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Exploring the Current Scenario and Profitability Analysis of Goat Farming in Three Distinct Regions of Bangladesh

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Abstract

GOAT farming in Bangladesh stands as a promising frontier of opportunity, driving rural economies and offering a sustainable livelihood to millions of landless and marginal farmers. This study aimed to assess the socio-economic condition, management practices, and profitability of goat farming in the Hilly, Barind, and Plain Land regions of Bangladesh. Data were gathered from 90 randomly selected goat-raising farmers across four sub-districts from Bandarban, Rajshahi, and Jashore districts. Goat farming was a prominent activity in the Barind region, where 70% of farmers were engaged in agriculture. Farmers in the Hilly region predominantly relied on semi-extensive or free-range rearing systems (100%), while Barind and Plain Land regions employed more structured housing and feed supplementation for their goat. The average number of goats per household 7.97, was highest in the Barind region. Disease outbreaks, especially Peste des Petits Ruminants (PPR) were common across all regions, with the highest disease prevalence in the Plain Land. The Benefit-cost Ratio (BCR) of goat farming was highest in the Barind (1.94), followed by the Hilly (1.82) and Plain Land regions (1.63). However, major constraints across all regions included high feed prices, disease outbreaks, and inadequate access to vaccines and veterinary services. The study highlighted the need for improved management practices, better breeding techniques, affordable feed prices, and adequate health care facilities to enhance the income generation from the goat enterprise. Therefore, this study also emphasizes improving farmers' knowledge through hands-on training, promoting methods and technologies of scientific management practices to ensure the profitability and sustainability of goat farming.

Keywords: Goat farming, Management practices, Profitability, Socio-economic condition, Sustainable livelihood.

Introduction

Livestock is a crucial component of agriculture and provides multifaceted contributions that significantly enhance the growth and development of Bangladesh's agricultural sectors. Among the 57.557 million ruminant livestock population, the domestic goat (Capra hircus) comprises about 47.11% of the total and represents the highest ruminant livestock population in Bangladesh, of which more than 90% comprises Black Bengal goats. Bangladesh is home to 27.117 million goats, which are a key contributor to the country's total livestock meat production of 92.25 Lakh Metric Tons [1]. Goats significantly contribute to the national GDP and are ranked in second place in terms of the production of meat, milk, and skin, goats providing around 38.0%, 23.1%, and 28.0% of all livestock, respectively [2]. Goats are renowned for their adaptability in hot and humid environments, high reproductive efficiency, delicious meat and skin softness with a substantial contribution to meet the regular dietary protein requirements. It is one of the primary sources of

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income for farmers, especially rural women who are affected by poverty and it also provides supplementary earnings for the farmers throughout Bangladesh. The goat may be the only livestock in Bangladesh that's raised for its products (meat and milk) and by-products (skins and faeces) all at the same time. Goat offers a valuable protein source and the enterprises that are centred on goats may occasionally serve as a reliable fund when immediate finance is needed to aid farmers in overcoming unforeseen emergencies. It is also widely regarded as a renewable resource for the underprivileged and due to its long history as the earliest agricultural animal to have had a close association with humans for a very long time, the goat is often referred to as the "poor man's cow". Based on current knowledge, goats are likely the earliest domesticated animals. 90% of the goats raised there are Black Bengal Goats because of their desirable characteristics [3]. In Bangladesh, goats are kept by underprivileged farmers as a valuable supplementary source of earnings. Beyond their role in business ventures, goat farming contributes a considerable portion of the family's revenue [4]. Appropriate intervention is crucial for increased goat productivity and marketing. Data regarding the present goat production and management system is required to meet these goals [5]. The goat industry has evolved into a vital sector that drives income generation, job creation, poverty alleviation, food production, nutrition, socioeconomic development for Bangladesh's rural poor, vulnerable women, and unemployed youth, as well as its notable environmental aspects. The majority of the goat population in rural locations is used to sustain with almost "zero input-no maintenance" costs, requiring only a little space and minimal overhead. Purchasing goats demands a lower initial investment than buying cattle. As a result, goat farming is an easy and viable option for marginal and landless farmers. Goat is a multi-functional animal, contributing greatly to the economy and nutrition of landless, small and marginal farmers in the country [6]. Goats are currently abundant and numerous studies have been conducted to examine the conditions of goat farming in Bangladesh; however, there was insufficient information and insights regarding the comparative study of the existing scenario and profitability analysis of goat farming in the different regions of Bangladesh. Considering the above facts and circumstances, the study was designed to assess the comparative socio-economic status, management practices, productive and reproductive potentiality of the goat, as well as the profitability of goat rearing in three distinct selected areas of Bangladesh.

The current study aims to define the socio-economic characteristics of goat raising farmers and assess the extent to which goat farming contributes to their income; to determine the key management practices and challenges associated with goat rearing in the selected areas; and to assess and compare the costs and returns of farmers involved in goat farming.

Material and Methods

Study site and duration

The research investigation was conducted in three selected regions, such as Hilly, Barind and Plain land across four sub-districts (Naikhongchhari, Godagari, Sharsha and Jashore Sadar) from three different districts- Bandarban, Rajshahi and Jashore under Chattogram, Rajshahi and Khulna divisions of Bangladesh. Fig 1 represents the geographical location of the studied areas (Bandarban, Rajshahi and Jashore districts in Bangladesh). Naikhongchhari is a sub-district of Bandarban district in the Chattogram division, Bangladesh which is located in between 21°11' and 21°40' North latitudes and in between 92°06' and 92°23' East longitudes. Godagari is located between 24°21' and 24°36' North latitudes and between 88°17' and 88°33' East longitudes which is a sub-district of Rajshahi district in the Rajshahi Division, Bangladesh. Sharsha and Jashore Sadar are two sub-districts of Jashore district in the Khulna Division, Bangladesh. Sharsha sub-district is located between 22°55' and 23°12' North latitudes and between 88°51' and 89°01' East longitudes, whereas Jashore Sadar is situated between 23°04' and 23°20' North latitudes and between 89°06' and 84°06' East longitudes. Data were collected from February to April 2024.

Study population and design

A baseline survey was conducted to assess the existing scenario of goat, the livelihood status, and the profitability of goat farming, including gross income, gross costs, and the challenges faced by farmers in goat rearing in the selected regions of Bangladesh. A pre-designed questionnaire was developed, aligned with the objectives and purpose of the study. Pretesting of the questionnaire was performed to ensure the accuracy of the data collection process and the availability of essential information. Primary data were collected through face-to-face interviews and direct observation of the selected farmers' households based on their goat population and availability of data resources. A total of 90 goat-raising farmers were randomly interviewed from three sub-districts in each district. These sub-districts were deliberately selected for data collection to represent the diversity of goat-rearing practices across the regions, which helped to identify and compare the profitability of goat farming with providing valuable insights into regional variations. The sample size was chosen to balance the need for a manageable dataset and was considered sufficient for the objectives of the study and deemed adequate for the analysis. Secondary data were gathered from numerous sources, including

books, theses, reports, journals, official records, and statistical yearbooks of Bangladesh.

