A SURVEY ON QUALITATIVE AND QUANTITATIVE CONSTRAINTS OF BUFFALO FARMING OF BANGLADESH

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Roll No: 119/06

Registration No: 648

Session: 2019-2020

A thesis submitted in the partial fulfilment of the requirements for the degree of Master of Science in Epidemiology

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JUNE 2021

Authorization

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This is to certify that we have examined the above Master's thesis and have found that is complete and satisfactory in all respects, and that all revisions required by the thesis examination committee have been made.

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Acknowledgements

At first, I want to express my deepest gratitude to almighty God for giving me the strength, ability, patience and opportunity to do my research and complete it successfully for the degree of Master of Science (MS) in Epidemiology under the Department of Medicine and Surgery, Chattogram Veterinary and Animal Sciences University (CVASU), Bangladesh.

I would like to express the first and foremost heartiest appreciation, deepest sense of gratitude and best regards to my supervisor Professor Dr. Mizanur Rahman, Department of Medicine and Surgery, CVASU. His cordial supervision and important suggestions helped me a lot to complete this thesis. It was my pleasure and great experience to work with him for his inspirations during the whole journey.

Thanks so much to my co-supervisor Dr. Marjolein Derks, Farm Technology Unit, Wageningen University and Research, The Netherlands for her advice, guidance, inspirations and suggestions during the whole study period especially in questionnaire preparation, data collection and analysis.

I sincerely acknowledge the contribution of Professor Md. Ahasanul Hoque, Department of Medicine and Surgery, CVASU for his guidance during the whole study period. His guidance helped me a lot in data analysis and interpretation with his valuable comments and suggestions. My special thanks and gratitude to the project leader Dr. Ylva Persson, Associate State Veterinarian, National Veterinary Institute (SVA), Sweden, who was always first to respond.

This MS research study was a part of the project, "Climate change mitigation by a sustainable water buffalo dairy chain in Bangladesh" funded by Swedish Research Council and operated jointly by CVASU, Bangladesh; SVA, Sweden; UNIMI, Italy; UU and WUR, The Netherlands.

I would like convey my special thanks to Dr. Shuvo Singha for his advice, guidance and suggestion during the whole journey. Special thanks to Dr. Ovirup Bhushan Paul and Dr. Samla Chowdhury for their co-operation and help in data collection.

I also appreciate the support of all the Veterinarians of Department of Livestock Services (DLS), Buffalo researcher, Other Veterinarians and farmers for their co-operation and thoughts to conduct the study effectively.

Finally, I express my deepest gratitude to my parents and my family for their spontaneous blessings, encouragement and support to continue the work efficiently.

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Abbreviations	Elaborations
%	*Percentage*
≥	*Greater than or equal to*
≤	*Less than or equal to*
^{0}C	*Degree Celsius*
95% CI	*95% confidence interval*
AI	*Artificial insemination*
ANOVA	*Analysis of variance*
β	*correlation coefficient*
BCR	*Benefit cost ratio*
BCS	*Body condition score*
BDT	*Bangladeshi taka*
BLRI	*Bangladesh Livestock Research Institute*
BQ	*Black quarter*
CH_4	*Methane*
CO_2	*Carbon dioxide*
CVASU	*Chattogram Veterinary and Animal Sciences University*
DLS	*Department of Livestock Services*
DVM	*Doctor of Veterinary Medicine*
et al.,	*and others*
ET	*Embryo Transfer*
FAO	*Food and Agricultural Organization*
FGD	*Focus group discussion*
FMD	*Foot and mouth disease*
GBM	*Ganges Brahmaputra Meghna*
HS	*Haemorrhagic septicemia*
IVF	*In Vitro Fertilization*

L	*Litter*
MMT	*Million metric tons*
MOET	*Multiple ovulation embryo transfer*
NGO	*Non-government organization*
N_2O	*Nitrous oxide*
OIE	*World Organisation for Animal Health*
p	*Probability*
sq-km	*Square kilometer*
sq. mi	*Square mile*
UMS	*Urea molasses straw*
UNEP	*United Nations Environment Programme*
UNIMI	*University of Milan*
vif	*variance inflation factor*
WUR	*Wageningen University and Research*

Abstract

Water buffalo holds the second position in the worlds' milk production and its contribution in certain south Asian countries is higher than cow milk production. In Bangladesh, buffaloes contribute only 3-4% to the national milk production. The constraints of water buffalo rearing have not been studied systematically in Bangladesh. The present cross-sectional study was therefore conducted to investigate the qualitative and quantitative constraints of buffalo farming in Bangladesh, determine the level of concern of buffalo farmers and livestock professionals, assess the relationship between concern level and farm demographic factors, and identify the farmer's demand for sustainable buffalo rearing. A total of 170 farms were conveniently selected from seven buffalo concentrated areas of Bangladesh. We also conducted an online google survey for the livestock professionals (n=50). Based on the literature, a list of issues around buffalo farming was constructed. A structured questionnaire was used to collect information like farm demography, constraints related to housing, feeding, breeding, disease, and marketing of buffalo milk. Likert scale questions (1-5) were used to investigate the perception of the farmers and livestock professionals regarding constraints. The aggregated score of concern was calculated by summarizing the subtracted value of each constraint score from the median. No significant difference (p=0.81) was observed between the perceived level of concerns of the farmers and livestock professionals. Three farm demographic factors- farm type, education and position of the interviewee were found significantly related to the aggregated score of concern. Semi-bathan (β=-12.2; p=0.004) and household or intensive (β=-10.5; p=0.02) farming system compared to bathan system and interviewees other than the owner (β=-16.3; p=0.002) compared to the owner were found less concerned. On the other hand, literate farmers (β=8.9; p=0.01) compared to illiterate were found highly concerned. Lack of available wallowing area, the high construction cost of the shed and lack of skilled labor were the major housing constraint, while the high price of concentrate and unavailable grazing land were the major constraints under feeding management. Multivariate linear regression analysis revealed that not practicing balanced ration (β=2.4; p=0.04), not having available drinking water (β=3.3; p=0.008) and knowledge about UMS (β=2.0; p=0.04) were positively correlated with a high aggregated score of concern of feeding constraints. Farmers opined that preference of natural insemination; poor conception rate of AI and

poor quality of semen were the top breeding constraints. Additionally, not having breeding bull (β=3.04; p=0.006) was positively correlated with a high concern score of breeding constraints compared to having breeding bull, and farmers who detected heat by observation (β=-6.9; p=0.00) and both methods (β=-4.39; p=0.004) were less concerned compared to the farmers detect heat with the help of bull. Farmers of bathan and semi-bathan systems were less aware of using deworming and vaccination resulting in more disease outbreaks. However, important disease constraints were remote veterinary facilities, higher calf mortality rate and lack of knowledge about vaccination and deworming. It was found that a higher calf mortality rate (≤11) was positively associated (β=1.96; p=0.06) with a higher aggregated score of concern of disease constraints. On the other hand, not getting enough milk price (β=2.1; p=0.01) was positively associated and low cost of transportation (β=-1.99; p=0.02) was negatively associated with an aggregated score of concern of economic and marketing constraints. Nevertheless, major economic and marketing constraints were low milk price and higher transport cost. The majority of the farmers opined that buffalo milk and meat were good for health (81.5%) and it was economically profitable (94.9%). However, the constraints identified in this study should be considered to take necessary strategies by the policymakers to overcome the current situation.

Keywords: Aggregated score of concern, buffalo farming, breeding constraints, disease constraints, buffalo milk and meat, bathan system.

Chapter 1: Introduction

Water buffalo (*Bubalus bubalis*) is one of the most important livestock species reared mostly in the tropical and sub-tropical countries of the world (Das and Khan, 2010). The tropical climatic condition of Bangladesh is supportive to livestock rearing. Buffalo is playing a significant role in both the national economy and livelihood development of the rural people of Bangladesh (Saadullah, 2012). It is the second most important livestock species serving three important purposes, which are milk, meat, and drought power (Ghaffar et al., 1991). Buffalo farmers of Bangladesh follow a traditional farming system integrated with crop production with a minimum input for the buffaloes (Saadullah., 2012). Extensive (Bathan), semi-extensive (Semi-bathan) and household systems are the most common rearing systems. Nowadays, commercial or intensive buffalo farms are also gaining popularity in the country (Habib et al., 2017; Rahman et al., 2018a; Rahman et al., 2019b).

Bangladesh holds about 0.8% of the world's buffalo with a population of near 1.5 million. Buffaloes of Bangladesh are mostly concentrated in the coastal areas (40%), the Meghna-Ganga flood plain, and the Brahammaputra-Jamuna flood plain areas (Faruque et al., 1990; Sohel and Amin, 2015). Some other buffalo pockets are also found in the Sylhet haor area, sugarcane belt of Jamalpur, the Trishal upazila of Mymensingh, and the northern part of the country (Huque and Khan, 2017). The buffalo population of Bangladesh is dominated by the indigenous non-descriptive riverine type with the exception of the swamp type, found in the eastern part of the country. Indigenous non-descriptive buffaloes are also found in the coastal areas and marshy land of the country. As a part of buffalo breed development, the Department of Livestock Services (DLS) imported 100 pregnant Nili-Ravi heifers and first lactation cows from Pakistan to establish a buffalo breeding and development farm at Bagerhat, in the south-east part of Bangladesh. Unfortunately, they could not maintain the breed properly and mixed it up with local buffaloes through a bull distribution program (Hamid et al., 2016b). Recently, the Bangladesh Livestock Research Institute (BLRI) and Milk vita have imported some Murrah buffalo from India for breeding purposes.

Milk production of indigenous buffaloes is not quite satisfactory compared to other breeds. These buffaloes produce 2-3L of milk per day and the average lactation yield is around 620-1161L in 270-330 days (Hamid et al., 2016a). Another study showed that the average milk yield per day and per lactation were 2.39L and 469.52L respectively in a semi-intensive farming system (Rahman et al., 2018a). In India, the average lactation yield of Murrah buffalo in 305 days is 2335L and in Nili-Ravi buffaloes of Pakistan it is about 2345L in 312 days of lactation (Singh, 2013; Anwar, 2013). In Turkey, an average milk yield was 1000kg in 230 days of lactation length (Borghese and Mazzi, 2005). Contribution of buffalo milk in the annual milk production of India, Pakistan and Nepal are 48%, 67%, and 71% respectively. The demand of daily milk consumption is 250ml/head/day and the availability of milk is 193.38 ml/head/day, but the contribution of buffalo milk is only 3-4%. The annual milk production is 119.85 Lakh Metric Ton and the demand is 154.94 Lakh Metric Ton (DLS, 2021). In these circumstances, to fill up this gap, buffalo could be a potential source of more milk as it can survive harsh environments compared to cattle.

Buffalo meat is popular in some parts of Bangladesh like Chittagong. However, in many instances, the meat fiber is sticky and hard to chew as the buffaloes are slaughtered at the end of their work life when they are emaciated and weak. Buffalo meat has a lower cholesterol level compared to beef. The superiority of buffalo meat and marketing of tender aged buffalo meat may attract consumers (Hamid et al., 2016b). The contribution of buffalo in the overall annual meat production is 0.9%, whereas in India and Pakistan buffalo contributes 17% and 27.9% to the annual meat production respectively (FAO, 2012; Pasha, 2013).

Nowadays, buffalo farming in Bangladesh is becoming popular due to its ability to produce higher quality milk and meat, better conversion of poor-quality feed, and greater disease resistance power. Moreover, they need less attention than cattle and better adoption capacity to harsh environment made them a more efficient livestock species than other ruminants (Hamid et al., 2016b; Thomas, 2008). Despite their advantages over other ruminants, this multipurpose domestic species remained neglected and their importance was never addressed properly.

There are many constraints impeding the productive and reproductive performance of indigenous buffaloes. Poor genetic makeup and breeding programs, low input by the herders, unavailable feed, unfavorable market structure, lack of awareness about buffalo husbandry, high calf mortality and disease prevalence are the main challenges of buffalo farming in Bangladesh (Hamid et al., 2016a; Hamid et al., 2016b). These challenges or constraints can be categorized as housing constraints, feeding constraints, breeding constraints, health or disease constraints and economic or marketing constraints.

Farmers follow traditional farming system rather than scientific management system. For about 99% of the buffaloes there is no separate housing system (Hamid et al., 2016b). No housing is provided to the buffaloes in bathans (Extensive), but some farmers provide a shed with or without any side wall and brick flooring to the buffaloes in the household system (Rahman et al., 2018a). A lack of scientific knowledge about housing, high construction costs, and ignorance of the farmers to provide a separate house for the buffaloes were the main housing constraints (Munish, 2015).

Not practicing animal identification is another constraint, which hampers individual record keeping of the animals (Habib et al., 2017). In the bathans hundreds of buffaloes of different owners graze together, where they use a unique identification cut mark in the ear of the buffaloes.

Feeding practices by the farmers vary depending on rearing or farming system. Farmers mostly depend on public grazing land (Saadullah, 1990) with or without supplement of concentrate and straw in the bathan and semi-bathan system. In the household system, buffaloes graze on public land and sometimes straw and little concentrate is given when at home (Uddin et al., 2016). Major constraints related to feeding are lack of knowledge about balanced ration, lack of fodder and pasture land, high price of concentrate feed and unavailable mineral mixture. Studies in different regions of India showed that high cost of feed (90%), poor irrigation facility (81.33%), unavailable green roughage round the year (73.33%), lack of knowledge about balanced ration (72.5%), and lack of knowledge about silage preparation (50.67%) were the leading constraints related to feeding (Pata et al., 2018; Rajkumar et al., 2017; Patel et al., 2013).

Productive and reproductive performance of indigenous buffalo is quite unsatisfactory due to their poor genetic makeup (Hamid et al., 2016b). Almost all farmers in both household and bathan (extensive) system practices natural insemination (Uddin et al., 2016). However, inbreeding causes common reproductive problems like abortion and repeat breeding. Overall reproductive efficiency of buffalo cows is hampered by delayed puberty, seasonal breeding, poor estrus detection and long calving interval (Habib et al., 2017). Lower pregnancy rate in these buffaloes is due to very low bull and cow ratio (Uddin et al., 2016). Artificial insemination (AI) in buffalo is not popular in most parts of the country. Other important constraints related to breeding are scarcity of proven breeding bulls, no progeny-testing program, and slow adoption of AI and lack of quality semen (Hamid et al., 2016b). A proper strategy on breed upgradation can improve the reproduction traits of our native buffaloes (Saadullah, 2012).

Infectious disease is one of the most important constraints of livestock including buffalo rearing all over the world, which hampers the potentialities of buffalo and causes economic loss by reducing productivity, reproductive performance, mortality and retarred growth (Latif, 1994; Roeder and Taylor, 2007). Common infectious diseases in buffaloes are Foot and Mouth disease, anthrax, black quarter, haemorrhagic septicemia, brucellosis, tuberculosis and mastitis (Rahman et al., 2011; Hossain et al., 2012; Hamid et al., 2016a; Islam et al., 2016; Habib et al., 2017). Gastrointestinal parasitic infestation is highly prevalent (64.2%) in buffaloes of coastal areas of Bangladesh (Islam et al., 2016). This higher prevalence of diseases occurs due to poor management practice, unavailable timely veterinary services, lack of knowledge and ignorance about vaccination and deworming (Amin et al., 2015; Ali et al., 2019).

Farmers of Bangladesh rear buffaloes with a traditional system with minimum investment. Farmers depending on natural pasturelands do not want to spend much money for feeding. The majority of the farmers cannot provide proper feed, breeding bulls and treatment because of a lack of money (Rahman et al., 2018). Moreover, financial support from government and NGOs is very limited. Other important economic constraints are lack of own capital, high construction cost, high interest rate of loans and high price of milking animal (Pasha and Hayat, 2012; Sarita et al., 2017; Pata et al., 2018; Ali et al., 2019).

The marketing of buffalo milk, buffalo milk products and meat is not well developed in Bangladesh. Besides family consumption, farmers sell milk to the local processor and market (Uddin et al., 2016). The milk price and payment system are not similar all over the country, rather it varies depending on place and season. Several studies in India, Pakistan and Nepal reported that non-remunerative price of milk, lack of preservation facility, lack of knowledge about clean milk production, exploitation by middleman (by water, chemicals and drugs), distance of milk co-operative, lack of cold chains, and lack of transportation facility were the most important marketing constraints (Patel et al., 2013; Nagrale et al., 2015; Rajkumar et al., 2017; Pata et al., 2018; Zia, 2007; Banskota, 2015).

Knowing the potentials and overall constraints of buffalo farming is important to develop necessary policies to sustain buffalo farming in Bangladesh. A few systematic study has been conducted so far in Bangladesh to identify the overall constraints and farmers' level of concern about buffalo farming. We hypothesized that perceived level of concern will vary between farmers and livestock professionals, location and farming system. This study will help to identify constraints related to buffalo farming, to assess factors associated with higher concern level, and to help the policy makers where to target the new strategies.

Objectives:

a) To assess overall constraints of buffalo farming in Bangladesh.

b) To determine the level of concern of the buffalo farmers and different stakeholders regarding the constraints.

c) To assess the relationship between level of concern and farm demographic factors and different constraints.

d) To identify farmers demand to sustain buffalo farming in Bangladesh.

Anticipated outcomes:

a) Estimate the level of concern of different stakeholders and the farmers in different farming systems and region.

b) Determination of important constraints in different farming systems.

c) Determination of factors that significantly affect the level of concern.

d) Determination of farmers demand for sustainable buffalo farming.

Chapter 2: Literature Review

2.1. Buffalo population

Buffalo is a high potential livestock species used for milk, meat, and draft purposes. It is distributed mostly in Asia, and a small population is found in some other parts of the world, like Italy. Buffalo contributes to economic development, poverty alleviation, rural livelihoods and the increasing demand for animal protein (Naveena and Kiran, 2014). Water buffalo holds the second position in the world milk-production and fourth in meat production compared to other milk and meat producing livestock (FAO, 2017).India and Pakistan produce more buffalo milk than cattle because they have the highest number of buffaloes in the world and some high yielding breeds like Nili-ravi and Murrah. Buffalo is mainly reared in tropical and sub-tropical countries (Das and Khan, 2010).The current global water buffalo population is more than 201 million, of which Asia contributes around 97%,and south Asian countries contribute 77.5% (including India 56.7%, Pakistan 17.7%, China 12.2%, Nepal 2.7% and Bangladesh 0.8%) (Deb et al., 2016; Hegde, 2019).

