EFFECT OF SEASON ON REPRODUCTIVE PERFORMANCE OF BLACK BENGAL GOAT IN DINAJPUR DISTRICT

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CERTIFICATE

This is to certify that the thesis entitled "EFFECT OF SEASON ON REPRODUCTIVE PERFORMANCE OF BLACK BENGAL GOAT IN DINAJPUR DISTRICT" submitted to the Department of Animal Nutrition, Genetics and Breeding, 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 results of a piece of bona fide research work carried out by MOST. SELINA AKHTER, Registration No. 17-08235 under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma in any other institution.

I further certify that any help or sources of information received during the course of this investigation, has duly been acknowledged.

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EFFECT OF SEASON ON REPRODUCTIVE PERFORMANCE OF BLACK BENGAL GOAT IN DINAJPUR DISTRICT

ABSTRACT

This study was conducted at different places of Dinajpur district namely Kornai, Noshipur, Bangibachar hat, Vagobanpur from July/2017 to June/2018. Birth weight of kids were 0.94±0.02, 1.05±0.02 and 0.90±0.02 kg respectively in summer, rainy and winter season of Black Bengal goat. The birth weight of Black Bengal kids at 1st, 2nd, 3rd and 4th parity were 0.95±0.02, 0.97±0.01, 0.98±0.02, 0.96±0.03 kg respectively. There is no significant effect of parity on birth weight of Black Bengal kids. Average gestation length of Black Bengal goat at summer, rainy and winter season were 142.9±0.52, 143.2±0.54 and 145.6±0.48 days respectively. The average litter size of Black Bengal goat at summer, rainy and winter season were 2.09±0.10, 2.01±0.10 and 2.07±0.09 respectively. The average litter size of Black Bengal goat at 1st, 2nd, 3rd and 4th parity was 1.53±0.09, 1.83±0.08, 1.97±0.09 and 2.17±0.15 respectively. There is no significant effect of season on litter size of Black Bengal goat. But there is highly significant (p<0.01) effect of parity on litter size of Black Bengal goat. Average age at puberty of Back Bengal goat at summer, rainy and winter season were 185.45±3.03, 182.72±3.10 and 183.95±2.76 days respectively. There is no significant effect of season on age at puberty of Black Bengal goat. The average age at first kidding of Black Bengal goat at summer, rainy and winter season were 369.82±1.76, 371.92±1.80 and 366.02±1.60 days respectively. There is no significant differences between season and parity on kid mortality rate but there is a significant (p<0.05) effect of season on birth weight of kid, gestation length, age at first kidding and weight at first kidding of Black Bengal goat. The average weight of first kidding of Black Bengal goat at summer, rainy and winter season were 9.34±0.16, 9.33±0.16 and 7.79±0.14 kg respectively. There is no significant effect of season on lactation length of Black Bengal goat. The average lactation length of Black Bengal goat at summer, rainy and winter season were 72.8±0.54, 73.2±0.55 and 73.07±0.49 days respectively. Average kidding interval of Black Bengal goat at summer, rainy and winter season were 186.97±0.82, 184.3±0.84 and 190.48±0.75 days respectively. There is a highly significant (p<0.01) effect of kidding interval on season but having a significant (p<0.05) effect of kidding interval on parity. There is no significant effect of season and parity on kid mortality rate of Black Bengal goat. The average kid mortality rate of Black Bengal goat at summer, rainy and winter season were 16.66±6.39, 18.75±6.54 and 24.79±5.82 % respectively. The average kid mortality rate at 1st, 2nd, 3rd and 4th parity was 17.36±5.75, 20.60±5.40, and 20.64±6.14 and 14.09±9.31 %. From this experiment it can be concluded that better reproductive performance found in rainy season because the birth weight of kid, age at puberty, lactation length, kidding interval was better than other season. The reproductive performance was excellent in fourth parity because litter size, kidding interval, kid mortality rate were better than other parity.

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LIST OF ABBREVIATIONS AND SYMBOLS

%	=	Percentage
>	=	Greater than
<	=	Less than
±	=	Plus minus
AI	=	Artificial insemination
ANOVA	=	Analysis of Variance
BAU	=	Bangladesh Agricultural University
BBG	=	Black Bengal goat
B.C.	=	Before Christ
BLRI	=	Bangladesh livestock Research Institute
BW	=	Birth weight
CIRG	=	Central institute for Research on Goats
DF	=	Degree of freedom
DM	=	Dry matter
DLS	=	Department of livestock Services
et al.	=	Associate
FAO	=	Food and Agricultural Organization
GDP	=	Gross Domestic Product
Gm	=	Gram
GLM	=	General linear model
MW	=	Month Weight
MS	=	Mean Square
NBF	=	Nucleus Breeding Flock
Lbs	=	Pound
ONBS	=	Open Nucleus Breeding System
Kg	=	Kilogram
LSD	=	Least Squares Means
Ml	=	Milliliter
no.	=	Number
NS	=	Non-significant
PPR	=	Peste des Petits Ruminants

LIST OF ABBREVIATIONS AND SYMBOLS (cont'd)

SAARC	=	South Asian Association for Regional Co-operation
SAS	=	Statistical Analysis
SAU	=	Sher-e-Bangla Agricultural University
SAURES	=	Sher-e-Bangla Agricultural University Research System
SE	=	Standard Error
SS	=	Sum of Squares
Viz.	=	Namely

CHAPTER 1

INTRODUCTION

Bangladesh has only one goat breed of its own, known as the Black Bengal goat. More than 90% of the goat population in Bangladesh is comprised of Black Bengal goat having some variation in coat color and size. Most of the Black Bengal goat bears black hair coat but they may also carry white, brown, black and white, white and brown coat color (Husain, 1993). It has soft, glossy short hair. The legs are short with a straight back and a beard is found in both sexes. The horns in male are curved in backward but in female it is upward or straight and thinner compare to male. Mature body weight of buck is about 25-30 kg and doe is 20-25 kg. Goats were probable the first domestic ruminant after dogs around 9000-7000 B.C. It is believed that Asiatic breeds of domestic goats are derived from a single wild species *Capra hircusaegagrus*. The dwarf goat would be descended from a different origin and perhaps from African ancestors.

The achievement of goat farming hugely depends on the environment where the goats are kept and their arrangement system of rearing. Reproductive efficiency of goat is thought as one of emergent factors that assures better productivity in certain climatic conditions. Genetic quality of goat is influenced by the reproductive traits which having low heritability. Breed selection is done on the basis of genetic gain or breeding value. It is obvious that better production efficiency can be obtained from goats when they have a high reproductive efficiency with the potentials for increased litter size and shorter generation interval specially having higher fertility rate in comparison to other farm animals (Haque *et al*, 2013).

Reproductive performance of goats is an exponent of their adjustment in adverse condition. Reproductive efficiency of doe is ascertained by variant processes such as the length of the breeding season, cyclic activity, ovulation rate, age at puberty, age at first conception, and age of first kidding, birth weight of kids, litter size, kidding interval, fertilization rate and post-partum anestrus period. For these among other factors e.g. genetic and environmental, management system can be considered as conclusive. Reproductive traits are an important factor which have lifetime influence on the production of an animal (Banergee, 1989). The variability of generation is created by a number of environmental factors such as climate condition, nutrition level, and general management practices. Genotypic value of a quantitative character is modified and

changed by the environmental factors. Both genetic and non-genetic factors contribute to the changes in performance of Black Bengal goat.

Phenotypic variation in economic traits occurs due to environmental factor. Environmental factor of the phenotypic variation which are non-genetic in nature. Season is one of the most non-genetic factors which are influencing the reproduction performance of Black Bengal goat. Proper environmental practice demonstrate potential genetic merit adequate management and appropriate experimental design can minimize the effect of a season on reproduction performance of Black Bengal goat. Rapid improvement can be made in the efficiency of goat production by supplying uniform and superior environmental condition to breeding Black Bengal goat. Reproduction efficiency in does is characterized by the individual and compound parameters (Bushara *et al,* 2007).

There are five government owned goat development farms have been set up different parts of the country (Dhaka, Sylhet, Rajshahi, Chuadanga and Jhenaidah). These farms are also involved in conservation and extension of Black Bengal goat breed, buck production and its distribution to poor and distressed women at low price. In Bangladesh most of the farmers used natural mating systems to serve their does. Although, some NGO's mainly BRAC started artificial insemination in goat with very limited scale. Hossain *et al.* (2004) found that majority of goat keepers (70.7%) used village buck to inseminate their does and most of the farmers (73.2%) paid service charge to the buck keepers while, most of the farmers (80.5%) did not keep bucks for breeding. Bangladesh Livestock Research Institute (BLRI) trying to improve the performances of Black Bengal goat through selective breeding and open nucleus breeding system (ONBS). BLRI also conserve Black Bengal goats by applying different technologies in field levels. The important technologies are goat rearing for poverty alleviation, Black Bengal goat rearing under stall feeding system, Black Bengal goat rearing under semi-intensive system, use of different tree fodder as feed, high quality goat selection for starting Black Bengal goat farm, rearing kids, development of PPR vaccine, integrated treatment approaches for PPR, development of goat pox vaccine, Enzyme-Linked Immunosorbent Assay(ELISA) method for the detection of goat pox, Competitive Enzyme-Linked Immunosorbent Assay(C-ELISA) method for the detection of antibody against PPR. Scientific knowledge is about animal recording (pedigree and performance), selection goat, selection criteria, animal selection procedure and mating design are

yet to be organized in the said government farms. Goats are regarded as an intimate and integral part of rural farming system in Bangladesh (Hasan, 2014). Semi-intensive rearing compromise between extension and intensive system followed in some flocks having limited grazing. It is an intermediated system involves extension management but usually with controlled grazing of fenced pasture. It consists of provision of stall feeding, shelter at night under shed and 3-5 hours daily for grazing. In this method, the feed cost is somewhat increased. The contribution of the livestock sector to overall GDP was 1.66% for 2015-16 where the share of livestock in total agriculture GDP was 14.21% (DLS, 2016). Goat provides 20 million square feet of skins. The skin is unique throughout the world known as "Kushtia grade". The export earnings from all leather and leather goods were 4.31% of the total export in 2012. The contribution of goat skin plays a significant role for achieving currency from foreign country. Thus goat farming plays an important and potential role for poverty reduction income generation, contribution to food and nutrition security and employment generation.

Bangladesh is a densely populated country having about 163 million of people in its 147570 square km of area. The goat population is about 25.77 million in the year 2015-16 (BBS, 2017) of which about 90% are Black Bengal goats reared by women's and children. Now a days, the growth of goat population drastically reduced after 2011-12 in Bangladesh due to involvement of women in other profession mainly in readyment garments sector. At present goat farming has become a profitable business due to high demand of goat meat in local market with high market price.

Dinajpur district is a gracious place for keeping Black Bengal goat due to favorable climatic condition and have sufficient free area for pasturage. There are lots of Jackfruit, Mango, Jiga, Banana, Guava and Bamboo leaves for stall feeding. Native grasses are available for grazing. There is limited previous report on investigate the effect of season on reproductive performance of Black Bengal goat. From the stand point the present study was designed to fulfill the following objectives:

i.   To observe the effect of season on reproductive traits of Black Bengal goat.
ii.   To estimate reproductive performance of Black Bengal goat.

CHAPTER 2

REVIEW OF LITERATURE

Actual research works have been carried out in different countries of the world related to the effect of season on reproduction performance of Black Bengal goat in several areas. In Bangladesh this kind of works have also been done in different region. However Kornai, Noshipur, Bangibachar hat, Vagobanpur in Dinajpur district there are no research work about effect of season on reproduction performance of Black Bengal goats. But the related findings of research work carried out in Bangladesh as well as abroad are reviewed in this section.

2.1 Effect of season and parity on birth weight

Season is an emergent factor for the reproduction performance of Black Bengal goat. Somewhat season variation and parity effect influences the reproduction performance of Black Bengal goat. A number of research works have been carried out in this purpose which are summarized as follows:

Routa *et al.* (2018) studied that the Jamnapari goats were introduced to the study area (CIRG) from their natural habitat, the Chakarnagar area of Etawah district of Uttar Pradesh, which is located 150 km from the Central Institute for Research of Goats in Mathura, India, 1982 to 2012.The experiments area has semiarid climate and an average annual rainfall of about 375mm which is separated during the months of June to September. The result of the research work observed that the seasonal effect of birth weight had significant level (P<0.01).

