

**Effect of Urea Molasses Multi-Nutrient Block (UMMB)
Supplementation on Growth Performance of Crossbred Sheep**

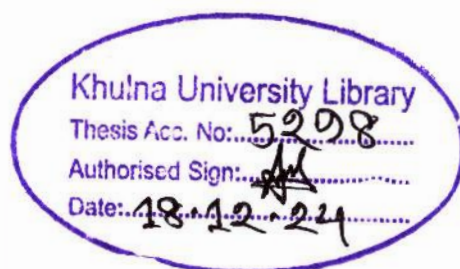
A THESIS

BY

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STUDENT ID. NO. MS- 230826

**A Thesis (Course No. 081108 AN-6118) Submitted to Agrotechnology Discipline in Partial
Fulfilment of the Requirement for the Degree of Master of Science in Animal Nutrition**



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KHULNA UNIVERSITY

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By



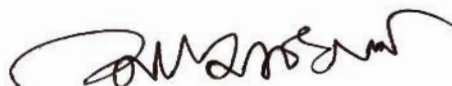
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**DEDICATED
TO MY BELOVED
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Abstract

The urea molasses multi-nutrient block (UMMB) supplementation can be an efficient method to maximize rumen microbial activity through a balanced supply of protein, energy, minerals, and vitamins. Sheep grazing on pastures may not fulfill their nutritional requirement, especially during the dry season. Thus, the goal of this experiment was to identify the impact of UMMB supplementation on crossbred sheep under grazing condition in southwest Bangladesh region. Twelve sheep were divided into four treatment groups, each consisting of three replications. Control group (T_0) continued to graze normally, while groups T_1 , T_2 , and T_3 were permitted to lick UMMB for 1 hour, 1.5 hours, and 2 hours, per day accordingly. Based on randomized complete block design, the experimental design was organized. The average body weight of the four treatment groups was maintained randomly constant during the initial weighing and grouping of the sheep. The UMMB consists of DM (76.08 ± 0.57) %, CP (17.90 ± 0.24) %, CF (7.46 ± 0.01) %, EE (3.57 ± 0.31) %, ash (26.84 ± 0.36) %, and NFE (44.23 ± 0.51) %. Each group of sheep allowed to graze for 10 hours a day, from 9 am to 7 pm. In the morning, the allotted UMMB was given to lick. Regular records of all pertinent information, including body weight, date of parturition, deworming and vaccination were kept in a registrar. Every week, in the morning, live weight measurements in empty stomach were done before allowing them to lick UMMB and graze. The R software was used to analyze the data. The findings showed that although the mean differences did not differ significantly ($p > 0.05$), body weight (kg sheep^{-1}) rose numerically as UMMB licking periods increased. Sheep licking UMMB for 2 hours was found to have the numerically highest body weight in the majority of cases. The initial body weight of four treatments, T_0 , T_1 , T_2 , and T_3 was 13.48 ± 2.84 kg, 13.87 ± 1.78 kg, 13.67 ± 4.81 kg, and 14.12 ± 3.40 kg, respectively. After 13 weeks of licking UMMB, their final body weights were 17.37 ± 2.18 kg, 19.20 ± 2.46 kg, 21.13 ± 5.31 kg, and 22.27 ± 2.58 kg, respectively for T_0 , T_1 , T_2 , and T_3 groups. The growth rate (g day^{-1}) of crossbred sheep rose, as the length of UMMB licking sessions increased. Within supplemented groups as well as between supplemented and non-supplemented groups, crossbred sheep mean differences varied significantly. At weeks two, five, seven, ten, and thirteen, sheep's average growth rate differed significantly ($p < 0.05$) based on the duration of UMMB supplementation they were allowed to lick. At weeks 6, 9 and 12, the growth rate (g day^{-1}) was shown to be significantly highest ($p < 0.01$) while licking UMMB at 2 hours ($110.00^a \pm 22.45$), 1.5 hours ($88.10^a \pm 14.87$), and 2 hours ($90.48^a \pm 16.49$). It can be concluded that UMMB licking session of 2-hour per day is necessary to ensure optimum growth.

Keywords: Body weight, licking UMMB, crossbred sheep, growth rate, performance

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molasse block supplementation affected sheep growth performance, especially how much sheep gained in weight, how much they consumed, and how quickly they converted feed to meat when given UMMB-supplemented grass.

The main obstacle to the expansion of livestock in developing countries is the absence of reliable, year-round, high-quality facilities for producing animal feed. Pastoralists, the landless, and smallholders who mostly graze on common land are among the millions of people in the developing world whose livelihoods depend on an adequate supply of animal feed (Mengistu & Hassen, 2017). The majority of livestock animals in developing countries are fed fibrous diets that mostly consist of leftover cereals and poor pasture that is deficient in important minerals, vitamins, and crude protein. These roughages have an irregular mineral, vitamin, and nitrogen (N) composition and are extensively lignified. This reduces their digestion of dry matter (DM). Due to these characteristics, voluntary dry matter intake (DMI) and low productivity result in decreased or nonexistent output of animal products (meat, milk, and wool) (Bresciani & Valdés, 2007).

Anywhere in the world, natural pasture grazing served as the main source of feed for livestock. There is currently less natural grazing space available due to the country's rapid population increase and rising land demand for crop development (Kifle, 2021). In typical agricultural systems, crop leftovers—a roughage with a high fiber content, low quality, and poor digestion—now serve as the main feed source for animals. Malnutrition and a decrease in disease resistance will cause livestock productivity to deteriorate (Malede & Takele, 2014). Rainfall intervals differ significantly in terms of the availability and quality of feed. Animals that are let to graze have phases of weight gain and loss because the quality and quantity of feed varies with the season. Despite exhibiting remarkable resilience in the face of adversity, the animals' production is not on pace with their more gregarious species counterparts. The development of suitable feeding regimens is necessary to mitigate the negative impacts on animal output during difficult periods, such as the dry season (Kamalzadeh et al., 1997). Reduced ruminant productivity was caused by a variety of factors, such as genetic defects, parasite infections, and insufficient protein and energy supply. Large-scale grazing ruminant farms often feed their animals native grasses and agricultural waste, which are high in fiber (>25%) and low in crude protein (<6%) but low in other nutrients (mostly vitamins and minerals) (Zahari24 et al., 2007). In tropical animals, low productivity and poor reproductive success are often associated with mineral imbalances. This problem stems from an imbalance of minerals in the soil and pastures (Yusuf & Zeleke, 2015).

Research on feeding tiny ruminant animals is currently lacking, despite the fact that modern ruminant animal ranchers employ urea, a nitrogen that is not protein but can be turned into protein, and that it improves production performance. Urea molasses multi-nutrient block (UMMB): urea, molasses, maize meal, vitamins, and minerals make up this block (Neric et al., 1984; Hatungimana & Ndolisha, 2015). This is one way to provide urea. The animal and microorganisms can receive nutrients by feeding the blocks that may be lacking in their basic diet at a little cost.

Tekeba et al. (2012) state that even in years of normalcy, Ethiopians should expect an average 35% shortage in feed supply; during drought years, this percentage may increase to 70% (Kumssa, 2017). The main objective used to be to increase the amount of straw that ruminants eat. Although straw is widely available, it is not very nutritious due to its high lignocellulose content, low amount of crude protein, and high mineral content. Adding readily digested protein and energy to the meal—which were absent from the baseline diet—was another tactic to boost rumen fermentation and enhance productivity and reproductive efficacy. The technology that was discovered was the utilization of mineral block lick urea molasses (Mahesh & Mohini, 2014). Creative feeding strategies designed to increase animal output have been influenced by reductions in highly populated pasture zones. Urea-molasse multi-nutrient blocks are just one option for supplemental feeding, given their simplicity in production and storage (Togtokhbayar, 2004).

In several countries, molasses was added to cow feed in the form of Urea Molasses Multi-Nutrient Blocks (UMMB) to help with the nutritional problem. Due to their short reproductive cycles and high returns from specialist feeding techniques like urea-molasse multi-nutrient block supplements, tiny ruminants have been shown to be a key factor in the elimination of poverty. Several studies have demonstrated positive benefits on the reproductive and productive abilities of ruminant animals, as well as an enticing cost-benefit ratio. According to Bohra et al. (2012), Urea Molasses Multi-Nutrient Blocks (UMMB) are lick blocks that include urea, molasses, vitamins, minerals, and other multi-nutrients. Supplementing with Urea Molasses Multi-Nutrient Blocks (UMMB) can increase feed intake by up to 20% overall, by 25% to 30% for the animal, and by up to 20% for the animal's ability to digest fibrous foods (Yami, 2007). UMMB is produced and used in many countries, and studies indicate that it improves the reproductive and productive capacities of sheep and dairy cows (Aye & Adegun, 2010). Numerous techniques have been put forth by researchers to improve the nutritional content and palatability of low-quality roughages. According to Jayawickrama et al. (2013), feeding UMMB together with roughages of lower quality is one of the simplest and most

effective ways. This study gives a summary of current studies on multi-nutrient block supplemental feeding for ruminant animals with the goal of boosting production. It also offers suggestions for further developments in this field.

A strategy for livestock development must prioritize the feeding of a balanced diet. To fully utilize an animal's genetic potential, a sufficient and well-balanced nutrition supply is a needed prerequisite. The two main forages utilized to feed animals in India are crop wastes and dry grasses. Due to their high fiber and lignin content and low nitrogen, mineral, and vitamin content, these agricultural residues limit the amount that animals can eat and digest. The outcome is frequently subpar animal performance, which manifests as stunted development, delayed maturity, an extended duration between pregnancies, and low milk production. The effective utilization of low-quality roughages in this situation requires the judicious addition of nutrients. Roughages of low quality might be better used if essential nutrients are supplemented into the diet. Farmers in low-resource areas may hardly afford concentrate mixtures given their availability and cost. Globally, animal nutritionists have demonstrated that agricultural wastes may have their nutritional value increased by supplementing them with inadequate nutrients (Makkar et al., 2007; Singh & Singh, 2003). Enhancing cereal straws' nutritional content through targeted supplements—which are also less expensive than grains and oilseed meals—is one of the primary goals of animal nutrition research conducted in this nation. To guarantee animal life at a time of shortage, IVRI developed a liquid supplement of urea molasses. After being developed at NDDB (Baviskar & George, 1988), urea molasses mineral block (UMMB) was further refined at IVRI (Tripathi, 1997; Garg et al., 1998). Supplementing UMMB with other feeds can potentially improve animal productivity and nutrient utilization (Sahoo et al., 2009). Deoiled mahua seed cake, when added to compressed complete feed block (CCFB) at a rate of 5%, had no negative effects on the serum biochemical profile of CB calves fed for an extended period of time, according to Patil et al. (2013). In order to support optimal microbial development, UMMB licks to periodically deliver fermentable nitrogen, energy, and minerals. An animal's demand for crude protein can be contributed by 30–40% by microbial protein. When fed crop-residue-based diets, UMMB supplementation in the ration is particularly advantageous since ruminants may synthesize microbial protein from nonprotein nitrogen. According to Misra et al. (2006), there is a chance that adding UMMB to cattle diets based on agricultural residues may boost yields and daily net income. Although they may be fed all year round, UMMB are best used in the dry season or when the animals are grazing inferior feed. Another strategy to improve nutrient utilization and accelerate growth rate and reproductive performance in cattle is to use liquid supplements based on molasses and

enriched with additional N, minerals, and vitamins. Additionally, liquid supplements have the benefits of being easier to transport, providing nutrients in a set quantity, and having greater availability.

1.2. Statement of the study

The study's goal is to determine the optimum licking period of urea molasses multi-nutrient block (UMMB) to optimize growth performance of crossbred sheep in Bangladesh's southwest. Sheep may thrive in harsh environments and with inadequate care. Anywhere they can find food, including fields, fallow land, and roadside verges, is a good place for sheep to graze. They thus save farmers time in maintaining their management; however, there is a problem in that roadside verges, fallow fields, and forage from fields are not able to supply all the nutrients that sheep need, including minerals, protein, and other nutrients. Sheep farming significantly improves the standard of living for farmers those living in rural areas. In this instance, giving them more nutrients are crucial for their improved development and functionality. The multi-nutrient block made of urea molasses is a good source of minerals, protein, and other elements that support the growth and productivity of sheep.

To have the accurate information about effective urea molasses feeding period for the sheep the researcher had introduce research entitled, "Effect of Urea Molasses Multi-Nutrient Block (UMMB) Supplementation on Growth Performance of Crossbred Sheep".

The researcher was undertaken to look for the answer of the following questions:

- i. What is urea molasses multi nutrient block's nutritional benefits?
- ii. How can urea molasses multi-nutrient block affect the growth performance of sheep?
- iii. How much time is perfect of licking urea molasses multi-nutrient block for better growth and performance of sheep?

1.3. Objectives of the study

The specific objectives are given bellow:

1. To determine the impact of urea molasses multi-nutrient block (UMMB) supplementation on the growth performance of crossbred sheep.
2. To identify the optimum licking period of urea molasses multi-nutrient block (UMMB) for optimizing the growth performance of crossbred sheep under grazing condition.

1.4. Justification of the study

Sheep, with their many uses including wool, meat, milk, skins, and droppings, are a vital part of the rural economy, especially in Bangladesh. Sheep can be raised on marginal and unproductive soil. In order to improve growth and reproductive performance, sheep should be given access to urea molasses multi-nutrient block for a specific period of time when grazing is the primary source of feed supplementation. The purpose of the study was to determine the optimal use of urea molasses multi-nutrient block and its licking period for Bangladeshi crossbreed sheep in terms of their performance.

1.5. Scope of the study

Researchers, planners, field workers, farmers, and other individuals involved in sheep farming in Bangladesh can all benefit from the study's substantial knowledge. The study's findings can aid researchers and farmers in determining the ideal period to feed sheep urea molasses block so they can perform at their peak throughout a typical grazing season. Sheep farming has the potential to generate income for the unemployed and unproductive coastal regions of Bangladesh. There is a positive relationship among growth, performance, and urea molasses multi-nutrient supplementation periods.

1.6. Advantages of using UMMB technology

- a) In practical, every area in Bangladesh, ingredients of UMMB are freely accessible.
- b) Preparation methods are rather simple.
- c) When stored in a dry location, UMMB has a lengthy shelf life.
- d) The ingredients' densities are substantially lower than UMMB's, allowing for more affordable long-distance shipping.
- e) To maintain ruminant sustainability in the face of droughts and floods, UMMB blocks can be added to dry fodder-based diets.
- f) Compared to traditional sources of protein like oil cakes, UMMB is substantially less expensive.