Data recording

The data were collected on the demographic characteristics of goat-rearing farmers, rearing conditions, feeding strategies, productive and reproductive performances, health management and biosecurity practices, marketing conditions, and the profitability of goat farming. Additionally, constraints and opportunities related to goat rearing were identified to investigate the current scenario and determine the most profitable regions for goat farming in the selected areas of Bangladesh.

Statistical analysis

Microsoft Excel sheets were used to enter, sort, assemble, tabulate, and arrange the collected data and statistical analysis, especially descriptive statistics including frequency distribution, percentage, mean value, and standard error using the Statistical Package for the Social Sciences (SPSS), Version -25.

For calculating the net return, we used the following formula:

GC=TFC+TVC (Where, TFC=Total fixed cost, TVC=Total variable cost)

Net return= GR-GC (Where, GR=Gross return, GC=Gross cost)

The gross return includes the average return from the main product and by-products of different Ducks. Gross cost includes the total cost of Duck rearing. To calculate the benefit-cost ratio, the following formula was used:

$$\text{Benefit-Cost ratio} = \frac{\text{Gross return (GR)}}{\text{Gross cost (GC)}} \quad \text{..... (1)}$$

The benefit-cost ratio served as a relative measure that was used to compare the benefit per cost. It assisted in analysing the financial efficiency of the farms. The multiple regression model was employed to evaluate the effects of key variables on overall goat farming. The relationship between dependent variable (Y) and independent variables (X) was determined through regression analysis, where the variation in Y resulting from changes in X was estimated using a Linear Multiple Regression model, which is represented as the following equation:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + \text{.....} + b_{10}X_{10} + e \text{ .....} \quad \text{(Formula 2)}$$

Where, Y: Profit of goat-rearing farmers (BDT/year), a: Constant b: Regression coefficient, X_1: Initial stock value (BDT/year), X_2: Goat buying cost, X_3: Feed value, X_4: Housing cost with 10% depreciation, X_5: House repairing cost, X_6: Deworming and vaccination cost, X_7: Treatment and medicine cost, X_8: Electricity cost, X_9: Breeding expense, X_{10}: Miscellaneous Cost and e: Error term. Besides various expenses regarding goat rearing, the farmer's age, family size and earning members per household had a great effect on the overall production and profitability in goat farming. To simplify the estimation of the above equation, it is converted into a multiple linear form by applying the logarithm. The logarithmic version of the equation is presented as follows:

$$\text{Log } Y = \text{Log } a + b_1 \log X_1 + b_2 \log X_2 + \text{.....} b_{10} \log X_{10} + e \text{.....} \quad \text{(Formula 3)}$$

The multi-collinearity is a key component of multiple regression analysis. The multi-collinearity test is used to assess the correlation among the independent variables (X_1, X_2, X_3,…., X_{10}). Multi-collinearity is identified when the correlation coefficients between these variables surpass a certain threshold level (typically 0.85). If the correlation is less than or equal to 0.60, it indicates that there is no significant multi-collinearity [7].

Results

Socio-economic demography of the goat raising farmer

TABLE 1 represents various parameters related to education, occupation, family status and goat rearing practices across the Hilly, Barind, and Plain Land regions of Bangladesh. In the Hilly and Plain Land regions, 16.67% of individuals were illiterate, while the Barind region exhibited a slightly lower illiteracy rate at 13.33%. A significant portion of respondents in the Barind region (56.67%) had received primary education, followed by 43.33% in the Plain Land and 23.33% in the Hilly region. Regarding secondary education (SSC), the Hilly and Barind region exhibited a similar percentage (20%), while farmers of the Plain Land regions observed 16.67%. The highest proportion of respondents completed higher secondary education (HSC) was seen in the Hilly region (16.67%) followed by Barind (10%) and Plain Land (3.33%). Graduate-level education was minimal (10%) and only observed in the Hilly region.

A substantial proportion of respondents in Barind (70%) were engaged in agriculture, which was far higher than 16.67% in the Plain Land and only 3.33% in the Hilly region. In contrast, homemaking was the dominant occupation across all regions, with the highest 80% in the Plain Land, 76.67% found in the Hilly region and 23.33% in the Barind region. Service and business activities were relatively uncommon, while only 6.67% of respondents in Barind and 3.33% in the Plain Land region were involved in business. About 13.33% of Hilly farmers engaged in different services and 6.67% of respondents were day labourers.

The goat raising farmers of the Hilly region had the largest average family size of 5.30 members per household, followed by Barind (4.60) and the Plain Land (3.50). A similar number of earning members was observed across the regions, with an overall of 1.23±0.05 members per household. The Hilly region's farmers had the highest average annual income of BDT. 178,966, while Barind had the lowest BDT. 146,033.33 with an intermediate income of BDT. 159,333.33/years were seen in the Plain Land region.

Farmers reared the highest average of 7.97≈8 goats per household in the Barind region compared to 6.3≈6 goats in the Hilly with 5.10≈5 goats in the Plain Land region. Moreover, the least experience of 4.43 years in goat rearing was observed in the Hilly farmers, while the farmers from Plain Land had the most rearing experience of 9.93 years and the Barind farmers possessed the intermediate level of goat rearing experience (8.07 years).

Goat rearing and management strategies

TABLE 2 highlights the diverse goat management practices across three regions of Bangladesh. In the Hilly region, 96.67% of respondents housed goats separately, with only a small proportion of 3.33% kept goats alongside cattle. In contrast, 100% of Barind farmers exclusively housed goats with cattle, whereas farmers from Plain Land (100%) predominantly kept goats in separate houses, with overall 65.56% of farmers across all regions providing separate shelters to their goats. About 53.33% of Hilly farmers primarily used tin, whereas most of the Barind farmers relied on a combination of tin and mud (83.33%) for preparing the goat house. Plain Land farmers also preferred tin (56.67%) for house construction. Other materials included- bamboo (23.33%) and wood (23.33%) were used in the Hilly region, with concrete goat houses used by a small proportion in both the Plain Land (13.33%) and the Barind (3.33%) regions. In the Plain Land, 80% of farmers elevated the goat shelter above ground level, called 'matcha' which was less common in the two other regions.

On the other hand, a maximum of 96.67% of Barind farmers used mud floors, while mud floors were common in 60% of Hilly farmers' goat houses. Concrete floors were rare, observed in only 5.56% of the respondents' goat houses. In terms of house cleaning, overall 97.78% of respondents maintained a regular cleaning schedule. In the Hilly region, 86.67% of farmers used a broom for cleaning, while all (100%) Barind farmers used brooms and Plain Land farmers had a similar practice (83.33%). A smaller percentage of farmers 16.67% and 13.33% cleaned their goat house with a broom and water both in the Plain Land and the Hilly regions.

