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Influence of genetic and non-genetic factors on growth performance in Black Bengal goats under field condition in West Bengal

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ABSTRACT

Data on 10148 Black Bengal kids recorded from 2008 to 2019 and maintained at farmer's fields at different agroclimatic clusters of West Bengal under the project "AICRP on Goat Improvement, Black Bengal Field Unit-Kolkata" were used to study the effect of non-genetic factors on body weight from birth to 12 months of age. The data were analysed using least squares analysis technique. The average birth weights of Black Bengal goats obtained under four different agro-climatic clusters revealed that there was a significant variation in body weight (kg) of all ages. The effect of year of kidding, influence of season and parity of the dam on body weight of Black Bengal kids at different ages were significant. But a non-significant result was found at the body weight in all the seasons as well as in all the parities at 9 and 12 months of age. Sex of the kid and type of birth had significant effect on body weights from birth to 12 months of age. Significantly higher body weight at birth was recorded in single born kid, followed by twin and triplets. The study concluded that it is possible to improve non-genetic elements in the field, particularly by providing excellent housing, reducing stress, having access to grazing pasture, and doing routine deworming and vaccinations. The findings supported the need for environmental changes that can aid in the development of management strategies and decision making regarding the selection.

Keywords: Black Bengal goat, Growth, Genetic factors, Non-genetic factors

Goat plays a significant role for small farmers particularly in the rainfed areas where rearing large animals is restricted due to acute scarcity of feed and fodder. India is home to 148.88 million goats (20th Livestock Census 2019), giving its potential towards the rural economy. Goats have the ability to thrive on meagre fodder and cope with harsh environments, so they are universally called as "poor man's cow" (Hassan *et al*. 2016).

The Black Bengal goat is disseminated throughout West Bengal and adjoining states and famous for its adaptability, fertility, prolificacy, delicacy of meat and superior quality of skin (Siddiki *et al.* 2020). Growth traits as an economically important feature in livestock breeding, and is an important indicator to measure the economic value of agricultural animals (Amiri *et al.* 2017, Gholamhoseini *et al.* 2018, Mohammadi *et al.* 2009). Growth traits can be used as an indicator for the biological parameters that influence the physical growth and health of animals (Nassiry *et al.* 2005, Amiri Roudbar *et al.* 2018, Barazandeh *et al.* 2019, Ghotbaldini *et al.* 2019). These are quantitative traits that are influenced by many factors, especially genetic factors. The main factors that restrict the development of animal farming are their relatively slow growth rate and long breeding cycle. In general, the live weight and growth rate of animals are considered as profitability drivers for animal production systems (Norouzy *et al.* 2005, Zamani *et al.* 2015, Gooki *et al.* 2019, Mohammadabadi *et al.* 2021). Therefore, the selection and breeding goals of animal breeding is to produce animals with high growth rates and significant weight gain.

Growth traits are considered one of the important traits in a genetic improvement (Ghotbaldini *et al.* 2019). Since the growth performance of kid determines the meat producing ability at a marketable age, both the birth weight and the weaning weight are taken into account for the growth potential and muscle development in meat goats (Gholamhoseini *et al.* 2018). Thus, by improving the growth potential and survival rate, the growth performance is enhanced and heavy market weight is achieved (Gooki *et al.* 2019).

MATERIALS AND METHODS

Data description: Data on 4511 male and 5627 female Black Bengal kids recorded between 2008 to 2019, maintained at farmer's field, at four different agro-climatic clusters of West Bengal (Table 1) which included eight villages (two villages under each cluster) under the ongoing project "All India Coordinated Research Project on Goat Improvement, Black Bengal Field Unit- Kolkata" were used for this study.

