

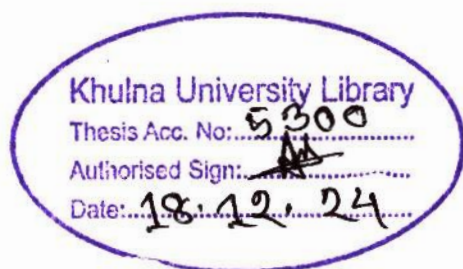
**EFFECT OF UREA MOLASSES STRAW (UMS) FEEDING ON THE  
GROWTH PERFORMANCE OF CROSSBRED SHEEP**

**A THESIS BY**

**PRONoy TARAFDER**

**STUDENT ID NO. MS- 230829**

**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**



**AGROTECHNOLOGY DISCIPLINE**

**KHULNA UNIVERSITY**

**KHULNA-9208**

**JUNE, 2024**

**EFFECT OF UREA MOLASSES STRAW (UMS) FEEDING ON THE  
GROWTH PERFORMANCE OF CROSSBRED SHEEP**

**A THESIS BY  
PRONoy TARAFDER**

**STUDENT ID NO.**

**MS- 230829**

**Approved as to style and contents By**



**PROF. DR. SARDER SAFIQUUL ISLAM**  
**(SUPERVISOR)**



**PROF. DR. MD. SHAFIQUUL ISLAM**  
**(CO-SUPERVISOR)**



**PROF. DR. SHAMIM AHMED KAMAL UDDIN KHAN**  
**(CHAIRMAN)**

**EXAMINATION COMMITTEE**

**and**

**HEAD**

**AGROTECHNOLOGY DISCIPLINE**

**KHULNA UNIVERSITY**

**KHULNA-9208**

**JUNE, 2024**

**DEDICATED  
TO MY  
BELOVED  
PARENTS**

## ACKNOWLEDGEMENT

First, I want to thank God deeply for giving me the ability to successfully complete the research and write the thesis within the allotted time.

I want to express my gratitude to my esteemed supervisor Dr. Sarder Safiqul Islam, Professor, Agrotechnology Discipline, Khulna University, Khulna, under whose careful supervision and guidance, ongoing cooperation, advice, and ideas this study was undertaken. This study would not have been possible without his direction and oversight. No written form can adequately convey my adherence to him. I want to thank my co-supervisor, Dr. Md. Shafiqul Islam, Professor of Agrotechnology Discipline, Khulna University.

I would want to offer my gratitude to every one of the responders for taking the time to complete my research. I want to express my gratitude to all of my friends specially H.M. Ashiquzzaman Rana and Shahriar Kabir Shuvo for their support throughout the course of my thesis.

I also want to express my sincere gratitude to my senior Dhiman Mondal who was the former master's student of Agrotechnology Discipline, Khulna University. For his assistance in gathering information and encouragement in finishing the research.

I am also thankful to S.M. Sohel Rana, Caretaker, Sheep Improvement Project, Agrotechnology Discipline, Khulna University, for his assistance in weight collection and sheep upkeep.

Finally, yet importantly, I am very grateful to my dear parents whose inspiration and constant mental support has helped me largely to complete the research.

June 2024

Author

## ABSTRACT

The difficulty of maximizing sheep growth rates while maintaining sustainability and economic viability remains a less focused research topic. Adding urea molasses straw (UMS) can be a good way to boost rumen microbial activity by giving animals a healthy diet of protein, energy, and minerals. Optimizing the effect of UMS supplementation on crossbred sheep in the southwest of Bangladesh was, thus, the experiment's main objective. The 12 sheep were separated into four treatment groups, each with three replications. Groups T<sub>1</sub>, T<sub>2</sub>, and T<sub>3</sub> were allowed to feed UMS for one hour, 1.5 hours, and two hours, in addition to grazing respectively, while control group (T<sub>0</sub>) continued to graze as usual for 10 hours per day. The experimental setup was based on randomized complete block design (RCBD). The initial weighing and grouping of the sheep involved maintaining a random constant average body weight for each of the four treatment groups. The UMS contains 36.67% ± 0.00 dry matter (DM), 8.47% ± 0.08 crude protein (CP), 26.25 ± 0.23 crude fiber (CF), 1.06% ± 0.14 ether extract (EE), 17.39% ± 0.29 ash, and 46.82% ± 0.19 nitrogen-free extract (NFE). Each sheep group was allowed to graze for 10 hours a day, from 9 am to 6 pm. The allocated UMS was provided in the morning. A registrar maintained regular records of all relevant data, such as body weight, deworming, and immunization. Before letting them feed UMS and graze, empty body weight measurements were taken every week in the morning. The data analysis software utilized was named R. As UMS feeding durations extended, body weight increased even though the mean differences did not differ substantially ( $p > 0.05$ ). The highest numerical body weight in sheep was recorded in sheep group receiving a daily two-hour UMS supplementation. After 13 weeks of UMS supplementation, the final body weight of the sheep in the T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub>, and T<sub>3</sub> groups was 16.22 ± 3.45 kg, 18.45 ± 1.13 kg, 19.50 ± 3.67 kg, and 21.90 ± 0.70 kg, respectively. The growth rate of sheep varied significantly depending on the UMS feeding periods. The average growth rate of sheep was shown to be significantly ( $p < 0.05$ ) depending on the amount of UMS supplementation provided at the fifth, seventh, eighth, and eleventh weeks of experiment. Growth rate (g/day) in feeding UMS was assessed at week 9, 10 and 12 for two hours with UMS accordingly (90.47a ± 8.25), (80.95a ± 8.24), and (90.48a ± 16.49), which significantly varied ( $p < 0.01$ ). It can be concluded that UMS feeding for 2-hour is suitable for optimum growth of crossbred sheep.

Keywords: Body weight, crossbred sheep, UMS, growth rate, mortality, performance.

## List of contents

| CHAPTER    | TITLE                                                          | PAGE NO. |
|------------|----------------------------------------------------------------|----------|
|            | Acknowledgement                                                | i        |
|            | Abstract                                                       | ii       |
|            | List of Figures                                                | v        |
|            | List of Tables                                                 | vi       |
| <b>One</b> | <b>Introduction</b>                                            |          |
|            | 1.1 Background of the study                                    | 1-4      |
|            | 1.2 Significance of the research                               | 5        |
|            | 1.3 Research objectives                                        | 5        |
|            | 1.4 Limitations of feeding UMS in sheep                        | 5-6      |
|            | 1.5 Research's scope in Bangladesh                             | 6-7      |
|            | 1.6 Some restrictions that were placed on the research         | 7        |
| <b>Two</b> | <b>Literature review</b>                                       |          |
|            | 2.1 Existing condition of sheep in Bangladesh                  | 8        |
|            | 2.2 Weight during birth, weaning, and maturity of native lambs | 9        |
|            | 2.3 The care and management of sheep in coastal areas          | 10       |
|            | 2.4 Prospects of sheep farming in Bangladesh                   | 10-12    |
|            | 2.5 Properties of rice straw                                   | 12       |
|            | 2.6 Enhancement of straw using alternative means               | 13-14    |
|            | 2.7 Properties of molasses                                     | 14       |
|            | 2.8 Impact of molasses on the metabolic processes of the rumen | 15-16    |
|            | 2.9 Molasses in diets for weight gain                          | 16       |
|            | 2.10 Preparation of urea molasses straw                        | 16-17    |
|            | 2.11 Effect of UMS feeding on body weight of steers            | 17-18    |
|            | 2.12 Impact of UMS feeding on milk production                  | 18-19    |
|            | 2.13 Effect of urea molasses straw on beef fattening           | 19-20    |
|            | 2.14 Impact of UMS feeding on calves' weight gain              | 20       |
|            | 2.15 Nutrition utilization of different feed for goats         | 20-21    |

|                                                                       |       |
|-----------------------------------------------------------------------|-------|
| 2.16 Impact of UMS feeding on factors related to hematological health | 21-23 |
|-----------------------------------------------------------------------|-------|

### Three

### Materials and Methods

|                                                   |       |
|---------------------------------------------------|-------|
| 3.1 Study area                                    | 24-25 |
| 3.2 Design of experiment                          | 26    |
| <b>3.3 Housing of the experimental sheep</b>      | 26-28 |
| 3.3.1 Floor                                       | 27    |
| 3.3.2 Water facilities                            | 27    |
| 3.3.3 Ventilation                                 | 27    |
| 3.3.4 Sanitation                                  | 27-28 |
| 3.3.5 Grazing of experimental sheep               | 28    |
| 3.4 Composition of urea molasses treated straw    | 29    |
| 3.5 Procedure of making urea molasses straw (UMS) | 29-30 |
| 3.6 Composition of UMS for experimental sheep     | 31    |
| 3.7 Animal adaptation                             | 31    |
| 3.8 Urea molasses straw supplementation           | 31    |
| 3.9 Weight measurements of the experimental sheep | 32    |
| 3.10 Record keeping of experimental sheep         | 32-33 |
| 3.11 Data collection                              | 33    |
| <b>3.12 Proximate analysis</b>                    | 33-37 |
| 3.12.1 Crude Protein Analysis                     | 33-34 |
| 3.12.2 Crude Fibre Analysis                       | 34-35 |
| 3.12.3 Ether Extract Analysis                     | 35-36 |
| 3.12.4 Dry matter                                 | 36    |
| 3.12.5 Ash analysis                               | 37    |
| 3.13 Data analysis                                | 37    |



### Four

### Results and Discussion

|                               |       |
|-------------------------------|-------|
| 4.1 Body weight of sheep (Kg) | 38-39 |
|-------------------------------|-------|

|              |                                                |       |
|--------------|------------------------------------------------|-------|
|              | 4.2 Growth rate (g/day)                        | 40-41 |
|              | 4.3 Mortality of sheep (%)                     | 42    |
| <b>Five</b>  | <b>Summary, Conclusion and Recommendations</b> |       |
|              | 5.1 Summary                                    | 43-44 |
|              | 5.2 Conclusion                                 | 45    |
|              | 5.3 Recommendations                            | 45-46 |
| <b>Six</b>   | <b>Reference</b>                               | 47-65 |
| <b>Seven</b> | <b>Appendix</b>                                | 66-82 |

## List of figures

|                                              |    |
|----------------------------------------------|----|
| 1. Mean body weights of steers.....          | 18 |
| 2. Effect of UMS feeding on milk yield ..... | 19 |
| 3. Impact of UMS feeding on PCV .....        | 22 |
| 4. Impact of UMS feeding on Hb .....         | 22 |
| 5. Impact of UMS feeding on TEC .....        | 22 |
| 6. Impact of UMS feeding on TLC .....        | 23 |
| 7. Impact of UMS feeding on DLC .....        | 23 |

## List of Tables

|                                                                                                         |    |
|---------------------------------------------------------------------------------------------------------|----|
| 1. Composition of urea molasses straw .....                                                             | 17 |
| 2. Body weight gains (kg) of bulls during the experimental period for 21 weeks .....                    | 20 |
| 3. Nitrogen balance and nutrient utilization in goats given concentrate-fortified forage<br>silage..... | 21 |
| 4. The vaccination and deworming routines for the experimental animals .....                            | 28 |
| 5. Composition of urea molasses treated straw .....                                                     | 29 |
| 6. Proximate composition (%) of urea molasses straw fed to experimental sheep.....                      | 31 |
| 7. Body weight (Kg) of sheep fed urea molasses straw (UMS) at different time periods .....              | 39 |
| 8. Growth rate (g/day) of sheep fed urea molasses straw (UMS) at different periods .....                | 41 |
| 9. The mortality rate (%) of sheep under various feeding durations of UMS .....                         | 42 |

# Chapter I

## Introduction

### 1.1 Background of the study

It is crucial to the economics of the nation that livestock be raised, which is one of the four pillars of agriculture (Kamal et al., 2019). It is estimated to account for around 6.5% of the gross domestic product and 13% of the total revenues from foreign exchange (Baset et al., 2003). Agriculture contributes to 14.20 percent of Bangladesh's gross domestic product (B.B.S., 2019). According to (Begum et al., 2012) Bangladesh is significantly dependent on livestock, which not only contributes to the production of high-quality meat and milk but also provides a large number of employment opportunities. This sector of the economy is responsible for a green revolution in the country by transforming traditional goods into inputs that are supported and have an impact on the environment, socioeconomics, and agro-ecology of the region. The production and consumption of animal products in Bangladesh is still much lower when compared to that of other nations, despite the fact that the growth of livestock output in Bangladesh is second in importance among all other sub-sector of agriculture. In Bangladesh, livestock constitute an integral part of the agricultural sector, and they make a number of contributions to the growth and development of the agricultural sectors in a range of different ways. The majority of Bangladesh's livestock resources including cattle, goats, sheep, buffalo, and poultry come from the country's livestock industry. Approximately 247.00 lakh cattle, 15.80 lakh buffaloes, 37.52 lakh sheep, and 267.74 lakh goats are expected to be present in Bangladesh (B.B.S., 2019). According to the data, livestock gives a contribution of 1.47 percent to the GDP and 13.46 percent to the agricultural sector. More over twenty percent of the population is directly dependent on livestock, and fifty percent of the population is dependent on livestock in some way (B.B.S., 2019). Keeping into consideration that 25% of Bangladesh's workforce works directly in the livestock industry and that around 50% of the population is connected in some way to Bangladesh's livestock sector (Hossen et al., 2008). Following cattle and goats as the most prevalent animals in Bangladesh, sheep are the third most common animal, and the majority of the time, they are raised for their meat. The vast majority of sheep in Bangladesh are indigenous, nondescript sorts that do not belong to any specific breed. In

Bangladesh, tiny and landless farmers grow about 37.5% of the sheep, medium farmers raise 40%, and large farms raise 22.3% (Faylon, 1989). The rearing of tiny ruminants is a very important part of the daily lives of households in poor nations. This is because of the life that these households lead. This is because of the straightforward reason that small ruminants provide an appealing and quickly accessible kind of financing that is available for the purpose of meeting immediate social and economic commitments. The majority of the time, animals are kept close to homes and are either fed scraps from the kitchen or permitted to graze on surrounding herbs and shrubs. Feed, on the other hand, is the most expensive input in any system of raising livestock. It accounts for between sixty and seventy percent of the total cost of production. Due to the limited availability of land in Bangladesh, there is a significant disparity between the supply of livestock feed and the demand for it, which causes prices to rise. A shortage of high-quality feed is the principal obstacle that is keeping animals from developing to their full potential. Grass and crop residues are the types of animal food sources that are being responsible for the decline in the animals' ability to produce. The lack of roughage feed, particularly green roughage during the summer and winter seasons, prompted farmers to use their crop residues as a source of nutrition for their ruminants. However, this yield is of poor quality and does not fulfil the requirements of the animals. This is due to the low nutritive value and digestibility of the lignin, which is bound to cellulose and hemicellulose, as well as the fact that the microorganisms in the rumen are unable to digest and utilize the nutrients (Hassan & Mohamed, 2012). Based on the findings of Baset et al., (2003), in most tropical or subtropical areas, ruminants eat a significant amount of agricultural residue called straw, which makes up the majority of their diet. There is a severe lack of feeds and fodder in Bangladesh, which is the primary obstacle the country has in terms of livestock output. The vast majority of her land is devoted to the production of rice, and the byproducts of this crop, such as rice straw, are the only source of feed that is both affordable and readily available for sheep. Straw is an essential agricultural residue that comprises the majority of the fibrous component of the diet of sheep in tropical and subtropical areas. Straw serves as a source of nutrition for these animals. As a result, rice straw was chosen as the primary source of nutrition for ruminants because of its limited digestibility and low nutritional content. The amount of roughage that is available for ruminants in Bangladesh is around 29.1 million tons, with rice straw accounting for approximately 23.57 million tons (81%) of that total. Green grasses, on the other hand, only account for 1.6 million tons (Saha et al., 2018). As a consequence of this, rice straw, which is both low in

digestibility and low in nutritional value, is consumed by ruminants as their main source of nourishment (Saha et al., 2018). In order to achieve maximum animal productivity in Bangladesh, utilizing rice straw to its full potential is crucial because it includes significant amounts of lignin, silica, and oxalate and has a low nitrogen content. (Islam et al., 2018). This is the reason why the performance of our animals is not satisfactory (Baset et al., 2002). As a consequence of the high humidity (86%) and the heavy rainfall (230 cm/h), the supply of rice straw, both quantitatively and qualitatively, has been severely diminished. During the monsoon season, which runs from July to August, it has been estimated that around 7.7 million tons of dry matter rotten rice straw are produced (Chowdhury & Huque, 1996). Furthermore, rice straw is the principal source of energy for ruminants and accounts for more than sixty percent of the total dietary energy in Bangladesh (Jackson, 1982). Nevertheless, it is abundantly clear that the primary challenges to the production of ruminants in this country are the limited quantity of nitrogen that can be easily fermented, the lack of energy for the rumen, and the lack of volatile fatty acids and amino acids for the animal that are supplied by the rice straw. Rice straw contains 25–45% cellulose and 18–30% hemicellulose, respectively, and 10–15% lignin (Sheikh et al., 2017a; Akinfemi and Ogunwale, 2012; Ganai and Teli, 2010; Hossain et al., 2010; Wanapat et al., 2009; Van Soest, 2006). Despite the fact that ruminants are endowed with the ability to convert low-quality feed into high-quality protein and utilize feeds from land that is not suitable for the cultivation of crops, the utilization of these low-quality crop residues is hindered by the fact that they contain a low amount of protein, fiber, digestibility, vitamin, and mineral content (Akinfemi, 2010). Notwithstanding the restriction caused by low nitrogen and a high concentration of fibrous materials, which restrict the process of breakdown (Van Soest, 2006), several research have been undertaken with efforts targeted towards reaching most of the potential nutritional value of this abundant agricultural residue. A number of different treatment approaches, including physical, biological, and chemical treatment, have been utilized in order to enhance the nutritious content of rice straw (Wanapat et al., 1996). Urea treatment is a typical method that is used to improve the quality of rice straw by increasing the amount of nitrogen that is present in the straw (Sheikh et al., 2014; Khang and Dan, 2001; Shen et al., 1998). Because of their digestibility and the fact that the chemicals are reasonably inexpensive and the procedures to utilize them are quite straightforward, they appear to be the most feasible for usage on a farmer's level. In contrast, low growth rates and poor reproductive performance were caused by the low voluntary feed intake that occurred while using rice straw that had been treated

with urea as the only feed. This resulted in a low nutritional intake (energy and crude protein) due to a low dry matter intake in sheep. (Hue & Ledin, 2008). Given that rice straw has a high structural carbohydrate content (lignin-cellulose and hemicelluloses), it is necessary to make use of molasses in order to enhance the palatability and energy content of the treated crop residues. Molasses is a byproduct of sugar mills that doesn't require much effort to acquire and has the potential to supply energy, minerals, and vitamins in a lightning-fast manner. Not only does it impart a pleasant aroma and flavour, but it also possesses a unique value that enhances the palatability and effectiveness of feed. It is possible to provide ruminants with an appropriate amount of protein and energy in a cost-effective manner by incorporating molasses with a nitrogenous component that does not include any proteins. Straw that has been combined with urea and molasses is referred to as Urea Molasses Straw (UMS), which is an appropriate feed. Additionally, the use of biological agents (feed additives) is essential in order to maximize the benefits that can be obtained from the feeds that are provided to animals. One of the benefits of using a mixture of urea and molasses is the reality that it can reduce the amount of time needed for treatment as well as the strong odor of free ammonium or ammonium carbonate. Additionally, molasses improves the palatability of the meal and serves as a quickly available source of energy for the bacteria in the rumen, which promotes the efficiency with which ammoniacal nitrogen is utilized for the production of proteins. Ammonia nitrogen is more effectively utilized for protein synthesis when molasses is added to the diet to increase the energy content and palatability of the ruminal micro flora. Thus, better ammonium or ammonium carbonate utilization and a shorter treatment time are benefits of using a urea and molasses mixture. (Shiekh et al., 2017b). Numerous investigations revealed that combining urea and molasses increased the amount of low-quality roughage consumed (Freeman et al., 1992). through the modification of the effectiveness of microorganisms (Orskov, 1992). It is common practice to add urea and molasses to rice straw-based diet to up-grade the quality of the feed (Huque & Talukder, 1994; Chowdhury & Huque, 1998). The government of Bangladesh is currently putting more focus on sheep farming, and farmers are aware that sheep husbandry generates lambs. Additionally, they act as insurance against economic failures, especially for landless, small-scale, and marginal farmers in Lances, and they provide a vital livestock resource that keeps growing over time. Therefore, the purpose of this study was to investigate the impact showed urea molasses-treated rice straw improved the growth performance of crossbred sheep.

