

# MORPHOMETRIC CHARACTERIZATION OF BLACK BENGAL GOAT AT SAVAR GOAT DEVELOPMENT FARM UNDER FARMING CONDITION

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JUNE, 2020

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FARMING CONDITION**

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**A Thesis**

*Submitted to the Faculty of Animal Science & Veterinary  
Medicine, Sher-e-Bangla Agricultural University, Dhaka-  
1207,*

*in partial fulfillment of the  
requirements for the degree of*

**MASTER OF SCIENCE**  
**(MS) IN**  
**ANIMAL BREEDING AND GENETICS**  
**SEMESTER: January-June, 2020**

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### CERTIFICATE

This is to certify that the thesis entitled, *“Morphometric Characterization of Black Bengal Goat at Savar Goat Development Farm Under Farming Condition”* Submitted to the Department of Animal Nutrition, Genetics and Breeding, Faculty of Animal science and veterinary medicine, Sher-E-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (MS) in Animal Breeding and Genetics** embodies the result of a piece of bonafide research work carried out by **Muhammad Habibur Rahman, Registration No. 13-05388** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that such help or source of information, as has been availed of during the course of this investigation has been duly acknowledged by her.

**Dated:**  
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**DEDICATED TO**

*Professor Dr. Lam Lea Asad*

*And*

*My beloved Parents*

## **ACKNOWLEDGEMENTS**

*Alhamdulillah Rabbil Al-Amin, all praises are due to the almighty Allah for His gracious kindness and infinite mercy in all the endeavors the author to let his successfully complete the research work and the thesis leading to Master of Science.*

*The author would like to express his heartfelt gratitude and most sincere appreciations to her **Supervisor Professor, Dr. Lam Yea Asad**, Department of Animal Nutrition, Genetics and Breeding, Sher-e-Bangla Agricultural University, Dhaka, for her valuable guidance, advice, immense help, continuous direction, constructive criticism, encouragement and valuable suggestions in carrying out the research work and preparation of this thesis. Likewise, grateful appreciation is conveyed to **Co-Supervisor Professor, Dr. Md. Mufazzal Hossain**, Department of Animal Nutrition, Genetics and Breeding for constant encouragement, cordial suggestions, constructive criticisms and valuable advice to complete the thesis.*

*The author would like to express his deepest respect and boundless gratitude to all the respected teachers of the Department of Animal Nutrition, Genetics and Breeding for their valuable teaching, sympathetic co-operation, and inspirations throughout the course of this study and research work.*

*The author wishes to extend his special thanks to Bishrat Farhana Amy, Md. Hafizur Rahman, Md. Rakibul Islam for their keen help as well as heartiest co-operation and encouragement. Special thanks to all other friends for their support and encouragement to complete this study.*

*The author is deeply indebted and grateful to his parents, brother and other relatives for their moral support, encouragement and love with cordial understanding.*

*Finally, the author appreciate the assistance rendered by the staff of the Department of Animal Nutrition, Genetics and Breeding, Sher-e-Bangla Agricultural University, Dhaka, who have helped him during the period of study.*

*The author*

# **MORPHOMETRIC CHARACTERIZATION OF BLACK BENGAL GOAT AT SAVAR GOAT DEVELOPMENT FARM UNDER FARMING CONDITION**

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## **ABSTRACT**

The study was undertaken to characterize Black Bengal goat (BBG) under farming condition. Data on different parameters were collected during January 2019 to December 2019 at Savar Goat Development Farm. A total of 60 animals of different ages from three months to more than 12 months of both sexes were included. All type of measurements was taken when goats standing freely. All measurements were taken in metric unit. Body length were higher in males  $34.05 \pm 0.069$ ,  $41.60 \pm 1.2$  and  $49.10 \pm 0.98$  cm than that of females  $29.70 \pm 0.82$ ,  $37.20 \pm 0.90$  and  $45.80 \pm 1.17$  cm for age groups 3-6, 6-12 and >12 months of age. Male goats had higher heart girth  $40.81 \pm 0.37$ ,  $51.86 \pm 0.30$  and  $55.43 \pm 0.19$  cm than that of female goats  $39.59 \pm 0.13$ ,  $48.57 \pm 0.25$  and  $53.32 \pm 0.37$  cm irrespective of age. Average adult (>12 months' age) body weight of male and female goats as  $16.00 \pm 0.14$  and  $13.51 \pm 0.09$  kg, respectively. Withers height was higher in adult males  $36.14 \pm 0.37$ ,  $46.55 \pm 0.81$  and  $52.90 \pm 0.60$  cm than females  $34.67 \pm 0.30$ ,  $42.83 \pm 0.78$  and  $49.33 \pm 0.30$  cm for same age. Tail length of Black Bengal goats ranged from  $7.45 \pm 0.15$  to  $10.37 \pm 0.15$  cm for different age and sex group. Average male foreleg length in >12 months of age possessed higher than that of female. Average udder length of BBGs were  $6.87 \pm 0.27$ ,  $8.52 \pm 0.29$  and  $11.59 \pm 0.25$  cm and breadth were  $4.34 \pm 0.18$ ,  $6.58 \pm 0.16$  and  $8.00 \pm 0.16$  cm, respectively for age groups 3-6, 6-12 and >12 months of age. The average scrotal length of Black Bengal bucks at 3-6, 6-12 and more than 12 months were  $5.80 \pm 0.24$ ,  $9.26 \pm 0.16$  and  $11.19 \pm 0.32$  cm respectively. Whereas, all the findings gradually increased for all parameters according to their different age groups. Body weight has been a positive correlation with body length, heart girth, withers height, scrotal length. All the parameters studied found comparatively higher in buck than in does and it increased linearly with increasing ages.

**Keywords:** Black Bengal goat, Characterization, Body parts

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## LIST OF ABBREVIATIONS AND SYMBOLS

%	= Percentage
>	= Greater than
<	= Less than
±	= Plus minus
AI	= Artificial insemination
AICRP	= All India Co-Ordinated Research Project
BAU	= Bangladesh Agricultural University
BBG	= Black Bengal goat
BLRI	= Bangladesh Livestock Research Institute
BW	= Birth weight
CIRG	= Central Institute for Research on Goats
DLS	= Department of Livestock Services
<i>et al.</i>	= Associate
FAO	= Food and Agricultural Organization
GDP	= Gross Domestic Product
gm	= Gram
GLM	= General linear model
MW	= Month Weight
lbs	= Pound
Kg	= Kilogram
LSD	= Least Squares Means
MFTSP	= Microfinance and Technical Support Project
n	= Number of observation
NS	= Non-significant
Cm	= Centimeter
FAnGR	= Farm Animal Genetic Resources
ANOVA	= Analysis of variance

# CHAPTER 1

## INTRODUCTION

Bangladesh is an Agricultural country and its economy backbone is mainly based on agriculture. Livestock is the most viable sector in the economy of Bangladesh. Livestock being one of the major component of agriculture (crop, livestock, fisheries and forestry) play a vital role in national economy, contributing about 2.73% of overall Gross Domestic Products (GDP) and 4.31% export earnings from leather and leather goods of total export, 20% of the population is directly and 50% is party dependent on this sector (Draft sixth five-year plan, 2010). However, in 2018-19, the contributions of livestock in gross domestic production 1.47% and GDP growth rate of livestock 3.47%. The total livestock population (55.53 million) composed of 26.27 million goats, 24.24 million cattle, 1.49 million buffaloes and 3.54 million sheep (DLS Livestock economy at a glance, 2018-19).

Bangladesh has the fourth highest population of goats and there are about 14.8 million goats in the country. Bangladesh has only one goat breed of its own, popularly known as the Black Bengal goat (BBG). It is estimated that more than 90% of goat population in Bangladesh comprised the Black Bengal, the remainder being Jamunapari and their crosses (Husain, 1993). It is also observed that there are wide variations in color, body size and weights of goats found in different locations. The BBG is mostly black in color, which comprises 69% of the total goat population. However, white stripe on black (13%), brown (5%), solid white (4%), black with white patches or brown with white or brown with black (9%) also found (Chowdhury, 2002). As a reservoir of genetic resource, BBG occupies very illustrious position among the dwarf meat type goat of the world. Higher prolificacy, fertility, resistance against common diseases, adaptability to stressful adverse environmental condition, early maturity, seasonality and superiority in the kidding intensity are some of the outstanding features of BBG. Besides, it produces excellent quality flavored, tender and delicious meat and skin of extra ordinary quality for which there is tremendous demand all over the world (Devendra and Burns, 1983; Islam *et al.*, 1991; Singh *et al.*, 1991 and Husain, 1993).

Prasad *et al.*, 1981 reported that there was a correlation of body weight with length, height and heart girth in BBG. Correlation of body weight with heart girth was highest and this was followed by length and height, respectively. High relationship of body weight with heart girth was also observed by Singh *et al.*, 1986 in BBG and by Mukherjee *et al.*, 1979 in Grey and Brown Bengal

goats. Husain *et al.*, 1996 observed the existence of large variation within breed in terms of birth weight, mature body weight, growth rate and milk yield of dam which may be exploited for their immediate improvement through selective breeding. Relationship between body weight and length might be due to close association between weight and growth of muscles and bones leading to increase in length. Increase in heart girth includes the growth of bones, muscle and viscera.

At present goats are wide spread and found in all place of the world more or less. A statistics show that the total number of goats (live animals) in 2013 was 975.8 million (FAOSTAT, 2015). Increasing the number of goats is observed since 1990. The number of goats increase per year has been between 1 to 4 % and the total number of goats in the world has increased with 166 % from 1990 (589.2 million) to 2013 and at the same time, per year the number of cattle has increased by 5% and sheep has decreased by 10 % (Aziz, 2010). Now the fourth largest livestock groups in the world is goat (677 millions) (Morand-Fehr and Boyazoglu, 1999).

