

Study on the growth from birth to weaning of Black Bengal goat by fitting exponential model



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Study on the growth from birth to weaning of Black Bengal goat by fitting exponential model



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Abstract

Background: Mathematical models were used to predict values from recorded data and compare with the actual calculation. There were no complete data for taking breeding and nutritional study of BBG in both intensive and semi-intensive conditions. Therefore the research was conducted to determine the growth rate from birth to weaning and fitting exponential model of BBG data in both semi-intensive and extensive systems from January 2022 to July 2022.

Method: Data were collected from 9 male goats and 10 female goats in two semi-intensive farms and 5 male goats and 3 female goats from one intensive farm under different feeding regimes. The experimental males and females had their initial and subsequent live weight measured at fortnightly intervals until they reached weaning age. The weaning age happened to be within 4 months in average and was affected by feeding habit and rearing type. The variance of weight gains of same breed under two different farm types during birth to weaning period were studied. The data were fitted in Exponential model and was compared the result with actual value.

Result: The average birth weight of Black Bengal goat kids from semi-intensive was slightly higher than intensive farm. Among farms, the female goats' birth weights were lower than male goats. The weight gain of both male and female goats was positive with age.

Key words: Black Bengal goat, birth weight, weaning weight, semi-intensive, intensive farm

1. Introduction

Goats have evolved to a wide range of difficult environments, and as a result, they play an important role in providing nutrition of peoples through meat and milk, food security, self-employment, and socio-economic development to their owners in many low-income populations around the world (Monteiro et al., 2017). Bangladesh has the fourth largest population of goats in Asia, with approximately 26.7 million heads (DLS, 2022). The Black Bengal goats made up about 90% of the goat population, 8–9% Jamunapari, and the remainder other exotic breeds (Sirohi, Beetal) and their crosses (Siddiki et al. 2019). Goats become a vast range of colors, body sizes, and weights depending on where they are found. Black Bengal goats have a variety of coat colors, including black, brown, and white, as well as any proportion of those colors (Habib et al. 2019). Approximately 98 percent of goats in the communities are owned by tiny, marginal, and landless farmers. Black Bengal goats graze on barren and roadside area with grass and few homemade supplies like rice gruel, various tree leaves like jackfruit leaves, mango leaves, and so on. That's why it is considered a productive tool for supporting the financial crisis of the rural families.

Goats' birth weight and body weight are key factors to consider its productivity in terms of meat. The animal's future productive and reproductive performance is influenced by a positive link between birth weight and rate of growth, age at maturity, and mature body weight, which can have an impact on the animal's future reproductive and productive performance. The growth rate of Black Bengal goats was discovered as one of the most significant restrictions directly related to increase kid mortality, resulting in a reduction in total mortality production of biomass (Hussain et al., 2012)

It is worth mentioning that goat production system in tropical countries like Bangladesh includes extensive, semi-intensive, tethering, and intensive and integration into crop. Semi-intensive rearing represents in between extensive and intensive rearing system, and largely depends on the availability of land (Hasan et al, 2014). Semi-intensive system is popular where labor is limited for intensive agriculture. The greatest advantages of this method is effective conversion of crop residues, control of goats and little damage of this method is effective conversion of crop residues, control of goats and little damage to the environment, and cheap labor for maintenance of goat.

On the other side, Intensive farm system requires labor and accurate knowledge of production. This housing system is expensive to construct and may only recommended in commercial settings with high output.

Mathematical models are devised to describe a phenomenon of interest. This is usually done through equation(s) that have been derived from experimental data that capture the phenomenon to some degree. In practice, models are not perfect descriptors and may only accurately describe a phenomenon under a restricted set of conditions. There are several mathematical models such as linear regression, multiple regression, logistic, and non-linear models were used to predict the growth of goat because mathematical models can be used by predicting the values from imperfect or partial data. For example, exponential growth models only accurately describe population growth under ideal conditions. Exponential functions are commonly used in the biological sciences to model the amount of a particular quantity. Graphs of experimental data are usually drawn with one variable on the x-axis and the quantity on the y-axis. (The Biology Project, 2013)

In Bangladesh the data of live weight and live weight gain and milk yield of goats are limited. Therefore, the objective of this study is to observe growth rate of Black Bengal goat in two different type of farming conditions and compare the actual with the predicted value (estimated using exponential model).