## **1.2 Significance of the research**

The traditional rural and mostly subsistence-based economy of Bangladesh depends heavily on livestock (Haq, 1992). Sheep are ruminants that provide tasty meat. Sheep produce more meat as a percentage of total yield (Lalljee et al., 2019). Meat from sheep is softer and more delicious. If we can figure out their nutrition issues, sheep farming could become well-known. Feed accounts for about 70% of the expense of raising sheep. According to research, animals who receive straw in addition to a urea and molasses mixture consume more feed and are able to digest it more easily (Tareque, 1985). In addition to providing nutrients to them, such as protein, energy minerals, and vitamins (Neric et al., 1983; Hendratno, 1988), it helps by lowering the necessity for feed. UMS is a lowcost feed supplement that can be easily produced using locally available resources such as straw, urea, and molasses. Comprehending the impact of applying urea molasses straw on sheep's growth performance is important for offering economical feeding alternatives, optimizing nutrient utilization, improving rumen health, promoting sustainable agriculture, and enhancing livestock productivity and food security.

## **1.3 Research objectives**

- i. To find out the effect of urea molasses straw on growth performance of sheep.
- ii. To determine the optimal duration of urea molasses straw feeding for maximizing sheep growth.

## **1.4 Limitations of feeding UMS in sheep**

- I. UMS is deficient in vital elements that are critical to the growth and well-being of sheep, such as vitamins, and minerals.
- II. UMS may not be appetizing to sheep, which could result in decreased intake and possible feed waste.
- III. UMS containing urea can cause urea toxicity in sheep, which can result in health hazards or even death if improperly managed.
- IV. Due to its high moisture content, UMS needs to be stored in appropriate conditions to prevent spoiling. Managing large, heavy UMS can be difficult as well.

- V. Factors such as processing and maturity might alter the digestibility of UMS, which in turn can affect the absorption of nutrients and overall feed efficiency for sheep.
- VI. Reduced feed quality and possible health hazards for sheep can result from UMS's susceptibility to mold growth and deterioration during storage, caused by its high moisture content.
- VII. There may be seasonal variations in the availability and quality of UMS, which could impact its appropriateness as a regular feed source for sheep all year round.
- VIII. Transporting UMS to outlying or rural regions with a high concentration of sheep farms could be a logistical nightmare and a financial burden for the farmers.
- IX. The adoption and application of UMS by sheep producers may be hindered by regulatory restraints or prohibitions in certain places regarding animal feeding.

### **1.5 Research's scope in Bangladesh**

- i. Analyzing the nutrition of UMS that are available locally.
- ii. Assessing its effect on the health, growth, and feed efficacy of sheep in Bangladesh.
- iii. An economic assessment of the application of UMS in sheep management.
- iv. Concerns regarding the environment and long-term viability.
- v. Investigation on processing methods to enhance the quality of UMS.
- vi. Methods to encourage farmers to use UMS.
- vii. Policy and regulatory implications for UMS use in Bangladesh.
- viii. Investigating novel ways for incorporating UMS into various agricultural systems, including mixed farming, smallholder operations, and intensive production units.
- ix. Identifying gaps in current knowledge and research objectives for UMS use in sheep production in Bangladesh, as well as offering future research and partnership opportunities.
- x. Analyzing the potential for urea toxicity in sheep given UMS and finding ways to reduce it through feed management and formulation expertise. Also, checking in on the general well-being and health of sheep fed UMS-based feeds.

- xi. Assessing the environmental impacts of UMS production and consumption in Bangladesh on land use, water quality, and greenhouse gas emissions. Finding sustainable methods to reduce environmental impact and maximize resource efficiency.

### **1.6 Some restrictions that were placed on the research**

- i. The research did not extend throughout Bangladesh. It was limited to the Khulna University campus in the Khulna District.
- ii. The sheep were particularly vulnerable to a wide variety of diseases and infective organisms.
- iii. The housing arrangement for the sheep is not optimal.



## **Chapter II**

### **Literature Review**

#### **2.1 Existing condition of sheep in Bangladesh**

Livestock is a crucial sub-sector of agriculture in Bangladesh, benefiting significantly to the country's national economy (Sarma et al., 2014). Approximately 80 to 85% of households in rural areas engage in livestock farming, with a majority of them being landless, marginal, and small-scale agricultural producers (Hossain et al., 2016). Livestock can be regarded as a source of immediate cash income for rural farmers, which can be readily sold or exchanged (Hossen et al., 2008). The majority of the population in Bangladesh is impoverished, leading to widespread malnutrition. The livestock sector contributes around 1.66% to the national GDP and experiences an annual growth rate of 3.21% (DLS, 2015). Sheep play a crucial role in the agricultural sector of Bangladesh, serving as a significant source of revenue and food for poor farmers and contributing to their socio-economic status (Hossain et al., 2018; Sarker et al., 2017). It has a global distribution, as documented by the Food and Agriculture Organization (FAO, 2008; Haque et al., 2020). Over the past twelve years, the sheep population has grown by a factor of 2.5, with an annual growth rate of 5% (BBS, 2008). About 3.537 million sheep heads are distributed throughout the country and the sheep is the 3rd largest livestock population in the country (DLS, 2019). The majority of the sheep are native to the area, with only a small number being crossbred. These sheep have the ability to give birth twice a year and have many offspring (Bhuiyan, 2006). It is believed that native lambs can tolerate high ambient temperatures in a tropical setting (Rashid et al., 2013). The Jamuna basin lamb is extensively distributed on both banks of the Jamuna River in Bangladesh. The Jamuna basin lambs are characterized by their modest body size, with males weighing an average of 18.25 kg and females at an average of 15.22 kg. The body is covered in creamy white wool, whereas the head and belly have black wool. The legs and belly have less hair. (Hashem et al., 2020). This species exhibits a broad range of adaptability to various climatic situations and can be found in all types of livestock production systems (Berihulay et al., 2019).

## 2.2 Weight during birth, weaning, and maturity of native lambs

It was noticed that the average birth weight of lambs was  $2.90 \pm 0.50$  kg (Musa et al., 2005), whereas Sarder et al. (2015) identified that the overall birth weight of lambs was  $0.96 \pm 0.23$  kg. The weaning period was approximately three months was determined (Musa et al., 2005; Hashem et al., 2020). There have been much variations noted for sex in terms of birth weight and weaning period, which are influenced by genetic, physiological, litter size, ewe weight at parturition, and environmental factors (Berruecos, 1975; Combellas et al., 1979). According to some findings, the average birth weight of lambs under enhanced production methods was 2.6 kilograms, and around 1.3 lambs were born for every delivery (Combellas, 1980). The average birth weight of male and female lambs in the Jamuna basin was 1.47 kg and 1.45 kg, respectively, while their weaning weight was 6.77 kg and 6.51 kg (Hashem et al., 2020). Despite a slight gender gap at birth, male Jamuna basin lambs maintained a slightly greater mean body weight than their female counterparts throughout the whole 12-month experiment. In Rajshahi and Mymensingh, the average lamb birth weight, weaning weight, and mature weight were 1.7 vs. 1.3 kg, 8.9 vs. 6.9 kg, and 24.9 vs. 19.4 kg, respectively (Al Mansur et al., 2018). Lamb birth weight was reported to be 1.2 kg (Husain and Amin, 2003) and to be between 1.00 and 1.33 kg in the supplemented and controls groups (Zohara et al., 2014; Al Mansur et al., 2018) found that the mean weaning weight of native lambs was lower than the weaning weights of other breeds (Awgichew, 2000; Tibbo, 2006). They discovered that the mature body weight of Rajshahi sheep ( $24.9 \pm 7.3$  kg) was significantly greater ( $p < 0.001$ ) than that of Mymensingh sheep ( $19.4 \pm 2.7$  kg). The influence of breed may be the cause of this increased mature body weight. The average adult body weight of male and female sheep in the Jamuna basin, Barind, and Coastal belt was 17.84, 14.62; 16.85, 15.95; and 19.19, 16.16 kg, respectively, as determined by (Asaduzzaman et al., 2022). In a study conducted that the researchers found that the average birth weight and weaning weight of Bengal sheep raised in semi-intensive and intensive methods were 1.56 and 1.60 kilograms, and 7.3 and 7.7 kilograms, respectively (Sultana et al., 2011). Black Bengal goats and native sheep had average mature body weights of 19.03 and 19.35 kg, respectively (Murshed et al., 2014). The sheep's initial and end body weights were  $12.3 \pm 0.60$  and  $12.5 \pm 0.57$ ,  $12.33 \pm 0.33$  and  $12.83 \pm 0.33$ , and  $12.66 \pm 0.88$  and  $13.0 \pm 0.57$  kg for the sheep exposed to heat for 4 and 8 hours, respectively (Rana et al., 2014).

### **2.3 The care and management of sheep in coastal areas**

Sheep were not given water by a significant portion of farmers (66.70%). However, the vast majority (62.50%) of those who provided water took care to assure its safety. It should be noted that many of these farmers did not utilize a waterer. The sheep received a mixture of 100% green grass, 95.90% tree leaves, 36.40% concentration feed, and 20.80% rice straw. A significant number of farmers grazed their sheep continuously from sunrise to sunset. The sheep are reared in traditional feeding systems, grazing on harvested or fallow lands, roadways, and canal sides. Additionally, they consume grass and aquatic plants in knee-deep water (Sultana et al., 2010). Most sheep farmers (63.50%) employed staff to manage their flocks. There were two separate types among farmers. However, in char or coastal areas as well as on level land, sheep are mostly raised by family members with little to no outside assistance, according to Sultana et al. (2011). Approximately 46.90% of small-scale farmers maintain a flock of 5 to 20 sheep, Large-scale farmers, on the other hand, usually keep between 20 and 200 sheep in their herd. Every farmer cleaned their sheep, and most of them also periodically administered anthelmintics (53.10%) and were given vaccines (53.10%). The goal of all farmers' sheep farming was to produce meat. Additionally, 33.33% of farmers were keeping sheep as a longstanding family heritage. In order to achieve optimal output, it is necessary to consider the climatic conditions and production system while designing shelters or houses for sheep and goats (Hamito, 2009). The preceding discourse implies that grazing on verdant vegetation and providing tree foliage were the primary methods of feeding. However, a significant number of farmers lacked knowledge regarding water safety. A significant number of these farmers hired personnel to rear sheep, and a large proportion of them used vaccines and antibacterial medications to prevent worm infestations.

### **2.4 Prospects of sheep farming in Bangladesh**

In several nations with industrialization, lamb farming plays a vital role in economic development. Reduced birth weight, average daily gain (ADG), and slaughter weight, as well as reduced revenue in sheep farming in Bangladesh, are all associated with the constraints of inadequate and poor-quality feeds (Alemu, 2008; Hossain et al., 1997). Sheep are a type of small ruminants that exhibit gregarious behavior. They mostly rely on natural grasses found in fallow land, roadsides, crop

fields, and canal sides for their sustenance (Sultana et al., 2011). The sheep's capability to reproduce and be productive will be negatively impacted by the rise in body temperature, which is linked to a significant decrease in feed intake, a redistribution of blood flow, and adjustments in endocrine performing (Alam et al., 2013). The main obstacle limiting the productivity of sheep in subtropical and tropical regions is the high ambient humidity and temperature (Marai et al., 2001; Hashem et al., 2013; Hossain et al., 2021). The Jamuna basin, the Barind tract, and the coastal belt areas are the three natural zones where around 32% of Bangladesh's (2.7 million) sheep are grown (DLS, 2021). It's interesting to note that Asia is residence to the majority of the world's sheep populations (64.43%) and 25.32% of all sheep breeds (Hossain et al., 2018). Although there are enough of these sheep, they don't perform well at all. One of the most significant factors restricting Bangladesh's lamb output is nutrition. Roughages make up over 90% of the feed that ruminants eat, as is known. Due to their natural capacity to adapt to difficult environments, the majority of sheep are easily maintained in rural areas. However, poor management and feeding techniques can only partially meet the animal protein needs of these areas (Hashem et al., 2020; Sarder et al., 2022). Compared to goats, sheep are more resistant to viral and parasitic diseases, 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 domesticated solely for their meat, which is typically killed and consumed by humans. In Bangladesh, 7.17% of all livestock are comprised of sheep and goats (DLS, 2021). More than ninety eight percent of the production of goats and sheep is raised by rural farmers. 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 (DLS, 2021). There is a great chance for the growth of the sheep-producing community in Bangladesh's rural areas due to the country's increasing demand for lambs and the availability of suitable land in Bangladesh. It is absolutely necessary to make smart business decisions from the very beginning of the planning process all the way to the marketing and sale of the lambs, wool, or milk products on the market. Establishing a sheep farm requires a substantial financial investment, 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 raising sheep in order to produce enough lamb to meet Bangladesh's current meat demands. Energy and protein content in feed have an important effect on goat and sheep meat production (Sultana et al., 2010). Sheep productivity benefits greatly from good management and nutrition (Sarker et al., 2017; Sun et al., 2020;). However, depending on the breed, age, and length of stay of the animal upon entering the feedlot, as well as additional variables, the sheep's growth performance, yield, carcass quality, and noncarcass parts under feedlot circumstances may vary (Moniruzzaman et al., 2002).

## **2.5 Properties of rice straw**

One of the most widely grown cereal crops in the world is rice., and the majority of South and South-East Asian countries are responsible for the cultivation of it. The biggest crop leftovers of all the cereal crops are produced by the production of rice, with 330 million metric tons produced (Van Soest, 2006). Considering rice straw has a low protein content and digestibility, fewer animals are produced using it as the main source of nutrition.

Contrasting to other cereal straws, rice straw is distinct due to its high silica content and low lignin content (Jackson, 1977; Van Soest, 2006). While ammonia treatment does not eliminate silica, it severely destroys the cuticular layer, providing rumen bacteria access to the material for eventual digestion (Ha et al., 1994). The health benefits, digestibility, and lignin and silica concentrations of straw vary according on the variety and region (Singh & Singh, 1995). According to AgbaglaDohnami et al. (2003), there is actually more lignin and less silica in rice straw cultivars from Europe. Therefore, gathering straw from South Asia will be beneficial in observing their digestibility through the use of innovative supplements. Less phosphorus than what animals require for healthy growth and reproduction can be found in rice straw (Jackson, 1977). A positive calcium balance was seen in some rice straw samples (Nath et al., 1969), while a negative calcium balance was observed in others (Negi, 1971). Phenolic substances are crucial to the diet of ruminants. Though there isn't a lot of information on phenolic compounds in rice straw, (Vadiveloo, 1992) revealed that rice straw contains 90g kg<sup>-1</sup> of ytterbium precipitable phenolics.

## 2.6 Enhancement of straw using alternative means

The rising cattle business faces significant constraints due to a lack of farmed fodder, particularly during the seasonal dry period. Future feed resources for cattle will have to come from byproducts of human food production, such as harvesting cereals (Devendra & Leng, 2011; Laconi & Jayanegara, 2015). Products that can be utilized as animal feed include rice bran and rice straw, which are especially significant. But feeding rice straw to the animals on its own is insufficient to give them with enough nutrients for development and production because it contains low protein, highly lignified fiber, silica, and low digestible components (Van Soest, 2006). Additionally, rice straw contributes to a decrease in feed intake due to its poor rate of passage and ruminal degradation rate (Sarnklong et al., 2010). Due to increased acetate production at the expense of propionate, low quality roughage of rice straw has also been linked to increased intestinal methane emission (Jayanegara et al., 2013). Various methods can enhance the nutritional value of rice straw, including physical techniques such as chopping, grinding, and soaking, chemical treatments like alkali treatments using sodium or calcium hydroxide, ammoniation, or urea treatment, and biological approaches such as using fiber-degrading enzymes and white rot fungal inoculation (Sarnklong et al., 2010). Out of all the methods, the treatment of rice straw with urea is the most practical and cost-effective way to enhance its nutritional content. Ammonia is absorbed into the cell walls of rice straw as it dissolves in water. Then, the bond between lignin and cellulose or hemicellulose is broken. Since rice straw naturally has less nitrogen than other straws, the residual urea in the processed straw contributes a substantial amount of nitrogen. This nitrogen is important for rumen microbial protein synthesis, which contributes to the animal's metabolizable protein demand. Applying urea at a concentration of 26% in dry matter has been proven to enhance the digestibility of rice straw by 2-100% (Van Soest, 2006) and enhance the production of animals (Gunun et al., 2013). Additives including urea and molasses have been used in studies to enhance the forage ensiling process's fermentation quality (Cherdthong et al. 2021). Molasses has been shown in multiple investigations to promote lactic acid fermentation and decreasing silage pH (Zhao et al., 2019). Via ammonification, urea acts as a delignifying agent and a source of nitrogen (Mapato et al., 2010). It also extracts polymerized silica from the leaf sheath and leaf blade. Another supplement is urea molasses multi nutrient block (UMMB). A dietary supplement called urea molasses multi-nutrient block' (UMMB) can improve how well poor-quality roughages are

used. It accomplishes this by meeting the rumen bacteria' nutritional needs and fostering an environment that is more conducive to the fermentation of fibrous material. This ultimately causes a rise in the synthesis of volatile fatty acids and microbial protein (Makkar et al., 2007), (Lestari et al., 2016) discovered during their research that UMMB can provide ruminants with energy, non-protein nitrogen, vitamins, mineral supplements, and other necessary nutrients. In Mecheri lambs (Muralidharan et al., 2015), working bullocks (Kerketta et al., 2017), bulls (Liu et al., 2001), bulk cattle (Li et al., 2014), and crossbred cows that produce milk (Misra et al., 2006), the use of UMMB had an encouraging impact on body weight increases, feed intake, and blood biochemical parameters.

## 2.7 Properties of molasses

Molasses is a term that is used to describe a wide range of by-product feeds that are obtained from crops that are high in sugar. It is a thick liquid that is dark in colour and has a consistency similar to that of syrup. When sucrose can no longer be obtained from the latter in a way that makes it useful for its intended use of simple crystallization, it is the residue that remains after sugar extraction (Piccioni, 1962). Nevertheless, molasses cannot be sufficiently described by this term. While sucrose comes from the trunk medullary tissues of sugar cane (*Saccharum officinarum*), it comes from the deep root of sugar beets (*Beta vulgaris*). Molasses is a completely different component. There is no doubt that the byproducts that are produced as a result of these procedures are identical; However, they do exhibit distinct organoleptic and nutritional features that are neither insignificant nor difficult to estimate. Molasses, when present in ruminant diets in low levels, serves as a vehicle for other nutrients, such as urea and minerals. This seems to be the most appropriate role for molasses. Because of its high concentration of readily fermentable sugars, molasses is considered an energetic feed ingredient. Regardless of the source of the molasses, this remains true. That being said, it also contains a lot of mineral salts, which are highly bioavailable. Due to its low cost, it is a highly popular feed ingredient that may be utilized in diets and feed formulations for a wide range of species that are relevant to zootechnical researchers. It can also be used as a partial replacement for cereals, as it provides approximately two thirds of maize's energy content. In terms of certain physical-chemical qualities and the substance's overall energy

worth, beetroot and cane molasses are rather similar. In all instances, the liquids in question have a high density (Piccioni, 1962; El-Said, 2002) and a pH that varies between 5 to 5.8.