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Table 1. Details of Agro-climatic clusters

Zone	District	Village
Gangetic Flood Plain (GFP) region	Nadia	Ayeshpur, Ganguria
Coastal Flood Plain (CFP) region	South-24 Parganas	Jatirampur, Rangabelia
Alluvial Plain (AP) region	Murshidabad	Beliapukur, Bamunia
Undulating Lateritic (UL) region	Jhargram	Manapara, Dhangri

*Management of kids:*Kutcha, Pucca and Tethering in the house were the housing practices of the farmers. During winters, grazing was allowed continuously from 9.00 AM to 3.00 PM (6 h). During summer season, grazing was allowed on an intermittent basis from 7.00 A.M to 12.00 noon and from 3.00 PM to 6.00 PM (8 h). During rainy season, only a few hours of grazing was allowed if the weather was favourable. Few of the goat owners supplied balanced concentrate mixture, very less percentage of farmers provided single concentrate (e.g. broken wheat) or combination of two or three (e.g. mixture of broken wheat, broken rice and oil cakes). Few farmers applied mineral mixture through rice gruel. Vaccination for PPR and Goat pox was done as per the schedule and deworming was done regularly at an interval of 3 months.

*Statistical analysis:*The data was analysed statistically with IBM SPSS (Version 21.0) Software. One way ANOVA and Duncan's Multiple Range Test as modified by (Kramer, 1957) were used for testing the differences among the least squares means (using the inverse coefficient matrix).

The following model was used:

$$Y_{ijklmn} = \mu + A_i + B_j + C_k + D_l + E_m + e_{ijklmn}$$

Where, Y_{ijklmn} is the observation of n^{th} kid born in i^{th} cluster, j^{th} period, k^{th} season, l^{th} sex and m^{th} parity, μ is the overall mean, A_i is the fixed effect of i^{th} cluster, B_j is the fixed effect of j^{th} period, C_k is the fixed effect of k^{th} season, D_l is the fixed effect of l^{th} sex, E_m is the fixed effect of m^{th} parity and e_{ijklmn} is the residual random error with Y_{ijklmn} observation, assumed to be NID (0, $\sigma^2 e$)

RESULTS AND DISCUSSION

The overall body weight at birth of Black Bengal Goat in this study was in close agreement with the report of Malik *et al.* (1980) for birth weight of Black Bengal kids. The average body weight at 3 month age of Black Bengal Goat was almost similar as reported by Malik *et al.* (1986). However, higher estimate of the body weight at 3 month age was reported by Singh and Singh (1999) and another higher estimate was reported in field condition. The weight of Black Bengal Goat at 6 month age was found in close agreement with the report of Akhtar *et al.* (2006). However, comparatively higher estimate of body weight was reported by Haque *et al.* (2013). The body weight of Black Bengal Goat at 9 month age was in close agreement with the report of Husain *et al.* (1997) in their study on growth performance of Black Bengal goat upto fourth parity. The average body weight of Black Bengal Goat at 12 months age was in close agreement with the report of Singh *et al.* (2016) in Black Bengal Goats in coastal zone of Sundarban.

The significant (P<0.05) effect of cluster on body weight (kg) of Black Bengal kids at different ages was noticed (Table 2). Significantly the highest birth weight (kg) of kid was recorded in Jhargram cluster. At 3 month of age significantly the highest body weight (kg) was recorded in Jhargram cluster.

Significantly (P<0.05) highest body weight (kg) was recorded in Sundarban cluster at 6 and 9 month of age while significantly highest body weight (Kg) was recorded in Murshidabad cluster At 12 month of age. Sikder *et al.* (2015) in their study on variation in body growth performances of Black Bengal goat reared under four different agro-climatic regions of West Bengal found significant effect of cluster on body weight of Black Bengal Goat at different months of age.

The significant (P<0.05) effect of period of kidding on body weight (kg) of Black Bengal kids at different ages was noticed (Table 3). The highest birth weight (kg) was recorded during 2016-17 to 2018-19, birth weight of Black Bengal Goats under this study showed a decline trend up to 2015-16 and then gradually increased thereafter. At 3 month of age, significantly the highest body weight (kg) was recorded during 2008-09 to 2011-12. At 6 month of age, significantly highest body weight (kg) was recorded in 2008-09 to 2011-12.