In Bangladesh, the dairy sector is based mainly on cattle (24.5 million). The population size of buffalo is very small (1.5 million) (DLS, 2021). This small number of buffalo contributes only 3-4% and 0.9% to the total milk and meat production in Bangladesh, respectively (Hamid et al., 2016a; Habib et al., 2017). Bangladesh produces about 11.9 million metric tons (MMT) of milk per year, whereas the demand of milk is about 15.5 MMT, and the biggest share of milk comes from cattle (DLS, 2021). To meet the increasing demand of milk, other dairy species like buffalo should be prioritized and they are adoptable to tidal waves and climate change (Hamid et al., 2016b; Rahman et al., 2018a). Therefore, the Bangladesh government, private sector, and research organizations have recently come forward to increase the buffalo production in this country (Rahman et al., 2018b).

2.2. Buffalo breeds and their distribution in Bangladesh

In Bangladesh there are no recognized breeds of water buffalo and they are mainly of the indigenous non-descriptive type (Faruque et al., 1990; Hamid et al., 2016a). Exotic breeds (river type breeds like Murrah, Nili-Ravi, Surti and Jaffrabadi) are not common in Bangladesh. Non-descriptive buffaloes are found in coastal areas and marshy lands of the country; river and Murrah types are found in the eastern part of the country. Some cross

breeds of Nili-Ravi, Surti and Jaffrabadi are found in areas near the Indian border of the country (Faruque et al., 1990; Huque and Borghese, 2012). Common buffalo breeds reared in intensive farms of Bangladesh are Murrah, Nili-ravi, Surti and cross-breeds of indigenous buffalo with Nili-ravi, Murrah, Jafrabadi and Surti (Siddiky et al., 2014; Habib et al., 2017).

In Bangladesh, buffaloes are concentrated in the Meghna-Ganga flood plain as well as in the Brahammaputra-Jamuna flood plain (Sohel and Amin, 2015). In addition, buffaloes are also found in the coastal area, Sylhet haor area, sugarcane belt of Jamalpur, Trishalupazila of Mymensing and northern part of the country (Huque and Khan, 2017)**.**

2.3. Buffalo production systems of Bangladesh

Based on management practice and feeding system there are four different buffalo rearing systems prevailing in Bangladesh. These are- i) Household / Semi-intensive system (average size: 1 to 3 per household), ii) Bathan/ Free range system (average herd size: 51 to 200) iii) Semi-bathan (average herd size: 4 to 57) and iv) Commercial/ Intensive system (average herd size: 6 to 22) (Habib et al., 2017; Rahman et al., 2018a; Rahman et al., 2019b)

Household buffaloes are kept in an open yard near the farmer's house at milking time (morning) and then allowed to the grazing land for the whole day. Farmers separate the calf from the dam at evening and feed the cows straw, and sometimes a little concentrate supplement. Very few farmers build a house or shed made of tin or leaves of the golpata (*Nipa fruticans*) tree for the buffaloes (Rahman et al., 2018b).

The management system in semi-intensive systems is almost similar to the household system. During daytime buffaloes are allowed for grazing in open field and kept in a house made of brick or tin.

In the intensive farming system, farmers rear buffalo in a shed. Feed and water are supplied in the house and for wallowing farmers provide a shower in the farmyard (Rahman et al., 2018a).

Free range or bathan systems are found in coastal, river basin areas and mostly island areas in Bangladesh. Animals graze the whole day in the open field in groups. Sometimes buffaloes graze with cattle, sheep and goat together. These animals are fed on green grass

only. No additional feed supplement is given to the animals. There is no house for the buffaloes but the calves are kept in a high fenced place called kella. During rainy season, as water level increases, farmers also move their buffaloes to “Kella” (Uddin et al., 2016)..

The semi-bathan system is the combination of bathan and household systems. Buffaloes are kept in islands most of the time, but at the beginning of monsoon farmers bring the buffaloes back to the main land close to their homestead, because there is plenty of grass and crop residue available for the buffaloes at that time. Both grazing and the cut and carry method is practiced for feeding.

2.4. Advantages of buffalo rearing

The interests in the production of buffalo has risen lately, due to the high quality of their products, high disease resistance and their adaptability to the environmental conditions (Rey and Povea, 2012). In Bangladesh mainly the people of the char and coastal area are rearing buffaloes for their own nutrition and income sources (Harun-Or-Rashid et al., 2019). There are many advantages for buffalo rearing in Bangladesh such as i) Buffaloes are better converters of poor-quality feed than other ruminants, ii) There are many river basins, growing islands and vast coastal areas, iii) They are more adopted to the coastal ecosystem, iv) They produce high quality milk and meat in comparison to cows, v) Buffaloes have a higher disease resistance and vi) They provide mechanical power to mankind, and vii) They gain more daily body weight.

2.4.1. Better converter of poor-quality roughage

Buffaloes are very efficient converters of low-quality roughage, especially agricultural crop residue and by-products. They produce more protein/kg roughage and gain more body weight than cattle, and have outstanding draft capacity (Wanapat and Kang, 2013; Hamid et al., 2016b). Indigenous buffaloes of Bangladesh also provide those advantages to the farmers (Saadullah, 2012). Buffalo have the extraordinary ability of utilizing coarse feed in a more efficient way than cattle and produce more solids in milk (Dubey et al., 1997) which makes buffalo milk of a higher quality than the milk of other ruminants (Hamid et al., 2016b).

2.4.2. Abundance of river basins, growing islands and coastal areas

Bangladesh is the largest delta of the word and its coastal area covers 32% of total land mass, spread over 19 districts (Ahmad, 2019). This huge land surface is more suitable for buffalo farming then other livestock species. There are many rivers in Bangladesh and these river basin areas are also suitable for buffaloes. New islands are rising in the big rivers and farmers are trying to start buffalo rearing in those islands, as there is available grass for feeding.

2.4.3. Well adopted to coastal ecosystem

Lots of indigenous buffaloes (40%) are found in the coastal areas of Bangladesh and they can survive tidal waves (Faruque et al., 1990; Hamid et al., 2016b). They are more adopted to the coastal ecosystem and salt water (5gm/L) than other livestock species (Thomas, 2008; Siddiky and Faruque, 2017). Buffalo rearing in coastal areas is highly profitable and this may be a good way for poverty alleviation and livelihood improvement (Hasan et al., 2016).

2.4.4. Produce high quality product

Buffalo produces high quality milk and meat from poor quality feed supply. Buffalo meat is superior to beef because it is low in fat and cholesterol, is high in protein, and has good water holding capacity and emulsifying capacity (Wilson, 2012; Kandeepan et al., 2013). It is a very good source of Beta carotene and vitamin-B_{12} (Kandeepan and Biswas, 2007). Buffalo milk is high in total solid content, protein and fat. It contains 16% total solid, 6-8% of fat (50-60% higher than cow milk) and 4.5% protein, which makes it superior to cow milk (Hamid et al., 2016b). Another advantage of buffalo farming is the higher price of milk (72 BDT/L)compared to cows (50 BDT/L) (Sohel and Amin, 2015; Rahman et al., 2019a). In some parts of Bangladesh, the buffalo milk price is 100-150 BDT (Personal communication; Ripon Kanti Das). The average milk production of buffaloes in household or semi-intensive (799L/ Lactation) and intensive systems (2001L/ Lactation) is higher than those reared in free-range bathan system (435L). This may be due to the variations in feeding resources, management system and genotypes of buffaloes (Uddin et al., 2016; Rahman et al., 2018a). The average milk production of cattle in intensive farms was 1000-1400 L/cow/lactation and in traditional or household system is 600-800L/cow/lactation(Uddin et al., 2011).

2.4.5. Higher disease resistance power

A higher adoptability power of buffaloes makes them more resistant than cattle against many infectious and contagious diseases (Hamid et al., 2016b)**,** such as contagious bovine pleuropneumonia, foot root, foot and mouth disease (FMD), anthrax, black quarter, and mastitis (Thomas, 2008). Routine deworming, vaccination, and improved feeding are suitable strategies to maintain a healthy buffalo flock efficiently (Hamid et al., 2016a) especially in bathan systems, because bathans are located so remote from the lands and veterinary services are not always available.

2.4.6. Provide mechanical power to mankind

Buffaloes also provide draft and transport facilities, besides milk and meat production. Buffaloes are very essential animals for the poor farmers in crop dominant mixed production systems in developing countries (Cruz, 2007). They are considered as the tractor in most of the Southeast Asian countries, because they provide 20% to 30% of farm power in China, Thailand, Indonesia, Malaysia and the Philippines (Singh et al., 2000). Buffaloes are used to plough and level land, plant crops, puddle rice fields, cultivate field crops, carry people, thresh grain, press sugar cane, pump water, haul carts, sleds and shallow-draft boats. In wet and muddy areas buffalo provides more advantages as they have larger hooves then other animals (Siddiky and Faruque, 2017).

2.4.7. More daily body weight gain

Buffaloes have a unique characteristic to produce protein rich high quality low fat lean meat by converting coarse roughage and feed residue. Average body weight gain of buffaloes is also high compared to cattle.

2.5. What do the buffalo need?

From the welfare point of view buffalo needs proper housing, feeding, breeding, and treatment facilities. These are the basic needs of buffalo production for any production system. Buffalo is also known as water buffalo because of its habit to wallow in water and muddy pools. Physiologically they have small number of sweat glands in the skin; as a result they cannot tolerate much heat and try to control body temperature by wallowing in water or mud (Hegde, 2019). Usually during winter, they do not do much wallowing. If they are kept in a comfortable shed in terms of temperature, sprinkling water several times on the body surface is enough to avoid wallowing (Bah et al, 2021). Buffalo is properly

adopted to coastal areas where water salinity is higher (Siddiky and Faruque, 2017). They can graze on grass grown in saline water, but they cannot drink saline water. Therefore, they need a large amount of drinking water to survive. The feed conversion efficiency of buffalo is excellent. They do not need high quality roughage. They can survive on grazing in pasture land, agricultural crop residue and mineral salt without supplementation of concentrate feed (Hamid et al., 2016b). However, buffaloes are highly resistant to many diseases, regular vaccination (FMD, HS and BQ) and deworming is important (Hamid et al., 2016b).

2.6. Challenges of Buffalo Rearing

Besides those advantages in buffalo farming, there are many challenges in buffalo farming such as inadequate nutrition supply, poor management practices, in-breeding, unavailability of quality bulls and semen, lack of skilled AI technicians and insufficient veterinary services (Naveena and Kiran, 2014). Challenges or constraints in buffalo farming can be categorized as: i) Housing or rearing constraints, ii) Feeding and nutrition constraints, iii) Breeding constraints, iv) Health or disease constraints, v) Economic constraints, vi) Marketing constraints and vii) Superstitions and ignorance in the society.

2.6.1. Housing or Rearing Practices and Constraints

Housing management varies depending on the production system farmers are involved in. No standard housing system exists in buffalo rearing in Bangladesh. Uddin et al., (2016) described that farmers kept buffaloes near the house only for night and only 15% farmers used roof but no flooring materials. In intensive systems animals are confined in the house for the whole day and houses were built up by brick and tin (Rahman et al., 2018a). In bathan systems (extensive rearing system) there is virtually no house for buffaloes (Akbar et al., 2009). Uddin et al., (2016) reported that farmers kept buffaloes in an open place throughout the year in both household and bathan systems. Kella is also used as shelter in the flood seasons for adult buffaloes.

Lack of sufficient space, inconvenient practice, and lack of knowledge about scientific housing were the perceived constraints in housing practice (Ali et al., 2019). Munish, (2015) observed in a different study that lack of scientific knowledge(housing design, ventilation facility, flooring and roofing, drainage facility etc.) about housing was the main

problem along with high construction costs and ignorance of the farmers to make a separate house for the buffaloes.

Wallowing is important for buffaloes to control their body temperature and external parasites. Very few farmers (11%) allowed wallowing of buffaloes in a household system. Almost all of the farmers in intensive system practice showering of buffaloes in the household yard instead of wallowing in ponds or canals (Rahman et al., 2018a) which is a typical arrangement for buffalo rearing. It has been described that the buffaloes have their own wallowing place and sometimes the whole village herd lies down together in the mud and wallows until evening in ponds, canals and rivers (Saadullah, 2012; Uddin et al., 2016; Rahman et al., 2018a)**.**

Another important management practice for any farming system is record keeping, but it is not practiced at all by the buffalo farmers of Bangladesh. However, they can memorize some important things to some extent, like disease, vaccination, deworming, purchase and parturition history. They don't practice individual animal identification (Habib et al., 2017). The majority of the farmers put a common identification mark (for example, a specific pattern of cut in ear) in all buffaloes of their herds, which is different from other herds. It helps them find their buffaloes in the bathan, where many buffalo graze together. Farmers having a few numbers of buffalo select a name for each buffalo and call them by their names.

2.6.2. Feeding Practices and Constraints:

Farmers usually follow traditional feeding practices for the buffaloes, for example common grazing land, grazing on roadside grass, but provide supplementation of crop residue, household waste, tree fodder, roots and tuber, rice straw, and a small amount of concentrate of rice bran, wheat bran, and pulse bran. Feeding ingredients varied depending on season and place. Most of the farmers do not own fodder land for their buffaloes in Bangladesh. Therefore, buffalo farmers broadly use public land for grazing (Saadullah, 1990; Hamid et al., 2016a).

In household systems, buffaloes graze on natural pasture or the roadside. Common roughage sources were paddy straw (*Oryza sativa*), Dol (*Saccrolepsis indica*), Dubla (*Cynodon dactylon*), Halancha (*Enhydra fluctuens*), Sesbania, Water hyacinth (*Eichhornia*

crassipes) and kheshari (*Lathyrus sativus*). Buffaloes grazed the whole day in the field and then they are tied up in homestead from evening to morning and animals were supplied with straw. Sometimes a little amount of concentrates (wheat bran, rice bran and rice polish) is given to the lactating buffaloes (Uddin et al., 2016; Rahman et al., 2018b)**.** Similar kinds of feeding practices are observed in semi-intensive systems. Farmers of the Ganges-Brahmaputra flood plain rear buffalo with minimum inputs. Buffaloes graze all day in natural pasture and stall feeding is done with straw and little amounts of concentrate (Akbar et al., 2009).

In rainy and winter season, some legumes and green grass are grown sporadically in some areas of the country, but in the next six months, there was very limited growth of green grass. During this period rice straw is the main source of roughage (Tareque, 1991). During the rainy season, grazing is restricted to upland non-cropped area. Farmers face difficulties in grazing animals during rainy season and cropping season (Habib et al., 2017).In coastal areas of the Pirojpur and Borguna district farmers allow grazing for the whole day when there are no crops in the field (Karim et al., 2013).

In bathan or free-range systems, buffaloes are allowed to graze freely in an open field throughout the year. No additional feed supplement is given to the animals. Farmers who have small herds (below 50) usually move their animals to the main land and keep them in the homestead area during the dry period (January to April) as there is scarcity of feed in bathans (Uddin et al., 2016).

In Nepal complete stall feeding is practiced during cropping season, but occasionally buffaloes are allowed to graze freely in crop land where there are no standing crops (Rasali, 2000). In Turkey, small-scale buffalo farming mostly depends on grazing on the field. They do not feed concentrate to the animals, but during scarcity (the period from October to April) farmers purchase straw and alfalfa to feed buffaloes (Işik and Gül, 2016). A similar kind of feeding practice is observed in Greece, where grazing is practiced year-round, and during November to April farmers supplied complementary feed to the animals (Ligda and Georgoudis, 2005).

Poor feeding practice is responsible for nutritional deficiency which results in reduced milk production of the existing buffalo population (Habib et al., 2007). Different feeding

constraints are responsible for those poor feeding practices. Most of the farmers do not have knowledge about balanced rations, there is a lack of fodder and pasture land, they do not feed concentrate because of high prices, and mineral mixtures are not available (Munish, 2015; Habib et al., 2017; Rahman et al., 2018a). Major problems related to feeding were lack of feeds and fodder, lack of grazing land and lack of enough drinking water during flood or prevalence of salt water (Islam et al., 2017b).

In Pakistan Ali et al., (2019) found that high prices of concentrates, unavailability of green fodder throughout the year, lack of knowledge about the importance of mineral mixtures, and lack of skills regarding preparation of balanced ration are the major constraints related to feeding and nutrition. Similar feeding constrains for buffaloes have been reported in India. Dairy farmers of the tribal belt of Narmada valley of Gujarat faced high cost of feed (90%), non-availability of green roughage (73.8%) throughout the year, lack of knowledge about balanced ration (72.5%) and lack of drinking water source (43.8%) as major feeding constraints (Patel et al., 2013; Rajkumar et al., 2017)**.** Mohapatra et al., (2012) in a separate study also described similar kind of feeding constraints in different regions of India.

2.6.3. Breeding Practice and Constraints

Reproductive efficiency of buffalo is influenced by different management practices (Agrawal, 2003). Indigenous buffaloes show first heat at the age of 37-38 months, and they are seasonal breeders (Uddin et al., 2016; Basu, 1962; Qureshi et al., 1999). Buffaloes usually show heat between early nights to early morning. Therefore, it is difficult to know when they come to heat. The majority of the farmers in both household (95%) and bathan (99%) systems practice natural insemination for breeding and only 5% of the farmers used artificial insemination (AI) in a household system (Uddin et al., 2016). Insemination is done by their own bull or a neighbor's bull in open field or in the shed (Rahman et al., 2018a). Akbar et al., (2009) reported that farmers in coastal areas kept high enough numbers of breeding bulls and no fertility problems were observed.

Buffalo farmers in Bangladesh face many reproductive and breeding constraints. Reproductive efficiency of the buffaloes of Bangladesh is very low compared to the buffaloes of neighboring countries. It is hampered by delayed puberty, seasonal breeding, long calving interval, lack of knowledge about estrus detection, no progeny testing

program, poor genetic potential, scarcity of proven bulls, and slow adaptation of artificial insemination (Hamid et al., 2016a; Habib et al., 2017).