1.7. Limitations of the study

The following limitations were observed in completing the present study

1. The study was only confined to the campus of Khulna University of Khulna District, not in the whole southeast coastal region of Bangladesh.
2. Genetic characteristics of the cross-breed sheep is unknown.
3. The grass quality of the pasture land was unknown.
4. The preparation of urea molasses multi-nutrient block with maintaining the proper ratio of the ingredient, would be more difficult for the unskilled farmers.

Chapter II

Review of Literature

2.1. Livestock population of Bangladesh

Having an average annual growth rate of 3.31%, livestock is a crucial part of Bangladesh's agricultural farming system, accounting for 14.31% of agricultural GDP in FY 2016–17 and 1.60% of the country's total gross domestic product (GDP) (Nahar et al., 2019). Cattle, buffalo, goats, sheep, horses, and pigs are among the species of livestock in Bangladesh. The population size trends of the key livestock species have been displayed in Table 2.1. The majority of the aforementioned species are native, with the exception of cattle, which only make about 20% of the total (Akther, 2023). Small-holder farmers raise the majority of the animals, with 1-2 heads of cattle, 2-4 heads of goats or sheep, and a few chickens under a mixed subsistence farming system (Bhuiyan et al., 2017). A valuable resource for the impoverished in rural areas (where non-farm and smallholders own up to 70% of the animals), livestock not only meets the daily needs for animal protein but also helps to increase rural income, provide jobs, empower women, and enhance livelihoods. Thus, the mainstay of livestock farming in Bangladesh continues to be smallholders' low-input production systems.

Table 2.1. Recent livestock population in Bangladesh

Livestock animals and birds	Population in lakh number
Cattle	248.56
Buffalo	15.16
Sheep	38.27
Goat	269.45
Poultry	3857.04

(Source: [Livestock Economy at a glance 2022-2023](#)).

2.2. Present native sheep status in Bangladesh

In Bangladesh, sheep are a significant agricultural commodity that both improve the socioeconomic standing of impoverished farmers and serve as a major source of food and revenue (Hossain et al., 2018a; Sarker et al., 2017a). Global distribution of it is extensive (Campbell & Pauly, 2013; Haque et al., 2020). The number of sheep has grown 2.5 times in the past twelve years, with an annual growth rate of 5% (Hasan et al., 2013). According to Sultana et al. (2011), sheep are sociable small ruminants that mostly feed on the natural grasses found on agricultural fields, roadsides, fallow ground, and canal banks. The majority of sheep are native in Bangladesh, with very few being crossed, and they may give birth to many lambs

twice a year (Bhuiyan, 2006). According to Rashid et al. (2013), native lambs are thought to be tolerant to high ambient temperatures in tropical environments. The Jamuna River of Bangladesh provides a large supply of lamb from the basin. Jamuna basin lambs are known for their petite bodies (18.25 kg for males and 15.22 kg for females). Its body is covered in creamy white wool, with less wool in the legs and belly and black wool on the head and belly (Hashem et al., 2020). This species is present in all livestock production systems and has a wide range of climate adaptations (Berihulay, 2019). In many affluent nations, lamb farming has a substantial impact on economic development. Lower birth weight, average daily gain (ADG), slaughter weight, and the profitability of sheep husbandry in Bangladesh are all correlated with the limitations of inadequate and low-quality diets (Alemu, 2008; Hossain et al., 1997). The sheep's ability to reproduce and be productive will be adversely affected by the rise in body temperature, which is linked to a significant decrease in feed intake, a redistribution of blood flow, and modifications in endocrine functioning (Alam et al., 2013). In tropical and subtropical regions, sheep productivity is mostly limited by high ambient temperature and humidity (Marai et al., 2001; Hashem et al., 2013; Hossain et al., 2021). About 32% of Bangladesh's 2.7 million sheep are raised in three natural zones: the Jamuna basin, the Barind tract, and the coastal belt regions (Rashid et al., 2023). It's interesting to note that Asia is home to the majority of the world's sheep populations (64.43%) and 25.32% of all sheep breeds (Hossain et al., 2018a). Even if there are enough of these sheep, they don't perform well at all. One of the main things restricting Bangladesh's lamb output is nutrition. Roughages make up over 90% of the diet that ruminants eat, as is known. Because sheep can adapt to severe environments, the majority of them are readily maintained in rural areas. However, inadequate management and feeding techniques can only partially meet the animals' urgent demand for protein (Hashem et al., 2020; Sarder et al., 2022). In terms of litter size, Hassan and Talukder (2011) found that the breeding performance of sheep from the Jamuna basin was superior to that of sheep from the Coastal and Barind. Ahmed et al. (2018) examined the daily gain, growth performance, and potential for lamb production in three native sheep species from the region and discovered that coastal sheep had more potential. Islam et al. (2018a) found notable variances in lamb production and provided an explanation of the reproductive and productive capabilities of indigenous sheep from twelve Upazilas. Compared to goats, sheep are more resistant to viral and parasitic illnesses, and they require less care when raised on natural grass (Ahmed et al., 2018). Sheep have an impact on the production of livestock and revenue. However, low genetic values prevent a farmer with a large sheep herd from being productive. Reduced growth rate and subpar reproductive outcomes are the outcomes of this production strategy, which leads to

significant financial losses. In Bangladesh, sheep are raised only for their meat, which is often killed and consumed by humans. In Bangladesh, 7.17% of all livestock are comprised of sheep and goats (Rashid et al., 2023). Over 98% of the output of goats and sheep is raised by rural residents. In Bangladesh, over 70% of the rural population works in agriculture either directly or indirectly, with 85% of them being landless farmers with little to no land used for their homestead (Rashid et al., 2023). There is a great chance for the growth of the sheep-producing community in Bangladesh's rural areas due to the country's rising need for lambs and the availability of appropriate land in Bangladesh. Making wise business decisions from the very beginning of the planning process all the way through to the marketing and sale of the lambs, wool, or milk products is essential for success in the sheep sector. Establishing a sheep farm requires a substantial financial commitment, just like starting any other type of farm, whether it's a stand-alone venture or a way to expand an already-existing farm. It may be highlighted to use sheep and other uncommon species as meat producers. Currently, sheep farming is receiving a lot of attention from the Department of Livestock Services (DLS), and farmers are eager to start growing sheep in order to produce enough lamb to meet Bangladesh's current meat needs. Energy and protein content in food have a significant impact on how much meat goats and sheep produce (Sultana et al., 2010). Sheep productivity benefits greatly from good management and nutrition (Sarker et al., 2017a; Sun et al., 2020; Hossain et al., 2018b). However, depending on the breed, age, and length of stay of the animal upon entering the feedlot, as well as other parameters, sheep's growth performance, yield, carcass quality, and non-carcass components under feedlot circumstances may vary (Moniruzzaman et al., 2002). In adult sheep, higher concentrations of concentrate feeding resulted in higher carcass fatness, which enhances softness because intramuscular lipids are present (Nishimura, 2010). Majdoub et al. (2013) state that there is a strong correlation between carcass yield, carcass quality, and fat deposition and nutritional levels, particularly concentrate feeding. Because of the grazing system, green grass has natural antioxidants that can help prevent meat from oxidizing too much (Wood et al., 2004). Lambs from the Jamuna basin was marketed for slaughter at 9–12 months of age, weighing around 15–18 kg, after achieving an ADG of 46–55g during the active growth period (Hashem et al., 2020). A different approach to solving the feeding issue would be to create a system where sheep are finished on high-energy supplemental foods prior to lambs being sold. According to Zervas and Tsiplakou (2011), lambs given concentrate had superior carcass shape, greater growth rates, and lower final pH, while lambs fed pasture had slimmer carcasses and a lower dressing percentage.

2.3. Feeding status of sheep in Bangladesh

According to Devendra and Burns (1983), sheep production in Bangladesh is well-known for its early maturity, high prolificacy, exquisite meat, exceptional skin quality, remarkable disease resistance, and broad range of acceptability despite unfavorable agroclimatic conditions. Increasing the output of sheep is a feasible idea due to their higher reproductive efficiency, improved ability to survive on a strict diet, and reduced danger of mortality. To be more precise, the species' obliquity may be attributed to a combination of factors such as a relatively short breeding cycle, superior reproductive efficiency, quick growth rate, effective heat balance mechanism, crucial water turnover rate, simple behavioral pattern, and anatomical traits (Salem & Smith, 2008). One of the main obstacles to the large-scale production of sheep is its poor calorie intake (McGregor, 1984). Because of careless breeding, inadequate quality feed, and improper management techniques, sheep genetic potential in our country is declining. Sheep production is extremely low in many tropical nations, which has been linked to disease limits, genotypes related to diet, and management techniques. The majority of farmers in Bangladesh raise sheep using both the traditional method of grazing without any supplements and tethering. Low reproductive success and decreased development are the results of this production strategy. Research from a variety of authors has shown that grazing may not be enough to maximize sheep live weight increase and reproductive efficiency. Thus, production levels may be raised at the lowest possible cost if scavenger raising methods can be enhanced with a minimal amount of concentrate as an extra nutritional energy source. For general sheep improvement, not much effort has been done. In order to forecast the impact of dietary energy supplementation on feed intake, growth, and reproductive efficiency of female sheep under grazing conditions, the current study was conducted.

2.4. Features of native sheep hybridized with Garole

In Bangladesh, sheep make up the third largest group of ruminant animals and are mostly raised for their meat. It is predicted that there are 3.22 million sheep in the nation (BLRI, 2018). A significant proportion of them are unremarkable native varieties with little hybrids, exhibiting comparatively higher resistance to parasite infections (Bhuiyan, 2006). According to Pervage et al. (2009), indigenous sheep are fairly concentrated in a few agro-ecological zones, including coastal regions, barind tracts, north-eastern wetlands, Sundarbans-delta regions, and Jamuna River basin areas. They are sparsely spread across the country. According to Hassan and Talukder (2011), sheep may give birth to many lambs twice a year and are well-suited to hot and humid agro-climatic conditions. According to Banerjee et al. (2011), they can effectively consume low-quality roughages and can also make use of crop stubbles, tree toppings, farm

waste, small vegetation in harvested fields or fallow lands, roadsides grasses, canal side grasses, and even aquatic weeds and grass in knee-deep water for grazing. This makes them great for habitats that are swampy or coastal. Other than the unremarkable native population, the districts bordering Bangladesh's Sunderban delta area and the state of West Bengal are home to the well-known sheep breed known as the "Garole" (Singh and Bohra 1996; Sharma et al., 1999; Sahana et al., 2001). Because of great prolificacy in sheep, Garole is thought to be a reservoir for the Booroola gene (FecBgene) (Ghalsasi and Nimbkar, 1993). CSIRO Booroola Merino was created by introducing the prolificacy traits to Australian Merinos in the early 1900s in an effort to increase the number of births (Fogarty, 2009). The rural people in Bangladesh's southwest area who live along the coast understand the value of Garole sheep for their livelihood. Since they were raised by rural people using traditional husbandry methods, indigenous sheep in Bangladesh actually receive less care than other animals. Little thought has been given to improving this priceless germplasm up to this point, and it continues to be ignored. The indigenous nondescript sheep found in Bangladesh are an important source of genetic variation, particularly because of their ability to maintain consistent production in rural areas despite climatic change and their contribution to total genetic diversity. The Department of Livestock Services (DLS) and the Bangladesh Livestock Research Institute (BLRI) have recently introduced a community-managed sheep breeding programme in order to promote the genetic diversity of sheep in some areas of Bangladesh with potential (Bhuiyan et al., 2017). To determine the current sheep production methods and their genetic potential, data was gathered as the first stage of the aforementioned breeding programme. Investigating the morphology, morphometric traits, productive capacity, and reproductive potential of Bangladesh's native sheep was the purpose of this study.

2.5. Litter size of indigenous sheep in Bangladesh

The three sites did not significantly differ in litter size, while the Jamuna area had more litter (Hassan and Talukder, 2011). According to research done in 2002 by Nimbkar et al., the average litter size of Garole x Deccani sheep was 1.6. Romney marsh ewes' litter sizes varied according to year and age, according to Bhuiyan and Curran (1991). Rahman and Huq (1976) discovered that 48% of Native ewes had single births and 52% had multiple births. At 40% single, 53% twins, 5% triplets, and 1.7% quadruplets, Sharma et al. (1999) reported that the average litter size of Garole was 1.7. However, Banerjee, (2015) reported that the litter size in Garole was 1.7 and that the percentages of singles, twins, triplets, and quadruplets were, respectively, 42, 43, 15, and 0.2. While Singh and Bohra (1996) discovered that the litter size at first lambing in Garole was 2 and at successive lambing was 2.3, Pan et al. (2004) reported

that the average frequency of lambing was between 1.6 and 1.9. According to Hossain et al., (2023a), native Bengal Garole litter sizes averaged 1.9. Numerous reports on the Garole sheep are accessible from various locations over the globe. The average litter size of Garole sheep was determined to be 2.27 by Ghalsasi and Nimbkar (1993) with 7.3% single, 64.45% twins, 21.8% triplet, and 5.45% quadruplet; however, Ghalsasi et al. (1994) found the average litter size to be 2.23 with 9% single, 65% twins, 21% triplet, and 5% quadruplet. The litter size in Garole was 1.74, according to Bose et al. (1999), with singles, twins, triplets, and quadruplets accounting for 41.63, 43.35, 14.81, and 0.21% of the total, respectively. Pan et al. (2004) reported that the average lambing frequency was between 1.63 to 1.94, with singles accounting for 24%, twins for 66.4%, triplets for 11.55, and quadruplets for 0.2%. In Garole, the average litter size was recorded by Singh and Bohra (1996) as 2, and it increased to 2-3 in consecutive lambings. The incidence of single births was recorded as 25–30%, twin births as 55.66%, triplet births as 15-20%, and quadruplet births as 1%. In the Deccan plateau of Maharashtra, Nimbkar et al. (1998) discovered that the average litter size was 2.03 ± 0.9 and that the percentages of singles were 35, twins 57, triplets 7, and quadruplets 1. Banerjee, (2008) conducted a survey in the native tract of Bengal Garole and found that the litter size was 1.86, with singles accounting for 23.9%, twins for 67.22%, triplets for 83.1%, and quadruplets for 0.57%. We could soon lose these unique, exceptional genetic resources entirely since all of these sheep are geographically separated in their natural regions, along various rivers and seas. The study conducted by Sarder et al. (2015) yielded an overall result of 1.85 ± 0.01 , while Held et al. (1997) reported nearly identical findings of 1.74.

Norduz ewes produced 1.09 ± 0.43 lambs per mated, according to Demirel et al. (2004). The first cross between the D'Man and the Queue Fine de l'Ouest pure breed produced litter sizes of 1.26 ± 0.44 and 1.07 ± 0.26 , respectively, according to Lassouedinst and Rekik (2001). The following variables, such as breed generation, parity, age, body weight, improved environmental and nutritional circumstances, sample size, and management techniques, may cause variations in litter size.

