022	4.578
C. Grass (native mix)	4.980	0.060	0.697
D. Total(A+B+C)	17.390	0.365	6.417

Daily average digestible crude protein(DCP) supply in the lactating buffaloes in Bhola district were 364 g d^{-1} which were undersupplied as compared to requirement of Kearl (1982) standard (Table 7; Fig 2) considering average body weight 242.0±45.1 and milk fat percent (7.3±2.66). Other studies aimed at evaluating the nutritional status of dairy animals in India based on survey of different districts/regions showed variable trends-most of them showing undersupply of DCP as compared to standard requirements (Vidya et al., 2013; Bakshi et al., 2010; Jawale et al., 2007; Singh et al., 2003). These findings agreed with our observation. However daily average DCP intake in the buffaloes in Patan district of India was observed 1.049 kg d^{-1} that indicates the buffaloes got adequate DCP as per the requirement (Chavda and Parnerkar, 2016). Daily average total digestible nutrient (TDN) supply to the lactating buffaloes in Bhola areas of Bangladesh were observed 6.417 kg d^{-1} (Table 6) which indicated that the buffaloes got few amount of low TDN (-0.353 kg d^{-1}) than requirement of Kearl (1982) standard (Table 7; Fig 3). Chavda and Parnerkar (2016) got surplus amount of average TDN intake (10.17 kg d^{-1}) in the buffaloes in Patan district of India. The findings of Chavda and Parnerkar (2016) are supported by the observations of Patange et al., (2002) and Singh et al., (2003) indicating a surplus of TDN supply. However, deficit supply of TDN in lactating buffaloes was also reported by Chaturvedi et al., (2009) and Singh et al., (2008) in their study.

Table 7. Deficit (-) and surplus (+) of DCP and TDN in lactating buffaloes in different agro-climatic zone in Bangladesh

Areas	Total requirement of DCP (g)	Total supply of DCP (g)	Deficit (-) /surplus (+) of DCP	TDN requirement (kg d^{-1})	TDN supply (kg d^{-1})	Deficit (-) /surplus (+) of TDN (kg d^{-1})
Coastal area	697.000	364.790	-332.210	6.770	6.416	-0.353

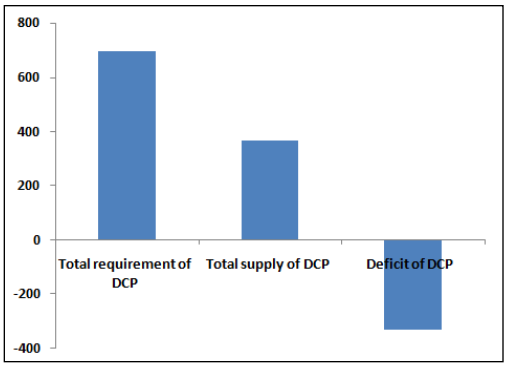


Figure 2. Total requirement and supply of DCP (gm d^{-1})

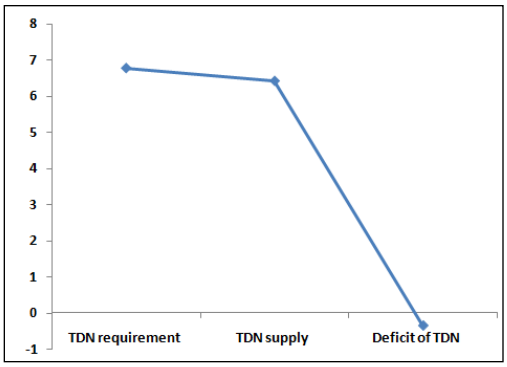


Figure 3. Total requirement and supply of TDN (kg d^{-1})

Productive and reproductive performance

Productive and reproductive efficiency are influenced by different management system, nutrition and environment factors. A very low protein diet can cause cessation of oestrus (Agrawal, 2003). Though actual reproductive parameters is very difficult to find out without record or close supervision but farmer's experience would be asset for those information.

