Research Article:

FACTORS INFLUENCING DIFFERENT STAGES OF GROWTH IN FIRST-GENERATION BOER CROSSBRED GOATS

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ABSTRACT

This study aimed to evaluate the growth performance of first-generation Boer crossbred kids, focusing on the effect of non-genetic factors like location, breed, production system, herd size, sex, parity, dam size, and birth type. The research was carried out at two municipalities of Surkhet district namely Birendranagar and Lekbesi. Data were gathered from 901 kids and 446 does raised in a pasture and stall-feeding system. The data were analyzed using the Mixed Model Least-square and Maximum Likelihood Computer Program PC-2 statistical package, and the means were compared using Duncan's Multiple Range Test (DMRT). In this study, the least means square live birth weight, pre-weaning weight, weaning weight, post-weaning weight, weight at 6 months and weight at 12 months were 3.30±0.06 kg, 12.45±0.26 kg, 19.23±0.36 kg, 24.17±0.53 kg, 27.96±0.98 kg, and 34.68±1.53 kg respectively. The results revealed that breed, birth type, sex, location, herd size, and production system are significant factors influencing growth variations in goats. These insights can guide goat farmers in planning effective strategies for extensive and intensive crossbred goat production and farming.

Key words: Birth weight, herd size, indigenous, location, parity

INTRODUCTION

In Nepalese economy, goats play a vital role with significant influence around 3.3% of AGDP with its 17.9% share to national meat production (MoALD, 2024). Despite of good number of indigenous goats of the country, the demand of goat meat cannot be fulfilled by the national goat population. The importation of goat is decreasing every year from neighboring countries especially from Tibet, China and India (MoALD, 2024) in these recent years. Furthermore, in order to fulfill the demand, genetic improvement through crossbreeding with exotic was the avenue considered to increase the productivity of national goat population of Nepal (Kadel et al., 2023; Wakchaure et al., 2015). By integrating crossbreeding with well-defined breeding objectives, farmers can improve the productivity and sustainability of their herds (Leory et al., 2015).

The Boer goat, renowned for its rapid growth rate and superior meat quality, has been strategically introduced since 2012 for crossbreeding with non-descript goat populations in the country for increasing farmers' profitability through increasing meat production (Panth et al., 2021), while ensuring the conservation of pure indigenous goat breeds (AFSP, 2015). Performance evaluation of different levels of crossbreeds focusing on growth and efficiency-related traits is pre-requisite to design a program to introduce a breed and crossbreeding scheme (Tesema et al., 2018). In addition, the knowledge of environmental factors affecting performance is imperative to improve the efficiency of breeding program. So far, research on the performance of Boer crossbreds has been conducted only sporadically and in limited aspects. Previous studies have indicated that Boer goats are well-suited to agro-climatic zones up to an altitude of 1500 meters above sea level. (GRS, 2018; Kadel et al., 2023) and is compatible to cross with local goats (indigenous Khari and locally adapted Jamunapari and Sirohi goats) available in these locations (Bhattarai et al., 2019; Sapkota et al., 2016). A little is known about the influence of non-genetic factors on the performance for different levels of Boer crossbreds. This study aims to evaluate the growth performance and to identify non-genetic factors affecting the performance of different first generation crossbred goats.

MATERIAL AND METHODS

Location and sampled animals

The research was conducted in two specific sites of Surkhet municipalities, Birendranagar Municipality-16 and Lekbesi Municipality-10, at upper elevations ranging from 1170 to 1650 masl from 2016 to 2019. Similarly, Lekbesi Municipality- 3, 4, and 6 at lower elevations ranging from 450 to 750 masl. Purposive sampling techniques were utilized, with total of 901 kids studied (331 from lower and 570 from upper altitude, respectively). 42 and 52 percent of the total goat population were under sampling from the study sites chosen for this present study.