## **2.8 Impact of molasses on the metabolic processes of the rumen**

It was discovered that supplementing the diet of calves fed hay with 1.3 kg of glucose per day resulted in a doubling of the number of bacteria in the rumen contents (Bortree et al., 1946). When a same amount of starch was added, the number of bacteria remained the same as when hay was used alone. The amount of bacteria in the rumen contents increased linearly from 60 to 115 billion per milliliter when cane molasses was fed to cows on a hay diet in increments of up to 3.6 kg per day (which made up up to 35% of their diet) (Foreman & Herman, 1953). The two prevailing bacterial forms were single cocci and short rods, both of which exhibited an increase in frequency with higher concentrations of molasses. The bacteria, which had a rodlike structure, had been identified for their ability to break down cellulose. However, it was observed that the digestion of cellulose was hindered when the diets had higher amounts of molasses. It is possible that the broad classification of bacteria by shape was not accurate, as research has demonstrated that introducing more corn grain to corn stalk diets reduces the number of cellulolytic bacteria in the rumen. This reduction is exactly proportional to the decrease of cellulose digested (Henning et al., 1980). When the amount of molasses in the diet was increased from 0% to 20%, it was found that the population of protozoa (particularly, ciliates) in the rumen dropped by about 320,000 to 158,000 per milliliter of rumen contents (Foreman & Herman, 1953). Nevertheless, the number of protozoa per milliliter rose to 323,000 when the amount of molasses was raised to 35% of the diet. Research revealed that cows fed a diet of meadow hay responded similarly to injections of fructose and glucose into their rumen (Sutton, 1968). But when xylose and arabinose were employed as infused sugars, no similar reaction was found. Following infusions of glucose and fructose, cows fed a diet consisting of flaked corn exhibited an increase in the molar proportion of butyric acid (Sutton, 1969). Conversely, it was found that whereas glucose lowered the amount of acetic acid, fructose decreased the percentage of propionic acid. Pentose sugars reduced the amount of butyric acid and raised the fraction of propionic acid. Several investigations were carried out to find the cause of the decline in milk production efficiency that occurred when dairy diets with a low percentage of molasses (10%) were consumed. The molar proportion of butyric acid in the rumen was shown to significantly rise when breastfeeding cows' diets included up to 9% sucrose (Owen et al., 1967;

Kellogg and Owen, 1969). Nevertheless, no regular trends in the proportions of propionic or acetic acids were found. The inclusion of molasses was found to improve the digestion of cellulose. Remarkably, unlike dextrose, sucrose, or starch, which had a depressive impact when given in identical proportions, molasses did not impede cellulose digestion even when considerable amounts (33 and 50% of the medium) were added to the fermentation medium (Arias et al., 1951). It was showed that molasses ash is the catalyst for enhancing the *in vitro* digestibility of cellulose (Burroughs et al., 1950; Burroughs et al., 1951). Further experiments on animals showed that supplementing with molasses significantly decreased the amount of dry matter that grazing steers could digest, with the amount of depression being correlated with the amount of molasses ingested (Brannon et al., 1954). Research conducted (Martin et al., 1981; Johnson et al., 1942) showed that adding molasses to diets based on pasture increased the dry matter's digestibility. On the other hand, it adversely affected the cellulose and crude fiber digestibilities, suggesting a decrease in the digestibility of the feed component.



## **2.9 Molasses in diets for weight gain**

In order to improve the rate of weight gain and dry matter utilization, it has been demonstrated in several studies (Bray et al., 1945; Lofgreen & Otagakit, 1960; Bradley et al., 1966; Brown et al., 1967; Lishman, 1967) that cattle nearing the end of their developmental stages benefit significantly from concentrate diets that contain 2 to 10% cane molasses. In only three of the investigations that were analyzed (Van Niekerk and Voges, 1976; Heinemann & Hanks, 1977; Kargaard & Van Niekerk, 1977) did feeding 19–20 up to 10% cane molasses not increase animal performance when compared to a control treatment. The use of tiny amounts of molasses did not significantly affect carcass quality in either of the aforementioned investigations. The studies show compelling evidence that supplementing finishing diets with up to 10% molasses increases nitrogen utilization, improves energy and fiber digestibility, also boosts microbial activity (Crawford et al., 1978).

## 2.10 Preparation of urea molasses straw

The urea and water were first mixed with the molasses in a bowl. After that, a thick paste was created by thoroughly mixing the molasses mixture with the little pieces of straw. After that, the mixture was moved to an airtight dish and compacted in a dark room for two to three hours. The UMS were prepared, trimmed to a weight of 2 kg, and then distributed to the experimental group (Islam et al., 2023).

Table 2.1. Composition of urea molasses straw (Islam et al., 2023)

| Ingredients | Amount (kg) | Percentage (DM basis) |
|-------------|-------------|-----------------------|
| Straw       | 10          | 83                    |
| Molasses    | 2.5         | 15                    |
| Urea        | 0.25        | 2                     |
| Water       | 5 litter    |                       |

## 2.11 Effect of UMS feeding on body weight of steers

The steers' body weight on the first day of the experiment did not differ significantly among the UMS-treated group and the group that was not treated (Figure 2.1). Nevertheless, the steers treated with UMS had significantly greater body weights from days 15 to day 90 of the study compared to the steers in the untreated group that did not receive any treatment (Figure 2.1). When comparing the body weight of the UMS treated steers to the untreated steers in the control group at days 15 and 30, there was a significant increase ( $p < 0.05$ ) (Figure 2.1). Steers treated with Urea molasses straw showed significant increases in body weight at day 45 and 60 ( $p < 0.01$ ), as well as day 75 and 90 ( $p < 0.001$ ), compared to the control group (Islam et al., 2023).

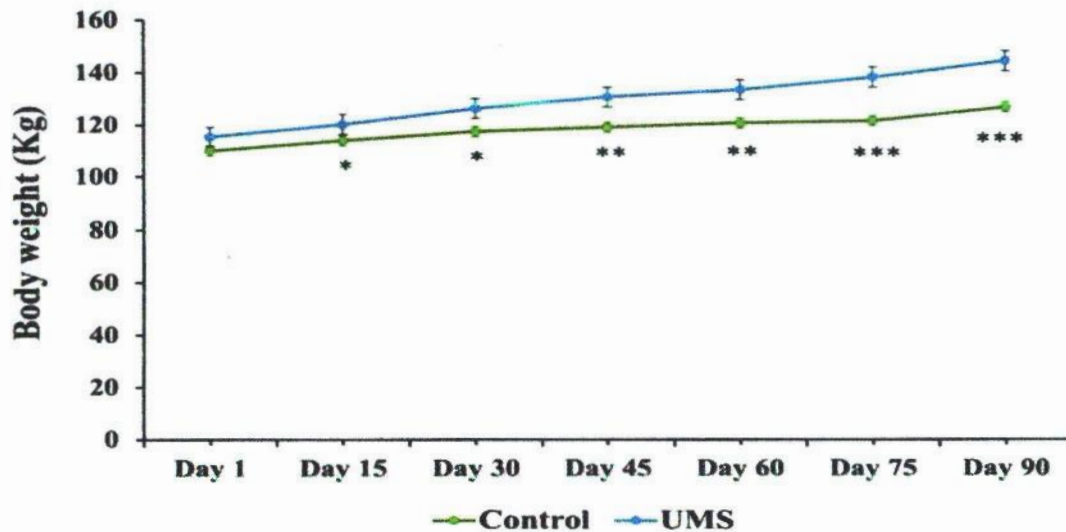


**Figure 2.1.** Body weight as a result of UMS feeding. The Figure shows the mean body weights from day 1 to day 90. Groups A and B are the UMS-treated group and the control group (normal straw). The mean  $\pm$  SD of ten animals per group was used to express all the data. The results between the two groups were compared using an unpaired t-test. Here, \*\*\* denotes statistical significance at the 0.1% level ( $p < 0.001$ ), \*\* denotes significance at the 1% level ( $p < 0.01$ ), and \* denotes significance at the 5% level ( $p < 0.05$ ) (Islam et al., 2023).

## 2.12 Impact of UMS feeding on milk production

Figure 2.2 shows that the average milk yields for the control and treatment groups were  $1.83 \pm 0.79$  and  $2.5 \pm 1.01$  kg day<sup>-1</sup>, respectively. This outcome was corroborated in part by Islam & Huque (1995). Between the two groups of cows, there was a statistically significant difference in milk yield ( $p < 0.01$ ). In this experiment, the treated group accomplished around 42% more milk than the control group, even though the cows in both the control and treated groups produced more milk than they initially did. Additionally, the treatment group consistently produced significantly more milk than the control group, month-by-month, during lactation. Investigations show that UMS has a favorable impact on native cows' ability to produce milk. Numerous studies have reported that supplementing cows' diets with urea and molasses increases their milk production (Saadullah, 1991; Davison et al., 1986).

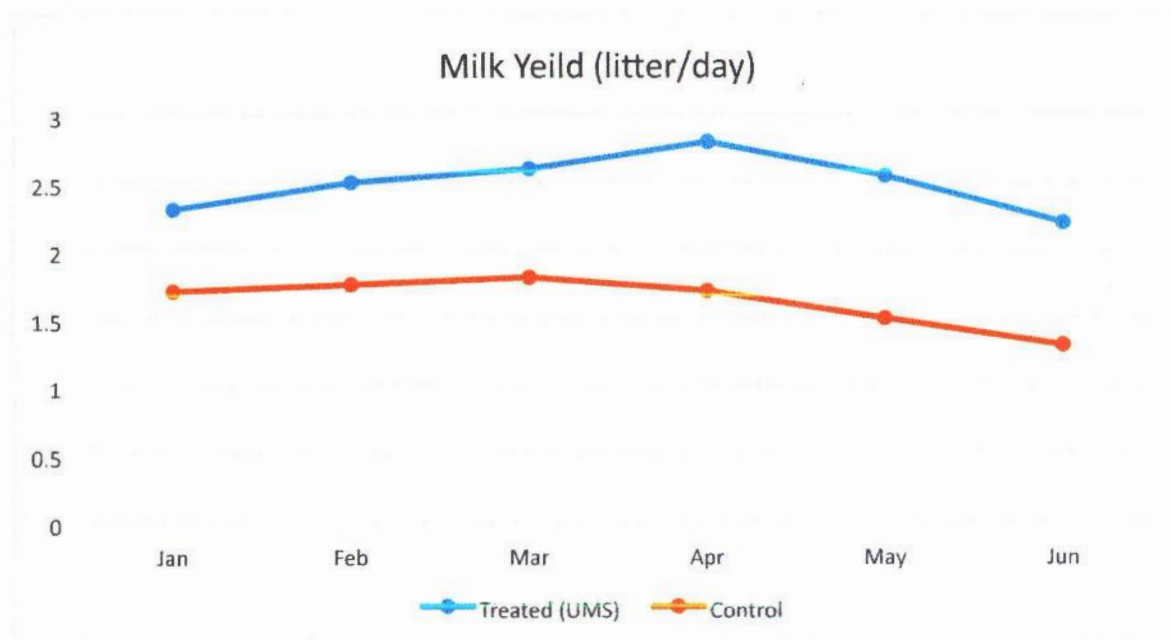


Figure 2.2. Effect of UMS feeding on milk yield (Hossain et al., 2002).

### 2.13 Effect of urea molasses straw on beef fattening

As per Chowdhury & Huque (1998), Table 2.2 displays the growth performance of the experimental bulls in both the treatment and control groups. The treatment group had a greater average daily body weight gain of  $492.67 \pm 29.09$  g than the control group, which had an average daily body weight growth of  $365.33 \pm 42.85$  g. It is clear that UMS had a positive effect on live weight when comparing the average live weight of the bulls in the treatment group and the control group. But this impact isn't noticed until a few weeks after the bulls are given UMS. The average live weight of the bulls in the treated group was 132.95 kg, while the control group's life weight was 123.75 kg. This suggests that UMS has a substantial effect on increasing the live weight of the bulls ( $p < 0.05$ ). A daily live weight change of 292 g was recorded for UMS, 125 g for UGS, and 19 g for US during the experimental period (Chowdhury & Huque, 1998). It was determined that supplementing with easily fermentable nitrogen (urea) alone is insufficient for optimizing rumen function (Chowdhury & Huque, 1998). They found that a supply of easily fermentable energy is also necessary. Rice gruel is less efficient than molasses in increasing voluntary intake and providing amino acids of microbial origin for absorption from the small intestine. Bulls treated

with molasses had a greater availability of substrate for protein synthesis and gluconeogenesis compared to those supplemented with rice gruel. Twelve to eighteen months old male Limousin x Jersey cattle were fed a meal consisting of fifteen percent wheat straw and eighty percent sugar beet pulp, or a diet supplemented with fifteen percent zeolite (Colpan et al., 1995). 333.25 kg and 354.80 kg, respectively, were the final live weights at the end of the feeding. There was a daily average rise of 1132 g and 12469 g. This result is in line with the findings of (Chowdhury & Huque, 1998).

Table 2.2. Body weight gains (kg) of bulls during the experimental period for 21 weeks

| Attributes             | Controlled group | UMS treated group  |
|------------------------|------------------|--------------------|
| Initial body weight    | 95.33±12.74      | 95.33±6.83         |
| Final body weight      | 150.17±9.78      | <b>169.23±3.06</b> |
| Total body weight gain | 54.83±6.45       | <b>73.90±4.36</b>  |

Source: Chowdhury & Huque (1998)

#### 2.14 Impact of UMS feeding on calves' weight gain

The calf weight gain averages were  $96.99 \pm 15.30$  g day<sup>-1</sup> in the control group and  $139.35 \pm 29.69$  g day<sup>-1</sup> in the treated group. This was backed by Sahoo et al. (1990) and Daniel et al. (1986). A statistical study revealed a significant difference ( $p < 0.01$ ) between the two groups' calf weight gains. Taking UMS and concentrate mixture allowed for a higher weight gain. Early on in the trial, the calf weight increase was not very satisfactory; but, later on in the trial, it performed better. Daniel et al. (1986) achieved similar results. Because the calf's rumen was well-developed and capable of effectively using the UMS in the later stage.

#### 2.15 Nutrition utilization by goats from different feeds

Table 2.3 illustrates the digestibility of various diets as stated by Talukder et al. (2016). The Talukder et al. (2016) suggested that there were no significant variations among the different dietary groups of animals in terms of dry matter (DM), crude protein (CP), acid detergent fibre (ADF), and organic matter (OM). However, the digestibility of the silage group was slightly greater

compared to the other groups. The current research shown that the utilization of old feeds did not have a significant impact on the digestibility of the entire diets provided to the animals.

However, the silage diet exhibited somewhat higher values for digestibility of dry matter (DM), crude protein (CP), acid detergent fibre (ADF), and organic matter (OM). The correlation between intake and digestibility was not always stable; substances that are highly digested may be consumed poorly, and vice versa (Wilson, 1977). There were significantly different variations ( $p < 0.05$ ) seen in the mean values of nitrogen retention (%) data. There were notable disparities in the average values, with the silage group of animals exhibiting much higher values compared to the UMS and UTS groups. The nitrogen balance study results clearly shown that silage had a considerable beneficial impact on nitrogen retention in the animals' bodies. The results suggested that the elevated nitrogen concentration in silage had a beneficial effect on the preservation of nitrogen in the animal's body. This has been shown in the notably greater growth rate of animals in the silage groups compared with the other groups, as was previously mentioned.

Table 2.3. Nitrogen balance and nutrient utilization in goats given concentrate-fortified forage silage

| Parameters        | UMS   | UTS   | Silage | SED  | Level of sig. |
|-------------------|-------|-------|--------|------|---------------|
| Digestibility (%) |       |       |        |      |               |
| DM                | 70.01 | 70.01 | 73.00  | 3.11 | NS            |
| CP                | 58.01 | 57.01 | 59.01  | 4.13 | NS            |
| ADF               | 71.01 | 67.01 | 70.00  | 2.85 | NS            |
| OM                | 66.56 | 68.60 | 69.71  | 1.78 | NS            |
| N-retention (%)   | 30.33 | 29.10 | 34.00  | 2.91 | *             |

# UMS, UTS, Silage; Mean values in a row with different superscripts differ significantly, NS= Non-significant, \* $P < 0.05$ . DMI= Dry matter intake, MEI= Metabolizable energy intake, MJ= Megajoule.

## 2.16 Impact of UMS feeding on factors related to hematological health

At the conclusion of the trial, Figures 2.3 to 2.5 show the hematological measurements (TEC, Hb, PCV, TLC, and DLC) of the steers from the treatment and control groups. When comparing the TEC and Hb levels of the treated steers to the untreated steers in the control group, a substantial ( $p < 0.01$ ) rise was observed. Likewise, when compared to the untreated steers in the control group, the packed cell volume (PCV) of the steers in the treatment group demonstrated a significant increase ( $p < 0.05$ ). When it came to TLC, there were no appreciable variations between the groups receiving treatment group's cattle and the control group's untreated steers (Figure 2.3). The percentages of neutrophil, eosinophil, basophil, lymphocyte, and monocyte in the DLC case did not show any significant changes between the steers in the treatment and control groups (Figure 2.5).

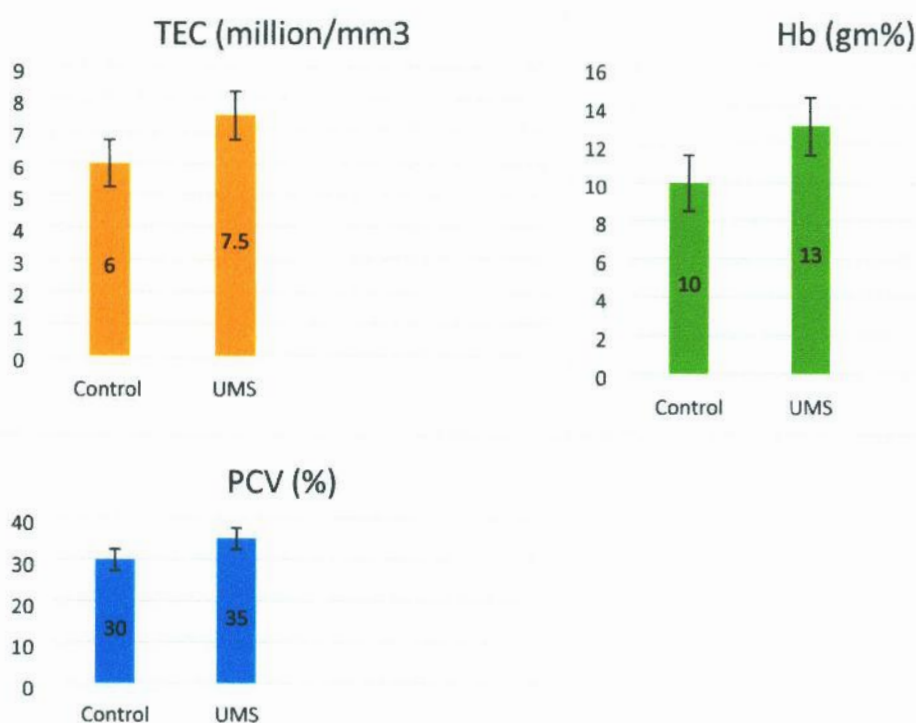


**Figure 2.3.** Impact of UMS feeding on PCV, Hb, and TEC. The figure displays the mean TEC, Hb, and PCV values. Group B is the UMS-treated group; Group A is the control group (normal straw). The information was presented as the mean  $\pm$  SD of ten animals per group. To compare the outcomes between the two groups, an unpaired t-test was employed. The following are the

statistical significance levels: \*\*=  $p < 0.01$ ) at the 1% level and \*=  $p < 0.05$  at the 5% level (Islam et al., 2023).

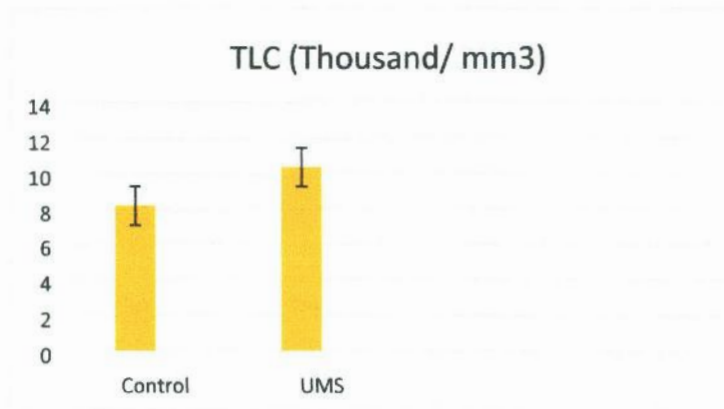


**Figure 2.4.** The impact of consuming UMS on TLC: The TLC mean values are displayed in the figure. Group B: the UMS-treated group, and Group A: the control group (normal straw). For every group of ten animals, the mean  $\pm$  SD was used to express the data. To compare the outcomes between the two groups, an unpaired t-test was employed (Islam et al., 2023).