Farmers are mostly depending on a natural breeding system using a bull, but the number of breeding bulls is very low in most of the areas (Saadullah, 2012). Timely insemination was not possible sometimes due to an insufficient number of breeding bulls (Rahman et al., 2018a). It has been reported that the average age at first heat is very high and this may be due to a few bulls and cow ratio in different farming systems. Similar results are also observed by the study of (Habib et al., 2017). However, abortions and inbreeding are also common due to repeated use of same bull. Inbreeding occurs due to low population number, which leads to poor genetic potential and low productivity (Wilson, 2012).

Very few farmers practice artificial insemination (AI) in buffaloes. This is due to non-availability of an AI facility, lack of AI technicians, long distances (8.81 km), and high cost of AI (540 BDT) (Saadullah, 2012; Islam et al., 2017b). In addition, movement cost of animals from farm to AI center was also very high (2500-3000 BDT) (Rahman et al., 2018a). Some farmers think that insemination through a bull may increase conception rate. This is a great barrier for practicing AI (Sawarkar et al., 2001). Poor estrus detection rate was another challenge that limited efficient use of AI (Pasha and Hayat, 2012; Wilson, 2012; Rahman et al., 2018b). Recently a government buffalo project started AI in the Bhola region, but it is not popular because of insufficient AI technicians, unavailable buffalo semen, and low conception rate (Rahman et al., 2018b).

In Pakistan common constraints faced by the farmers in adoption of breeding practices are high costs of a breeding bull, lack of trained technicians for AI, poor result of AI in cows, lack of timely AI, lack of knowledge about proper timing of AI, and lack of knowledge about heat detection (Ali et al., 2019).

In India, farmers' preference of natural service over AI (51.66%) was the top ranked constraint followed by low conception rate in artificial insemination (41.7%) and non-availability of breeding bull (38.3%) (Nithya and Selvaraj, 2018). Similar results were observed by the study of (Munish, 2015) and, in addition, non-availability of pregnancy diagnostic facilities and repeat breeding were mentioned. The study of (Rajkumar et al., 2017) showed that infertility of buffalo (76.6%), non-availability of AI facilities (73.6%),

poor conception rate of AI (63.2%), and lack of a good breeding bull (60.7%) were the key breeding constraints.

From the above description, we can conclude that the most common breeding constraints are low numbers of breeding bulls, poor genetic character, non-availability of AI, poor quality of semen and poor adoptability of AI. To improve the above condition an appropriate breeding policy is necessary that can upgrade the genotypic character of indigenous buffalo is urgently needed. Enough proven bulls are very essential to stop inbreeding and produce a superior offspring. Systemic breeding of native buffalo cows through AI with imported semen of proven bulls is essential at this moment (Harun-Or-Rashid et al., 2019). Training of farmers about breeding management and benefits of AI is urgently needed.

2.6.4. Health and Disease Management and Constraints:

Buffalo has higher disease resistance than any other livestock, but they are not free from disease. Incidence rate of most common viral and bacterial diseases of buffalo causing economic losses are Foot and Mouth disease (FMD) 63%, anthrax 15%, black quarter (BQ) 12%, haemorrhagic Septicemia (HS) 10%,brucellosis 7.1%, tuberculosis 4.08%, and mastitis 23.68% (Rahman et al., 2011; Hossain et al., 2012; Hamid et al., 2016a; Islam et al., 2016; Habib et al., 2017).

Inability to combat local diseases is a major problem in health management (Wilson, 2012). Hamid et al., (2016a) found foot and mouth disease to be the most problematic disease because of unavailability of a free vaccine. Adult buffaloes are more susceptible to Haemorrhagic septicemia and it is the major cause of death in adult buffaloes (Thomas, 2008; Islam et al., 2013). In household and intensive systems, the use of vaccination was 23% and 100% respectively (Rahman et al., 2018a). In case of vaccination, 66% farmers used FMD, 24% used BQ and 20% used HS vaccine (Islam et al., 2017b).

Islam et al., (2016) found a prevalence of gastrointestinal parasites at an alarming rate (64.2%), with one or more species of parasites in highly buffalo concentrated coastal areas of Bangladesh. A similar prevalence (61.02%) was observed by Mamun et al., (2011) in selected area of Bangladesh, and Azam et al., (2002) reported a prevalence of 64.41% parasite in buffaloes of Pakistan. An epidemiological study in the Bhola region found

84.3% of parasitic infestation of buffaloes which is higher than in other studies (Biswas et al., 2014). Most common gastro-intestinal parasites found in buffaloes are *Paramphistomum cervi* (32.1%), *Fasciola gigantica* (21.6%), *Toxocara vitulorum* (5.56%), *Schistosoma indicum* (1.85%), Strongyles sp. (1.85%) and *Strongyloides sp*. (1.23%) (Islam et al., 2016). This high prevalence rate of parasites is due to a lack of regular use of anthelmintic and a lack of knowledge about deworming (Sarkar et al., 2013; Amin et al., 2015; Hamid et al., 2016a). In household and intensive systems use of anthelmintic was 31% and 100% respectively (Rahman et al., 2018a). The study of Islam et al., (2017b), carried out in 10 districts of Bangladesh, observed that 90% farmers used deworming for the buffalo.

High calf mortality rate is a big problem and causes economic losses in buffalo farming (Hamid et al., 2016b; Siddiky and Faruque, 2017). Calf mortality rate in household and intensive system has been found to be 8% and 7% respectively in some selected area of Bangladesh (Rahman et al., 2018a). Most common diseases of buffalo calves causing calf mortality are calf pneumonia and diarrhea, which result from poor management, poor nutrition, and various infectious and parasitic agents (El-Ghari et al., 1994; Galiero et al., 1994; Islam et al., 2013; Hamid et al., 2016b; Islam et al., 2016; Rahman et al., 2018a). In Pakistan, very few farmers practice vaccination and deworming. The reasons behind this are lack of knowledge, awareness and unavailable veterinary services (Moaeen-ud-Din and Babar, 2006).

Farmers faced problems to get proper veterinary services. High cost of treatment of animals was ranked as the major constraint followed by a lack of veterinary services of the Livestock Department, high fee for a qualified veterinarian, non-availability of timely medicine/vaccine, and lack of knowledge about cause and control of diseases (Ali et al., 2019).

2.6.5. Economic Constraints

Buffalo farming is economically and culturally important for Bangladesh (Arefaine and Kashwa, 2015). Farmers rear buffalo in traditional systems with low inputs. Major costs in the buffalo production chain are human labor, feeding, breeding, housing and equipment and health care costs. Breeding and feeding cost are low in some areas because farmers

depend on natural grazing system and for breeding farmers practice natural breeding. On the other hand, major health care costs are medicine and vaccination costs(Sarkar et al., 2013; Amin et al., 2015).Islam et al., (2017b) found 57% of the costs of milking buffalo rearing was human labor followed by 41% feeding costs in 10 buffalo concentrated districts of Bangladesh. Besides those costs, the author found that farmers get enough economic benefit with very low inputs. A separate economic analysis of buffalo farming in Bagerhat and Subornochar showed that average management costs were 5,070.00 BDT and 6,850.00BDT respectively and net return was 15,630.00 BDT and 13,920.00BDT respectively per buffalo per lactation (Sarkar et al., 2013; Amin et al., 2015). Islam et al., (2017b) found that total rearing cost was 24,507.00 BDT per lactation and farmers got a net return of 7,607.00 BDT/Lactation with a benefit cost ratio (BCR) of 1.31. Some rich buffalo farmers want more output with less input. They do not pay more attention to milk production, as their main purpose is having a calf from the dam every year (Personal communication, Aiub ali).

Most of the farmers rearing buffalo are poor and illiterate. They do not have knowledge about a good management system and advanced technologies. As a result, the adaptation level of good husbandry systems and new technology is poor (Rahman et al., 2018b).

Farmers cannot provide proper feed, breeding bull and treatment, as they do not have enough money. Financial support from government and NGOs is very limited (Rahman et al., 2018a).Some informal credit facilities are available but the interest rate is very high and the procedure is complicated (Pasha and Hayat, 2012; Sarita et al., 2017; Ali et al., 2019).

In India, major economic constraints faced by the farmers were a lack of own capital, high construction costs, high feed costs, lack of credit facility, high interest rate, and high costs of milch cow (Pata et al., 2018). Financial support from government or NGOs is essential for the farmers to start up and run their farm properly, but this kind of support is currently not available for the farmers in some part of Bangladesh (Rahman et al., 2019).

2.6.6. Marketing Constraints

There is no proper milk marketing system in Bangladesh. The traditional and most common marketing system of buffalo milk is that farmers sell milk to a Ghosh (middleman) on a

contract basis and take advance money from them. On the other hand, the milk market is more volatile for the farmers who didn't get an advance from Ghosh (Rahman et al., 2018b).

In the household system, almost 53% of the farmers used buffalo milk for family consumption or sold it on the local market, and 47% farmers sold their milk to middlemen and local processors(Uddin et al., 2016).Rahman et al., (2018a) found in his study area that household farmers sell milk to the milkman and get a very low price (40-42 BDT/L). They did not get a milk price based on fat percentage. In contrast, intensive farmers sold their milk directly to the sweet shop and got a little higher price (50-55 BDT/L). Farmers who sold milk to the middleman did not get their payment regularly, but this condition is not necessarily the same all over the country. Milk price and payment system varies from place to place. It has been reported that in river basin regions buffalo farmers get the highest milk price (72 BDT/L) (Rahman et al., 2019b).

In the bathan system, about 58% of the farmers sold their milk to a middleman. Many farmers in bathans do not get the actual price of milk due to lack of a proper transportation system and sell their milk at a low price to local processors (Uddin et al., 2016).

Studies in different regions of India reported the main marketing constraints were a non-remunerative price of milk, lack of preservation facilities, lack of knowledge about clean milk production, exploitation by middlemen, distance to milk co-operative, lack of awareness in marketing strategy and lack of transportation facilities (Patel et al., 2013; Nagrale et al., 2015; Rajkumar et al., 2017; Pata et al., 2018).

It has been reported in Turkey that a lack of sufficient information about the benefits of buffalo milk products created a problem in the marketing of those products (Işik and Gül, 2016). In Egypt, a study on the milk value chain found that smallholders were exploited by the intermediaries and get a very low price for their milk. Moreover, there was a lack of marketing infrastructure such as proper transportation and cold storage facilities to maintain milk quality (Abou El-Amaiem, 2014).

It is therefore important that a full milk value chain should be explored. Besides that, improvement of the current milk value chain is necessary to minimize feed costs and increase milk price in the market (Rahman et al., 2018a).

Though buffalo meat has a higher nutritional value than beef, it is not as popular as beef. In Bangladesh almost all buffaloes are slaughtered after completing their whole life in work, when they are emaciated and average dressing percentage was 44%. (Hasnath, 1985; Hamid et al., 2016b)**.** A good number of buffaloes are slaughtered in village and city markets and sold at a lower price (370 BDT/kg) than beef. This low price of buffalo meat is due to ignorance of general people. Moreover, aged buffalo meat is sticky and hard to chew (Hamid et al., 2016b). However, in Chittagong the scenario is different. Buffalo meat is very popular in this area and its price is higher than beef. Many buffaloes are slaughtered in Chattogram every day and during religious festivals, people prefer buffalo for sacrifice.

2.6.7. Other constraints

2.6.7.1. Superstition and ignorance about product value

During the field visit, a couple of superstitions were revealed about drinking buffalo milk. Some people believe that drinking buffalo milk may cause indigestion in children and worm infestation, while some other people think that drinking buffalo milk and eating buffalo meat may convert their skin appearance to that of buffaloes. It has also been heard that long time drinking of buffalo milk may produce arthritis. So, some farmers do not let their children drink buffalo milk, but rather they sell it and buy cow milk instead for the children. These types of superstition hamper marketing and consumption of buffalo milk and meat resulting in economic losses for the farmers. Furthermore, farmers do not have knowledge and skills about milk by-product value addition. Very few (11%) farmers in river basin areas produce by-product from buffalo milk, most commonly sour curd (Rahman et al., 2019a).

2.6.7.2. Shrimp culture in coastal areas

In some coastal areas of Bangladesh, shrimp culture is the main source of livelihood. This Shrimp culture had been extended in Khulna, Bagetgat, Satkhira and Cox's Bazar. People are more interested in shrimp culture because of its big demand in the international market, but shrimp culture has some bad effects on environment by increasing salinity of soil and drinking water (Mahmuduzzaman et al., 2014). Increased salinity of soil has an impact on

crop production and human health (Huq et al., 1999). A large proportion of buffalo feed comes from agricultural crop residue and natural grazing land. Due to increased salinity of soil and shrimp culture cropping is not possible and the area of natural grazing land has decreased.

2.6.7.3. Islands occupied by Army and Navy

The Bangladesh army recently occupied part of Swarnadwip (Golden Island), locally known as Jahaijjarchar, which is located at Meghna estuary in Noakhali with an area of 360 sq-km. They are doing developmental work including building a cyclone center, village, training center, afforestation, and livestock farming. The island has a population of over 200 and all of them are farmers. They are using the island for a long time for rearing cattle, buffalo, sheep and goat. As a large portion of the island has been occupied by the army, grazing land has been drastically reduced displacing a large part of the buffalo herds to other adjacent further remote islands. Due to a lack of land many farmers stopped rearing buffalo and sold them to the market. Another island named Bhashan Char (total area, 40 sq.km.) located 11 nautical miles away from Jahaijjar Char was also used as free grazing land for livestock by the local people. But recently, the Bangladesh Navy built a shelter, which can accommodate 100,000 people, to relocate Rohingya refugees from Cox's bazar.

2.6.7.4. Afforestation in coastal areas

The coastal zone of Bangladesh is highly vulnerable to climatic hazards like cyclones, flooding, and erosion. To save those highly vulnerable areas the Bangladesh Forest Department started an afforestation program. There is a new law by which new islands can be afforested without prior permission from the government. Furthermore, in recent years the forest department has occupied some coastal areas that were used as natural pasture land for livestock, especially buffaloes. In those areas, farmers are facing shortage of feed as they mostly depend on natural grazing land to feed their animals. Sometimes the forest is fenced by barbed wires and buffaloes get injured frequently by crossing the fence while searching for food. Farmers claimed that the forestry department does not allow animals in the forest for grazing. Sometimes they torture and fine cowboys if animals enter the forest area.

2.6.7.5. Farakka barrage

Farakka barrage is located 18 km away from the Bangladesh-Indian boarder on the Ganges River and was commissioned by Indian government in 1975. This blockage of normal flow of water has a significant impact on the hydrology of the Ganges River system in Bangladesh. During dry season (November- May) water flow decreases significantly, but during monsoon (July- October) water flow increases rapidly and causes floods in the Bangladesh part (Khan, 1993). Reduced flow of water caused saline water intrusion in upstream rivers and inland water that effects agriculture, forestry, industry and drinking water sources. Intrusion of saline water caused gradual increase of soil salinity. As a consequence, paddy cultivation and grazing land for livestock decreased remarkably (Mirza, 1998; Salam, 2007).Though buffalo can tolerate salt water, agricultural activity and fodder cultivation is not possible in saline soil. Many rivers have died due to decreased/controlled water flow from the Ganges and smaller islands grown inside the big rivers, further affecting the normal water flow in the dry season and ultimately affect suitability of the river basin for buffalo grazing.

2.6.7.6. Welfare issues

Animal welfare is now an important issue all over the world. Developing countries like Bangladesh are lagging behind in this aspect compared to developed countries. It is a challenging issue for Bangladesh nowadays because of poor management and handling of animals. On-farm welfare parameters can be measured by for example body condition score (BCS), lameness, leg injury, cleanliness and health condition(Ahsan et al., 2016). Most of the buffaloes reared in extensive (Bathan) and semi-intensive system have a low BCS. Some buffaloes have skin and leg injuries mainly due to poor management. Other important aspects of welfare are transportation and slaughtering. Global guidelines for animal welfare have been adopted by The World Organization for Animal Health (OIE, 2014**),** aiming to improve and maintain welfare for food animals before and during slaughter. In Bangladesh, most of the cattle and buffaloes slaughtered have some degree of dehydration, injuries, and oculo-nasal discharge and many of the animals were dull and depressed (Alam et al., 2020). It has been reported by Alam et al., (2010) that 99% of the buffaloes present in livestock markets have injuries. In Bangladesh, the most common method for animal transportation is by foot and vehicle over long distances. Very few

farmers use boats in coastal or river basin areas. During transportation there is usually high stocking density, poor ventilation, dehydration, muscle injury and heat stress (Kober et al., 2014).

2.7. Climate Change and Buffalo Farming

The global temperature is increasing rapidly due to increased production of greenhouse gases, causing long-term change to the climate. Greenhouse gases responsible for global warming are mainly carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Due to a rapidly increasing industrialization rate, also greenhouse gas emission is increasing rapidly. The increasing amount of greenhouse gas is raising global temperature at an alarming rate. Furthermore, due to an increased demand for food and inhabitation for humans, deforestation is also increasing, speeding up the process of climate change. This climate change and increased global temperature causes a raise in sea water levels by melting down the mass volume of ice in the polar region (Mahmuduzzaman et al., 2014). Day by day new areas are going under water (Nerem et al., 2018). As a result, people of those areas become homeless and their livelihood is under threat. Bangladesh is the largest delta of the world and highly vulnerable to climate change. It is one of the countries, which suffer most from the adverse impacts of climate change. Although Bangladesh emits around 0.1% of the total amount of greenhouse gas (Huq, 2001), coastal and river basin areas are gradually going under sea water and salinity increases at an alarming rate. In 2009, the total saline affected area was 105.6 million hectares and it is increasing progressively. The livestock sector is very vulnerable to climate change and raised water level (Zhang et al., 2017). Livestock like cattle, sheep and goat have problems to maintain themselves in saline areas. In addition, most crops cannot grow in saline water. Around 35 million people representing 29% of total population of Bangladesh live in the 19 districts of the coastal zone and most of them depend on agriculture and livestock rearing to earn their livelihood (Ahmad, 2019). In a report, the World Bank (2000) showed that the sea level would increase 10cm, 25cm and 1m by 2020, 2050, and 2100 affecting 2%, 4%, and 17.5% of total land very respectively. Another prediction by UNEP (1989) showed that by 2030 sea level will rise 1.5 m in the Bangladesh coast, flooding 22,000 sq. km (16% of total land mass) and displacing a population of 17 million (15% of total population). In the future, rearing cattle, sheep, and goat in coastal areas may be quite difficult because of

shortage of feed, grazing land, and salinity of land. In these foreseeable circumstances buffaloes can be an alternative option because of their salt-tolerant adaptability (Thomas, 2008) and the fact that they are efficient converters of poor-quality roughage. Buffalo can easily eat feed from marshy land. So, it is comparatively easier for the farmers to rear buffaloes in the coastal belt.