Hassan *et al.* (2007) investigated to detect the status of productive and reproductive parameters of Black Bengal goat and crossbred goats at Bandaikhara village under Atrai Upazila of Naogaon district. He found the average birth weight of Black Bengal goat was 1.60±0.50 kg.

Gous *et al.* (2016) compared between productive and reproductive performance of Black Bengal goat and Jamnapari under semi-intensive system. They collected the data from the selected areas Chittagong district of Bangladesh. The study was about Black Bengal and Jamnapari goats. The average birth weight of Black Bengal and Jamnapari goat was 956.13±19.72 and 1776.56±75.13 gms respectively which reared under semi-intensive system.

Chowdhury *et al*. (2002) studied at the Bangladesh Livestock Research Institute. Black Bengal goats 90 pre-puberal female and 15 pre-puberal male were collected from different parts of Bangladesh on the basis of their phenotypic characteristics. In this study goats were reared under semi-intensive management in permanent house. In this research work observed that the birth weight of male and female kids was 1.24±0.03 and 1.19±0.13 kg respectively.

Islam *et al*. (2009) reported the growth, milk production and reproduction performances of Black Bengal goat under semi-intensive production (IP) and scavenging production (SP) system. He observed that the birth weight of male and female kids were in IP system were 1.38±0.01 and 1.23±0.01 kg respectively. He also observed that the birth weight of Black Bengal goats were under IP and SP system 1.30±0.03 and 0.96±0.03 kg respectively.

Paul *et al*. (2014) studied to know the productive and reproductive parameters of Black Bengal goat in a nucleus breeding flock (NBF) of Bangladesh Agricultural University (BAU) and two other regions i.e., Modhupur (Tangail), Dimla (Nilphamari). In this study data were collected on a regular basis from January 2011 and January 2012. He found the average birth weight of kids in NBF, Modhupur and Dimla were 1.09±0.27, 1.09±0.25 and 1.10±0.27 kg respectively. In that study they observed that the season of birth has a significant effect (P<0.05). They also said that winter born kids were significantly (P<0.05) heavier than that of other seasons at that study areas.

Husain *et al.* (1993) was conducted a study in four different regions of Bangladesh from July 1987 to September 1991.The four regions were (1) Mymensingh,(2) Trisal, (3) Tangail and (4) Rangpur. Goats and kids were maintained under an extensive system allowing grazing from morning to evening. In that study they reported that body weight was highest in summer season and lowest in rainy season.

Kuthu *et al*. (2013) studied on pedigree, breeding and performance records of Teddy goats (male and female) kept at (I) Livestock Experiment Station Rakh Ghulaman, District: Bakkhar (1984-2008) (II) Livestock Experiment Station, Rakh Khariewala District: Layyah (1972-2008) and (III) Livestock Experiment Station Chak Katora, District: Bahawalpur (1974-2008) Pakistan were conducted in this study. In the study showed that monsoon born kids are higher than summer born due to adequate availability of greens to dams during winter and monsoon season.

Hossain *et al.* (2004) observed the reproductive and productive performance of Black Bengal goat in different parity reared in semi-intensive system. He reported that the birth weight of male kids in 1st parity, 2nd parity and 3rd parity were respectively 1.05±0.04, 1.22±0.03 and 1.15±0.03 kg. He also reported that the birth weight of female kids in 1st parity, 2nd parity and 3rd parity were 1.02±0.04, 1.05±0.03 and 1.11±0.03 kg respectively. He found the average birth weight of male and female kids of Black Bengal goats were 1.14 and 1.06 kg respectively.

Hasan *et al.* (2014) conducted the experiment at rural areas in Bangladesh to investigate the effect of housing system on reproductive traits. About 200 Black Bengal goat were selected which reared under semi-intensive and extensive conditions. In this experiment reported that under semi-intensive condition give better reproductive performances than extensive housing system in Black Bengal goat at rural areas in Bangladesh. The average birth weight of Black Bengal goat was 1.86±0.02 kg in first parity and 1.66±0.09 kg in second parity in case of male kids and 1.57±0.10 kg in first parity and 1.42±0.40 kg in second parity in case of female kids in first litter size under semi-intensive and extensive housing system respectively.

Jahid *et al.* (2015) conducted the study to observe the status of different reproductive parameters of Black Bengal goats in rural area of Mukterpur under charghat Upazila of Rajshahi district. He studied these parameters under both semi-intensive and extensive conditions. He found the average birth weight of kids was 1.28±0.11 kg and 1.25±0.10 kg respectively under semi-intensive and extensive conditions.

2.2 Effect of season on gestation length.

The word "gestation" comes from the Latin "gestate" meaning to carry or to bear. It is the time between fetal development and the time of conception until birth. Gestation length is highly variable and influenced by various environmental factors. Season is one of the most important environmental factors which influencing the reproduction performances of goat. This may confer survival advantages for neonates. Those does conceiving early and late in the breeding season have longer and shorter gestation length.

Haque *et al.* (2013) conducted the study to investigate the reproductive performance of Black Bengal goat at semi-intensive rearing system. He collected data for this study from three different region that was Bangladesh Agricultural University (BAU), Modhupur and Dimla region. He found the average gestation length of Black Bengal goat at BAU, Modhupur and

Dimla region was 144.02±0.9, 145.34±0.5 and 147.34±0.4 days respectively. He also observed gestation length at different parity and season. At 1st, 2nd and 3rd parity the average gestation period was respectively 144±0.53, 144±0.45 and 143±0.39 days. In this study the average gestation period of Black Bengal goat were 144.55±1.12, 144.80±1.12 and 143.23±1.90 days respectively at winter, summer and rainy season.

Gous *et al.* (2016) compared between productive and reproductive performances of Black Bengal goat and Jamnapari goat under semi-intensive system in Bangladesh. Average gestation length of Black Bengal goat and Jamnapari goat was 147.90±0.255 and 150.88±0.846 days respectively. He also observed the average gestation length at different parity. He found the gestation length of Black Bengal goat at 1st, 2nd, 3rd and 4th parity were 146.73±0.81, 148.46±0.79, 149.49±0.79 and 148.46±1.21 days respectively. He found the gestation length of Jamnapari goat were 149.69±0.87, 152.42±0.90, 151.25±0.81 and 151.42±1.18 days respectively at 1st, 2nd, 3rd and 4th parity.

Mia *et al.* (2013) carried out the study to know genetic and phenotypic parameters for some reproductive traits of Black Bengal goats. He found the average gestation length was 144.71±2.94 days of Black Bengal goats. He observed the gestation length of Black Bengal goats at 1st, 2nd and 3rd parity which were 144.26±1.01, 145.07±1.17 and 143.25±1.61 days respectively. The average gestation length were at winter, summer and rainy season 144.55±1.12, 144.80±1.12 and 143.13±1.90 days respectively.

Halim *et al.* (2011) conducted the study to know reproductive and productive performances of Black Bengal goats reared by moderate and ultra-poor households at three different districts of Bangladesh. The average gestation length of Black Bengal goats was 145.61±2.17 days.

Kabirul *et al.* (2013) investigated to know about the productive and reproductive performance of Black Bengal goat. He gathered the data from the research farm of Chittagong Veterinary and Animal Sciences University, Bangladesh. About 16 Black Bengal goat and 3 buck were collected from village and village market. After collecting goats were reared in quarantined shed for 15 days. The birth weight of kids increased faster than advanced stage. In this study goats were reared with 5 to 6 hours grazing and whole goats were divided into 2 groups with 6 goats in each group such as group A and B. He observed the average gestation period were at group A and group B were 149.0±2.00 and 148.0±3.50 days respectively.

Jalil *et al.* (2016) carried out the studied to investigate the productive and reproductive performances of Black Bengal goat under farming condition. The average gestation length was 142.45±0.31 days of Black Bengal goat. He found the average gestation length at 1st, 2nd and 3rd parity were 143.99±1.38, 145.18±1.86 and 143.37±1.29 days respectively.

Faruque *et al.* (2010) conducted the study to know performance and genetic parameters which are economically important traits of Black Bengal goats. He reported the average gestation length at intensive and semi-intensive system were respectively 143.0±1.71 and 142.8±1.4 days of Black Bengal goats. He also reported that the gestation periods of Black Bengal goats at summer, rainy and winter season were 142.3±1.35, 142.83±2.42 and 143.8±1.87 days respectively.

Hossain *et al.* (2004) studied to know the reproductive and productive performances at Black Bengal goat in different parity reared in semi-intensive system. He observed the average gestation period at 1st, 2nd and 3rd parity were 148.0±0.91, 147.0±0.91 and 148.0±0.91 days respectively.

Chowdhury *et al.* (2001) conducted the study to evaluate physiological and reproductive performances of Black Bengal goats under semi-intensive management. He reported that the gestation length were at 1st, 2nd, 3rd and 4th parity were respectively 146.0±2.94, 147.0±3.12, 142±2.43 and 146.0±3.27 days. He also reported that the average gestation period at low and high feeding system were 144.0±1.75 and 146.0±2.53 days respectively.

2.3 Effect of season and parity on litter size

Litter size means the number of offspring produced at one birth by an individual. The season of the year significantly affected litter size of the goat. Litter size is usually smallest in the first parity, rises to a maximum between the third and fifth parity and then remains constant or declines slightly with older parities.

Hassan *et al*. (2007) investigated to detect the status of productive and reproductive parameters of Black Bengal goat and crossbred goats at Bandaikhara village under Atrai Upazila of Naogaon district. He found the litter size of Black Bengal goat and crossbred goat were 1.96±0.75 and 1.25±0.25 respectively.

Hossain *et al.* (2004) studied to know the reproductive and productive performances at Black Bengal goat in different parity reared in semi-intensive system. He observed the average litter size at 1st, 2nd and 3rd parity were respectively 1.08±0.11, 1.76±0.12 and 1.96±0.12. He also found that the overall litter size was 1.60±0.06 of Black Bengal goat.

Islam *et al.* (2009) reported the growth, milk production and reproduction performances of Black Bengal goat under semi-intensive production (IP) and scavenging production (SP) system. He observed that the average litter size of does in IP and SP system was 2.00 and 2.33 respectively.

Jahid *et al.* (2015) studied about the status of different reproductive parameters of Black Bengal goat in rural area of Mukterpur under Charghat upazila of Rajshahi district. About 200 Black Bengal goat were selected for experiment under both semi-intensive and extensive condition. He reported that the average litter size of Black Bengal goat at semi-intensive and extensive system respectively were 1.60±0.06 and 1.46±0.05. He also reported that the average litter size of Black Bengal goat at 1st, 2nd and 3rd parity at semi-intensive condition were 1.06±0.13, 1.76±0.12 and 1.96±0.12 respectively. Due to extensive condition, he found that the average litter size at 1st, 2nd and 3rd parity of Black Bengal goat were respectively 1.01±0.10, 1.62±0.12 and 1.75±0.11. Due to season 1 (summer), season 2 (rainy) and season 3 (winter) the average litter size of Black Bengal goat were 1.37±0.11, 1.0±0.23 and 1.0±0.17 respectively.

Paul *et al*. (2014) studied to know the productive and reproductive parameters of Black Bengal goat in a nucleus breeding flock (NBF) of Bangladesh Agricultural University (BAU) and two other regions i.e. Modhupur, Dimla. In this study data were collected on a regular basis from January 2011 and January 2012. Paul et al. (2014) found the average litter size of Black Bengal goat at 1st, 2nd and 3rd parity were respectively 1.37±0.07, 1.52±0.10 and 1.84±0.14 at NBF. In Modhupur region the litter size were at 1st, 2nd and 3rd parity were 1.50±0.07, 1.47±0.02 and 1.81±0.11 respectively. In Dimla region the litter size were respectively 1.54±0.05. 1.49±0.05 and 1.92±0.14 at 1st, 2nd and 3rd parity. In NBF at winter, summer and rainy season the litter size were respectively 1.54±0.10, 1.47±0.08 and 1.52±0.14 respectively. In Modhupur at winter, summer and rainy season the litter size of Black Bengal goat were 1.51±0.02, 1.47±0.08 and 1.56±0.04 respectively. In Dimla at winter, summer and rainy season the litter size were respectively 1.61±0.07, 1.67±0.07 and 1.66±0.09 of Black Bengal goats.

Chowdhury *et al.* (2002) studied with 90 pre-puberal female and 15 pre-puberal male Black Bengal goats were collected from different parts of Bangladesh on the basis of their phenotypic characteristics. In this study goats were reared under semi-intensive management in permanent house. They observed that the litter size at 1st, 2nd, 3rd and 4th parity of Black Bengal goats were 1.29, 1.71, 1.87 and 2.17 respectively.