2.6. Weight of native lamb at birth, weaning, and maturity in Bangladesh

Sarder et al. (2015) stated that the average weight of lambs at birth was 0.96 ± 0.23 kg, whereas Musa et al. (2005) reported to be 2.90 ± 0.50 kg. Similar to the study of Hashem et al., (2020), Musa et al. (2005) discovered that the weaning process lasted around three months. There have been notable variations noted for sex in terms of birth weight and weaning duration, which are influenced by genetic, physiological, litter size, ewe weight at parturition, and environmental variables (Berruecos, 1975; Hossain et al., 2023a). The average birth weight and number of

lambs per parturition under enhanced production methods, according to Combellas, (1980), were 2.6 kg and 1.3, respectively. According to Hashem et al. (2020), the average birth weight and weaning weight of male and female Jamuna basin lambs were 1.47 and 1.45 kg, respectively. Male Jamuna basin lambs had slightly higher mean birth weights than females, and as a result, males had higher mean body weights for the duration of the trial, up to 12 months. The average lamb birth weight, weaning weight, and mature weight in Rajshahi and Mymensingh regions were 1.7 kg, 8.9 kg, and 19.4 kg, respectively (Al Mansur et al., 2018a). Researchers discovered that lamb birth weights ranged from 1.2 kg (Husain and Amin, 2003) to 1.00 and 1.33 kg in the supplemented and controls groups (Zohara et al., 2014). Weaning weights of other breeds (Awgichew, 2000; Tibbo, 2006) were heavier than the mean weaning weight of native lambs as reported by Al Mansur et al. (2018b). They discovered that sheep from Rajshahi had mature body weights that were substantially ($p < 0.001$) greater (24.9 ± 7.3 kg) than those from Mymensingh (19.4 ± 2.7 kg). Breed effects may be to blame for this greater mature body weight. The average matured body weight of male and female sheep in the Jamuna basin, Barind, and Coastal belt was determined by Asaduzzaman et al. (2022) to be 17.84, 14.62; 16.85, 15.95, and 19.19, 16.16 kg, respectively. The average birth weight and weaning weight of Bengal sheep raised under semi-intensive and intensive methods, respectively, were 1.56 & 1.60 and 7.3 & 7.7 kg, according to Sultana et al. (2011). According to Murshed et al. (2014), native sheep and black Bengal goats had average adult body weights of 19.35 kg and 19.03 kg, respectively. The sheep's starting and ending body weights were 12.3 ± 0.60 and 12.5 ± 0.57 kg, 12.33 ± 0.33 and 12.83 ± 0.33 , and 12.66 ± 0.88 and 13.0 ± 0.57 kg for the sheep exposed to heat for four and eight hours, respectively (Rana et al., 2014).

2.7. Average daily gain (ADG) of indigenous sheep

For the winter and summer seasons, the ADGs were 183.33 & 170.00 and 50.30 & 48.27 g day⁻¹, respectively, for one month and twelve months. The 3-month (98.44 and 72.33), 9-month (54.59 and 51.78), and 12-month (50 and 48.27) g day⁻¹ effects on ADG were significantly ($p < 0.05$) dependent on the season (winter and summer). The average daily growth (ADG) for a single, twin, and triplet at the same age was 131.00, 108.67 & 107.67, 76.44, 70.56 & 68.33, 56.33, 52.22 & 53.44, 54.59, 55.22 & 46.85 g d⁻¹, respectively. During the first month of life, the impact of litter size on ADG was shown to be significant ($p < 0.001$). At 6 and 12 months of age, litter size also significantly ($p < 0.05$) affected ADG (Hashem et al. 2020). According to Hossain et al. (2021), the average daily growth (ADG) of lamb from the Jamuna basin was 57.39, 59.80, and 58.15 g day⁻¹ at 6, 9, and 12 months of age, respectively. These results were non-significantly ($p > 0.001$) varied. The ADG of the lamb from the Jamuna basin for stall

feeding and grazing was reported by Hossain et al. (2022b) to be 61.61 and 53.79 kg. According to Chellapandian and Balachandran (2003), the ADG was 35 g for the lone grazing group and 79 g for the concentrate supplementation group. According to Yeaman et al. (2013), in an intensive feeding scheme, the ADG for Dorper lambs was 340 g, whereas for Rambouillet lambs it was 346 g. Black Bengal (BB) goats supplemented with 300 g UMB after 6 hours of grazing showed significantly decreased ADG, according to research by Kawsar et al. (2006) and Sarkar et al. (2008). When BB goats were fed in stalls as opposed to grazing systems, Moniruzzaman et al. (2002) discovered a greater ADG. Huq et al. (1996) discovered that, in addition to pasture grazing, the ADG of BB goats was 52 and 47 g with supplements of 120 g fish meal and UMB, respectively. Male lambs at different ages had higher body weight and ADG than female lambs. Compared to Jamuna and Barind sheep, Coastal sheep had a considerably ($p < 0.01$) greater ADG and overall live weight growth (Ahmed et al., 2018).

The ADG of the Jamuna basin for Barind and Coastal lamb was found by Mobin et al. (2022) to be 59.07, 53.15, and 61.17 kg, respectively. Hossain et al. (2022a) observed that the ADG of lamb from the Coastal Belt was higher at 64.88 g day^{-1} as compared to lamb from the Jamuna basin at 61.02 g/d and lamb from the Barind area at 38.47 g day^{-1} . Hossain et al. (2022a) reported that the ADG of uncastrated lambs was substantially ($p < 0.05$) greater than that of castrated lambs. Sultana et al. (2010) discovered the same pattern. The results of the study by Fogarty and Mulholland (2012) were closely supported by the greater ADG for uncastrated lambs as opposed to castrated lambs. Male sex hormones like testosterone are to blame for the ADG increases in uncastrated lambs (Kiyama et al., 2000). These hormones cause a decrease in muscle fat deposition and an increase in dietary nitrogen utilization efficiency. Average 1.5% supplementation of lamb from the Jamuna basin resulted in a higher ADG (58.85 g day^{-1}) than the 2% supplementation (55.69 g day^{-1}) reported by Hossain et al. (2023b).

2.8. Production of milk and wool

The differences in lamb wool (Targhee and Dorset) and hair (St. Croix) as well as the impact of heat stress on food and water intake, digestive system performance, and nitrogen balance were demonstrated by Horton and Rodriguez (1997). They came to the conclusion that hair sheep were more heat-tolerant than wool sheep because they ate more feed, put on more weight, and had better digestibility in hot environments. In sheep chosen for differing staple strengths, they saw the notable impact of cortisol acetate on wool quality. The association between OFDA curvature and staple crimp/wave frequency was examined by Smuts et al. (2001) in regard to sheep breed and mohair style. According to their summary, the OFDA curvature may be used to calculate the frequency of mohair waves and the crimp of wool staples without taking into

account the breed of sheep or the characteristics of the mohair. The conditioning certificate, which signifies release from quality control via several gradation testing processes, is issued in accordance with the wool grading and marketing rules. When evaluating attributes like length, fineness, color, and appearance that affect the final usage and value of wool, Kott (1980) discussed a variety of techniques, including the American system, the English or Spinning count system, and the Micron system. He also talked about the distribution of fiber diameter and fineness, which are the most crucial quality variables for grading. Whether or whether wool is utilized for a blanket, jumper or garment depends heavily on fairness. All aspects of wool development, structure, production, characteristics, grading, and processing were covered in depth by Choudhary et al. (2019). In a research, Banerjee (2015) examined the wool characteristics of Garole sheep and discovered that their fleece was incredibly coarse, hairy, and not particularly dense. According to Bose and Maitra (1999), each Garole sheep produced 152 g of greasy fleece on average per year. According to Sharma et al. (1999), the average yearly adult wool output per Garole sheep that was purchased from the Sundarbans region was 179 g. For the rough carpet, this wool was utilized. The average wool production per shearing from each Garole sheep, which had rough carpet type wool, was 150 g, according to Singh and Bohra's (1996) study on wool parameters. According to Raghuvansi et al. (2007), each sheep produced about 300 g of wool on average per year. Even though each Garole sheep could produce around 400 g of oily fleece per year, Pan et al. (2004) demonstrated that shearing was not a popular practice. Compared to Barind and Jamuna regions, the average wool output per cutting and yearly wool production of native sheep were substantially ($p < 0.05$) greater in the coastal districts.

Summer output of wool outpaced winter production. As a result, the wool output and body weight of the coastal sheep were higher. In India, Khan et al. (2003) discovered that Tirahi breed sheep produced more wool annually—1.3 kg—than local sheep. Sheep that were indigenous produced relatively little milk. The Jamuna basin sheep produced between 250 and 270 g of milk per day. The average milk output in the intensive system was 264.5 g day⁻¹, which was not statistically significantly ($p > 0.05$) greater than the semi-intensive feeding system's 281.0 g day⁻¹, as reported by Sultana et al. (2011).

2.9. Mortality and illness of indigenous sheep in Bangladesh

Sheep farms are highly vulnerable to infections caused by bacteria, viruses, and internal parasites. Native sheep are less prolific and have a higher worm infection rate, which has a negative impact on output in the nation's main agriculturally based enterprises. Anemia is caused by some blood sucking parasites and blood protozoa. The sheep husbandry is harmed

by some viral illnesses as PPR, FMD, sheep pox, etc. and bacterial infections like foot rot 4, infectious pododermatitis, or Gid (*Multiceps multiceps*). Anthelmintic or medication resistance has become a concern recently, leading to the development of sustainable Integrated Pest Management (IPM) worm control concepts and/or host genetic resistance against some bacteria or viruses. No trematode infection was found in Garole sheep, and the percentage of infection in the gastrointestinal system was around 54.6%. Abortion, recurrent breeding, and placenta retention were the next most common causes of post-gestational death, with rates of 7.82, 9.35, 2.62, and 14.08%, respectively (Pan et al., 2004).

Lambs sired by G and B rams were more resistant to naturally acquired worm infections and to artificial challenges from *Haemonchus contortus* than those sired by D rams, according to research done by Nimbkar et al. (2000) on the growth performance and worm resistance of lambs produced by diallel crossing of three Indian sheep breeds: Deccani (D), Bannur (B), and Garole (G). When it came to growth and birth weight, the lambs produced by D and B rams outgrew those sired by G rams up to the age of six months. Native sheep had an average lamb mortality rate of 12.4% from July to October, 17.6% from November to February, and 12.5% from March to May (Hassan and Talukder, 2011). According to research by Nimbkar et al. (2002), the average lamb mortality rate among Indian Garole sheep was 13.8%. According to Hassan and Talukder (2011), the most prevalent illnesses were skin conditions, respiratory disorders, bloat, diarrhea, and lice. Pneumonia and diarrhea were the most prevalent issues across all age groups from newborn to adolescence. Compared to Barind and Jamuna regions, the Coastal region had a greater frequency of parasite infection in adult sheep. Coastal areas had the greatest rate of alopecia (14.2%), but conjunctivitis was more prevalent in Barind areas (7.5%). All locations have comparable rates of other illnesses. According to Hoque and Mollah (1972), local sheep frequently have lice infestations. Average 58% of sheep had lice infestation, 18% had filthy fleece, 12% had mange and mycotic dermatitis, and 11% had various skin conditions, according to Nooruddin et al. (1988). Peste des petits ruminants did not harm sheep. Lambs were predominantly afflicted by the illnesses, which mostly happened during the wet season. Both the common liver fluke and the roundworm *Haemonchus contortus* are far more deadly to Garole sheep (Nimbkar et al., 2002). According to Hossain et al. (2023a), Garole sheep have immunity against bacterial and viral infections, liver flukes, and internal parasites. In a commercial sheep operation, the quantity of lambs born per ewe was undoubtedly a crucial economic characteristic. Understanding the causes and timing of lamb mortality may help to maintain a low mortality rate. Hashem et al. (2020) reported that the death rates were 11.11%. Native sheep had an average lamb mortality rate of 12.4%, according to Hassan and Talukder

(2011). Average 13.8% of Indian Garole sheep died, according to Nimbkar et al. (2002). Weaning shock in lambs caused a considerably high mortality rate after three months of age as compared to other times (Hashem et al., 2020). Reducing mortality may be aided by improved management techniques prior to lambing and during the four months while lambs are under care. It was anticipated that the combination of poor native pasture quality and weaning stress would slow the growth rate of lambs with lower weights. During this time, mismarriage, low birth weight, ewe age, immunity from colostrums, malnourishment, weakened resistance, and illness were all contributing factors to the increased mortality rate. Because of improved management, a lack of green grass, and geographic position, the mortality rate was greater in hilly areas than in char areas. The extreme drought that has left the research locations low on feed may be the cause of the seasonal variations in death. Due to inadequate care and insufficient mother's milk, triplet mortality was greater than that of single and twin lambing. The outcome of Mustafa et al. (2014) was in agreement with this result. The mortality rate of the fifteen-group flock was greater than that of the five and ten group flocks because of inadequate floor space, poor management, and inadequate feeding. Average 23% of all deaths occurred during the newborn stage. According to Nowak and Poindron (2006), the day of birth accounts for about half of all pre-weaning mortalities, making the neonatal period the most hazardous in a lamb's life. The reasons of newborn mortality were infections, pneumonia, and inadequate care of the ewes. According to Hasan and Talukder (2011), the fatality rate from pneumonia and diarrhea in sheep from the Jamuna basin was 15.4% and 23 respectively. Determining the reasons of mortality in lambs becomes more challenging in the absence of a complete necropsy. Modest adjustments to lambing management might significantly lower the rate of lamb mortality. Undoubtedly, the most common causes of mortality are metabolic illnesses and disorders. Diarrhea disease had a higher death rate. According to Mustafa et al. (2014), the two main illnesses that killed lambs the most were pneumonia and gastroenteritis. The risk of lamb death is reduced when pregnant ewes are fed properly. Inadequate or incorrect handling of ewes and lambs was the cause of more than 3-4% of all deaths. Hashem et al. (2020) suggested that there would be a significant decrease in the number of deaths if basic management practices were used for the flock before to, during, and following lambing. They also stated that if the lamb is healthy, it does not require any medication; there was almost no miraculous medication for a weak lamb, and none at all for a dead one. It is ideal for lamb mortality to be reduced to a level that is acceptable for sheep producers, which is between 4 and 5% (Hashem et al., 2020).