Table 1. Samples distribution of the study site

Location	Altitude (m asl)	Total
Birendra Municipality-16; Lekbesi Municipality- 10	1170 – 1650	570
Lekbesi Municipality- 3, 4, and 6	450 – 750	331
Total		901

Data and studied traits

Primary data were collected from individual household with the help of herd register maintained at breeder and multiplier herd. A data collection sheet was developed for this purpose to collect required information through direct conversation with farmers and monthly weighing of kids of respective goats. The traits analyzed were birth weight (BW, n=901), live weight at 2 months (2MW, n=806), live weight at 4 months (4MW, n=806), live weight at 6 months (6MW, n=509), live weight at 9 months (9MW, n=232), and live weight at 12 months (12MW, n=138). The various non-genetic factors considered during the study were altitude (lower and upper), seasons of kidding (Spring-March, April and May; Summer rainy- June, July and August; Autumn-September, October and November; and Winter- December, January and February), genetic groups (Boer 50% x Khari 50%, Boer 50% x Jamunapari 50%, and Boer 50% x Sirohi 50%), parity of dams (Early -1st and 2nd, Mid- 3rd to 6th, and Late ->6th), production system(Grazing and stall feeding), sex of kids (male and female), type of birth (Single, Twins, and Triplets), and herd size (Small -10 goats, Medium- 11 to 25 goats, and Large - > 26).

Data analysis

The data were analyzed using Harvey 1990 statistical package, developed by Walter R. Harvey. It is designed for statistical analysis using a mixed model approach. It incorporates Least Squares and Maximum Likelihood Estimation methods for analyzing data with unbalanced subclass numbers, often encountered in animal breeding research. This software is based on the C.R. Henderson Model, which provides a robust framework for handling fixed and random effects in genetic and statistical studies.

Mean comparison for different level were performed using Duncans' Multiple Range Test (DMRT) software based on Duncan (1955).

Weight of kids at different stages of growth was analyzed using the following fixed effect model:

$\mathbf{Y_{ijklmnop} = \mu + a_i + b_j + c_k + d_l + f_m + g_n + h_o + x_p + e_{ijklmnopq}}$,

Where, **μ** is the overall mean

$\mathbf{Y_{ijklmnop}}$ = adjusted mean for different variables taken under study

a_i is the effect of i[th] genetic group (i=% 50%:50%: Boer & Khari, 50%:50%Boer: Jamunapari and 50%:50% Boer:Sirohi)

b_j is the effects of j[th] location (j = upper and lower)

c_k is the effects of k[th] production system (k = grazing and stall feeding)

d_l is the effect of l[th] herd size (l = Small up to 10, medium - 11 to 25 and large - >26)

f_m is the effect of m[th] parity (m = Early -1[st] and 2[nd], Middle- 3[rd] to 6[th], and Late ->6[th])

g_n is the effect of n[th] season of kidding (n = Spring, Summer rainy, Autumn and Winter)

h_o is the effect of o[th] birth type (o = Single, Twin and Triplet)

x_p is the effect of p[th] sex (p = male and female)

$e_{ijklmnnopq}$ is the random element (error mean) assumed to be normally and independently distributed among the sampled population.

RESULTS AND DISCUSSION

The overall least-square mean of body weight at BW, 2MW, 4MW, 6MW, 9MW and 12MW were 3.30±0.06, 12.45±0.26, 19.23±0.36, 24.17±0.53, 27.96±0.98, and 34.68±1.53 kg, respectively. The least square mean with standard error of live weight of first filial generation Boer crossbred kids and different factors are presented in Table 2. The current results have higher body weight of Boer crosses than reported by Bhattarai et al. (2019) for 50 % Boer kids' goats and lower than weight of pure Boer kid of average birth weight 3.79 kg and average yearling weight 45.74kg in a National Goat Research Program, Bandipur study (NGRP, 2020). The genetic potential of indigenous parental lines, the physical environment, and the variation of flock management could explain the variability across studies.

Effect of sex on kids growth

The male kids were significantly heavier than female (P<0.001) at all ages (Table 2). The weight was significantly different up to 6 months but it was statistically at par at 9 and 12 months age. Similar results were also founded in different research conducted by Duricic et al. (2012); Gautam (2017) and Parajuli et al. (2015). All found that sex had a substantial influence on body weight of goat kids. Male were about 8% heavier than female kids. Heavier weight of male at birth might be due to the anabolic effect of male sex hormones during the prenatal development as suggested by Tudu et al. (2015). However, Ghimire et al. (2020); Bhattarai (2017); Yilmaz et al. (2013) in the study of Khari, Sannen, and crossbred goats, respectively reported non-significant effect of sex on the body weight of kids. Higher pre-weaning weight of male kids compared to females might be due to dominating/aggressive behavior of males during feeding and suckling mother along with anabolic effect of male sex hormone as suggested by previous authors (Bhattarai, 2017; Gautam, 2017; Ghimire et al., 2020; Tudu et al., 2015).