Faruque *et al.* (2010) conducted the study to know performance and genetic parameters which are economically important traits of Black Bengal goats. He reported the average litter size at intensive and semi-intensive system were respectively 1.5±0.16 and 1.06±0.13 of Black Bengal goats. He also reported that the litter size of Black Bengal goats at summer, rainy and winter were 1.37±0.1, 1.0±0.23 and 1.0±0.17 respectively. He showed that the average litter size of Black Bengal goat was 1.94±0.06.

Haque *et al.* (2013) conducted the study to investigate the reproductive performance of Black Bengal goat at semi-intensive rearing system. He collected data for this study from three different region that was Bangladesh Agricultural University (BAU), Modhupur and Dimla region. He showed that the litter size of Black Bengal goat at 1st, 2nd and 3rd parity were 1.33±0.04, 1.54±0.07 and 1.77±0.09 respectively. He also found that the litter size of Black Bengal goat at winter, summer and rainy season were 1.54±0.10, 1.47±0.08 and 1.52±0.14 respectively.

2.4 Effect of season on age at puberty

Age at puberty is the time when an individual becomes sexually mature and capable of reproduction. It is a major determinant of lifetime reproductive efficiency of goats. Season is one of the better defined variables that influences timing of puberty onset in goats.

Hassan *et al.* (2007) investigated to detect the status of productive and reproductive parameters of Black Bengal goat and crossbred goats at Bandaikhara village under Atrai Upazila of Naogaon district. He found the average age at puberty of Black Bengal goat and crossbred goat were 222.5±5.5 and 196.5±5.5 days respectively.

Hasan *et al.* (2014) conducted the study to investigate the influence of housing system on female reproductive traits of Black Bengal goats at rural areas in Bangladesh during the period of July to

December 2012. He reported that average age at puberty was under semi-intensive conditions 197.82±12.58 days and under extensive condition was 208.82±12.60 days.

Hossain *et al*. (2004) studied on milk production performance of Black Bengal goats in different parity reared in semi-intensive system. He observed that the age at puberty of Black Bengal goat was 209.0±32.25 days.

Chowdhury *et al.* (2002) studied with 90 pre-puberal female and 15 pre-puberal male Black Bengal goats were collected from different parts of Bangladesh on the basis of their phenotypic characteristics. In this study goats were reared under semi-intensive management in permanent house. They observed that the age at puberty of Black Bengal goats was 216.0±9.52 days.

Faruque *et al.* (2010) conducted the study to know performance and genetic parameters which are economically important traits of Black Bengal goats. He reported the average age at puberty at intensive and semi-intensive system were 138.83±15.38 and 197.82±12.58 days respectively of Black Bengal goats. He also reported that the age at puberty of Black Bengal goats at summer, rainy and winter season were 152.29±12.16, 216.16±21.75 and 193.2±16.85 days respectively.

Jalil *et al.* (2016) carried out the studied to investigate the productive and reproductive performances of Black Bengal goat under farming condition. He found the average age at puberty of Black Bengal goat was 182.7±7.25 days.

Halim *et al.* (2011) conducted the study to know reproductive and productive performances of Black Bengal goats reared by moderate and ultra-poor households at three different districts of Bangladesh. The average age at puberty of Black Bengal goats was 234.16±6.54 days.

Kabirul *et al.* (2013) investigated to know about the productive and reproductive performance of Black Bengal goat. He gathered the data from the research farm of Chittagong Veterinary and Animal Sciences University, Bangladesh. About 16 Black Bengal goat and 3 buck were collected from village and village market. After collecting goats were reared in quarantined shed for 15 days. The birth weight of kids increased faster than advanced stage. In this study goats were reared with 5 to 6 hours grazing and whole goats were divided into 2 groups with 6 goats in each group such as group A and B. He observed the average age at puberty were at group A and group B respectively were 226.0±7.45 and 222.0±8.12 days.

2.5 Effect of season on age at first kidding

Age at first kidding means the time when doe first give birth. Season is one of the determinant which influences the age at first kidding.

Halim *et al.* (2011) conducted the study to know reproductive and productive performances of Black Bengal goats reared by moderate and ultra-poor households at three different districts of Bangladesh. The average age at first kidding of Black Bengal goats was 316.83±11.29 days.

Faruque *et al.* (2010) conducted the study to know performance and genetic parameters which are economically important traits of Black Bengal goats. He reported the average age at first kidding at intensive and semi-intensive system were respectively 283.83±31.16 and 370.26±25.48 days of Black Bengal goats. He also reported that the age at first kidding of Black Bengal goats at summer, rainy and winter season were 331.41±24.63, 368.33±44.07 and 365.4±34.14 days respectively.

Hossain *et al*. (2004) studied on milk production performance of Black Bengal goats in different parity reared in semi-intensive system. He observed that the age at first kidding of Black Bengal goat was 401.50±32.08 days.

Hasan *et al.* (2014) conducted the study to investigate the influence of housing system on female reproductive traits of Black Bengal goats at rural areas in Bangladesh during the period of July to December 2012. He found the average age at first kidding were 448.26±25.48 and 450.07±22.43 days under semi-intensive and extensive conditions respectively.

Jahid *et al.* (2015) conducted the study to observe the status of different reproductive parameters of Black Bengal goats in rural area of Mukterpur under charghat Upazila of Rajshahi district. He studied these parameters under both semi-intensive and extensive conditions. He found the average age at first kidding were 448.26±25.48 and 450.07±22.43 days under semi-intensive and extensive conditions respectively. He also observed that the average age at first kidding of Black Bengal goat at season 1 (summer), season 2 (rainy) and season 3 (winter) were 331.41±24.63, 368.±44.07 and 365.4±34.14 days respectively.

Hassan *et al*. (2007) investigated to detect the status of productive and reproductive parameters of Black Bengal goat and crossbred goats at Bandaikhara village under Atrai Upazila of Naogaon

district. He found the average age at first kidding of Black Bengal goat and crossbred goat were 360.5±10.0 and 411.5±15.5 days respectively.

Haque *et al.* (2013) conducted the study to investigate the reproductive performance of Black Bengal goat at semi-intensive rearing system. He collected data for this study from three different region that was Bangladesh Agricultural University (BAU), Modhupur and Dimla region. He found that the average age at first kidding of Black Bengal goat was 465.6±12.45 days.

2.6 Effect of season on weight at first kidding

Weight at first kidding means the body weight when doe first give birth. Season is one of the determinant which influences the weight at first kidding.

Faruque *et al.* (2010) conducted the study to know performance and genetic parameters which are economically important traits of Black Bengal goats. He reported the average weight at first kidding at intensive and semi-intensive system were respectively 18.91±0.67 and 16.07±0.55 kg of Black Bengal goats. He also reported that the weight at first kidding of Black Bengal goats at summer, rainy and winter season were respectively 18.27±0.53, 15.16±0.96 and 16.32±0.74 kg.

Haque *et al.* (2013) conducted the study to investigate the reproductive performance of Black Bengal goat at semi-intensive rearing system. He collected data for this study from three different region that was Bangladesh Agricultural University (BAU), Modhupur and Dimla region. He found that the average weight at first kidding of Black Bengal goat was 13.22±0.24 kg.

Hasan *et al.* (2014) conducted the study to investigate the influence of housing system on female reproductive traits of Black Bengal goats at rural areas in Bangladesh during the period of July to December 2012. He found the average weight at first kidding were 18.3±0.54 and 16.2±0.50 kg under semi-intensive and extensive conditions respectively.

Jahid *et al.* (2015) conducted the study to observe the status of different reproductive parameters of Black Bengal goats in rural area of Mukterpur under charghat Upazila of Rajshahi district. He studied these parameters under both semi-intensive and extensive conditions. He found the average weight at first kidding were 18.3±0.54 and 16.2±0.50 kg under semi-intensive and

extensive conditions respectively. He also observed that the average weight at first kidding of Black Bengal goat at summer, rainy and winter were 18.27±0.53, 15.16±0.96 and 16.32±0.74 kg respectively.

2.7 Effect of season on lactation length

Lactation length describes the period of time that a doe gives milk to fed her young. It is a measure of persistency and heritable trait. Management, nutrition, season are the vital environmental factors affecting lactation performances of does. Lactation length of goat depends upon genetic and environmental factors. Genetic background, climate, diseases, feeding and season have been reported to affect the reproduction performances of goat.

Hossain *et al*. (2004) studied on milk production performance of Black Bengal goats in different parity reared in semi-intensive system. He observed that the lactation length in 1st parity, 2nd parity and 3rd parity respectively were 61.56±1.89, 66.4±1.89 and 67.0±1.89 days. He also reported that the average lactation length 64.99±1.08 days.

Hassan *et al.* (2007) conducted the study to observe the status of different productive and reproductive parameters of Black Bengal goats and crossbred goats in Bandaikhara village under Atrai Upazila of Naogaon district during the period of September to December, 2005. He reported that the lactation length of crossbred goats and Black Bengal goats were 99.25±10 and 65.50±7.5 days respectively.

Islam *et al.* (2009) reported the growth, milk production and reproduction performances of Black Bengal goat under semi-intensive production (IP) and scavenging production (SP) system. He observed that the average lactation length of does in IP and SP system was 95.33±1.45 and 84.66±1.45 days respectively. The lactation length of IP system was found 10 days higher than SP system.

Armin Akter completed the study in three upazilla at Dinajpur district of Bangladesh from June 2016 to May 2017 to compare productive and reproductive performances of Black Bengal goat and prevalence of different dieases in goat at small holder farm. She observed that the average lactation length of Birganj, Sadar and Birol upazila were 121.67±10.06, 88.33±5.75 and 111.67±5.20 days respectively. The average lactation length was highest 121.67±10.06 days in Birganj among the three upazillas.

Faruque *et al.* (2010) conducted the study to know performance and genetic parameters which are economically important traits of Black Bengal goats. He also reported that the lactation length of Black Bengal goats at summer, rainy and winter were 51.16±12.03, 66.5±15.36 and 61.0±11.89 days respectively. He also found the average lactation length at 1st, 2nd and 3rd parity were 71.82±3.91, 83.4±3.66 and 79.52±3.75 days respectively.

Jalil *et al.* (2016) carried out the studied to investigate the productive and reproductive performances of Black Bengal goat under farming condition. The average lactation length was 61.5 days of Black Bengal goat. He also found the average lactation length of Black Bengal goat at foundation generation, 1st generation, 2nd generation and 3rd generation were respectively 71.0±1.80, 69.0±5.80, and 63.0±3.34 and 43.0±7.31 days.

Halim *et al.* (2011) conducted the study to know reproductive and productive performances of Black Bengal goats reared by moderate and ultra-poor households at three different districts of Bangladesh. He reported that the average lactation period at moderate and ultra-poor household system was 69.83±10.09 days.

2.8 Effect of season and parity on kidding interval

The kidding interval means period of time between two consecutive kidding. Season had an effect on kidding interval that does kidded in the cool season had shorter kidding interval followed by does that gave birth the wet season.

Bushara *et al.*(2011) conducted the study to observe the effect of season of Birth and Litter size on Tagger Goats production in Western Sudan .In that study they reported that nutrition have direct impact on ovulation rate and fertility, since the nutritional stress appears to be a fundamental cause of cyclic activity and long kidding interval in the goats.

Gous *et al.* (2016) compared between productive and reproductive performances of Black Bengal goat and Jamnapari goat under semi-intensive system in Bangladesh. He observed kidding interval of Black Bengal goat and Jamnapari goat were 186.15±1.258 and 199.22±2.407 days respectively. He also observed the kidding interval at different parity. He found the kidding interval of Black Bengal goat at 1st, 2nd, 3rd and 4th parity were 185.61±2.67, 185.97±2.60, 186.50±2.77 and 187.49±3.97 days respectively.

Hassan *et al.* (2007) conducted the study to observe the status of different productive and reproductive parameters of Black Bengal goats and crossbred goats in Bandaikhara village under Atrai Upazila of Naogaon district during the period of September to December, 2005. He reported that the kidding interval of crossbred goats and Black Bengal goats were 179.0±20 and 270.0±22 days respectively.

Hasan *et al.* (2014) conducted the study to investigate the influence of housing system on female reproductive traits of Black Bengal goats at rural areas in Bangladesh during the period of July to December 2012. He found the average kidding interval of Black Bengal goat were 190.2±0.20 and 178.23±0.50 days under semi-intensive and extensive conditions respectively.