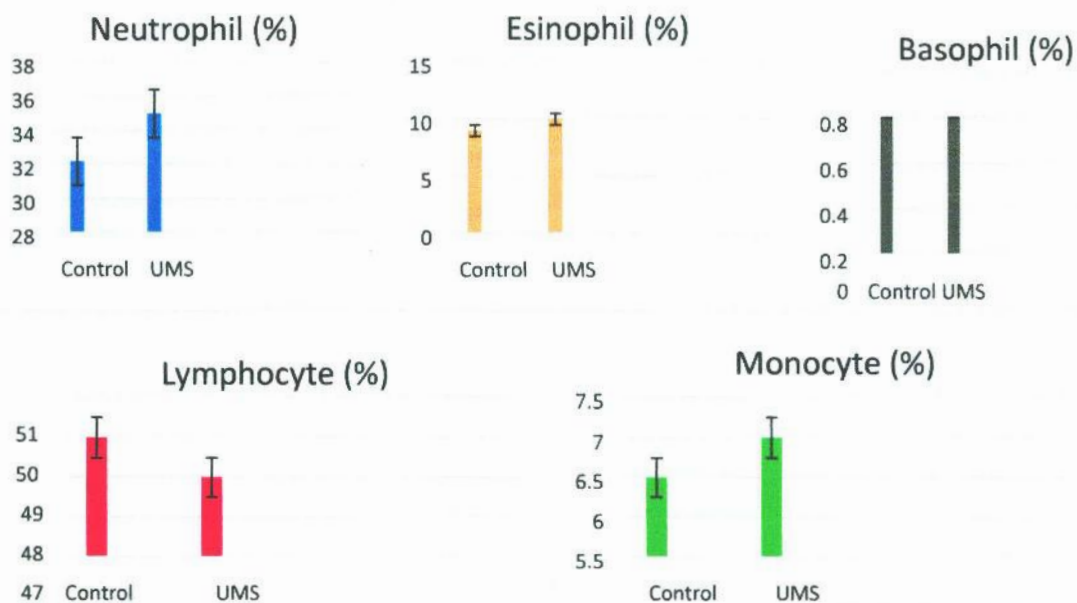


**Figure 2.5.** UMS feeding's impact on DLC. The following are the mean values for neutrophils, eosinophils, basophils, lymphocytes, and monocytes. Group B is the UMS-treated group, and Group A is the control group (normal straw). The data is given as the mean  $\pm$  SD of ten animals per group. A t-test without pairing was used to compare results between the two groups (Islam et al., 2023).

# Chapter III

## Materials and Methods

Materials and procedures provide in-depth information regarding the procedure that had been carried out throughout the course of the research. A part under "method" explains the procedure to carry out the work, while the "materials" section describes the raw materials, tools, and other items that were utilized in an experiment. The essence of a scientific paper lies in its ability to demonstrate credibility and validity. The term "research methodology" refers to the precise sets of methods or strategies that are utilized in order to find, select, process, and evaluate information pertaining to a subject. The methodology section in a research report gives the reader the opportunity to assess a study's general validity and dependability critically (Morrison et al., 2021). The term "research methodology" refers to a methodical approach to solving a research challenge. The current study was conducted to determine the effect of urea molasses straw (UMS) on the growth performance of crossbred sheep. In order for the researcher to obtain a structured summary, he was required to carefully observe and collect data that was tenable, effective, and dependable. It was necessary to collect the precise data at a predetermined time period in order to accomplish the goals. Within the scope of this chapter, I have covered the methodologies and processes that were utilized in the execution of the study.

### 3.1 Study area

The research was carried out at Agrotechnology Discipline, Khulna University in Khulna, Bangladesh. It is situated near Gollamari, which is in the Khulna district of Bangladesh, close to the Sher-e-Bangla Road and the Moyur river. The research region is under Harintana Police station. Under the Ganges Tidal Flood Plain, this region is part of the Agro-Ecological Zone (AEZ) (Rahaman et al., 2019). It is located at a latitude of 22.80 degrees north and 89.53 degrees east that the research facilities are located.

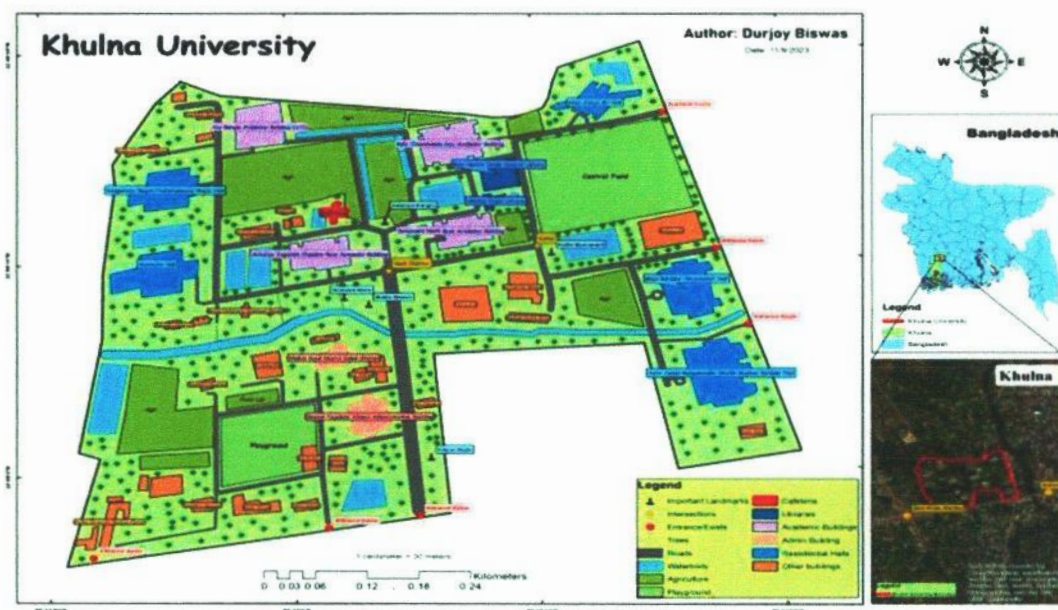
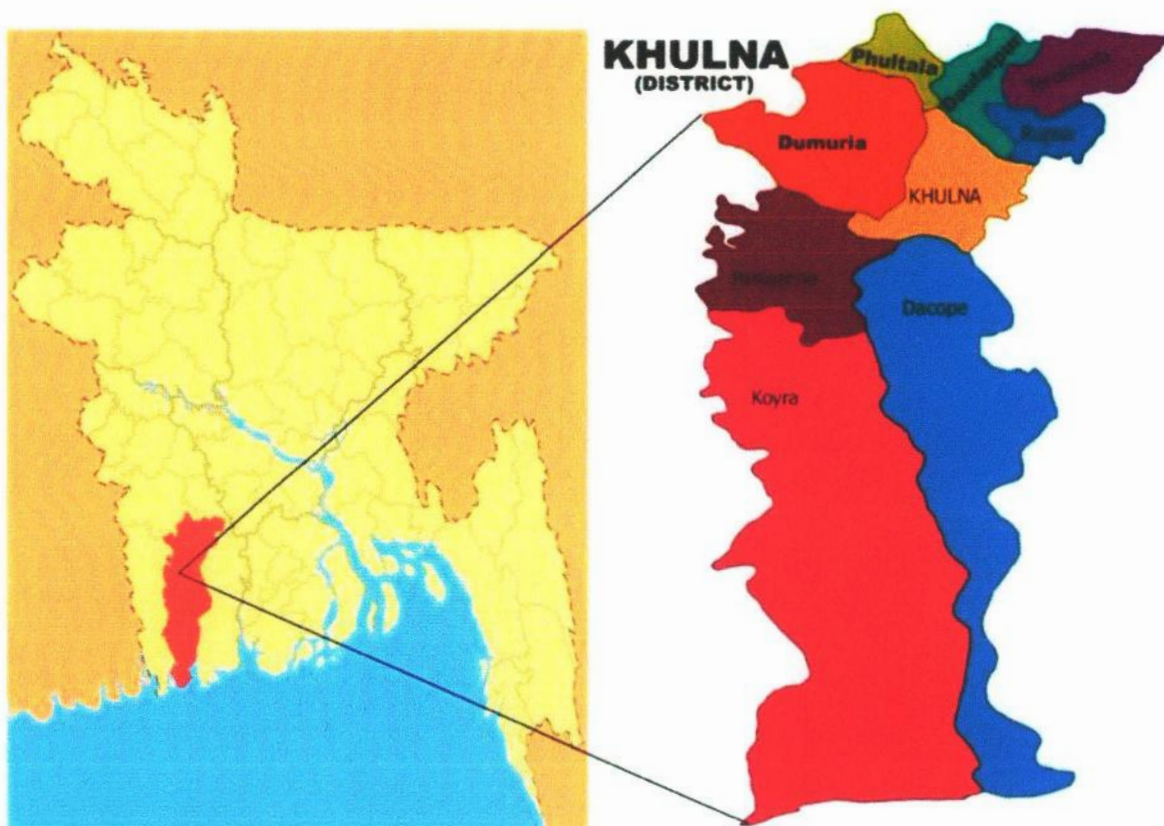


Figure 3.1: Study area

### 3.2 Design of experiment

Twelve sheep of 1 year of age was divided into 4 treatment groups having three replications for each. The experimental animals were weighed individually, blocked into four groups based on their initial live weight and randomly assigned to three different time periods of urea molasses feeding where one group (control:  $T_0$ ) was allowed to graze for 10 hours daily without feeding urea molasses straw. Among the treatment groups, three different time period of urea molasses straw (UMS) feeding were 1-hour, 1.5-hour and 2-hour in addition to the 10-hour of grazing of the control group. The trial design was based on Randomized Complete Block Design (RCBD).

The following parameters of sheep was be recorded during the feeding trial: a)

Body weight (kg)

b) Growth rate (g/day)

c) Survivability (%)

### 3.3 Housing of the experimental sheep

The traditional goal of housing sheep was to protect them from predators and bad weather, as well as to provide an extra urea molasses straw feeding. The residence has all the necessary amenities.



Photograph 3.1. Shed for crossbreed sheep

### ***3.3.1 Floor***

During two thirds of the trial, the sheep were housed on a bamboo slate floor; for the remaining one-third, they were moved to a sturdy construction house with a timber slate floor.



Photograph 3.2. Floor for sheep

### ***3.3.2 Water facilities***

The sheep had plenty of fresh water inside their shed. In addition, each animal group had its own waterer in the enclosure.

### ***3.3.3 Ventilation***

The sheep shed had been provided with adequate ventilation systems.

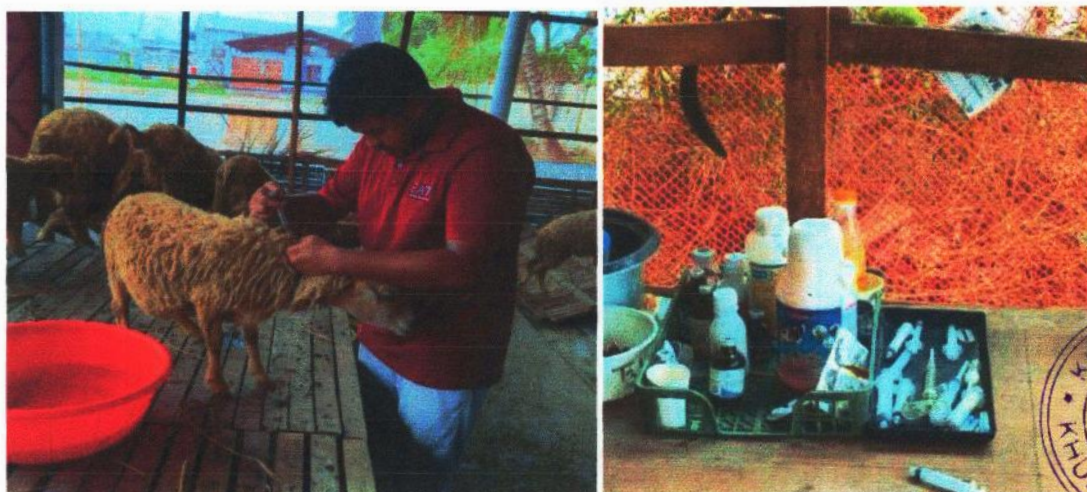
### ***3.3.4 Sanitation***

The living area was kept as dry as possible, and the entire shed, including the feeders and waterers, was cleaned every day in compliance with the regimen. Sanitation and appropriate housing measures were put in place to prevent parasites, bugs, and diseases. Experimental sheep receive vaccinations and dewormed. Getting rid of the hook, round, and tape worms that commonly infest animal bodies is the technique of deworming. To deworm the animals, an injection of the

antihelminthic drug A-Mectin Plus was administered. The sheep received these immunizations right away and then again after three months. The proper route and dosage were followed for administering the vaccines. The vaccination and deworming schedule are presented in Table 3.1.

Table 3.1. The vaccination and deworming routines for the experimental animals are as follows

| Date     | Name of vaccine/deworming | Dose per sheep | Route         |
|----------|---------------------------|----------------|---------------|
| 01.09.23 | A-Mectin Plus             | 0.5cc          | Sub-cutaneous |
| 01.10.23 | PPR                       | 1.00ml         | Sub-cutaneous |
| 01.12.23 | A-Mectin Plus             | 0.5cc          | Sub-cutaneous |



Photograph 3.3. Vaccination of sheep

### 3.3.5 Grazing of experimental sheep

The practice of grazing entails allowing livestock to consume weeds and other wild vegetations. During the day, all of the sheep utilized in the experiment were allowed to graze in natural grassland near the Agrotechnology Discipline field laboratory and along the road sides of the Khulna University campus. They were restricted to the shed at night. The experimental sheep were allowed to graze from 9:00 a.m. to 6:00 p.m. every day.

### 3.4 Composition of urea molasses treated straw

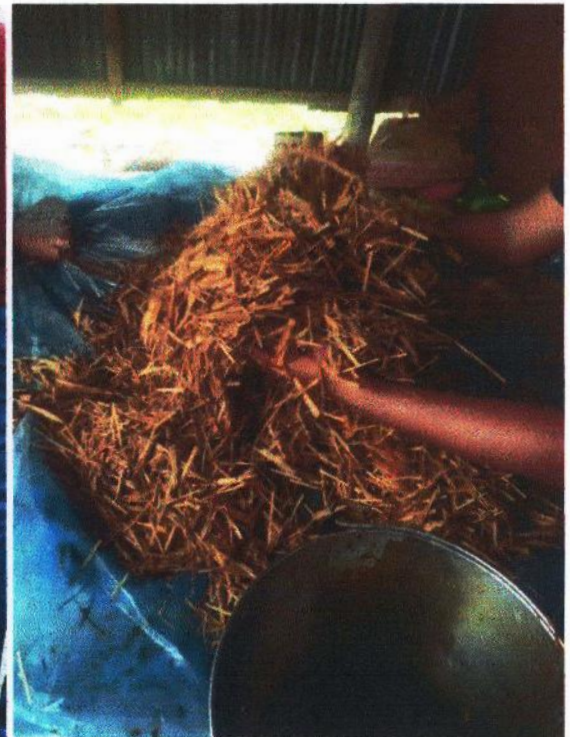
The ingredient composition of urea molasses straw is presented in Table 3.2. Proximate composition of urea molasses straw is presented in Table 3.3.

Table 3.2. The ingredient composition of urea molasses straw

| SL. No. | Ingredients | Quantity (%) |
|---------|-------------|--------------|
| 01.     | Molasses    | 15           |
| 02.     | Urea        | 3            |
| 03.     | Straw       | 82           |

### 3.5 Procedure of making urea molasses straw (UMS)

- Average 8.2 kg of dry and clean straw was chopped into small pieces and it was spread on a polyethene sheet.
- Three hundred grams of urea and 1.5 Kg molasses was mixed properly with 4 L of fresh water in a bucket.
- Half of the urea-molasses mixture was poured with a sprinkler onto the straw and mix well to ensure even distribution.
- Straw was turned and remaining half of the solution was spread over the straw evenly.
- The prepared UMS was covered with a polythene sheet to prevent the evaporation of nitrogen.



Photograph 3.4. Preparation of Urea molasses straw (UMS)

### 3.6 Composition of UMS for experimental sheep

#### 3.3. Proximate composition (%) of urea molasses straw fed to the experimental sheep

| Proximate components        | Mean $\pm$ SEM   |
|-----------------------------|------------------|
| Dry matter (DM)             | 36.67 $\pm$ 00   |
| Crude protein (CP)          | 8.47 $\pm$ 0.08  |
| Crude fiber (CF)            | 26.25 $\pm$ 0.23 |
| Ether extract (EE)          | 1.06 $\pm$ 0.14  |
| Ash                         | 17.39 $\pm$ 0.29 |
| Nitrogen-free extract (NFE) | 46.82 $\pm$ 0.19 |

### 3.7 Animal adaptation

Urea molasses straw (UMS) was gradually adapted over a minimum of 7 days by feeding them on a regular basis rather than all at once when the feeding period started. Because the animals' consumption may be higher than usual, this is especially important if they were underfed. Urea poisoning is more common in animals that are not acclimated to urea and eat quickly. Following the adaption phase, animal intakes return to about those originally indicated (200 to 300 gm). Setting a time limit on how long an animal could access the UMS was a straightforward way to control intake during the adaptation phase. Generally, I offered them 20 minutes every day for the first three days.

### 3.8 Urea molasses straw supplementation

Sheep in three treatment groups were given access to a urea molasses straw three time periods a day—1.0-hour, 1.5-hour and 2-hour per day. The control group was not allowed to feed UMS. Urea molasses straw was given for the allocated period of time in every morning. Three groups consumed the urea molasses straw: one group consumed it from 7 a.m. to 8.00 a.m., another group consumed it from 7 a.m. to 8.30 a.m., and a third group consumed it from 7 a.m. to 9.00 a.m. After that, they were let to graze.

### 3.9 Weight measurements of the experimental sheep

Each experimental animal was weighed individually. Every seven days, sheep weights were measured and recorded by a digital scale capable of weighing up to 50 kg.



Photograph 3.5. Weight measurements of the experimental sheep

### 3.10 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 ( $\text{g day}^{-1}$ )

- Survivality (%)

### **3.11 Data collection**

All the relevant data like

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

Body weights were measured 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) was determined.

### **3.12 Proximate analysis**

#### ***3.12.1 Crude protein analysis***

##### ***Test procedures***

##### ***Digestion***

Using the DK 8 Heating Digester VELP SCIENTIFICA, the digestion process was finished. The weight of 1 gram of sample was measured to within  $\pm 0.1$  milligrams. Twelve milliliters (98%) of H<sub>2</sub>SO<sub>4</sub> and two catalysts were added to each sample before it was put in the digesting block. For 60 minutes, the sample was heated until the odors subsided, and the digesting block's temperature was kept at 420°C. The sample was then cooled to between 50 and 60°C.

### ***The process of distillation***

The distillation procedure was carried out by VELP SCIENTIFICA's UDK 129 Distillation Unit. After the sample had been allowed to cool, it was combined with fifty milliliters of distilled water. Along with the solution, fifty milliliters of sodium hydroxide were added. 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. The process of distillation was carried out till the color of the indicator mixture solution did not change into a green color.

### ***Titration***

The flask sample was then removed for titration. The next step was to add 0.1% H<sub>2</sub>SO<sub>4</sub> drop by drop using a burette pipe. The process was carried out repeatedly until the conical flask's solution turned blue instead of green. The titration process was terminated when the color of the solution changed. Next, the titrate's strength was noted.