2.8. Summary

Currently many farmers are involved in buffalo farming in coastal and river basin areas of Bangladesh. Buffalo farming could be the best way to alleviate poverty of rural people in those areas and household buffalo faring increasing as bathan system is more vulnerable. Due to different obstacles, they failed to get an optimal production and benefits from buffalo farming. The number of buffaloes is decreasing day by day in this situation and livelihood of the peoples in those areas is under threat. Furthermore, not enough literature is available to identify those problems and challenges for buffalo farming in Bangladesh. Profound research is therefore necessary to draw the actual pictures of current buffalo farming system and identification of challenges. A prospective cross-sectional study could be applied in this circumstance.

Chapter 3: Materials and methods

3.1. Study area and target population

Bangladesh is a South Asian country and the largest delta in the world. It is located between 20º34'N to 26º38'N latitude and 88º01'E to 92º41'E longitude. It has an area of 147,570 square kilometers (56,990 sq. mi) and occupies 820 kilometers (510 mi) north to south and 600 kilometers (370 mi) east to west. The average temperature of the country ranges from 7.2^{0}C to 12.8^{0}C in winter and 23.9^{0}C to 31.1^{0}C in the summer season (Shahid, 2010). The average annual rainfall is over 2000 mm and it varies from 5500 mm to 1500 mm depending on season and region (Hamid et al., 2016b). Bangladesh is a riverine country, with 79 percent of the country covered by main rivers and their tributaries. The coastal zone of Bangladesh is mainly dominated by the Ganges Brahmaputra Meghna (GBM) river system and Bay of Bengal.

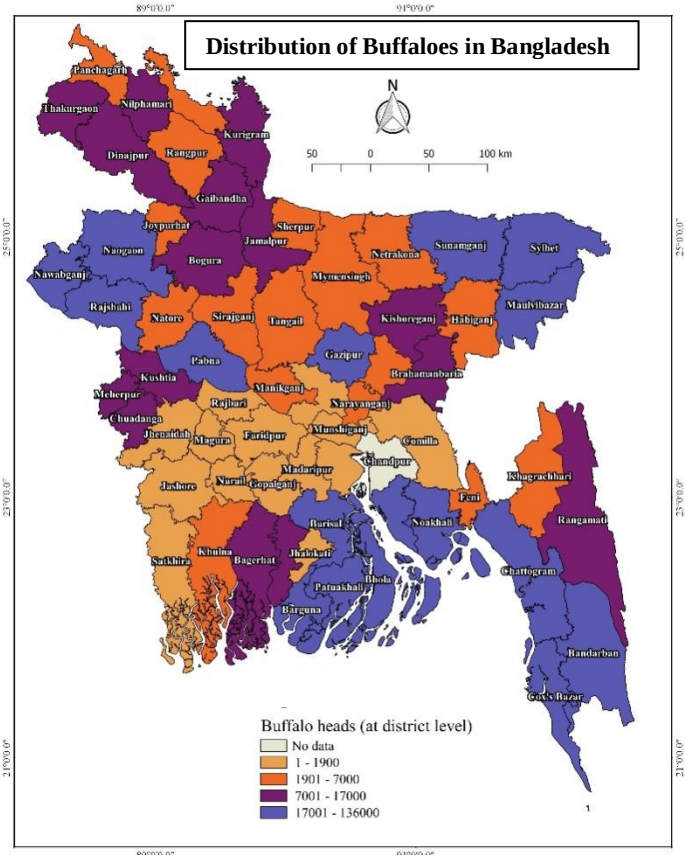

Figure 3.1. Distribution of buffaloes in Bangladesh

The study was conducted in the coastal and river basin areas, where buffaloes are highly concentrated. Seven Upazila with high buffalo concentrations were selected to conduct the study. The areas were categorized into two groups, namely i) Coastal saline zone and ii) River basin zone. A total of three districts; Chattogram (22.34°N to 91.84°E), Noakhali (22.70°N to 91.10°E) and Bhola (22.69°N to 90.65°E) were selected from the coastal saline zone and four districts; Jamalpur (24.92°N to 89.96°E), Mymensingh (24°38′3″N to 90°16′4″E), Sylhet (24°53′N to 91°52′E) and Rajshahi (24.40°N 88.50°E) were selected from the river basin zone with a high buffalo concentration. The target population was the buffalo farms and farmers in those areas.

3.2. Distribution of buffalo in Bangladesh

Buffaloes in Bangladesh are mainly of the non-descriptive indigenous type (Faruque et al., 1990), but there are also some cross breeds of Murrah, Nili-Ravi, Surti and Jaffrabadi with the indigenous type. Indigenous river type buffaloes are found in the coastal (Southern part of the country), marshy land and river basin areas of the country. Migrated buffaloes from India and Myanmar are found near the border areas, sugarcane belts and Cox's bazar. In addition, some indigenous swamp type buffaloes are found in the Eastern part of the country. Some pure bred Murrah and Nili-ravi are also available in the Government buffalo development and breeding farm, Milk vita buffalo farm and in some commercial buffalo farms of Bangladesh.

3.3. Study design, sample size and study period

This cross-sectional study aimed to ascertain the constraints of buffalo farming in Bangladesh. The reference population for the study was the buffalo population and farmers of the study area of Bangladesh. As there was a lack of data about the distribution of the buffalo population and farms in the different regions, convenience sampling was used to select the farms from the seven districts. We collected data of buffalo farmers from Upazila veterinary hospital, local non-veterinarians quacks (Local practioner without an DVM degree) and milk collectors. A total of 171 farms (n=171) were selected from different sub-districts (Upazila) of seven districts based on easy accessibility, cost

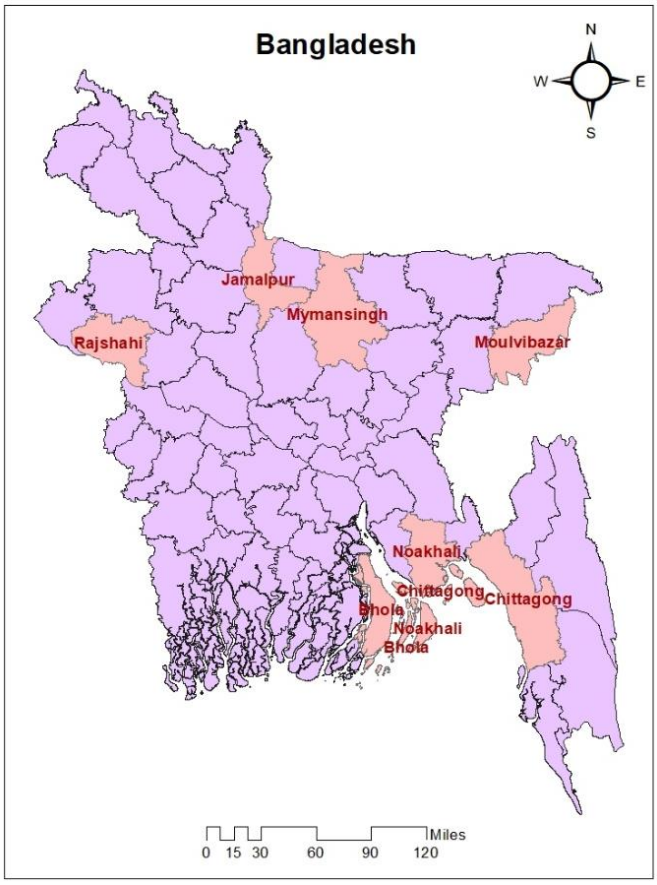

Figure 3.2. Map of the study area

effectiveness and farmer's willingness. The data was collected from February 2020 to April 2021 for a period of 15 months.

The study also included an online Google survey from different stakeholders (Local veterinarians, govt. veterinarian, buffalo researchers, academician and farmers) to ask about constraints they saw regarding buffalo farming in Bangladesh. A list of 101 participants (researchers (16), academics(9), government veterinarians (67), NGO veterinarians (5) and buffalo farmers(4) was prepared for the Google survey (Appendix) and the survey link was sent to the participants (20 people at a time). Participants were reminded every 1-2 week interval and requested to fill out the questionnaire through mobile phone after sending the questionnaire. It was conducted for the period of 6 months from December 2020 to May 2021.

3.4. Preparation of the questionnaire

3.4.1. Farm questionnaire

The farm questionnaire consisted of five main parts, along with questions about demographics of the farm and some open questions. The five main parts were: i) Housing/ Management constraints, ii) Feeding constraints, iii) Breeding constraints, iv) Health and disease constraints and v) Economic constraints. In each part there were several statements on different constraints, and farmers were asked to indicate the degree of agreement, using a five-point Likert scale (strongly disagree, disagree, neutral, agree and strongly agree).

3.4.2. Google survey questionnaire

This questionnaire was used to collect data from different stakeholders. The structure and contents of the questionnaire was almost similar to the farm questionnaire, with a few modifications: farm related questions were avoided in this questionnaire, and there were additional questions on the buffalo milk and meat value chain and climate change issues related to buffalo farming.

3.5. Methods of data collection

Data was collected in two different ways for the two types of questionnaires, as described below.

3.5.1. Farm data collection

A semi-structured questionnaire was prepared to collect data from the selected farms. Piloting was done in six farms in Subarnachar, Noakhali, to identify the gaps and assess

the time required to administer the questionnaire before the main study. The revised version of the questionnaire was used for farm data collection. Farm level data included farm location, farm type, farmer's demography, and farm composition. Constraint data related to housing management, feeding, breeding, health and disease, and economics were collected through Likert scale questions. The questionnaires were administered to the farm owner or a responsible employee of the farm and recorded (written) through face-to-face interview on farm (3-5 interview per day). Before data collection the objective of the study was described to the participants and oral consent was asked.

3.5.2. Data collection through online google survey

The online survey was done through personal communication through emails and phone calls with the participants. Before starting the survey, the online form was tested with one veterinary student of CVASU, one PhD student of UNIMI and two academics of CVASU, Bangladesh and Wageningen University and Research, the Netherlands. An email was sent to the participants that included the link to the questionnaire, together with a request to fill it out and submit. Before administration of the questionnaire, objectives of the study were described to the participants in the form. Both English and Bengali versions of the questionnaire were sent to the participants.

3.6. Data entry and evaluation

Data gathered from the field survey and online Google survey were entered into Microsoft Excel 2019 for checking, cleaning, and coding, and were then stored for further processing. STATA IC-13 (StataCorp, 4905, Lakeway Drive, College Station, Texas 77845, USA) was used for conducting statistical analysis.

3.7. Statistical analysis

3.7.1. Descriptive analysis

Descriptive statistics were performed for farm demographics, farmer's characteristics and some other variables using STATA 13. Categorical variables regarding housing, feeding, breeding, health and disease, and economic aspect of the farm were transformed to frequency and percentage. Farmers' expectations from government or NGOs to sustain buffalo farming in Bangladesh were measured by the total number of responses mentioning NGOs or Govt. divided by the total number of respondents and presented as frequency and percentage.

3.7.2. Calculation of concern score

There were a total of 40 Likert scale questions in the questionnaire. At first, median value of each of the statements or Likert questions was calculated. Then difference from the median was calculated by subtracting the median value from each individual score of the respondent. A total score of concern was then calculated by adding the subtracted values of every Likert questions. The aggregated score of concern of the respondents (farmers and livestock professionals) was visualized in a box plot. Normality and homogeneity of variance of aggregated was checked for conducting para-metric test.

3.7.3. Univariate analysis

Farm level factors having two or more categories were tested for association with the concern score using a t-test or one-way ANOVA. There were 8 factors, including farm location, position, farmer's education, farm type, record keeping, farmer's age, total number of animals, and average milk production per buffalo. Quantitative factors were categorized into two or three categories based of their percentile to ensure maximum frequency in each category of the factor. Qualitative variables were re-categorized to ensure enough number of observations in each category. The categories that were identified are listed below:

- The location of the farms was categorized into three groups based on their geographical location: coastal, inland, and river basin
- Farming systems were categorized into: Bathan, Semi-bathan and Household/ Semi-intensive/ Commercial
- Interviewee title: Owner and Others
- Farm size: small (10 or less), medium (11 to 25) and large (26 to more)
- Farmer's education: illiterate, primary and higher education.

3.7.4. Regression model

Farmers and farm demographic factors that were significantly associated ($p \leq 0.2$) with the aggregated score of concern in univariate analysis were selected for multiple linear regression. The model was manually constructed by backward selection, applying the maximum likelihood estimation procedure. The statistical significance of the contribution of individual factors (or group of factors) was determined by Wald's test and likelihood ratio test (Dohoo et al., 2003). Multicollinearity among the explanatory variables was

checked using the “vif” command to identify the highly correlated factors. VIF (Variance inflation factor) values higher than 10 indicate higher collinearity among the variables. Those highly correlated variables were removed from the final model.

3.8. Ethical consideration

The authors state that no animals were involved in the study. The authors involved humans (Buffalo farmers and livestock professionals) to conduct the study and a prior consent has been taken for their inclusion them in the study. The study was approved by the Sylhet Agricultural University Ethics committee [permit ref. #AUP2021006] Bangladesh.

Chapter 4: Results

4.1. Farm characteristics

Buffaloes are mainly reared in the coastal and river basin areas of Bangladesh. In the study area most of the famers are from coastal areas (n=83), and equal numbers of farmers are from the river basin (n=43) and inland area (n=43). All the farmers in the study areas were male (100%) and no female farmers were found in the sampling areas and most of the respondents were farm owner (n=152) of the farm. The age of respondents was (n=50) young age (≤30 years), (n=61) middle age (31 to 40 years) and (n=53) old age (41 to 80 years) group. Most of the farmers were literate (n=126) with the educational qualification ranging from primary to graduation. In the study area majority of the farms were semi-bathan type (n=83) and medium size (11-30) farms were most common (n=67). Buffalo population varied from 3 to 278 per farm and lactating animals ranged from 0 to 46 depending on different farming systems. Average milk production performance of most of the farms was between 1.01-2 liters/ buffalo/day (n=85) and the highest production was found to be about 4 liters.

4.2. Distribution of concern score

No significant difference (p=0.81) was observed between the aggregated score of concern of farmers and livestock professionals.

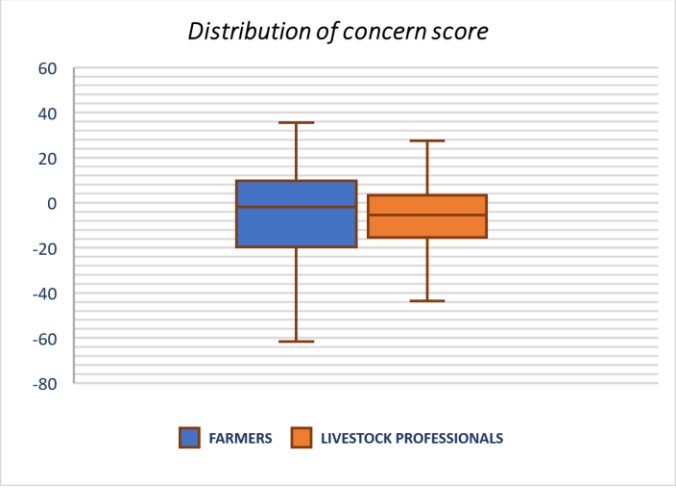

Figure 4. 1. Distribution of concern score of farmers and livestock professionals

4.3. Concern score and farm level factors

4.3.1. Univariate association between aggregated score of concern and farm level factors:

The farm level factors were- i. Location, ii. Farm type, iii. Interviewee title, iv. Farm size, v. age of the farmers, vi. Educational qualification, vii. Average production/ buffalo, and viii. Record keeping. The aggregated score of concern varied significantly by each of the aforementioned factors ($p \leq 0.2$) except farm size ($p=0.25$).

Table 4. 1. Results for univariate association between aggregated score of concern farm level factors-

Sl No	Variables	Category	Percentage (%)	95% CI	P
1	Location	Coastal	49.4	-14.54 to -6.27	0.11
		Inland	25.3	-20.5 to -5.64	
		River basin	25.3	-9.92 to 2.33	
2	Farm type	Bathan (Free range)	18.3	-9.66 to 4.57	0.005
		Semi-bathan	49.2	-16.22 to -6.41	
		Household/ semi-intensive/ Commercial	32.5	-14.44 to -4.87	
3	Interviewee title	Owner	89.4	-7.11 to -0.73	0.001
		Others	10.6	-33.59 to -8.86	
4	Farm size	3-10	24.4	-14.48 to -2.36	0.25
		11-25	39.9	-10.51 to -2.3	
		26-197	35.7	-20.67 to -6.6	
5	Average production/ cow	0.44-1	22.5	-13.22 to -0.84	0.01
		1.01-2	53.1	-17.35 to -8.44	
		2.01-4	24.4	-8.85 to 6.72	
6	Farmer age	14-30	30.5	-12.15 to -1.13	0.1
		31-40	37.2	-18.99 to -6.66	
		41-80	32.3	-11.88 to -2.3	

7	Farmer education	Illiterate	25.4	-21.75 to -6.50	0.001
		Literate	74.6	-6.34 to 0.37	
8	Record keeping	Yes	12.4	-8.47 to -1.68	0.14
		No	87.6	-21.77 to -2.75	

95% CI: 95 % confidence interval; p: probability

4.4. Multivariate linear regression model for perceived level of concern

Factors with a P value ≤ 0.2 were forwarded to build a multivariable linear regression model. Interaction was checked to build the final model. Factors were not collinear as the variance inflation factors remained below 10. The Cook-Weisberg p value was 0.07, indicating the model was well fitted. According to the final model, farmers of semi-bathan system (p=0.004), household or intensive or semi-intensive system (p=0.02) and respondents other than owner (p=0.002) are less concerned. On the other hand, farmers education level (Literate) is positively related with the aggregated score of concern (p=0.013).