2. Materials and Methods

The study took place broadly in two Upazilla, Boalkhali and Hathazari under the district of Chattogram of Bangladesh during February 2022 to June 2022.

2.1. The experimental animals:

27 Black Bengal goats' weights were collected from different parts of Chattogram from the age of birth to weaning of which 14 were male goats and 13 were female goats.

2.2. Management of Goat:

In this study, the goat samples are taken from both intensive and semi-intensive farming conditions.

2.3. Intensive farming:

In Intensive system, Goat are reared in confined and supplied them balanced ration, all health care and proper management;

The sheds were built using bamboo slice to create a foundation about 4ft up from the ground and wood planks to make floor and bamboo fence around it. The planks were placed with minimum spaces between them to dropout the feces and wastes in the ground. The house is well-ventilated with ample floor space. There is no separate housing for buck and doe and the kids are placed in jute sacks up to several days of age.

Concentrate feed was supplied three times a day with adlibitum water. Concentrate mixture includes wheat bran (*Triticum aestivum L.*), soybean (*Glycine max*), salt etc. Roughage sources were mostly Napier grass (*Pennisetum purpureum*), Jackfruit (*Artocarpus heterophyllus*) leaves, Matikalai (*Vigna mungo*) tree leaves, roadside grass etc.

2.4. Semi-intensive farming:

In semi-intensive system, goats are kept partially in confinement and supplemented them balanced ration and all health care, they are also allowed to scavenge in the homestead or in the fence during day time.

There are two different farms sample taken in this study. The shed is 1ft high from the ground with wooden planked floor. There is minimum space between the planks. The wall is made of bamboo fence with windows for enough ventilation. The buck is housed separated from the does especially during last stage of pregnancy. The kids are allowed to stay with the dams.

The other type is made of cemented floor with rice straw and jute sacks spread on the floor. The house has tin shed roof with tin fence around it.

Goats were given 6 to 7 hours of daily grazing and exercise. Concentrate feed were supplied in the afternoon including rice bran, wheat bran, soybean meal, motor bran etc. Besides during scarce period, chopped grasses are supplied. The goats have ad libitum water supply.

2.5. Reproduction:

The intensive farm goats have reproduced by natural mating as there is no separation between buck and does. The semi-intensive farms have both natural and AI breeding system.

2.5. Study of live weight and live weight gain:

Data were collected from 27 Black Bengal goats of 3 different farms in Boalkhali and Hathazari Upazilla. There were 9 male goats and 10 female goats in two semi-intensive farms in Boalkhali and Hathazari upazilla and 5 male goats and 3 female goats in one intensive farm in Boalkhali upazilla which weights were taken from birth to weaning age. The birth weight was taken within 18hrs after birth using a top loading balance. The consequent weight was taken at 15days intervals up to the weaning period. However, the data collection is less in quantity due to the fewer pregnant Black Bengal goat population.

2.6. Fitting the exponential regression equation:

To study the predicted growth of kids from birth to age at weaning, exponential model was fitted with the actual bi weekly recorded data.

The exponential equation,

$$y = ae^{bx} \quad \text{-----} \quad (1)$$

Where, Y is the value of traits, a and b are the parameters that define the shape of the curve which were used to fit the observed value in the equation, x is time and e is the natural logarithms value.

2.7. Statistical analysis:

The traits which are considered in the analysis were birth weight and weaning weights of kids, subsequent body weights and average daily body weight gains, rearing regimes. The analysis of body weight gain of weaning period was done separately for male and female kids per rearing regimes. Data were analyzed using exponential equation. The main affect considered in the analysis were constant value which includes the effects of location, season, rearing conditions, and parity.