Semi-extensive or free ranging (100%) was the prominent rearing method in the Hilly region followed by 96.67 and 86.67% of farmers practiced a similar method in Barind and Plain land. Although a small proportion of Plain Land farmers (13.33%) followed confined rearing but the lower overall proportion of 5.56% farmers opted for the same practice. Goat raising farmers from the Barind and Plain Land regions reported 100% of supplementation with locally available feed ingredients, whereas only 36.67% of farmers provided additional feeds.

In terms of breeding, all farmers (100%) practiced the natural method for breeding their goat in all the chosen regions. About 80% of Barind farmers bred their goats using local bucks, while 76.67% of farmers also followed a similar practice in the Plain Land region. A smaller proportion of farmers (30% and 10%) used bucks from specific farms or research institutes like the Bangladesh Livestock Research Institute, particularly in the Bandarban and Jashore regions. The Black Bengal (BB) buck was most commonly used for breeding purposes in the Hilly region (70%), while 86.67% of Barind farmers used crossbred goats (BB and Jamuna Pari cross). Maximum farmers (53.33%) in the Plain Land region utilized Jamuna Pari goats to serve their does. Plain Land farmers predominantly relied on bellowing (70%) as an indicator of heat/estrous, followed by 56.67% of Barind farmers and 33.33% of Hilly farmers reported similar behaviors. Moreover, Tail wagging and restlessness were observed in 26.67% of Hilly and Barind respondents. Frequent urination and discharge of mucus were reported by 15.56% and 7.78% of farmers across all regions.

Productive and Reproductive Performance

TABLE 3 represents the statistically significant regional variations in some productive and reproductive traits of the goat. Goats from the Plain land region generally showed the superior performance in terms of weaning weight, mature body weight of bucks and does, weight at first heat, gestation length and heat after first calving of 8.18±0.15kg, 26.75±0.42kg, 21.63±0.29, 15.30±0.32kg, 169.16±1.67days and 72.66±3.18days, respectively. However, the Barind farmers offered the maximum period of milk allowance for kids (3.93±0.07days) compared to other regions. Moreover, the maximum age at first heat (7.57±0.31months) and average litter size of 2.36±0.09 were observed at the Hilly region.

Disease prevalence of Goat in three different regions

TABLE 4 highlights the ranking of disease prevalence in goats across the Hilly, Barind, and Plain land regions. Peste-des-Petits-Ruminants (PPR) was the most prevalent disease and ranked 1st, affecting 70.00% of goats in Hilly, 80.00% in

Barind, and 93.33% in the Plain land region. Bloat had a significant prevalence with a 2nd ranking position in both the Plain land (70.00%) and the Barind (66.67%) regions, while Pneumonia was more common in the Barind (73.33%) compared to the Hilly (33.33%) and the Plain land (20.00%) regions. Additionally, parasitic infestations were most prevalent in Hilly (76.67%) and least in the Plain land (16.67%). Goat Ecthyma was observed primarily in Plain land (53.33%), whereas Myiasis infection and Goat pox were both rare in the overall regions.

Health management and Biosecurity practices

TABLE 5 shows the differences in health management, treatment access, disease outbreaks, and waste management practices among the three different regions. Results revealed that 50% of goat raising farmers practiced regular vaccination, with a higher rate of vaccination (66.67%) observed in the Barind region, followed by 50.00% in the Hilly and a relatively lowest proportion (10%) was seen in Plain land. Additionally, deworming practices were more common in Hilly (66.67%) and Barind (63.33%) regions, whereas only 16.67% of farmers in the Plain land followed regular deworming. The average vaccination interval for goats was shorter in the Hilly (5.7 months) region, where farmers from the Barind and Plain lands usually followed longer vaccination intervals (12 months).

Regarding the season and stages of disease outbreaks, Kids and young goats were mostly affected in the Hilly (83.33%) and Barind (56.67%) regions, whereas Plain land goats faced a higher incidence of disease during the growing stage (50%). Winter was the peak season for disease occurrence in the Hilly (80%) and Plain land (43.33%) regions, while Barind experienced outbreaks mainly during the rainy season (56.67%). Kid mortality was prominent, especially at an early age, with 76.67% observed in the Hilly region followed by 63.33% in Barind and 60% in the Plain lands. Mortality of goats during the growing stage was seen to be maximum in the Plain land (33.33%) and Barind (26.67%), while aged goats had relatively lower mortality rates with 16.67% being highest in the Hilly region.

In terms of biosecurity measures, 96.67% of Hilly farmers were more likely to separate diseased goats from other healthy animals compared to Plain land (86.67%) and Barind. Overall, 83.33% farmers in all regions treated their sick and diseased goat from quacks as their primary treatment provider, with limited use of formal and experts in livestock services like DLS and BLRI. Additionally, burying dead goats was the most common practice in the Barind region (100%), whereas about 73.33% and 70.00% of farmers in the Hilly and Plain land regions followed the burying of their dead goat's. A smaller proportion of Hilly farmers discarded goats by throwing them into a hilly slope (26.67%), whereas Plain land farmers occasionally disposed of dead goat in water (30%). On the other hand, all Plain land farmers and 70% farmers of the Barind region mostly practiced the dumping of goat faces in a hole. Some Hilly farmers (30.00%) dumped faces beside the hill slopes, whereas 100% of Barind and 33.33% of Plain land farmers tended to dump the faces beside their household, which is sincerely questionable for biosecurity issues.

Profitability of Goat Farming

TABLE 6 shows the benefit-cost ratio (BCR) of goat farming across three different geographical hilly, Barind, and plain land regions of Bangladesh. Results revealed from the study that goat farming was profitable across all areas, with varying degrees of return on investment. The total expenses regarding goat farming, which included both the fixed and variable costs, which was highest in the plain land region with BDT 75,474.76 followed by BDT. 55,949.52 in Barind and BDT 36,430.00 in the Hilly region. Corresponding total incomes, accounting for income from sold animals, family consumption, gifts, and the value of remaining stock, were BDT 122,747.60 was maximum in the Plain land region, with BDT 108,766.70 in Barind and BDT 66,428.33 in the Hilly region, respectively. However, the highest net income from goat rearing was accounted for BDT 52,817.15 in Barind, while BDT 47,272.86 in the Plain land and BDT 29,998.33 in the Hilly region. In addition, goat raising farmers in the Barind region had the highest BCR of 1.94, followed by the hilly region with a BCR of 1.82 and in the plain land (1.63). The overall BCR was found to be 1.79, indicating a favorable return from goat farming across all the regions.