Jahid *et al.* (2015) conducted the study to observe the status of different reproductive parameters of Black Bengal goats in rural area of Mukterpur under charghat Upazila of Rajshahi district. He studied these parameters under both semi-intensive and extensive conditions. He found the average kidding interval of Black Bengal goat were 190.2±0.20 and 178.23±0.50 days respectively under semi-intensive and extensive conditions.

Hossain *et al.* (2004) studied on milk production performance of Black Bengal goats in different parity reared in semi-intensive system. He observed that the kidding interval of Black Bengal goat at 2nd parity and 3rd parity respectively were 199.36±3.86 and 186.84±3.86 days.

Chowdhury *et al.* (2002) studied with 90 pre-puberal female and 15 pre-puberal male Black Bengal goats were collected from different parts of Bangladesh on the basis of their phenotypic characteristics. In this study goats were reared under semi-intensive management in permanent house. He observed that the kidding interval of Black Bengal goats at low and high feeding system was 192.0±3.85 and 177.0±5.88 days. He also observed the kidding interval at 2nd, 3rd and 4th parity at Black Bengal goat were respectively 191.0±4.89, 191.0±5.29 and 172.0±7.40 days.

Halim *et al.* (2011) conducted the study to know reproductive and productive performances of Black Bengal goats reared by moderate and ultra-poor households at three different districts of Bangladesh. He reported that the kidding interval of Black Bengal goat was 252.45±3.57 days.

Haque *et al.* (2013) conducted the study to investigate the reproductive performance of Black Bengal goat at semi-intensive rearing system. He collected data for this study from three

different region that was Bangladesh Agricultural University (BAU), Modhupur and Dimla region. He observed the kidding interval of Black Bengal goat 302.5±4.55 days. He showed that the kidding interval of Black Bengal goat at 2nd and 3rd parity were respectively 240.6±6.3, 285.9±10.3 days respectively. He also found that the kidding interval of Black Bengal goat at winter, summer and rainy season were respectively 288.6±11.3, 260.4±10.4 and 270.3±10.9 days.

Akter *et al.* (2006) investigated the production performances of Black Bengal goat. He reported that the kidding interval were at selected and controlled group respectively 233.47±15.46 and 274.60±14.48 days.

Faruque *et al.* (2010) conducted the study to know performance and genetic parameters which are economically important traits of Black Bengal goats. He also reported that the kidding interval of Black Bengal goats at 2nd, 3rd and 4th parity in generation 1 were respectively 205.11±9.08, 174.0±12.19 and 176.0±22.26 days. He also found the average lactation length at 2nd, 3rd and 4rth parity were 195.41±5.56, 189.93±5.56 and 170.02±6.17 days respectively.

Jalil *et al.* (2016) carried out the studied to investigate the productive and reproductive performances of Black Bengal goat under farming condition. The average kidding interval was 188.01±2.14 days of Black Bengal goat. He also found the average kidding interval of Black Bengal goat at 2nd, 3rd and 4th parity were respectively 196.31±4.60, 69.0±5.80, 186.28±4.08 and 171.15±2.11 days.

2.9 Effect of season and parity on kid mortality

Kid mortality is a major factor determining the productivity of a herd. It is considered as sensitive index of management efficiency. Seasonal variation and parity effect have a great impact on kid mortality.

Chowdhury *et al.* (2002) studied with 90 pre-puberal female and 15 pre-puberal male Black Bengal goats were collected from different parts of Bangladesh on the basis of their phenotypic characteristics. In this study goats were reared under semi-intensive management in permanent house. He observed that the kid mortality of Black Bengal goats at low and high feeding system were 35.2% and 6.5% respectively. He also observed the kid mortality at 1st, 2nd, 3rd and 4th parity at Black Bengal goat were 50%, 25%, 26.76% and 7.69% respectively.

Hossain *et al.* (2004) studied on milk production performance of Black Bengal goats in different parity reared in semi-intensive system. He selected goats for his experiment on the basis of their phenotypic characteristics and their ancestral history from goat development farm, Savar, Dhaka. He observed that the kid mortality of Black Bengal goat at 1st parity, 2nd parity and 3rd parity were 22.2%, 15.9% and 8.16% respectively.

Islam *et al.* (2009) reported the growth, milk production and reproduction performances of Black Bengal goat under semi-intensive production (IP) and scavenging production (SP) system. He observed that the kid mortality of Black Bengal goat in IP and SP system were 0% and 14.28% respectively. The higher kid mortality in the SP systems was probably due to traditional rearing system.

Jahid *et al.* (2015) studied about the status of different reproductive parameters of Black Bengal goat in rural area of Mukterpur under Charghat upazila of Rajshahi district. About 200 Black Bengal goat were selected for experiment under both semi-intensive and extensive condition. He reported that the average kid mortality of Black Bengal goat at semi-intensive and extensive system was 15% and 17% respectively. He also reported that the average kid mortality of Black Bengal goat at 1st and 2nd parity at semi-intensive condition was 7% and 18% respectively. Due to extensive condition, he found that the average kid mortality at 1st and 2nd parity of Black Bengal goat was respectively 3% and 18%. In that experiment they reported that the kid mortality was higher November to February i.e. in winter (10) due to the outbreak of diseases such as pneumonia, pest des petits ruminant (PPR). In this study they also stated that death occurred is higher in PPR than other diseases.

Mohammad *et al.* (2011) investigated the incidence and modulating effects of environmental factors on infectious diseases of Black Bengal goat in Cox's Bazar district of Bangladesh during the period of (September, 2008 to August, 2009). The result of the experiment revealed that the kid mortality was higher in winter 51.44% followed by 30.99% and 17.57% respectively in rainy and summer season.

Paul *et al.* (2014) studied to know the productive and reproductive parameters of Black Bengal goat in a nucleus breeding flock (NBF) of Bangladesh Agricultural University (BAU) and two other regions i.e. Modhupur, Dimla. In this study data were collected on a regular basis from January 2011 and January 2012. He found the average kid mortality of Black Bengal goat in

NBF, Modhupur and Dimla were 10±0.02%, 31±0.03% and 28.78±0.08 % respectively. In NBF at winter, summer and rainy season the kid mortality of Black Bengal goat was 9.00±0.02%, 9.09±0.06% and 13.04±0.05% respectively. In Modhupur at winter, summer and rainy season the kid mortality of Black Bengal goat was 17.50±0.90%, 25.00±0.06% and 52.77±0.05% respectively. In Dimla at winter, summer and rainy season the kid mortality of Black Bengal goat were 19.44±0.07%, 14.70±0.01% and 40.62±0.03% respectively.

Faruque *et al*. (2016) conducted the study to know the performance of Black Bengal goat and livelihood generated through goat rearing at three different village namely Kaichapar, Salia and Shimulia at Phulpur upazila. He reported that the average kid mortality rate was 12.58%.

Yonus Ali (2015) reported that the average kid mortality was 19.65%. He found that the highest kid mortality was up to 7days after birth that was 13.11%. He also found the kid mortality at 15 after birth were respectively 3.27%.

Kabirul *et al.* (2013) investigated to know about the productive and reproductive performance of Black Bengal goat. He gathered the data from the research farm of Chittagong Veterinary and Animal Sciences University, Bangladesh. About 16 Black Bengal goat and 3 buck were collected from village and village market. After collecting goats were reared in quarantined shed for 15 days. The birth weight of kids increased faster than advanced stage. In this study goats were reared with 5 to 6 hours grazing and whole goats were divided into 2 groups with 6 goats in each group such as group A and B. He observed the average kid mortality were at group A and group B respectively was 24.50±2.13% and 27.62±1.81%.

CHAPTER 3

MATERIALS AND METHODS

The present study was done under the Department of Animal Nutrition, Genetics and Breeding, Sher-e Bangla Agricultural University (SAU), Dhaka-1207, with the financial support of the Sher-e Bangla Agricultural University Research System (SAURES) as well as National Science and Technology (NST) Fellowship in a project entitled "Effect of season on reproduction performance of Black Bengal goat in Dinajpur district".

3.1 Study area

This study was investigated at different places of Dinajpur district. There are 205 villages in Sadar upazila, 4 villages namely Kornai, Noshipur, Bangibachar hat, Vagobanpur were selected for the present study. At northern part of Bangladesh Dinajpur district is situated. Dinajpur district is the largest district among all sixteen northern districts of Bangladesh. It was once a part of the ancient state of Pundravardhana. Dinajpur district under Rangpur division experiences a hot, wet and humid tropical climate. The district has a distinct monsoonal `season, with an annual temperature of 25℃ (77°F) and monthly means varying between 18℃ (64°F) in January and 29℃ (84°F) in August. The economy of Dinajpur mainly depends upon agriculture based production. Figure 1 represent the study area.

Figure 1. Map showing the study area in Dinajpur district

3.2 Study period and Data collection

Data for the experiment were conducted through door to door visit at farmer's house during July 2017 to June 2018. Data were collected through previously prepared interview schedule. The questionnaire include both open and closed question to collect data with view to objectives of this study. A measuring weight balance used to measure body weight of Black Bengal goat. An interview schedule is given in appendix-1. Season 1 represent the summer season which included March to June month, season 2 represent the rainy season which included July to October month and season 3 represent the winter season which included November to February month.

3.3 Animal and Management

Dinajpur district known as hot, wet and humid tropical climate. In these areas, most of the animals were reared under extensive management system. In this system goats are allowed to feed from naturally available feeds in day time and kept in confinement in night time. Most of farmers kept their goats beside their living room or under the space of their bed. Only at winter season farmer provide bedding materials such as rice straw, rice husk or dry tree leaves to their goats. Some farmers made house with bamboo or polythin sheet for their goats. At day time goats are allowed to grazing in natural or road side at village. Farmers were kept their goats at night in confinement shed. Sometimes the goats were tethered by rope and allowed to graze. During rainy season they provide tree leaves or some green grass which was cutting from road side.In village some farmers cultivated Napier, German and Maize for their goat beside their home. Broken rice, rice bran and household residue were also used in daily basis. Farmers take close observation of their goat during pregnancy and kids after birth. Major sources of drinking water for goats were tube well. Some farmers supply concentrated to their pregnant or lactating goats. Most of farmers did not kept breeding buck and allowed to mate naturally. Sometimes they use artificial insemination (AI) for their does. Farmers are not eager for proper treatment to their goats. When they faced disease, they provide treatment. The biosecurity was not maintained strictly in village. Most of farmers faced a common disease for goats that is Peste des Petits Ruminant (PPR). They also faced diarrhea, fever, naval infection etc. Few farmers provide some vaccination and anthelminthic drug for their goats.

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3.4 Parameters of the study

To evaluate the effect of season on reproductive performance of Black Bengal goat the following parameters were considered.

3.4.1 Birth weight of kids

Birth weight of kids means the body weight of kids just after birth. Birth weight of kids were recorded within 24 hours of birth and data was collected by digital weighing balance. This record included in the data sheet and analysis those kids only who remained alive.

3.4.2 Gestation period

Pregnancy period is known as gestation period. During gestation period a fetus develops, beginning with fertilization and ending at birth. This period is the time of conception to parturition.

3.4.3 Litter size

Total number of kids which were born in a time per birth per doe is called litter size. It can be single, twin or triplet or quadrate litter size of goats. Data collected on the number of kids and recorded in the data sheet for analysis.

3.4.4 Age at puberty

Age of puberty is the time between birth and first estrus. When a doe show the sign of first sign that age counted as age of puberty. By observing the wagging tail, swelling, watery discharge from vulva, jumping tendency to other and bleating detect the age of puberty of Black Bengal goats.

3.4.5 Age at first kidding

Age of first kidding indicate that time when doe first give birth a kid. It is the time of interval between birth and first kidding. That recorded in data sheet for analysis.

3.4.6 Weight at first kidding

Weight at first kidding means the body weight of Black Bengal does when gives birth first. The body weight of does were recorded in data sheet for analysis. Due to record body weight of doe use digital weighing balance.

3.4.7 Lactation length

Lactation length means the period when a doe gives milk. Lactation period of Black Bengal goats is short than others animal. The total period when doe gives milk were recorded in data sheet and analysis.

3.4.8 Kidding interval

Kidding interval is the interval between two consecutive parturitions that determines reproductive efficiency in production. Time between two successive parturition was recorded in data sheet for analysis.

3.4.9 Kid mortality rate

Kid mortality rate define as total of death of kids of Black Bengal goats during a specific time. It measured at percentages. It may be occurred disease, malnutrition, poor management etc. The total death of kid during this study were recorded and converted it in percentage to record in data sheet for analysis.

