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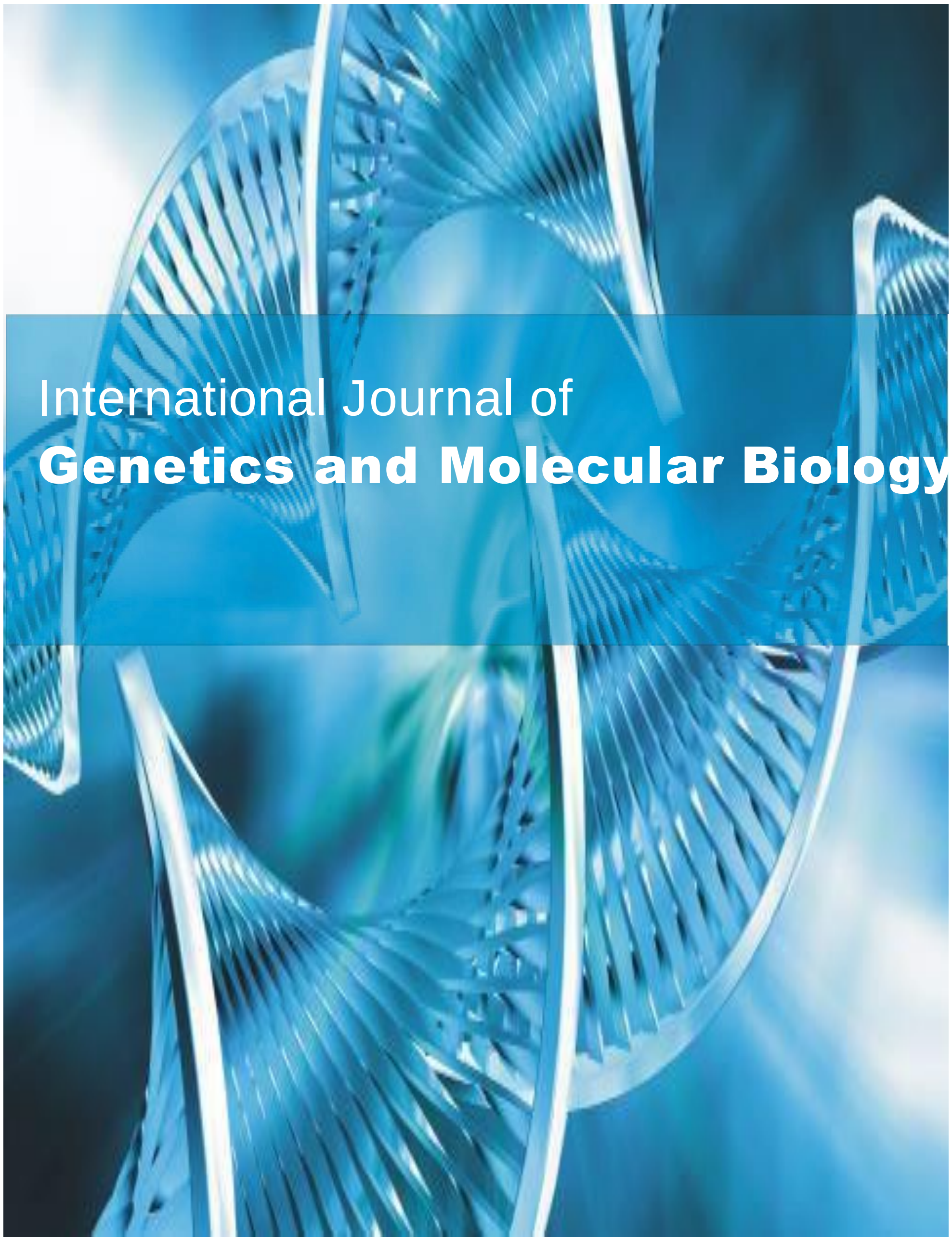

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Full Length Research Paper

Evaluation of growth and survival performances of Pure Borana goat and their crosses with Boer goats

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Evaluation on growth and survival performances of Borana goats and their crosses with Boer was performed at Yabello Pastoral and Dryland Agriculture Research Center. General Linear Model (GLM) and Chi-square procedure of Statistical Analysis System (SAS) were used to analyze the effect of breed group, sex, parity, birth type and kidding season on traits such as BWT, PADG, WWT, 6MWT, 9MWT, YWT, PoWADG and mortality rate. Growth performances and mortality rate of crossbred goats were significantly affected (p<0.05) by breed group, sex, parity, birth type and birth season. Average pre weaning growth performances of crossbred goats were 3.26±0.78 kg BWT, 138.34±41.87 g ADG and 11.79±2.88 kg WWT. While post-weaning growth performances were 16.63±3.51 kg, 19.55±4.62 kg, 21.61±5.47 kg and 84.68±29.1 g, for 6MWT, 9MWT, YWT and PoADG were varied (p<0.05) based on Boer to Borana goat blood ratios of kids. Mortality rates were 9.38, 16.95, 25, and 20.91%, in respective order, for 25% Boer, 50% Boer, 75% crosses of Boer and Borana goat. However, mortality rate was not significantly influenced by different blood levels (p>0.05). Generally, crossbred goats outperformed the indigenous goat breed. As a result, systematic crossing of Boer with indigenous Borana goat breed is recommended as it improves the growth performance without a major loss of kids due to the blood ratio of Boer up to 75% cross level. Further research work is needed to understand responses of breed groups in relation to various management systems in order to reduce mortality rates.