Goats have been aptly said to be “poor man’s cow” as they are living resort for poverty alleviation particularly in subsistence level of farming for many small and landless farmer families (Amin, 2000). Paradoxical to the breed name Black Bengal is not always solid black in coat color rather in this breed coat color polymorphism does exist. These are i. Full white or cream, ii. Bezoar, iii. Silver Bezoar, iv. Solid Black, v. Black with “Toggenburg pattern” of spotting, vi. Black with “Dutch belt” spotting (Nozawa *et al.*, 1984; Alam, 2006 and Faruque and Khandoker, 2007).

But owing to small body size, meat produced by this breed does not fetch a high economic return. As BBGs are being reared primarily for meat production, body weight and growth rate could be considered as the most important factors. In spite of promises of BBG amongst the world goat genetic resource no substantial amount of work has yet been done on the morphometric evaluation and characterization. Considering the above facts, it is the best tone to describe the BBG as a breed. There are wide variations in color, body size and weights of goats found in different locations. Black Bengal goats have different coat color variation i.e. black, brown, and white and any combination of those colors at any proportion (Nozawa and Katsumata, 1984). During selection of goat, attention should be given on the age, growth rate, body weight, heart girth, body length, height at wither and soundness of sexual organ.

Body length and heart girth may be used as good reliable predictors to assess live weight according to Bhattacharya *et al.* (1984) and Islam *et al.* (1991) reported that heart girth in males is a good predictor of live weight in Bengal goats. There was a correlation of body weight with length, height and heart girth in Black Bengal goats (Prasad *et al.*, 1981). Correlation of body weight with heart girth was highest and that was followed by length and height, respectively. Scrotal circumference has great value as indicator of genetic trait, puberty and total spermatozoa production (Ott, 1986). Determination of scrotal length and circumference is an important aspect of breeding soundness examination (BSE).

The world's livestock production is increasingly based on a limited number of breeds. Genetic diversity within these breeds also in declining mode. There is also evidence to suggest that, population that are genetically diverse in terms of their disease resistance characteristics are less susceptible to large scale disease epidemics (FAO, 2007). In spite of having values, these indigenous FAnGRs in many cases have been prejudiced and pushed under threatening situation. FAO's initiatives towards exploration and conservation of indigenous livestock genetic resources are seriously underway. It is reported that almost one breed of domestic animal disappeared per month during 2000-2006 and around 20 % of the reported breeds are classified at risk (FAO, 2007). Under these circumstances, it has become crucial to explore the coat color based sub- population of BB goats to have a better understanding on them and finally focusing such FAnGR on the global stream of literature. Effective management, planned breeding and in-situ conservation programme with these goats are to be prioritized among the activities related to their development (Husain and Amin, 2003).

Through community breeding system the provision of technical assistance to the goat producers can be provided by organizing them in rural areas. Encouraging them to establish new flocks with superior males using modern techniques and organizing the production and marketing of animals. The primary objectives of community breeding program is to improve Black Bengal goat and provide smallholder goat farmers with improved breeding animals particularly males. Although the primary goal would be the improvement of performance, the focus of all activities could be directed at utilization and conservation concomitant improvement of the Black Bengal goat.

It is known that there are several important quantitative traits for goat. Among these birth weight and body weight of goats are considered as important. There is a positive correlation between birth weight and rate of growth, age at maturity and mature body weight which influence the future productive and reproductive performance of the animal (Banerjee, 1989). Husain *et al.*, (1995) demonstrated that poor pre-weaning kid survivability could be improved by increasing birth weight of kids and milk yield of dam. In spite of promises of Black Bengal goat amongst the world goat genetic resource, the systematic information on genetic and phenotypic parameters in Black Bengal goat is very limited. It seems essential to identify and quantify the parameters by which Black Bengal goats can be described distinctively from others. Considering the above facts and circumstances the present study was undertaken to fulfill the following objectives:

- i) To determine some basic morphological information of Black Bengal goat.
- ii) Co-relation of body weight with body length heart girth and wither height of Back Bengal does.
- iii) Co-relation of body weight with body length, heart girth, wither height, scrotal length and scrotal circumference of Back Bengal bucks.

## CHAPTER 2

### REVIEW OF LITERATURE

Many researchers and scientist in different countries of the world have been carried out substantial research works related to the morphometric characterization of Black Bengal goat. In different farms of our country this type of work also has been done but limited. Besides at Savar goat development farm there is no research work done about morphometric characterization of black Bengal goat. For this reason, I have selected this area for my study. This chapter includes selective review of research work which is done by previous researcher and scientist related to the study.

#### 2.1 Body weight

Islam *et al.* (2009) conducted an experiment on Black Bengal doe and reported that body weight of Black Bengal doe under semi-intensive and scavenging production system were  $22.10 \pm 0.11$  and  $21.90 \pm 0.15$  kg, respectively.

Tesfaye (2009) found that body weight of indigenous goats in Metema woreda Amhara region of Ethiopia was  $12.73 \pm 0.13$  kg.

Rahman (2007) conducted an experiment on Black Bengal buck and reported that body weight of Black Bengal bucks at 0, 3, 6, 12 and 15 months of age were  $1.21 \pm 0.12$ ,  $4.25 \pm 0.25$ ,  $7.68 \pm 0.31$ ,  $12.76 \pm 0.42$ ,  $16.56 \pm 0.57$  and  $21.82 \pm 0.76$  kg, respectively. Body weight significantly ( $p < 0.05$ ) differ with different groups.

Alam (2006) conducted an experiment on white Bengal goat and reported that the body weight of bucks and does at birth, 3, 6, 9 and 12 months of age were 1.18, 4.17, 6.78, 10.91, 13.22 and 1.07, 3.18, 6.48, 10.32, 12.18 kg respectively.

Haque *et al.* (2005) observed that body weight of male and female Black Bengal goat at 6 months of age were  $7842.85 \pm 543.57$  and  $8958.75 \pm 454.06$  g, respectively.



Haque (2004) conducted an experiment on Black Bengal goat at farmer level through contract breeding system and reported that over all body weight at 6 months of age was  $8300 \pm 378.5$  g.

Norton (2004) observed that body weight of indigenous goats in Australia under village level at 12, 18 and 24 months of age were 13.0, 17.3 and 21.5 kg respectively.

Hasnat *et al.* (2003) reported that the body weight of male and female Black Bengal goats at 3, 6, 9 and 12 months of age were 5.08, 7.94, 10.71, 13.19 and 4.48, 7.27, 9.90, 12.47 kg, respectively. Male goats found significantly ( $p < 0.01$ ) higher in live weight than female one's. The overall body weight of Black Bengal goats at 3, 6, 9 and 12-months of age were 4.81, 7.69, 9.90, 12.48 kg, respectively. Hasnat *et al.* (2003) also observed that according to coat color of Black Bengal goat at 12 month of age, the body weights were 12.42, 12.81, 12.77 and 12.38 kg, respectively for solid black, black and white, white and brown. Brown and solid coat colored goats differed significantly ( $p < 0.05$ ) in their live weight.

Mia and Bhuiyan (1997) studied the birth weight of 381 kids born during 1989- 91 to find out possible interactions between year of birth, season of birth, type of birth (single or multiple) and sex of kids. Each of these factors, except season, influenced birth weight and various interactions were identified. Anglo-Nubian goats produced the heaviest kid, followed by Barbari, Black Bengal and Barbari crosses. Single & male kids were consistently heavier than other birth types. Average birth weights of Black Bengal kids were 1.03 and 0.93 kg for male and female in Bangladesh (Husain, 1993; Amin *et al.* 2001) and 1.13 kg in India (Acharya, 1988). Verma *et al.* (1991) reported that the average birth weight of Black Bengal kids was 1.45 kg.

Husain *et al.* (1996) analyzed data on birth weight and body weight at 9 and 12 months of age in Black Bengal goats. They found a large within-breed variation in birth weight of kids, ranging from 0.5-1.60 kg. Body weight at 9 and 12 months also showed a large variation, ranging from 1.08-5.0 kg and from 16.0-19.0 kg, respectively. Husain (1993) reported that the body weight of kids at 3, 6, 9, and 12 month of age were  $4.9 \pm 0.17$ ,  $8.4 \pm 0.28$ ,  $10.7 \pm 0.36$  and  $12.8 \pm 0.2$  kg, respectively in Black Bengal goats. Mia (1993) reported birth weight, 6 months' body weight and 12 months' body weight to be 1.35, 7.99 and 11.28 kg respectively in Black Bengal goats of Bangladesh reared in intensive farm.

Singh *et al.* (1991) studied the influence of genetic and non-genetic factors on body weights at birth and at weaning in Black Bengal and its crosses *with* Jamnapari and Beetal. The overall birth weight was  $1.64 \pm 0.02$  kg. Body weight at weaning (3 month) averaged  $6.88 \pm 0.08$  kg. Singh *et al.* (1991) observed the average birth weight and 3 months' weight of Black Bengal kids to be 1.24 and 5.65 kg respectively. Singh and Sengar (1990) reported that the body weight of Black Bengal goat was 4.31, 7.23 and 11.92 kg for the period 3, 6 and 9 months respectively. Singh (1989) described the performance of Black Bengal goats numbering 50 female and 5 males. Birth weights averaged  $1.18 \pm 0.04$  to  $1.43 \pm 0.4$  kg male (depending on year) and  $1.01 \pm 0.04$  to  $1.22 \pm 0.05$  kg for female. Six-month body weight was 8.16 and 6.23 kg respectively for male and female. Slaughter weight averaged  $9.23 \pm 0.95$  kg.