Effect of genetic group

Breed of dam significantly affect (p<0.05) the live weight of kids at all ages expect 6 and 9 months (Fig. 1). At birth, the live weight of Sirohi and Boer crosses was the highest, followed by crosses with Jamunapari and Khari, but at 2 W and 4W, the weight of Jamunapari crosses was higher, followed by Khari and Sirohi crosses. Finally at 12 W the live weight of Sirohi crosses was higher followed by Jamunapari and Khari. The higher birth weight of Sirohi and Boer crosses dam's kid may due to superior genetic predisposition of Sirohi goats, bigger dam size and better genetic mix up with Boer goats as compared to Jamunapari and Khari (Gautam, 2017; Nugroho et al., 2018; Okere et al., 2011; Sapkota et al., 2012). Higher weight of the kids born from Jamunapari crosses and Khari crosses dams at 2MW and 4MW was due to better adaptation of locally adapted breeds to the environment affecting the growth performance as suggested by Teklebrhan (2018) and Ghimire et al. (2020).

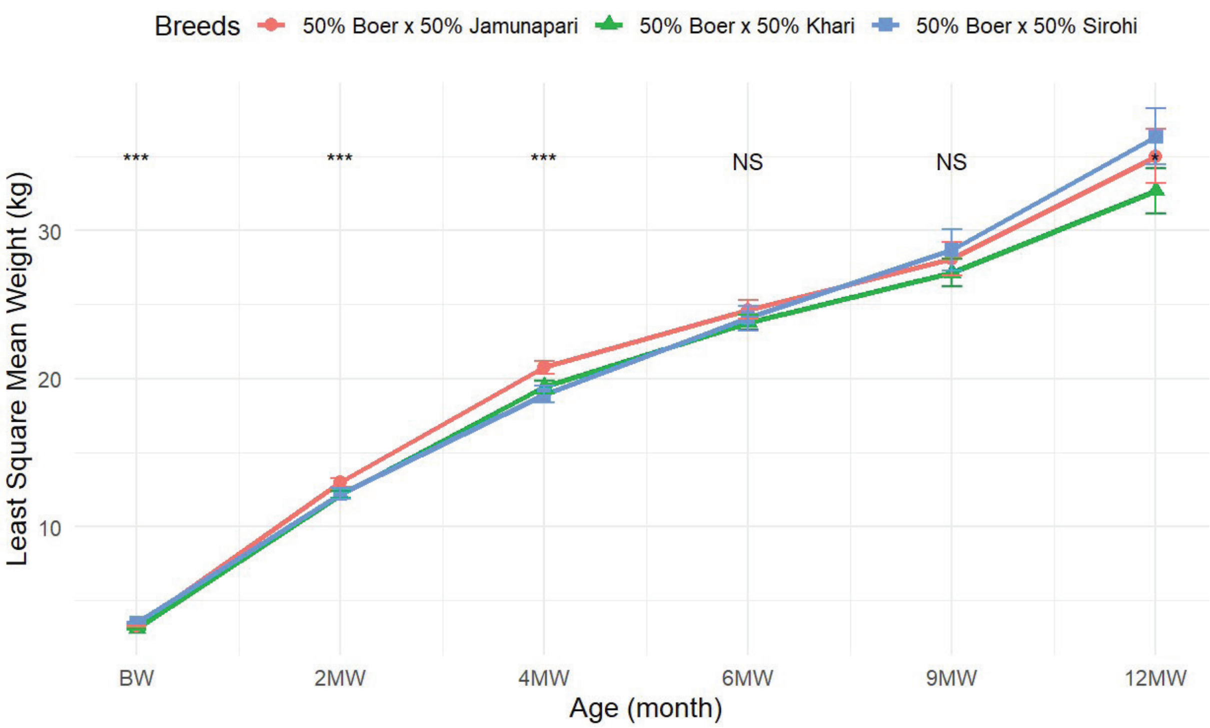

Fig. 1. Trend graph showing Least Square Means and Standard Errors (LSM ± SEM) of body weight across different growth stages (BW: Birth Weight, 2MW: Two-Month Weight, 4MW: Four-Month Weight, 6MW: Six-Month Weight, 9MW: Nine-Month Weight, and 12MW: Twelve-Month Weight) for various crossbred goats

Effect of Location

Location had no significant effects on birth weight of kids, but had significantly affected the live body weight at 2 months and 6 months (Table 2). The goats at lower altitude had higher weight than that of higher altitude. Similar result was also observed by Bhattarai et al. (2017); Gautam (2017); Parajuli et al. (2015); Rotimi et al. (2015) and Sapkota et al. (2012) also found the significant effect of location while studying on West African Dwarf goats and Khari goats. Kids at lower altitude were heavier which might be due to access to better availability of feeds, sufficient milk and a more suitable environment for kids at lower altitudes.