### ***Calculation***

$$CP = \frac{(\text{ml HCL sample} - \text{ml HCL blank}) \times \text{conc. HCL } 14.007 \times 100}{\text{Wight of sample} \times 1000}$$

### ***3.12.2 Crude fibre analysis***

#### ***Test methodology***

An analysis of crude fiber was carried out utilizing the VELP SCIENTIFICA FIWE Raw Fiber Extractor. A 1 g sample was placed in crucibles that had the channels fixed. With three to five drops of n-octanol added as an anti-foam agent, 150 milliliters of 1.25% HCL were placed in the analyzer flask. The fiber analyzer's switch was activated, and it was now operational. Boil for precisely thirty minutes. Filter the residual agent thirty minutes later. It is recommended that washing be performed three times using thirty milliliters (crucible filled to the top) of hot deionized water, with each application requiring a connection to compressed air in order 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:** Crude Fibre (%)

$$= \frac{F_1 - F_2}{F_0} \times 100$$

Where,

F<sub>0</sub> = Weight of sample in gram

F<sub>1</sub> = Weight of oven dried sample in gram

F<sub>2</sub> = Weight of ash containing crucible in gram



**3.12.3 Ether extract analysis**

**Test method procedure:**

The VELP SCIENTIFICASER 148 Solvent Extractor was used to analyze ether extract. Sample: Three grams of uniformly powdered and weighed material (about one milligram) was placed in an extraction thimble. 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 extraction apparatus was filled with a sample that contained a thimble or a glass crucible that held a dry, hydrolyzed sample. 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. Immediately following the completion of the extraction unit, the flow of cooling water and heating water began. The glass crucibles or thimbles were placed in the "Immersion" position for 30 minutes after the solvent began to boil.

Washing: A glass crucible or thimble was set 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 vessel evaporated entirely.

Weighing: We weighed the extract-containing cups after they had cooled in a desiccator and had been dried for 30 minutes at 125°C.

***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

***3.12.4 Dry matter***

***Test procedure***

Envelopes were initially weighted ( $W_1$ ). Following harvesting, the fresh shoot weight ( $W_2$ ) of the UMS was measured, and the envelope was then filled with the sample before being dried in an oven at 105 degrees Celsius for a period of twenty-four hours. The dried sample with the envelope ( $W_3$ ) inside is 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

### 3.12.5 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 sample weighing approximately three grams was placed into a crucible that had been coated with tar. 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. Following rapid cooling in a desiccator to room temperature, crucibles were weighed and the resultant weight was noted ( $W_3$ ). A single decimal place was given for the estimated ash%.

#### *Calculation*

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

Where,

$W_1$  = Weight of crucible in gram

$W_2$  = Weight of sample in gram

$W_3$  = Weight of crucible and ash in gram

### 3.13 Data analysis

Data was collected and analyzed using R software on a PC. The study utilized analysis of variance to examine the impact of urea molasses straw on sheep growth rate. A significance level of  $p < 0.05$  was set for mean treatment comparisons. A daily gain average was used to measure the sheep's growth performance. Excel 2019 was used to amend the data. In order to accomplish the study's goals, data were tallied and examined using a descriptive statistical approach.

## Chapter IV

### Results and Discussion

#### 4.1 Body weight of crossbred sheep (Kg)

At week intervals, the average body weight of the crossbred sheep that were fed urea molasses straw for varied amounts of time is displayed in Table 4.1. Based on the data, it was observed that the body weight increased as the duration of the UMS feeding time increased; nevertheless, there was no statistically significant difference among the means ( $p>0.05$ ). Sheep that were given a daily supplementation time of two hours with UMS reported having the highest numerical body weight in every single weight at a week interval. Since the sheep were allowed to graze on UMS supplements, there was no noticeable change in the body weight of the sheep. Due to the abundance of natural grasses in their grazing area, the various times of UMS supplementation did not have a substantial impact on the percentage of their body weight that was affected. Based on the findings of Hoque et al. (2019), it was determined that the beginning body weight crossbred sheep of control group ( $T_0$ : feeding of untreated straw) was  $106.25 \pm 14.44$  kg, whereas the treatment groups ( $T_1$ : Urea-molasses treated paddy straw (40%) + Concentrate mixture (40%) + Green Fodder (oat) (20%) and  $T_2$ : Total Mixed Ration (TMR) form of  $T_1$  ration) had  $104.05 \pm 14.06$  kg and  $105.55 \pm 12.22$  kg initially. According to the findings of the statistical analysis, there was not a significant difference between the groups could be found ( $p>0.05$ ). They (Hoque et al., 2019) also stated that the final average body weights of crossbred calves at the conclusion of the trial, which lasted for a period of 90 days, were  $140.35 \pm 17.74$  kg,  $153.15 \pm 17.27$  kg, and  $157.65 \pm 19.23$  kg respectively for the control group ( $T_0$ ) and the treatment groups ( $T_1$  and  $T_2$ ). It is evident that the body weights of crossbreed calves are progressively rising with the increase in the proportion of UMS. In the current research, the starting body weight of  $T_0$  (just 10 hours of grazing without UMS feeding),  $T_1$  (UMS feeding for 1 hour along with 10 hours grazing),  $T_2$  (UMS feeding for 1.5 hour along with 10 hours grazing), and  $T_3$  (UMS feeding for 2 hours along with 10 hours grazing) were  $13.19 \pm 3.70$  kg,  $13.33 \pm 2.83$  kg,  $13.12 \pm 3.23$  kg, and  $13.85 \pm 0.13$  kg, respectively. After 13 weeks of receiving UMS supplementation, the ultimate body weight of the subjects in the  $T_0$ ,  $T_1$ ,  $T_2$ , and  $T_3$  groups was approximately  $16.22 \pm 3.45$  kg,  $18.45 \pm 1.13$  kg,  $19.50 \pm 3.67$  kg, and  $21.90 \pm 0.70$  kg, respectively. It was evident from the current findings that the body weights of

sheep gradually grew as the time duration of the UMS feeding was extended throughout the experiment.

Table 4.1. Body weight (Kg) of sheep fed urea molasses straw (UMS) at different time periods

| Weight category     | UMS feeding time (Kg; Mean $\pm$ SE) |                  |                  |                  | Level of significance |
|---------------------|--------------------------------------|------------------|------------------|------------------|-----------------------|
|                     | No UMS                               | 1-hour           | 1.5-hour         | 2-hour           |                       |
| Initial body weight | 13.19 $\pm$ 3.70                     | 13.33 $\pm$ 2.83 | 13.12 $\pm$ 3.23 | 13.85 $\pm$ 0.13 | NS                    |
| Weight at week 1    | 13.48 $\pm$ 3.75                     | 13.67 $\pm$ 2.63 | 13.52 $\pm$ 3.15 | 14.51 $\pm$ 0.69 | NS                    |
| Weight at week 2    | 13.72 $\pm$ 3.76                     | 13.98 $\pm$ 2.46 | 13.99 $\pm$ 3.23 | 15.03 $\pm$ 0.76 | NS                    |
| Weight at week 3    | 13.96 $\pm$ 3.75                     | 14.43 $\pm$ 2.24 | 14.48 $\pm$ 3.35 | 15.60 $\pm$ 0.87 | NS                    |
| Weight at week 4    | 14.22 $\pm$ 3.73                     | 14.82 $\pm$ 1.96 | 14.90 $\pm$ 3.29 | 16.16 $\pm$ 0.90 | NS                    |
| Weight at week 5    | 14.40 $\pm$ 3.67                     | 15.24 $\pm$ 1.67 | 15.37 $\pm$ 3.43 | 16.90 $\pm$ 0.95 | NS                    |
| Weight at week 6    | 14.60 $\pm$ 3.57                     | 15.57 $\pm$ 1.42 | 15.88 $\pm$ 3.48 | 17.57 $\pm$ 0.74 | NS                    |
| Weight at week 7    | 14.79 $\pm$ 3.60                     | 15.95 $\pm$ 1.35 | 16.30 $\pm$ 3.63 | 18.17 $\pm$ 0.76 | NS                    |
| Weight at week 8    | 15.02 $\pm$ 3.58                     | 16.30 $\pm$ 1.29 | 16.70 $\pm$ 3.69 | 18.80 $\pm$ 0.75 | NS                    |
| Weight at week 9    | 15.30 $\pm$ 3.57                     | 16.70 $\pm$ 1.21 | 17.30 $\pm$ 3.76 | 19.43 $\pm$ 0.65 | NS                    |
| Weight at week 10   | 15.83 $\pm$ 3.55                     | 17.06 $\pm$ 1.10 | 17.85 $\pm$ 3.72 | 20.00 $\pm$ 0.66 | NS                    |
| Weight at week 11   | 15.72 $\pm$ 3.50                     | 17.51 $\pm$ 1.06 | 18.48 $\pm$ 3.64 | 20.70 $\pm$ 0.53 | NS                    |
| Weight at week 12   | 15.93 $\pm$ 3.47                     | 18.01 $\pm$ 1.15 | 19.02 $\pm$ 3.68 | 21.33 $\pm$ 0.58 | NS                    |
| Weight at week 13   | 16.22 $\pm$ 3.45                     | 18.45 $\pm$ 1.13 | 19.50 $\pm$ 3.67 | 21.90 $\pm$ 0.70 | NS                    |

UMS = Urea molasses straw; NS = Not significant ( $p > 0.05$ )

## 4.2. Growth rate of crossbred sheep (g day<sup>-1</sup>)

The average growth rate of the crossbred sheep is presented in Table 4.2, which displays the data at weekly intervals. This growth rate is presented under a variety of UMS feeding periods. The mean growth rate of sheep throughout their fifth, seventh, eighth, and eleventh weeks exhibited substantial variation ( $p < 0.05$ ) based on the UMS supplementation they were provided, as evidenced by the data presented in the table. In the alternative scenario, there was no noticeable disparity in the mean discrepancy ( $p > 0.05$ ). Moreover, there were statistically significant differences in the average growth rates of sheep during their ninth, tenth, and twelfth weeks between UMS supplementations ( $p < 0.01$ ). This indicates that providing sheep with UMS for a duration of two hours was more effective in promoting a greater rate of growth. The growth rate of sheep at week 9 was highest for those fed for 2 hours with UMS ( $90.47a \pm 8.25$ ), followed by 1.5 hours ( $58.09a \pm 27.15$ ), 1 hour ( $50.95b \pm 10.72$ ), and the group that did not receive UMS ( $40.48b \pm 4.13$ ). At week 10, the highest growth rate was observed for sheep fed for 2 hours with UMS ( $80.95a \pm 8.24$ ), followed by 1.5 hours ( $78.57a \pm 18.90$ ), 1 hour ( $52.38ab \pm 21.82$ ), and the group that did not receive UMS ( $26.19b \pm 4.12$ ). Similarly, at week 12, the highest growth rate was observed for sheep fed for 2 hours with UMS ( $90.48a \pm 16.49$ ), followed by 1.5 hours ( $76.19a \pm 10.91$ ), 1 hour ( $71.43a \pm 21.43$ ), and the group that did not receive UMS ( $30.95b \pm 8.24$ ). All of these growth rates were significantly varied ( $p < 0.01$ ) compared to each other, measured in grams per day. The growth rate of sheep per day ranged from  $27.14b \pm 14.84$  to  $104.76a \pm 8.25$  during week 5. The group that had a 2-hour feeding UMS period had the highest growth rate, while the UMS non-supplemented group had the lowest. Within week 7, the growth rate ranged from  $26.67b \pm 4.59$  to  $85.71a \pm 14.29$ , with the highest growth rate observed in the 2-hour UMS feeding period group and the lowest in the UMS non-supplemented group. In week 8, the growth rate ranged from  $32.85b \pm 4.95$  to  $90.47a \pm 8.25$ , with the highest growth rate in the 2-hour feeding UMS period group and the lowest in the UMS non-supplemented group. In week 11, the growth rate ranged from  $33.33b \pm 10.91$  to  $100.00a \pm 24.74$ , with the highest growth rate in the 2-hour UMS feeding group and the lowest in the UMS non-supplemented group. All of these variations were statistically significant ( $p < 0.05$ ). According to Hoque et al. (2019), the group of crossbred calves that were fed urea-molasses treated straw based total mixed ration (TMR) had the highest increase in total body weight ( $52.10 \pm 7.16$  kg) during a 90-day period. The group that was fed treated straw separately

(T<sub>1</sub>) had the second highest weight gain (49.10±3.46 kg), while the control group (T<sub>0</sub>) had the lowest weight gain (34.10±3.57 kg). The average daily body weight gain per animal (g d<sup>-1</sup>) was substantially larger in groups T<sub>1</sub> and T<sub>2</sub> compared to group T<sub>0</sub>. The values were 578.89 ± 31.15, 545.56 ± 16.38, and 378.89 ± 18.40 for T<sub>2</sub>, T<sub>1</sub>, and T<sub>0</sub>, respectively. The difference in weight gain between the groups was statistically significant (p≤0.001). The findings of Trach (2003) in cow, Hassoun et al. (2002) in malnourished bull, and Emmanuel et al. (2015) in camel were supported by the study on body weight gain. The outcomes obtained from doing experiments are all comparable.

Table 4.2. Growth rate (g day<sup>-1</sup>) of sheep fed urca molasses straw (UMS) at different periods

| Weight category        | UMS feeding time (Mean ± SE) |                             |                             |                             | Level of significance |
|------------------------|------------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------|
|                        | No UMS                       | 1-hour                      | 1.5-hour                    | 2-hour                      |                       |
| Growth rate at week 1  | 41.43 ± 7.56                 | 48.57 ± 34.38               | 56.19 ± 10.91               | 95.24 ± 87.04               | NS                    |
| Growth rate at week 2  | 34.76 ± 5.77                 | 45.24 ± 28.00               | 68.09 ± 18.64               | 73.33 ± 10.81               | NS                    |
| Growth rate at week 3  | 34.28 ± 5.15                 | 64.28 ± 32.29               | 69.05 ± 22.15               | 82.86 ± 14.84               | NS                    |
| Growth rate at week 4  | 36.67 ± 27.16                | 55.24 ± 41.04               | 60.48 ± 7.87                | 80.00 ± 9.90                | NS                    |
| Growth rate at week 5  | 27.14 <sup>b</sup> ± 14.84   | 60.00 <sup>ab</sup> ± 44.54 | 66.67 <sup>ab</sup> ± 21.82 | 104.76 <sup>a</sup> ± 8.25  | *                     |
| Growth rate at week 6  | 27.62 ± 15.74                | 47.62 ± 35.24               | 73.80 ± 14.87               | 95.24 ± 35.95               | NS                    |
| Growth rate at week 7  | 26.67 <sup>b</sup> ± 4.59    | 53.81 <sup>ab</sup> ± 16.06 | 59.52 <sup>ab</sup> ± 27.04 | 85.71 <sup>a</sup> ± 14.29  | *                     |
| Growth rate at week 8  | 32.85 <sup>b</sup> ± 4.95    | 50.95 <sup>b</sup> ± 10.72  | 58.09 <sup>b</sup> ± 27.15  | 90.47 <sup>a</sup> ± 8.25   | *                     |
| Growth rate at week 9  | 40.48 <sup>b</sup> ± 4.13    | 50.95 <sup>b</sup> ± 10.72  | 58.09 <sup>a</sup> ± 27.15  | 90.47 <sup>a</sup> ± 8.25   | **                    |
| Growth rate at week 10 | 26.19 <sup>b</sup> ± 4.12    | 52.38 <sup>ab</sup> ± 21.82 | 78.57 <sup>a</sup> ± 18.90  | 80.95 <sup>a</sup> ± 8.24   | **                    |
| Growth rate at week 11 | 33.33 <sup>b</sup> ± 10.91   | 64.29 <sup>ab</sup> ± 25.75 | 90.48 <sup>a</sup> ± 10.91  | 100.00 <sup>a</sup> ± 24.74 | *                     |
| Growth rate at week 12 | 30.95 <sup>b</sup> ± 8.24    | 71.43 <sup>a</sup> ± 21.43  | 76.19 <sup>a</sup> ± 10.91  | 90.48 <sup>a</sup> ± 16.49  | **                    |
| Growth rate at week 13 | 40.48 ± 17.98                | 61.90 ± 4.13                | 69.05 ± 10.91               | 80.95 ± 21.82               | NS                    |

UMS = Urea molasses straw; NS = Not significant ( $p>0.05$ ); \* =  $p<0.05$ ; \*\*  $p<0.01$  a,b,c means with uncommon superscripts in a row differ significantly ( $p<0.05$ )

### 4.3. Mortality of sheep (%)

There was no mortality rate in the treatment group that consisted of T0 (no UMS), T2 (feeding of UMS for 1.5 hours), and T3 (feeding of UMS for 2 hours), and their survivability rate was 100%. However, the treatment group T1, which received 1 hour of UMS feeding, experienced a death rate of 33.33%. One animal in the treatment group died after delivering birth. The remaining two replication animals in this kind of treatment group were still living. The experiment resulted in a total mortality rate of 8.33% and a total survivability rate of 91.67% among the 12 animals that were involved in the study.

Table 4.3 The mortality rate (%) of sheep under various feeding durations of UMS.

| Treatments                            | Mortality (%) |
|---------------------------------------|---------------|
| T <sub>0</sub> (No UMS)               | 00%           |
| T <sub>1</sub> (1-hour UMS feeding)   | 33.33%        |
| T <sub>2</sub> (1.5-hour UMS feeding) | 00%           |
| T <sub>3</sub> (2-hour UMS feeding)   | 00%           |

## **Chapter V**

### **Summary, Conclusion and Recommendations**

#### **5.1 Summary**

Livestock plays a vital role in the subsistence agricultural farming of Bangladesh. It serves as the main source of protein for human consumption and also provide the main supply of organic manure for crops. Livestock also serve as a source of financial income for farmers and make a substantial contribution to the country's foreign exchange profits through the export of animal hides. Sheep have a significant impact on improving the rural economy of our country compared to other ruminants. Sheep are highly cost-effective animals and can adapt well to many weather conditions. Sheep farming significantly contributes to farmers' revenue generation and ensures their livelihood security. There is a lack of availability of conventional feed supplies such as pastures as a result of competition from other uses of land and seasonal availability problems. The ruminant livestock farmed in this region tend to mirror the cyclical fluctuations in both the quantity and quality of the available feed. The region has a big and consistent supply of rice straw, which is the primary agricultural leftover. This abundant resource can be utilized as the primary feed for sheep. Rice straws have a low nitrogen content, as well as low levels of vitamins and minerals. These factors impede the breakdown of cellulose by rumen microorganisms, which in turn limits the absorption of required nutrients for optimal animal performance, particularly in ruminants. Urea and molasses can enhance the nutrient content and palatability of rice straw, hence improving its quality.

A mixture of urea, molasses, and water is what makes up urea molasses straw (UMS). In many countries, they are utilized to assist with the resolution of nutritional issues that arise in animal feed, notably for ruminant animals.

The purpose of the study was to assess the effect that supplementation with urea molasses straw (UMS) has on the growth performance of sheep and to track the growth rate and weight gain of sheep that were fed urea molasses straw for varying amounts of time. However, this experiment had a number of limitations, which includes the fact that it was only conducted on the campus of Khulna University, the fact that the genetic traits of the cross-breed sheep that were utilized in this experiment were unknown, and the fact that the grass quality of the grazing land was unknown.

There was a total of twelve sheep and nine of them were female while the remaining three were male. They were about one to one and a half years old. The initial live weight of each animal was used to construct four treatment groups, and in order to ensure that each treatment group was replicated, three experimental animals were included in each treatment group. The weight of each individual animal used in the experiment was recorded. While one group of sheep was allowed to continue with their regular feeding routine, which included grazing for ten hours without being fed urea molasses straw, the other three groups of sheep were given urea molasses straw for three different durations: one hour, one and a half hours, and two hours. Randomized Complete Block Design (RCBD) was the basis for the experimental design. The following characteristics of the sheep were noted during the feeding experiment: growth rate ( $\text{g day}^{-1}$ ), bodyweight ( $\text{kg sheep}^{-1}$ ), and survivability rate (%).

According to the results of a proximate analysis, the chemical composition of urea molasses straw was determined. The UMS had the composition (%) of Dry matter (DM)  $36.67 \pm 0.0$ , Crude protein (CP)  $8.47 \pm 0.08$ , Crude fiber (CF)  $26.25 \pm 0.23$ , Ether extract (EE)  $1.06 \pm 0.14$ , Ash  $17.39 \pm 0.29$  and Nitrogen-free extract (NFE)  $46.82 \pm 0.19$ . As the UMS feeding period prolonged, there was an observed increase in body weight of sheep. The maximum numerical body weight that was documented in sheep that were given a daily supplementation time of two hours with UMS. Due to the presence of a large number of natural grasses in the sheep's grazing area, the various times of UMS supplementation did not have a significant impact on the sheep's body weight measurements. Within the  $T_0$ ,  $T_1$ ,  $T_2$ , and  $T_3$  groups, the ultimate body weight of the individuals was  $16.22 \pm 3.45$  kilograms,  $18.45 \pm 1.13$  kilograms,  $19.50 \pm 3.67$  kilograms,  $21.90 \pm 0.70$  kilograms, respectively, after a total of thirteen weeks of receiving UMS supplementation. There was a large amount of variation in the growth rate of sheep based on the UMS feeding periods. At the fifth, seventh, eighth, and eleventh weeks of experiment, the average growth rate of sheep was shown to be significantly different ( $p < 0.05$ ) dependent on the amount of UMS supplementation that they were prescribed. In feeding UMS, the growth rate ( $\text{g day}^{-1}$ ) was measured at week 9, two hours with UMS ( $90.47a \pm 8.25$ ), week 10 ( $80.95a \pm 8.24$ ), and week 12, ( $90.48a \pm 16.49$ ), all of which were significantly differed ( $p < 0.01$ ).