Kanaujia and pander (1988) reported birth weight and weight at 3, 6 and 12 months of age in Black Bengal goats to be 1.13, 5.41/ 7.96 and 12.12 kg, respectively. Patnaik and Nayak (1988) studied the growth in Black Bengal goats in India and found highly significantly difference ( $p < 0.01$ ) in body weight at birth and 3 months of age. The average body weight at birth and 3 months of age in Black Bengal goats were 1.52 and 5.85 kg, respectively.

Singh *et al.* (1987) found body weight of male and female of Black Bengal goats at 12 months of age was 14.93 and 14.35 kg respectively.

Adult body weight is an important and economic factor which influences the growth and production pattern of any goat enterprise and has more influence mainly on the growth behavior of kids (McGreor, 1984).

## **2.2 Morphometric characters**

### **2.2.1 Heart girth, body length and wither height**

Mamabolo *et al.* (2010) reported that body length and wither height of goats in South Africa to be 56 to 98 cm and 51 to 75 cm, respectively at village level.

Rahman (2007) conducted an experiment with Black Bengal bucks on measurement of heart girths of bucks at 0, 3, 6, 9, 12 and 15 months of age and found to be  $26.35 \pm 0.38$ ,  $35.67 \pm 0.40$ ,

51.10±10.82, 54.26±10.64, 59.06±10.87 and 63.25±11.07cm, respectively. Age had significant effect ( $p<0.05$ ) on heart girth. The body lengths of Black Bengal bucks at 0, 3, 6, 9,12, and 15 months of age were found to be 24.15±10.38, 29.70±10.75, 41.20±10.76, 43.87±10.54, 47.83±10.75 and 51.25±10.92 cm, respectively and significantly ( $p<0.05$ ) differed with different age groups. The height at withers of Black Bengal bucks at 0, 3, 9,12 and 15 months of age were found to be 26.30±0.35, 28.45±0.80, 39.95±0.70, 43.73±0.55, 47.92±0.76 and 51.21±0.93 cm, respectively and significantly ( $p<0.05$ ) differed with different age groups except 0 and 3 months' age groups.

Alam (2006) conducted an experiment with white Bengal goat and reported that the body length of female goats at 6, 9, and 12 months of age to be 38.77, 42.85 and 46.95 cm, respectively. The heart girth was 49.69, 50.77 and 54.21 cm at the similar age groups whereas the height at wither was 38.46, 41.23 and 44.11cm, respectively. Husain *et al.* (2005) reported body measurement of different age groups of Black Bengal goat viz. 1-3, 4-8, 9-12, 13-20 and >20 months. Significantly higher body heights were found in the age group of 13- 20 months (48.75cm) and >20 months (50.21 cm) compared to others age groups. Male possessed significantly ( $p>0.05$ ) higher body length (43.85 cm) than female (40.57cm) at 12 months of age. Body lengths both in male (40.19 cm) and female (39.49 cm) goats were more or less similar at 12 months of age. Heart girth at >20 months (59.60 cm) of age was significantly ( $p>0.05$ ) higher compared to other age groups. Male goats had higher (50.57 cm) heart girth than female (47.96 cm) goats at 12 months of age.

Hasnat *et al.* (2003) observed the body measurement according to sex of Black Bengal goats at 12 months of age. The body lengths were 47.07 and 44.99 cm; heart girth were 55.42 and 52.93 cm and wither height were 48.50 and 46.44 cm, respectively having significantly ( $p<0.01$ ) higher measure for male. Majid *et al.* (1999) conducted an experiment with 182 Black Bengal goats from the adjacent area of Bangladesh Livestock Research Institute (BLRI) Savar, Dhaka and reported the average body length at 6-12 months to be 46.62 and 42.62 cm, wither height 44.11 and 42.83 cm, hip height 46.45 and 45,01 cm, and chest girth 54.44 and 50.01 cm, respectively for male and female.

Hussain (1993) reported the overall body length, wither height and heart girth values to 46.4±0.2,46.7±0.2 and 50.9±0.2 cm, respectively for Black Bengal goats.

Khan *et al* (1992) reported body length of Black Bengal goats at 10.08 months as 46.52 cm in male and at 15.08 months as 48.33 cm in female, heart girth 52.73 cm vs. 54.03 cm. They found positive correlation between body weight and age (0.47 and 0.76 for male and female respectively), body weight and body length (0.64 and 0.74) and body weight and heart girth (0.75 and 0.79). Bhattacharya *et al.* (1984) reported heart girth in Black Bengal goats to be  $44\pm 0.68$  cm and body length  $46\pm 0.68$  cm. They concluded that body length and heart girth may be used as good reliable predictors to assess live weight in male and female Black Bengal goats.

Katsumata *et al* (1984) reported that body length, body height and heart girth of male and female goat as  $48.2\pm 0.2$ ,  $48.4\pm 0.3$ ,  $52.6\pm 0.3$  and  $44.7\pm 0.3$ ,  $44.9\pm 0.3$ ,  $49.1\pm 0.3$  cm, respectively. They also reported that body length, body height and heart girth of Solid Black, Black and White, Brown and White goats to be  $44.9\pm 0.4$ ,  $46.6\pm 0.4$ ,  $45.7\pm 0.7$ ;  $46.6\pm 0.3$ ,  $47.8\pm 0.3$ ,  $46.0\pm 0.5$ ,  $47.6\pm 0.7$  and  $52.9\pm 0.4$ ,  $54.8\pm 0.5$ ,  $51.8\pm 1.0$  and  $54.1\pm 1.1$  cm, respectively. A functional and more useful criterion to characterize goat population is the body size which also indicates the performance orientation. Devendra and Bums (1983) also classified tropical and subtropical goat breeds according to height at withers as large (over 65 cm), small (51-65 cm) and dwarf (up to 50 cm).

Mukherjee *et al* (1981, 1986) and Singh *et al* (1987) observed significant correlation of body weight with chest circumference in various Indian goat breeds. Mukherjee *et al* (1981) reported that correlations of body weight with body length, height at wither and heart girth declined gradually with the increase of age.

Singh *et al* (1981) studied the relationship between live weight and body measurement in Black Bengal goats of both sexes at one year of age. The average body weight of male was found to be 14.25 kg, the body length was 44.60 cm, heart girth 56.2 cm and wither height 49.6 cm. The body length, wither weight and heart girth were significantly correlated with live weight.

### **2.2.2 Scrotal length and circumference**

A satisfactory potential breeding buck should have suitable scrotal Circumference, because scrotal circumference positively correlates with sperm concentration per milliliter and total spermatozoa per ejaculates (Bongso *et al*, 1982).

Rahman (2007) conducted an experiment with Black Bengal goat and reported that the average scrotal circumference of Black Bengal bucks was  $48.5\pm 0.22$ ,  $10.35\pm 0.39$ ,  $15.42\pm 0.24$ ,  $19.72\pm 0.33$

and  $20.83 \pm 0.41$  cm, at 0, 3, 6, 9, 12 and 15 months respectively. Scrotal circumference at 15 months of age was significantly ( $p < 0.05$ ) higher than that of other groups.

The mean scrotal circumference of Black Bengal buck at puberty was 14 cm to 16 cm when sexually matured (Shamsuddin *et al.*, 2000). Noran and Mukherjee (1997) reported that there was no significant correlation between body weight and scrotal circumference when they were working with local Katjang and cross-bred (local Katjang x German Fawn) bucks.

Scrotal circumference increases curvilinearly with increase in age and body weight and subsequently correlate positively with semen quality (Evans *et al.*, 1995). Scrotal circumference is a better predictor of puberty than either age or body weight, regardless of breed (Coutler, 1986).

### **2.2.3 Testis length and breadth**

Jalil *et al.* (2018) reported that testis length and breadth in different age groups of males were  $9.1 \pm 0.18$ ,  $7.5 \pm 0.48$  and  $9.8 \pm 0.49$  and  $6.8 \pm 0.13$ ,  $5.2 \pm 0.27$  and  $6.3 \pm 0.32$ , cm respectively for 6-12, 12-24 and >24 months of ages groups. There appears to have no more literatures on this.

### **2.2.4 Ear length and breadth**

Rahman (2007) and Alam (2006) observed that the ear length and breaths of bucks and does did not differ significantly ( $P > 0.05$ ). Similar results were also reported by. Hasanat *et al.* (2003) reported that the average ear length and breadth of Black Bengal bucks and does at 12 months of age were (12.87, 5.54) and (12.75, 5.43) cm, respectively.

### **2.2.5 Fore leg and hind leg length**

Rahman (2007) reported that the fore and hind leg lengths of Black Bengal bucks at 1<sup>st</sup> day, 6 and 9 months of age were (15.95, 23.67, 24.82 cm) and (17.90, 25.55, 27.29 cm) respectively. This research also found that the fore and hind leg lengths at 3 months of age were 18.22 and 20.19 cm respectively. Alam (2006) reported that the fore leg and hind leg length of male and female at 6, 9 and 12 months of age were slightly higher. Hasanat *et al.* (2003) who reported the average hind leg lengths of male and female were 25.91 and 25.04 cm respectively.

### **2.2.6 Head length and width**

Rahman (2007) found that the head lengths and width of Black Bengal bucks at 1<sup>st</sup> day and at 3, 6, 9 and 12 months of age were (8.6, 12.05, 14.40, 15.39 and 16.67 cm) and (7.00, 7.85, 11.45, 11.70 and 12.33 cm), respectively. Hasanat (2003) reported that the head length of male and female at 12 months of age were 15.53 and 15.49 cm. Rahman (2007) found the lower the head width of Black Bengal male and female at 12 months of age.