Key words: Crossbred, evaluation, Borana and Boer goats, growth, pre and post weaning, survival performance, Ethiopia.

INTRODUCTION

Country reports on farm animal genetic resources (FAO, 2007) indicated that importance of small ruminant is very diverse, particularly for the poor under low input production system in the developing countries. They are integral part of livestock keeping in Ethiopia that are mainly kept for immediate cash sources, milk, meat, wool, manure and saving or risk distribution (Tibbo et al., 2006).

The annual mutton and goat meat production of the country is estimated at 78 and 69 thousand metric tons, respectively (FAO, 2004). Live animals were being also exported to Middle East countries and were sources for

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foreign currency; for example, between 1995 and 1996 an estimated amount of 4.6 million US$ was derived from the export of small ruminant (EARO, 2000). In Ethiopia, sheep and goats provide 25% of the domestic meat consumption with production surplus, which is exported mainly as live animals (ILCA, 1993; Zelalem and Fletcher, 1993). The two species also provide about 40% of fresh skins and hides production and 92% of the value of semi-processed skins and hides for export trade (Kebede, 1995).

With the objectives to improve marketable weight, currently, exotic meat goat breed (Boer) and sheep breed (Dorper) have been imported and being serving as sire line for up-grading of local meat of sheep and goat breeds. Crossing of pure Borana goat with Boer and dissemination of first filial generation (F1) genotype has been in progress in different parts of the country with the initiative of Ethiopian Sheep and Goat Productivity Improvement Project (ESGPP). In this program, F1 genotypes have been disseminated to the goat producers to upgrade the performances of local breed through terminal crossing. Preliminary results indicated that the performance of F1 genotypes under station management level is significantly higher than pure dam line (Deribe et al., 2015). However, performances of crossbred goat with various exotic blood levels have not been yet thoroughly evaluated both at on-station and on-farm levels. Generally, little information was available on growth, reproduction and survival performances of crossbred genotypes in the country.

Systematic evaluation of different blood level is a pre-requisite prior to deciding wider scale dissemination of exotic bloods as different exotic blood levels vary in their performances. Thus, it is logical and procedural to evaluate the performances of different exotic blood levels with its full packages at station level prior to engagement in dissemination of crossbred animals for the producers. At the same time, adaptability and performance of different blood levels of crossbred genotypes should be evaluated at the farm levels. Among the arrays of reasons for the failure of past crossbreeding projects lack of systematic crossbreeding strategy could be one of the factors. Therefore, this study was conducted with the objective to evaluate the growth and survival performances of crosses of Boer and Pure Borana goats (75% and 25%) under station management system.

MATERIALS AND METHODS

Experimental site

The study was carried out in the Yabello Pastoral and Dry land Agriculture Research Center (YPDARC) in Yabello district of Borana zone, Oromia Regional State, Ethiopia (Figure 1). Borana zone lies between 3°36 - 6°38’ North latitude and 3°43’- 39°30’ East longitude (Markus, 2013). The center is located at 570 km south of Addis Ababa in the semi-arid ago-ecologies at an altitude of 1621 masl. Yabello district climatic region has mean annual temperature that varies between 18 and 27°C with high lands(over 1500 above sea level) are found in North central and southern parts, these in particular comprises Yabello and central parts of Dire including Yabello-Mega plateau considered as the extension of southern highland which rises to 2000 m (Fenetahun and Fentahun, 2020). The area is characterized by bimodal rainfall which is unreliable and erratic measured as average annual rainfall of 585 mm. 59% of annual precipitation occurs from March to May and 27% from September to November (Coppock, 1994).

Management of parent stock

Pure Borana goat kept at the breeding evaluation and distribution (BED) site or purchased from where pure Borana goats were found (Moyale and Dire) was used as dam line and best F1 males having good growth rate served as sire line for the production of F2 (25% Boer and 75% PBG). For 75% Boer and 25% PBG production, best 50% Boer × 50% Borana goat females mated to pure Boer bucks. Pure Boer bucks were purchased from nucleus sites of Werer, Haramaya and Fafen.

Breeding scheme and management

Cross breeding scheme followed was two way crosses, a cross between two breeds (Boer × PBG). The crossed animals were mated with either pure Borana goat or Boer goat depending on the desired blood level of the progeny (75% or 25% of the exotic blood). Similar procedure was followed for selection of F1 breeding bucks to produce progenies with 25% exotic blood level from local doe. Both males and females that failed to meet the breeding criteria were culled. Bucks were released for night mating during the peak-mating season (October to May) to synchronize kidding with optimum forage production.