## 5.2 Conclusion

According to the results, there were no appreciable variations in the effects of urea molasses straw (UMS) on body weight, despite large variations in the growth rate of native crossbred sheep ( $\text{g day}^{-1}$ ) following various UMS feeding periods. On the other hand, the growth rate of crossbred sheep increased when the feeding period for urea molasses straw increased ( $\text{g day}^{-1}$ ). In crossbred sheep, the mean differences in growth rate ( $\text{g day}^{-1}$ ) did not differ between the groups that were supplemented, but there was a significant difference between the groups that were supplemented and those that were not supplemented. It may be deduced from this that in order to ensure that crossbred sheep achieve optimal growth, it is necessary to provide them with urea molasses straw for a period of one hour every day.

## 5.3 Recommendations

### 5.3.1 General recommendations

- I. The findings of the research should be accessible to the farmers.
- II. The Government should take necessary measures, such as organizing training programs, issuing posters, and raising awareness among the public, in response to the research findings.
- III. Non-governmental organizations (NGOs), in collaboration with the government, should implement measures to enhance sheep farming through the provision of training, loans, opportunities, and the promotion of awareness.
- IV. In order to stimulate greater interest in this industry among farmers, it is crucial to incentivize and endorse accomplished producers.
- V. Engaging important stakeholders, such as farmers, extension services, policymakers, and industry representatives, to raise awareness, capacity, and implementation of UMS-based feeding practices in sheep farming.
- VI. Farmers should have access to economical and high-quality UMS supplements, as well as suitable grazing lands.

- VII. District or upazila offices, as well as organizations that are concerned about sheep farming, should take the necessary efforts to carry out extension activities that are associated with sheep farming. Additionally, it is necessary that they give them comprehensive information on UMS preparation to the farmers.
- VIII. Enough veterinarians ought to be assigned to the rural regions.

### ***5.3.2 Recommendation for further studies***

- I. Further study is needed to determine how urea molasses straw (UMS) feeding affects crossbred sheep growth and performance.
- II. The current research was conducted on the campus of Khulna University, and is not representative of the entire southwest coastal regions. In light of this, more study may be carried out in Bangladesh's other coastal and non-coastal regions as well.

## Chapter VI

### References

- Agbagla-Dohnani, A., Noziere, P., GAILLARD-MARTINIE, B., Puard, M., & Doreau, M. (2003). Effect of silica content on rice straw ruminal degradation. *The Journal of Agricultural Science*, 140(2), 183-192. <http://dx.doi.org/10.1017/S0021859603003034>
- Ahmed, S., Rakib, M. R. H., Yesmin, M., Sultana, N., Jahan, N., & Ershaduzamman, M. (2018). Evaluation of lamb production potentiality of the Barind, Jamuna River basin and coastal region sheep of Bangladesh under intensive management. *Journal of Advanced Veterinary and Animal Research*, 5(1), 37-43. <http://doi.org/10.5455/javar.2018.e243>
- Akinfemi, A. (2010). Bioconversion of peanut husk with white rot fungi: *Pleurotus ostreatus* and *Pleurotus pulmonarius*. *Livestock Research for Rural Development*, 22(3), 1-11. <https://lrrd.cipav.org.co/lrrd22/3/akin22049.htm>
- Akinfemi, A., & Ogunwole, O. A. (2012). Chemical composition and in vitro digestibility of rice straw treated with *Pleurotus ostreatus*, *Pleurotus pulmonarius* and *Pleurotus tuberregium*. *Slovak Journal of Animal Science*, 45(1), 14-20. [file:///C:/Users/USER/Downloads/Akinfemi\\_A\\_and\\_Ogunwole\\_O\\_A\\_2012\\_Chemical\\_composit.pdf](file:///C:/Users/USER/Downloads/Akinfemi_A_and_Ogunwole_O_A_2012_Chemical_composit.pdf)
- Al Mansur, M. A., Alam, M. G. S., Jha, P. K., Rimon, M. A., Naher, N., & Bari, F. Y. (2018). Productive and reproductive performances of Sheep at field level of Rajshahi and Mymensingh District of Bangladesh. *Asian Journal of Medical and Biological Research*, 4(1), 63-68. <http://doi.org/10.3329/ajmbr.v4i1.36823>
- Alam, M. M., Hashem, M. A., Rahman, M. M., Hossain, M. M., Haque, M. R., Sobhan, Z., & Islam, M. S. (2013). Effect of heat stress on behavior, physiological and blood parameters of goat. *Progressive Agriculture*, 22(1-2), 37-45. <https://doi.org/10.3329/pa.v22i1-2.16465>

- Alemu, Y. (2008). Nutrition and feeding of sheep and goats. Sheep and goat production system in Ethiopia, chapter seven. *Sheep and goat production handbook for Ethiopia, Ethiopian Sheep and Goat production improvement program*, 104-156.  
[https://www.researchgate.net/publication/292149329\\_Alemu\\_Yami\\_2008\\_Nutrition\\_and\\_feeding\\_of\\_Sheep\\_and\\_Goats\\_In\\_Sheep\\_and\\_Goat\\_Production\\_Handbook\\_for\\_Ethiopia\\_Alemu\\_Yami\\_and\\_RC\\_Merkel\\_Editors\\_Pp110-167](https://www.researchgate.net/publication/292149329_Alemu_Yami_2008_Nutrition_and_feeding_of_Sheep_and_Goats_In_Sheep_and_Goat_Production_Handbook_for_Ethiopia_Alemu_Yami_and_RC_Merkel_Editors_Pp110-167)
- Arias, C., Burroughs, W., Gerlaugh, P., & Bethke, R. M. (1951). The influence of different amounts and sources of energy upon in vitro urea utilization by rumen microorganisms. *Journal of Animal Science*, 10(3), 683-692. <https://doi.org/10.2527/jas1951.103683x>
- Asaduzzaman, M., Saha, A., Jemy, M. A., Datta, P. K., Alam, M. G. S., & Bari, F. Y. (2022). Morphometric traits with reproduction and production performances of indigenous and exotic sheep breeds of Bangladesh: <https://doi.org/10.12982/VIS.2022.014>. *Veterinary Integrative Sciences*, 20(1), 163-184. <https://doi.org/10.12982/VIS.2022.014>
- Awgichew, K. (2000). Comparative performance evaluation of Horro and Menz sheep of Ethiopia under grazing and intensive feeding conditions. <https://edoc.huberlin.de/handle/18452/15243>
- Baset, M. A., Rahman, M. M., Ali, M. L., Mahbub, A. S. M., & Haque, M. N. (2002). Effect of urea molasses straw (UMS) on the performance of steers (local zebu cattle) with supplementation of wheat bran. *Pakistan Journal of Biological Sciences*, 5(7). <https://agris.fao.org/search/en/providers/122650/records/64723e472c1d629bc978e60d>
- Baset, M. A., Rahman, M. M., Islam, M. S., Ara, A., & Kabir, A. S. M. (2003). Beef cattle production in Bangladesh-A Review. *Online Journal of Biological Sciences*, 3(1), 8-25. <https://doi.org/10.3923/jbs.2003.8.25>
- BBS. (2008). (Bangladesh Bureau of Statistics) Preliminary Report of Agricultural Census, Bangladesh Bureau of Statistics, Ministry of Planning, Government of the People's Republic of Bangladesh.

[https://www.fao.org/fileadmin/templates/ess/ess\\_test\\_folder/World\\_Census\\_Agriculture/Country\\_info\\_2010/Reports/Reports\\_3/BGD\\_ENG\\_REP\\_2008.pdf](https://www.fao.org/fileadmin/templates/ess/ess_test_folder/World_Census_Agriculture/Country_info_2010/Reports/Reports_3/BGD_ENG_REP_2008.pdf)

- Begum, I. A., Alam, M. J., Buysse, J., Frija, A., & Van Huylenbroeck, G. (2012). Contract farmer and poultry farm efficiency in Bangladesh: a data envelopment analysis. *Applied Economics*, 44(28), 3737-3747. <https://doi.org/10.1080/00036846.2011.581216>
- Berihulay, H., Abied, A., He, X., Jiang, L., & Ma, Y. (2019). Adaptation mechanisms of small ruminants to environmental heat stress. *Animals*, 9(3), 75. <https://doi.org/10.3390/ani9030075>
- Berruecos, V. J. (1975). Reproduccion y manejo del borrego Tabasco o Peligüey. *Tecnica Pecuaria en Mexico*.  
<https://agris.fao.org/search/en/providers/123819/records/64735b5d53aa8c89630852fb>
- Bhuiyan, A. K. F. H. (2006, April). Livestock genetic resources in Bangladesh: Preservation and Management. In *International conference on livestock services, Chinese Academy of Agricultural Science (CAAS), Beijing, China* (Vol. 6, pp. 16-20).
- Bortree, A. L., Dunn, K. M., Ely, R. E., & Huffman, C. F. (1946). A preliminary report on the study of factors influencing rumen microflora.
- Bradley, N. W., Overfield, J. R., & Little, C. O. (1966). Source of nitrogen for supplementing ground ear corn rations--1965. *Progress report-Kentucky Agricultural Experiment Station*.
- Brannon, W. F., Reid, J. T., & Miller, J. I. (1954). The influence of certain factors upon the digestibility and intake of pasture herbage by beef steers. *Journal of Animal Science*, 13(3), 535-542. <https://doi.org/10.2527/jas1954.133535x>
- Bray, C. I. (1945). Feeding blackstrap molasses to fattening steers. <https://repository.lsu.edu/cgi/viewcontent.cgi?article=1107&context=agexp>
- Brown, P. B. (1967). Roughage-molasses rations for wintering beef cattle. <https://repository.lsu.edu/cgi/viewcontent.cgi?article=1834&context=agexp>

- Burroughs, W., Latona, A., DePaul, P., Gerlaugh, P., & Bethke, R. M. (1950). Mineral influences upon urea utilization and cellulose digestion by rumen microorganisms using the artificial rumen technique. *Journal of Animal Science*, 10(3), 693-705. <https://doi.org/10.2527/jas1951.103693x>
- Burroughs, W., Long, J., Gerlaugh, P., & Bethke, R. M. (1950). Cellulose digestion by rumen microorganisms as influenced by cereal grains and protein-rich feeds commonly fed to cattle using an artificial rumen. *Journal of Animal Science*, 9(4), 523-530. <https://doi.org/10.2527/jas1950.94523x>
- Cherdthong, A., Suntara, C., Khota, W., & Wanapat, M. (2021). Feed utilization and rumen fermentation characteristics of Thai-indigenous beef cattle fed ensiled rice straw with *Lactobacillus casei* TH14, molasses, and cellulase enzymes. *Livestock Science*, 245, 104405. <https://doi.org/10.1016/j.livsci.2021.104405>
- Chowdhury, S. A., & Huque, K. S. (1996). Study on the development of a technique for preserving straw under wet condition in Bangladesh. *Asian-Australasian Journal of Animal Sciences*, 9(1), 91-99. <https://doi.org/10.5713/ajas.1996.91>
- Chowdhury, S. A., & Huque, K. S. (1998). Effect of Molasses or Rice Gruel Inclusion to Urea Supplemented Rice Straw on Its Intake, Nutrient Digestibilities, Microbial N Yield, N Balance and Growth Rate of Native (*Bos indicus*) Growing Bulls. *Asian-Australasian journal of animal sciences*, 11(2), 145-151. <https://doi.org/10.5713/ajas.1998.145>
- Colpan, I., Tuncer, Ş. D., Önel, A. G., & Yıldız, G. (1995). The effects of zeolite on fattening performance and carcass characteristics of Limousin× Jersey (F1) crossbred bulls. <https://www.cabidigitallibrary.org/doi/full/10.5555/19971410188>
- Combellas JB, deMartinez N, Gonzalez EJ. (1979). Estudio de algunos factores que influyen en el peso al naciementoy al destete en corderos VII Reunion Asociacion Latincamericana de Production Animal Panama. Delhi, India.

- Combellas, J. D. (1980). Production and reproduction parameters of tropical sheep breeds in improved production systems. *Tropical Animal Production*, 5(3), 266-272.  
[https://www.cipav.org.co/TAP/TAP/TAP53/53\\_11.pdf](https://www.cipav.org.co/TAP/TAP/TAP53/53_11.pdf)
- Crawford, D. F., Anthony, W. B., & Harris, R. R. (1978). Evaluation of concentrated hemicellulose extract as cattle feed. *Journal of Animal Science*, 46(1), 32-40.  
<https://doi.org/10.2527/jas1978.46132x>
- Daniel, S. J., Hasan, Q. Z., & Nath, K. (1986). Compensatory growth in crossbred calves fed on urea-molasses liquid diet.  
<https://www.cabidigitallibrary.org/doi/full/10.5555/19871490390>
- Davison, T. M., Isles, D. H., & McGuigan, K. R. (1986). The effect of dietary supplementation with molasses and Christmas Is. phosphate on milk yield of cows grazing tropical pastures.  
<https://www.cabidigitallibrary.org/doi/full/10.5555/19871490908>
- Devendra, C., & Leng, R. A. (2011). Feed resources for animals in Asia: issues, strategies for use, intensification and integration for increased productivity. *Asian-Australasian Journal of Animal Sciences*, 24(3), 303-321. <https://doi.org/10.5713/ajas.2011.r.05>
- DLS (Department of Livestock Services). (2015). General information related to livestock. Annually Fisheries and Livestock Bulletin, published by Fisheries and Livestock Information Office, Khamarbari, Farmgate, Dhaka, Bangladesh.
- DLS. (2019). Livestock Economy Report. Department of Livestock Services, Bangladesh.  
[https://dls.portal.gov.bd/sites/default/files/files/dls.portal.gov.bd/page/ee5f4621\\_fa3a\\_40a\\_c\\_8bd9\\_898fb8ee4700/2023-07-23-12-04-afbccccb96f8b27d4bab6501aa8c2c2ff.pdf](https://dls.portal.gov.bd/sites/default/files/files/dls.portal.gov.bd/page/ee5f4621_fa3a_40a_c_8bd9_898fb8ee4700/2023-07-23-12-04-afbccccb96f8b27d4bab6501aa8c2c2ff.pdf)
- DLS. (2021). Livestock Economy Report. Department of Livestock Services. GOB, Dhaka, Bangladesh.  
[https://dls.portal.gov.bd/sites/default/files/files/dls.portal.gov.bd/page/ee5f4621\\_fa3a\\_40a\\_c\\_8bd9\\_898fb8ee4700/2022-07-18-03-43-37d18965a6458cda3c542ab146480962.pdf](https://dls.portal.gov.bd/sites/default/files/files/dls.portal.gov.bd/page/ee5f4621_fa3a_40a_c_8bd9_898fb8ee4700/2022-07-18-03-43-37d18965a6458cda3c542ab146480962.pdf)

- El-Said, A. H. M. "Mycotoxins and invertase enzyme of the mycoflora of molasses in Upper Egypt." *Mycobiology* 30.3 (2002): 170-174  
<https://www.tandfonline.com/doi/epdf/10.4489/MYCO.2002.30.3.170?needAccess=true>
- Emmanuel, N., Patil, N. V., Bhagwat, S. R., Lateef, A., Xu, K., & Liu, H. (2015). Effects of different levels of urea supplementation on nutrient intake and growth performance in growing camels fed roughage based complete pellet diets. *Animal Nutrition*, 1(4), 356-361.  
<https://doi.org/10.1016/j.aninu.2015.12.004>
- FAO. 2008. Production Year Book, 41: 89.  
<https://openknowledge.fao.org/server/api/core/bitstreams/61c29fcf-f3ae-49cc-a2edbc6bb580898b/content>
- Faylon, P. S. (1989). Sheep production and development in the Philippines. In *Contributions to a Proceeding of a Workshop on Sheep production in Asia* (pp. 166-183). <https://hdl-bncidrc.dspacedirect.org/server/api/core/bitstreams/ab849197-f4f4-4bb5-bfc8a95e80178ece/content#page=179>
- Foreman, C. F., & Herman, H. A. (1953). *Effects of carbohydrate feeding levels on roughage digestion in dairy cattle*. University of Missouri, College of Agriculture, Agricultural Experiment Station. <https://hdl.handle.net/10355/57841>
- Freeman, A. S., Galyean, M. L., & Caton, J. S. (1992). Effects of supplemental protein percentage and feeding level on intake, ruminal fermentation, and digesta passage in beef steers fed prairie hay. *Journal of Animal Science*, 70(5), 1562-1572.  
<https://doi.org/10.2527/1992.7051562x>
- Ganai, A. M., & Teli, M. A. (2010). Nutritive value of urea and fungal treated paddy straw on nutrient utilization in sheep.  
<https://www.cabidigitallibrary.org/doi/full/10.5555/20113196270>
- Gunun, P., Wanapat, M., & Anantasook, N. (2013). Rumen fermentation and performance of lactating dairy cows affected by physical forms and urea treatment of rice straw. *Asian*

<https://doi.org/10.5713%2Fajas.2013.13094>

- Ha, J. K., Lee, S. S., Moon, T. H., McAllister, P., Cheng, K. J., & Bae, H. D. (1994). Studies on improving the nutritive value of rice straw by chemical treatment-(7)-Effects of chemical treatment of rice straw on attachment to rice stems by microorganisms in the rumen of holstein dairy cows. *Korean Journal of Animal Nutrition and Feedstuffs (Korea Republic)*, 18(1).  
<https://agris.fao.org/search/en/providers/122646/records/647226ab2a40512c710f422d>
- Hamito, D. (2009). Shelters and Housing for Sheep and Goats. *Technical bulletin*, (32).  
<https://docplayer.net/7329746-Technical-bulletin-no-32-shelters-and-housing-for-sheepand-goats.html>
- Haq, S. (1991). Livestock development in Bangladesh: Some reflections.  
<https://agris.fao.org/search/en/providers/122479/records/6471ec6377fd37171a7130d1>
- Haque, M. I., Sarder, M. J. U., Islam, M. A., Khaton, R., Islam, M. H., & Hashem, M. A. (2020). Morphometric characterization of Barind sheep of Bangladesh. *Journal of Earth and Environmental Science*, 4(192), 2577-0640. <http://dx.doi.org/10.29011/2577-0640.100192>
- Hashem, M. A., Hossain, M. M., Rana, M. S., Hossain, M. M., Islam, M. S., & Saha, N. G. (2013). Effect of heat stress on blood parameter, carcass and meat quality of Black Bengal goat.  
<http://dx.doi.org/10.3329/bjas.v42i1.15783>
- Hashem, M. A., Islam, T., Hossain, M. A., Kamal, M. T., Sun, M. A., & Rahman, M. M. (2020). Production performance of Jamuna basin lamb under semi-intensive management system in Bangladesh. *Journal of Animal and Veterinary Advances*, 19(11), 150-158.  
[https://www.researchgate.net/profile/Md-Kamal/publication/346714077\\_Production\\_Performance\\_of\\_Jamuna\\_Basin\\_Lamb\\_under\\_Semi-](https://www.researchgate.net/profile/Md-Kamal/publication/346714077_Production_Performance_of_Jamuna_Basin_Lamb_under_Semi-)

[Intensive Management System in Bangladesh/links/5fd12eda45851568d1508164/Production-Performance-of-Jamuna-Basin-Lamb-under-Semi-Intensive-Management-System-in-Bangladesh.pdf](#)

Hassan, A. A., & Mohamed, S. F. (2012). Chemical composition and digestibility of urea-calcium hydroxide treated barley straw, date palm frond and corn cobs with and without molasses. *Al-Anbar J. Vet. Sci*, 5(1), 103-115.