Production Function Analysis (Multiple Regression Test)

A total of eleven (10) independent variables were considered for this analysis, among them five (05) variables were identified as the statistically significant contributors that mostly affected the production process, while the other five (05) variables expressed statistically non-significant results in the t-test and two (02) variables represented the negative value of the regression coefficient. TABLE 7 shows the results from the estimation of the model for multiple regression analysis on goat rearing.

Interpretation of the estimated model

The analysis of the production function remarked that the values of Initial stock, goat buying cost, feed value, housing cost with 10% depreciation and breeding expenses significantly affected the gross returns and profits from goat production.

Initial stock value (X_1)

The findings revealed that the regression coefficient for the initial stock value was estimated at 0.217 for goats, which was significant at the 5% probability level. This indicates a positive relationship between the value of initial stock and gross returns (TABLE 7) that a 5% increase in the initial stock value on average led to a 21.7% increase in gross return for goat-rearing farmers, holding other variables constant.

Goat buying cost (X_2)

The estimated value of the coefficient of goat buying expenses was 0.329 for goat-rearing farmers, which was significant at a 1% probability level. This value implied that the respondents, who spent more on buying a goat, got 32.9% more profit than the respondents who did not spend on buying a goat.

Feed value (X_4)

In the case of feed cost, the regression coefficient was found as -0.247 for the goat raising farmers which was significant at a 1% probability level. As a result, a strongly negative relationship was observed between increased feed value and gross returns, indicating that 1% decrease in feed cost on average, led to a 24.7% increase in gross return from goat farming, the other variables remained unchanged.

Housing cost with 10% depreciation (X_4)

The regression coefficient for housing cost with 10% depreciation was 0.220 for the goat raising farmers which was significant at a 1% probability level. As a result, a strongly negative relationship was observed between increased feed value and gross returns, indicating that 1% decrease in feed cost on average, led to a 22.0% increase in gross return from goat farming, holding other variables unchanged.

Breeding expense (X_9)

The computed regression coefficient value of breeding expenses was estimated as 0.006 for serve female goat which was significant at a 1% probability level. Thus, there was a positive relationship between the cost for breeding purposes and the gross return, indicating that the 1% increase in the breeding expense on average led to a 6.00% increase in gross return for goat rearing farmers, holding other variables constant.

Value of R^2

The estimated value of the adjusted coefficient of the multiple determinations, R^2 Value of the model was 0.666, which indicated that about 66.6% of the total variation in gross return among goat rearing farmers had been explained by the variables included in the model. In other words, 33.4 % of the total variation in the gross return was unexplained due to the exclusion of other variables from the model.

Value of adjusted R^2

The computed value of the adjusted R^2 of the model was 0.622 for goat raising farmers according to TABLE 7. The study of [7] described the term adjusted means adjusted for the degrees of freedom. This value demonstrated that approximately 62.2% of the total variation in the gross return under goat farming had been explained by the variables included in the model, considering the degrees of freedom.

F-count

The F-test was performed to evaluate the overall significance of the estimated model. The derived F-count of the model was 15.161. This value was highly significant at a 1% probability level implying that all the explanatory variables included in the model were crucial for explaining the variation in gross return and profit from goat farming.

Multi-linearity Test

The multi-collinearity test was designed to determine the correlation among the independent variables in the regression model. The results shown in TABLE 8 indicate that all correlation coefficients were below 0.85, which indicates that there is no multi-collinearity and no significant relationships among the independent variables.

Operational Constraints in goat farming

Table 9 represents the major constraints/challenges encountered by goat rearing farmers across three regions: hilly, Barind, and plain lands. Higher feed price, lack of vaccine and Disease outbreaks were identified as the most significant constraints across all selected areas. About 76.67% of respondents in the Hilly region remarked higher feed price as a major constraint which ranked 1^{st,} followed by higher risk of Dog bites (50.00%), lack of vaccine (46.67%) and high incidences of goat diseases (43.33%). Similarly, the Barind farmers highlighted disease outbreaks as the 2nd most common issue (56.67%), where higher feed price was the top concern to 73.33% of respondents. Other notable challenges included the lack of pasture land (46.67%) which was a common issue in Barind with a higher mortality rate of kids (33.33%), unavailability of vaccine and insufficient treatment facilities (30%). However, both disease outbreaks and higher feed prices were the 1st ranked problem reported by 66.67% of goat raising farmers in the Plain land region, followed by lack of vaccine (60.00%), unavailable treatment facility (46.67%) and higher rates of kid mortality (40.00%). Problems for attacking predatory animals by goat were mostly observed in the Hilly region (30.00%) compared to the Plain land (16.67%) and Barind (6.66%) regions.

Discussion

In the study of [8], they reported that the majority proportion of goat raising farmers (48%) completed primary education, with 28% having an educational

status of below HSC and 7% farmers were illiterate in the Munshiganj district. The present findings were consistent with those of [9]; [10], where they stated that most of the goat raisers were illiterate. About 11% respondents were illiterate (only signature) followed by 58% had primary, 22% received secondary and only 9% had higher secondary education stated by [11], whereas [12] reported about 20.0% of goat farmers were illiterate, with 40.0%, 30.0% and 10.0% farmers attained primary, secondary and above the secondary education, respectively which supported to the current results. According to the study of [13], farmers had formal education in terms of primary level (36.67%), secondary level (23.86%) and above secondary education (5.11%) in the Sylhet district. The regional disparities in educational access and economic development such as the prominence of agriculture and livestock farming might have influenced the opportunities for farmers to attain higher education.

Approximately 47% of the goat farmers were involved in agricultural crop farming along with 22% farmers engaged with goat rearing and rest of them were occupied with other business or services mentioned by [8]. According to the study of [14] approximately 66% of goat rearing farmers in the Saurashtra region of India considered agriculture (24.17%), particularly animal husbandry (65.83%) as their primary occupation. The findings of [6] expressed that the respondents took goat rearing as a secondary or side occupation for generating additional income for the family. The majority of farmers were day laborers (59.33%), while 31.33% fully engaged in agricultural operations with 5.33% of farmers involved in livestock farming practices in Sylhet district reported by [13]. The variations could be attributed to differences in the social status, economic factors, such as the extent of land availability; types of agricultural operations, likely influenced the primary and additional occupations of the respondents.

In the study of [11], they reported nearly similar results to the present study, with the average family size of 5.60 for organic goat farmers in Mymensingh district. The majority of goat farmers' families were the poorest of the poor reported by [15] and [16]. However, the findings of [8] revealed a closely similar result to the present study where they stated almost 60% of the goat framers belonged to medium income categories, with annual income between 01 to 04 lakhs. In the study of [13], they categorized the goat farmers based on their annual income (Thousand BDT.), whereas the majority proportion (79.33 %) were in low category (50-106) followed by 18.00% of farmers had medium income (107-150) and 2.67% fell in high income group (151-400) in Sylhet district.