Table 4. 2. Multivariable linear regression model between perceived level of concern and farm demographic factors-

Variable	Category	β	P	vif	95% CI
Farm type	Bathan	**Ref.**			
	Semi-bathan	-12.19	0.004	1.90	-20.42 to -3.95
	Household/ Intensive/ Semi-intensive	-10.45	0.02	1.87	-19.16 to -1.75
Education	Illiterate	**Ref.**			
	Literate	8.85	0.013	1.04	1.88 to15.83
Position of Interviewee	Owner	**Ref.**			
	Others	-16.26	0.002	1.02	-26.28 to -6.23

β: coefficient; p: probability; vif: variance inflation factor

4.5. Housing constraints

The majority of the farmers does not have a separate house (85.29%) for the buffaloes and do not practice record keeping (87.57%). Only a few farmers (12.43%) practice record keeping to some extent, and it was found higher in household or intensive or semi-intensive

farms (n=11) and lowest in semi-bathan system (n=7). On the other hand, most of the farmers had a wallowing area available for the buffaloes around the year. Descriptive statistics of the Likert scale questions showed that major housing or rearing constraints are a lack of wallowing area around the year, high construction costs of sheds, a lack of enough space, and unavailable skilled labor. No significant association was observed between the housing/rearing constraints and aggregated score of concern for the housing constraints in univariate analysis.

4.6. Feeding constraints

In the study population most of the farmers practice stall-feeding (n=110), feed vitamin supplements (n=89) to the buffalo, and had a drinking water source (n=143) available for the buffaloes. On the other hand, most of the farmers do not have knowledge about a balanced ration (n=110) and UMS (Urea Molasses Straw) (n=123), do not practice a balanced ration (n=134), and feed concentrate (n=96) to the buffaloes in the bathan. It was found that the majority of the respondents lacking knowledge about balanced ration, preparing UMS or silage and enough grazing land.

Table 4. 3. Univariate association of aggregated score of concern for feeding constraints and factors related to feeding-

Sl no	Factor	Category	Parentage (%)	95% CI	P
1	Available grazing land	Yes	71.1	-0.79 to 1.37	0.27
		No	28.9	-0.18 to 2.97	
2	Feeding concentrate	Yes	55.4	-0.66 to 1.63	0.81
		No	44.6	-0.72 to 2.13	
3	Feeding vitamin	Yes	52.4	-1.72 to 0.98	0.04
		No	47.6	0.4 to 2.64	
4	Know balanced ration	Yes	34.5	-2.04 to 0.87	0.06
		No	65.5	0.09 to 2.31	
5	Practice balanced ration	Yes	18.8	-3.82 to -0.18	0.005
		No	81.2	0.27 to 2.26	
6		Yes	26.8	-2.72 to 0.77	0.04

	Knowledge on UMS	No	73.2	0.13 to 2.18	
7	Stall feeding	Yes	65.1	-1.16 to 0.87	0.05
		No	34.9	0.003 to 3.45	
8	Available drinking water	Yes	85.1	-1.04 to 0.9	0.004
		No	14.9	1.54 to 5.58	
9	Feed in bathan	Only grazing	58.9	-0.64 to 2.04	0.55
		Grazing with Supplement	41.1	-0.03 to 2.60	
10	Feed concentrate in bathan	Yes	32.4	0.04 to 3.05	0.37
		No	67.6	-0.65 to 1.86	

95%CI: 95 % confidence interval; p: probability

Factors showing a significant relation with the aggregated score of concern of feeding constraints were selected to build a multivariate linear regression model. In the final model, three factors were found significantly related with an increased level of concern. Practicing a balanced ration (p=0.04), having knowledge about preparation of UMS (p=0.04), and having available drinking water (p=0.008) were negatively associated with concern level of feeding constraints. No interaction was found between the variables and the factors were not collinear as the VIF values were below 10. The Cook-Weisberg p value of 0.98 indicate the model was well fitted.

Table 4. 4. Results of multivariate linear regression model for variables influencing aggregated score concern for feeding constraints-

Variable	Category	*B*	P	Vif	95% CI
Practice balanced ration	Yes	**Ref.**			
	No	2.36	0.04	1.06	0.11 to 4.61
Knowledge about UMS	Yes	**Ref.**			
	No	2.00	0.04	1.04	0.03 to 3.97
Available drinking water	Yes	**Ref.**			
	No	3.28	0.008	1.04	1.86 to 5.71

β: coefficient; p: probability; vif: variance inflation factor

4.7. Breeding constraints

Table 4. 5. Univariate association between breeding constraints and aggregated score of concern for breeding constraints-

Sl no	Factor	Category	Percentage (%)	95% CI	P
1	Breeding bull	Yes	53.5	-3.84 to -0.57	0.04
		No	46.5	-1.40 to 1.66	
2	Insemination	Bull	94.1	-2.15 to 0.21	0.32
		Both (AI+Bull)	5.9	-7.62 to 0.42	
3	Bull source	Own bull	31.4	-2.96 to 1.6	0.23
		Other's bull	50.3	-2.07 to 0.94	
		Both	18.3	-5.82 to -0.5	
4	Knowledge about AI	Yes	74.3	-2.02 to 0.43	0.38
		No	25.7	-4.75 to 0.85	
5	Heat detection	Help of bull	20.4	1.11 to 5.71	0.0001
		Observation	45.5	-4.92 to -1.24	
		Both	34.1	-2.44 to 0.72	
6	Face problem in heat detection	Yes	26.6	-3.58 to 0.92	0.82
		No	73.4	-2.38 to 0.30	
7	Incidence of abortion	Yes	42.9	-2.16 to 1.32	0.38
		No	57.1	-2.87 to 0.03	

95% CI: 95 % confidence interval; p: probability

Of 170 farmers, 53.53% of the farmers have breeding bull in the farm or in the herds. The majority of the farmers in the study areas know about AI (74.25%) in buffalo, but only 5.88% of them use AI to inseminate their buffaloes (Table 5). Heat detection in buffaloes was performed with the help of a bull (20.36%), observation (45.51%), and both by observation and bull (34.13%). It was reported that major breeding constraints were farmer's preference of natural service, poor conception rate of AI, lack of skilled AI technicians and lack of a breeding bull. Two factors, having a breeding bull (p=0.04) and method of heat detection (p=0.0001) were significantly associated with the aggregated score of concern of breeding constraints.

Table 4. 6. Results of multivariate linear regression model for variables influencing aggregated score concern for breeding constraints-

Variable	Category	Coff.	P-value	Vif	95% CI
Breeding Bull	Yes	**Ref.**			
	No	3.04	0.006	1.02	0.89 to 5.20
Detection of heat	Help of bull	**Ref.**			
	Observation	-6.93	0.00	1.78	-9.78 to -4.08
	Both	-4.39	0.004	1.76	-7.37 to -1.41

β: coefficient; p: probability; vif: variance inflation factor

Regression analysis of breeding constraints shows that not having breeding bull in the farm is positively associated (p=0.006, β= 3.04) with perceived level of concern of breeding constraints. On the other hand, detection of heat with the help of a breeding bull had a significant positive effect on increased level of perceived concern. No interaction was observed between the variables during the final model building process.

4.8. Health and disease constraints

Table 7 presents the descriptive statistics and univariate analysis of disease constraints. In the study areas most of the farmers practice regular deworming (n=138) and vaccination (n=93). The majority of the farmers agreed that they faced epidemic outbreaks (n=99) every year. Only few farmers contacted their veterinarian (n=43) to get veterinary services. On the other hand, most of the farmers get veterinary services from local quacks, AI technicians, and through self-treatment. The calf mortality rate was below or equal to 10% in 79 farms and above 10% in 47 farms.

Table 4. 7. Univariate association between breeding constraints and aggregated score of concern for disease constraints-

Sl no	Factor	Category	Percentage (%)	95% CI	P
1	Regular vaccination	Yes	55.0	-3.76 to -1.33	0.21
		No	45.0	-2.69 to -0.20	
2	Regular deworming	Yes	81.2	-3.46 to -1.47	0.03
		No	18.8	-1.61 to 1.43	
3	Epidemic outbreak	Yes	59.6	-2.46 to -0.48	0.1
		No	40.4	-4.56 to -1.35	
4	Available veterinary service	Yes	69.8	-4.0 to -1.83	0.002
		No	30.2	-1.31 to 1.27	
5	Contact with doctor	Veterinarian	23.4	-6.72 to -2.56	0.005
		Quack	41.3	-2.71 to -0.53	
		Self-treat	35.3	-2.56 to 0.62	
6	Calf mortality rate (%)	≥10	62.7	-4.56 to -1.72	0.02
		≤11	37.3	-1.92 to 0.65	

95% CI: 95 % confidence interval; p: probability

Several factors were found significantly associated with the aggregated score of concern for disease constraints. Only two factors were found to be associated with the aggregated concern of score of disease constraints in a multivariate linear model.

Table 4. 8. Results of multivariate linear regression model for variables influencing aggregated score concern for disease constraints-

Variable	Category	Coff.	P-value	Vif	95% CI
Contact with doctor	Veterinarian	**Ref.**			
	Local quack	3.51	0.005	0.65	1.10 to 5.92
	Self-treatment	4.67	0.00	0.65	2.09 to 7.24
Calf mortality rate (%)	≥10	**Ref.**			
	≤11	1.96	0.06	0.97	-0.05 to 3.97

β: coefficient; p: probability; vif: variance inflation factor

4.9. Economic and marketing constraints

Most of the farmers do not get financial support from NGOs (n=132), have a low milk price (n=102), and a lack of chilling centers (n=111). Farmers also agreed that the transportation of milk is not costly (n=102) and the majority of the farmers get regular payments (n=148). In the univariate analysis five factors: high enough price of milk, available chilling center, milk co-operative, transportation cost and regular payment were found significantly associated with aggregated score of concern for economic and marketing constraints (Table 8).

Table 4. 9. Univariate association between breeding constraints and aggregated score of concern for economic and marketing constraints-

Sl no	Factor	Category	Percentage (%)	95% CI	P
1	Support from NGO	Yes	21.0	-2.48 to 0.59	0.42
		No	79.0	-1.06 to 0.73	
2	Enough price	Yes	38.9	-2.89 to -0.28	0.008
		No	61.1	-0.40 to 1.44	
3	Chilling center	Yes	34.7	-3.96 to -0.98	0.00
		No	65.3	-0.03 to 1.55	
4	Milk co-operative	Yes	42.4	-3.61 to -1.06	0.00
		No	57.6	0.25 to 1.92	
5	Transportation costly	Yes	33.8	0.22 to 2.55	0.003
		No	66.2	-2.14 to -0.08	
6	Regular payment	Yes	88.6	-0.82 to 0.70	0.04
		No	11.4	-5.64 to 0.48	
7	Change milk price	Yes	75.5	-1.12 to 0.76	0.55
		No	24.4	-2.06 to 0.62	
8	Milk price/L	≤60	63.3	-1.53 to 0.56	0.67
		>60.1	36.7	-1.19 to 0.89	
9	Distance of market	≤5	63.4	-2.11 to 0.19	0.77
		>5.1	36.6	-2.20 to 0.83	

95%CI: 95 % confidence interval; p: probability

Table 4.9 presents the results of multivariate linear regression model between economic and marketing constraints and the aggregated score of concern for economic and marketing constraints. Farmers not getting a high enough price of milk (p=0.01) and that have a higher transportation cost of milk to the market (p=0.02) had a positive relationship with increased concern score. The Cook-Weisberg p value was 0.08 and no interaction was observed between the variables indicates the model was well fitted.

Table 4. 10. Results of multivariate linear regression model for variables influencing aggregated score concern for economic and marketing constraints-

Variable	Category	*β*	P	Vif	95% CI
Enough price	Yes	**Ref.**			
	No	2.09	0.01	1.06	1.47 to 3.71
Transportation costly	Yes	**Ref.**			
	No	-1.99	0.02	1.06	-3.66 to -0.32

β: coefficient; p: probability; vif: variance inflation factor

4.10. Farmer's perception towards buffalo milk and meat quality

Table 4.10 shows the descriptive statistics of farmer's perception towards buffalo milk and meat quality. The majority of the farmers said that buffalo milk quality is good (91.9%) and consuming buffalo milk and meat is good for health (81.5). A good number of farmers agreed with the statements that eating buffalo milk regularly may cause indigestion (26%) and buffalo milk can cause helminth problem in children/ adults (37%).

Table 4. 11. Descriptive analysis of farmers' perception towards buffalo milk and meat quality-

Variables	Categories	Frequency (%)
What do you think about the quality of buffalo milk? (n=137)	Good	126 (91.9)
	Not good	9 (6.6)
	Same as cow milk	2 (1.5)
What does your neighbor think about eating buffalo milk and meat? (n=135)	Good for health	110 (81.5)
	Cause disease	17 (12.6)

	Costly	1 (0.7)
	Others	7 (5.2)
What does your neighbor think about rearing buffalo in terms of economy? (n=137)	Profitable	130 (94.9)
	Not profitable	3 (2.2)
	Others	4 (2.9)
What does your neighbor think about rearing buffalo in terms of social status? (n=135)	Prestigious	96 (71.1)
	As usual	22 (16.3)
	Filthy	15 (11.1)
	Don't like	2 (1.5)
Do you think buffalo milk may cause indigestion if you drink it regularly? (n=137)	Yes	36 (26.3)
	No	101 (73.7)
Can buffalo milk cause helminth problem in children/adults? (n=137)	Yes	37 (27.0)
	No	100 (73.0)
Do you think eating buffalo milk and meat can cause buffalo like skin and hair or something else in the human body? (n=137)	Yes	4 (2.9)
	No	1337.1)

4.11. Farmers demands to sustain buffalo farming in Bangladesh

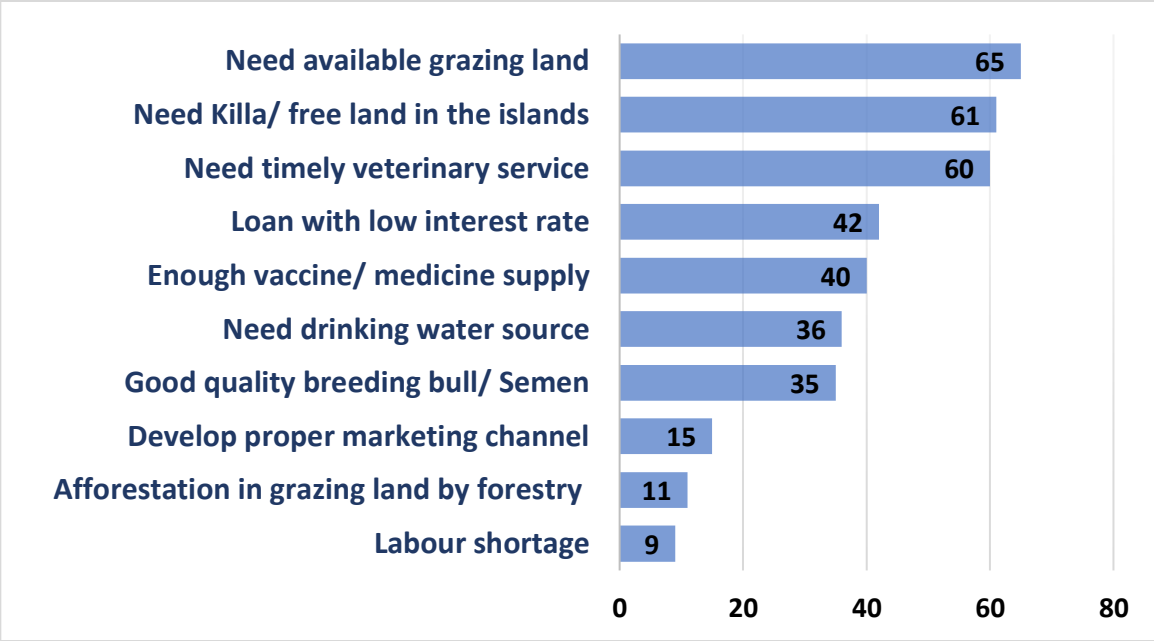

Figure 4.2. Farmers demand to sustain buffalo farming in Bangladesh

In the study areas farmers demanded that they need available grazing land, a safe shelter or killa, timely veterinary services and enough vaccine and medicine supply for the buffaloes. Some other demands are quality bull and semen, drinking water supply, a proper marketing channel, a loan with low interest rate and skilled labor in the farm.

Chapter 5: Discussion

Studies conducted on constraints of buffalo farming in Bangladesh are mainly of the descriptive type. Studies on the perceived level of concern on constraints of buffalo farming between farmers and livestock professionals have not been conducted previously. Moreover, a detailed study on the identification of constraints of buffalo farming in Bangladesh was necessary to take proper strategies to overcome the constraints in buffalo farming. Therefore, the present study was conducted to fill up the previous information gaps and understand the relationship between farmers' perceived level of constraints and farm characteristics. In this part, important results of this current study, limitations, conclusions and recommendations will be discussed.

5.1. Farm characteristics

The majority of the farmers in the study area were from the middle age group (37.2%) followed by old age group (32.3%) and the young age group (30.5%), which partly agreed with the study by Gami et al. (2012) in North Gujarat. Uddin et al., (2016) found that 79% of the farmers in the bathan system were from the middle age group. More than half of the farmers completed primary education (53.9%) followed by secondary education 17.8%, and illiterate 25.4%. Only 2.9% of the farmers completed higher secondary or graduation level and all the respondents were male. The educational status of the farmers indicates that it is possible to change their attitude to adopt good management practices and new technologies to improve farming practices (Nithya and Silvaraj., 2018). In the case of the farming system, the semi-bathan type is most common (49.1%) as most of the farmers keep the buffaloes in the islands or bathan for 6-8 months and the majority of the herd size is medium (11-25 heads) (39.9%). Only 12.4% of the buffalo farmers practice record-keeping in written form. Poor milk production (≤2L/ day, 75.6%) of the indigenous buffalo in the study areas reflects the usual scenario of buffalo farming in Bangladesh (Rahman et al., 2019a).