### **2.2.7 Horn length and circumference**

Jalil *et al.* (2018) reported that horn length and circumference of Black Bengal goat shows that left and right horn length in both sexes ranged from 3.6 to 13.2 cm. Husain *et al.*, (1998) who stated that both sexes have horn 6 to 12 cm. Chowdhury and Faruque, 2001b also shown that adult male and female goats have horn 4 to 12 cm. Horn circumference of both sexes of adult goat ranges from 3.9 to 9.7 cm.

### **2.2.8 Udder length and breadth**

Jalil *et al.* (2018) observed that udder length and breadth of different age groups of female goats were  $7.5 \pm 0.24$ ,  $11.7 \pm 0.44$  and  $14.3 \pm 0.46$  and  $5.9 \pm 0.16$ ,  $7.4 \pm 0.28$  and  $7.8 \pm 0.23$  cm, respectively for age groups 6-12, 12-24 and >24 months of age. No available literature was cited on mammary gland of BBG. Udder length may be varied due to age and hand milking of doe.

### **2.2.9 Teat length and circumference**

Jalil *et al.* (2018) reported that teat length of adult goats (6-12, 12-24 and >24 months of age groups) were  $2.6 \pm 0.07$ ,  $3.8 \pm 0.14$  and  $4.9 \pm 0.15$  cm and circumference were  $3.6 \pm 0.17$ ,  $5.4 \pm 0.19$  and  $7.4 \pm 0.22$  cm respectively for those age groups. Teat length and circumference depends upon age and milking of doe. Literatures are not available to compare for this trait with others.

## **2.3 Measurement of reproductive parameters**

### **2.3.1 Service per conception**

Alam (2006) conducted an experiment-with White, Bengal goat and reported the number of services per conception of  $1.29 \pm 0.13$  and  $1.57 \pm 0.14$  for White and Black Bengal goats, respectively.

Ahmed (2006) reported the number of service per conception were  $1.5 \pm 0.69$ ,  $1.55 \pm 0.69$  and  $1.3 \pm 0.47$  for Black Bengal, Jamnapari and Jamnapari x Black Bengal, respectively.

Chowdhury *et al.* (2002) found the average services required for conception of Black Bengal goat under semi-intensive management system to be 1.45. The number of services per conception did not differ significantly breed types.

In the first generation three genetic groups of Black Bengal goats were studied by Amin *et al* (2001). Genetic groups were Jamnapari  $\times$  Black Bengal, selected crossbred Black Bengal and Randombred Black Bengal. Age at first heat (d) was 319.31, 249.63 and 241.23 respectively. They differed significantly ( $p < 0.001$ ) in three genetic groups. The kidding intervals (d) were 321.25, 255.32 and 300.40 respectively. Service per conception rates was 1.22, 1.24, 1.30 and post-partum heat period were 164.75, 125.23 and 154.86. These traits in the three genetic groups did not differ significantly.

Faruque (1999) found the number of services per conception and litter size for Jamunapari ,Black Bengal, selected Black Bengal and random bred Black Bengal as 1.18, 1.18, 1.24 and 1.15, 1.29, 1.11, respectively under farm condition. He also reported that the kidding interval and mortality rate of kids of Jamnapari x Black Bengal, selected Black Bengal and random bred Black Bengal Were 243, 276, 347 days and 15.84%, 4.76%, 10.86%, respectively.

Koratkar *et al.* (1998) collected data on the reproductive performance of 171 females at the University farm in Maharashtra during 1993-95. They analyzed data and observed average number of services per conception to be 1.23.

Garci *et al* (1996) analyzed data for 832 Criollo Nubain  $\times$  Criollo, Alpine  $\times$  Criollo, Toggenberg x Criollo and Nubain x (Nubain  $\times$  criollo) goats in Venezuela during 1969-78 & The average number of services per conception was 1.10, 1.17, 1.15, 1.14, and 1.24 respectively.

### **2.3.2 Litter size**

Mamabolo *et al.* (2010) reported that average litter size, kidding interval and kid mortality of goats in South Africa at village level was 1.5, 145-148 days and 44.2 percent, respectively.

Islam *et al.* (2009) found that litter size and of Black Bengal doe under semi- intensive and scavenging system were  $2.00\pm 0.00$  and  $2.33\pm 0.33$ , respectively. He also found kid mortality up to weaning of Black Bengal doe as 14.28%.

Talore (2009) observed litter size, kidding interval and of indigenous goat in Southern Ethiopia was  $1.47\pm 0.04$ ,  $9.05\pm 0.08$  months and 10.7%, respectively.

Belete (2009) reported that litter size and kid mortality of Keffa goats in Western Ethiopia under-traditional system was 1.7 and 22.58%.

Grima (2008) found that litter size varies between 1.08 and 1.75 with average of 1.38 for tropical breeds.

Alam (2006) reported litter size higher in White goats ( $2.21\pm 0.05$ ) than in Black goats ( $2.03\pm 0.04$ ). He also reported that kidding interval to be  $11.11\pm 0.20$  and  $12.57\pm 0.19$  months for White and Black Bengal goats respectively.

Ahmed (2006) reported litter size, kidding interval and litter size of Black Bengal, Jamnapari and Jamnapari x Black Bengali  $1.9\pm 0.56$ ,  $1.55\pm 0.60$ ,  $1.7\pm 0.66$ ,  $193\pm 9.80$ ,  $271\pm 2.9$ ,  $244\pm 12.61$  days and  $10.5\pm 2.32$ ,  $5.25\pm 1.22$  and  $11.4\pm 2.68$  percent, respectively.

#### **2.4 Community based breeding program with goats**

Masika *et al.* (2004) conducted an experiment with small scale goat farmers was in two villages of the Nkonkobe region, in the central Eastern Cape. The aim of the study was to assess and document the prevailing goat production systems in the rural areas. Information obtained was mainly on flock sizes, reason for keeping, breeding and management practices. A structured questionnaire, based on interviews of 52 respondents revealed variability in response among flock sizes (2-84), with goat mainly kept for slaughter during rituals. Daily milk yields for both villages ranged between 0.125 and 2.0 liter per goat. In each village, only 20% kept their own bucks. There was a high incidence of goats bearing twins, and despite the high birth rate, mortality due to tick borne disease were high. Implications of the high status quo in the communal farming system on goat milk production were outlined.



Joyce Njoki Nojoro (2001) reported that the farmers are not quite focused on what end product they required. They need technical guidance from professional breeders to help them map out their breeding strategy and long term objectives. Technical guidance could be a clear breeding policy to guide them on the way forward in their breeding program.

Joyce Njoki Nojoro (2001) observed the farmer's objectives in improved breeding initiatives are mainly to improve livelihoods of the farmers through its higher production of their livestock to ensure food security. This can be achieved through building a strong local community capacity to address livestock production constrains. Improving household income through the sale of goats for slaughter and using the young crosses for breeding exploiting the local existing gene for goats to achieve higher productivity of goat.

Mizeck *et al.* (2001) found that indigenous farm animals in Malawi are praised predominantly by smallholder farmers. Some of the constrains of livestock development are lack of adequately defined breeding goats and insufficient description of the animal population regarding their phenotypic and genetic performance in production, reproduction and adaptation. Regular performance recording under field condition is rare, but it is essential for improving and preserving farm genetic resources, which are important components of the prevailing crop-livestock production system in Malawi. A group breeding scheme is proposed for the interactive conservation of farm animal genetic resources in Malawi such a program would only work well with the full participation of the farmer's and all institutions involved in animal production.

Mwale *et al.* (1999) and Mulume *et al.* (1999) reported that preulous and ongoing on-farm project have demonstrated that farmers were quite willing to collaborate in a record keeping scheme if no counterproductive interventions take place and information and knowledge was made available to livestock farmers.

Goat production was the primary occupation of poor and landless laborers in India. A research strategy (Misra, 1993) for genetic improvement of native breeds was proposed that would involve organization of a breeder's individual's herds to form a nucleus test herd. Males born in this nucleus herd wasranked on the basis of breeding value and used as improved sires for genetic improvement of the base herd.

## **CHAPTER 3**

### **MATERIALS AND METHODS**

#### **3.1 Location of the study area**

This study was conducted at Savar Goat Development Farm for a period of 1 year from January 2019 to December 2019 which is located at Savar upazila in Dhaka District. The location of the study was illustrated in figure-1 and figure-2 respectively. The ecology of this area is suitable for goat rearing. The temperature ranges from 35°C to 20°C and the annual rainfall average 2070 mm. Grazing land is available here where the goat can graze. In this study two approaches were adopted viz.

- i) Initial in-depth monitoring of the activities of goat farm before collection of data.
- ii) Recording body measurement directly on the animals in their habitat by using weighing balance and measuring tapes.

#### **3.2 Population and sampling of the study**

A total of 60 animals of different ages from three months to over 1 year of both sexes were studied throughout the experiment in Savar Goat Development Farm. All type of measurement was taken when goats standing freely. All measurement was taken in metric unit.

#### **3.3 Instrument for data collection**

Data were collected at different times according to the age and sex of the goat. Measuring taps and weighing balance was used during collection of data. At first the collected data were enlisted in a previously prepared sheet and in later the collected data were computerized.