The findings of the current study were supported by the results of [17] and [16] where they reported that about 37.5% of the goat farmers reared small-sized flocks, with 35% keeping medium and large-sized flock had 27.5% of the goat raisers. From the findings of [18], they mentioned 40.5 % of the respondents had 1-5 years of experience in goat farming goat, which nearly supported the current study. Similar results were reported by [19] in terms of rearing experience and average family size of 8.70years and 4.90nos. of goat raising farmers in the Godagari Sub-district. The variations among the above findings underscore the complexity of goat farming across the perspective regions and highlight the importance of considering regional context for improving the farming practices as well as the livelihood of the goat raising farmers.

In the study of [20], they noted a minimum proportion (12.2%) of farmers employed the free-range system, while the use of the confinement rearing system (7.3%) was almost comparable to the findings of the present study. Goat farmers mainly allowed their goats to graze at communal lands, irrigation banks, road-sides and within the villages in the Munshiganj district stated by [8]. Maximum 67.3% of the respondents reared goats under semi-intensive management but only 8.5% practiced intensive rearing, while 24.1% of farmers used a free-range system, while about 50.8 % of the respondents provided medium to well-constructed night shelters to their goats separately, while 59.8 % offered corrugated steel sheets made goat houses. Most of the goat raisers (61.8 %) used earthen/mud flooring, whereas 47.5 % utilized straw as bedding materials mentioned in the study of [18]. About 34.2 % of the goat raising farmers mostly depended on the pasture for feeding their goats, only 30.2 % of farmers provided a negligible amount of supplement feeds (grass with concentrate). According to [13], the maximum number of sheds were constructed made of tin (54%), while a small proportion was built with bamboo-straw (28%) combined with soil and other materials like Coconut or Nipa Palm leaves.

According to the findings of [11], 100% of goat raising farmers followed natural breeding to serve their does under organic farming in Mymensingh district which strongly agreed with the current study. In the study of [8], they reported that 55% of farmers kept Black Bengal (BB) goat followed by 24% reared crossbred and 21% of respondents rearing Jamnapari goat in Munshiganj district. Approximately 92% farmers served their does by village bucks in the Mymensingh district and 70.7% in Barguna and Patuakhali which supported the present study mentioned by [21]. About 54% of the farmers mated their goats by using a buck owned by other farmers in Munshiganj district stated by [8]. The findings from the present study were consistent with the previous research, yet also highlighted some unique regional variations, particularly in the choice of goat breeds and supplemental feeding practices

that underscoring the diverse approaches to goat farming in different regions of Bangladesh.

In the study of [8], they noted an average weaning weight, age at first heat, gestation length**,** post-partum heat period and prolificacy of 5.5kg, 7.4 months, 153 days, 45.5 days and 2.1, respectively in goat which were nearly similar to the results of the present study. Relatively higher age at first heat of 8.0-8.87 months than the present study in the case of Black Bengal goat reported by [22]. According to [21], nearly similar overall age at first heat and weight at first heat and gestation length of 173.62days, 9.26kg and 152.65days among different coat colors of Black Bengal goat which agreed with the current study. The Black Bengal goat produced an average of 1.76±0.08 kids per year stated in the study of [23], whereas [24] conducted a study on meat type Black Bengal goat in India, showed an average of 1.75 kids/ kidding per year which supported the findings of [25] who reported that Black Bengal goat in Bangladesh typically had an average of 1.96 kids per kidding. In the study of [26], they stated that Black Bengal goat available in Bangladesh usually possessed a medium-sized frame with a mature body weight of 25–30 kg, which agreed with the findings of the current study. Additionally, the results of the present study closely aligned with the findings of [27], who reported an average adult body weight of 24.3kg for male and 21.1 kg for female goats. They also mentioned the average age at puberty and gestation period of 194.1 days and 146.72±7.6 days in goats, whereas [28] found the mean litter size of 2.1, with the age at puberty, gestation length and post-partum oestrous at 197.4, 147.90±0.3 and 36.0 days, respectively. However, the study of [29] observed the litter size of 1.8–2.4 in Black Bengal goats, which strongly supported the findings of the present study.

Pneumonia, PPR, Contagious ecthyma, Diarrhoea and Tetanus are more common diseases in goat especially in rural areas, reported by [30]. Higher prevalence rates of PPR were observed in overall regions under the present study compared to the findings of [31], where they mentioned that PPR was more prevalent in Black Bengal goat (54.93%) than in Jamunapari goat (31.78%). In the study of [32], they found the highest 28.52% of PPR outbreak in male goats compare to 13.04% in females. The prevalence of Peste des Petits Ruminant (PPR) 20.0% and 8.0% pneumonia in goat was reported by [8], whereas [16] found that the two most common goat diseases were skin disease (73.3%) and PPR (26.7%) in the Mymensingh district. The study of [18] highlighted the prevalence of several common diseases affecting the goats including- PPR (49.2 %), Acidosis (38.7 %) and Myiasis (27.4 %). These variations among the above findings might reflect the regional environmental factors, goat management practices, and differences in disease control measures, which emphasize the need for region-specific strategies to mitigate disease risks in goat farming.

According to the study of [18] reported the higher proportion of farmers (91% and 80%) practiced regular vaccination and deworming of their goat under organic goat farming in Mymensingh district which was relatively higher than the traditional rearing condition. However, only 10% farmers practiced regular vaccination in the Munshiganj district stated by [8]. Goats in the chosen region were more prone to diseases, whereas farmers possessed limited knowledge of the actual reason for disease occurrence. This knowledge gap was attributed to the insufficient training provided to farmers on goat rearing and management. According to [18], a large proportion of farmers did not rely on proper veterinary services such as 83.7% and 67.3% of farmers did not practice schedule vaccination and deworming practices, while goats were usually treated with native quack medicine by 85.7 % of the respondents.

The incidence of numerous infectious diseases was most common during the rainy season (77.0%) followed by the winter season (13%) and the summer (10%) reported by [8]. According to [32], the incidence of PPR was greatest in the winter season (13.38%) and lowest during the summer (8.93%). The lower proportion than the result of the present study, with 67% of farmers separating their sick goats from healthy stock reported by [11]. Relatively higher benefit-cost-ratio (2.14) compared to the current study was reported by [19] in Godagari sub-district which mainly falls in the Barind region of Bangladesh. In the research of [33], they estimated the Benefit-Cost Ratio (BCR) of 1.82 in the herd size of 4-6 goats which strongly supported to the current study, indicating that goat raising had proven to be economically profitable at medium-sized herd groups. The calculated BCR of 1.99 was found from the study of [34] in goat farming in the Mymensingh district.