2.10. The scope of sheep farming in Bangladesh

Since they may be used to reduce poverty, empower women, and provide jobs, small ruminants like goats and sheep are crucial to Bangladesh's rural economy (Islam et al., 2016). In Bangladesh, local sheep play a significant role in the production of meat among small ruminants. Originating from the wild Urial (*Ovis orientalis vignei*) of Asia, the native sheep of Bangladesh are known as *Ovis aries* (Statistics, 1999). There are 3.46 million sheep live in Bangladesh (Al Mansur et al., 2018b). Although some are crossbred, the majority of sheep in Barind, the Jamuna valley, and coastal areas are raised by their native people and are capable of multiple births and twice-yearly lambing (Statistics, 1999). Sheep from coastal regions have greater potential than sheep from other regions for the production of commercial lamb. Native sheep are a significant source of revenue that require little upkeep, care, or investment (Ahmed et al., 2018). Mostly fed on naturally occurring grasses, sheep also thrive on a variety of agricultural leftovers, including straws, stovers, stalks, and cereal byproducts (Sarker et al., 2017b). But the majority of the feed that sheep eats is roughages, and their traditional feeding methods account for over 90% of their diet (Sultana et al., 2017). The sheep are raised on roadsides, canal banks, and fallow areas. Additionally, sheep in rural regions perform poorly in terms of development and reproduction since they feed solely on grass and aquatic weeds without any supplements (Hossain et al., 2018b). Additionally, a large amount of money is lost since rural poor farmers raise the majority of native sheep without using better economic traits or management techniques (Alam, 2014). Local sheep breeds are integral to rural communities' social and economic structures, and understanding rearing management is crucial to the survival of the economy and environment (Tempelman & Cardellino, 2007). Native sheep are important to the economy since they are mostly raised by small and marginal farmers. Raising native sheep in the altered climate will thereby address the future economic growth and sustainability of rural poor, particularly rural women.

2.11. Bangladeshi sheep farmers' employment situation

Figure displays the occupational status of farmers across all research areas. According to the report, agriculture accounted for the majority of sheep rearing farmers' occupations (65.16%). Nonetheless, it was discovered that the primary occupations in the research regions were housewife (3.11%), day laborer (5.26%), company (16.12%), and service provider (2.60%). Similar to the current survey, the prior study found that 77% of farmers worked primarily in agriculture, with business coming in second at 15% (Islam et al., 2018b).

Employment Situation

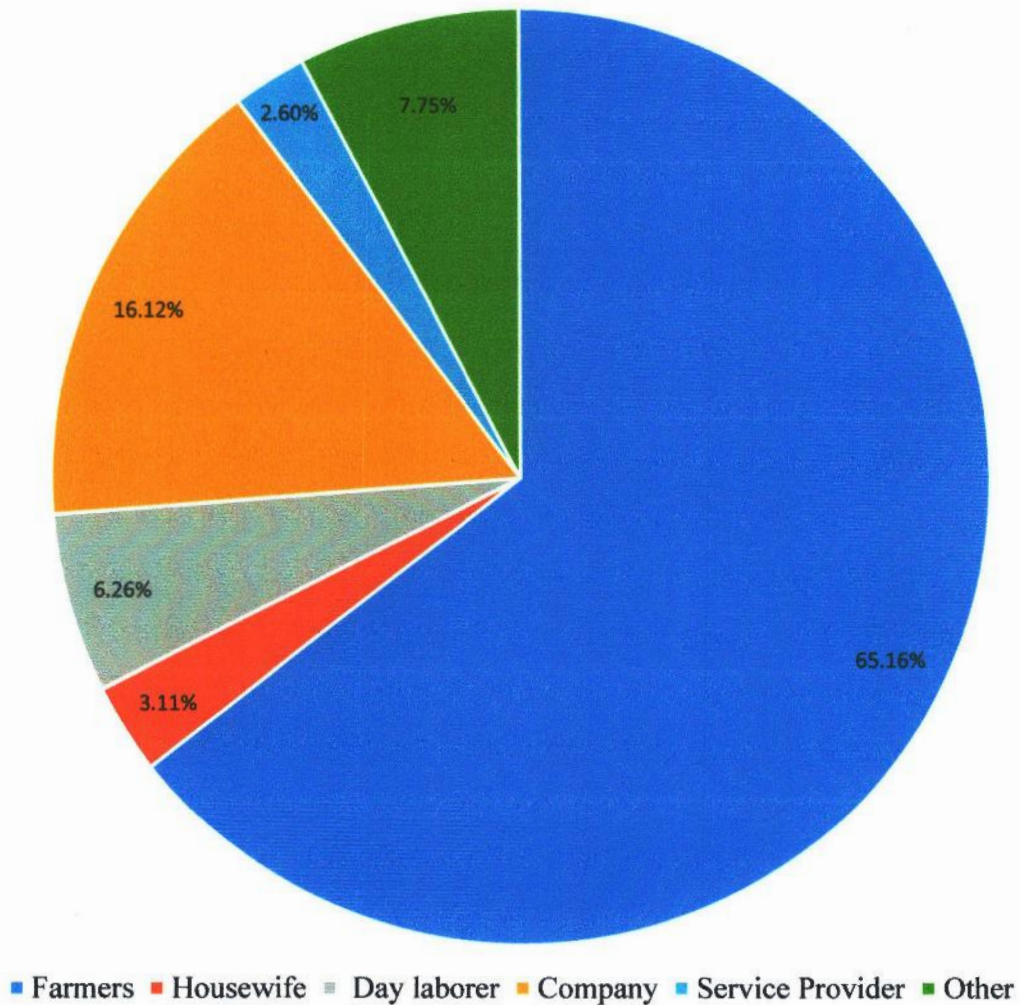


Figure 2.1: Bangladeshi sheep farmers' employment situation (Source: Islam et al., 2018b).

2.12. Limitations of sheep rearing

The difficulty and limitations encountered in raising sheep in the research locations were questioned of the farmers who raise sheep. The farmer shown in figure encountered numerous issues and limitations. A scarcity of natural feeding land was reported by the greatest percentage of farmers (43.15%), followed by issues relating to illness and treatment (41.00%) (Amin et al., 2020). Previous research has shown that the primary issues with sheep production are that local sheep are typically grown on natural feed sources and that there are insufficient and low-quality feed resources (Salma et al., 2015). Yet, it was discovered that one of the biggest obstacles to raising sheep was a lack of funding (23.30%). Furthermore, farmers encountered issues at the field level with regard to high feed costs, marketing challenges, better breed and training facilities, sheep theft, lack of excellent quality rams, dog bites, low sheep prices, and foul-smelling sheep, among other things.

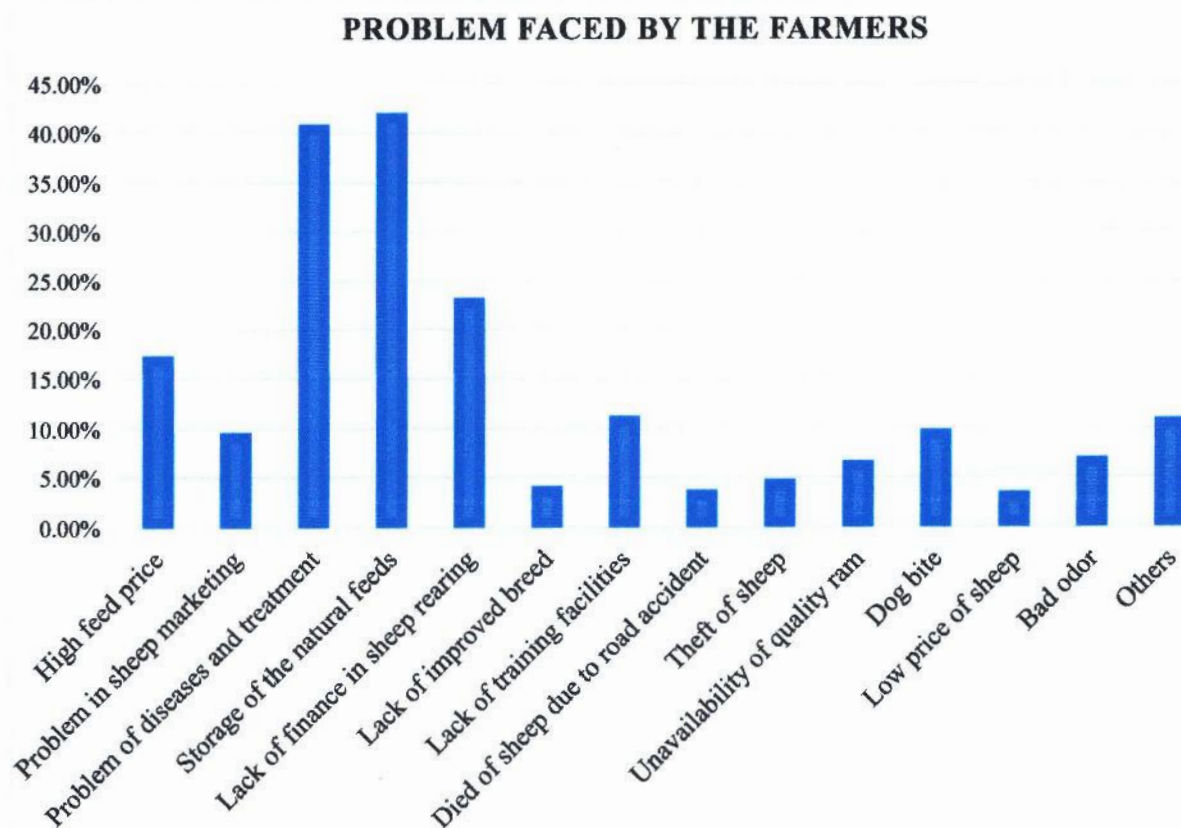


Figure 2.2: Problem faced by the sheep farmers in Bangladesh (Source: Amin et al., 2020).

2.13. Role of urea in ruminant feeding

One nitrogen molecule that is not a protein is urea. To put it another way, rumen microorganisms use the nitrogen in urea as a building block to produce microbial body protein. Nitrogen is found in most urea at a rate of 46% and in protein at 16%. Urea has a crude protein equivalent value of around 281% when it is transformed into protein. Vitamins, minerals, or energy are among the other beneficial feed ingredients that are absent from urea. By producing ammonia and carbon dioxide, cattle and other ruminants transform urea into protein. After being liberated from urea, ammonia is either detoxified and eliminated in the urine or it is utilized to produce microbial protein. Fermentation experiments with ruminants have made considerable use of urea. It is rapidly degraded in the rumen when administered in this manner to ruminants, and the ammonia that is produced is not effectively used for the production of microbial proteins. According to reports (Deyoe et al., 1968; Chopra et al., 1974; Gupta et al., 1988), different complexes of urea can be released more slowly when combined with starch, molasses, or as ammoniated agricultural wastes. But to sustain optimal ruminal activity, ruminants must have an appropriate quantity of minerals, energy, and nitrogen in their food. Animals fed diets low in nitrogen have higher production without sufficient ATP formation

due to energy uncoupling, in addition to a drop in voluntary intake. It has been required to sustain optimal microbial activity in rumen to provide a steady and uninterrupted supply of both nitrogen and energy. The use of urea to substitute protein in part for ruminant meals was discovered by German scientists (Zuntz, 1891). It is widely recognized that urea may be used by ruminal microorganisms as an unconventional source of non-protein nitrogen. The forms of urea that have been fed to cows and buffaloes in India include urea-treated straw (Bakshi et al., 1986), urea molasses liquid supplement (Kaur & Kakkar, 1995) and uromol (Chopra et al., 1974).

2.14. Molasses as a source of energy

Sugars make up 60–65% of the solids in sugarcane molasses, molasses is known for having a high sugar content. Protein that can be metabolized by the dairy animals and rumen degradable protein might be better supplied if the rate of carbohydrate fermentation is increased. According to Stokes et al. (1991), there is proof *in vitro* that the fermentation of carbohydrates increases the net output of ruminal microbial protein. Starch did not ferment in the rumen as quickly as sugars did (Chamberlain et al., 1993). Comparatively to the organisms that ferment starches in high moisture maize, those that ferment soluble sugars may give around 18% more microbial protein. It is feasible to feed dairy cows' molasses, either in liquid or dry form, as a source of dietary sugars (Hall, 2002).

2.15. Effect of urea molasses mineral block on dry matter intake and digestibility of ruminants

According to Tiwari et al. (1990), block feeding of buffaloes on a diet based on straw resulted in a notable increase in DM consumption. Growing calves on wheat bhoosa alone, with a meagre amount of low-quality concentrate, is the prevalent method in rural developing nations. This approach is not productive. It was shown that adding UMMB and fish meal to wheat straw improved its feeding value (Tiwari et al., 1990). The animals in the group treated with UMMB *ad libitum* and fish meal at 100g day⁻¹ were likewise shown to be superior converters of wheat straw into biomass in terms of nutrient digestibility and utilization. For calves to maintain a decent development rate, this diet can be economically supplemented with 100 gm fish meal and UMMB.

2.16. Effect of urea molasses mineral block on growth of livestock

There have been several findings indicating that feeding animals' urea molasses has improved their development and productivity. According to Ram & Gupta (1988), buffalo calves given block together with ammoniated paddy straw or untreated straw developed early age at maturity, but their daily weight increase was not significant. Additionally, the cost per kilogram

growth varied greatly amongst the calves. Study carried out on mature mixed-breed cattle (Toppo et al., 1997) revealed that adding concentrate to a diet based on straw to provide 50% of energy requirement enhanced UMMB intake and nutrient utilization.

2.17. Effect of urea molasses mineral block on milk yield and its composition of ruminant

Drought and flooding are frequent occurrences in nations such as India and Bangladesh, which means that cattle suffer from a severe lack of feed and fodder, negatively impacting animal development and productivity. In an experiment done recently in the Jaipur area, Tanwar et al. (2013) evaluated the impact of UMMB on sixty breastfeeding buffaloes that were chosen from four villages, fifteen from each. In comparison to pre-treatment, they saw a daily rise in the total milk output of 1.02 lit (13.21%) as observed. Daily net profit from the sale of excess milk was Rs. 13.75, and the average amount of urea molasses mineral block used by each buffalo was 375 grammes. As a result, feeding nursing buffaloes with UMMB licks enhanced their milk output and revenue. The UMMB supplemented group showed a considerably higher milk output and butter fat % compared to the un-supplemented group, according to Tekeba et al. (2012). Similarly, Mandal et al. (2001) found a favourable correlation between the amount of milk output and the gradually increasing UMMB consumption. It was also revealed that over the 140-day study period, the milk output was 49.76% greater in the UMMB supplementation group compared to the control group.

2.18. Effect of urea molasses mineral block on control of parasitism

Investigations were conducted on the effects of feeding UMMB on the growth and intestinal nematode parasitism of weaner goats that were grazing the same pasture. As per Waruiru et al. (2004), these findings suggested that UMMB had significant impacts on the parasitism of GI nematodes and promoted the development of kids. By contrasting the live weight gains of supplemented and un-supplemented heifers grazing the same pasture, the impact of feeding medicated UMMB (in-corporate with Fenbendazole) on the growth of dairy heifers in a marginal area of central Kenya was evaluated.