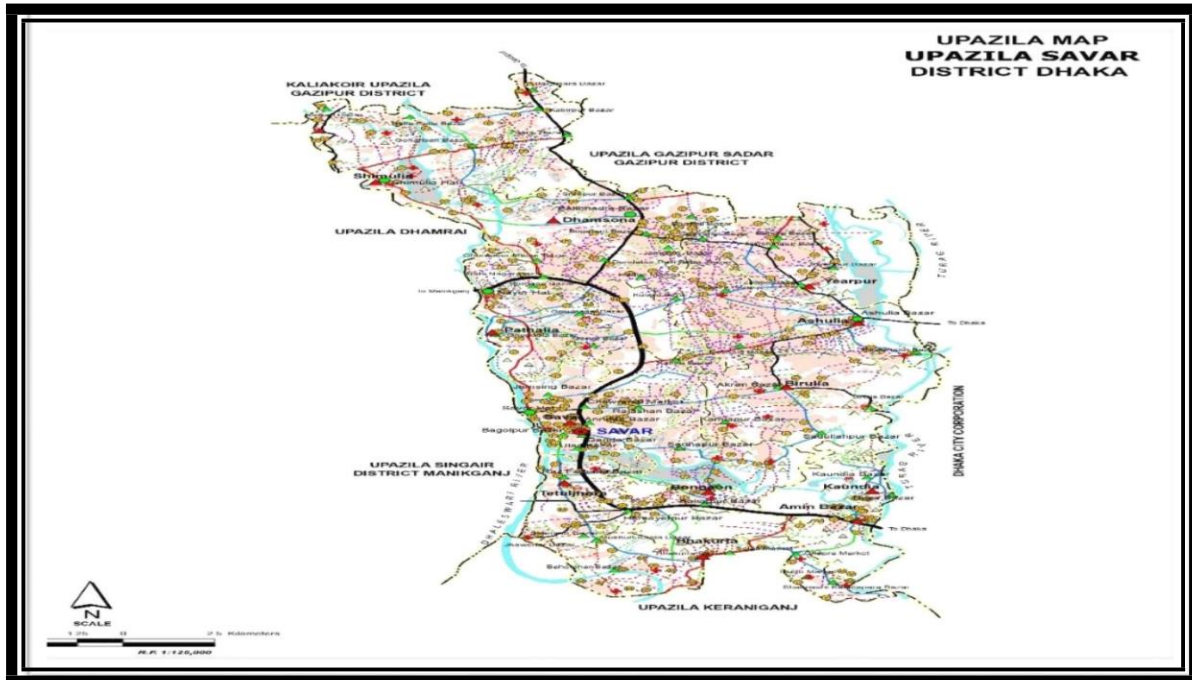


Figure 1. Map of Dhaka district showing in the Savar upazila

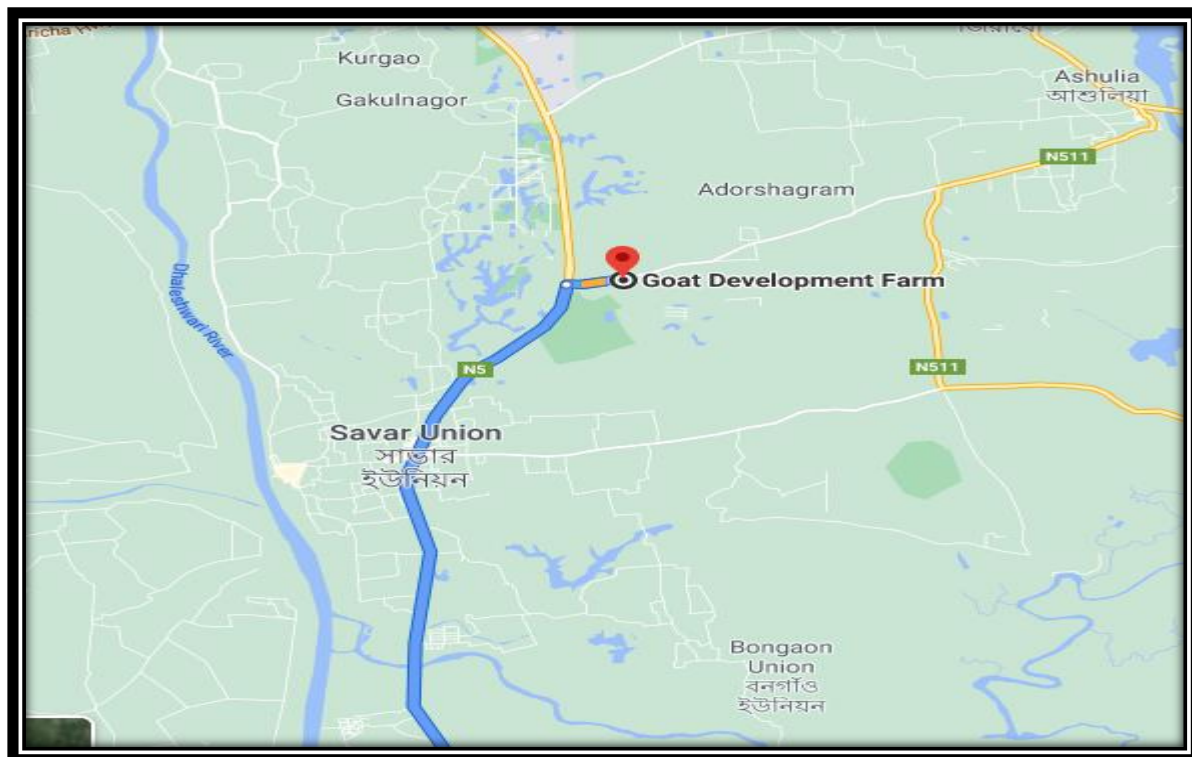


Figure 2. Map showing the study area in Savar upazila

### 3.4 Feeding and management system of the goats

Goats were reared under semi-intensive management system in which goats were browsing in nature and allowed to graze in field. All goats were housed in a wooden made floor house and allowed to graze 6-8 hours in a day and concentrate was offered twice daily during morning and evening at the rate of 1% of their body weight per day. The goats were fed rice gruel, rice, broken rice, wheat bran, rice bran etc. at pregnancy and lactation period. Sometimes goats were provided tree leaves ad libitum. Endo parasite controls were performed after every three months and vitamins were also provided depending on the situation. Vaccination of goats against Peste des Petits Ruminants (PPR) was done here. The bio- security was strictly maintaining all of farm to reduce the incidence of diseases. Selective breeding was done here.

### 3.5 Age class of goat

The age class of Black Bengal goat was classified into 3-6, 6-12 and more than 12 months.

#### 3.5.1 Sex

Goat populations were grouped as male and female.

### 3.6 Body size

Body size of goats were recorded according of each individual's size. Body size of goat classified into three groups as 1= small, 2= medium and 3=large.

### 3.7 Body condition

Table 1: Body condition of goats was recorded according to the observation of goats.

Body condition score (BCS)	Spinous process	Rib cage	Loin eye
BCS 1 Very thin	Easy to see and feel, sharp	Easy to feel and can feel under	No fat covering
BCS 2 Thin	Easy to feel, but smooth	Smooth, slightly rounded, need to use slight pressure to feel	Smooth, even fat cover

BCS 3 Good condition	Smooth and rounded	Smooth, even feel	Smooth, even fat cover
BCS 4 Fat	Can feel with firm pressure, no points can be felt	Individuals rib cannot be felt, but can still feel indent between ribs	Thick fat
BCS 5 Obese	Smooth, no individual vertebrata can be felt	Individuals ribs cannot be felt. No separation of ribs felt.	Thick fat covering, may be lumpy and jiggly

### 3.8 Morphometric Characters

#### 3.8.1 Morphometric Characters of female Black Bengal goat

The following body measurement was considered for morphometric study of female Black Bengal goat.

- ✓ Body weight
- ✓ Body length
- ✓ Heart girth
- ✓ Neck length
- ✓ Neck breadth
- ✓ Head length
- ✓ Head width
- ✓ Ear length
- ✓ Ear breadth
- ✓ Wither height
- ✓ Fore leg length
- ✓ Hind leg length
- ✓ Udder length
- ✓ Udder breadth
- ✓ Teat length
- ✓ Teat circumference
- ✓ Tail length

#### 3.8.2 Morphometric Characters of male Black Bengal goat

The following body measurement was considered for morphometric study of male Black Bengal goat.

- ✓ Body weight
- ✓ Body length
- ✓ Heart girth
- ✓ Neck length
- ✓ Neck breadth
- ✓ Head length
- ✓ Head width
- ✓ Ear length
- ✓ Ear breadth
- ✓ Wither height
- ✓ Fore leg length
- ✓ Hind leg length
- ✓ Tail length
- ✓ Scrotal length
- ✓ Scrotal circumference

Different body measurement, scrotal length, scrotal circumference, udder length, udder breadth, teat length, teat circumference was taken by a measuring tape in centimeter (cm).

### 3.9 Source of data

Data on the different parameters were collected during January 2019 to December 2019 from Savar goat farm. A total of 60 animals of different ages from three months to more than 1 years of both sexes were included. All measurements were taken in metric unit.

**Body length:** Body length was measured between points of shoulder and point of hip.



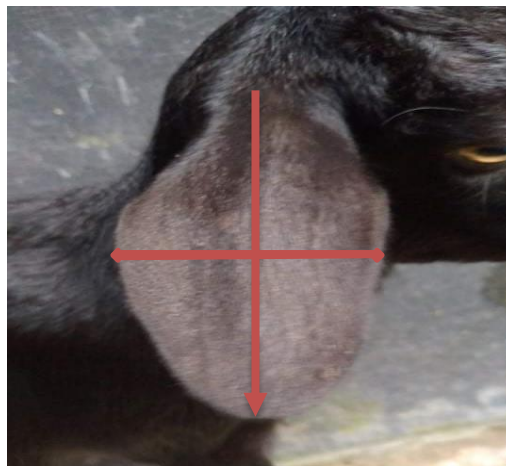
**Wither height:** Distance from the ground to the point of wither.