[https://iraqjournals.com/article\\_59345\\_0.html](https://iraqjournals.com/article_59345_0.html)

Hassoun, P., Fulcheri, C., & Nabeneza, S. (2002). Feeding dairy heifers untreated or urea-treated fibrous sugarcane residues: effect on dry matter intake, growth, and metabolic parameters. *Animal feed science and technology*, 100(1-2), 31-41. [https://doi.org/10.1016/S0377-8401\(02\)00143-8](https://doi.org/10.1016/S0377-8401(02)00143-8)

Heinemann, W. W., & Hanks, E. M. (1977). Cane molasses in cattle finishing rations. *Journal of Animal Science*, 45(1), 13-17. <https://doi.org/10.2527/jas1977.45113x>

Hendratno, K. (1988). *Induced mutations in soybean for earliness and tolerance to high concentrations of aluminium in high acid soil* (p. 463).

<https://www.cabidigitallibrary.org/doi/full/10.5555/19901616680>

Henning, P. A., Van Der Linden, Y., Mattheyse, M. E., Nauhaus, W. K., Schwartz, H. M., & Gilchrist, F. M. (1980). Factors affecting the intake and digestion of roughage by sheep fed maize straw supplemented with maize grain. *The Journal of Agricultural Science*, 94(3), 565-573.

<https://www.semanticscholar.org/paper/Factors-affecting-the-intake-and-digestion-of-by-Henning-Linden/faaa9c105aa9a660e69fdb2f8f12bc194f293b0d>

Hoque, E., Dutta, T. K., Chatterjee, A., & Satapath, D. (2019). Effects of feeding urea molasses treated straw based total mixed ration on growth performance in cross bred Calves. *Int J Chem Stud*, 7(1), 1581-4.

<https://www.chemijournal.com/archives/2019/vol7issue1/PartAA/7-1-344-950.pdf>

- Hossain MA, Rahman MM, Rahman MW, Hossain MM, Hashem MA. (2021). Optimization of slaughter age of Jamuna Basin lamb based on carcass traits and meat quality. *SAARC Journal of Agriculture*, 19 (2): 257-270. <https://doi.org/10.3329/sja.v19i2.57686>
- Hossain, M. A., Akhtar, A., Easin, M., Maleque, M. A., Rahman, M. F., & Islam, M. S. (2018). Women livelihood improvement through sheep (*Ovis aries*) rearing in Sirajganj district of Bangladesh. *Int J Nat Soc Sci*, 5, 1-8. <https://ijnss.org/wp-content/uploads/2018/06/IJNSS-V5I3-1-pp-01-08-1.pdf>
- Hossain, M. D., Hossain, M. M., Hashem, M. A., & Bhuiyan, K. J. (2016). Organic beef cattle production pattern at Shahjadpur upazilla of Sirajgonj district in Bangladesh. <http://dx.doi.org/10.3329/bjas.v45i1.27484>
- Hossain, M. M., Hashem, M. A., & Hossain, M. S. (1997). Relationship of carcass and non-carcass parameters with live weight of sheep. *Bangladesh Journal of Animal Science*, 26, 39-44.
- Hossain, M. M., Khan, M. J., & Akbar, M. A. (2010). Nutrient digestibility and growth of local bull calves as affected by feeding urea and urease enzyme sources treated rice straw. *Bangladesh Journal of Animal Science*, 39(1-2), 97-105. <http://dx.doi.org/10.3329/bjas.v39i1-2.9682>
- Hossain, M. S., Haque, M. N., Aziz, S. A., Mazumder, M. S., Ali, M. L., & ME-Elahi, A. T. M. (2002). Effect of urea molasses straw on the productive and reproductive performance of indigenous cows under the village conditions of Bangladesh. *Pakistan Journal of Biological Science*, 9, 997-999. <https://doi.org/10.3923/pjbs.2002.997.999>  
<https://doi.org/10.3923/pjbs.2002.997.999>
- Hossen, M. J., Hossain, M. S., Abedin, M. J., Karim, M. R., & Rume, F. I. (2008). Animal production strategies in southern region of Bangladesh. *The Agriculturists*, 6(1&2), 77-83. <http://dx.doi.org/10.3329/agric.v6i1.5217>
- Hue, K. T., & Ledin, I. (2008). Effect of supplementing urea treated rice straw and molasses with different forage species on the performance of lambs. *Small Ruminant Research*, 78(1-3), 134-143. <http://dx.doi.org/10.1016/j.smallrumres.2008.05.010>

- Huque, K. S., & Talukder, A. I. (1994). Effect of supplementation of straw diet with molasses on growth performance of growing bulls. *Asian Australasian J Animal Sc*, 8. <https://www.animbiosci.org/upload/pdf/10-6.pdf>
- Husain, S. S., & Amin, M. R. (2003). Genetic resource conservation and utilization: participatory maintenance of animal Genetics resource at rural level in Bangladesh. *Paper presented Genetic resource conservation, Bangladesh Livestock Research Institute, Savar Dhaka, Bangladesh.*
- Islam, M., & Huque, K. S. (1995). On farm evaluation of urea molasses straw (UMS) feeding to lactating cows. *Asian-Australasian Journal of Animal Sciences*, 8(5), 523-527. <https://www.animbiosci.org/upload/pdf/8-79.pdf>
- Islam, O., Akter, S., Islam, M. A., Jamee, D. K., & Khan, R. I. (2018). Preparation of wastelage with poultry droppings and rice straw (*Oryza sativa* L.) as a cattle feed. *Asian Journal of Medical and Biological Research*, 4(3), 251-258. <https://doi.org/10.3329/ajmbr.v4i3.38463>
- Islam, S., Bhuiyan, M. E. J., Hossain, M. G., Bhuiyan, M. E. R., & Akter, S. (2023). Effects of urea molasses straw on growth performance and hemato-biochemical parameters in Sahiwal steers. *Journal of Advanced Biotechnology and Experimental Therapeutics*, 2023; 6(1): 265-275. <https://doi.org/10.5455/jabet.2023.d124>  
<https://doi.org/10.5455/jabet.2024.d37>
- Jackson, M. G. (1977). Rice straw as livestock feed. *World Animal Review*, 23(25), 79-81. <https://www.fao.org/4/X6512E/X6512E07.htm>
- Jackson, M. G. (1982). Evolving a strategy for maximum livestock production on minimum land: the first annual seminar and developments resulting from it [model of Bangladesh agriculture, straw treatment]. <https://agris.fao.org/search/en/providers/122514/records/647124653c73b155c84983ab>

- Jayanegara, A., Marquardt, S., Wina, E., Kreuzer, M., & Leiber, F. (2013). In vitro indications for favourable non-additive effects on ruminal methane mitigation between high-phenolic and high-quality forages. *British Journal of Nutrition*, 109(4), 615-622. <https://doi.org/10.1017/S0007114512001742>
- Johnson, B. C., Hamilton, T. S., Mitchell, H. H., & Robinson, W. B. (1942). The relative efficiency of urea as a protein substitute in the ration of ruminants. *Journal of Animal Science*, 1(3), 236-245. <https://doi.org/10.2527/jas1942.13236x>
- Kamal, M. T., Hashem, M. A., Al-Mamun, M., Hossain, M. M., & Razzaque, M. A. (2019). Study of cattle fattening system in selected region of Bangladesh. <https://doi.org/10.3329/sja.v17i1.42765>
- Kargaard, J., & Van Niekerk, B. D. H. (1977). Incorporation of DPW, urea and fishmeal with varying molasses levels in cattle feedlot rations. *South African Journal of Animal Science*, 7(1), 117-125. <https://www.ajol.info/index.php/sajas/article/view/140634/130375>
- Kellogg, D. W., & Owen, F. G. (1969). Relation of ration sucrose level and grain content to lactation performance and rumen fermentation. *Journal of dairy science*, 52(5), 657-662. [https://doi.org/10.3168/jds.S0022-0302\(69\)86624-5](https://doi.org/10.3168/jds.S0022-0302(69)86624-5)
- Kerketta, N., Victor, V. M., Chandraker, A. K., & Jogdand, S. V. (2017). Effect of Urea Molasses Mineral Block as feed Supplement on Body Weight Gain and haemato-biochemical Parameters of Working Bullocks. *International Journal of Agriculture Innovations and Re-search*, 5(6), 917-920. [https://www.ijair.com/administrator/components/com\\_jresearch/files/publications/IJAIR\\_2365\\_FINAL.pdf](https://www.ijair.com/administrator/components/com_jresearch/files/publications/IJAIR_2365_FINAL.pdf)
- Khang, D. T., & Dan, C. X. (2001). Chemical composition of several crop by-products as animal feeds in Vietnam. In *Proceeding of a Workshop on Improved Utilisation of By-Products for Animal Feeding, NUFU Project, Nauy, Vietnam* (pp. 1-5).

- Laconi, E. B., & Jayanegara, A. (2015). Improving nutritional quality of cocoa pod (*Theobroma cacao*) through chemical and biological treatments for ruminant feeding: in vitro and in vivo evaluation. *Asian-Australasian journal of animal sciences*, 28(3), 343. <https://doi.org/10.5713/ajas.13.0798>
- Lalljee, S. V., Soundararajan, C., Singh, Y. D., & Sargison, N. D. (2019). The potential of small ruminant farming as a means of poverty alleviation in rural southern India. *Tropical animal health and production*, 51, 303-311. <https://link.springer.com/article/10.1007/s11250-0181686-4>
- Lestari, V. S., Rahardja, D. P., Rasyid, T., Asnawi, A., Saleh, I. M., & Rasyid, I. (2016). Beef cattle farmers perception toward urea mineral molasses block. *International Journal of Agricultural and Biosystems Engineering*, 10(10), 675-678. <https://doi.org/10.5281/zenodo.1127360>
- Li HaiLi, L. H., Hou ZiHua, H. Z., Yang Qi, Y. Q., Li QinFan, L. Q., Wang KeLing, W. K., Lang LiMin, L. L., ... & Wang JianHua, W. J. (2014). Study the effect of urea molasses multinutrient block on fattening cattle. [http://world-food.net/download/journals/2014issue\\_2/2014-issue\\_2-agriculture/a57.pdf](http://world-food.net/download/journals/2014issue_2/2014-issue_2-agriculture/a57.pdf)
- Lishman, A. W. (1967). Cane molasses as a substitute for maize in beef-finishing rations. *South African Journal of Agricultural Science*, 10, 51-59. <https://www.cabidigitallibrary.org/doi/full/10.5555/19681403659>
- Liu, H., Hu, M., & Zhang, B. (2001). Red lodge" mineral nutrition UMMB fattening bee f cattle effect test. *Journal of Cattle Magazine*, 6, 23-25.
- Lofgreen, G. P., & Otagaki, K. K. (1960). The net energy of blackstrap molasses for fattening steers as determined by a comparative slaughter technique. *Journal of Animal Science*, 19(2), 392-403. <https://doi.org/10.2527/jas1960.192392x>

- Makkar, H. P., Sánchez, M., & Speedy, A. W. (Eds.). (2007). *Feed supplementation blocks: ureamolasses multivitamin blocks: simple and effective feed supplement technology for ruminant agriculture* (No. 164). Food & Agriculture Org. Makkar, H. P., Sánchez, M., & Speedy, A. W. (Eds.). (2007). <https://books.google.com.bd/books?id=JGJX-2punygC&printsec=frontcover#v=onepage&q&f=false>
- Mapato, C., Wanapat, M., & Cherdthong, A. (2010). Effects of urea treatment of straw and dietary level of vegetable oil on lactating dairy cows. *Tropical animal health and production*, 42, 1635-1642. <https://link.springer.com/article/10.1007/s11250-010-9613-3>
- Marai, I. F. M., Ayyat, M. S., & Abd El-Monem, U. M. (2001). Growth performance and reproductive traits at first parity of New Zealand White female rabbits as affected by heat stress and its alleviation under Egyptian conditions. *Tropical animal health and production*, 33, 451-462. <https://link.springer.com/article/10.1023/a:1012772311177>
- Martin, L. C., Ammerman, C. B., Henry, P. R., & Loggins, P. E. (1981). Effect of level and form of supplemental energy and nitrogen on utilization of low quality roughage by sheep. *Journal of Animal Science*, 53(2), 479-488. <https://doi.org/10.2527/jas1981.532479x>
- Misra, A. K., Reddy, G. S., & Ramakrishna, Y. S. (2006). Participatory on-farm evaluation of urea molasses mineral block as a supplement to crossbred cows for dry season feeding in rainfed agro-ecosystem of India. *Livestock Research for Rural Development*, 18(2), 1-11. <https://www.lrrd.cipav.org.co/lrrd18/2/misr18024.htm>
- Moniruzzaman, M., Hashem, M. A., Akhter, S., & Hossain, M. M. (2002). Effect of feeding systems on feed intake, eating behavior, growth, reproductive performance and parasitic infestation of Black Bengal goat. *Asian-Australasian Journal of Animal Sciences*, 15(10), 1453-1457. <https://doi.org/10.5713/ajas.2002.1453>
- Morrison, G. S., Enzinger, E., Hughes, V., Jessen, M., Meuwly, D., Neumann, C., ... & Anonymous, B. (2021). Consensus on validation of forensic voice comparison. *Science & Justice*, 61(3), 299-309. <https://doi.org/10.1016/j.scijus.2021.02.002>

- Muralidharan, J., Jayachandran, S., Thiruvankadan, A. K., Singh, D., & Sivakumar, K. (2015). Effect of concentrate and urea molasses mineral block supplementation on the blood biochemistry of off season Mecheri lambs. *Indian Journal of Animal Research*, 49(3), 409-412. <http://dx.doi.org/10.5958/0976-0555.2015.00070.9>
- Murshed, H. M., Sarker, M. A. H., Rahman, S. M. E., & Hashem, M. A. (2014). Comparison of carcass and meat quality of Black Bengal goat and Indigenous sheep of Bangladesh. *Journal of Meat Science and Technology*, 2(3), 63-67. <https://www.researchgate.net/publication/316561299>
- Musa, H. H., El-Amin, F. M., Suleiman, A. H., & Chen, G. H. (2005). Reproduction and production performance of West African sheep in Sudan. <https://www.cabidigitallibrary.org/doi/full/10.5555/20073050684>
- Nath, K., Sahai, K., & Kehar, N. D. (1969). Effect of water washing, lime treatment and lime and calcium carbonate supplementation on the nutritive value of paddy (*Oryza sativa*) straw. *Journal of Animal Science*, 28(3), 383-385. <https://doi.org/10.2527/jas1969.283383x>
- Negi, S. S. (1971). Calcium assimilation in relation to metabolism of soluble and insoluble oxalates in the ruminant system: a reappraisal. <https://www.cabidigitallibrary.org/doi/full/10.5555/19721400500>
- Neric, S. P., Aquino, D. L., Dela Cruz, P. C., & Ranjhan, S. K. (1984). Effect of urea-molasses mineral block lick on the growth performance of caracows kept on the media pasture of central Luzon during the wet season. In *The use of nuclear techniques to improve domestic buffalo production in Asia*.
- Orskov, E. R. (1992). Protein Nutrition in Ruminants. 2nd. *Harcourt Brace Jovanovich, Publishers, London*.
- Owen, F. G., Kellogg, D. W., & Howard, W. T. (1967). Effect of molasses in normal and high grain rations on utilization of nutrients for lactation. *Journal of Dairy Science*, 50(7), 1120-1125. [https://doi.org/10.3168/jds.S0022-0302\(67\)87576-3](https://doi.org/10.3168/jds.S0022-0302(67)87576-3)

- Piccioni, M. (1962). Dizionario degli alimenti per il bestiame.
- Rahaman, M. A., Rahman, M. M., & Hossain, M. S. (2019). Climate-resilient agricultural practices in different agro-ecological zones of Bangladesh. *Handbook of climate change resilience*, 1-27. [http://dx.doi.org/10.1007/978-3-319-71025-9\\_42-1](http://dx.doi.org/10.1007/978-3-319-71025-9_42-1)
- Rana, M. S., Hashem, M. A., Sakib, M. N., & Kumar, A. (2014). Effect of heat stress on blood parameters in indigenous sheep. *Journal of the Bangladesh Agricultural University*, 12(1), 91-94. <https://ageconsearch.umn.edu/record/209902/?v=pdf>
- Rashid, M. M., Hossain, M. M., Azad, M. A. K., & Hashem, M. A. (2013). Long term cyclic heat stress influences physiological responses and blood characteristics in indigenous sheep. <http://dx.doi.org/10.3329/bjas.v42i2.18486>
- Saadullah, M. (1991). The importance of urea-molasses blocks and bypass protein in animal production: the situation in Bangladesh. In *Isotope and related techniques in animal production and health*. [https://inis.iaea.org/search/search.aspx?orig\\_q=RN:23027693](https://inis.iaea.org/search/search.aspx?orig_q=RN:23027693)
- Saha, N. G., Akter, Q. S., Chowdhury, M. R. H., Tareq, K. M. A., & Fouzder, S. K. (2018). Effect of urea molasses straw on beef fattening at rural areas in Chattogram district. *Int J Nat Soc Sci*, 5(3), 09-15. <https://ijnss.org/wp-content/uploads/2018/05/IJNSS-V5I3-2-pp-09-15.pdf>
- Sahoo, A., Singh, U. B., Mehra, U. R., & Elangovan, A. V. (1992). Response of urea-molasses supplement on live weight gain and nutrient utilization in buffalo calves. <https://eurekamag.com/research/002/210/002210517.php>
- Sarder, M. J. U., Islam, M. H., Moni, M. I. Z., Jahan, S. S., Aktar, S., & Uddin, J. (2015). Reproductive and productive performance of sheep of Rajshahi, Bangladesh insight about effects of genotype and parity. *Bangladesh livestock journal*, 1, 31-34. [https://www.researchgate.net/profile/Jashim-Uddin-3/publication/298421094\\_Reproductive\\_and\\_productive\\_performance\\_of\\_sheep\\_of\\_Rajshahi\\_Bangladesh\\_insight\\_about\\_effects\\_of\\_genotype\\_and\\_parity/links/56e95d7208ae77f](https://www.researchgate.net/profile/Jashim-Uddin-3/publication/298421094_Reproductive_and_productive_performance_of_sheep_of_Rajshahi_Bangladesh_insight_about_effects_of_genotype_and_parity/links/56e95d7208ae77f)