3.5 Statistical Analysis

For analysis of the collecting data were coded and entered in Microsoft Excel Worksheet. Duncan test was performed to see the significant differences among mean values. The parameter of the reproductive traits were analyzed simple ANOVA was performed by using Statistical Analysis System (SAS, 1998).

Plate 1. Data collection from rural area

Plate 2. Weight measuring of kids

Plate 3. Physical performance of Black Bengal goat

CHAPTER 4

RESULTS AND DISCUSSION

The research was conducted in Dinajpur district of Bangladesh from July 2017 to June 2018 to know the effect of season and parity on reproductive performance of Black Bengal goat at village condition. The experimental data for this study were collected from some villages such as Kornai, Noshipur, Bangibachar hat, Vagobanpur in Dinajpur district. This chapter represent the findings of this study according to the objectives of the study.

4.1 Effect of season and parity on birth weight of kids

In Table 1 presented the effect of season on reproductive performance of Black Bengal goat. Least squares means of birth weight of kids were 0.94±0.02, 1.05±0.02 and 0.90±0.021 kg respectively in season I, season II and season III of Black Bengal goat. The highest birth weight (1.05±0.024) was observed at season II. There is a non-significant differences between season I and season III but statistically differences present in season II and season III.

Table 1: Effect of season on reproductive performance of Black Bengal goat.

Parameters	Season I	Season II	Season III	Probability
	Mean ± SE	Mean ± SE	Mean ± SE	
Birth weight (kg) of kids	0.94^b±0.02	1.05^a±0.02	1.05^a±0.02	*
Gestation length (d)	142.9^b±0.52	143.2^b±0.54	145.6^a±0.48	*
Litter size (n)	2.09±0.10	2.01±0.10	2.07±0.09	NS
Age at puberty (d)	185.45±3.03	182.72±3.10	183.95±2.76	NS
Age at first kidding (d)	369.82^{ab}±1.76	371.92^a±1.80	366.02^b±1.60	*
Weight at first kidding (kg)	9.34^a±0.16	9.33^a±0.16	7.79^b±0.14	*
Lactation length (d)	72.8±0.54	73.2±0.55	73.07±0.49	NS
Kidding interval (d)	186.97^b±0.82	184.3^c±0.84	190.48^a±0.75	**
Kid mortality rate (%)	16.66±6.39	18.75±6.54	24.79±5.82	NS

Mean with different superscripts within each column and traits differed significantly *, (P<0.05); **, (P<0.01), NS: non-significant. Season-I (summer), season-II (rainy) & season-III (winter).

The effect of season (P<0.05) significant on birth weight of kid of Black Bengal goat. The birth weight of Black Bengal kids at 1st, 2nd, 3rd and 4th parity were 0.96±0.02, 0.97±0.01, 0.97±0.02,

0.95±0.03 kg respectively. There is no significant effect of parity on birth weight of Black Bengal kids. The effect of parity on reproductive performance of Black Bengal goat is presented in Table 2 and Figure 2.

Hassan *et al.* (2007) reported that the average birth weight of Black Bengal goat was 1.60±0.50 kg which was higher than this study. Rainy season give better results (1.046 kg) than the summer (0.94 kg) and winter season (0.90 kg). This study conducted in Rangpur district. Rangpur district known as humid subtropical area. The climate of Rangpur is generally marked with monsoon, high temperature and considerable humidity. In summer season, temperature raise highly and in winter temperature drop down a lot.

Table 2: Effect of parity on reproductive performance of Black Bengal goat.

Parameters	First parity	Second parity	Third parity	Fourth parity	Probability
	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	
Birth weight of kids (kg)	0.95±0.02	0.96±0.01	0.97±0.02	0.95±0.03	NS
Litter size (n)	1.53^c±0.09	1.83^b±0.08	1.97^b±0.09	2.17^a±0.15	**
Kidding interval (d)	187.19^{ab}±0.74	189.32^a±0.69	186.13^b±0.79	184.99^b±1.20	*
Kid mortality rate (%)	17.35±5.75	20.60±5.40	20.64±6.14	14.08±9.31	NS

Mean with different superscripts within each column and traits differed significantly *, (P<0.05); **, (P<0.01), NS: non-significant. SE = Standard error.

Due to high temperature in summer, birth weight may be low in summer season. In winter due to low temperature animal cannot go outside and their growth rate slow in winter. Birth weight in this study similar with Gous *et al.* (2016) the result was (956.13±19.72) gms. Birth weight in this study lower than the results of Chowdhury *et al.* (2002). Islam *et al.* (2009) reported that the birth weight of Black Bengal kids in semi-intensive system 1.30 kg which is higher than the present study. Higher birth weight recorded may be due to management and environmental factors. In semi-intensive system, goats are provided some extra food and care. Islam *et al.* (2009) also reported the birth weight in extensive system of Black Bengal kids 0.96 kg which is almost similar to the present study. Paul *et al.* (2014) found the birth weight 1.09, 1.09 and 1.10 kg respectively in Nucleus breeding flock, Modhupur and Dimla which is slightly higher than this study. Hossain *et al.* (2004) found the birth weight of Black Bengal kids 1.05, 1.22 and 1.15 kg respectively at 1st,

2nd and 3rd parity which is slightly higher than this study. The present study results of birth weight of Black Bengal kid slightly lower than the results of Jahid *et al*. (2015), Hasan *et al*. (2014), Faruque *et al.* (2010) and Hossain *et al*. (2004).
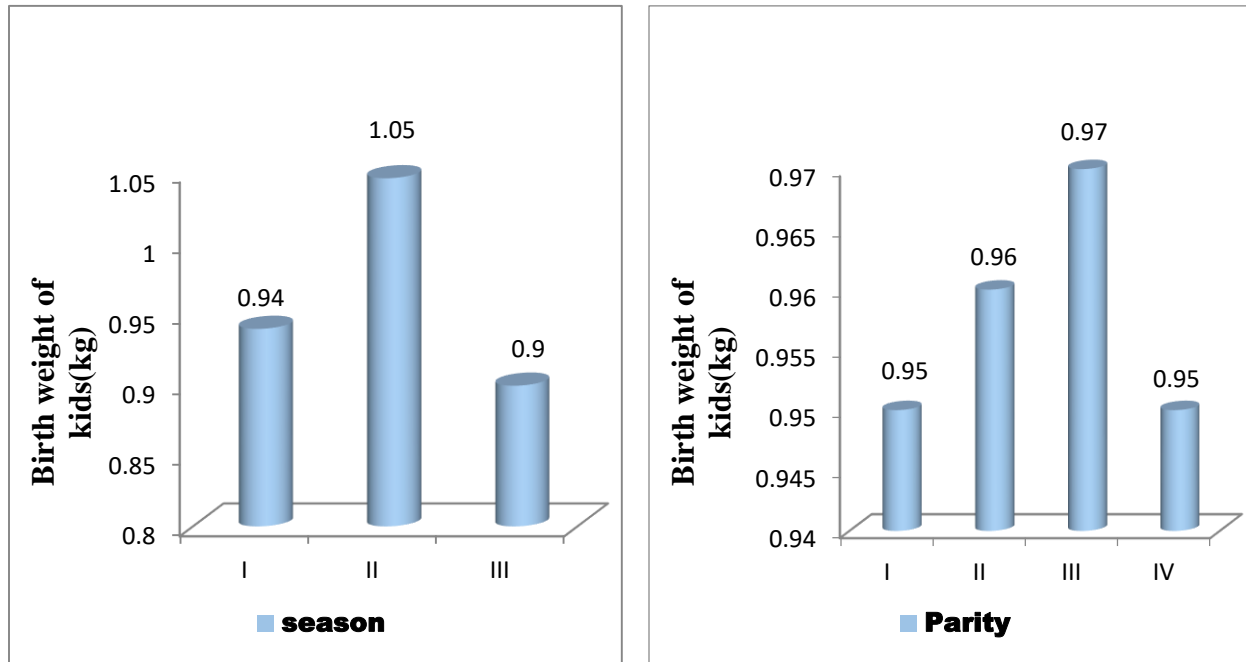
Figure 2. Effect of season and parity on birth weight of kids of Black Bengal goats.

4.2 Effect of season on gestation length

Average gestation length of Black Bengal goat in this study at season I, season II and season III were 142.9±0.52, 143.2±0.54 and 145.6±0.48 days respectively. There is significant (p<0.05) effect of season on gestation length of Black Bengal goat. The average gestation length and effect of season on gestation length is presented on Table 1 and Figure 3. There is a significant effect in season I season III. But there is no statistically differences between season I and season II. Highest gestation period observed in season III. There is a positive correlation between gestation length and birth weight and doe weight during service (Mishra *et al.* 1979). Hafez, (1979) reported that older animals have extend gestation length and more litter size is responsible for shorter gestation length. Gupta *et al.* (1964) reported that gestation length dependent on season, year and also kid birth weight and weight of dam at mating (Mishra *et al.* 1979). Haque *et al.* (2013) showed the average gestation length of Black Bengal goat at winter, summer and rainy season 144.55±1.12, 144.80±1.12 and 143.23±1.90 days respectively which almost similar with this study.

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The average gestation length of Black Bengal goat is almost similar with these result of Mia *et al.* (2013), Halim *et al.* (2011), Jalil *et al.* (2016) and Faruque *et al.* (2010). Gous *et al.* (2016) found the average gestation length of Black Bengal goat at first parity, second parity, third parity and forth parity were 146.73±0.81, 148.46±0.79, 149.69±0.87 and 148.46±1.21 days respectively which was higher than this study. This difference occurs due to may be season, parity, environmental and nutritional factors. Kabirul *et al.* (2013) observed that the average gestation length of Black Bengal goat at group A and group B were 149.0±2.00 and 148.0±3.50 days which were higher than present study. Hossain *et al.* (2004) found gestation length of Black Bengal goat were 148.0±0.91, 147.0±0.91 and 148.0±0.91 days at 1st, 2nd and 3rd parity which were higher than present study. Chowdhury *et al.* (2001) reported gestation length al low and high feeding system were 44.0±1.75 and 146.0±2.53 days respectively which are slightly higher than this study.
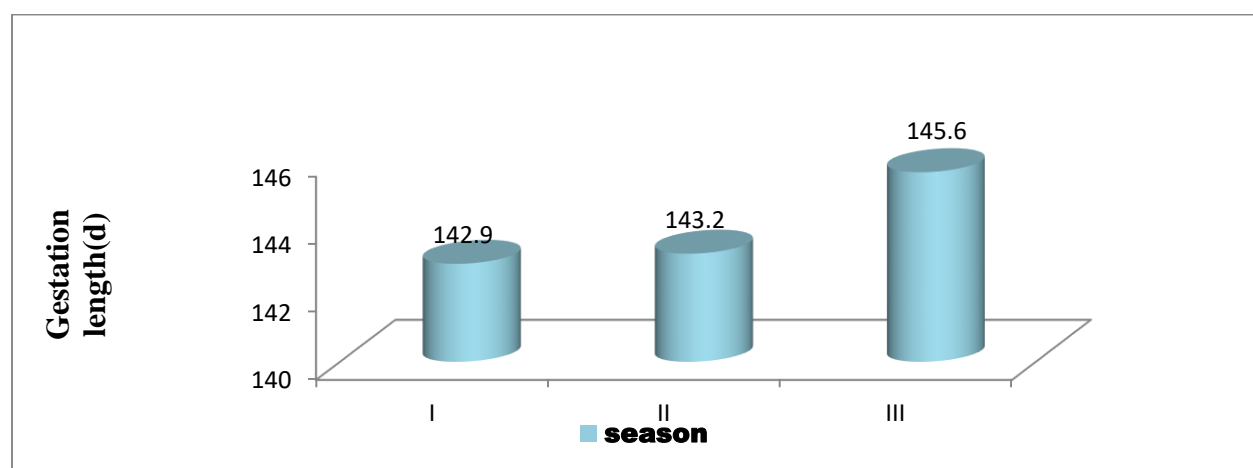
Figure 3. Effect of season on gestation length of Black Bengal goats

4.3 Effect of season and parity on litter size

The effect of season and parity on litter size of Black Bengal goat is presented in Table 1, Table 2, and Figure 4. The average litter size of Black Bengal goat at season I, season II and season III were 2.09±0.10, 2.01±0.10 and 2.07±0.09 respectively in the present study. In this actual findings the average litter size of Black Bengal goat at 1st, 2nd, 3rd and 4th parity were 1.53±0.09, 1.83±0.08, 1.97±0.09 and 2.17±0.15 respectively. There is no significant effect of season on litter size of Black Bengal goat. But there is highly significant (p<0.01) effect of parity on litter size of Black Bengal goat. Highest litter size found in 4th parity. Litter size increases with the parity number.