**Head length and width:** Head length is measured from the upper lip to the pole of head. Breadth is distance between two eyes.



**Ear length and breadth:** Ear length is the distance between the base and the pinna of ear. Ear breadth was measured at broadest portion of the ear.



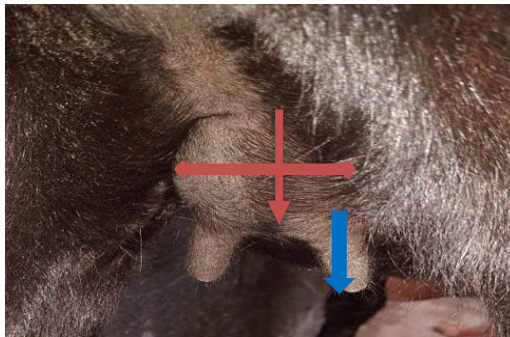
**Neck length and breadth:** Neck length is the distance between the base of head and point of shoulder. Neck breadth was measured from the middle position of neck.



**Tail length:** Length was measured from the base of tail to the pinpoint of the tail without hair.

**Leg length:** Fore leg length is the distance from hoof to joint of shoulder and hind leg length is the distance from the hoof to elbow joint.

**Udder length and breadth:** Length was measured from base of teat to the attachment point of udder and belly. Breadth was measured from the middle portion of udder.



**Teat length and circumference:** Teat length was measured from the base of the teat to pin-point of teat. Circumference was measured from middle portion of teat.

**Scrotal length and breadth:** Distance between two-pin point of testes and breadth was measured from the middle portion of two testes.





### 3.10 Experimental design and data analysis

The gathered data were subjected to analysis of variance (ANOVA) using with the following statistical model.

#### 3.10.1 Model for analysis of data

##### Model 1:

$$Y_{ijk} = \mu + A_i + B_j + S_k + e_{ijk}$$

Where,

$Y_{ijkl}$  is the dependent variable (Body length, wither height, scrotal length, scrotal circumference) of the experiment.

$\mu$  is the overall mean

$A_i$  is the effect of the  $i^{\text{th}}$  age class

$B_j$  is the effect of the  $j^{\text{th}}$  body condition

$S_k$  is the effect of the  $k^{\text{th}}$  body condition

$e_{ijk}$  is the error term specific to each record.

All the data obtained from the research goat farm were organized, structured and analyzed. Analysis of variance method using the General Linear Model (GLM) procedure under Statistical Package for Social Science (SPSS) version 16.0. In addition, for significant variables, pair wise comparison of treatment means was made using Duncan's Multiple Range Test (DMRT).

## Different body measurement of Black Bengal Goat



Plate-1: Neck measurement of Buck



Plate-2: Hind leg measurement of buck



Plate-3: Fore leg measurement of buck



Plate-4: Tail measurement of doe



Plate-5: Ear length measurement of doe



Plate-6: Ear breadth measurement of doe



Plate-7: Wither height measurement of buck

## CHAPTER 4

### RESULTS AND DISCUSSION

#### 4.1 Morphometric characteristics of goats

Morphometric information relating to goats which were obtained through an initial in-depth monitoring at Savar goat farm is presented below.

##### 4.1.1 Body weight

The body weight of bucks ( $7.49\pm 0.09$ ,  $11.68\pm 0.15$ ,  $16.00\pm 0.14$ ) and does ( $7.26\pm 0.07$ ,  $9.78\pm 0.08$ ,  $13.51\pm 0.09$ ) at 3-6, 6-12 and >12 months of age are presented in Table 2 and 3. In all cases bucks' body weight are higher than does. Rahman (2007) reported that the body weight of male goats at 3-6 and 6-12 month of age were 7.23 and 10.7 kg, respectively which strongly support the results of the present study. Alam (2006) studied body weight of Black Bengal male and female, and reported that female goats were lighter (6.20 and 13.20 kg) than male goats (7.22 and 15.8 kg) at the age 3-6 months and 12 months which strongly supported the present study. The live weights of male and female in this study were higher than the weights reported by Singh *et al.* (1987) which were 14.93 and 14.35 kg at 12 months of age. The relationship of body weight with body length, heart girth, wither height, scrotal length and scrotal circumference for bucks are presented in Table 4 and 5 respectively. In bucks, the body weight had highly significant correlation ( $P<0.01$ ) with body length (0.904), heart girth (0.946), wither weight (0.955), scrotal length (0.924) and scrotal circumference (0.929) in Table 4. In does the body weight of female has highly significant correlation ( $P<0.01$ ) with body length (0.903), hearth girth (0.944) and wither height (0.941). The findings of the present study strongly support the results of Rahman (2007) who reported the almost similar correlation between body weight and heart girth (0.937), body weight and body length (0.939) as well as body weight and height at wither (0.934).

##### 4.1.2 Body length

The body length of Black Bengal bucks at 3-6, 6-12 and more than 12 months were  $34.05\pm 0.69$ ,  $41.60\pm 1.12$  and  $49.10\pm 0.98$  cm respectively. On the other hand, the body length of Black Bengal does at 3-6, 6-12 and more than 12 months were  $29.70\pm 0.82$ ,  $37.20\pm 0.90$  and  $45.80\pm 1.17$  cm respectively. The study revealed that at different age bucks body length are always higher than

does. Hasanat *et al.* (2003) also reported that sex had significant influence ( $P<0.01$ ) on body length. It was observed that body lengths in male has highly significant correlation ( $P<0.01$ ) with body weight (0.904), heart girth (0.855), wither height (0.847), scrotal length (0.891) and scrotal circumference (0.856) in Table 4. The relationship of body length with body weight, heart girth and wither height for does are presented in Table 5. It was observed in does that body length has highly significant correlation ( $P<0.01$ ) with body weight (0.903), heart girth (0.944) and wither height (0.941).

#### **4.1.3 Heart girth**

The heart girth of Black Bengal bucks at 3-6, 6-12 and more than 12 months were  $40.81\pm 0.37$ ,  $51.86\pm 0.30$  and  $55.43\pm 0.19$  cm respectively. On the other hand, the heart girth of Black Bengal does at 3-6, 6-12 and more than 12 months were  $39.59\pm 0.13$ ,  $48.57\pm 0.25$  and  $53.32\pm 0.37$  cm respectively. It was observed that heart girth of buck has highly significant correlation ( $P<0.01$ ) with body weight (0.946), body length (0.855), wither height (0.939), scrotal length (0.938), and scrotal circumference (0.921). On the other hand, heart girth of does has highly significant correlation ( $P<0.01$ ) with body weight (0.944), body length (0.892) and wither height (0.947). The study revealed that at different age bucks' heart girth are always higher than does. The heart girth reported by Singh *et al.* (1987) for male was almost similar but that of female was lower in comparison to present study.

#### **4.1.4 Wither height**

The Wither height of Black Bengal bucks at 3-6, 6-12 and more than 12 months were  $36.14\pm 0.37$ ,  $46.55\pm 0.81$  and  $52.90\pm 0.60$  cm respectively. On the other hand, the Wither height of Black Bengal does at 3-6, 6-12 and more than 12 months were  $34.67\pm 0.30$ ,  $42.83\pm 0.78$  and  $49.33\pm 0.30$  cm respectively. It was found that wither height of buck has highly significant correlation ( $P<0.01$ ) with body weight (0.955), body length (0.847), heart girth (0.939), scrotal length (0.929), and scrotal circumference (0.905). On the other hand, wither height of does has highly significant correlation ( $P<0.01$ ) with body weight (0.941), body length (0.898) and heart girth (0.947). Rahman (2006) reported that wither height of Black Bengal bucks at 3-6, 6-12 and >12 months of age were (36.13, 46.12 and 51.92 cm), respectively which strongly support the results of the present study.

#### **4.1.5 Tail length**

The tail length of Black Bengal bucks at 3-6, 6-12 and more than 12 months were  $7.45\pm 0.13$ ,  $8.36\pm 0.16$  and  $10.37\pm 0.15$  cm respectively. On the other hand, the tail length of Black Bengal does at 3-6, 6-12 and more than 12 months were  $7.35\pm 0.11$ ,  $7.74\pm 0.19$  and  $8.63\pm 0.22$  cm respectively. The study revealed that at different age bucks' tail length is always higher than does.

#### **4.1.6 Head length and head width**

The head length of Black Bengal bucks at 3-6, 6-12 and more than 12 months were  $12.23\pm 0.10$ ,  $14.17\pm 0.12$  and  $16.06\pm 0.11$  cm respectively. On the other hand, the head length of Black Bengal does at 3-6, 6-12 and more than 12 months were  $11.95\pm 0.18$ ,  $13.96\pm 0.23$  and  $15.13\pm 0.12$  cm respectively. The study revealed that at different age bucks' head length is always higher than does. Hasanat (2003) reported that the head length of male and female at 12 months of age were 16.53 and 15.49 cm which are very close to the results of the present study.

The head width of Black Bengal bucks at 3-6, 6-12 and more than 12 months were  $8.25\pm 0.14$ ,  $10.59\pm 0.10$  and  $10.48\pm 0.25$  cm respectively. On the other hand, the head width of Black Bengal does at 3-6, 6-12 and more than 12 months were  $8.10\pm 0.09$ ,  $8.98\pm 0.12$  and  $9.85\pm 0.08$  cm respectively. The study revealed that at different age bucks' head width is always higher than does. Rahman (2007) found the lower the head width of Black Bengal male and female at 12 months of age than the present study.