R^2 (co-efficient of determination) was obtained by fitting the exponential model. These value was used to compare the predicted value with the actual one, the higher the R^2 value indicated higher fit. The collected data were corrected and analyzed by using Microsoft Office Excel 2016.

3. Result & Discussions

3.1. The productive traits:

The actual weight of Black Bengal goat kids at birth and weaning and their constant weight gain throughout the period under intensive and semi intensive conditions are shown in Table 1.

The data were collected from two semi-intensive and one intensive farm in Boalkhali and Hathazari Upazilla, Chattogram District. The overall weight of the male kid was slightly higher than the female kids in both types of farms. The birth weight, weaning weight and weight gain of kids was higher in semi-intensive farms than the intensive farm. In semi-intensive farm, the growth rate was higher in females than the male. These can be effected by various causes like environment, feeding habit and exposure of grazing. These variables affect the growth rate of kids.

Table 1: Parameters of exponential model and the actual predicted value of traits (mean \pm Sd)

Traits	Sex	Intercept(a)	Slope(b)	R ²	Actual Value	Predicted Value
Semi-intensive farming system						
Birth weight (kg)	Male	1.198	0.023	0.36	1.33 \pm 0.12	1.25
	Female	1.124	0.004	0.013	1.14 \pm 0.02	1.13
Weaning weight (kg)	Male	5.857	0.006	0.056	5.72 \pm 0.35	5.93
	Female	5.129	0.002	0.003	5.24 \pm 0.22	5.14
Weight gain(g) from birth to weaning			Male		44	46.6
			Female		41	40.1
Intensive farming system						
Birth weight	Male	1.15	0.007	0.043	1.18 \pm 0.08	1.16
	Female	0.996	0.021	0.233	1.06 \pm 0.07	1.018
Weaning weight	Male	5.66	0.015	0.607	5.36 \pm 0.2	5.745
	Female	4.93	0.03	0.255	5.17 \pm 0.26	5.083
Weight gain(g) from birth to weaning			Male		37.32	45.85
			Female		33.67	40.65

After fitting the parameters of exponential model and prediction, the values under two farming system (intensive and semi-intensive) the model parameters, fit statistics value and predicted yield are presented in table 2.

In semi-intensive system, the intercept (a) of the exponential model for male birth weight and weaning weight were 1.198, 5.857, respectively. The slope of male birth weight and weaning weight were 0.023, 0.006. The intercept of female birth weight and weaning weight was 1.124, 5.129 respectively and slopes were 0.004, 0.002 for birth weight and weaning weight respectively. In another study, the intercept and slope of a male goat under semi-intensive system was 0.929, 0.278, 0.938, 0.259 respectively (Khan et al. 2013).

In intensive system, the intercept of male birth weight and weaning weight were 1.15, 5.66 respectively and slopes were 0.007, 0.015 for birth weight and weaning weight, respectively. The intercept of female birth weight and weaning weight were 0.996, 4.93 respectively, and slopes was 0.021, 0.03 for birth weight and weaning weight, respectively. Here, the intercept and slope of male goat were higher than female goat.

In semi-intensive system, the co-efficient of determination (R^2) of male and female of birth weight was 0.3632, 0.013, respectively and the R^2 of male and female weaning weight was 0.056, 0.003. As the R^2 value of male kid was higher than the female kid in the birth weight where the exponential model fits more with the male goat kids' value. However, in the study conducted by Khan et al. (2013), the R^2 of males was much higher which was 0.996. In the intensive system, the co-efficient of determination (R^2) of male and female goats of birth weight are 0.043, 0.233 respectively and weaning weight are 0.607, 0.255, respectively.

In this study, the exponential model of both birth and weaning weight for male kid in semi-intensive condition was more fitted with the actual value than the female kid. Under intensive condition, the exponential model of male goats' birth and weaning weight were more fitted than the female goats'. Overall, the male goat kid's model of birth was more fitted than the rest with highest R^2 value.