In rural areas, high mortality rates of kids were identified as a major constraint in goat production, whereas the primary causes of kids' mortality were disease outbreaks (63.46%) and attacks by predatory animals (23.08%) mentioned by [30] which supported the current study. However, in commercial goat farming, infectious disease (63%) was the main cause of kid mortality followed by predatory attacks (10%) reported by [36]. The study of [35] highlighted several issues in goat rearing, including the scarcity and high price of feed, inadequate training facilities, a disorganized marketing system and a lack of motivation among farmers. PPR was a more prevalent disease which is a highly infectious viral disease affecting goat that could emerge at any time stated by [37]. According to the study of [14], most of the respondents faced constraints such as

higher kid mortality (80.83%), the unavailability of green fodder (75.83%) and the reduction of grazing land (64.17%) for feeding their goats which supported the findings of the current study. The findings of [18] revealed that maximum goat raisers encountered various challenges, with insufficient access to green fodder (Rank II) and shortage of purebred bucks (Rank III).

Conclusion

Goats are considered a valuable asset, especially for rural farmers with marginal land, not only contributing to economic stability and family nutrition but also enhancing the well-being and livelihood of the goat-raising farmers. Goat-raising Farmers in the Hilly region predominantly relied on semi-extensive or free-range rearing systems, while Barind and Plain Land farmers employed more structured housing and supplementation practices. Notably, the Plain Land region demonstrated superior productive traits while the Hilly region showed the most significant challenges in terms of kid mortality and disease outbreaks. All the regions exhibited favorable profitability from goat farming, where the benefit-cost ratio (BCR) was higher in the Barind region because of lower cost involvement in goat raising compared to other regions. However, challenges such as higher feed prices, disease outbreaks, inadequate vaccination and treatment facilities were common across all regions. Addressing these challenges, it is necessary to improve knowledge of farmers through hands-on-training programs, field demonstration of improved technological intervention and their appropriate usages in several areas such as selecting prolific goat breeds, proper breeding techniques, improved methods of rearing and affordable feed prices, disease control strategies, better access to veterinary services, entrepreneurship and marketing facilities etc. to transform goat farming into a profitable and sustainable enterprise.

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Declarations of Conflict of Interest

There is no conflict of interest regarding this research and manuscript.

Authors Contribution

All authors earnestly contributed to this entire research work. Authors Razia Khatun and Sharmin Sultana conceptualized this research. Authors Sharmin Sultana and Syidul Islam designed the research methodology and author Md. Ashraful Islam helped in the questionnaire development for the field survey. Author Sharmin Sultana completed the formal analysis of the data and wrote this manuscript. Authors Syidul Islam, Md. Ashraful Islam, Md. Abu Haris Miah, Bijoy Barua and Sukumar Roy were helped in data collection. Author Razia Khatun provided the necessary guidelines in writing and finalized the manuscript.

TABLE 1. Socio-economic status of the Goat rearing farmers

Parameters	Category	Percentage (%) of respondents			
		Hilly (n=30)	Barind (n=30)	Plain land (n=30)	Overall (n=90)
	Illiterate	16.67 (5)	13.33 (4)	16.67 (5)	15.56 (14)
	Signed only	13.33 (4)	-	20.00 (6)	11.11 (1)
Education	Primary level	23.33 (7)	56.67 (17)	43.33 (13)	41.11 (37)
	Secondary (SSC)	20.00 (6)	20.00 (6)	16.67 (5)	18.89 (17)
	Higher secondary (HSC)	16.67 (5)	10.00 (3)	3.33 (1)	10.00 (9)
	Graduate (Honors)	10.00 (3)	-	-	3.33 (3)
	Agriculture	3.33 (1)	70.00 (21)	16.67(5)	30.00 (27)
	Homemaker	76.67 (23)	23.33 (7)	80.00 (24)	60.00 (54)
Occupation	Business	-	6.67 (2)	3.33 (1)	3.33 (3)
	Service	13.33 (4)	-	-	4.44 (4)
	Day labor	6.67 (2)	-	-	2.22 (2)
Parameters (Mean±S.E.)					
Family member (nos.)		5.30±0.28	4.60±0.26	3.50±0.16	4.47±0.16
Earning member (nos.)		1.40±0.12	1.17±0.07	1.13±0.67	1.23±0.05
Annual family income (BDT.)		178966.67	146033.33	159333.33	161444.44
Number of goats per household		6.3±0.92	7.97±1.06	5.10±0.31	6.46±0.49
Goat rearing experience (years)		4.43±1.26	8.07±0.34	9.93±0.62	8.14±0.50

*n= Number of Respondents; SSC= Secondary School Certificate; HSC= Higher Secondary School Certificate; S.E. =Standard Error; nos.=Numbers; BDT. = Bangladeshi Taka

TABLE 2. Management practices (housing, rearing, feeding and breeding) of Goat at three distinct areas of Bangladesh

Parameters	Percentage (%) of respondents			
	Hilly (n=30)	Barind (n=30)	Plain land (n=30)	Overall (n=90)
Separate goat house	96.67 (29)	-	100.00 (30)	65.56 (59)
Kept in Cattle house	3.33 (1)	100.00 (30)	-	34.44 (31)
Hosing Materials				
Tin	53.33 (16)	13.33 (4)	56.67 (17)	41.11 (37)
Tin and mud	-	83.33 (25)	23.33 (7)	35.56 (32)
Wood	23.33 (7)	-	-	7.78 (7)
Concrete	-	3.33 (1)	13.33 (4)	5.56 (5)
Bamboo	23.33 (7)	-	6.67 (2)	10.00 (9)
Floor type				
Above the ground level (matcha)	40.00 (12)	-	80.00 (24)	40.00 (36)
Concrete floor	-	3.33 (1)	13.33 (4)	5.56 (5)
Mud floor	60.00 (18)	96.67 (29)	6.67 (2)	54.44 (49)
House cleaning practices and cleaning materials				
Yes (regular)	100.00 (30)	93.33 (28)	100.00 (30)	97.78 (88)
No	-	6.67 (2)	-	2.22 (2)
Cleaning with a broom	86.67 (26)	100.00 (30)	83.33 (25)	90.00 (81)
Cleaning with a broom and water	13.33 (4)	-	16.67 (5)	10.00 (9)
Goat Rearing Methods				
Free-ranging	100.00 (30)	96.67 (29)	86.67 (26)	94.44 (85)
Confined rearing	-	3.33 (1)	13.33 (4)	5.56 (5)
Providing feed supplement	36.67 (19)	100.00 (30)	100.00 (30)	87.78 (79)
Place of goat breeding				
Local farm	60.00 (18)	80.00 (24)	76.67 (23)	72.22 (65)
Buck farm	10.00 (3)	20.00 (6)	13.33 (4)	14.44 (13)
BLRI Goat farm	30.00 (9)	-	10.00 (3)	13.33 (12)
Breeding Method				
Natural	100.00 (30)	100.00(30)	100.00 (30)	100.00 (90)
Breed of breeding buck				
Black Bengal (BB) goat	70.00 (21)	13.33 (4)	16.67 (5)	33.33 (30)
Hilly Brown Bengal (HBB)	23.33 (7)	-	-	7.78 (7)
Jamuna Pari	-	-	53.33 (16)	17.78 (16)
Crossbred goat (BB/ HBB/ Jamuna Pari cross)	6.67 (2)	86.67 (26)	30.00 (9)	41.11 (37)
Signs of showing heat				
Bellowing	33.33 (10)	56.67 (17)	70.00 (21)	53.33 (48)
Tail wagging and restless	26.67 (8)	26.67 (8)	10.00 (3)	21.11 (19)
Frequent urination	20.00 (6)	10.00 (3)	16.67 (5)	15.56 (14)
Discharge mucus	13.33 (4)	6.67 (2)	3.33 (1)	7.78 (7)
Fond of male	6.67 (2)	-	-	2.22 (2)