#### **4.1.7 Ear length and Ear breadth**

The Ear length of Black Bengal bucks at 3-6, 6-12 and more than 12 months were  $9.90\pm 0.08$ ,  $11.06\pm 0.10$  and  $12.12\pm 0.06$  cm respectively. On the other hand, the Ear length of Black Bengal does at 3-6, 6-12 and more than 12 months were  $9.67\pm 0.11$ ,  $11.31\pm 0.20$  and  $12.02\pm 0.09$  cm respectively. The study revealed that at different age bucks' Ear length are slightly lower than does. The Ear breadth of Black Bengal bucks at 3-6, 6-12 and more than 12 months were  $5.00\pm 0.05$ ,  $5.56\pm 0.06$  and  $5.92\pm 0.04$  cm respectively. On the other hand, the Ear breadth of Black Bengal does at 3-6, 6-12 and more than 12 months were  $4.81\pm 0.06$ ,  $5.13\pm 0.06$  and  $5.43\pm 0.06$  cm respectively. The study revealed that at different age bucks' Ear breadth are always higher than does. Hasanat *et*

*al.* (2003) found the average ear length and breadth of Black Bengal bucks and does at 12 months of age were (12.87, 5.54) and (12.75, 5.43) cm, respectively which are in close agreement with the results of this study.

#### **4.1.8 Neck length and breadth**

The neck length of Black Bengal bucks at 3-6, 6-12 and more than 12 months were  $10.53 \pm 0.18$ ,  $12.49 \pm 0.26$  and  $14.13 \pm 0.25$  cm respectively. On the other hand, the tail length of Black Bengal does at 3-6, 6-12 and more than 12 months were  $11.55 \pm 0.18$ ,  $13.26 \pm 0.17$  and  $14.25 \pm 0.25$  cm respectively. The neck breadth of Black Bengal bucks at 3-6, 6-12 and more than 12 months were  $20.60 \pm 1.14$ ,  $25.19 \pm 1.60$  and  $29.91 \pm 1.71$  cm respectively. On the other hand, the neck breadth of Black Bengal does at 3-6, 6-12 and more than 12 months were  $18.78 \pm 0.35$ ,  $22.67 \pm 0.31$  and  $24.92 \pm 0.37$  cm respectively. The neck length of does are slightly higher than buck.

#### **4.1.9 Fore leg and Hind leg length**

The fore leg length of Black Bengal bucks at 3-6, 6-12 and more than 12 months were  $22.71 \pm 0.43$ ,  $30.77 \pm 0.47$  and  $33.75 \pm 0.67$  cm respectively. On the other hand, the fore leg length of Black Bengal does at 3-6, 6-12 and more than 12 months were  $20.52 \pm 0.26$ ,  $27.51 \pm 0.58$  and  $34.13 \pm 0.65$  cm respectively. The study revealed that at different age bucks' fore leg length is always higher than does. The hind leg length of Black Bengal bucks at 3-6, 6-12 and more than 12 months were  $23.86 \pm 0.52$ ,  $31.62 \pm 0.67$  and  $40.71 \pm 0.48$  cm respectively. On the other hand, the hind leg length of Black Bengal does at 3-6, 6-12 and more than 12 months were  $23.98 \pm 0.35$ ,  $31.42 \pm 0.40$  and  $37.7 \pm 0.78$  cm respectively. The study revealed that at different age bucks' hind leg length is always higher than does. Rahman (2007) reported that the fore and hind leg lengths of Black Bengal bucks at 3-6, 6-12 and more than 12 months of age were (15.95, 23.67, 24.82 cm) and (17.90, 25.55, 27.29 cm), respectively.

#### **4.1.10 Scrotal length and circumference**

The scrotal length at 3-6, 6-12 and more than 12 months were  $95.80 \pm 0.24$ ,  $9.26 \pm 0.16$  and  $11.19 \pm 0.32$  cm and scrotal circumference were  $12.90 \pm 0.33$ ,  $17.34 \pm 0.25$  and  $20.25 \pm 0.34$  cm respectively (Table 2). It was found that scrotal length has highly significant correlation ( $P < 0.01$ ) with body weight (0.924), body length (0.891), heart girth (0.938), wither height (0.929), and

scrotal circumference (0.909). Scrotal circumference has highly significant correlation ( $P < 0.01$ ) with body weight (0.929), body length (0.856), heart girth (0.921), wither height (0.905), scrotal length (0.909). Rahman (2007) reported that the scrotal circumference of Black Bengal bucks at 3-6, 6-12 and 12 months were 5.85, 9.40, 11.42 cm which strongly support the results of the present study. Samsuddin *et al.* (2000) reported that the mean scrotal circumference of Black Bengal buck at 3-6, 6-12 and more than 12 months were 13.0, 18.0 cm and 21 cm which is slightly higher than the present study.

#### **4.1.11 Udder length and udder breadth**

The udder length of Black Bengal does at 3-6, 6-12 and more than 12 months were  $6.87 \pm 0.27$ ,  $8.52 \pm 0.29$  and  $11.59 \pm 0.25$  cm respectively (Table 3). On the other hand, the udder breadth of Black Bengal does at 3-6, 6-12 and more than 12 months were  $4.34 \pm 0.18$ ,  $6.58 \pm 0.16$  and  $8.00 \pm 0.16$  cm respectively (Table 3). No available literature was cited on mammary gland of BBG. Udder length may be varied due to age and hand milking of doe.

#### **4.1.12 Teat length and teat circumference**

The teat length of Black Bengal does at 3-6, 6-12 and more than 12 months were  $1.17 \pm 0.08$ ,  $2.64 \pm 0.09$  and  $3.93 \pm 0.09$  cm respectively (Table 3). On the other hand, the teat circumference of Black Bengal does at 3-6, 6-12 and more than 12 months were  $7.11 \pm 0.16$ ,  $8.67 \pm 0.17$  and  $8.97 \pm 0.54$  cm respectively (Table 3). Teat length and circumference depends upon age and milking of doe. Literature are not available to compare for this traits with others.



**Table 2. Measurement of different body traits at varying age in Black Bengal buck**

Age (Month)	No. of Observation (n)	Body weight (Kg) (Mean±SE)	Body length (cm) (Mean±SE)	Heart girth (cm) (Mean±SE)	Wither height (cm) (Mean±SE)	Tail length (cm) (Mean±SE)	Head length (cm) (Mean±SE)	Head width (cm) (Mean±SE)
3-6	10	7.49 <sup>c</sup> ±0.09	34.05 <sup>c</sup> ±0.69	40.81 <sup>c</sup> ±0.37	36.14 <sup>c</sup> ±0.37	7.45 <sup>c</sup> ±0.13	12.23 <sup>c</sup> ±0.10	8.25 <sup>c</sup> ±0.14
6-12	10	11.68 <sup>b</sup> ±0.15	41.60 <sup>b</sup> ±1.12	51.86 <sup>b</sup> ±0.30	46.55 <sup>b</sup> ±0.81	8.36 <sup>b</sup> ±0.16	14.17 <sup>b</sup> ±0.12	10.59 <sup>b</sup> ±0.10
>12	10	16.00 <sup>a</sup> ±0.14	49.10 <sup>a</sup> ±0.98	55.43 <sup>a</sup> ±0.19	52.90 <sup>a</sup> ±0.60	10.37 <sup>a</sup> ±0.15	16.06 <sup>a</sup> ±0.11	10.48 <sup>a</sup> ±0.25

**Table 2. Contd.**

Age (Month)	No. of observation	Ear length (cm) (Mean±SE)	Ear breadth (cm) (Mean±SE)	Neck length (cm) (Mean±SE)	Neck breadth (cm) (Mean±SE)	Fore leg length (cm) (Mean±SE)	Hind leg length (cm) (Mean±SE)	Scrotal length (cm) (Mean±SE)	Scrotal circumference (cm) (Mean±SE)
3-6	10	9.90 <sup>c</sup> ±0.08	5.00 <sup>c</sup> ±0.05	10.53 <sup>c</sup> ±0.18	20.60 <sup>c</sup> ±1.14	22.71 <sup>c</sup> ±0.43	23.86 <sup>c</sup> ±0.52	5.80 <sup>c</sup> ±0.24	12.90 <sup>c</sup> ±0.33
6-12	10	11.06 <sup>b</sup> ±0.10	5.56 <sup>b</sup> ±0.06	12.49 <sup>b</sup> ±0.26	25.19 <sup>b</sup> ±1.60	30.77 <sup>b</sup> ±0.47	31.62 <sup>b</sup> ±0.67	9.26 <sup>b</sup> ±0.16	17.34 <sup>b</sup> ±0.25
>12	10	12.12 <sup>a</sup> ±0.06	5.92 <sup>a</sup> ±0.04	14.13 <sup>a</sup> ±0.25	29.91 <sup>a</sup> ±1.71	33.75 <sup>a</sup> ±0.67	40.71 <sup>a</sup> ±0.48	11.19 <sup>a</sup> ±0.32	20.25 <sup>a</sup> ±0.34

Here,

SE= Standard error

Mean with different superscripts are significantly different (P<0.05)