2.19. The reaction of rumen microbes to UMMB supplementation

When compared to control groups, UMMB supplementation significantly increased the viable bacterial count by UMMB in buffalo calves (Singh et al., 2013). When compared to the control group, the buffalo calves in the supplemented group exhibited a significant ($p < 0.05$) increase in protozoal count (Rao & Singh, 2016). According to a citation by Suharyono et al. (2014), the microbial protein synthesis in the rumen fluids (mg/l/hour) rose by 205.67% in buffaloes. Comparable increases in microbial protein production were found in the rumen fluids of 67.56% of dairy goats from Etawa and 37.99% of beef cattle per hour.

2.20. Effects of UMMB on daily intake and live weight gain of sheep

A daily consumption of 220-230 g in sheep grazing on natural pastures supplemented with multi-nutrient blocks has been reported in Saskatchewan (Mengistu & Hassen, 2017). Sheep that were allowed to graze in China shown notable productivity; the animals given a multi-nutrient block supplemented with urea molasses gained much more weight than the control group (Liu et al., 2007). According to Salman's (1996) study from Iraq, providing multi-nutrient blocks to Awassi ewe while they grazed enhanced their weight increase in comparison to the control group, and no weight loss was detected. Comparable patterns were also seen in the on-farm trial, where ewes supplemented with multi-nutrient blocks acquired more live weight than the non-supplemented group following rainy season feeding on grasslands. A higher supply of energy and amino acids at the tissue level may also be the cause of the supplemented groups' positive live weight, as this leads to the hormone adjustments required for better development. The effects of adding multi-nutrient blocks to Yankasa sheep in the Guinea Savanna Region of Nigeria during the wet season were examined. The live weight changes for the three groups were 0.19 kg day⁻¹ for the multi-nutrient block without molasses, 0.21 kg/day for the multi-nutrient block with molasses, and 0.11 kg day⁻¹ for the control. All of the groups differed significantly ($P < 0.01$). Non-supplementation did not result in any weight loss (Mubi et al., 2011). The significant quantity of nutrients in the grazed pasture during the rainy season may be the cause of this. The multi-nutrient blocks supplemented groups showed higher live weight gains. This could be attributed to the supply of degradable nitrogen from these blocks, which improved the growth of rumen microorganisms and increased the animal's intake of microbial protein. The multi-nutrient block supplementation's optimal nutrition supply might be another likely explanation. According to Muralidharan et al. (2015), supplementing with UMMB had a positive effect on the blood biochemical parameters (total protein levels, serum albumin levels, calcium values, and serum phosphorus levels) in the off-season Mecheri lambs. It was advised to give the lambs some kind of protein and mineral supplementation in the summer.

2.21. The effect of UMMB feeding on digestibility and dry matter intake in dairy cattle

The digestibility of fibrous feed and the rate at which it fragments into particles small enough to pass through the reticulo-omasal aperture are the primary factors limiting its dry matter intake (DMI). One of the best ways to boost crop waste utilization is to supplement energy and nitrogen (N) in the form of urea molasses mineral blocks (Brar & Nanda, 2003). During rumen fermentation, fibrous foods can be broken down into smaller particles, which enhances flow and digestion. In other studies, UMMB supplementation resulted in a 30-to 50% rise in straw

DML.

2.22. Effect of UMMB feeding on fertility and reproduction of ruminant animals

For dairy farming to be lucrative, reproduction must be done effectively. Crossbred dairy cows, however, have longer inter-calving intervals due to delayed postpartum ovarian activity and a high frequency of profound anestrus, particularly during dry seasons. Forty percent of the Indian buffaloes exhibited behavioral oestrous activity when administered urea molasses multi-nutrient block, while just ten percent of the control group did so (Salman, 1996). Three-quarters of the cross-bred cows and seventy-five percent of the supplemented Fogera cows showed behavioral oestrous behavior after applying urea molasses multi-nutrient block supplementation. By comparison, just 13% of the crossbred cows and 25% of the unsupplemented Fogera cows gave birth. Fogera animals did not seem to have profited as much from UMMB supplementation as crossbred cows did, according to Tekeba et al. (2014). In a number of nations, molasses was added to livestock feed in the form of Urea Molasses Multi-Nutrient Blocks (UMMB) in order to address the nutritional problem. For both native and crossbred dairy cows, numerous studies have demonstrated positive benefits on reproductive and productive performance together with an enticing benefit-cost ratio (Misra et al., 2006). According to Upreti et al. (2010), the body condition score of crossbred dairy cows increased from 3.5 to 4 when they were administered UMMB supplements during the dry season.

Table 2.2. The effect of UMMB on the fertility of crossbred dairy cattle (Source Hermosillo, 2014).

Fertility measurements	Before UMMB		After UMMB	
	N	Mean $\pm$ SEM.	N	Mean $\pm$ SEM.
Interval from calving to first service (days)	64	77.54 ^a $\pm$ 5.20	60	65.91 ^b $\pm$ 3.53
Interval from calving to conception (days)	64	127.21 ^c $\pm$ 11.30	60	92.35 ^d $\pm$ 6.65
Interval of calving (days)	64	405.40 ^e $\pm$ 11.34	60	365.06 ^f $\pm$ 5.33

P<0.01 indicates significant differences in the means of consecutive separate letters.

The average number of days between calving and conception reduced ($P < 0.01$) from 127.2 to 92.4 days as a result of a significant decline in services per conception. The intervals between calving to first service and calving 77.54 to 65.9 and 405.4 to 365.1 days, respectively, were

similarly shortened by using UMMB (Hermosillo, 2014). Documentation by Miah et al. (2000), showed how UMMB supplementation affected the pre- and postpartum weights of calves. The UMMB group's supplementation was significantly ($P < 0.05$) greater at 14.61 kg compared to the control group's 12 kg. Compared to the non-supplemented cows (56g d^{-1}), the UMMB-supplemented cows had a substantial effect on the calves' live weight increase (117g d^{-1}). There were no deaths throughout the research period, however there was a 9.0% death rate in the control group.

2.23. Live weight, nutritional intake, and digestibility of goats supplemented with UMMB

In developing countries, the ability of producing goat meat is limited by many nutritional and environmental limits. A vast variety of wild plant species are available to goats who are permitted to browse freely. A decrease in pasture quality and availability in the winter and dry seasons has an impact on nutritional intake. When goats are fed high-fiber, low-protein forages that are enriched with protein and minerals, improvements in intake and performance are usually seen. Goats fed low-quality fodder may become even more nutrient-deficient; nevertheless, goats can improve rumen fermentation by consuming homemade multi-nutrient blocks comprised of urea and molasses (Kawas et al., 2010). Every day, the Dry Matter Intake (DMI) of the goats assigned to the various treatment groups was noted. In the order of 1.499 ± 0.128 kg, 1.395 ± 0.129 kg, and 1.502 ± 0.121 kg, the goats' daily mean DMIs were recorded in the UMMB, MUMB, and control groups. Research by Faftine & Zanetti (2010) in Mozambique found that goat consumption of maize was considerably ($p < 0.05$) boosted by the multi-nutrient block. This was seen by contrasting the UMMB and MMB supplemented groups' mean daily DMI with that of the control group (Abid et al., 2016). According to a study by Faftine and Zanetti (2010) on goat performance in Mozambique, the multi-nutrient block enhanced corn eating significantly ($p < 0.05$) in Mozambique because it offered additional nutrients.

Table 2.3. The effects on the goats' daily total nutrient intake (g animal⁻¹) of feeding a multi-nutrient block made from maize stover with or without urea molasses (Faftine & Zanetti, 2010).

Parameter	Maize stover	Maize stover with urea molasses multi-nutrient Block
Maize stover	279 ^a	340 ^b
UMMB	-	180 ^b
CP	12.5 ^a	67.8 ^b
NDF	184 ^a	293 ^b
OM	220 ^a	369 ^b
ADF	126 ^a	208 ^b
Hemicelluloses	57.5 ^a	83.1 ^b
Total intake of dry matter	279 ^a	520 ^b

Significant differences ($p < 0.05$) are seen between the ^{ab} means of the same row when superscripts differ.

Due to the rumen's enhanced rate of digesta transit and higher capacity to break down dry stover due to the increased activity of cellulolytic rumen bacteria, the increased intake of maize stover in the multi-nutrient block diet is most likely the result of these two factors. According to Faftine & Zanetti (2010), the apparent digestibility coefficients (%) of all meal components with a multi-nutrient block were greater. Average 78% of the total CP consumed by the supplemented animal can be attributed to its high apparent digestibility of CP. Urea provides a high amount of nitrogen, which is nearly entirely hydrolyzed in the rumen to become ammonia, which is used by microorganisms for the synthesis of microbial protein.

2.24. Effect of multi-nutrient block on live-weight variation of goats

In a study by Abid et al. (2016) the weight growth of the goats was noted every week. In the control, UMMB, and MUMB groups, the mean daily weight gained (MDWG) was 64 ± 23 , 71 ± 22 , and 85 ± 21 g, respectively. Comparing the experiment group to the control group, the average weight gained was greater ($p < 0.05$) (Abid et al., 2016). In comparison to the diet comprising just of maize Stover (- 7.99 g) the diet with multi-nutrient block had an average daily weight increase of 9.17 g that was considerably larger ($p < 0.05$) (Faftine and Zanetti,

2010). The non-supplemented group's liveweight loss suggests that the nutrients provided by maize stover are insufficient for the goats' ongoing needs. Impact of diet on the mother goat at various stages of pregnancy compared to expectant mothers who had not fed the supplement, it was observed that birth weight was greater in the parent group that received feed supplements throughout pregnancy UMMB stem from age 1 to 3 months (early pregnancy) and 3 to 5 months (late pregnancy), as well as during pregnancy 1 to 5 months. UMMB 1 to 5 months of pregnancy and the end of the highest birth weight (2.293 kg) and then early pregnancy (2.286 kg) based on the findings of studies in which the pregnant mother feeding without supplements only 2,017 kg in the two types of goats (Muralidharan et al., 2015).

Table 2.4. Impact of a multi-nutrient block on the variance in live weight of goats fed maize stover with & without multi-nutrient block (Faftine & Zanetti, 2010).

Parameter	Maize stover	Maize stover with multi nutrient block
Initial live-weight, kg	11.2 ^a	11.1 ^b
Final live-weight, kg	9.55 ^a	12.6 ^b
Total live-weight change kg	-1.44 ^a	1.65 ^b
Average daily gain, g/d	-7.99 ^a	9.17 ^b

Significant differences ($p < 0.05$) exist between ^{ab}means in the same row with different superscripts.

2.25. The main ingredients in the blocks' diet and qualities of each ingredient

In diets based on low-quality agricultural residues, which make up the majority of the dry matter (DM) that ruminants consume in field settings, the multi-nutrient block made of urea molasses (UMMB) is an excellent source of nutrients, protein, and energy that can be used to improve the efficiency of nutrient utilization (Mubi et al., 2011). Makkar, (2007) states that it is extremely promising to build multi-nutrient blocks that do not compete with human meals and are based on affordable, easily obtainable feed materials. According to (Mengistu & Hassen, 2017), the components and ratios used in the creation of multi-nutrient blocks determine their acceptability and ingestion by ruminants. Urea molasses blocks can be made from a wide variety of materials. The selection process will consider a number of aspects, including cost, availability, handling convenience, nutritional content, and impact on block quality. Urea, molasses, offal from abattoirs, beetroot pulp, citrous pulp, tomato pulp, cassava waste, groundnut shells that have been ground, brewer's grain, bagasse, poultry manure and waste, and oilseed meals and cakes (soybean, coconut, groundnut, cottonseed, and olive) are among the ingredients that can be used (Mengistu & Hassen, 2017).

2.26. Making procedure of multi-nutrient blocks with urea molasses

The urea molasses multi-nutrient block (UMMB) is manufactured in accordance with the guidelines provided by Jayawickrama et al. (2013). The five meticulous stages that went into making Urea Molasse Multi-Nutrient Block (UMMB) were selecting and prepping feed components, mixing ingredients, molding the mixture, slicing or rotating the block, and drying the blocks. Following their weighing, the feed components were mixed using a formula that met the nutritional requirements of animals, as recommended by the National Research Council (1985). Urea, soybean, cement, minerals, molasses, and maize bran were among its constituents. The mixture was poured into a mold to take on the required shape after it had acquired a consistent consistency. The board was taken out the day after molding to hasten the drying process. A flat spade was then used to finish the cutting. All you had to do was turn the containers over and tap the bottom to release the blocks. The molds were taken out and separated, and the blocks were put on a wooden shelf in the drying chamber. It remained for 15 hours to harden (Garg et al., 1998). The blocks were stored in a well-ventilated room and away from direct sunlight.

2.27. Difficulties with UMMB supplementation

If a block is too soft, it could be devoured quickly, and if it is too hard, it might not be consumed at all. This means that the degree of hardness may determine the voluntary intake of the block (Kunju, 1986). According to Leng and Preston (1983), the animals' nutritional state and the composition of the block, particularly the amount of urea, had an impact on intake. Just 40% of the animals had begun licking the block at the first opportunity, according to reports by Leng (1984) and Tiwari et al. (1990). There's not a lot of information available in the literature on different cattle species' block intake. Maximum block consumption in buffaloes was to be 1 kilogram, however in Jersey bulls, it was 0.53 kg (Leng, 1984). Crossbred cattle did not experience any negative effects from 0.3 to 0.5 kg of intake (Toppo et al., 1997).

2.28. Chemical analyses of urea molasses multi-nutrient block

The Bangladesh Agricultural University in Mymensingh's animal nutrition lab routinely examined the UMMB to determine their chemical composition (Islam et al., 2022). The AOAC (Horwitz & Latimer, 1975) was used to estimate crude protein (CP). The proportion of CP in the sample was then estimated by multiplying the percentage of nitrogen content by 6.25. As for UMMB's chemical makeup, it was DM 81.57%, CP 18.75%, CF 3%, EE 2.2%, NFE 41% and Ash 16.62% (Islam et al., 2022).

Chapter III

Materials and Methods

All of the materials utilized to perform the study and the processes carried out, are thoroughly explained in the materials and methods section. The content in each subsection of a research paper should be presented logically as research writing should be structured and systematic. The most crucial technique should come first in each area of the materials and methods, then the least crucial. To make the materials and methods section comprehensible, each subsection uses headings and subheadings.

3.1. Study area

This study was conducted at Khulna University in Khulna, Bangladesh, under the auspices of the Field Laboratory of Agrotechnology Discipline. It is located in Gollamari, Khulna, Bangladesh, close to the Moyur River and the Sher-e-Bangla Road. The research area is in Horintana Thana. This area is located inside the Agro Ecological Zone (AEZ) of the Ganges Tidal Flood Plain, according to Rahaman et al. (2019). Positions of the research facilities are N 22.80° and E 89.53° latitude and longitude.