TABLE 3. Productive and reproductive traits (Mean±S.E.) of Goat at three distinct areas

Parameters	Hilly (n=189)	Barind (n=239)	Plain land (n=153)	Overall (n=581)	P value
Weaning weight (kg)	4.65±0.16	5.17±0.16	8.18±0.15	6.00±0.19	≤0.001***
Mature Buck weight (kg)	22.90±0.95	22.97±0.53	26.75±0.42	24.21±0.43	≤0.001***
Mature Doe weight (kg)	17.53±0.83	18.11±0.41	21.63±0.29	19.00±0.37	≤0.001***
Milk allowance for kids (months)	2.63±0.12	3.93±0.07	3.00±0.00	3.21±0.07	≤0.001***
Age at first heat (months)	7.57±0.31	5.97±0.10	6.40±0.09	6.64±0.13	≤0.001***
Weight at first heat (kg)	9.07±0.34	10.63±0.21	15.30±0.32	11.67±0.33	≤0.001***
Avg. gestation length (days)	161.67±2.49	150.77±0.32	169.16±1.67	160.53±0.28	≤0.001***
Avg. litter size (nos.)	2.36±0.09	2.33±0.08	2.17±0.08	2.28±0.05	0.230 NS
Heat after each calving (days)	47.67±1.75	51.50±1.36	72.66±3.18	57.33±1.73	≤0.001***

***P≤0.001 indicates the probability level at 1%, **P≤0.05 indicates the probability level at 5% and ≥ 0.05 indicates the non-significant probability value; S.E. = Standard Error; n= Number of observations; kg= Kilogram; nos.= Numbers.

TABLE 4. Prevalence of different diseases of goat

Disease outbreaks	Hilly, % (n)	Barind, % (n)	Plain land, % (n)	Overall, % (n)	Overall Ranking
PPR	70.00 (21)	80.00 (24)	93.33 (28)	81.11 (73)	I
Pneumonia	33.33 (10)	73.33 (22)	20.00 (6)	42.22 (38)	III
Parasitic infestation	76.67 (23)	33.33 (10)	16.67 (5)	42.22 (38)	III
Bloat	20.00 (6)	66.67 (20)	70.00 (21)	52.22 (47)	II
Goat Ecthyma	13.33 (4)	-	53.33 (16)	22.22 (20)	IV
Myasis infection	-	-	6.67 (2)	2.22 (2)	V
Goat pox	-	6.67 (2)	-	2.22 (2)	V

*%= Percentage; PPR= Peste des Petits Ruminants; n= Number of respondents.

TABLE 5. Health and biosecurity management of goat at three different chosen areas

Parameters (%)	Hilly (n=30)	Barind (n=30)	Plain land (n=30)	Overall (n=90)
Regular vaccination practice	50.00 (15)	66.67 (20)	10.00 (3)	42.22 (38)
Deworming practices	66.67 (20)	63.33 (19)	16.67 (5)	48.89 (44)
Vaccination interval, months	12.00	12.00	12.00	12.00
Deworming interval, months	5.79	11.31	3.00	6.70
Stage of maximum disease outbreak				
Kids/ early age	83.33 (25)	56.67 (17)	33.33 (10)	57.78 (52)
Growing stage	10.00 (3)	43.33 (13)	50.00 (15)	34.44 (31)
Aged goat	6.67 (2)	-	16.67 (5)	7.78 (7)
Season of disease outbreak and sick goat management				
Summer	6.67 (2)	-		2.22 (2)
Rainy	13.33 (4)	-	56.67 (17)	23.33 (21)
Winter	80.00 (24)	-	43.33 (13)	52.22 (47)
Both rainy and winter	-	100.00 (30)	-	33.33 (30)
Diseased goat separation	96.67 (29)	-	86.67 (26)	61.11 (55)
Kept with other goats/ livestock	3.33 (1)	100.00 (30)	13.33 (4)	38.89 (35)
Treatment facility for goat farmers				
DLS	20.00 (6)	-	-	6.67 (6)
BLRI	20.00 (6)	-	-	6.67 (6)
Quack	60.00 (18)	100.00 (30)	100.00 (30)	86.67 (78)
Stage of maximum death occurrence				
Kids/ early age	76.67 (23)	63.33 (19)	60.00 (18)	66.67 (60)
Growing stage	6.66 (2)	26.67 (8)	33.33 (10)	22.22 (20)
Aged goat	16.67 (5)	10.00 (3)	6.67 (2)	11.11 (10)
Dead goat management				
Buried	73.33 (22)	100.00 (30)	70.00 (21)	81.11 (73)
Thrown into hilly slope/yard	26.67 (8)	-	-	8.89 (8)
Thrown into water	-	-	30.00 (9)	10.00 (9)
Faces management practices				
Dumped in hole	70.00 (21)	-	100.00 (30)	56.67 (51)
Dumping besides hilly slope	30.00 (9)	-	-	10.00 (9)
Dumping besides farmyard	-	100.00 (30)	-	33.33 (30)

TABLE 6. Benefit-cost ratio analysis on goat faming

Parameters (BDT.)	Hilly area	Barind area	Plain land area	Overall
Initial stock value	16256.67	33100.00	51833.33	33730.00
Goat buying expense	11200.00	14633.33	12666.67	12833.33
Feed cost	4081.65	3758.33	4520.00	4119.99
Housing cost with 10% depreciation	1030.00	1476.67	1446.67	1317.78
A. Fixed cost	**32568.32**	**52968.3**	**70466.67**	**52001.10**
House repairing cost	833.38	1010.50	1683.33	1175.74
Deworming and vaccination cost	351.63	198.69	187.67	246.00
Medicine and treatment cost	1946.67	1416.67	1702.33	1688.56
Breeding expense	-	250.00	510.00	380.00
Electricity cost	-	-	246.43	246.43
Miscellaneous expenses	730.00	105.33	678.33	504.55
B. Variable cost	**3861.68**	**2981.19**	**5008.09**	**3950.32**