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There is positive correlation between litter size and parity number. These result of Islam *et al.* (2009), Hassan *et al.* (2007), Akter *et al.* and (2006) Hossain *et al.* (2004) almost similar with this findings. Jahid *et al.* (2015) studied the litter size of Black Bengal goat at 1st, 2nd and 3rd parity at semi-intensive condition were 1.06±0.13, 1.76±0.12 and 1.96±0.12 respectively which were lower than present study. Lower litter size observed by Islam *et al.* (2002) may be due to parity, age, genetic and environmental factors. Haque *et al.* (2013) also observed the litter size of Black Bengal goat at season I, season II and season III were 1.47±0.08, 1.52±0.14 and 1.54±0.10 respectively which is lower than the present study. Chowdhury *et al.* (2002) observed the litter size at 1st, 2nd, 3rd and 4th parity of Black Bengal goat were 1.29, 1.71, 1.87 and 2.17 respectively which were also lower than this present study. Faruque *et al.* (2010) reported the litter size at season 1, season 2 and season 3 of Black Bengal goat were 1.37±0.1, 1.0±0.23 and 1.0±0.17 respectively which were also lower than the present findings. The litter size of Black Bengal goat in this study were higher than these result of Paul *et al.* (2014), Haque *et al.* (2013), and Chowdhury *et al.* (2009).
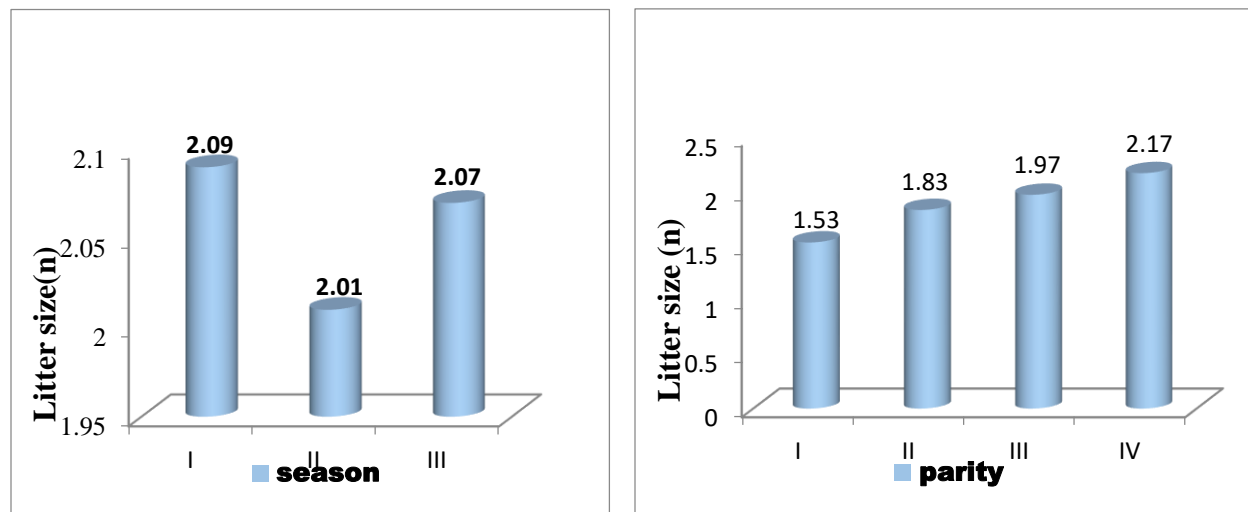
Figure 4. Effect of season and parity on litter size of Black Bengal goats

4.4 Effect of season on age at puberty

Average age at puberty of Back Bengal goat in this experiment at season I, season II and season III were 185.45±3.03, 182.72±3.10 and 183.95±2.76 days respectively. The effect of season on age at puberty of Black Bengal goat is presented in Table 1and Figure 5. There is no significant effect of season on age at puberty of Black Bengal goat. Hassan *et al.* (2007) found average age at puberty of Black Bengal goat was 222.5±5.5 days which is higher than this result. Jalil *et al.* (2016)

observed the average age at puberty of Black Bengal goat was 182.7±7.25 days which is similar with this research findings. The age at puberty in this findings is higher than these study of Hasan *et al.* (2014), Faruque *et al.* (2010) and Hossain *et al.* (2004). Halim *et al.* (2011) observed the age at puberty of Black Bengal goat 234.16±6.54 days which is higher than present study.
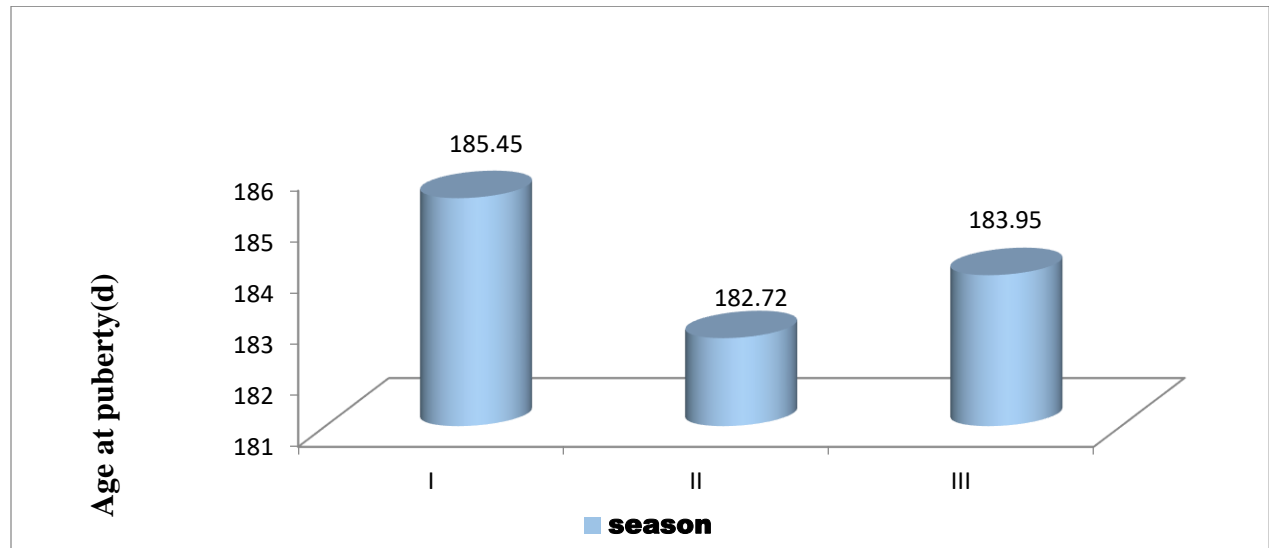
Figure 5. Effect of season on age at puberty of Black Bengal goats

4.5 Effect of season on age at first kidding

In this present study average age at first kidding of Black Bengal goat at season I, season II and season III were 369.82±1.76, 371.92±1.80 and 366.02±1.60 days respectively. The effect of season on age at first kidding is presented in Table 1 and Figure 6. There is a significance (p<0.05) effect of season on age at first kidding of Black Bengal goat. But statistically significant differences is present season I from the season II and season III. Age at first kidding of Black Bengal goat at season III that means in winter season lower (366.02 days) than the season I (369.82 days) and season II (371.92 days). Halim *et al.* (2011) observed average age at first kidding of Black Bengal goat 316.83 days which is lower than present result. Faruque *et al.* (2010) reported the age at first kidding at season 1 (summer), season 2 (rainy) and season 3 (winter) were 331.41±24.63, 368.33±44.07 and 365.4±34.14 days respectively which is almost similar with this result. Hossain *et al.* (2004) reported the age at first kidding of Black Bengal goat was 401.50 days which is higher than this study findings. Jahid *et al.* (2015) reported that the age at first kidding of Black Bengal goat at season 1, season 2 and season 3 was 331.41, 368.0 and 365.4 days respectively which also

similar with present findings. Hassan *et al.* (2007) observed age at first kidding of Black Bengal goat was 360.5±10.0 days which was also almost similar with the present study. Haque *et al*. (2013) reported the age at first kidding of Black Bengal goat was 465.6±12.45 days which is higher than the current study.
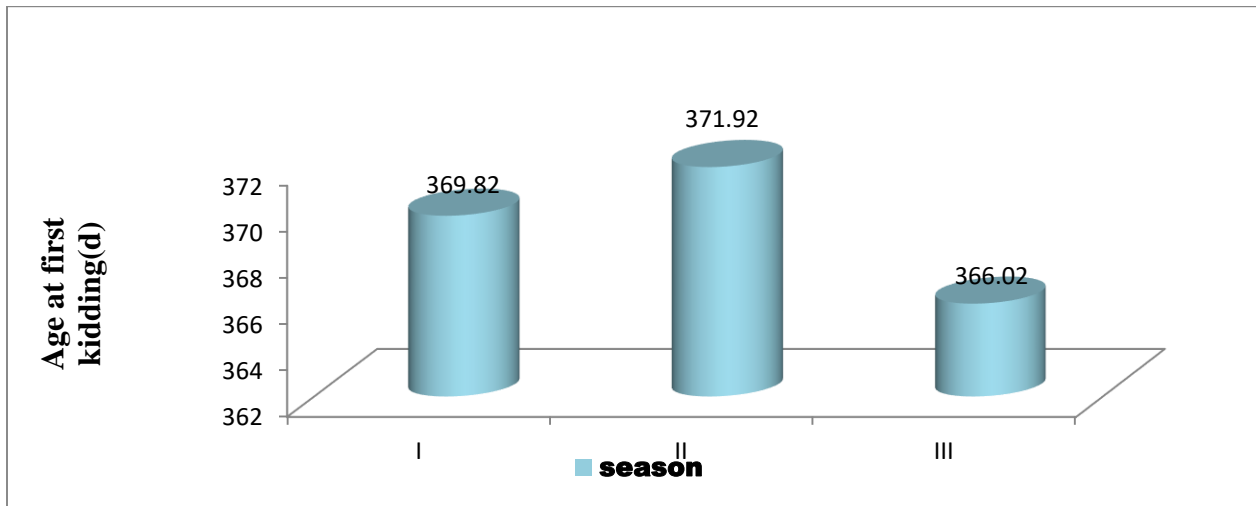
Figure 6. Effect of season on age at first kidding of Black Bengal goats

4.6 Effect of season on weight at first kidding

Table 1and Figure 7 represent the effect of season on weight at first kidding of Black Bengal goat. The average weight of first kidding of Black Bengal goat at season I, season II and season III were 9.34±0.156, 9.33±0.16 and 7.79±0.14 kg respectively. There is significant ($p<0.05$) effect of season on weight at first kidding of Black Bengal goat. Weight at first kidding has statistically significant differences on effect of season I and season II with season III. But there is no differences between season I and season II. Highest weight at first kidding on season this result (9.34 kg) than season II (9.33 kg) and season III (7.79kg). Faruque *et al.* (2010) observed the weight at first kidding at season 1, season 2 and season 3 were 18.27±0.53, 15.16±0.96 and 16.32±0.74 kg respectively which were higher than this findings. Haque *et al.* (2013) found the average body weight at first kidding was 13.22 kg which was also higher than the present result. Hasan *et al.* (2014) observed the weight at first kidding of Black Bengal goat at semi-intensive and extensive condition were respectively 18.3 and 16.2 kg which were also higher than the impending findings. Jahid *et al*. (2015) also found the average weight at first kidding of Black Bengal goat at season 1,

season 2 and season 3 were 18.27, 15.16 and 16.32 kg respectively which were higher than the present study.
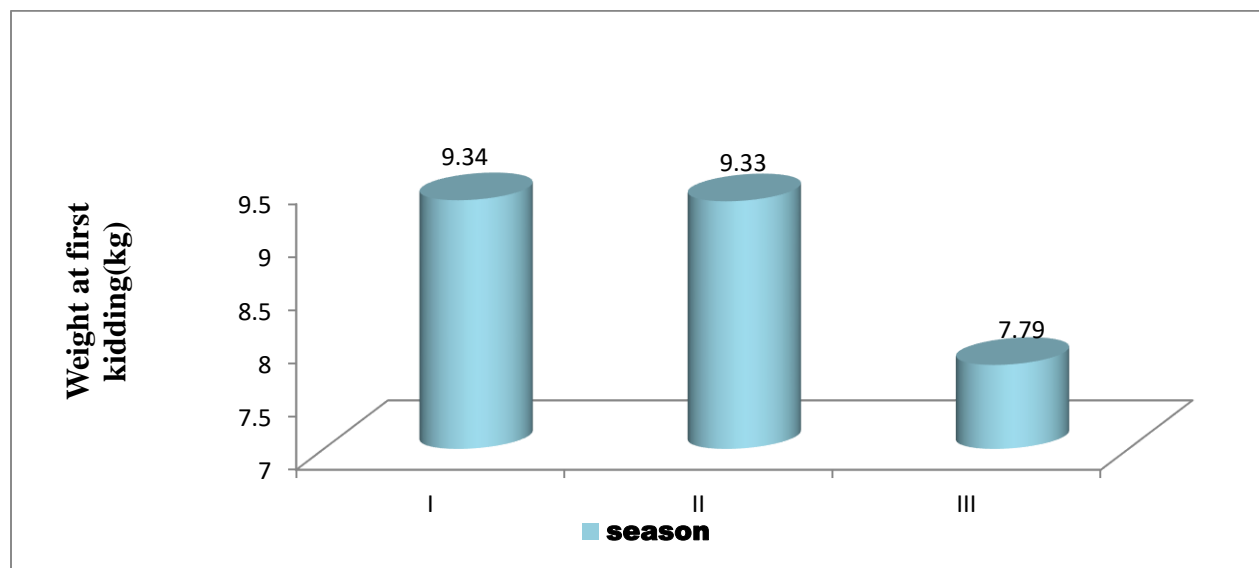
Figure 7. Effect of season on weight at first kidding of Black Bengal goats