**Table 3. Measurement of different body traits at varying age in Black Bengal does**

Age (Month)	No. of Observation (n)	Body weight (Kg) (Mean±SE)	Body length (cm) (Mean±SE)	Heart girth (cm) (Mean±SE)	Wither height (cm) (Mean±SE)	Tail length (cm) (Mean±SE)	Head length (cm) (Mean±SE)	Head width (cm) (Mean±SE)	Ear length (cm) (Mean±SE)
3-6	10	7.26 <sup>c</sup> ±0.07	29.70 <sup>c</sup> ±0.82	39.59 <sup>c</sup> ±0.13	34.67 <sup>c</sup> ±0.30	7.35 <sup>c</sup> ±0.11	11.95 <sup>c</sup> ±0.18	8.10 <sup>c</sup> ±0.09	9.67 <sup>c</sup> ±0.11
6-12	10	9.78 <sup>b</sup> ±0.08	37.20 <sup>b</sup> ±0.90	48.57 <sup>b</sup> ±0.25	42.83 <sup>b</sup> ±0.78	7.74 <sup>b</sup> ±0.19	13.96 <sup>b</sup> ±0.23	8.98 <sup>b</sup> ±0.12	11.31 <sup>b</sup> ±0.20
>12	10	13.51 <sup>a</sup> ±0.09	45.80 <sup>a</sup> ±1.17	53.32 <sup>a</sup> ±0.37	49.33 <sup>a</sup> ±0.30	8.63 <sup>a</sup> ±0.22	15.13 <sup>a</sup> ±0.12	9.85 <sup>a</sup> ±0.08	12.02 <sup>a</sup> ±0.09

**Table 3. Contd.**

Age (Month)	n	Ear breadth (cm) (Mean±SE)	Neck length (cm) (Mean±SE)	Neck breadth (cm) (Mean±SE)	Fore leg length (cm) (Mean±SE)	Hind leg length (cm) (Mean±SE)	Udder length (cm) (Mean±SE)	Udder breadth (cm) (Mean±SE)	Teat length (cm) (Mean±SE)	Teat circumference (cm) (Mean±SE)
3-6	10	4.81 <sup>c</sup> ±0.06	11.55 <sup>c</sup> ±0.18	18.78 <sup>c</sup> ±0.35	20.52 <sup>c</sup> ±0.26	23.98 <sup>c</sup> ±0.35	6.87 <sup>c</sup> ±0.27	4.34 <sup>c</sup> ±0.18	1.17 <sup>c</sup> ±0.08	7.11 <sup>c</sup> ±0.16
6-12	10	5.13 <sup>b</sup> ±0.06	13.26 <sup>b</sup> ±0.17	22.67 <sup>b</sup> ±0.31	27.51 <sup>b</sup> ±0.58	31.42 <sup>b</sup> ±0.40	8.52 <sup>b</sup> ±0.29	6.58 <sup>b</sup> ±0.16	2.64 <sup>b</sup> ±0.09	8.67 <sup>b</sup> ±0.17
>12	10	5.43 <sup>a</sup> ±0.06	14.25 <sup>a</sup> ±0.25	24.92 <sup>a</sup> ±0.37	34.13 <sup>a</sup> ±0.65	37.7 <sup>a</sup> ±0.78	11.59 <sup>a</sup> ±0.25	8.00 <sup>a</sup> ±0.16	3.93 <sup>a</sup> ±0.09	8.97 <sup>a</sup> ±0.54

Here,

SE= Standard error

Mean with different superscripts are significantly different (P<0.05).

**Table 4. Co-relation of body weight with body length, heart girth, wither height, scrotal length and scrotal circumference in Black Bengal bucks**

	Body weight	Body length	Heart girth	Wither height	Scrotal length
Body weight	-	-	-	-	-
Body length	0.904 <sup>**</sup>	-	-	-	-
Heart girth	0.946 <sup>**</sup>	0.855 <sup>**</sup>	-	-	-
Wither height	0.955 <sup>**</sup>	0.847 <sup>**</sup>	0.939 <sup>**</sup>	-	-
Scrotal length	0.924 <sup>**</sup>	0.891 <sup>**</sup>	0.938 <sup>**</sup>	0.929 <sup>**</sup>	-
Scrotal Circumference	0.929 <sup>**</sup>	0.856 <sup>**</sup>	0.921 <sup>**</sup>	0.905 <sup>**</sup>	0.909 <sup>**</sup>

<sup>\*\*</sup>Mean with different superscripts are significantly different (P<0.01)

**Table 5. Co-relation of body weight with body length, heart girth and wither height in Black Bengal does**

	Body weight	Body length	Heart girth
Body weight	-	-	-
Body length	0.903 <sup>**</sup>	-	-
Heart girth	0.944 <sup>**</sup>	0.892 <sup>**</sup>	-
Wither height	0.941 <sup>**</sup>	0.898 <sup>**</sup>	0.947 <sup>**</sup>

<sup>\*\*</sup> Mean with different superscripts are significantly different (P<0.01)

## Chapter 5

### Summary and Conclusion

Data on the Black Bengal goats collected through the initial in depth monitoring and direct measurement at Savar Goat Development Farm for a period of one year. Body morphometric at varying age class, body weight, body length, heart girth, wither height, tail length, tail width, neck length, neck width, head length, head width, fore leg length, hind leg length, scrotal length, scrotal circumference, udder length, udder breadth, teat length and teat circumference were analyzed in this study.

Body weight significantly ( $P < 0.05$ ) differed with age class, body size and body condition in both male and female goats. Body weight of buck was significantly ( $P < 0.05$ ) higher than does. In bucks, the body weight had highly significant correlation ( $P < 0.01$ ) with body length (0.904), heart girth (0.946), wither height (0.955), scrotal length (0.924) and scrotal circumference (0.929). In does the body weight of female has highly significant correlation ( $P < 0.01$ ) with body length (0.903), heart girth (0.944) and wither height (0.941).

Body length significantly ( $P < 0.05$ ) differed with age class of Black Bengal goat. In this study it was observed that body lengths in male has highly significant correlation ( $P < 0.01$ ) with body weight (0.904), heart girth (0.855), wither height (0.847), scrotal length (0.891) and scrotal circumference (0.856). It was observed in does that body length has highly significant correlation ( $P < 0.01$ ) with body weight (0.903), heart girth (0.892) and wither height (0.898).

The Wither height of Black Bengal bucks at 3-6, 6-12 and more than 12 months were  $36.14 \pm 0.37$ ,  $46.55 \pm 0.81$  and  $52.90 \pm 0.60$  cm respectively and the wither height of Black Bengal does at 3-6, 6-12 and more than 12 months were  $34.67 \pm 0.30$ ,  $42.83 \pm 0.78$  and  $49.33 \pm 0.30$  cm respectively. The average ear length of Black Bengal bucks was  $9.90 \pm 0.08$ ,  $11.06 \pm 0.10$  and  $12.12 \pm 0.06$  cm respectively at 3-6, 6-12 and more than 12 months. The Ear length of Black Bengal does at 3-6, 6-12 and more than 12 months were  $9.67 \pm 0.11$ ,  $11.31 \pm 0.20$  and  $12.02 \pm 0.09$  cm respectively. Ear breadth of Black Bengal bucks at 3-6, 6-12 and more than 12 months were  $5.00 \pm 0.05$ ,  $5.56 \pm 0.06$  and  $5.92 \pm 0.04$  cm and ear breadth of does were  $4.81 \pm 0.06$ ,  $5.13 \pm 0.06$  and  $5.43 \pm 0.06$  cm. Fore leg length

of Black Bengal bucks at 3-6, 6-12 and more than 12 months were  $22.71\pm0.43$ ,  $30.77\pm0.47$  and  $33.75\pm0.67$  cm whereas in does were  $20.52\pm0.26$ ,  $27.51\pm0.58$  and  $34.13\pm0.65$  cm respectively. Hind leg length of Black Bengal bucks at 3-6, 6-12 and more than 12 months were  $23.86\pm0.52$ ,  $31.62\pm0.67$  and  $40.71\pm0.48$  cm whereas in does were  $23.98\pm0.35$ ,  $31.42\pm0.40$  and  $37.7\pm0.78$  cm respectively.

The head length of Black Bengal bucks at 3-6, 6-12 and more than 12 months were  $12.23\pm0.10$ ,  $14.17\pm0.12$  and  $16.06\pm0.11$  cm respectively whereas in does were  $11.95\pm0.18$ ,  $13.96\pm0.23$  and  $15.13\pm0.12$  cm respectively. Head width of Black Bengal bucks at 3-6, 6-12 and more than 12 months were  $8.25\pm0.14$ ,  $10.59\pm0.10$  and  $10.48\pm0.25$  cm respectively whereas in does were  $8.10\pm0.09$ ,  $8.98\pm0.12$  and  $9.85\pm0.08$  cm respectively. The scrotal length of Black Bengal bucks at 3-6, 6-12 and more than 12 months were  $5.80\pm0.24$ ,  $9.26\pm0.16$  and  $11.19\pm0.32$ . The udder length of Black Bengal does were  $6.87\pm0.27$ ,  $8.52\pm0.29$  and  $11.59\pm0.25$  cm and breadth were  $4.34\pm0.18$ ,  $6.58\pm0.16$  and  $8.00\pm0.16$  respectively at 3-6, 6-12 and more than 12 months of age. The teat length of Black Bengal does at 3-6, 6-12 and more than 12 months were  $1.17\pm0.08$ ,  $2.64\pm0.09$  and  $3.93\pm0.09$  cm respectively and the teat circumference of Black Bengal does at 3-6, 6-12 and more than 12 months were  $7.11\pm0.16$ ,  $8.67\pm0.17$  and  $8.97\pm0.54$  cm respectively.

The results on different morphometric measurements obtained in this study showing that most of the parameters in male in higher than females and it increases linearly with increasing ages and body weight has a strong positive co-relation with body length, heart girth, wither height, scrotal length and scrotal circumference.

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