C. Total Cost, (A+B)	**36430.00**	**55949.52**	**75474.76**	**55951.43**
Income from sold animal	26245.00	32566.67	32600.00	30470.56
Family consumed and gift value	4250.00	9666.67	16214.29	10043.65
Value of end stock	35933.33	66533.33	73933.33	58800.00
D. Total Income	**66428.33**	**108766.70**	**122747.6**	**99314.21**
Net Income/Profit (D-C)	**29998.33**	**52817.15**	**47272.86**	**43362.78**
Benefit-Cost Ratio, (D/C)	**1.82**	**1.94**	**1.63**	**1.79**

TABLE 7. Production function analysis on goat farming expenses and income generation

Multiple regression and coefficient test			
Independent Variables	**Coefficients**	**t test**	**Probability**
(Constant)	24937.305	2.187	0.032*
Initial stock value (X_1)	0.217	2.537	0.013*
Goat buying cost (X_2)	0.329	4.165	0.000***
Feed value (X_3)	-0.247	-3.330	0.001***
Housing cost with 10% depreciation (X_4)	0.220	2.737	0.008**
House repairing cost (X_5)	0.113	1.303	0.197^{NS}
Deworming and vaccination cost (X_6)	-0.082	-0.926	0.357^{NS}
Treatment and medicine cost (X_7)	0.162	1.751	0.084^{NS}
Electricity cost (X_8)	0.059	0.661	0.510^{NS}
Breeding expense (X_9)	0.006	5.827	0.000***
Miscellaneous cost (X_{10})	0.410	0.064	0.950^{NS}
F count	15.161	-	0.000***
R		0.816	
R Square		0.666	
Adjusted R Square		0.622	

***P≤0.001 and **P≤0.01 indicates the probability levels at 1%, *P≤0.05 indicates the probability level at 5% and ≥0.05 indicates the non-significant probability value; Y= Total Income (Dependent Variable)

TABLE 8. Multi-linearity diagnostics

Dimensions	**Constant**	**X_1Log**	**X_2Log**	**X_3Log**	**X_4Log**	**X_5Log**	**X_6Log**	**X_7Log**	**X_8Log**	**X_9Log**	**X_{10}Log**
Constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
X_1Log	0.00	0.00	0.02	0.00	0.00	0.00	0.07	0.04	0.13	0.00	0.03
X_2Log	0.00	0.00	0.04	0.02	0.00	0.00	0.18	0.05	0.18	0.08	0.00
X_3Log	0.00	0.00	0.02	0.00	0.00	0.01	0.02	0.00	0.05	0.79	0.03
X_4Log	0.02	0.04	0.13	0.02	0.01	0.08	0.09	0.15	0.02	0.00	0.06
X_5Log	0.00	0.02	0.01	0.12	0.00	0.01	0.16	0.14	0.15	0.03	0.25
X_6Log	0.00	0.07	0.67	0.02	0.00	0.01	0.01	0.12	0.24	0.01	0.10
X_7Log	0.00	0.52	0.01	0.09	0.03	0.01	0.00	0.04	0.00	0.01	0.36
X_8Log	0.02	0.00	0.00	0.19	0.01	0.80	0.35	0.40	0.09	0.04	0.08
X_9Log	0.11	0.33	0.04	0.44	0.26	0.06	0.10	0.07	0.00	0.03	0.06
X_{10}Log	0.84	0.00	0.06	0.09	0.67	0.01	0.02	0.00	0.15	0.00	0.01

TABLE 9. Major operational constraints regarding Goat rearing in the chosen regions

Constraints in Duck Rearing	**Hilly**	**Ranking**	**Barind**	**Ranking**	**Plain land**	**Ranking**
Disease outbreaks	43.33 (13)	IV	56.67 (17)	II	66.67 (20)	I
Higher Feed price	76.67 (23)	I	73.33 (22)	I	66.67(20)	I
Lack of pasture land	-	-	46.67 (14)	III	-	-
Kids mortality higher	26.67 (8)	VII	33.33 (10)	IV	40.00 (12)	IV
Lack of vaccine	46.67 (14)	III	30.00 (9)	V	60.00 (18)	II
Lack of treatment facility	33.00 (10)	V	30.00 (9)	V	46.67 (14)	III
Attacking by predatory animals	30.00 (9)	VI	6.67 (2)	VI	16.66 (5)	V
Higher risks of Dog bites	50.00 (15)	II	-	-	-	-

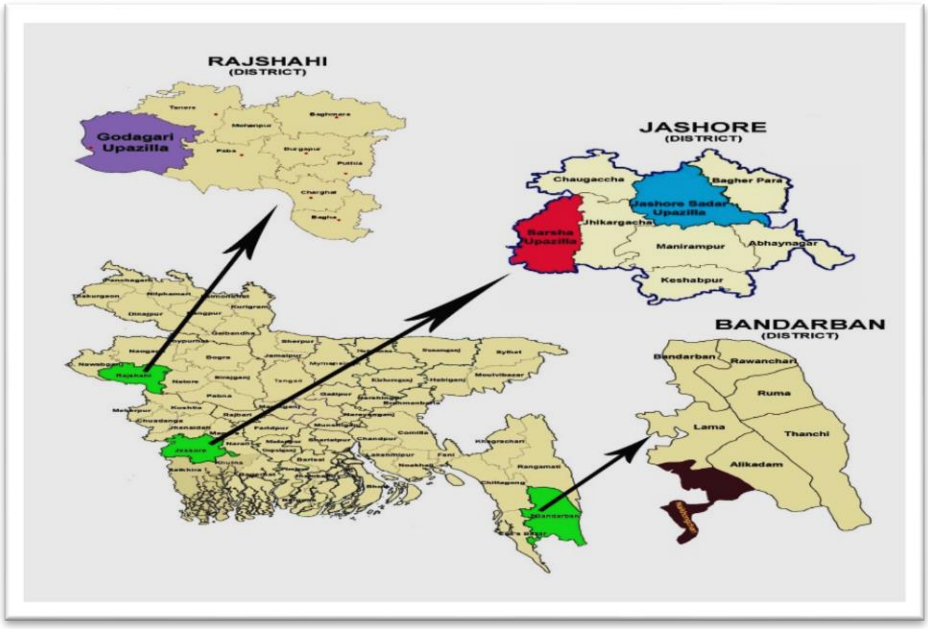

Fig. 1. Geographical location of the studied areas (Bandarban, Rajshahi and Jashore districts in Bangladesh)

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