4.7 Effect of season on lactation length

The effect of season on lactation length of Black Bengal goat is given Table 1and Figure 8. There is no significant effect of season on lactation length of Black Bengal goat. The average lactation length of Black Bengal goat at season I, season II and season III were 72.8±0.54, 73.2±0.55 and 73.07±0.49 days respectively. Hossain *et al.* (2004) observed the lactation length of Black Bengal goat at 1st, 2nd and 3rd parity were 61.56, 66.4 and 67.0 days which were lower than current study. In this present findings the average lactation length of Black Bengal goat higher than these result of Hassan *et al.* (2007), Faruque *et al.* (2010) and Halim *et al.* (2011). Jalil *et al.* (2016) found the average lactation length was 61.5 days which was also lower than the present findings. Islam et al. (2009) reported that the lactation length of Black Bengal goat at IP and SP system were 95.33 and 84.66 days respectively which were higher than the existent study. Armin akter found the lactation length of Black Bengal goat at Birganj, Sadar and Birol upazila was 121.67, 88.33 and 111.67 days respectively which were higher than the present study.
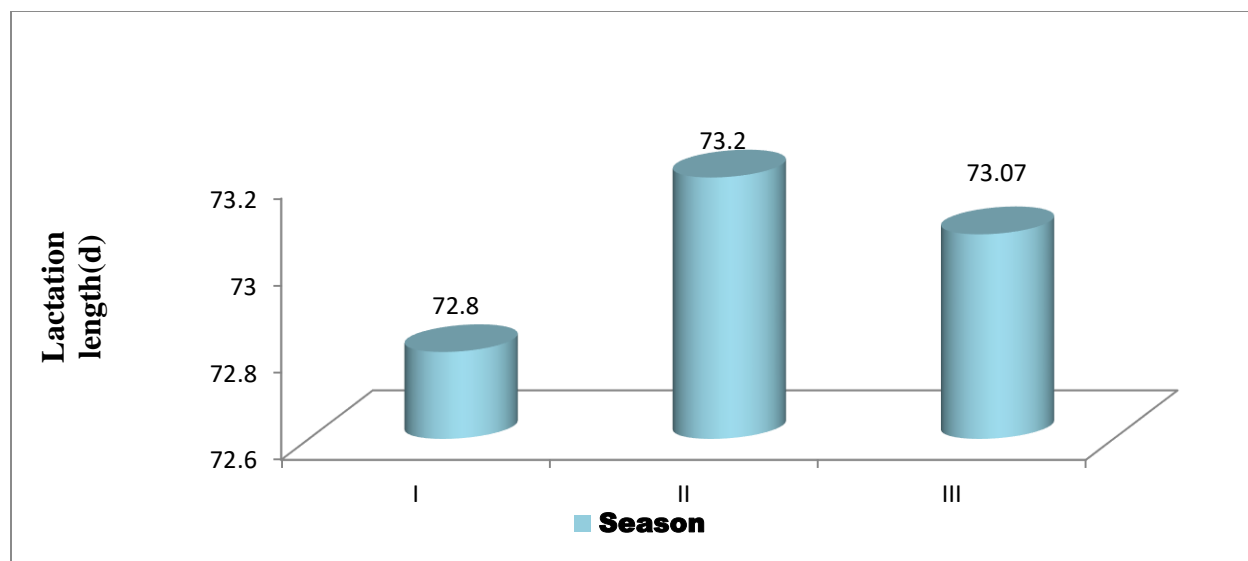
Figure 8. Effect of season on lactation length of Black Bengal goats

4.8 Effect of season and parity on kidding interval

Average kidding interval of Black Bengal goat at season I, season II and season III were 186.97±0.82, 184.3±0.84 and 190.48±0.75 days respectively. The effect of season on kidding interval and parity are presented Table 1, Table 2 and Figure 9. There is highly significant effect (p<0.01) of season on kidding interval of Black Bengal goat. Lowest kidding interval found in season II (184.3 days) than season I (186.97 days) and season III (190.48 days). Kidding interval of Black Bengal goat of my findings almost similar with these result of Gous *et al.* (2016), Jahid *et al*. (2015), Hasan *et al.* (2014), Hassan *et al*. (2007), Hossain *et al*. (2004) and Chowdhury *et al*. (2002). Akter *et al.* (2006) found the average kidding interval at selected and controlled group were 233.47 and 274.60 days respectively which were higher than the present results. Hassan *et al.* (2007) observed the kidding interval of Black Bengal goat was 179.0 days which was lower than present study. Halim *et al*. (2011) observed the kidding interval was 252.45 days of Black Bengal goat which was higher than the study. Haque *et al.* (2013) reported the kidding interval at winter, summer and rainy season of black Bengal goat were 288.6, 260.4 and 270.3 days which were higher than the study. Jalil *et al.* (2016) reported that the average kidding interval of Black Bengal goat 188.01 days which is almost similar with the present findings. Faruque *et al*. (2010)

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showed the average kidding interval of Black Bengal goat was 181.23±4.55 days which is lower than this study.

Average kidding interval of Black Bengal goat at first, second, third and fourth parity were 187.19±0.74, 189.32±0.69, 186.13±0.79, and 184.99±1.20 days respectively. There is a significant differences between second and third parity but no differences present in between third and fourth parity. Lowest kidding interval found in fourth parity(184.99 days) than third parity (186.13 days), first parity(187.19 days) and second parity(189.32 days). The parameters of this findings are almost similar with the result of Gous *et al.* (2016), Jalil *et al.* (2016), Faruque *et al.* (2010), and Hossain *et al.* (2004). Haque *et al.* (2013) and Chowdhury *et al.* (2002) found the findings were 240.6 and 285.9 days respectively in second and third parity which were higher than present findings.
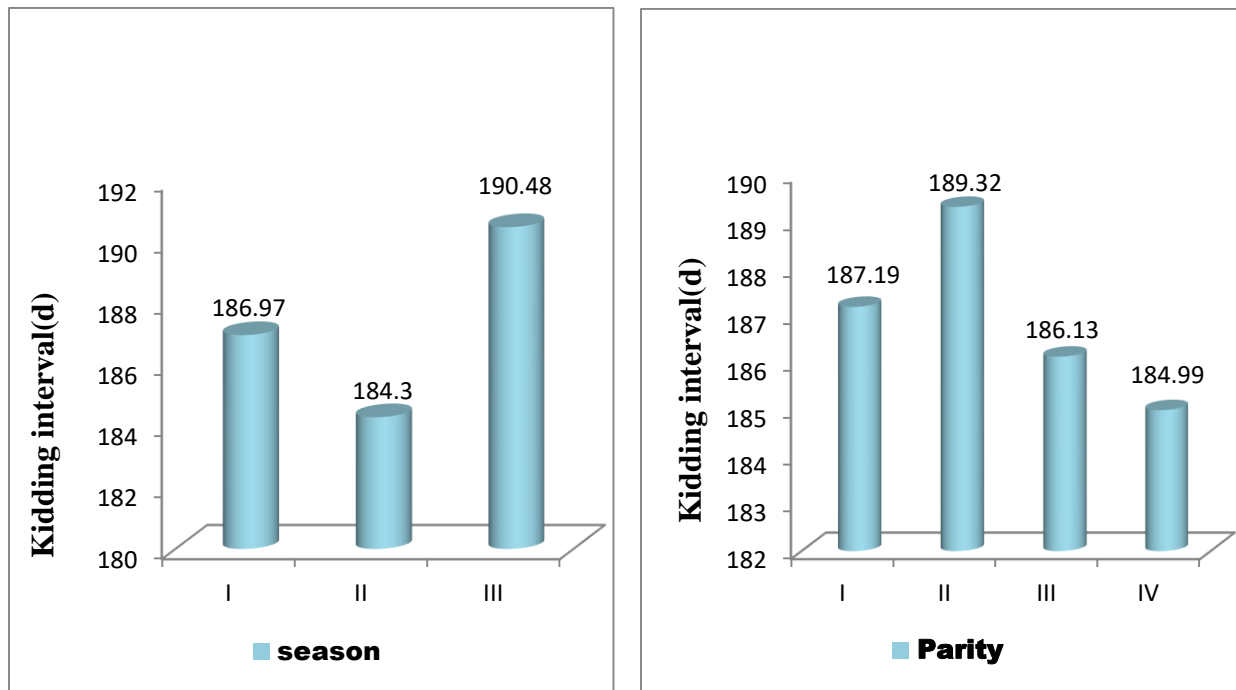
Figure 9. Effect of season and parity on kidding interval of Black Bengal goats

4.9 Effect of season and parity on kid mortality rate

The effect season and parity on kid mortality rate of black Bengal goat is presented Table 1, Table 2 and Figure 10. There is no significant effect of season and parity on kid mortality rate of Black Bengal goat. The average kid mortality rate of Black Bengal goat at season I, season II and season

III were 16.66±6.39, 18.75±6.54 and 24.79±5.82 % respectively. The effect of season and parity have not statistically significant effect on kid mortality rate of Black Bengal goat.