Figure 3.1: Study area

3.2. Experimental animals and their management

Twelve sheep in all, ranging in age from one year to one year and six months. Every animal had a unique number attached to it for identification purposes. The sheep used in the studies were kept in cages with consistent lighting and ventilation during UMMB licking.

3.3. Experimental design

The feeding trial and data collection were continued between September 19, 2023, to March 20, 2024, and utilized in this study. Twelve sheep in all, nine of which were female and three of which were male. Every experimental animal was weighed individually. Based on their initial live weight, four groups of experimental sheep were created. As a replication, three experimental animals were included in each treatment group. While one treatment group of sheep (T_0) stuck to their traditional feeding schedule, such as grazing for ten hours without receiving urea molasses multi-nutrient blocks (UMMB), the other three treatment groups of sheep T_1 , T_2 & T_3 received urea molasses multi-nutrient blocks at three different time durations—1 hour, 1.5 hours and 2 hours respectively. Randomized Complete Block Design (RCBD) was the basis for the experimental design. Throughout the feeding experiment, the following traits of the sheep were observed: Bodyweight (kg sheep^{-1}), Growth Rate (g day^{-1}) & Survivability Rate (%).

3.4. Housing of the experimental sheep

Sheep were traditionally kept in houses for a number of purposes, including as providing an additional urea molasses multi-nutrient block and shielding the animal from predators and adverse weather. All facilities were available in the house.



Photograph 3.1: Sheep house

3.4.1. Floor of shed

For two thirds time of the experiment, the sheep were kept on a slate floor made of bamboo; for the remaining one third time, they were relocated to a well-built building house with a slate floor made of timber. The subsequent concrete constructing house was well-facilitated, which is essential for preserving the sheep's optimal health.



Photograph 3.2: Slat floor of sheep shed

3.4.2. Feeding pan

Each group of animals was kept in a separate feeding pen to minimize the spread of infectious diseases and the loss of the urea molasses multi-nutrient block.



Photograph 3.3: Feeding pan

3.4.3. Water facilities

In their shed, the sheep had access to enough fresh water. Additionally, every animal group had a separate waterer in their enclosure.



Photograph 3.4: Waterer for sheep

3.4.4. Ventilation

There were sufficient ventilation systems maintained in the sheep shed.

3.5. Sanitation

Every day, the entire shed, including the feeders and waterers, was cleaned in accordance with the daily schedule, and an effort was made to maintain the living area dry. Proper housing and sanitation protocols were implemented to avert diseases, bugs, and parasites.

3.6. Deworming and vaccination of experimental sheep

The process of deworming involves getting rid of the hook, round, and tape worms that frequently infest animal bodies. An injection of A-Mectin Plus (an anti-helminthic) was used to deworm the animals. These deworming was given to the sheep both immediately in the experiment period and again after three months. The vaccinations were administered via the recommended route and dosage. The experimental animals' vaccination and deworming schedule is listed below.

Table 3.1. Vaccination and deworming schedule for experimental sheep

Date	Name of vaccine/deworming	Dose per sheep	Route
01.09.23	A-Mectin Plus	0.5cc	Sub-cutaneous
15.09.23	Peste des petits ruminants (PPR)	1.0 cc	Sub-cutaneous
01.12.23	A-Mectin Plus	0.5cc	Sub-cutaneous



Photograph 3.5: Vaccine and medicinal instruments

3.7. Grazing of experimental sheep

Grazing is the process of permitting animals to intake grass and other wild vegetation. The sheep employed in the experiment were allowed to graze for ten hours during the day on natural ground grass area next to the Agrotechnology Discipline field laboratory and alongside the roads on the campus of Khulna University. At night they were shut up in the shed. Daily grazing hours for the experimental sheep were 9.00 am to 7.00 pm.



Photograph 3.6: Grazing of sheep

3.8. Composition of urea molasses multi-nutrient block

Table 3.2. Ingredient composition of UMMB

Sl. No.	Ingredients	Percent (%)
01.	Molasses	40.0
02.	Rice polish	23.0
03.	Urea	10.0
04.	Mineral mixture	2.0
05.	Lime	15.0
06.	Salt	10.0



(Source: Jayawickrama et al., 2013)

3.9. Procedure of making 10 kg urea molasses multi-nutrient block (UMMB)

In accordance with Jayawickrama et al. (2013), urea molasses multi-nutrient block (UMMB) was made. The following ingredients, in the amounts of 2.3, 4.0, 1.0, 0.2, 1.0, and 1.5 kg for rice polish, molasses, urea, mineral mixture, salt, and lime, were used to prepare 10.0 kg of UMMB. The molasses, urea and salt were mixed well. The mixture then refrigerated for overnight. The mixture was then re-mixed by hand after 12 hours. Then rice polish, mineral mixture & lime that were previously kept into another bowl were added with the above mixture & mixed well. The mixture was then put into a wooden disc and pressure was applied by a wooden cover to give the block its shape. The block was then be removed from the disc and placed on a polyethylene sheet where it was remained for 15 hours to be harden (Garg et al., 1998).



Photograph 3.7: UMMB preparation



Photograph 3.8: UMMB preparation



Photograph 3.9: UMMB preparation



Photograph 3.10: UMMB preparation



Photograph 3.11: UMMB preparation



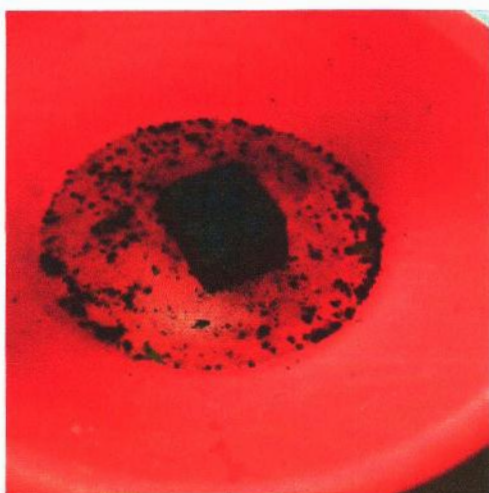
Photograph 3.12: UMMB

3.10. Adaptation of animals

Urea molasses multi-nutrient blocks were gradually adapted over a minimum of 7 days by feeding regularly, rather than being given in full every day as soon as the feeding period began. Because the animals' intake might be higher than usual, this is especially crucial if the animals have experienced any underfeeding. Urea poisoning is particularly common in animals that are not used to urea and that also feed quickly. Animal intakes is reverted to approximately those previously advised ($70\text{--}100\text{ g day}^{-1}$) following the adaptation phase. Putting a time restriction on how long an animal might access the blocks was a simple method of limiting intake during the adaption phase. Generally, I offered them for 20 minutes a day for the first three days, and then for 30 minutes a day for the next four days. Blocks were then available for use on the basis of the experimental design.

3.11. Urea molasses multi-nutrient block supplementation

Urea molasses multi-nutrient block was allocated for sheep under three treatment groups T_1 , T_2 & T_3 for three different periods- 1 hour, 1.5 hours and 2 hours respectively. Allocated urea molasses multi-nutrient block was given to them in the morning every day. One group licked the urea molasses multi-nutrient block from 7.00 am to 8.00 am, another one group licked the urea molasses multi-nutrient block from 7.00 am to 8.30 am and another one group was allowed to lick ate urea molasses multi-nutrient block from 7.00 am to 9.00 am in separate chamber. Then they were allowed for grazing.



Photograph 3.13: Prepared UMMB



Photograph 3.14: UMMB licking



Photograph 3.15: UMMB licking in one group

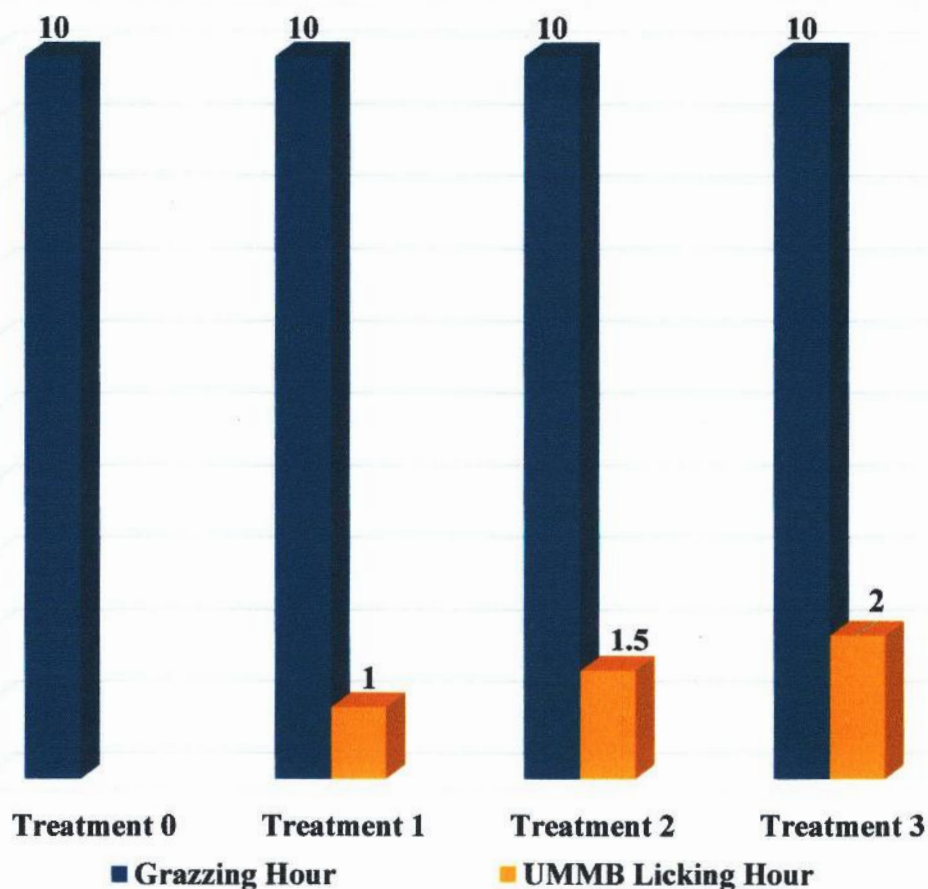


Figure 3.2: Grazing and UMMB licking periods

3.12. Precautions of UMMB licking

1. Animals under six months of age should not be fed UMMB.
2. Aim to avoid consuming excessive amounts of UMMB. Clean drinking water for animals has long been a need. To prevent it from becoming softer, the block has to be shielded from precipitation.
3. Feeding UMMB on its own is not a good idea; the animals require a minimum amount of roughage to prevent urea poisoning from excessive urea consumption.
4. The best location for UMMB storage is somewhere dry and rodent-proof.
5. Preventing the animal from getting wet and providing UMMB in a dry manger. It might become mushy when wet, making swallowing easier.
6. Along with maintenance, it enhances the nutritional availability for ruminants and helps with some amount of output.

3.13. Proximate analysis

3.13.1. Sampling

Researcher take a preset number of observations from a wider population as part of the statistical analysis procedure known as sampling. Sampling was done to determine the proximate composition of urea molasses multi-nutrient block (UMMB).



Photograph (3.16, 3.17, 3.18): UMMB sample preparation for chemical analysis



Photograph 3.19: UMMB sample for proximate analysis



3.13.2. Dry matter

Test procedure

Envelopes were initially weighted (W1). Fresh weight (W2) of UMMB was measured and the envelope was filled with the sample and dried in an oven at 105°C for 24 hours. The dried sample with the envelope (W3) inside was then weighted.

Calculation

$$\text{Dry Matter (\%)} = \frac{W_3 - W_1}{W_2} \times 100$$

Where,

W_1 = Weight of envelope in gram

W_2 = Weight of fresh sample in gram

W_3 = Weight of envelope and dried sample in gram



Photograph 3.20: Dry matter determination using an oven

3.13.3. Crude protein analysis

Test procedures

Digestion

VELP SCIENTIFICA DK 8 Heating Digester was used to do the digestion process. A gram of the material was weighed with a precision of ± 0.1 mg. Twelve milliliters (98%) of H_2SO_4 and two catalysts were added to each sample before it was put in the digesting block. The sample was heated for 60 minutes at $420^\circ C$ to halt the fumes while the digesting block remained at that temperature. The sample was then cooled to between 50 and $60^\circ C$.

Distillation

The UDK 129 Distillation Unit VELP SCIENTIFICA was used to carry out the distillation process. The sample was cooled and then combined with 50 milliliters of distilled water. The mixture was added to 50 milliliters of NaOH. After that, the distillation chamber received the digestion flask. A conical flask was filled with a 30 ml solution of boric acid, and three drops of indicator were added. The water flow was adjusted earlier. Distillation was carried out up till the indicator combination solution's color did not change green.

Titration

The flask sample was then removed for titration. Next, a burette pipe was filled with 0.1% HCl and added drop by drop. The process was carried out repeatedly until the conical flask's solution's color changed from green to blue. The titration process was terminated when the color of the solution changed. Next, the titrates strength was noted.

Calculation

Nitrogen (%)

$$= \frac{(\text{ml HCl required for sample} - \text{ml HCl required for blank}) \times 14.007 \times 100}{\text{Wight of sample} \times 1000}$$

$$\text{CP\%} = \text{Nitrogen (\%)} \times 6.25$$



Photograph (3.21, 3.22): Determination of crude protein

3.13.4. Crude fibre analysis

Test procedures

An analysis of crude fiber was carried out utilizing the VELP SCIENTIFICA FIWE Raw Fiber Extractor. A one-gram sample was placed in crucibles that had the channels fixed. Three to five drops of n-octanol were added to 150 milliliters of 1.25% H_2SO_4 in the analyzer flask as an anti-foam agent. The fiber analyzer's switch was switched on. Boil for precisely thirty minutes. Filter the residual agent thirty minutes later. Wash the crucible three times, adding 30 ml of hot deionized water to the top each time, and using compressed air to mix the contents of the crucible. The last wash was drained, and 150 ml of 1.25% KOH and three to five drops of an anti-foam agent were added. Once more, after 30 minutes of boiling and three washings, the crucible was cooled with a final washing in cold deionized water. The crucible was then cleaned three times with 25 milliliters of acetone while being stirred with compressed air. Using 25 ml of acetone, the contents of the crucible were cleaned. Following that, the crucibles were dried in an oven at 105°C for an hour, and they were chilled in a desiccator to determine their

dry weight (F1). After cooling in a desiccator (F2), the crucibles were put into a muffle and heated to 550° C for three hours to reweight.

Calculation

$$\text{Crude Fibre (\%)} = \frac{F_1 - F_2}{F_0} \times 100$$

Where,

F₀ = Weight of sample in gram

F₁ = Weight of oven dried sample in gram

F₂ = Weight of ash containing crucible in gram



Photograph 3.23: Determination of crude fibre

3.13.5. Ether extract analysis

Test procedure

Ether extract analysis was conducted by using VELP SCIENTIFICASER 148 Solvent Extractor.