Effect of Production system

Production system significantly affected the 2 months, 6 months and 12 months body weight (Fig. 2). Kids born from those does rear under stall feeding had heavier live weight which contrasts with the finding of Gautam (2017). It may be due to access to more nutritious diet in stall feeding, which helped them produce more milk. Liotta et al. (2020) observed significant difference while evaluating the effect of the production system on growth performances and meat quality of suckling Messinese goat kids.

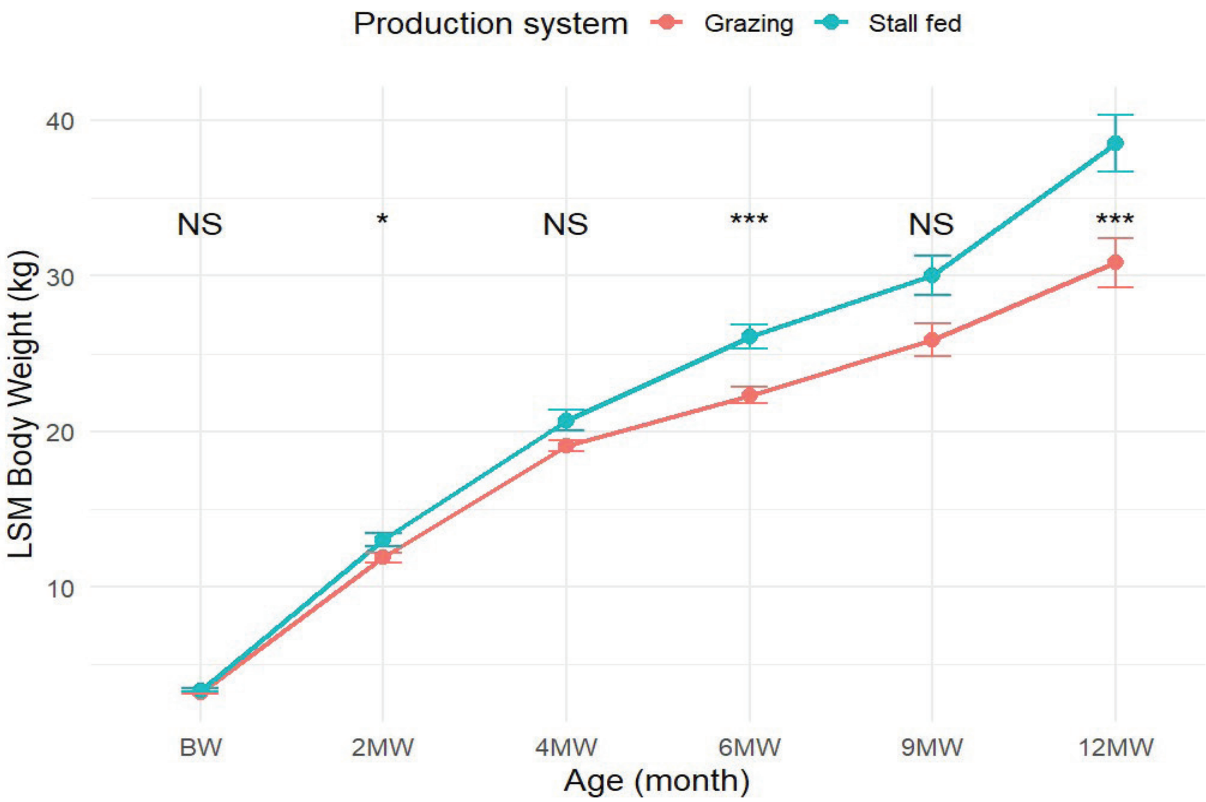

Fig. 2. Trend graph showing Least Square Means and Standard Errors (LSM ± SEM) of body weight across different growth stages (BW: Birth Weight, 2MW: Two-Month Weight, 4MW: Four-Month Weight, 6MW: Six-Month Weight, 9MW: Nine-Month Weight, and 12MW: Twelve-Month Weight) for various production system