At 9 month of age, the highest body weight (kg) was recorded during 2008-09 to 2011-12. At 12 month of age, the body weight of kids born during 2008-09 to 2011-12 was significantly (P<0.05) highest. It was observed that kids born during 2008-12 had lower weight at birth but had higher growth rate as 12 month body weight was higher than kids born in other periods. Malik *et al.* (1986) reported significant effect of year of birth of kid on body weights at birth and 3 month and Husain *et al.* (1997) also reported

Table 2. Cluster wise variation of body weight (Mean ± SE) of Black Bengal Goat

Cluster	Body Weight (in kg)				
	At birth	At 3 month	At 6 month	At 9 month	At 12 month
Overall	1.326±0.003 (10148)	5.200±0.016 (8626)	7.724±0.021 (7522)	10.441±0.024 (6010)	13.226±0.030 (4064)
Nadia	1.253^{a}±0.002 (5720)	4.927^{a}±0.015 (4706)	7.395^{a}±0.020 (4057)	10.115^{a}±0.022 (3226)	12.984^{a}±0.028 (2008)
Sundarban	1.155^{b}±0.003 (3053)	5.130^{b}±0.019 (2748)	8.072^{b}±0.025 (2479)	10.698^{b}±0.027 (2038)	13.532^{b}±0.032 (1558)
Murshidabad	1.287^{c}±0.007 (616)	4.991^{ac}±0.042 (571)	7.543^{ca}±0.054 (523)	10.301^{c}±0.060 (424)	13.627^{bc}±0.074 (285)
Jhargram	1.608^{d}±0.007 (759)	5.752^{d}±0.041 (601)	7.886^{d}±0.058 (463)	10.648^{bd}±0.068 (322)	12.761^{ad}±0.086 (213)

Values in parenthesis are number of observations. Column-wise means with different superscripts are significantly different at P<0.05.

Table 3. Period wise variation of body weight (Mean±SE) of Black Bengal Goat

Period	Body weight (in Kg)				
	At birth	At 3 month	At 6 month	At 9 month	At 12 month
Overall	1.251±0.002 (10148)	5.072±0.011 (8626)	7.685±0.015 (7522)	10.377±0.016 (6010)	13.258±0.020 (4064)
2008-09 to 2011-12	1.235^{a}±0.004 (2596)	5.214^{a}±0.022 (2188)	7.892^{a}±0.029 (1945)	10.540^{a}±0.032 (1545)	13.490^{a}±0.039 (1065)
2012-13 to 2015-16	1.245^{ab}±0.003 (3946)	4.965^{b}±0.018 (3378)	7.534^{b}±0.023 (3022)	10.253^{b}±0.025 (2503)	13.099^{b}±0.031 (1745)
2016-17 to 2018-19	1.273^{c}±0.004 (3606)	5.037^{bc}±0.018 (3060)	7.628^{c}±0.025 (2555)	10.338^{bc}±0.028 (1962)	13.183^{bc}±0.036 (1254)

Values in parenthesis are number of observations. Column-wise means with different superscripts are significantly different at P<0.05.

significant effect of year of birth of kids on their body weight.

The significant (P<0.05) effect of season on body weight (kg) of Black Bengal kids upto 6 months of age was noticed (Table 4). A significantly higher birth weight was recorded in summer born kids. At 3 month of age, significantly higher body weight was recorded in summer born kids.

At 6 month of age, significantly higher body weights were recorded in winter and summer born kids. The summer born kids are heavier than monsoon and winter born kids except at 6 and 9 month of age. The result indicated that season of birth has some effect on growth which reduces gradually and has no effect after 6 month of age. The significant effects of season of birth on kid's body growth were also reported by Husain *et al.* (1997) and Paul *et al.* (2014) in Black Bengal Goat in Bangladesh and India respectively.

The male kids were found to be significantly (P<0.05) heavier than female kids (Supplementary Table 1) at all the ages. The male kids were always significantly heavier than female at all the ages as reported by Choudhury *et al.* (2013) and Haque *et al.* (2013) in Black Bengal Goat in Mymensingh. Significant effect of sex on kid's body weight at different ages was reported by Malik *et al.* (1986) in Black Bengal Goat in India, Husain *et al.* (1997) in Bangladesh.

Body weight of Black Bengal kids at different ages varied significantly (P<0.05) in different parities upto 6 months of age (Supplementary Table 2). Significantly higher birth weight was recorded in fourth parity. At 3 month of age significantly higher body weights were recorded at third parity.

At 6 month of age, significantly higher body weights were recorded at third parity. Whereas, at 9 and 12 months of age, there was no significant effect of parity of doe on body weight of kids was noticed. Paul *et al.* (2014) studied at the productive and reproductive parameters of Black Bengal goat in a nucleus breeding flock, and two other regions, reported that the parity of dam significantly (P<0.01) influenced the birth weight in three different regions. There was a tendency to increase weight with the advance of parity in all regions. Significantly highest (P<0.05) birth weight was observed in third parity and lowest in first parity in all regions.