Sample: An extraction thimble containing 3 g of homogenized and pulverized material was weighed using digital weighing balance. Wet sample weight is equal to total weight - thimble weight.

Chemicals: Petroleum ether at 40–60° C with a maximum residue evaporation of 10 mg/l. After an hour at 125° C, the thimble was dried using sample drying.

Immersion: The glass crucible holding the dry hydrolyzed sample or the sample with a thimble were added to the extraction apparatus. 40 ml of petroleum ether was added to the extract collecting vessel after it had been weighed. Sample-filled thimble connected to the extraction unit via a thimble connector. The heating and cooling water flow began when the extraction

unit was closed. The glass crucibles or thimbles were placed in the "Immersion" position for 30 minutes after the solvent began to boil.

Washing: Thimbles or glass crucibles were put in the "Washing" position for 60 minutes following the 30-minute extraction period.

Recovery: Following washing, the submerged stopcock was closed, the condenser cooled, and the solvent in the extraction tank was entirely evaporated.

Weighing: After chilling in a desiccator, the extract-containing cups were weighed after being dried for 30 minutes at 125 degrees Celsius in the oven.

Calculation

$$\text{Ether Extract (\%)} = \frac{W_3 - W_2}{W_1} \times 100$$

Where,

W_1 = Weight of sample in gram

W_2 = Weight of empty vessel in gram

W_3 = Weight of vessel and ether extract in gram



Photograph 3.24: Determination of ether extract

3.13.6. Ash analysis

Test procedure

The crucibles were placed in a muffle furnace and heated to 600°C for half an hour. The crucible's weight was noted (W_1). A crucible that had been tarred was filled with a sample weighing around 3 g. The sample's weight was noted (W_2). For six hours, crucibles were kept in a muffle furnace at 600°C. The crucibles were placed in a desiccator with a vented lid after

being allowed to cool in a furnace to less than 20°C. The crucibles were weighed as soon as they were brought to room temperature in a desiccator, and the weight was noted (W3). A single decimal place was given for the estimated ash%.

Calculation

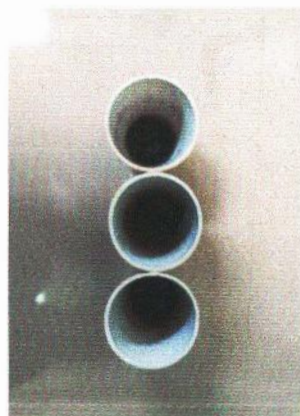
$$\text{Ash (\%)} = \frac{W_3 - W_1}{W_2} \times 100$$

Where,

W₁ = Weight of crucible in gram

W₂ = Weight of sample in gram

W₃ = Weight of crucible and ash in gram



Photograph (3.25, 3.26): Determination of ash through muffle furnace

3.14. Chemical composition of urea molasses multi-nutrient block

Table 3.3. Proximate composition (%) of urea molasses multi-nutrient block (UMMB) fed to experimental sheep

Proximate components	(Mean ± SEM) %
Dry matter (DM)	76.08 ± 0.57
Crude protein (CP)	17.90 ± 0.24
Crude fiber (CF)	7.46 ± 0.01
Ether extract (EE)	3.57 ± 0.31
Ash	26.84 ± 0.36
Nitrogen-free extract (NFE)	44.23 ± 0.51

3.15. Weight determination of experimental sheep

Each experimental animal was weighed separately. Sheep weights were taken and recorded every seven days using a digital scale with a 50 kg capacity. Body weight of sheep was taken in the morning before they were allowed to graze.

3.16. Record keeping of experimental sheep

Each animal was given a unique number that was used for identification. The following records were kept regularly.

- Body weight (kg)
- Growth rate (gm/day/head)
- Mortality %
- Litter size (number)
- Survivability (%) parameters were recorded in this experiment.

3.17. Data collection

All the relevant data like

- Body weight
- Mortality rate
- Growth rate
- Litter size
- Deworming, vaccination and medication were recorded in a register regularly.

Body weights were measured with digital weighing machine on an empty stomach in the morning in every seven days, four times a month. By deducting the prior weight from the current weight and dividing by the number of days, the growth rate (g day^{-1}) was determined.



Photograph 3.27: Body weight measurement of sheep

3.18. Data analysis

Data was recorded and analyzed using the R software in computer. Effects of urea molasses multi-nutrient block on the growth rate of sheep was tested by analysis of variance and DMRT was used to compare the treatment means, with significance level considered at $p < 0.05$. The growth performance of sheep was estimated on average daily gain. Data was edited using Excel 2019. Data were tabulated and analyzed with a descriptive statistical method by fulfilling the objectives of the study.

Chapter IV

Results and Discussion

4.1. Bodyweight of sheep (kg sheep⁻¹)

The average body weight of the crossbred sheep with varying licking periods of urea molasses multi-nutrient block (UMMB) at week intervals is shown in Table 4.1. The body weight grew as the UMMB licking period extended, according to the data, however there was no significant difference among the means ($p>0.05$). Sheep given a daily supplementation time of two hours with UMMB reported the highest numerical body weight in every instance. There was no discernible variation in the sheep's body weight since they were let to graze on UMMB supplements. Their grazing region had a lot of natural grasses, hence the different periods of UMMB supplementation did not significantly affect their body weight. According to Hatungimana & Ndolisha (2015), the initial body weight of P0 (control; sheep fed on grass only), P1 (sheep fed on grass with UMB containing 3.6% of urea), P2 (sheep fed on grass with UMB containing 4.8% of urea) and P3 (sheep fed on grass with UMB containing 7.2% of urea) were respectively 20.2^a kg, 20^a kg, 20^a kg and 20.1^a kg. Their final body weight was 22.4^a kg, 24.1^b kg, 24.4^b kg and 25.4^c kg respectively after 14 weeks of licking UMB supplementation in P0, P1, P2 and P3 groups. Here we can see that the body weights of sheep are gradually increasing as the portion of urea increases in UMB. In present research the initial body weight of T₀ (only 10 hours grazing without feeding of UMMB), T₁ (UMMB licking for 1 hour with 10 hours grazing), T₂ (UMMB licking for 1.5 hours with 10 hours grazing) and T₃ (UMMB licking for 2 hours with 10 hours grazing) was 13.48 ± 2.84 kg, 13.87 ± 1.78 kg, 13.67 ± 4.81 kg and 14.12 ± 3.40 kg respectively. Their final body weight was 17.37 ± 2.18 kg, 19.20 ± 2.46 kg, 21.13 ± 5.31 kg and 22.27 ± 2.58 kg respectively after 13 weeks of UMMB supplementation in T₀, T₁, T₂ and T₃ groups, respectively. Similar results were seen where, the body weights of sheep were gradually increasing as the time of UMMB licking period increased. According to Islam et al. (2022), in case of cattle, the body condition score of cows for control group was $2.30^a \pm 0.64$ and for the extra supplementation of solidified UMMB (250 g d⁻¹ cow⁻¹) with normal feeding like as control group was $2.51^b \pm 0.19$.

Table 4.1. Body weight (kg) of sheep licked UMMB at different time periods

Weight category	UMMB licking time (Kg, Mean $\pm$ SE)				Level of significance
	No UMMB	1-hour	1.5-hour	2-hour	
Initial body weight	13.48 $\pm$ 2.84	13.87 $\pm$ 1.78	13.67 $\pm$ 4.81	14.12 $\pm$ 3.40	NS
Weight at week 1	13.75 $\pm$ 2.73	14.27 $\pm$ 1.78	14.48 $\pm$ 4.82	14.78 $\pm$ 2.36	NS
Weight at week 2	14.07 $\pm$ 2.65	14.72 $\pm$ 1.88	14.88 $\pm$ 4.94	15.50 $\pm$ 3.30	NS
Weight at week 3	14.37 $\pm$ 2.55	15.17 $\pm$ 1.86	15.43 $\pm$ 4.94	16.13 $\pm$ 2.97	NS
Weight at week 4	14.70 $\pm$ 2.43	15.40 $\pm$ 1.85	15.83 $\pm$ 4.96	16.57 $\pm$ 3.18	NS
Weight at week 5	15.03 $\pm$ 2.37	15.77 $\pm$ 1.90	16.40 $\pm$ 5.11	17.20 $\pm$ 3.13	NS
Weight at week 6	15.32 $\pm$ 2.30	16.18 $\pm$ 1.78	17.03 $\pm$ 5.12	17.97 $\pm$ 3.09	NS
Weight at week 7	15.62 $\pm$ 2.27	16.57 $\pm$ 1.80	17.60 $\pm$ 5.15	18.67 $\pm$ 3.00	NS
Weight at week 8	15.93 $\pm$ 2.27	17.17 $\pm$ 2.41	18.20 $\pm$ 5.25	19.33 $\pm$ 2.89	NS
Weight at week 9	16.20 $\pm$ 2.29	17.57 $\pm$ 2.31	18.82 $\pm$ 5.21	19.90 $\pm$ 2.77	NS
Weight at week 10	16.42 $\pm$ 2.26	17.94 $\pm$ 2.47	19.40 $\pm$ 5.23	20.50 $\pm$ 2.69	NS
Weight at week 11	16.80 $\pm$ 2.19	18.38 $\pm$ 2.48	19.97 $\pm$ 5.26	21.03 $\pm$ 2.63	NS
Weight at week 12	17.08 $\pm$ 2.22	18.77 $\pm$ 2.46	20.50 $\pm$ 5.27	21.67 $\pm$ 2.58	NS
Weight at week 13	17.37 $\pm$ 2.18	19.20 $\pm$ 2.46	21.13 $\pm$ 5.31	22.27 $\pm$ 2.58	NS

UMMB = Urea molasses multi-nutrient block; NS = Not significant ($p>0.05$)

4.2. Growth rate of sheep (g day⁻¹)

The average growth rate of the crossbred native sheep under varying UMMB licking periods is shown in Table 4.2, which shows the data at weekly intervals. The average growth rate of sheep at their second, fifth, seventh, tenth, and thirteenth weeks varied significantly ($p < 0.05$) depending on the UMMB supplementation they received, as indicated by the data in the table. In the other case, there was no discernible difference among the means ($p > 0.05$). Furthermore, between UMMB supplementations, there were highly significant difference in average growth rates for sheep at their sixth, ninth, and twelfth weeks ($p < 0.01$). This suggests that supplementing sheep with UMMB for two hours is more successful in achieving a higher rate of growth. Numerically highest growth rate (g day⁻¹) at week 6, was observed for sheep licking 2 hours UMMB ($110.00^a \pm 22.45$) followed by 1.5 hours ($90.47^{ab} \pm 8.25$), 1 hour ($59.52^{bc} \pm 20.62$) and no UMMB group ($40.48^c \pm 10.91$); highest growth rate (g day⁻¹) at week 9, was observed for sheep licking 2 hours UMMB ($80.95^{ab} \pm 16.49$) followed by 1.5 hours ($88.10^a \pm 14.87$), 1 hour ($57.14^{bc} \pm 14.29$) and no UMMB group ($38.09^c \pm 4.13$); similarly highest growth rate (g day⁻¹) at week 12, was observed for sheep licking 2 hours UMMB ($90.48^a \pm 16.49$) followed by 1.5 hours ($76.19^{ab} \pm 8.24$), 1 hour ($54.76^{bc} \pm 14.87$) and no UMMB group ($40.48^c \pm 4.13$) and treatments were significantly varied ($p < 0.01$) in growth rate (g day⁻¹) at the mentioned week. The growth rate (g day⁻¹) at week 2 ranged from $45.24^b \pm 10.91$ to $102.86^a \pm 19.80$ with the highest in the 2 hours licking UMMB period group and the lowest in the UMMB non supplemented group, the growth rate (g day⁻¹) at week 5 ranged from $47.62^b \pm 8.24$ to $90.00^a \pm 17.32$ with the highest in the 2 hours licking UMMB period group and the lowest in the UMMB non supplemented group, the growth rate (g day⁻¹) at week 7 ranged from $42.86^c \pm 7.15$ to $100.00^a \pm 24.75$ with the highest in the 2 hours licking UMMB period group and the lowest in the UMMB non supplemented group, the growth rate (g day⁻¹) at week 10 ranged from $30.95^b \pm 4.12$ to $85.71^a \pm 24.75$ being highest in the 2 hours licking UMMB period group and the lowest in the UMMB non supplemented group, the growth rate (g day⁻¹) at week 13 ranged from $40.48^b \pm 10.91$ to $85.71^a \pm 0.00$ with the highest in the 2 hours licking UMMB period group and the lowest in the UMMB non supplemented group, and the mean differences were significant ($p < 0.05$). According to Hatungimana & Ndolisha (2015), the body weight gain (g day⁻¹) of P0 (sheep fed on grass only, control), P1 (sheep fed on grass with UMB containing 3.6% of urea), P2 (sheep fed on grass with UMB containing 4.8% of urea) and P3 (sheep fed on grass with UMB containing 7.2% of urea) were respectively 22.0^a, 40^b, 44.0^c and 54^d. It is clear from the findings of current experiment that the growth rate of sheep (g day⁻¹) was gradually increasing as the portion of urea increases in UMB. According to Islam et al. (2022),

in case of calf, the growth rate for control group was $(55 \pm 36) \text{ g day}^{-1}$ and for the extra supplementation of solidified UMMB with normal feeding like as control group was $(84 \pm 39) \text{ g day}^{-1}$. The effect of UMMB on sheep and calf were similar with the current experiment.