Effect of Herd size

Herd size had affected considerably in live weight of 2W, 4W and 6W ($p<0.01$) as presented in Fig. 3. Herd size had no effect on birth weight and post weaning weight after 6 months. The kids born in large herd had lower live weights up to weaning (4W), while kids of large herd were heavier after weaning (6W). Kids raised in medium and small herds weighed more than those raised in big herds before weaning, which might be due to greater availability to nutrition, care, and management. Medium and large herd size farmers are commercial farmers and that goats/herd is the main source of income and in any cost, they are improving their goats by selection, breeding and proper feeding. Herd size affects foraging variables, such as weight gain and organic matter intake (Tester, 2019).

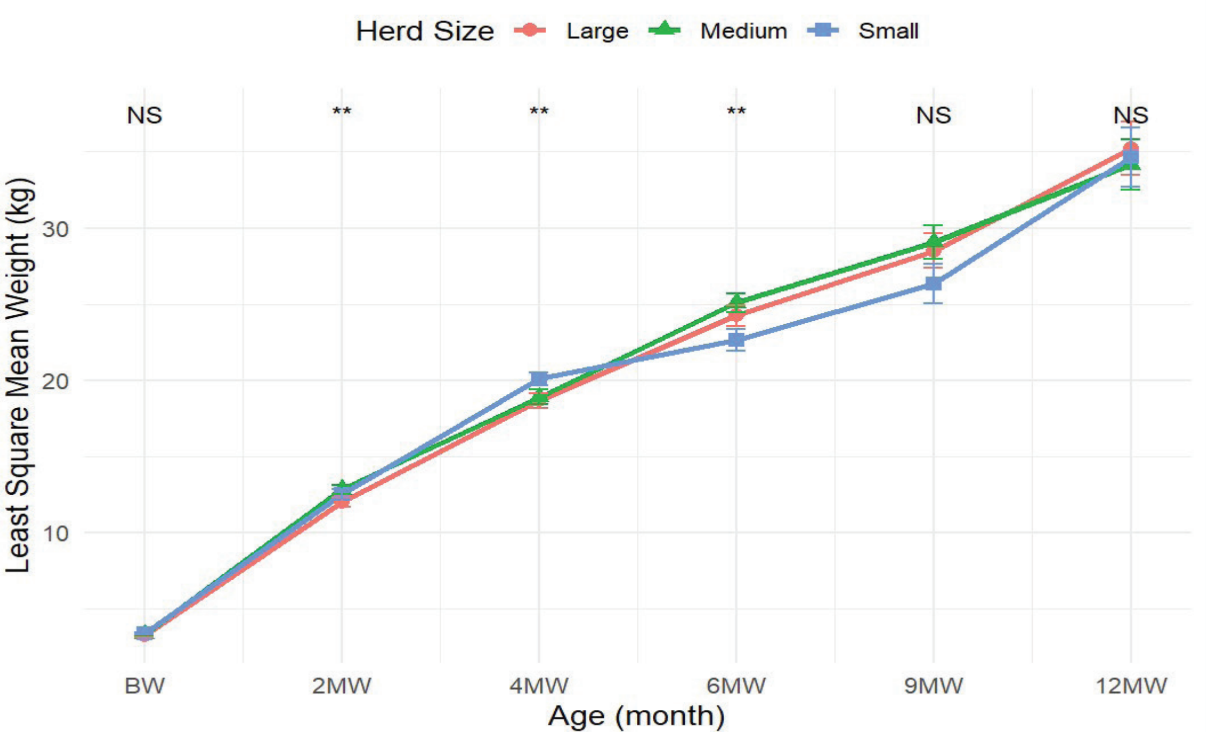

Fig. 3. Trend graph showing Least Square Means and Standard Errors (LSM ± SEM) of body weight across different growth stages (BW: Birth Weight, 2MW: Two-Month Weight, 4MW: Four-Month Weight, 6MW: Six-Month Weight, 9MW: Nine-Month Weight, and 12MW: Twelve-Month Weight) for various herd size of crossbred goats

Effect of Dams' parity

Dam's parity had a significant effect on BW only ($p<0.05$), but it had no effect on later ages (Table 2). This finding was in line with the finding of Sodiq (2012) while studying the effect of non genetic factors on pre-weaning weight and growth rate of *Ettawah* grade goats. This might be due to well-established reproductive tract, increase in doe weight, good maternal ability, adequate milk production and uterine environment as dams mature, which result in better growth and development of the kids (Bhattarai, 2017; Deribe & Taye, 2013; Gautam, 2017).