5.2. Distribution of concern score

We hypothesized that the aggregated score of concern will differ significantly between the farmers and livestock professionals. Statistical analysis showed that there was no significant difference (p=0.8) of concern scores between the two groups. A similar study

on yak farming in Bhutan found no significant difference of concern scores between yak herders and livestock professionals (Dorji et al., 2020).

5.3. Factors associated with perceived level of concern

The multivariate linear regression model (Table 4.2) between perceived level of concern and farm demographic factor found that farming system, education level, and position of the interviewee were the significant factors associated with concern level.

Respondents of the semi-bathan (0.004) and household or intensive or semi-intensive system (0.02) were less concerned compared to the respondents of the bathan system. The result are representative for the actual situation of buffalo farming in Bangladesh. There were many reasons behind the higher concern level, like that in the bathans there was a lack of feed and drinking water, low numbers of breeding bulls, a lack of veterinary services, and higher transportation costs of milk (Uddin et al., 2016). Most of the bathan farms were situated in remote islands where transportation is difficult and timely veterinary services were not possible. Farmers used the islands as natural grazing land for cattle, buffalo, and sheep mainly (Islam et al., 2017). Recently two of the most important islands used as natural grazing land had been occupied by Bangladesh Army and Navy. The Bangladesh army is now using a part of Swarnodweep (Island) for their routine activities, agriculture, and livestock rearing. Another island named Vashanchar is now used as the shelter for the Rohingya refugees.

The position of the interviewee had a significant influence on the concern score. Most of the times workers were not much aware and motivated about good management practices resulting in a lower perceived level of concern. Regression analysis showed that the owners were more concerned compared to the workers.

5.4. Housing constraints

Results from the descriptive analysis of Likert scale questions showed the housing or rearing constraints of buffalo farming were unavailable wallowing area around the year, lack of enough space for the buffaloes, the high construction cost of the shed, and unavailable skilled labor (Ali et al., 2019; Munish, 2015; Pata et al., 2018). Most of the farmers in the study areas had wallowing areas for the buffaloes but these were not available all around the year. The majority of the farmers agreed that the lack of separate

housing for the buffaloes is not a problem and about 85.3% of the farmers in the study area did not have a shed or house for the buffaloes. Only 14.7% of the farmers provide shelter to the buffaloes, which was in line with the study of Uddin et al., (2016). In another study, the authors found 99% of the buffaloes in Bangladesh did not have houses (Siddiky and Faruque, 2017), and this scenario was the same in most parts of the world including South Asia (Faruque, 2016). Habib et al., (2017) mentioned that not providing house, animal identification, and recordkeeping were the important problems of general husbandry practices in buffalo farming which were in close agreement with our study. In the study areas, very few farmers practice record keeping (12.4%) and animal identification. In the bathans, farmers use a separate name to call the buffaloes and they memorize some information such as milk production, parity, age and disease history to some extent.

5.5. Feeding constraints

Feeding practices vary in the different farming systems. Most farmers practiced stall feeding and feed vitamin supplements to the buffaloes in the different farming systems. But the majority of the farmers were not aware of feeding a balanced ration, UMS, and did not feed concentrate to the buffaloes which causes nutritional deficiency (Uddin et al., 2016). It was observed in semi-intensive and household systems that very few farmers provided a little amount of concentrate to the buffaloes while stall-feeding (Akbar et al., 2009; Rahman et al. 2018a; Uddin et al., 2016). Balanced ration feeding in buffalo was not studied in Bangladesh. However, some private and government buffalo farms are using balanced ration for the buffaloes. Three factors- i) practicing balanced ration, ii) knowledge about UMS, and iii) available drinking water- were found negatively associated with concern level of feeding constraints.

Buffalo farmers of Bangladesh were mainly depending on natural pastureland or roadside grass to feed the buffaloes (Saadullah, 1990; Hamid et al., 2016a). It was the common scenario of buffalo rearing in many other countries like India, Pakistan, Nepal, Turkey, and Greece (Işik and Gül, 2016; Rasali, 2000; Ligda and Georgoudis, 2005). Farmers who did not practice balanced ration and did not have knowledge about preparing UMS were found more concerned. This was because in the dry season there was very little natural pastureland available for the buffaloes in both household and bathan systems. Though there

was a scarcity of feed for the buffaloes, farmers did not provide concentrate or mixed feed, which caused serious nutritional deficiency (Uddin et al., 2016). The study by Rahman et al., (2018b) described that farmers provide a wide variety of concentrate (ready feed, broken maize, rice bran, wheat bran, mustard oil cake, molasses, etc.) to the buffaloes in the household yard and the completely intensive system.

Having an available drinking water supply for the buffalo was significantly associated with a decreased aggregated score of concern. Providing enough clean drinking water is important to maintain normal physiological activities (body temperature, milk production and blood plasma volume) (Buffalopedia, 2018). Buffaloes in the bathans face serious scarcity of drinking and wallowing water during the dry season. During this period, the animals need to walk a long distance to drink fresh water from natural water reservoirs and rivers. Sometimes farmers dig big ponds to collect water for the dry season. The findings of the study do not agree with the study of Rahman et al., (2019b) who mentioned that 100% of the buffalo farmers provide enough drinking water to the buffaloes.

The present study also found that the most important feeding constraints were a high price of concentrate feed, lack of knowledge about balanced ration, silage, and UMS preparation, and unavailable grazing land around the year mainly in the winter season (Uddin et al., 2016; Habib et al., 2017; Munish et al., 2015; Islam et al., 2017b; Ali et al., 2019; Sarita et al., 2017).

5.6. Breeding constraints

In the study, area farmers (94.1%) were mostly dependent on a bull for breeding and they prefer natural service over AI. In Bangladesh, it was found that most farmers (95%) practice natural services both in the household and bathan system, which is in agreement with the findings reported by Uddin et al., (2016). In Pakistan more than 80% of the farmers adopted natural insemination because bull was available for natural service for 24 hours (Moaeen-ud-Din and Babar, 2006). The logic behind preferring natural service is that it may increase the conception rate (Sawarkar et al., 2001) though there were insufficient breeding bulls available for breeding at the right time (Saadullah., 2012). Low numbers of breeding bulls were also responsible for inbreeding, which leads poor genetic potential and productivity in the next generation. However, a study by Akbar et al., (2009) reported that

farmers in coastal areas had enough breeding bulls and there was no fertility related problem observed.

Very few farmers were found using both bulls and AI for breeding purposes, though a good number of farmers were found aware of AI in buffaloes. Only a few farmers rearing buffaloes in household and intensive systems were found practicing AI. This is in agreement with the study of Rahman et al., (2019b) where they found 3.7% of the farmers were using AI. The reasons behind not practicing AI were non-availability of AI facility in the villages, lack of sufficient number of skilled AI technicians, unavailability of quality semen, poor conception rate of AI, and educational status and lack of awareness of the farmers (Saadullah, 2012; Islam et al., 2017b; Nithya and Selvaraj, 2018, Moaeen-ud-Din and Babar, 2006). Success of AI is largely dependent on proper timing of insemination and for this detection of heat by the farmers was very important. The present study showed that a good number of farmers face problems (n=45) in detecting heat. This was due to weakness of estrus symptoms, variation in estrus length and seasonality of breeding (Habib et al., 2017; Qureshi et al., 1999).

Multivariate linear regression models found that two factors- having a breeding bull and method of heat detection - had a significant association with aggregated score of concern of breeding constraints. It was found that farmers who do not have their own breeding were highly concerned ($p=0.006$) compared to the farmers who had their own breeding bull. This can probably be explained by the fact that they need to be dependent on other's bull, and sometimes timely insemination is not possible due to lack of breeding bulls (Rahman et al., 2018b).

Farmers who depend on a bull for heat detection were found more concerned compared to the farmers using observation and presence of bulls for heat detection. We found that the majority of the farmers (n=91) do not have a breeding bull of their own, which indicates it is not possible for them to detect heat with the help of a bull. They need to be dependent upon observation.

Breeding constraints responsible for poor genetic makeup and low productivity of the existing buffalo population were farmers' preference of natural service over AI, lack of a quality breeding bull, lack of quality semen, unavailable AI semen, lack of knowledge

about heat detection and AI and high cost of AI (Hamid et al., 2016b; Patel et al., 2013; Pata et al., 2018). Regular breeding between a locally screened buffalo cow with imported proven bull semen through AI could be applied to step towards a more efficient and desired cross-breed (Habib et al., 2017). Modern reproductive technologies like Artificial Insemination (AI), In Vitro Fertilization (IVF), and Embryo Transfer (ET), which are regularly practiced in the dairy cattle industry in many countries, can be adopted for buffalo reproduction. This is a good solution for upgrading existing buffalo breeds (Naveena and Kiran, 2014). Moreover, change of farmers' attitude towards modern breeding technologies and AI is also necessary through capacity building training programs (Rathod et al., 2017).

5.7. Health and disease constraints

This cross-sectional study found that the most common diseases affecting buffaloes were haemorrharic septicemia, foot and mouth disease, pneumonia, diarrhea, and helminthiasis. This finding was in line with the study of Islam et al., (2016) and Hamid et al., (2016b) conducted in some selected areas of Bangladesh where the buffalo concentration is higher.

We found that the majority of the farmers used regular deworming (81.2%) and regular vaccination (55.0%). Our findings almost agreed with the study of Islam et al., (2017b), who found 90% of the farmers used deworming and partly agreed with the findings of Rahman et al., (2018b)where they found all the farmers in the intensive system used deworming and vaccination, and in the household system, it was 31% and 23% respectively. Farmers of the bathan, semi-bathan and household systems were found less aware of using vaccination. This was due to farmers' ignorance, low access to government vaccines, and unavailable veterinary services. It was observed that very few farmers in the bathan and semi-bathan system get veterinary services and they are mostly dependent on local quacks for treatment.

More than half of the farmers said that they faced epidemic outbreaks (mostly FMD and HS) every year in the different farming systems. Disease outbreaks were more common in the bathan, semi-bathan, and semi-intensive system. In bathan and semi-bathan systems, farmers do not get enough vaccine supply and no veterinary services, and as a result,

the outbreak was more common in those farming systems. According to farmers' opinion during the rainy season flood water spread microorganisms throughout the islands and river basin areas, which causes outbreaks. They also accused the government that no initiative had been taken to investigate the outbreak.

Regular deworming (p= 0.03), available veterinary services (p=0.002), contact with a veterinarian (p=0.0001), and calf mortality rate (p=0.02) were the factors associated with an aggregated score of concern of health and disease constraints in univariate analysis. Results of the multivariate linear regression model showed that farmers' contact with doctors and calf mortality rates were significantly related to concern score of health and disease constraints. Farmers who got contact with veterinarians for treatment were found less concerned compared to those who did not contact veterinarians (but instead contacted a local quack or used self-treatment). The reason behind this was that farmers were not satisfied with the treatment of local quacks and in most of the cases, it was difficult for them to get in contact with the veterinarians as buffaloes were reared in the most remote areas (Hamid et al., 2016b). It was also observed that the majority of the farms who got contact with the veterinarian had calf mortality between 0 to 10%. A high calf mortality rate (≤11) was found to be positively related (p=0.06) with an aggregated score of concern of health and disease constraints. The average calf mortality rate was 10.7% in the study areas. Another study by Rahman et al., (2018b) found 8% and 7% calf mortality in households and intensive farming systems. Higher calf mortality causes major economic losses to the farmers. The most common causes of calf mortality were calf pneumonia and diarrhea resulting from poor management, poor nutrition, various infectious, and parasitic agents (El-Ghari et al., 1994; Galiero et al., 1994; Islam et al., 2013; Hamid et al., 2016b; Islam et al., 2016; Rahman et al., 2018a).

Overall health and disease constraints faced by the farmers in the study areas were remote veterinary facilities, high calf mortality rate, lack of knowledge about vaccination and deworming, insufficient vaccine supply, and unavailable timely veterinary services, which agreed with most of the studies conducted in Bangladesh, India, and Pakistan (Hamid et al., 2016b; Patel et al., 2013; Pata et al., 2018; Ali et al., 2019).

5.8. Economic and marketing constraints

The multivariate linear regression model showed that not getting a high enough milk price (0.01) and costly transportation methods (0.02) were the most significant factors associated with the aggregated score of concern of economic and marketing constraints. Not getting a high enough milk price was positively associated with the concern score. This could be explained by the lower price of milk which causes economic loss to the farmers. Milk price varies from 30 to 150 BDT depending on location and farming systems and the average milk price was 66 BDT, which is a little bit higher compared to the study by Rahman et al., (2018a) in households (40-42 BDT) and intensive systems (50-55 BDT). Another study by Rahman et al., (2019b) reported that farmers in the river basin areas get a higher milk price (72 BDT).

Higher transportation costs were found to be positively associated with a higher concern level. Milk price is highly influenced by transportation costs. Farmers of the bathan and semi-bathan systems mostly faced higher transportation costs. This was due to the remote location of the farms and lack of proper transportation facilities. Bathans are located in the remote islands and river basin areas where the transportation of milk is difficult and costly. Transportation of milk from those remote areas was time-consuming and chilling centers were not available for most of the farms (65.3%) which causes spoilage of milk. Farmers sold the milk to the milk collectors at a very low price, and they carry the milk to the mainland for processing. This scenario agreed with the study of Uddin et al., (2016), who explained that farmers sold whole milk to the middleman at a low price due to the lack of transportation facilities.

Analysis of the Likert scale data uncovered that major economic constraints were a lack of own capital, higher interest rate loans, and lack of financial support from government or NGOs. A study by Gami et al., (2012) reported similar constraints in addition to the higher construction costs of sheds. The findings are also consistent with Pata et al., (2018) who also found higher interest rates of loans, unavailable loan facilities, the high construction cost of the byre, and the high price of concentrate were the major economic constraints. Major marketing constraints of buffalo farming in Bangladesh were a low milk price in the market, higher transportation costs, and lack of chilling centers for preservation. These

findings were in line with the study of Uddin et al., (2016), Rahman et al., (2019b), and Patel et al., (2013).

5.9. Farmers perception towards buffalo milk and meat quality

The present study also tried to find out farmers' perceptions towards buffalo milk and meat quality (Table-10). A small percentage of the respondents (6.6%) said that buffalo milk was not good for their health. According to the farmers' opinion, few (12.6%) of the neighboring people thought that eating buffalo milk and meat may cause disease in the human body. We found this in all the study areas. Some people (26.3%) think that drinking buffalo milk regularly may cause indigestion and buffalo milk can cause helminth problems in children and adults (27%). They also explained that it was due to the higher fat percentage and that children and adults are unable to digest buffalo milk, resulting in indigestion. We found that some farmers sold buffalo milk to the market and bought cow milk for their children. Among the respondents, only four farmers believed that eating buffalo milk and meat can cause buffalo-like hair and skin in the human body, so they do not consume buffalo milk and meat. The majority of the farmers (95%) said that buffalo farming was profitable, which agrees with the study of Rahman et al., (2018a) in the same selected area of Bangladesh and with Borghese and Mazzi (2005) in Turkey.

5.10. Farmers' demands to sustain buffalo farming in Bangladesh

The present study investigated the farmers' demands and urgent needs to sustain buffalo farming profitably. In the first place, farmers demanded available grazing land for the buffaloes in the islands and mainland. In the coastal areas, buffaloes were mainly reared at the islands. Swarnadweep and Bhasan char are the two most important islands for the farmers where thousands of buffalo graze freely all around the year. Recently, Bangladesh army has occupied a huge portion of the Swarnadweep to establish army camps and for agricultural purposes. Farmers also complained that the army bought buffaloes from them at a very low price and they seize buffaloes if they enter the army boundary. Recently they have placed barbed wire in the boundary areas that caused serious injury and sometimes death to many animals including buffalo, cattle, and sheep. Moreover, farmers claimed that the army sometimes detains cowboys if their buffaloes graze on the protected lands. Another island highly concentrated with buffaloes is Bhasan char, which is occupied by

the Bangladesh Navy to build a shelter to relocate Rohingya refugees from Cox's Bazar. As a result, farmers need to replace their herds with other islands and the mainland. In the mainland, there is a lack of free grazing land for the buffaloes due to increased human habitation and agricultural practices (Islam et al., 2017a). In the second place, farmers need a killa or safe shelter for the buffaloes in the bathans that are located in coastal and river basin areas. Farmers usually built earthen killas, which they need to repair every year, causing economic loss to the farmers. Moreover, every year farmers lost many animals due to natural calamities. So, a permanent shelter or killa can solve this problem (Islam et al., 2017a). In addition, there was a lack of drinking water supply for the buffaloes (Islam et al., 2017a). Therefore, the farmers demanded a deep tube well or ponds to reserve drinking water for the buffaloes during the dry season. In the third place, farmers need available veterinary services and enough government vaccine supply to prevent epidemic outbreaks. As buffaloes are reared in remote places, veterinary service is not available (Islam et al., 2017a). In these circumstances satellite veterinary clinic services at a routine interval are urgently needed. Some other problems that need to be solved were availability of a good quality breeding bull for natural insemination, stopping afforestation in grazing land by the forestry department, and government subsidy for the buffalo farmers with low-interest rate loans.

5.11. Limitations of the study

1. Selection bias: As we followed a convenient sampling method, which lacked proper randomization, there might be presence of selection bias. We had chosen the convenient sampling method due to inadequate data on buffalo farmers.

2. Time limitation: Buffalo rearing in Bangladesh is a dynamic farming system. The majority of the farms moves from one place to another depending on the availability of feed and water. We took point-in-time data, which may not reflect the overall management system.

3. Confounding bias: It is possible that there may be some other external factors that may influence the significant association of certain factors with farmers' concern score, like season.

Chapter 6: Conclusion, Recommendations and Future Directions

6.1. Conclusions

As far as we know, this was the first study conducted in Bangladesh to determine the farmers' and livestock professionals' concern level towards overall constraints of buffalo farming and to identify the factors that influence the concern score. No significant difference of aggregated score of concern was observed between the farmers and livestock professionals. Overall educational status of the farmers was good, which indicate that it is possible to overcome the existing management constraints by proper motivation.