The significant (P<0.05) effect of type of birth of kid on body weights up to 12 months of age was noticed in Black Bengal kids (Supplementary Table 3). Significantly higher body weights at birth and 3 months of age, were noticed in single born kid respectively. At 6 month of age significantly the highest body weight was recorded in pentaplet kids. At 9 and 12 months of age, significantly the highest body weights were recorded in single born kids respectively. Husain *et al.* (1997) also reported significant effect of birth type on birth weight of Black Bengal kids for single (1.03 kg), twin (0.98 kg) and triplet (0.92 kg).

Agro-climatic clusters had significant effect (P<0.05) on body weight (kg) of all ages in Black Bengal Goat. The growth of kids was significantly high in Jhargram upto 3 months of age, the growth of kids in Sundarban was significantly high from 6 to 9 months of age, At 12 month of age the growth of kids was significantly high in

Table 4. Season wise variation of body weight (Mean ± SE) of Black Bengal Goat

Season of birth	Body weight (in Kg)				
	At birth	At 3 month	At 6 month	At 9 month	At 12 month
Overall	1.252±0.002 (10148)	5.040±0.011 (8626)	7.641±0.015 (7522)	10.359±0.017 (6010)	13.223±0.021 (4064)
Summer	1.273^{a}±0.004 (3572)	5.143^{a}±0.018 (3205)	7.658^{a}±0.024 (2750)	10.340±0.028 (2049)	13.262±0.035 (1384)
Monsoon	1.245^{b}±0.004 (2548)	4.942^{b}±0.023 (1997)	7.538^{b}±0.031 (1719)	10.389±0.034 (1393)	13.181±0.041 (1005)
Winter	1.239^{bc}±0.003 (4028)	5.035^{c}±0.018 (3424)	7.727^{ac}±0.023 (3053)	10.347±0.025 (2568)	13.227±0.031 (1675)

Values in parenthesis are number of observations. Column-wise means with different superscripts are significantly different at P<0.05.

Murshidabad. However, the body weight of kids of Nadia was lowest from birth to 9 months of age and the body weight of kids of Jhargram was lowest at 12 months of age. The effect of year of kidding on body weight of Black Bengal kids at different ages were significant (P<0.05). The kids born during the period 2008-09 to 2011-12 showed the lowest birth weight but maintained the highest growth pattern from 3 to 12 months of age. The kids born in 2012-13 to 2015-16 having medium birth weight showed a lowest growth pattern up to the age of maturity and lowest body growth even in 12 months of age. The kids born during the period of 2016-17 to 2018-19 showed the highest birth weight but maintained a medium growth pattern upto the age of maturity and even in 12 months of age. Effect of season of birth on body weight of Black Bengal kids at different ages were also significant (P<0.05) where the summer born kids are heavier than monsoon and winter born kids except at 6 and 9 months of age. The differences in body weights of two sexes are due to sex hormones that are released from gonads and influence the animal's physiological system. The females have slower growth rate than males because of early maturing body and reach a smaller mature size due to effect of estrogen, which restrict the growth of long bones. Parity has a significant effect (P<0.05) on body weight of Black Bengal kids at different ages except at 9 and 12 months of age. Significantly (P<0.05) higher birth weight were recorded in fourth parity, followed by seventh, third, fifth, sixth, second, first parity and at eighth parity and above. However, the lowest weight at 3 and 6 months of age were recorded in eighth parity and above and in seventh parity respectively. Effect of types of birth on body weight at different ages upto 12 months of age of Black Bengal kids were significant (P<0.05). Significantly higher body weights at birth were noticed always in single born kid, followed by twin and triplets. At 12 months of age the types of birth did produce some effect in the variation of growth and the body weight of Black Bengal at 12 month of age varied between 13.048 to 13.376 kg.

Therefore, it is concluded that the variability is due to a combination of genetic and environmental factors. Thus, mass selection would be effective in bringing genetic improvement in these traits along with appropriate pedigree selection and conjunction with improved managemental and nutritional approaches.

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