Effect of Kidding Season

Kidding seasons had significant effect on birth weight but not afterwards (Table 2). The current study's findings were also consistent with those of Ray et al. (2015) and Soundararajan and Sivakumar (2011). On contrast to this Bhattarai (2017) and Parajuli (2012) found that the season of kidding had no effect on newborn weight. Kids born during the autumn months may be heavier because dams may have access to sufficient nourishment in the form of grazing throughout the spring season immediately before to the beginning of summer. The stressful high humidity of monsoon season, increased parasite load, high crude fiber content, and decreased protein content all have a detrimental impact on growth performance (Banerjee & Jana, 2010). The kids born at autumn and winter (36.14±1.61 kg, 36.30±1.53 kg) were heavier than kids born at summer and spring (33.24±2.42 kg, 33.04±1.77 kg). The fodder availability is dependent upon season. Kids born in autumn can get more milk from its dam as they get more nutritious fodder in these flush season.

Effect of Birth type

Birth type had significantly affected the live weight of kids ($p<0.001$) at all ages except 9 months. At all ages, single-born kids weighed more than multiple-born kids. Birth weight and number of kids were negatively related were also reported by Gautam (2017), Bhattarai (2017), Sapkota et al. (2016), Parajuli et al. (2015). The effect of birth type might be linked mostly to the fact that single kid had less competition for space or resources in their mothers' uterus, as opposed to twins or triplets (Bazzi, 2013). As a result, the lower birth weight of triplets and twins may be due to competition for favorable nutrients and space in the dam's womb. Similar variations due to 'type of birth–effect' were also reported by Bhattarai (2017) and Gautam (2017) in Khari and crossbred goats; and Hagan et al. (2014) in West African Dwarf Goat respectively.