Farming system, educational status, and position of the interviewee were found significantly associated with aggregated score of concern. Farmers of the bathan system were highly concerned compared to other farming systems as they faced more problems than the other farmers did. Major housing constraints were unavailable wallowing water for the buffaloes, higher construction costs of sheds and lack of enough space.

Not practicing balanced ration, no knowledge about preparation of UMS and an unavailable drinking water source were associated with a higher aggregated score of concern. So, proper training of the farmers on use of balanced ration and preparation of UMS is needed. Study also showed that a higher concentrate price, lack of knowledge about balanced ration, silage and UMS, and scarcity of grass during winter season were the major feeding constraints.

Farmers not having a breeding bull and farmers detecting heat with the help of bull were found significantly associated with higher concern score. In addition, farmers' preference to natural insemination, unavailable AI facility, poor conception rate of AI, unskilled AI technicians and lack of good quality bull were the main concern of the farmers. The government should come forward to make the AI facility available in all parts of the country so that modern reproductive technologies like in vitro fertilization and embryo transfer can be adopted to upgrade the genetic potential of our indigenous buffaloes.

The study found that contact with a veterinarian and calf mortality rate were significantly associated with the higher concern score of health and disease constraints. The government

should produce enough vaccine for the buffaloes and veterinary services should be made available for the buffaloes in the remote areas.

Higher transportation cost, unavailable chilling centers, lower milk price in the market, high interest rate of loans, and lack of own capital were the major marketing and economic constraints faced by the buffalo farmers. Not getting a high enough milk price and higher transportation costs were found positively related with concern score of economic and marketing constraints.

6.2. Recommendations

1. To minimize the problems of buffaloes, farmers need to be trained about good housing and management practices and the advantage of record keeping in farming. In addition, providing technical and financial support for improved housing development is also necessary. Trained and skilled work force can upgrade this system to a sustainable state.

2. Capacity building of the farmers through a series of training programs and seminars on modern buffalo husbandry practices, feeding technologies and fodder processing is needed. They should be motivated to produce their own fodder and provided with good quality fodder seeds and technical support.

3. Good quality breeding bulls can be provided in the bathans where not enough breeding bulls are not available. Regular rotation of the bulls is also necessary to stop inbreeding. Training of AI technicians is also necessary to increase the success rate of AI in buffaloes. Modern reproductive biotechnologies (AI and MOET) should be initiated to enhance the genetic potential and productivity in existing buffalo population.

4. Enough support should be provided to the buffalo farmers' group and milk cooperatives to set up milk chilling centers, milk-processing units, and sales centers in the local market and towns for marketing of milk.

5. To support buffalo rearing in the bathans, the government can provide free grazing land for the buffaloes and other livestock species in the islands. The department of livestock services (DLS) formulates laws so that it can acquire newly formed islands for buffalo rearing like that of the forest department. The department of forestry and DLS should collaborate for their own interest. In addition, modern killa with water reservoir, deep tube

well and shelter for the farmers can be established in the islands, which will protect the animals from natural calamities.

6.3. Future directions

1. A longitudinal study could be conducted to investigate the buffalo rearing system at different times, as the farming system changes depending on season.

2. Further studies should be conducted to find out the solutions for existing problems using interview and focus group discussion (FGD) of farmers and livestock professionals.

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Appendix-I

Questionnaire Survey to Assess the Qualitative and Quantitative Constraints of Buffalo Farming in Bangladesh

Objectives:

1. Identify the qualitative and quantitative constraints of buffalo farming in Bangladesh.

Declaration: I have answered all the questions in the interview sheet and I have full consent about the information given. Best of my Knowledge, the information given by me is correct and can be used in research. If necessary, the researcher can contact me for further information or vice versa in future.

==========

Interviewee signature

Farm ID:	Date: / /

1. General information:

1.1: Interviewee Name:			1.2: Mobile no:	
1.3: Gender: ☐ Male ☐ Female			1.4: Age:	
1.5: Location	Village:	Union:	Upazilla:	
1.6: GPS coordinates Latitude (Degree): Longitude (Degree): Altitude (m):				
1.7: Title of Interviewee:	☐ Owner	☐ Manager	☐ Other	
1.8: Educational status:	☐ Illiterate	☐ Primary	☐ Secondary	☐ Graduation
1.9: Farm type:	☐ Household	☐ Commercial	☐ Semi Bathan	☐ Bathan ☐ Semi intensive
1.10: Composition of farm	Milking buffaloes:	Heifers:	Calves:	Bulls:
	Pregnant:	Dry buffalo:	**Total no of buffalo:**	
1.11: Milk production (Today)				

1.12: Purpose of rearing	☐ Milk	☐ Meat	☐ Draught	☐ For Calf	☐ All

2. Housing/ Rearing Constraints:

2.1: Do you have separate house for buffaloes?	☐ Yes	☐ No
2.2: How much space (m^2) is available per buffalo indoor?		
2.3: Do you have any record book?	☐ Yes	☐ No
2.4: If yes, what kind of record do you maintain?	☐ Witten record	☐ Digitalized
2.5: Is there any wallowing area for the buffaloes?	☐ Yes	☐ No
2.6: Do you have available wallowing water across the year?	☐ Yes	☐ No

2.7	Main housing/ rearing constraints	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
2.7.a	Lack of separate housing for the buffalo					
2.7.b	Lack of available wallowing water/mud around the year					
2.7.c	Lack of enough space for the buffalo					
2.7.d	High construction cost of shed					
2.7.e	Unavailable skilled labor in the farm					

3. Feeding and Nutrition Constraints (Household/ Intensive/ Semibathan):

3.1: What do you feed to the buffalo?			
3.2: Do you feed dry/ green roughage to the buffalo when kept in the stall?	☐ Yes	☐ No	
3.3: If yes, amount (kg)/ buffalo/day			
3.4: Is there available grazing land for the buffaloes?	☐ Yes	☐ No	
3.5: Do you feed concentrate to the buffaloes?	☐ Yes	☐ No	
3.6: If yes, amount (kg)/ buffalo/day			
3.7: If no, what are the potential reasons?	☐ High price	☐ Not available	☐ Don't want to feed
3.8: What is the Price per kg concentrate (Tk)			
3.9: Do you feed vitamin and mineral supplements to the buffaloes?	☐ Yes	☐ No	
3.10: Do you have knowledge about balanced ration?	☐ Yes	☐ No	
3.11: Do you practice it?	☐ Yes	☐ No	

3.12: If no, do you like to have training on balanced ration?	☐ Yes	☐ No
3.13: Do you have any knowledge about the preparation of UMS/ UMB/ Silage?	☐ Yes	☐ No
3.14: If no, do you like to learn it?	☐ Yes	☐ No
3.15: Do you practice stall-feeding?	☐ Yes	☐ No
3.16: Is there available drinking water for the buffaloes?	☐ Yes	☐ No

3.17: How do you feed your buffaloes in Bathan?	☐ Only grazing	☐ Grazing with supplement
3.18: Do you feed concentrate to the buffaloes in Bathan?	☐ Yes	☐ No

3.19	**Availability of roughage around the year**	**Abundant availability**	**Enough available**	**Moderate available**	**Less available**	**Not available**
3.19.a	Availability at Summer					
3.19.b	Availability at Rainy season					
3.19.c	Availability at Winter season					

3.20	**Main feeding constraints**	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
3.20.a	Unavailability of green and dry roughage around the year					
3.20.b	Lack of available grazing land					
3.20.c	The quality of roughage is poor					
3.20.d	High price of concentrate feed					
3.20.e	Lack of enough knowledge about balanced ration					
3.20.f	Lack of knowledge about silage/UMS/UMB preparation					
3.20.g	Lack of drinking water source in the farm					

3.20.h	Unavailable mineral mixture					

4. Breeding constraints:

4.1: Do you have any breeding bull?	☐ Yes		☐ No
4.2: If yes, how many per farm?			
4.3: If yes, how many per herd? (Bathan)			
4.4: What is the bull and cow ratio in the herd? (Bathan)			
4.5: What is the name of the breed?			
4.6:How do you inseminate your buffalo cow?	☐ Bull	☐ AI	☐ Both
4.7: If bull, what is the source of the bull?	☐ Own bull	☐ Other's bull	☐ Both
4.8: Do you know about AI?	☐ Yes		☐ No
4.9: If yes, why don't you practice AI?	☐ Not available	☐ Costly	☐ Both
4.10: If practicing AI, is there trained AI technician available?	☐ Yes		☐ No
411: How do you detect heat in your buffalo?	☐ With the help of bull	☐ Observation	☐ Both
4.12: Do you face problem in heat detection?	☐ Yes		☐ No
4.13: If yes, what problem are you facing?			
4.14: What is the average calving interval?			
4.15: Is there any incidence of abortion or post-partum complication over the last on year?	☐ Yes		☐ No
4.16: If yes, what were the reasons?			

4.17	Main breeding constraints	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
4.17.a	Lack of good breeding bull					
4.17.b	Unavailable AI facility					
4.17.c	Unavailability of quality semen					
4.17.d	Lack of skilled AI technician					
4.17.e	Poor conception rate of AI					
4.17.f	Infertility is a problem of buffalo rearing					

4.17.g	Lack of enough knowledge about heat detection					
4.17.h	Repeat breeding is a problem for buffalo rearing					
4.17.i	Farmers prefer natural service over AI					

5. Health and Disease constraints:

5.1: What are the most common diseases of buffaloes?			
5.2: Do you vaccinate your buffaloes regularly?	☐ Yes	☐ No	
5.3: If yes, what are is/are the vaccines?			
5.4: Do you practice regular deworming?	☐ Yes	☐ No	
5.5: If yes, what anthelmintics do you use?			
5.6: Is there any epidemic outbreak in last one year?	☐ Yes	☐ No	
5.7: If yes, what is the disease?			
5.8: Is there available veterinary services in your area?	☐ Yes	☐ No	
5.9: What do you do if animals get sick?	☐ Contact with Veterinarian	☐ Contact local Quack	☐ Self-treatment
5.10: What is the calf mortality rate in your farm?			

5.11	**Main health and disease constraints**	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
5.11.a	Unavailable timely veterinary service					
5.11.b	Insufficient medicine supply					
5.11.c	Lack of sufficient vaccine					
5.11.d	Lack of enough knowledge about vaccination					
5.11.e	Lack of enough knowledge about deworming					
5.11.f	High calf mortality is problem					

5.11.g	Veterinary hospital/ facilities are remote					

6. Economic constraints:

6.1: Do you have your own capital?	☐ Yes	☐ No
6.2: Do you get any financial support (subsidy) from government or NGOs?	☐ Yes	☐ No
6.3: Have you taken any loan from NGOs or bank?	☐ Yes	☐ No

7. Marketing constraints:

7.1: Do you sell milk in the market?	☐ Yes	☐ No	
7.2: What is the distance between farms to market?			
7.3: Is this distance is a problem for marketing?	☐ Yes	☐ No	
7.4: What is the price of milk (Tk)?			
7.5: Is it change according to season?	☐ Yes	☐ No	
7.6: Is the price enough for you round the year?	☐ Yes	☐ No	
7.7: Is there any chilling canter nearby your farm?	☐ Yes	☐ No	
7.8: Is there any milk co-operative in your area?	☐ Yes	☐ No	
7.9: How do you transport your milk to the Market?	☐Bicycle	☐Van	☐ Boat
7.10: Is it costly?	☐ Yes	☐ No	
7.11: Do you get your payments regularly?	☐ Yes	☐ No	

7.12	Main economic and marketing constraints	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
7.12.a	Lack of own capital					
7.12.b	Lack of financial support from govt. or NGOs					
7.12.c	High interest rate of loan					
7.12.d	Low price of milk in the market					
7.12.e	High transportation cost					
7.12.f	Unavailable preservation/ chilling center near the farm					

7.12.g	Irregular payment system					
7.12.h	Lack of awareness among general people about benefit of buffalo milk					

8. Perception Constraints:

8.1: What do you think about the quality of buffalo milk?	☐ Good	☐ Not good	☐ Same as cattle	☐ Others
8.2: What your neighbor thinks about eating buffalo milk and meat?	☐ Cause disease	☐ Good for health	☐ Costly	☐ Others
8.3: What your neighbor thinks about rearing buffalo in terms of economy?	☐ Profitable	☐ Not profitable		☐ Others
8.4: What your neighbor thinks about rearing buffalo in terms of social status?	☐ Prestigious	☐ As usual	☐ Filthy	☐ Others
8.5: Do you think buffalo milk cause indigestion if drink it regularly?	☐Yes		☐No	
8.6: Can buffalo milk cause helminth problem in children/ adult?	☐Yes		☐No	
8.7: Do you think eating buffalo milk and meat can cause buffalo like skin and hair or something else in human body?	☐Yes		☐No	

9. Others:

9.1: Have you got any training on buffalo farming from government or NGOs?	☐ Yes	☐ No/Never
9.2: Is there any livestock extension service available?	☐ Yes	☐ No
9.3: Do you agree to form an association to address problems?	☐ Yes	☐ No
9.4: Do you have available labour?	☐ Yes	☐ No

10. What are the five main supports you need to sustain/ expand your buffalo farming?

SL No	Support
01	
02	
03	
04	
05	

Appendix-II

Google Survey Form (English)

Questionnaire Survey to Assess the Qualitative and Quantitative Constraints of Buffalo Farming in Bangladesh

Objectives:

1. Identify the qualitative and quantitative constraints of buffalo farming in Bangladesh.

Date: / /

1. General information:

1.1: Interviewee Name:	
1.2: Mobile no:	1.3: Email:
1.4: Gender: ☐ Male ☐ Female	
1.5: Address:	
1.6: Designation:	

2. Housing/ Rearing Constraints:

2.1:Do you think separate housing is important for buffalo rearing?	☐ Yes	☐ No
2.2:If yes, how much space does an adult buffalo need (square meter)?		
2.3: Do you think maintain a record book for breeding, production and disease data is important for buffalo farming?	☐ Yes	☐ No
2.4: Do you think wallowing is mandatory for the buffaloes?	☐Yes	☐No
2.5: Is there available wallowing water in your area for the buffalo across the year?	☐ Yes	☐ No

2.6	**Main housing/ rearing constraints**	**Strongly disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly agree**
2.6.a	Lack of separate housing for the buffalo					
2.6.b	Lack of available wallowing water/mud around the year					

2.6.c	Lack of enough space for the buffalo					
2.6.d	High construction cost of shed					
2.6.e	Unavailable skilled labor in the farm					

3. Feeding and Nutrition Constraints (Household/Intensive/Semi-bathan):

3.1: What are the common feed sources used to feed the buffaloes in households/ intensive system?		
3.2: What are the common feed sources used to feed the buffaloes in bathan?		
3.3: Is there available grazing land in your area across the year?	☐ Yes	☐ No
3.4: Do the farmers feed concentrate to the household buffaloes?	☐ Yes	☐ No
3.5: Do the farmers feed concentrate to the buffaloes in Bathan?	☐ Yes	☐ No
3.6: Is there available drinking water for the buffaloes in your area?	☐ Yes	☐ No

3.7	**Availability of roughage around the year**	**Abundant availability**	**Enough available**	**Moderate available**	**Less available**	**Not available**
3.7.a	Availability at Summer					
3.7.b	Availability at Rainy season					
3.7.c	Availability at Winter season					

3.8	Main feeding constraints	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
3.8.a	Unavailability of green and dry roughage around the year					
3.8.b	Lack of available grazing land					
3.8.c	The quality of roughage is poor					
3.8.d	High price of concentrate feed					
3.8.e	Lack of enough knowledge about balanced ration and its necessity					
3.8.f	Lack of knowledge about silage/UMS/UMB preparation					
3.8.g	Lack of drinking water source in the farm					
3.8.h	Unavailable mineral mixture					

4. Breeding constraints:

4.1: Is there enough breeding bull available in your area?	☐ Yes		☐ No	
4.2: Please mention the breed of breeding bull.				
4.3: What should be the bull and cow ratio in the farm/ Bathan?				
4.4: Is AI service available for the buffaloes in your practicing area?	☐ Yes		☐ No	
4.5: If yes, who supplies the buffalo semen?	☐Government	☐Local NGOs	☐Other organizational	
4.6:If other organizations, please mention.				
4.7: Are there trained AI technicians available in your area?	☐Yes		☐No	
	☐1 year	☐ 1.5 years	☐ 2 years	☐ 2.5 years

4.8: What is the average calving interval of buffalo cow?	☐ 3 years	☐ 3.5 years	☐ 4 years	☐other

4.9	Main breeding constraints	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
4.9.a	Lack of good breeding bull					
4.9.b	Unavailable AI facility					
4.9.c	Unavailability of quality semen					
4.9.d	Lack of skilled AI technician					
4.9.e	Poor conception rate of AI					
4.9.f	Infertility (repeat breeding) is a problem of buffalo rearing					
4.9.g	Lack of enough knowledge about heat detection					
4.9.h	Repeat breeding is a problem for buffalo rearing					
4.9.i	Farmers prefer natural service over AI					

5. Health and Disease constraints:

5.1: What are the most common diseases of buffaloes?		
5.2: Is there enough vaccine supply for the buffaloes?	☐ Yes	☐ No
5.3: What is the name of the available vaccines?		
5.4: Is there any disease outbreak last one year?	☐ Yes	☐ No
5.5: If yes, which disease?		

5.6	Main health and disease constraints	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
5.6.a	Unavailable timely veterinary service					
5.6.b	Insufficient medicine supply					
5.6.c	Lack of sufficient vaccine					
5.6.d	Lack of enough knowledge about vaccination					
5.6.e	Lack of enough knowledge about deworming					
5.6.f	High calf mortality is a problem					
5.6.g	Veterinary hospital/ facilities are remote					

6. Economic and Marketing constraints:

6.1: Is there any NGO or other organization working for buffalo development in your area?	☐ Yes	☐ No
6.2: Do your organization provide loan to the farmers?	☐ Yes	☐ No
6.3: Do you think farmers get the proper wholesale price of buffalo milk in your area?	☐ Yes	☐ No
6.4: Is there a proper transportation facility for milk?	☐ Yes	☐ No
6.5: Is there any chilling center available in your area?	☐ Yes	☐ No
6.6: Is there any milk co-operative society in the area you know?	☐ Yes	☐ No

6.7	Main economic and marketing constraints	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
6.7.a	Lack of own capital					
6.7.b	Lack offinancial support from govt. or any NGO					
6.7.c	High interest rate of loan					

6.7.d	Low price of milk in the market					
6.7.e	High transportation cost					
6.7.f	Unavailable preservation/ chilling center near the farm					
6.7.g	Irregular payment system					
6.7.h	Lack of awareness among general people about benefit of buffalo milk					

8. Buffalo milk value chain constraints:

8.1. Is it possible to establish a separate buffalo milk value chain in Bangladesh?	☐ Yes	☐ No	
8.2. Do you think farmers face problem in selling buffalo milk separately in the market?	☐ Yes	☐ No	
8.3. What is your opinion about the acceptability of buffalo milk compared to cow milk in general people?	☐ Poor	☐ Same as cow milk	☐ Higher than cow milk
8.4. If poor, Why and how to overcome it?			