From the table 1, in the semi-intensive system, the average birth weights of male & female goats were 1.33kg and 1.14kg. Here, the male kids were 10% heavier than female kids. Other studies

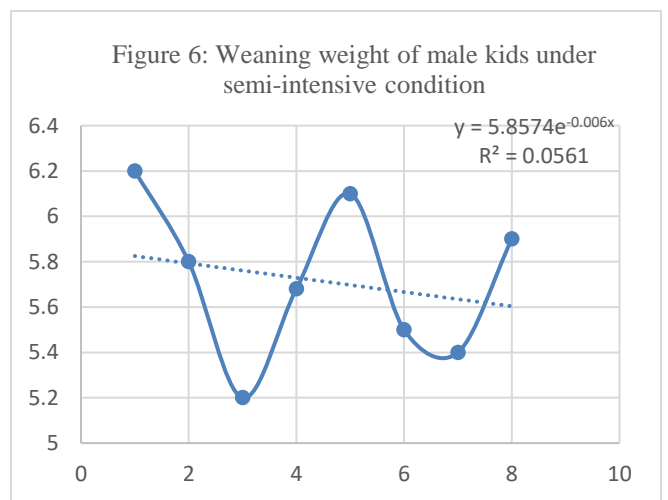
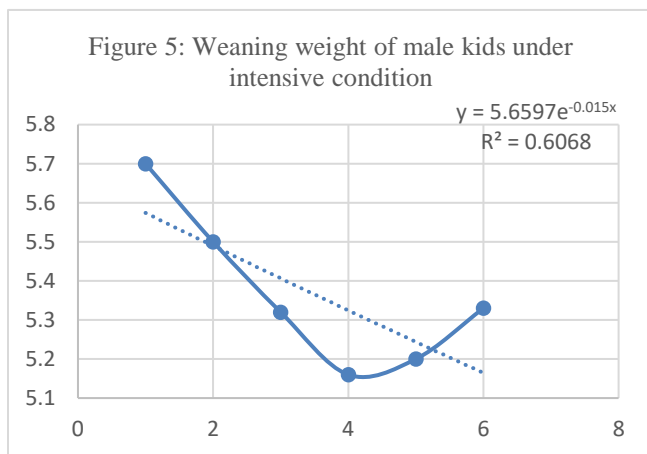
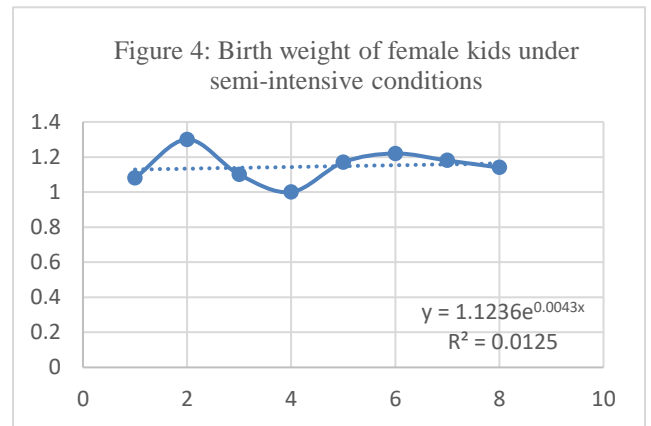
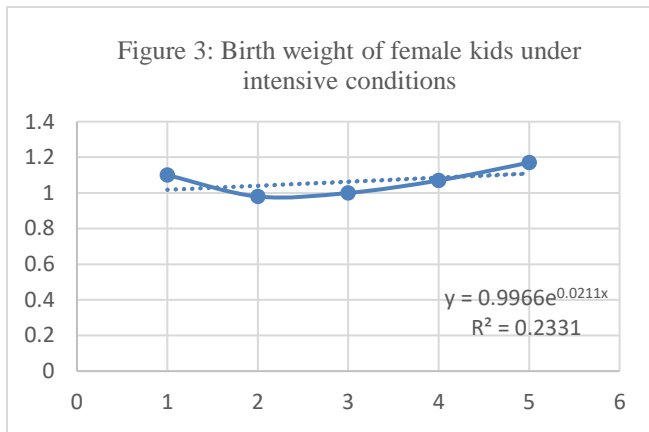
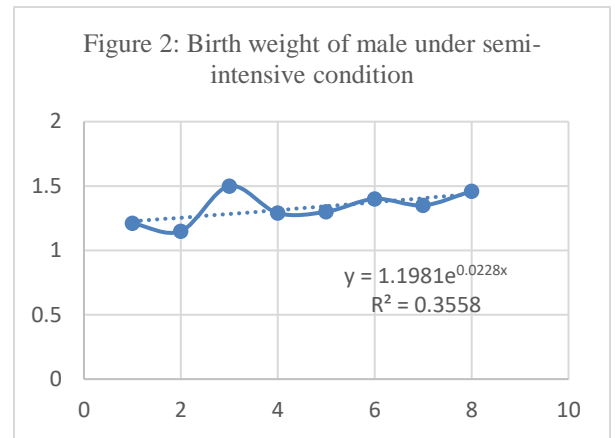
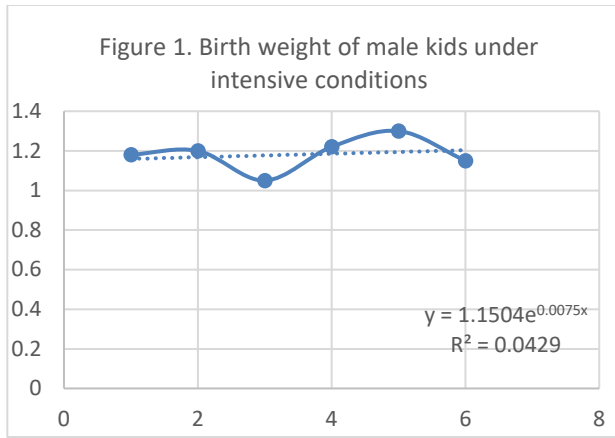
show quite similar results in the semi-intensive system, the average litter size of goats was 1.60 ± 0.06 . The male kids were about 16% heavier at birth than the female kids (Hasan et al. 2014).