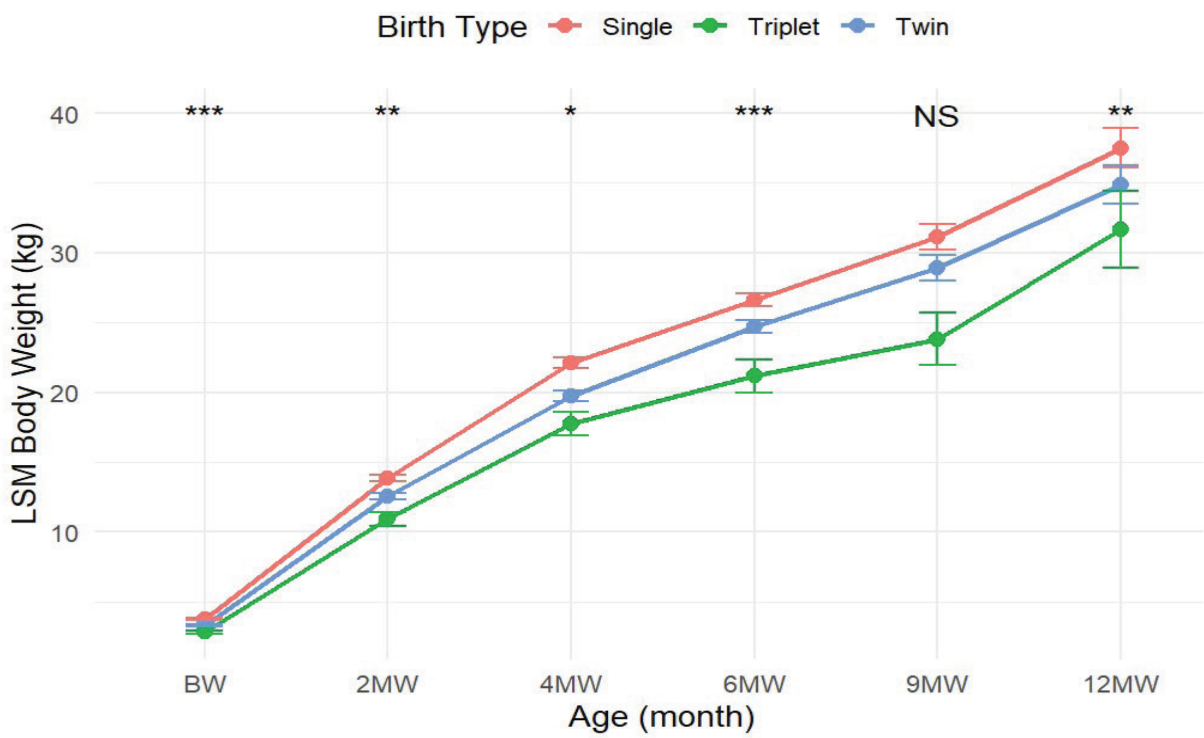

Fig. 4. Trend graph showing Least Square Means and Standard Errors (LSM ± SEM) of body weight across different growth stages (BW: Birth Weight, 2MW: Two-Month Weight, 4MW: Four-Month Weight, 6MW: Six-Month Weight, 9MW: Nine-Month Weight, and 12MW: Twelve-Month Weight) for various birth types of crossbred goats

Table 2. Effect of location, parity, season of birth and sex of kids on body weight (kg) at birth (BW), pre-weaning (2-month age) weight, weaning (4-month age) 6 months, 9 months and 12 months weight of kids (LS Mean ± SEM).

	Pre-Weaning Weight						Post-Weaning weight					
Factors	**N**	**BW**	**N**	**2W**	**N**	**4W**	**N**	**6W**	**N**	**9W**	**N**	**12W**
Overall mean	901	3.30±0.06	806		806	19.23±0.36	509	24.17±0.53	232	27.96±0.98	138	34.68±1.53
Location		NS		*		NS		*		NS		NS
Upper	570	3.35±1.4	513	11.03±1.23	513	18.28±0.48	351	23.44±0.70	151	26.52±1.28	88	36.26±1.79
Lower	331	3.26±1.4	293	13.88±1.26[a]	293	20.18±0.43	158	24.90±0.58	81	29.41±1.09	50	33.10±1.67
Dams' parity		*		NS		NS		NS		NS		NS
Early	293	3.24±0.07[c]	268	12.34±0.30	268	18.89±0.42	178	24.03±0.62	71	27.04±1.12	40	34.24±1.74
Mid	465	3.27±0.06[b]	408	12.52±0.27	408	19.21±0.37	253	24.22±0.54	126	28.29±0.96	78	34.35±1.52
Late	143	3.40±0.07[a]	130	12.50±0.32	130	19.58±0.48	78	24.27±0.70	35	28.56±1.27	20	35.44±1.83
Kidding Season		**		NS		NS		NS		NS		*

Spring	131	3.18±0.08[d]	119	12.29±0.33	119	19.46±0.55	50	23.37±0.80	23	26.51±1.33	22	33.04±1.77[b]
Summer rainy	56	3.38±0.10[b]	46	12.69±0.42	46	19.94±0.68	30	25.30±0.94	8	28.66±1.93	7	33.24±2.42[b]
Autumn	394	3.39±0.06[a]	341	12.67±0.28	341	20.44±0.47	224	24.45±0.56	135	28.46±0.94	60	36.14±1.61[a]
Winter	320	3.26±0.06[c]	300	12.17±0.27	300	19.68±0.44	205	23.56±0.54	66	28.22±1.00	49	36.30±1.53[a]
Sex of kids		***		***		***		***		NS		NS
Male	453	3.43±0.06	400	13.19±0.27	400	21.51±0.45	168	25.34±0.59	20	28.01±1.36	5	35.50±2.48
Female	448	3.18±0.06	406	11.71±0.28	406	18.25±0.46	341	23.01±0.55	212	27.92±0.87	133	33.86±1.11
CV		17.10		19.4		19.91		39.62		17.01		14.66
R^2		.363		.394		.389		0.301		0.462		0.349

Note: *: Significant at 5% level (P<0.05); **: Significant at 1% level (P<0.01); ***: Significant at 0.1% level (P<0.001); NS: Non-significant (P≥0.05); LS mean: Least square means; SEM: Standard error of Means; No: Number of observations, CV: Coefficient of variation R^2: Coefficient of determination.

CONCLUSION

This study highlighted the importance of accounting for non-genetic factors such as breed, herd size, production system, and sex in the production of Boer crossbreds with Jamunapari, Sirohi, and Khari goats. Results demonstrated superior growth performance in kids crossed with Boer goats, underscoring their potential to meet the growing meat demand in the country. These findings can guide goat farmers in strategically managing crossbreeding programs by understanding the relationship between growth performance and non-genetic factors, enabling them to adopt extensive and intensive farming practices effectively.

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