The average kid mortality rate at 1st, 2nd, 3rd and 4th parity were 17.36±5.75, 20.60±5.40, 20.64±6.14 and 14.08±9.31 %. Kid mortality is a major factor to determine productivity of a herd. One possible reason in the extensive system stress increase which increase disease and finally mortality rate. By providing better management can be reduced the rate of kid mortality. Chowdhury *et al.* (2002) found the kid mortality rate of Black Bengal goat at 1st, 2nd, 3rd and 4th parity were 50%, 25%, 26.76% and 7.69% respectively which is higher than this study findings. The kid mortality rate of Black Bengal goat in this study almost similar with these result of Jahid *et al.* (2015), Paul *et al.* (2014), Islam *et al.* (2009) and Hossain *et al.* (2004). Faruque *et al.* (2016) found the average kid mortality rate was 12.58% which lower than present study. Kabirul *et al.* (2013) reported the kid mortality rate of Black Bengal goat at group A and group B were 24.50% and 27.62% respectively which were also higher than the study.
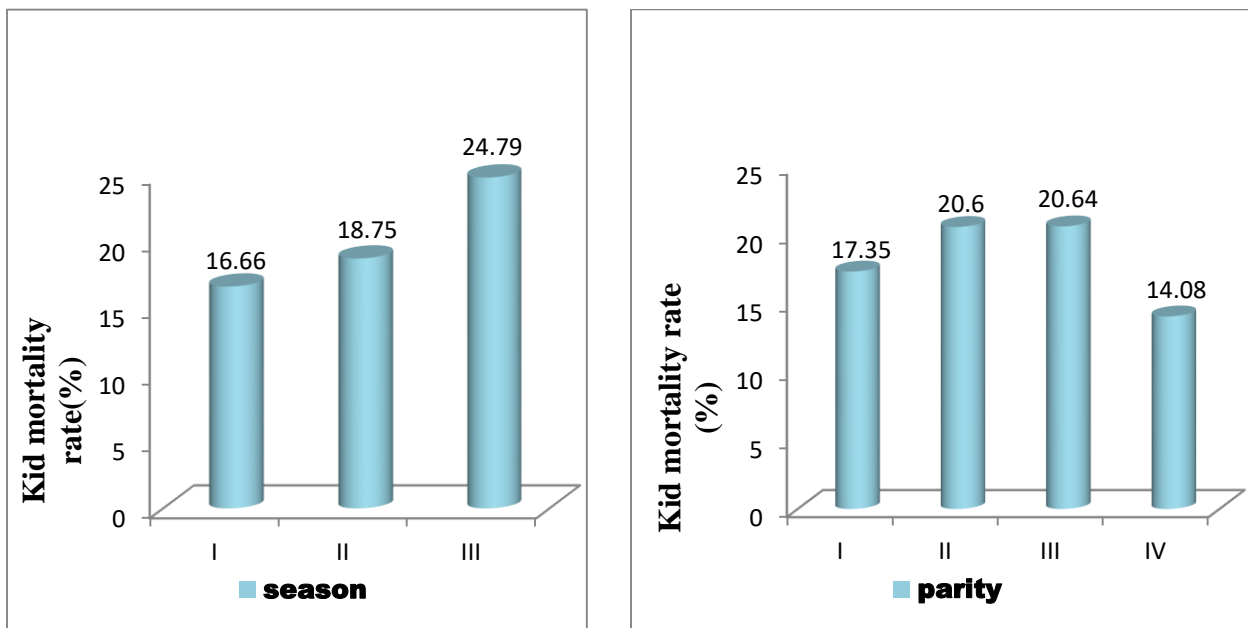
Figure 10. Effect of season and parity on kid mortality rate of Black Bengal goats

CHAPTER 5

SUMMARY AND CONCLUSION

This study was investigated at different places of Dinajpur district namely Kornai, Noshipur, Bangibachar hat, Vagobanpur. At Northern part of Bangladesh Dinajpur district is situated. Dinajpur district is the part of the Rangpur Division. The objectives of this study to estimate the reproductive performance of Black Bengal goat based on effect of season in village condition.

In village condition the birth weight of Black Bengal kids were 0.94 ± 0.02, 1.05 ± 0.02 and 0.90 ± 0.02 kg respectively in season I, season II and season III where season I (summer), season II (rainy) and season III (winter). The highest birth weight (1.05 ± 0.024 kg) was observed at season II than season I (0.94 ± 0.023 kg) and season III (0.90 ± 0.021 kg). The effect of season ($P<0.05$) significant on birth weight of kid of Black Bengal goat. The birth weight of Black Bengal kids at 1st, 2nd, 3rd and 4th parity were 0.95 ± 0.02, 0.96 ± 0.01, 0.97 ± 0.02, 0.95 ± 0.03 kg respectively. There is no significant effect of parity on birth weight of Black Bengal kids.

Average gestation length of Black Bengal goat in my study at season I, season II and season III were 142.9 ± 0.52, 143.2 ± 0.53 and 145.6 ± 0.48 days respectively. There is significant ($p<0.05$) effect of season on gestation length of Black Bengal goat. Highest gestation length observed in season III (145.6 ± 0.48 days) than season II (143.2 ± 0.53 days) and season II (142.9 ± 0.52 days).

The average litter size of Black Bengal goat at season I, season II and season III were 2.09 ± 0.10, 2.01 ± 0.10 and 2.07 ± 0.09 respectively in the present study. In this findings the average litter size of Black Bengal goat at 1st, 2nd, 3rd and 4th parity were 1.53 ± 0.09, 1.83 ± 0.08, 1.97 ± 0.09 and 2.17 ± 0.15 respectively. There is no significant effect of season on litter size of Black Bengal goat. But there is highly significant ($p<0.01$) effect of parity on litter size of Black Bengal goat. Highest litter size found in 4th parity. Litter size increases with the parity number. There is positive correlation between litter size and parity number.

Average age at puberty of Back Bengal goat in this study at season I, season II and season III was 185.45 ± 3.03, 182.72 ± 3.10 and 183.95 ± 2.76 days respectively. There is no significant effect of season on age at puberty of Black Bengal goat.

In this present study average age at first kidding of Black Bengal goat at season I, season II and season III were 369.82 ± 1.76, 371.92 ± 1.80 and 366.02 ± 1.60 days respectively. There is a

significant (p<0.05) effect of season on age at first kidding of Black Bengal goat. Highest age at first kidding of Black Bengal goat in village found in season II (371.92±1.80) days than season III (366.02±1.60) and season I (369.82±1.76).

The average weight of first kidding of Black Bengal goat at season I, season II and season III was 9.34±0.16, 9.33±0.16 and 7.79±0.14 kg respectively. There is highly significant (p<0.01) effect of season on weight at first kidding of Black Bengal goat. Highest weight at first kidding on season I (9.34 kg) than season II (9.33 kg) and season III (7.79kg).

There is no significant effect of season on lactation length of Black Bengal goat. The average lactation length of Black Bengal goat at season I, season II and season III were respectively 72.8±0.54, 73.2±0.55 and 73.07±0.49 days. Highest lactation length found in season II.

Average kidding interval of Black Bengal goat at season I, season II and season III were 186.97±0.82, 184.3±0.84 and 190.48±0.75 days respectively. The effect of season found on the kidding interval of Black Bengal goat. There is highly significant (p<0.01) of season on kidding interval of Black Bengal goat. Lowest kidding interval found in season II (184.3 days) than season I (186.97 days) and season III (190.48 days). Average kidding interval of Black Bengal goat at first, second, third and fourth parity were 187.19±0.74, 189.32±0.69, 186.13±0.79, and 184.99±1.20 days respectively. There is a significant differences between second and third parity but no differences present in between third and fourth parity. Lowest kidding interval found in fourth parity (184.99 days) than third parity (186.13 days), first parity (187.19 days) and second parity (189.32 days).

The effect season and parity on kid mortality rate of Black Bengal goat studied in this experiment. There is no significant effect of season and parity on kidding mortality rate of Black Bengal goat. The average kid mortality rate of Black Bengal goat at season I, season II and season III were 16.66±6.39, 18.75±6.54 and 24.79±5.82 % respectively. The average kidding mortality rate at 1st, 2nd, 3rd and 4th parity were 17.36±5.75, 20.60±5.40, and 20.64±6.14 and 14.09±9.31 %. Kid mortality is a major factor to determine productivity of a herd.

From this experiment it can be concluded that better reproductive performance found in rainy season because the birth weight of kid, age at puberty, lactation length, kidding interval was better

than other season. The reproductive performance was excellent in fourth parity because litter size, kidding interval, kid mortality rate were better than other parity.

Recommendation:

From the above study the following recommendations were made:

The effect of season on reproductive performance of Black Bengal goat in Dinajpur District studied in this research work. It is suggested that reproductive traits having low heritability which influenced the genetic quality of goat. Both genetic and non-genetic determinant responsible for the reproduction performances of goat. Phenotypic variation in economic traits occurs due to environmental factors. It is recommended that by providing proper management and care we can get better performances of reproductive parameters of Black Bengal goat in village condition. Adequate nutritional status and environmental practices demonstrate potential genetic merit by reducing the effect of season on regarding reproduction performances of Black Bengal goat.

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Appendix 1:

Questionnaire on effect of season on reproductive performance of Black Bengal goat in Dinajpur district

Name of the owner			
Name of the area/village			
Occupation			
Types and source of breed		Black Bengal	Cross
Number of goat		Doe	Buck
Rearing system			
Types of service	Natural	Artificial	
Parameters	Season I	Season II	Season III
Birth weight ok kids(kg)			
Gestation period(d)			
Litter size(n)			
Age at puberty(d)			
Age at first kidding(d)			
Weight at first kidding(kg)			
Lactation length(d)			
Kidding interval(d)			
Kid mortality rate (%)			

Appendix 2:

Analysis of variance of the effect of season on birth weight of kids of Black Bengal goat

Source	Degrees of freedom (df)	Sum of squares	Mean square	F value	Pr. > F
Model	7	0.49	0.07	5.11	0.0001
Error	113	1.56	0.01		
Corrected Total	120	2.06			

$$R^2=0.24$$

$$CV=12.17$$

Analysis of variance of the effect of season on gestation length of Black Bengal goat

Source	Degrees of freedom (df)	Sum of squares	Mean square	F value	Pr. > F
Model	7	201.04	28.72	4.02	0.0006
Error	113	808.12	7.15		
Corrected Total	120	1009.16			

$$R^2=0.19$$

$$CV=12.17$$

Analysis of variance of the effect of season on litter size of Black Bengal goat

Source	Degrees of freedom (df)	Sum of squares	Mean square	F value	Pr. > F
Model	7	9.06	1.29	4.63	0.0001
Error	113	31.55	0.28		
Corrected Total	120	40.61			

$$R^2=0.22$$

$$CV=28.42$$

Analysis of variance of the effect of season on age at puberty of Black Bengal goat

Source	Degrees of freedom (df)	Sum of squares	Mean square	F value	Pr. > F
Model	7	2637.62	376.80	1.58	0.1493
Error	113	26999.18	238.93		
Corrected Total	120	29636.79			

$$R^2=0.08$$

$$CV=8.48$$

Analysis of variance of the effect of season on age at first kidding of Black Bengal goat

Source	Degrees of freedom (df)	Sum of squares	Mean square	F value	Pr. > F
Model	7	3046.93	435.28	5.67	0.0001
Error	113	8668.59	76.71		
Corrected Total	120	11715.52			

$$R^2=0.26$$

$$CV=2.42$$

Analysis of variance of the effect of season on age at weight at first kidding of Black Bengal goat

Source	Degrees of freedom (df)	Sum of squares	Mean square	F value	Pr. > F
Model	7	66.05	9.44	14.91	0.0001
Error	113	71.52	0.63		
Corrected Total	120	137.57			

$$R^2=0.48$$

$$CV=9.01$$

Analysis of variance of the effect of season on lactation length of Black Bengal goat

Source	Degrees of freedom (df)	Sum of squares	Mean square	F value	Pr. > F
Model	7	43.19	6.17	0.81	0.5830
Error	113	863.73	7.64		
Corrected Total	120	906.93			

$$R^2=0.05$$

$$CV=3.78$$

Analysis of variance of the effect of season on kidding interval of Black Bengal goat

Source	Degrees of freedom (df)	Sum of squares	Mean square	F value	Pr. > F
Model	7	1221.89	174.56	10.48	0.0001
Error	113	1882.56	16.66		
Corrected Total	120	3104.45			

$$R^2=0.43$$

$$CV=2.18$$

Analysis of variance of the effect of season on kid mortality rate of Black Bengal goat

Source	Degrees of freedom (df)	Sum of squares	Mean square	F value	Pr. > F
Model	7	3327.66	475.38	0.45	0.8712
Error	113	120514.70	1066.50		
Corrected Total	120	123842.36			

$$R^2=0.03$$

$$CV=162.43$$

Analysis of variance of the effect of parity on birth weight of kids of Black Bengal goat

Source	Degrees of freedom (df)	Sum of squares	Mean square	F value	Pr. > F
Model	7	0.45	0.06	4.57	0.0002
Error	113	1.60	0.01		
Corrected Total	120	2.05			

$R^2 = 0.22$

CV=12.33

Analysis of variance of the effect of parity on litter size of Black Bengal goat

Source	Degrees of freedom (df)	Sum of squares	Mean square	F value	Pr. > F
Model	7	8.95	1.28	4.56	0.0002
Error	113	31.66	0.28		
Corrected Total	120	40.61			

$R^2 = 0.22$

CV=28.46

Analysis of variance of the effect of parity on kidding interval of Black Bengal goat

Source	Degrees of freedom (df)	Sum of squares	Mean square	F value	Pr. > F
Model	7	1104.86	157.84	8.92	0.0001
Error	113	1999.56	17.69		
Corrected Total	120	3104.45			

$R^2 = 0.43$

CV=2.18

Analysis of variance of the effect of parity on kid mortality rate of Black Bengal goat

Source	Degrees of freedom (df)	Sum of squares	Mean square	F value	Pr. > F
Model	7	3978.15	568.31	0.54	0.8058
Error	113	119864.20	1060.75		
Corrected Total	120	123842.36			

R^2=0.03

CV=161.95