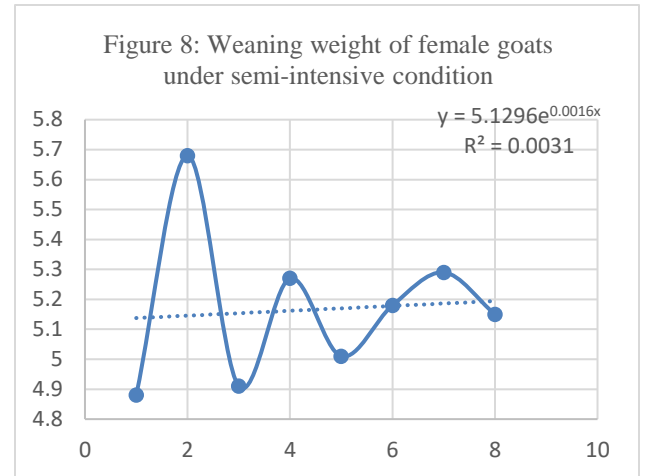
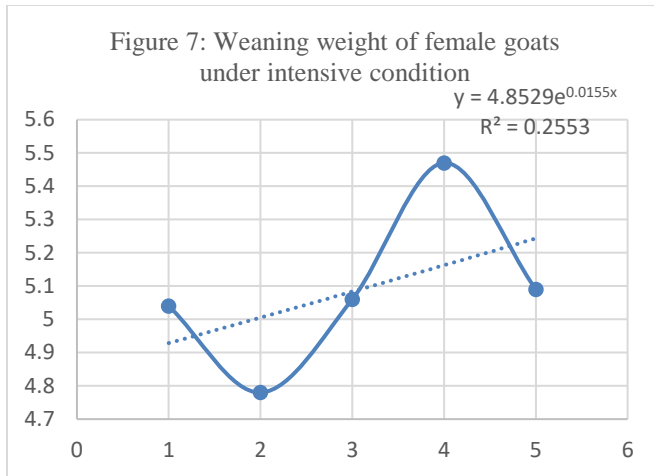
The average weaning weight of male and female under semi-intensive system 5.93kg & 5.14kg respectively. A similar result is found in another study done by Khan et al. (2013) where the average weaning weight of the goat was around 5.54kg. From the table, in an intensive system, the average weaning weight of male and female were 5.36kg and 5.08 respectively.