9. Buffalo meat value chain constraints:

9.1. Is it possible to establish a separate buffalo meat value chain in Bangladesh?	☐ Yes	☐ No	
9.2. Do you think farmers face problem in selling buffalo meat separately in the market?	☐ Yes	☐ No	
9.3. What is your opinion about the acceptability of buffalo meat compared to beef in general people?	☐ Poor	☐ Same as beef	☐ Higher than beef
9.4. If poor, Why and how to overcome it?			

10. Climate change:

7.1. Do you think farmers face problem in buffalo rearing due to natural calamities (flood/ cyclone/ drought)?	☐ Yes	☐ No	
7.2. Do you think it will be difficult in future to rear buffaloes because of climate change?	☐ Yes	☐ No	
7.3. If yes, which species may be preferable?			
7.4. In your opinion why buffalo farming is not popular in all parts of Bangladesh?			
7.5. Which farming system is suitable to sustain buffalo farming in Bangladesh in your opinion?	☐ Household	☐ Bathan/ Free range	☐ Commercial

11. Perception Constraints:

10.1: What are the possible ways to sustain buffalo farming in Bangladesh in your opinion?

10.2: What would be the most sustainable solution to use the limited land in your opinion?

Please rank the options from 1st to 7th based on your thinking. For example, Buffalo faring- 2, Shrimp culture-4, Crop cultivation-1. Do not repeat ranks. 1 is best option, 7 is the poorest

Sl.no								
A	Buffalo farming							
B	Shrimp culture							
C	Crop cultivation							
D	Crop cultivation and livestock rearing							
E	Integrated farming system(crop, livestock and fish)							
F	Tourism business							
G	Forestry							

12. Any other comments:

Google Survey Form (Bengali)

Questionnaire Survey to Assess the Qualitative and Quantitative Constraints of Buffalo Farming in Bangladesh

উদ্দ্যেশ্যঃ

১. বাংলাদেশে মহিষ পালনের গুনগত ও পরিমানগত বাধা সমুহ নির্নয়।

তারিখ: /

১. সাধারন তথ্যঃ

১.১ঃসাক্ষাতকারীর নামঃ	
১.২ঃমোবাইল নংঃ	১.৩ঃইমেইলঃ
১.৪ঃলিঙ্গঃ ☐পুরুষ ☐নারী	
১.৫ঃঠিকানাঃ	
১.৬ঃপদাবিঃ	

২.বাসস্থান/পালন সংক্রান্তবা ধাসমূহঃ

২.১ঃআপনি কি মনে করেন মহিষ পালনের জন্য আলাদা ঘরের দরকার আছে?	☐হ্যাঁ	☐না
২.২ঃহ্যাঁ হলে, একটি মহিষের জন্য কি পরিমান জায়গার প্রয়োজন (বর্গ মি,)?		
২.৩ঃআপনি কি মনে করেন প্রজনন, দুধ উৎপাদন এবং রোগের বিভিন্ন তথ্য সংরক্ষন করা মহিষ খামারের জন্য গুরুত্বপূর্ণ?	☐হ্যাঁ	☐না
২.৪ঃআপনি কি মনে করেন মহিষ কে নিয়মিত পানিতে নামানো আবশ্যক?	☐হ্যাঁ	☐না
২.৫ঃআপনার এলাকায় কি সারা বছর মহিষদের পানিতে নামার মত পর্যপ্ত স্থান রয়েছে?	☐হ্যাঁ	☐না

২.৬	বাসস্থান/ পালনের প্রধান বাধা সমূহ	একদম দ্বিমত	দ্বিমত	মতামত নেই	হতে পারে	অবশ্যই হ্যাঁ
২.৬.ক	মহিষের জন্য আলাদা ঘরের অভাব রয়েছে					
২.৬.খ	সারা বছর পুকুরের পানি বা কাদা পানির অভাব রয়েছে					

২.৬.গ	মহিষের জন্য পর্যাপ্ত জায়গার অভাব রয়েছে					
২.৬.ঘ	বাসস্থান নির্মাণ ব্যয় বাহুল					
২.৬.ঙ	খামারে দক্ষ শ্রমিকের অপর্যাপ্ততা					

৩.খাদ্য ও পুষ্টি সংক্রান্ত বাধা সমূহঃ

৩.১ঃগৃহপালিত/ ইন্টেন্সিভ পদ্ধতিতে মহিষের সাধারন খাবারের উৎস হিসাবে কি কি ব্যবহার করা হয়?		
৩.২ঃবাথানে মহিষের সাধারন খাবারের উৎস হিসাবে কি কি ব্যবহার করা হয়?		
৩.৩ঃআপনার এলাকায় কি সারা বছর পর্যাপ্ত চারনভূমি রয়েছে?	☐হ্যাঁ	☐না
৩.৪ঃখামারিরা কি গৃহপালিত মহিষকে দানাদার খাবার খাওয়ায়?	☐হ্যাঁ	☐না
৩.৫ঃ খামারিরা কি বাথানে মহিষকে দানাদার খাবার খাওয়ায়?	☐হ্যাঁ	☐না
৩.৬ঃআপনার এলাকায় কি মহিষের জন্য পর্যাপ্ত পানযোগ্য জল রয়েছে?	☐হ্যাঁ	☐না

৩.৭	**বছরের বিভিন্ন সময় ঘাসের পর্যাপ্ততা**	**প্রয়োজনের থেকে বেশি**	**পর্যাপ্ত**	**মোটামুটি**	**কম**	**একদম না**
৩.৭.ক	গ্রীষ্মকালে পর্যাপ্ততা					
৩.৭.খ	বর্ষাকালে পর্যাপ্ততা					
৩.৭.গ	শীতকালে পর্যাপ্ততা					

৩.৮	**খাদ্য সংক্রান্ত বাধা সমূহ**	**একদম দ্বিমত**	**দ্বিমত**	**মতামত নেই**	**হতে পারে**	**অবশ্যই হ্যাঁ**
৩.৮.ক	বছর জুড়ে কাঁচা এবং শুকনো খড়ের অপর্যাপ্ততা					

৩.৮.খ	পর্যাপ্ত চারন ভূমির অভাব					
৩.৮.গ	ভাল মানের ঘাসের অভাব					
৩.৮.ঘ	দানাদারখাবারেরউচ্চমূল্য					
৩.৮.ঙ	সুষম খাদ্য তালিকা এবং এর প্রয়োজনীয়তা সম্পর্কে জ্ঞানের অভাব					
৩.৮.চ	সাইলেজ/ ইউএমএস/ ইউএমবি তৈরি করতে না জানা					
৩.৮.ছ	খামারে খাবার পানির অভাব					
৩.৮.জ	খনিজ মিশ্রনের অভাব					

৪। প্রজনন সংক্রান্ত বাধা সমূহঃ

৪.১ঃআপনার এলাকায় কি পর্যাপ্ত ষাড় রয়েছে?	☐হ্যাঁ	☐না		
৪.২ঃথাকলে, কোন জাতের?				
৪.৩ঃখামার অথবা বাথানে ষাড় ও গাভীর অনুপাত কেমন হাওয়া উচিৎ?				
৪.৪ঃআপনার এলাকায় কি মহিষের এআই করানো হয়?	☐হ্যাঁ	☐না		
৪.৫ঃহ্যা হলে, কারা মহিষের বীজ সরবরাহ করে থাকে?	☐ সরকার	☐ স্থানীয় এনজিও	☐ অন্য সংস্থা	
৪.৬ঃঅন্য সংস্থা হলে তার নাম কি?				
৪.৭ঃআপনার এলাকাই কি দক্ষ এআই কর্মী রয়েছে?	☐হ্যাঁ	☐না		
৪.৮ঃমহিষের গড় বাচ্চা জন্ম দেওয়ার ব্যবধান কত?	☐১বছর	☐১.৫বছর	☐২বছর	☐২.৫বছর
	☐৩বছর	☐ ৩.৫বছর	☐৪বছর	☐অন্য

৪.৯	**প্রজনন সংক্রান্ত প্রধান বাধা সমূহ**	একদম দ্বিমত	দ্বিমত	মতামত নেই	হতে পারে	অবশ্যই হ্যাঁ
৪.৯.ক	ভাল জাতের ষাঁড়ের অভাব রয়েছে					
৪.৯.খ	কৃত্রিম প্রজননের সুবিধার অভাব আছে					
৪.৯.গ	ভাল বীজের অপর্যাপ্ততা আছে					
৪.৯.ঘ	দক্ষ কৃত্রিম প্রজনন কর্মীর অভাব আছে					
৪.৯.ঙ	এআই দ্বারা গর্ভধারন হার কম					
৪.৯.চ	মহিষের প্রজনন সংক্রান্ত সমস্যা					
৪.৯.ছ	মহিষের হিট সনাক্তকরন সম্পর্কে জ্ঞানের অভাব					
৪.৯.জ	রিপিট ব্রিডিং মহিষ খামারের জন্য একটি সমস্যা					
৪.৯.ঝ	খামারিরা কৃত্রিম প্রাজননের চেয়ে প্রাকৃতিক প্রজনন বেশি পছন্দ করেন					

৫. স্বাস্থ্য সংক্রান্ত বাধা সমূহঃ

৫.১ঃমহিষের সাধারন রোগ গুলো কি কি?		
৫.২ঃআপনার এলাকায় মহিষের জন্য কি পর্যাপ্ত টিকার সরবরাহ রয়েছে?	☐হ্যাঁ	☐না
৫.৩ঃসরবরাহকৃত টিকার নাম কি?		
৫.৪ঃগত এক বছরে আপনার এলাকায় কি কোনো মহামারি হয়েছে?	☐হ্যাঁ	☐না
৫.৫ঃযদি হয়, রোগের নাম।		

৫.৬	স্বাস্থ্য সংক্রান্ত প্রধান বাধা সমূহ	একদম দ্বিমত	দ্বিমত	মতামত নেই	হতে পারে	অবশ্যই হ্যাঁ
৫.৬.ক	অপ্রতুল ভেটেরিনারি সেবা					
৫.৬.খ	অপর্যাপ্ত ঔষধ সরবরাহ					
৫.৬.গ	পর্যাপ্ত টিকার অভাব					
৫.৬.ঘ	টিকা সম্পর্কে জ্ঞানের অভাব					
৫.৬.ঙ	কৃমিনাশক সম্পর্কে জ্ঞানের অভাব					
৫.৬.চ	বাছুরের উচ্চ মৃত্যুর হার একটি সমস্যা					
৫.৬.ছ	ভেটেরিনারি হাসপাতাল/ সেবা দূরে					

৬. অর্থনৈতিক এবং বাজারজাতকরণ সংক্রান্ত বাধা সমূহঃ

৬.১ঃআপনার এলাকায় মহিষের উন্নয়নে কোনো এনজিও বা অন্য সংস্থা কাজ করছে?	☐হ্যাঁ	☐না
৬.২ঃআপনার সংস্থা কি খামারিদের ঋণ দেয়?	☐হ্যাঁ	☐না
৬.৩ঃআপনার এলাকার মহিষ খামারিরা কি দুধের সঠিক দাম পায়?	☐হ্যাঁ	☐না
৬.৪ঃসেখানে কি দুধ পরিবহনের পর্যাপ্ত সুবিধা রয়েছে?	☐হ্যাঁ	☐না
৬.৫ঃআপনার এলাকায় কি কোনো দুগ্ধশীতলীকরন কেন্দ্র রয়েছে?	☐হ্যাঁ	☐না
৬.৬ঃআপনার এলাকায় কি কোনো দুগ্ধ প্রক্রিয়াজাতকরন কারখানা আছে?	☐হ্যাঁ	☐না

৬.৭	অর্থনৈতিক এবং বাজারজাতকরণের প্রধান বাধা সমূহ	একদম দ্বিমত	দ্বিমত	মতামত নেই	হতে পারে	অবশ্যই হ্যাঁ
৬.৭.ক	নিজস্ব মূলধনের অভাব					
৬.৭.খ	সরকার বা এনজিও থেকে অর্থনৈতিক সাহায্যের অভাব					

৬.৭.গ	ঋণে উচ্চ সুধের হার					
৬.৭.ঘ	বাজারে দুধের স্বল্প মূল্য					
৬.৭.ঙ	অধিক যাতায়াত খারচ					
৬.৭.চ	খামারের নিকটে দুগ্ধশীতলীকরন কেন্দ্রের অভাব রয়েছে					
৬.৭.ছ	নিয়মিত দুধের দাম পরিশোধ না করা					
৬.৭.জ	মহিষের দুধের উপকারিতা সম্পর্কে সাধারন মানুষের সচেতনতার অভাব					

৮. <u>মিল্ক ভ্যালুচেইনের বাধা সমূহ:</u>

ক.	আপনি কি মনে করেন খামারিরা মহিষের দুধ আলাদাভাবে বিক্রি করতে সমস্যায় পড়েন?	☐হ্যাঁ		☐না
খ.	সাধারন জনগনের মধ্যে মহিষের দুধের গ্রহনযোগ্যতা নিয়ে আপনি কি মনে করেন?	☐কম গ্রহনযোগ্য	☐গরুর দুধের মতই	☐গরুর দুধের চাইতে বেশি
গ.	যদি কম গ্রহনযোগ্য হয়, কেন এবং কিভাবে এটি দূর করা যায়?			
ঘ.	বাংলাদেশে কি মহিষের দুধের আলাদা মিল্ক ভ্যালু চেইন প্রতিষ্ঠা করা সম্ভব?	☐হ্যাঁ		☐না

৯. মিট <u>ভ্যালুচেইনের বাধা সমূহ:</u>

ক.	আপনি কি মনে করেন খামারিরা মহিষের মাংস আলাদাভাবে বিক্রি করতে সমস্যায় পড়েন?	☐হ্যাঁ		☐না
খ.	সাধারন জনগনের মধ্যে মহিষের মাংসের গ্রহনযোগ্যতা নিয়ে আপনি কি মনে করেন?	☐কম গ্রহনযোগ্য	☐গরুর মাংসের মতই	☐গরুর মাংসের চাইতে বেশি
গ.	যদি কম গ্রহনযোগ্য হয়, কেন এবং কিভাবে এটি দূর করা যায়?			
ঘ.	বাংলাদেশে কি মহিষের মাংসের আলাদা ভ্যালুচেইন প্রতিষ্ঠা করা সম্ভব?	☐হ্যাঁ		☐না

১০. জলবায়ু পরিবর্তনজনিত বাধা সমূহঃ

ক.	আপনি কি মনে করেন বিভিন্ন প্রাকৃতিক দুর্যোগের (বন্যা/ ঘূর্ণিঝড়/ খরা) কারণে খামারিরা মহিষ পালনে সমস্যায় পড়েন?	☐হ্যাঁ		☐না	
খ.	জলবায়ু পরিবর্তনের কারণে কি খামারিরা ভবিষ্যতে মহিষ পালনে সমস্যায় পড়বেন?	☐হ্যাঁ		☐না	
গ.	যদি হ্যা হয়, কোন প্রাণীটি বেশি উপযোগী?				
ঘ.	আপনার মতে কেন মহিষ পালন বাংলাদেশের সব জায়গায় জনপ্রিয় নয়?				
ঙ.	বাংলাদেশের বিরূপ জলবায়ুতে মহিষ পালন টেকসই করতে কোন পদ্ধতিটি বেশি উপযোগী বলে মনে করেন?	☐ গৃহপালিত পদ্ধতি	☐ বাথানে পদ্ধতি	☐ বাণিজ্যিক পদ্ধতি	☐সেমি-ইন্টেসিভ পদ্ধতি

৭. প্রত্যক্ষবাধা সমূহঃ

৭.১ঃআপনার মতে কি কি উপায়ে বাংলাদেশে মহিষ পালনের ধারা অব্যাহত রাখা যাবে?

৭.২ঃআপনার মতে বাংলাদেশের সীমিত পরিমান ভূমিকে কিভাবে অধিক কার্যকারিতার সাথে ব্যবহার করা যাবে?

দয়া করে নিম্মের তালিকাটিকে আপনার পছন্দ অনুযায়ী ১ম থেকে ৭ম স্থান পর্যন্ত সারিবদ্ধ কারুন। যেমন, মহিষপালন- ২য়, চিংড়িচাষ-৪র্থ, শস্যচাষ-১ম।

ক্রমিক নং								
ক	মহিষ পালন							
খ	চিংড়ি চাষ							
গ	শস্য চাষ							
ঘ	শস্য চাষ এবং পশু পালন							
ঙ	স্বমন্বিত খামার (শস্য, পশু ও মাছচাষ)							
চ	পর্যটন ব্যবসা							
ছ	বনায়ন							

৮ ।অন্যান্য মন্তব্যঃ

Biography

Sanjib Chandra Nath, the author of this manuscript was born on October 1994 in the Raozan upazila of the Chattogram district of Bangladesh. He passed his Secondary School Certificate (SSC) in 2010 and the Higher Secondary Certificate (HSC) in 2012. Afterwards, he obtained a Doctor of Veterinary Medicine (DVM) degree from Chattogram Veterinary and Animal Sciences University (CVASU) in 2018. He did his clinical training in veterinary clinical medicine at Tamil Nadu Veterinary and Animal Sciences University (TANUVAS), India and the Khon Kaen University (KKU), Thailand in the year 2018. He then joined the MS degree in Epidemiology in 2019, in the department of medicine and surgery under the faculty of Veterinary Medicine, Chattogram Veterinary and Animal Sciences University (CVASU).