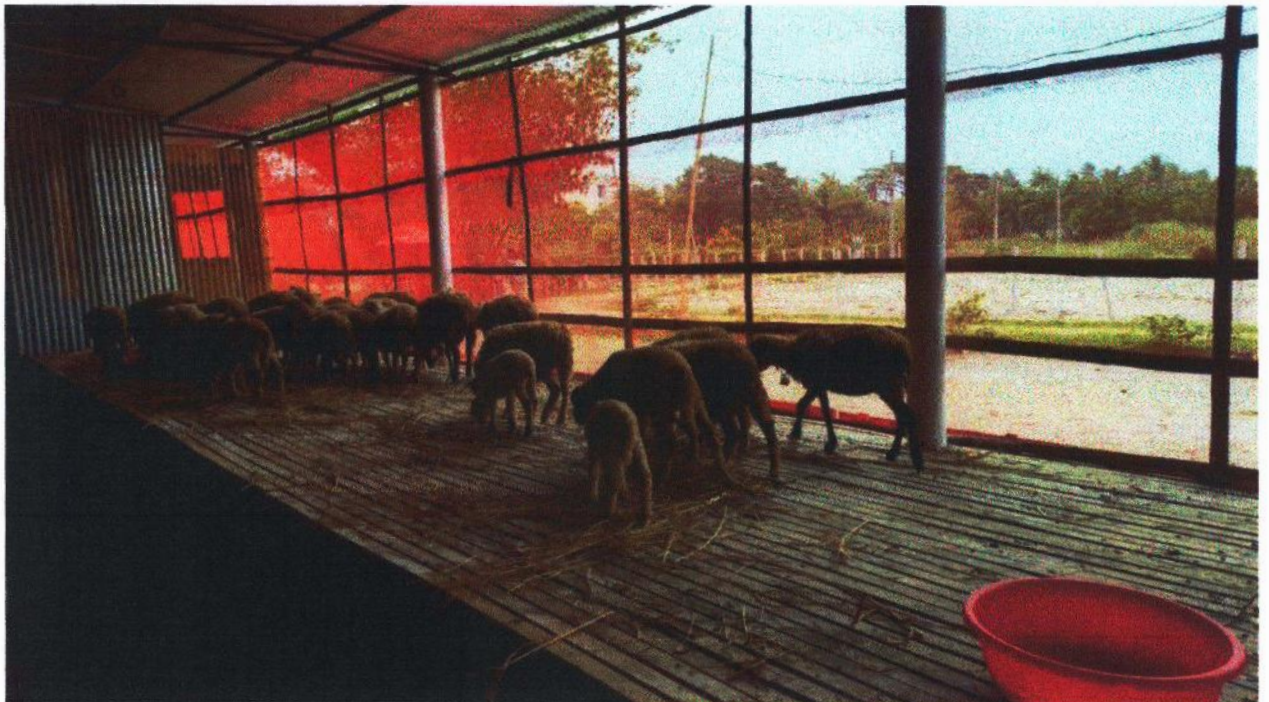
- Sarder, M. J. U., Khaton, R., Islam, M. H., Islam, M. A., Hashem, M. A., & Haque, M. I. (2022). Effect of slaughter age on carcass characteristics and meat quality of Barind lamb. *Meat Research*, 2(1). <http://dx.doi.org/10.55002/mr.2.1.11>
- Sarker, A. K., Amin, M. R., Hossain, M. A., Ali, M. S., & Hashem, M. A. (2017). Present status of organic sheep production in Ramgoti Upazila of Lakshmipur district. *Journal of Environmental Science and Natural Resources*, 10(2), 95-103. <https://doi.org/10.3329/jesnr.v10i2.39018>
- Sarma, P. K., Raha, S. K., & Jorgensen, H. (2014). An economic analysis of beef cattle fattening in selected areas of Pabna and Sirajgonj Districts. *Journal of the Bangladesh Agricultural University*, 12(1), 127-134. <http://dx.doi.org/10.3329/jbau.v12i1.21402>
- Sarnklong, C., Cone, J. W., Pellikaan, W., & Hendriks, W. H. (2010). Utilization of rice straw and different treatments to improve its feed value for ruminants: a review. *Asian-Australasian Journal of Animal Sciences*, 23(5), 680-692. <http://dx.doi.org/10.5713/ajas.2010.80619>
- Sheikh, G. G., Ganai, A. M., Ishfaq, A., Afzal, Y., & Ahmad, H. A. (2017a). In vitro effect of probiotic mix and fibrolytic enzyme mixture on digestibility of paddy straw. *Adv. Anim. Vet. Sci*, 5(6), 260-266. <http://dx.doi.org/10.17582/journal.aavs/2017/5.6.260.266>
- Sheikh, G. G., Ganai, A. M., Sheikh, F. A., Bhat, S. A., Masood, D., Mir, S., ... & Bhat, M. A. (2017b). Effect of feeding urea molasses treated rice straw along with fibrolytic enzymes on the performance of Corriedale Sheep. *Journal of entomology and zoology studies*, 5(6), 2626-2630. <https://www.researchgate.net/publication/322243707>
- Sheikh, G. G., Sarkar, T. K., Gania, A. M., Ahmed, H. A., & Islam, S. (2014). Effect of Feeding Urea-Molasses Impregnated Paddy Straw on Nutrient Utilization, Milk Yield and Economics of Feeding in Crossbred Cows. *Indian Journal of Animal Nutrition*, 31(2), 152155. <https://www.indianjournals.com/ijor.aspx?target=ijor:ijan&volume=31&issue=2&article=>

- Shen, H. S., Ni, D. B., & Sundstøl, F. (1998). Studies on untreated and urea-treated rice straw from three cultivation seasons: 1. Physical and chemical measurements in straw and straw fractions. *Animal Feed Science and Technology*, 73(3-4), 243-261.  
[https://doi.org/10.1016/S0377-8401\(98\)00157-6](https://doi.org/10.1016/S0377-8401(98)00157-6)
- Singh, M., & Singh, H. P. (1995). Genetic variation in chemical composition and digestibility of nutrients in rice straw. *International Rice Research Notes (Philippines)*, 20(3).  
[http://books.irri.org/IRRN20no3\\_content.pdf](http://books.irri.org/IRRN20no3_content.pdf)
- B. B. S. (2019). Bangladesh Bureau of Statistics (BBS) Statistics. Informatics Division (SID) Ministry of Planning.  
[https://bbs.portal.gov.bd/sites/default/files/files/bbs.portal.gov.bd/page/a1d32f13\\_8553\\_44f1\\_92c6\\_8ff80a4ff82e/2020-05-15-09-25-dccb5193f34eb8e9ed1780511e55c2cf.pdf](https://bbs.portal.gov.bd/sites/default/files/files/bbs.portal.gov.bd/page/a1d32f13_8553_44f1_92c6_8ff80a4ff82e/2020-05-15-09-25-dccb5193f34eb8e9ed1780511e55c2cf.pdf)
- Sultana, N., Hassan, N., Ershaduzzaman, M., Talukder, M. A. I., & Iqbal, A. (2011). Effect of intensive and semi-intensive feeding system on productive and reproductive performances of native sheep. *Journal of Scientific Research*, 3(3), 693-698.  
<https://doi.org/10.3329/jsr.v3i3.7129>
- Sultana, N., Hossain, S. M. J., Chowdhury, S. A., Hassan, M. R., & Ershaduzzaman, M. (2010). Effects of age on intake, growth, nutrient utilization and carcass characteristics of castrated native sheep. <https://doi.org/10.3329/bvet.v27i2.7556>
- Sun, M. A., Hossain, M. A., Islam, T., Rahman, M. M., Hossain, M. M., & Hashem, M. A. (2020). Different body measurement and body weight prediction of Jamuna basin sheep in Bangladesh. *SSARC Journal of Agriculture*, 18(1), 183-196.  
<https://doi.org/10.3329/sja.v18i1.48392>
- Sutton, J. D. (1968). The fermentation of soluble carbohydrates in rumen contents of cows fed diets containing a large proportion of hay. *British Journal of Nutrition*, 22(4), 689-712.  
<https://doi.org/10.1079/BJN19680080>

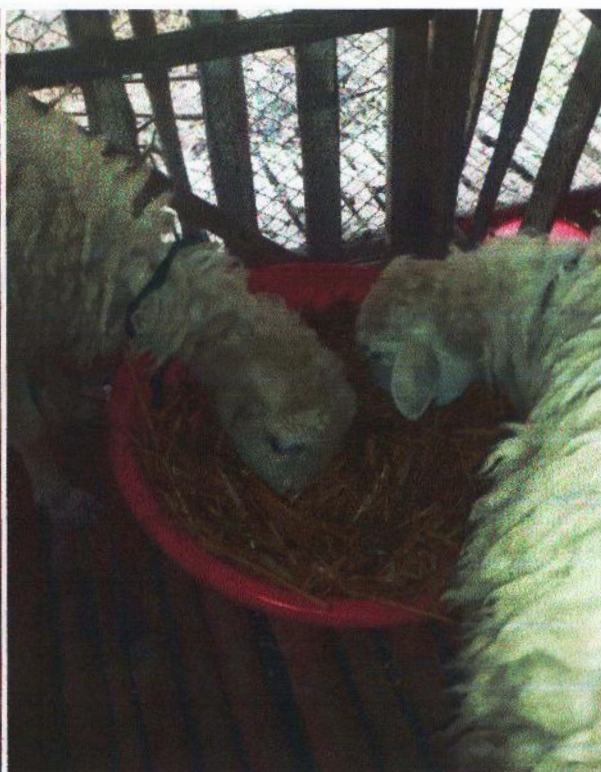
- Sutton, J. D. (1969). The fermentation of soluble carbohydrates in rumen contents of cows given diets containing a large proportion of flaked maize. *British Journal of Nutrition*, 23(3), 567-583. <https://doi.org/10.1079/BJN19690065>
- Talukder, M. A. I., Rahman, M. Z., & Ali, M. Y. 1 Bangladesh Livestock Research Institute, Savar, Dhaka-1341, Bangladesh Corresponding author: Md. Yousuf Ali, Scientific Officer, Bangladesh Livestock Research Institute, Savar, Dhaka-1341. E-mail: 113yousuf.bau@gmail.com Received: 15 March 2016/Accepted: 10 April 2016/Published: 30 April 2016. <https://www.ebupress.com/journal/aaibb/wp-content/uploads/sites/3/2016/06/12.pdf>
- Tareque, A. M. M. (1985). Bangladesh pashupushti Bartaman Porishthiti Samashyaboli. Bangladesh Pashusampad Unnayan-Neeti 0 Kowshal, BARC, Dhaka.
- Tibbo, M. (2006). *Productivity and health of indigenous sheep breeds and crossbreds in central Ethiopian Highlands* (Doctoral dissertation, Swedish University of Agricultural Sciences). [https://www.researchgate.net/publication/317002112\\_Productivity\\_and\\_Health\\_of\\_Indigenous\\_Sheep\\_Breeds\\_and\\_Crossbreds\\_in\\_the\\_Central\\_Ethiopian\\_Highlands](https://www.researchgate.net/publication/317002112_Productivity_and_Health_of_Indigenous_Sheep_Breeds_and_Crossbreds_in_the_Central_Ethiopian_Highlands)
- Trach, N. X. (2003). Responses of growing cattle to wet brewers' grains or sugarcane molasses supplemented to diets based on untreated or treated rice straw. *Livestock Research for Rural Development*, 15, 3. <https://lrrd.cipav.org.co/lrrd15/3/trac153.htm>
- Vadiveloo, J. (1992). Varietal differences in the chemical composition and in vitro digestibility of rice straw. *The Journal of Agricultural Science*, 119(1), 27-33. <https://doi.org/10.1017/S0021859600071513>
- Van Niekerk, B. D. H., & Voges, D. J. (1976). Cane molasses as a replacement for maize meal in beef fattening rations. *South African Journal of Animal Science*, 6(1), 67-72. <https://www.sasas.co.za/journals/cane-molasses-as-a-replacement-for-maize-meal-in-beef-fattening-rations/>

- Van Soest, P. J. (2006). Rice straw, the role of silica and treatments to improve quality. *Animal Feed Science and Technology*, 130(3-4), 137-171.  
<https://doi.org/10.1016/j.anifeedsci.2006.01.023>
- Wanapat, M., Polyorach, S., Boonnop, K., Mapato, C., & Cherdthong, A. (2009). Effects of treating rice straw with urea or urea and calcium hydroxide upon intake, digestibility, rumen fermentation and milk yield of dairy cows. *Livestock Science*, 125(2-3), 238-243.  
<https://doi.org/10.1016/j.livsci.2009.05.001>
- Wanapat, M., Sommart, K., & Saardrak, K. (1996). Cottonseed meal supplementation of dairy cattle fed rice straw. *Livestock Research for Rural Development*, 8(3), 23-26.  
<https://lrrd.cipav.org.co/lrrd8/3/metha83.htm>
- Wilson, A. D. (1977). The digestibility and voluntary intake of the leaves of trees and shrubs by sheep and goats. *Australian Journal of Agricultural Research*, 28(3), 501-508.  
<https://doi.org/10.1071/AR9770501>
- Zhao, J., Dong, Z., Li, J., Chen, L., Bai, Y., Jia, Y., & Shao, T. (2019). Evaluation of *Lactobacillus plantarum* MTD1 and waste molasses as fermentation modifier to increase silage quality and reduce ruminal greenhouse gas emissions of rice straw. *Science of the total environment*, 688, 143-152. <https://doi.org/10.1016/j.scitotenv.2019.06.236>
- Zohara, B. F., Islam, M. F., Alam, M. G. S., & Bari, F. Y. (2014). Exfoliative vaginal cytology and serum progesterone during the estrous cycle of indigenous ewes in Bangladesh. *Journal of Embryo Transfer*, 29(2), 183-188.  
[https://www.researchgate.net/publication/348191289\\_Exfoliative\\_Vaginal\\_Cytology\\_and\\_Serum\\_Progesterone\\_during\\_the\\_Estrous\\_Cycle\\_of\\_Indigenous\\_Ewes\\_in\\_Bangladesh](https://www.researchgate.net/publication/348191289_Exfoliative_Vaginal_Cytology_and_Serum_Progesterone_during_the_Estrous_Cycle_of_Indigenous_Ewes_in_Bangladesh)

## Appendices



*Photograph 1:* Shed for crossbreed sheep



***Photograph 2:*** Feeding urea molasses straw (UMS) to crossbreed sheep



***Photograph 3:*** Preparation of Urea molasses straw (UMS)



***Photograph 4:*** Feeding trial of crossbreed sheep



***Photograph 5: Grinding of the sample (UMS)***



***Photograph 6: Ash (UMS)***



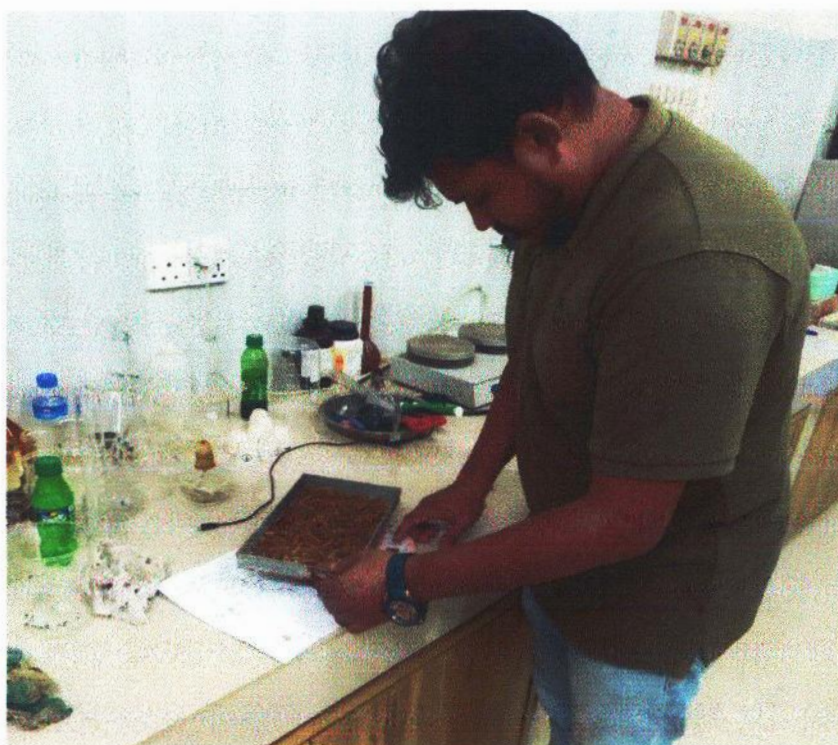
*Photograph 7: Crushed UMS sample*



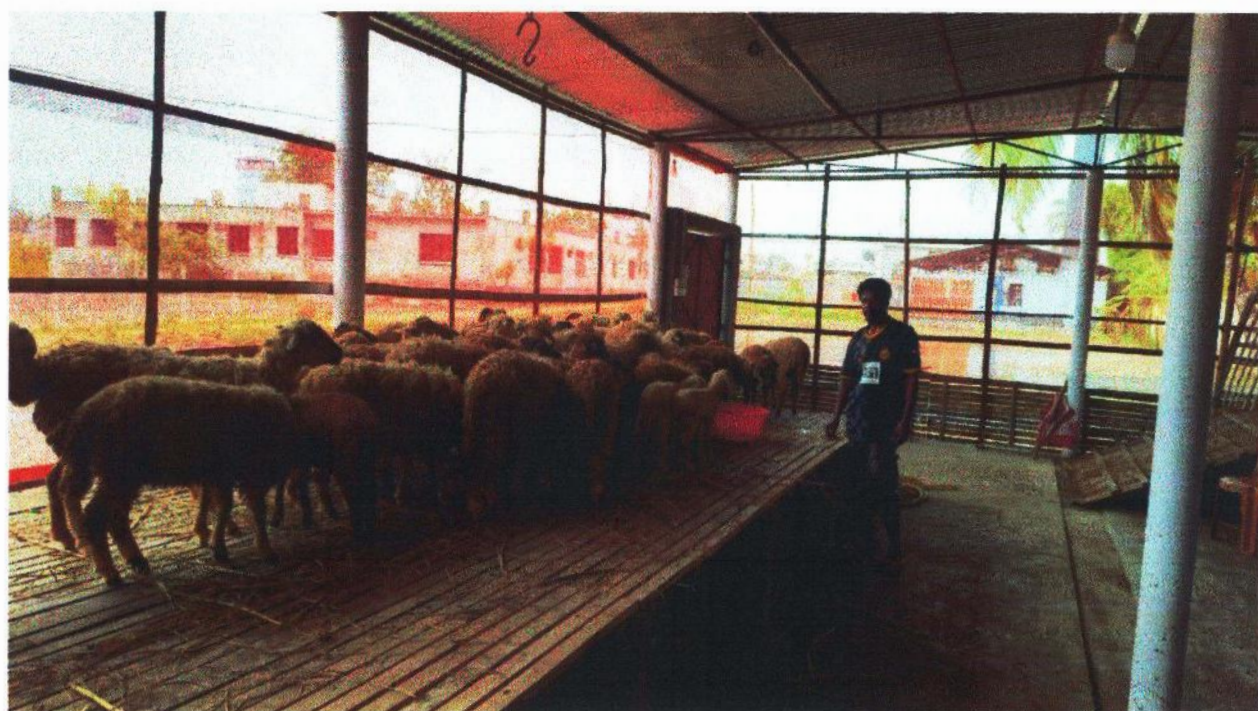
*Photograph 8: Crossbreed sheep*



***Photograph 9:*** Feeding fresh water to croosbreed sheep



***Photograph 10:*** Weighing of the sample (UMS)



*Photograph 11: Floor for crossbreed sheep*



**Photograph 12:** Different shed for experimental animal



**Photograph 13:** Analysis of CP percentage of UMS



*Photograph 14:* Weighing of experimental animal



***Photograph 15:*** Determine the weight of the sample (UMS)



*Photograph 16: Oven*



*Photograph 17: Grazing of crossbreed sheep*



*Photograph 18: Feeding UMS*



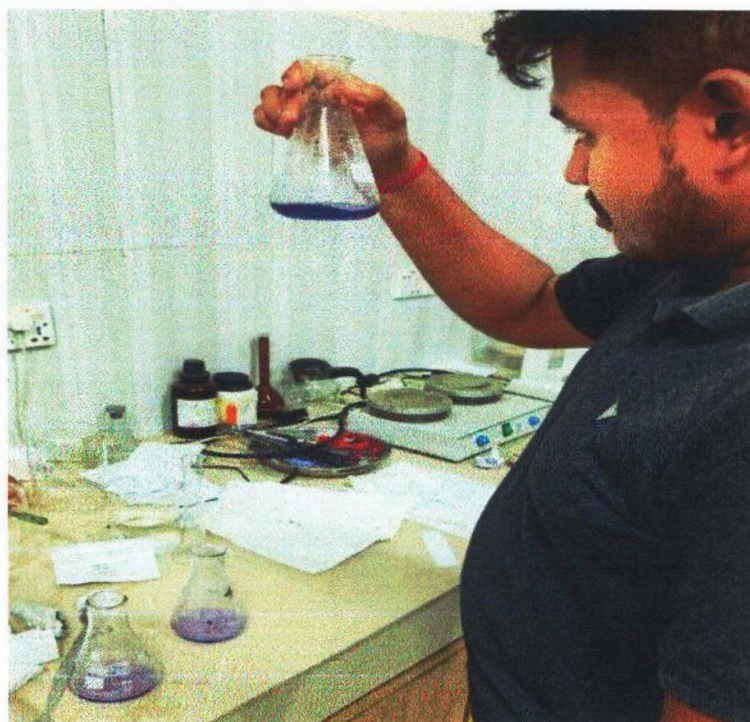
*Photograph 19: Oven drying of the sample (UMS)*



*Photograph 20: vaccination of crossbreed sheep*



**Photograph 21:** Different chamber for UMS feeding



**Photograph 22:** Determination of CP% of UMS



**Photograph 23:** Urea molasses straw



**Photograph 24:** Equipment for determination of CP %



**Photograph 25:** Shed for sheep



**Photograph 26:** Water bowl



*Photograph 27: Grazing land for sheep*



*Photograph 28: Grazing area for sheep*