This variation might be due to more body weight of the does and intake of more nutritive feed. These findings were in support of Mia et al. (1993), who reported the birth weight of Black Bengal as 1.35 kg. Similar results also reported by Choudhury et al. (2012). Relatively higher birth weight in male kid was observed in Black Bengal goat, as described by Chowdhury et al. (2002) and Bobhate et al. (2003).

A daily average weight gain from birth to weaning of the male and female goat was 44g & 41g respectively under semi intensive conditions. However, the study done by Khan et al. (2013) result was lower, which was 34.29 ± 0.21 g per day. In intensive system, daily average weight gain from birth to weaning of the male and female goat was 37.32g and 33.67g, respectively. It was quite similar to the earlier study done by Bar et al. (2020), which was 34.29 ± 0.21 g per day.

Table 1, showed the actual and predicted live weight and weight gain of Black Bengal goat from birth to weaning. Here, the predicted value and the actual value didn't match in every angle, but quite proximate to one another in both farms. It indicates that the exponential model applied in the collected data fits well.





The growth curves to the weight-farm data of Black Bengal goat were fitted in the exponential model and plotted in Figure 1 to 8. In these models, the birth weights of both male and female Black Bengal goat were slightly different from one farm to another yet parallel. The shape of the growth curve of birth weights was straight to somewhat higher in the semi-intensive farm system than intensive farm. This was because of the birth weights of both male and female goat kids' were higher in semi-intensive farm. The male growth curves at weaning weight slopes downward in both intensive and semi-intensive system, whereas the growth curve of female goat at weaning weight slopes upward. However, the growth of the goats could be influenced by sex, season & management (Najari et al, 2007 and Thiruvankadan et al, 2009).

The study reveals that the productive traits of goats were influenced by the feeding regime, sex, management and farm types and also body status of them. It was found that kids' birth weight linearly grew with age unless any mismanagement or disease issue occurred. For at least one month, the kids were dependent on dam's milk supply which was interconnected with parity. The more kids that dam gives, the less chance of getting enough milk for each kid. This puts a remark on the kid's growth in the early stage.

4. Conclusion

The productive performance potentials of Black Bengal goats appear to be promising based on the findings of this study. This study showed that goats' birth weight and weaning weight can be different under different production system. The parameters were higher in the semi-intensive system in every aspect than the intensive system. So, it can be concluded that a natural grazing system with a healthy farming condition can yield a satisfactory amount of meat from black Bengal. This study can be beneficial for those who are interested to establish a goat farm in the rural areas in Bangladesh, which may help in alleviating poverty. However, a further intensive study with a large population size is recommended.

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Biography of Author

This is Fatema Jannat, the fourth child of Syed Hamza and Showkat Ara Begum, doing her graduation on Doctor of Veterinary Medicine (DVM) at Chattogram Veterinary and Animal Sciences University under Faculty of Veterinary Medicine. She passed the Secondary School Certificate Examination (SSC) in 2014 from Chattogram Govt. Girls' School, Chattogram and got GPA 5.00 and then Higher Secondary Certificate Examination (HSC) in 2016 from Chattogram Govt. Womens' College, Chattogram and got GPA 4.86 out of 5.00. Currently she is doing her yearlong internship. He has a great enthusiasm in his study area to develop day one skills and gain more practical knowledge to be prepared for the modern era of science.