The average lactation length of indigenous buffalo cows were 197 days under semi-intensive system in the study area (Table 8) which was low as compare to Karim et al., (2013); Faruque and Amin (1995). It might be happen for week management practice of the farmers as this system newly introduced in upper land in Bhola. Karim et al., (2013) found 286 days of lactation period in similar kind of buffaloes under extensive production system in Mathbaria and Pirozpur, which was 290 days in Pathorghata and Barguna. Faruque and Amin (1995) also reported that the lactation yield of indigenous buffalo in Khulna region were 280 liters. The findings of this study were also less similar to the findings of other authors (Bezerra et al., 2014; EI-Kirabi1995). The average milk yield (L d^{-1}) and lactation yield (L $lactation^{-1}$) were found as 2.39±0.83 and 469.52±163.71, respectively (Table 8). The average dry period (day), weaning age (day), service per conception (Number), age at first pregnancy (month), age at first caving (month), calving interval (month), gestation period (month), post partum heat period (month) were 42.80±26.44, 201.88±77.63, 1.11±0.32, 35.37±9.44, 46.56±6.80, 14.21±2.09, 10.04±0.23 and 3.94±1.51, respectively (Table 8). Similar findings were also reported by other authors (Karim et al., 2013; Shabede et al., 2003).

Table 8. Productive and reproductive trait of lactating buffalo under semi-intensive system

Parameters	Mean ±SD	Minimum	Maximum	Highest frequency percentage
Lactation Length (d)	197.44±29.06	150	270	180 (37%)
Milk yield (L d^{-1})	2.39±0.83	1	5	2.3(18.2%)
Lactation yield (L $lactation^{-1}$)	469.52±163.71	196	916	392(15%)
Dry Period (d)	42.80±26.44	30	90	30 (60%)
Weaning age(d)	201.88±77.63	7	365	180 (24%)
Service Per Conception (Number)	1.11±0.32	1	2	1 (88%)
Age at first Pregnancy (month)	35.37±9.44	33	48	34 (34%)
Age at first caving(month)	46.56±6.80	34	58	46(28%)
Calving interval (month)	14.21±2.09	11	18	16 (15.4%)
Gestation period (month)	10.04±0.23	10	11	10(80%)
Post Partum heat period (month)	3.94±1.51	2	6	3(29.2%)

L, liter; d, day.

Milk composition

Milk composition of indigenous lactating buffalo under semi-intensive system is shown in Table 9. Milk composition attributed for breed, physiology of animal, environment, and management system (Ravikala et al., 2014). Nahar et al., (2014) found different milk composition of buffalo, though those were little lower or higher for different selected areas of Bangladesh. The average fat percentage of buffalo milk from Noakhali (8.16), Sirajgang (7.54), Potuakhali (7.18) and Bagerhat (6.92) (Nahar et al., 2014) which was similar value of fat % of our present study (7.30). The range of protein, lactose and SNF percentage were 3.00-4.36, 3.64-4.8 and 7.52-9.35 respectively. EC (ms cm^{-1}) value for present study was shown as 2.73±3.53 with the range of 2.00-3.53mS cm^{-1}. Fahmid et.al., (2016) observed that EC value had less than 5.5 mS cm^{-1} which considered as healthy milk production.

Table 9. Milk composition of lactating buffalo under semi-intensive system

Variables	Mean±SD (N=15)	Minimum	Maximum
TS(%)	15.60±2.55	12.81	19.63
Fat(%)	7.30±2.66	4.07	11.97
SNF(%)	8.30±0.54	7.52	9.35
Lactose(%)	4.03±0.32	3.64	4.8
Ash(%)	0.62±0.06	0.53	0.75
Protein(%)	3.64±0.41	3.00	4.36
Electric conductivity (EC) (mS cm^{-1})	2.73±3.53	2.00	3.53

Marketing

All of the farmers sold milk to Ghosh. About 57.89 percent farmers received advance money (BDT3000-10000) on monthly basis from the Ghosh and 42.11 percent farmer didn't receive the same. The higher milk selling price was BDT 55.71±5.34 for the farmer who didn't take advance from Ghosh but selling price was relatively low (BDT 52.72±4.10) who had taken advance (Table 10). It also noted that milk market was more volatile in case of the farmers who didn't take advance from Ghosh as CV% was higher (9.59%) than other (7.77%). The present finding is in agreement with the earlier findings of (Raha, 2010) who reported that price of milk was set below by BDT 5 $liter^{-1}$ in the case of advance payment.