Table 4.2. Growth rate (g day^{-1}) of sheep licked UMMB at different time periods

Weight category	UMMB licking time (Mean $\pm$ SE)				Level of significance
	No UMMB	1-hour	1.5-hour	2-hour	
Growth rate at week 1	38.09 $\pm$ 16.49	57.14 $\pm$ 0.00	116.19 $\pm$ 61.03	93.81 $\pm$ 24.18	NS
Growth rate at week 2	45.24 ^b $\pm$ 10.91	64.28 ^b $\pm$ 25.75	56.67 ^b $\pm$ 17.63	102.86 ^a $\pm$ 19.80	*
Growth rate at week 3	42.86 $\pm$ 14.29	64.29 $\pm$ 7.15	79.52 $\pm$ 17.28	89.52 $\pm$ 46.54	NS
Growth rate at week 4	47.62 $\pm$ 21.82	33.33 $\pm$ 8.25	57.14 $\pm$ 44.61	62.86 $\pm$ 30.24	NS
Growth rate at week 5	47.62 ^b $\pm$ 8.24	52.38 ^b $\pm$ 8.24	80.95 ^a $\pm$ 21.82	90.00 ^a $\pm$ 17.32	*
Growth rate at week 6	40.48 ^c $\pm$ 10.91	59.52 ^{bc} $\pm$ 20.62	90.47 ^{ab} $\pm$ 8.25	110.00 ^a $\pm$ 22.45	**
Growth rate at week 7	42.86 ^b $\pm$ 7.15	54.76 ^{bc} $\pm$ 14.87	80.95 ^{ab} $\pm$ 21.82	100.00 ^a $\pm$ 24.75	*
Growth rate at week 8	45.24 $\pm$ 14.87	85.71 $\pm$ 98.98	85.71 $\pm$ 14.29	95.24 $\pm$ 16.50	NS
Growth rate at week 9	38.09 ^c $\pm$ 4.13	57.14 ^{bc} $\pm$ 14.29	88.10 ^a $\pm$ 14.87	80.95 ^{ab} $\pm$ 16.49	**
Growth rate at week 10	30.95 ^b $\pm$ 4.12	53.33 ^{ab} $\pm$ 23.10	83.33 ^a $\pm$ 10.91	85.71 ^a $\pm$ 24.75	*
Growth rate at week 11	54.76 $\pm$ 10.91	63.33 $\pm$ 44.18	80.95 $\pm$ 21.82	76.19 $\pm$ 8.24	NS
Growth rate at week 12	40.48 ^c $\pm$ 4.13	54.76 ^{bc} $\pm$ 14.87	76.19 ^{ab} $\pm$ 8.24	90.48 ^a $\pm$ 16.49	**
Growth rate at week 13	40.48 ^b $\pm$ 10.91	61.90 ^{ab} $\pm$ 8.25	90.48 ^a $\pm$ 29.74	85.71 ^a $\pm$ 0.00	*

UMMB = Urea molasses multi-nutrient block; NS = Not significant ($p > 0.05$); * = $p < 0.05$;

** $p < 0.01$

^{a,b,c} means with uncommon superscripts in a row differ significantly ($p < 0.05$)

Chapter V

Summary and Conclusion

5.1. Summary

Sheep farming is a growing trend in Bangladesh, providing surplus animal protein and contributing to the country's GDP. However, challenges exist in the sector, such as the lack of reliable facilities for producing animal feed and the deficiency of minerals, vitamins, and crude protein in the diets of sheep. The growth performance of native sheep and the opportunities associated with sheep farming in Bangladesh specially in southwest coastal regions are more challenging due to lack of qualitative fodders and grazing land.

Urea-molasse multi-nutrient blocks (UMMB) are a low-cost way to supplement the diet of small ruminants to get the better performance of animals. Developing country like as Bangladesh faces more challenge due to the lack of reliable, year-round, high-quality feed resource facilities for animal's growth and production. In there, livestock animals are fed fibrous diets that are deficient in minerals, vitamins, and crude protein, leading to decreased or nonexistent output of animal products. Rainfall intervals also affect the availability and quality of feed, causing animals to have phases of weight gain and weight loss.

Urea molasses multi-nutrient block (UMMB) contains urea, molasses, vitamins, minerals, and other multi-nutrients. It has been using in many countries to mitigate nutritional problems in animal feed, particularly for ruminant animals. The study was aimed to determine the impact of urea molasses multi-nutrient block (UMMB) supplementation on the growth performance of sheep and monitor the growth rate and weight gain of sheep fed urea molasses multi-nutrient block for different periods.

Twelve sheep consisting of 9 female and 3 male animals having the ages between 1.0 and 1.5 years were taken to conduct the feeding trial. Based on their original live weight, 12 animals were spitted in to four treatment groups considering 3 replications for each treatment. While one group of sheep was remained to their typical feeding schedule, such as grazing for ten hours without licking urea molasses multi-nutrient blocks, the other three groups of sheep received urea molasses multi-nutrient blocks at three different time periods—1 hour, 1.5 hours and 2 hours. The trial design was based on Randomized Complete Block Design (RCBD). Throughout the feeding experiment, the following traits of the sheep were observed: Survivability rate (%), Bodyweight (kg sheep⁻¹) and Growth rate (g day⁻¹).

The chemical composition of urea molasses multi-nutrient block was determined by Proximate analysis. The UMMB contained DM (76.08 ± 0.57) %, CP (17.90 ± 0.24) %, CF (7.46 ± 0.01) %, EE (3.57 ± 0.31) %, ash (26.84 ± 0.36) % and NFE (44.23 ± 0.51) %.

The results revealed that the body weight was increased as the UMMB licking period extended. The highest numerical body weight reported in sheep given a daily supplementation time of two hours with UMMB for most of the weight categories. The sheep's grazing region had a lot of natural grasses, so different periods of UMMB licking did not significantly affect their body weight. Their final body weight was 17.37 ± 2.18 kg, 19.20 ± 2.46 kg, 21.13 ± 5.31 kg and 22.27 ± 2.58 kg respectively after 13 weeks of licking UMMB supplementation in T₀, T₁, T₂ and T₃ groups, respectively.

The growth rate of sheep was varied significantly depending on the UMMB licking periods. The average growth rate of sheep at their second, fifth, seventh, tenth, and thirteenth weeks varied significantly ($p < 0.05$) depending on the UMMB supplementation they received. Growth rate (g day^{-1}) was observed licking UMMB at week 6, 2 hours ($110.00^a \pm 22.45$), at week 9, 1.5 hours ($88.10^a \pm 14.87$), at week 12, 2 hours ($90.48^a \pm 16.49$) and the means were significantly different ($p < 0.01$).

5.2. Conclusion

The findings showed that there were no substantial differences in body weight of crossbred sheep (kg sheep^{-1}) but body weight rose numerically as UMMB licking periods increased. There were significant differences in growth rate of crossbred sheep (g day^{-1}) at different urea molasses multi-nutrient block licking periods. The growth rate (g day^{-1}) of crossbred sheep increased as the urea molasses multi-nutrient block licking period increased. Within supplemented groups as well as between supplemented and non-supplemented groups, crossbred sheep mean differences varied significantly. This indicates that for crossbred sheep to promote optimal growth, a minimal urea molasses multi-nutrient block licking period, 2-hours per day is required.

5.3. Recommendations

1. Government should take proper step for increasing the growth performance of ruminant animals by using UMMB.
2. Farmers should be encouraged to use UMMB.
3. Farmers should be informed about its feeding regime.
4. Use of urea as an NPN source is allowed as long as a ready supply of energy is available, due to the ruminants' special capacity to microbially synthesize adequate protein for upkeep.

5. Urea molasses mix may supplement feed and improve roughage utilization is therefore now well established.
6. There are a few restrictions associated with using this kind of supplemental mix, particularly when using a liquid system.
7. Forming a controllable and acceptable block out of the liquid urea molasses mix without harming the animals is one such approach that could be able to get around some of the restrictions.
8. The cost and manageability of UMMB technology development is very low.
9. Providing additional nourishment to the village's livestock, who graze on straw and crop leftovers, is the main goal of these blocks.
10. It is important to take great care to ensure that these blocks are solely intended for licking purposes, since they will be useless if they are too soft.
11. Reduced likelihood of ammonia poisoning can be achieved by releasing the urea nitrogen more gradually and regularly.
12. Such a method can further make it easier to give other nutrients, such vitamins and minerals.
13. At the local level, UMMB improves agricultural produce returns by assisting in the fight against hunger and undernutrition of our animals.
14. Monogastric animals (chicken, donkeys, horses, pigs, and rabbits) should never be given UMMB; only ruminants (buffalo, cattle, goats, and sheep) should get this diet.

5.4. Further studies

1. The current study was conducted on the campus of Khulna University, not in the entire southwest coastal region. Additional studies can be carried out in Bangladesh's non-coastal and coastal areas.
2. More investigation is needed to determine how supplementing with urea molasses multi-nutrient block (UMMB) affects the growth and reproductive capabilities of sheep.



Chapter VI

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Appendix

Photographic presentation of the study



Photograph 1: Sheep house



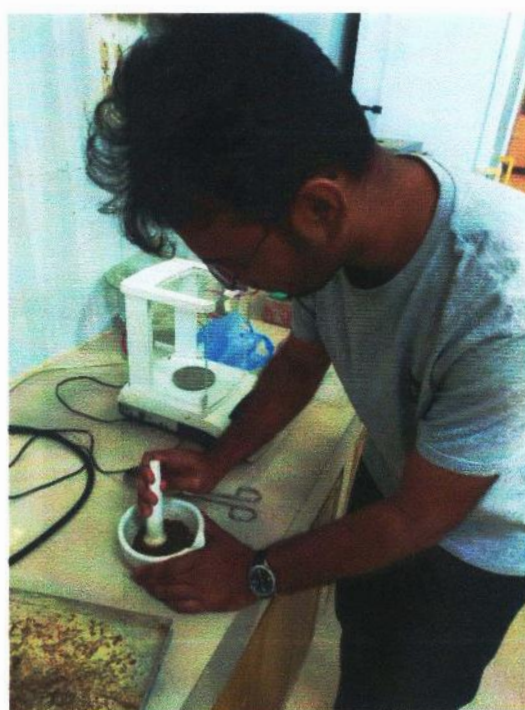
Photograph 2: Sheep house



Photograph 16: UMMB



Photograph 17: UMMB licking



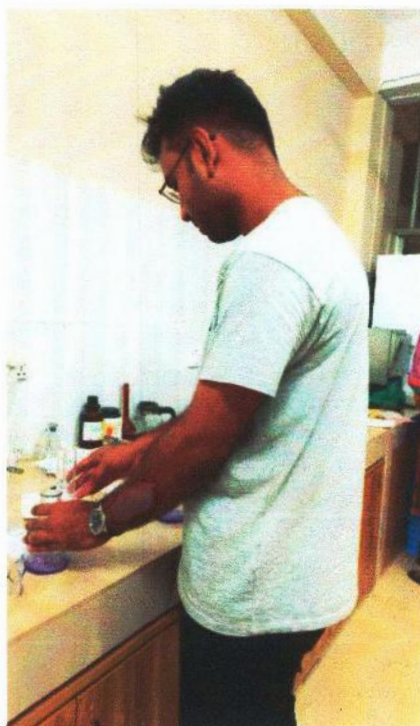
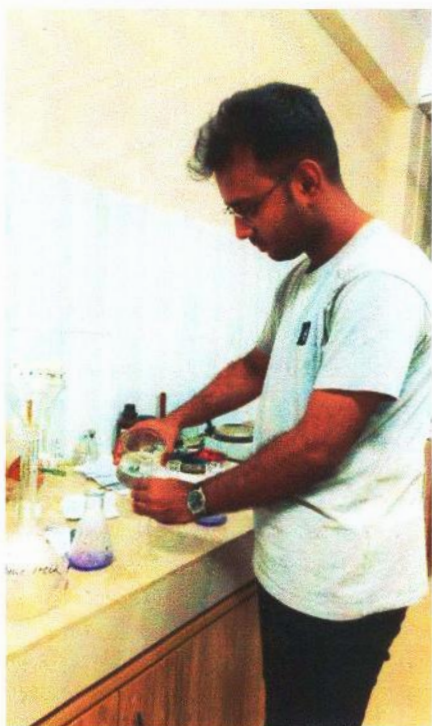
Photograph (24, 25): UMMB's sample preparation



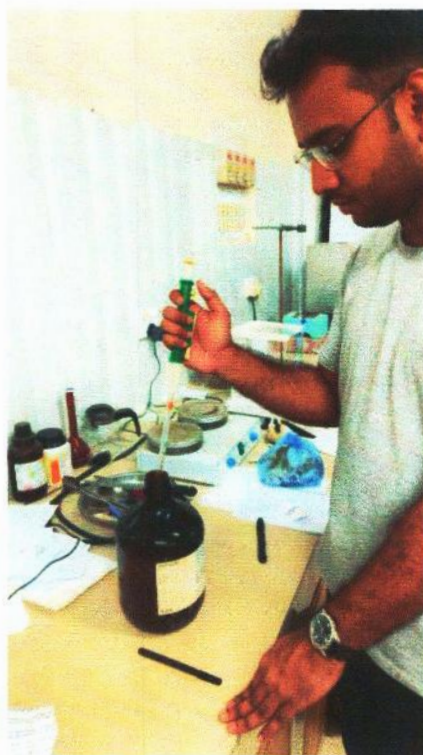
Photograph 26: Sample preparation



Photograph 27: UMMB's sample



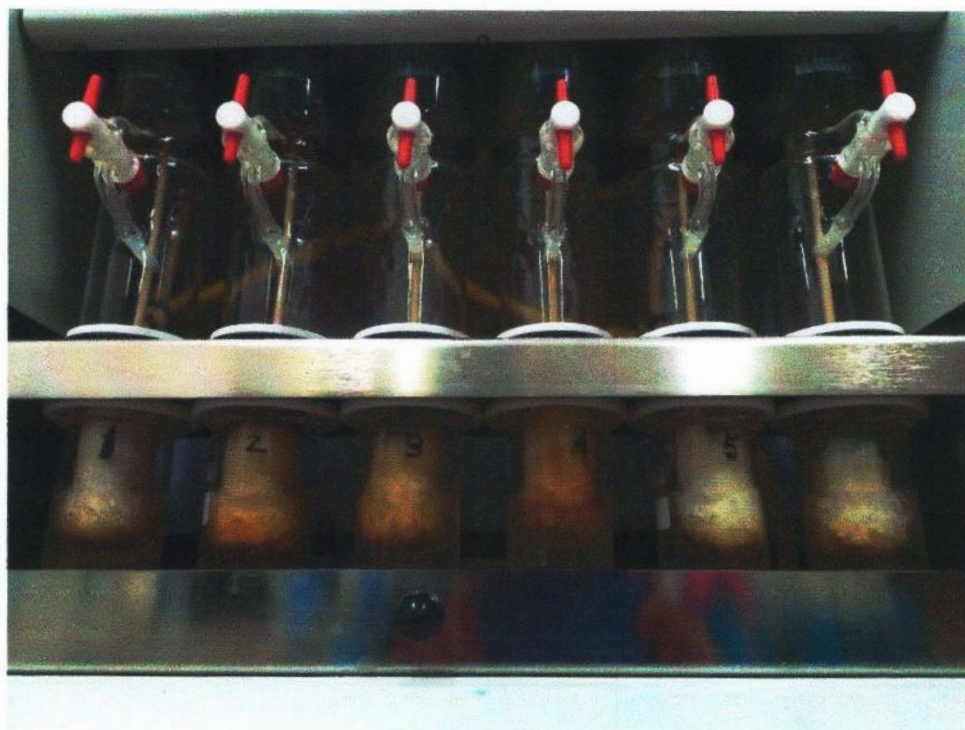
Photograph (31, 32): Determination of UMMB's crude protein



Photograph (33, 34): Determination of UMMB's crude protein



Photograph 35: Determination of UMMB's crude fiber



Photograph 36: Determination of UMMB's ether extract