Table 10. Milk marketing scenario in Bhola district (USD1=BDT78)

Group	% of farmers	Amount of advance money (BDT $Month^{-1}$) Min-Max	Average milk price (BDT L^{-1})	SD value	CV%
Farmers who taken advance	57.89	3000-10000	52.72	4.10	7.77
Farmers who didn't taken advance	42.11	-	55.71	5.34	9.59
Overall	100				

Technology adaptation

Adaptation levels of technologies for dairy buffalo farmers were very poor due to lack of public awareness and inadequate knowledge about buffalo husbandry (habitat, feeding, breeding & health care). Only 17.4 % farmer adopted for providing concentrate feed to their animal. Adaptation level of technologies e.g. use of urea-molasses straw/blocks, cultivation of fodder crops, use of Artificial Insemination(AI), practice for de-worming, practice for vaccination and provide vitamin-mineral premix from farmers were 0 ,0, 4.3,8.7,0 and 8.7%, respectively. Average adaptation capacity of technologies were 16.34, 11.53, 12.01, 13.46 23.07, 17.30 and 6.25% for use of urea-molasses straw/blocks, cultivation of fodder crops, use for AI, practice for de-worming, practice for vaccination and provide vitamin-mineral premix from farmers, respectively. Among those technologies, the capacity of technology was higher for practise of de-worming and vaccination though those were not followed regularly (Table 11). Creation of public awareness by different media; i.e. Radio, TV, Internet, Newspaper about the impotence of buffalo milk and meat as well as the good practice of dairy buffalo management might be improved the adaptation level of technologies.

Table 11. Technology adaptation of dairy buffalo farmers

Technical intervention	Level of adaptation(Frequency)			Average capacity(index) of technology
	Never	Tried but not adopt	Fully adopted	
Provide concentrate feed	69.6	13	17.4	16.34
Use of urea-molasses straw/blocks	95.7	4.3	-	11.53
Cultivation of fodder crops	91.3	8.7	-	12.01
Use for Artificial Insemination	82.6	13	4.3	13.46
Practice for de-worming	-	91.3	8.7	23.07
Practice for vaccination	34.8	65.2	-	17.30
Provide vitamin-mineral premix	52.2	39.1	8.7	6.25

Breeding

Recently government buffalo project has started AI in Bhola district, but it is not popular because of insufficient AI worker as well as unavailable of buffalo semen and low conception rate. Farmers didn't get AI worker in right time when buffaloes showed heat. Traditionally farmers kept buffalo bull to bred buffalo cows in these areas. It means that there were two breeding systems in Bhola district. A total of

95.7% buffalo cow received natural breeding whereas AI covered only 4.3% of buffalo cows. Akbar et al., (2009) reported that the sufficient number of breeding bull was kept by the farmer in coastal areas and there were no fertility problem. However, inbreeding and abortion due to use same bull was common. They also noted that low oestrous detection (i.e. 30%) was a major challenge that limited efficiency of AI use. According to farmer's observation, buffalo cows showed heat in different time. A few number of buffalo cows (4.2-5.2%) showed heat in day time but higher number of the buffalo cows showed heat in early morning (54.2%), followed to early night (22.2%) and late night (9.3%) (Table 12). Saadullah, (2012) stated that the buffaloes showed their maximum activity during the night and breeding take place mainly during night. Therefore present study has been supported to the information of Saadullah, (2012) though a few number of buffalo cows showed heat in day time (4.2-5.2%).

Table 12. Type of breeding and time of heat showed by buffalo cows

Variable	Value
Type of breeding	
Natural breeding (% of buffalo)	95.7
Artificial insemination (AI) (% of buffalo)	4.3
Time of showing heat	
Morning (% of buffalo)	54.2
Noon (% of buffalo)	4.8
Afternoon (% of buffalo)	5.2
Evening (% of buffalo)	4.2
Early night (% of buffalo)	22.2
Late night (% of buffalo)	9.3

Hygienic measure for buffalo rearing

Farmers kept manure near to the animal shed in small hole, situated from 2-20 feet distance from the shed. However sometime they did not make small hole and manure through the open places. A total of 22 % farmers did not follow good practice for waste management. The udder health situation of milking buffaloes was aggravating as mastitis was rising as of the notification of farmers (7%). Islam et al., (2016) isolated pathogens (i.e. Coagulase Negative Staphylococci (CNN), *Staptococcus spp*. and Bacillus spp. and *Staphylococcus aureus*) from milk sample in Bangladesh including coastal areas that were responsible for mastitis in lactating buffaloes. Only

hand milking was followed practiced in the study areas. They washed their hands, milking pots and also cleaned milking parlour/platform before milking. All of the farmers allowed calves to suckle udder of buffalo by the calf for stimulating hormonal affects before starting milking.

CONCLUSION

The productive and reproductive performance of indigenous dairy buffalo was not better to high producing dairy buffalo's. Scientific management and improved breeding system could minimize this situation. Optimum use of feed resources and their treatment whenever needed becomes evident from the present study. Improved adaptation level of technologies would be ensured by creating public awareness and by providing door-step service to the buffalo farmers. It is therefore, can be concluded that technological transformation is important to boost up of the productivity of the dairy buffaloes under semi-intensive system.

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