Animal management

Animals were raised under semi-intensive conditions with some supplementation depending upon status and age category. Animals were allowed to graze on pasture during the day and kept indoors during the night. Animals had access for local minerals (Soda). Doe with newborn kids were kept in separate pens up to weaning age. Within 24 h of birth, kids were sexed, weighed and identified with permanent ear tag. Thereafter, kid ID, dam ID, sire ID, date of birth, sex and birth status of the kids were recorded. Following birth, kids were weighed fortnightly using spring balance. Kids were allowed to suckle their dams twice a day (morning and evening) and weaned at approximately three months of age.

Data collection

Production data

Production performance data including birth weight, weaning weight, six-month weight and yearling weight were evaluated. Moreover, fortnight body weight recording was made up to six month of age and continued monthly until the animal existed from the breeding flock.

Health data

Data on daily health activity, periodic sampling along with laboratory analysis, number of kids born alive, number of kids born dead, date and season of death and sex of the kids dead were recorded.

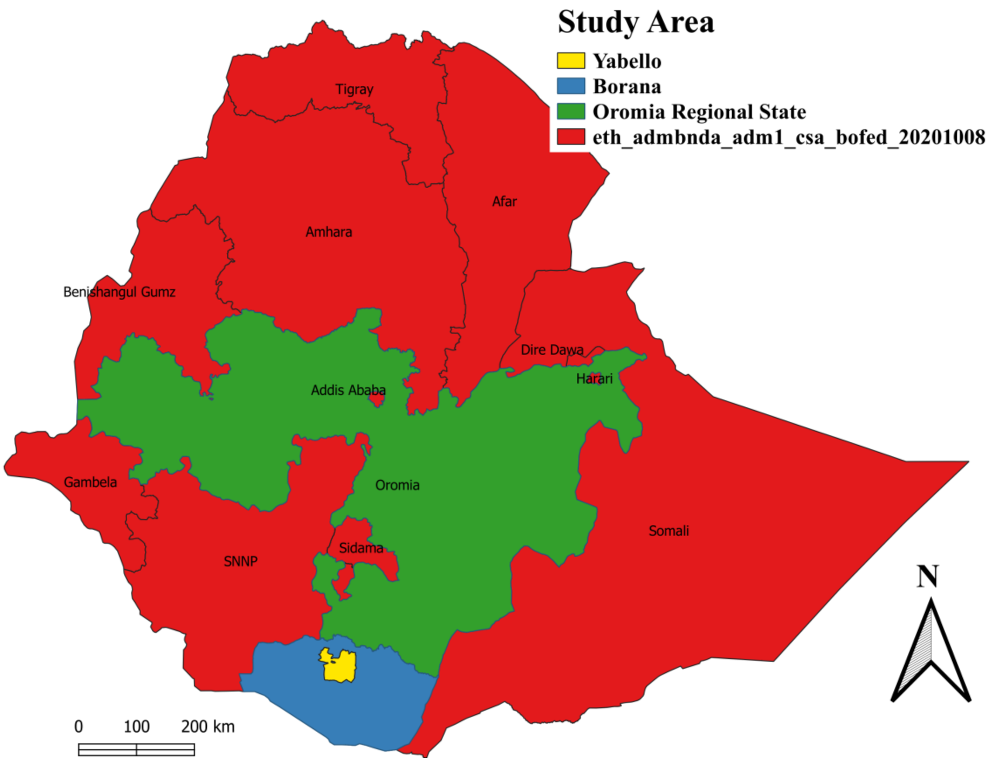

Figure 1. Map of study area.

Data management and statistical analysis

Relevant production, health and socio-economic data were recorded routinely on recording sheet, entered to computer and coded. All quantitative data collected were analysed using *General Linear Model* (GLM) procedure of SAS (2009) version 9.2. The model for birth weight, weaning weight, six month weight, yearling weight, ADG1 and ADG2 included fixed effects of sex (male, female), type of birth (single, twin and triplet), season of kidding (long dry, cool dry and wet/rainy season) and exotic blood level (100% local, 25% Boer, 50% Boer and 75% Boer). The effects of class variables expressed as Least Square Means (LSM) ± Standard Error (SE). Average pre-weaning gain values from birth to weaning (approximately 90 days of age) and average post-weaning gain from weaning to one year was calculated as live weight at weaning divided by age of the kid in days. Similarly, post weaning average daily gain from weaning to yearling was calculated as differences between weaning and yearling weight of the kids divided by age of the kids in days. The following model was fitted for the aforementioned growth traits:

$$Y_{ijklmn} = \mu + S_i + P_j + Bt_k + Ks_l + Bg_m + e_{ijkl}$$

where Y_{ijklmn}= ijklmnth observation of a trait on the ith sex, jth parity, kth type of birth, lth kidding season and mth breed group, μ = Overall mean, S_i = fixed effects of the ith sex (i= male and female), P_j = fixed effects of the jthparity (j = 1st parity, 2ndparity, 3rdparity, 4thparity, 5thparity), Bt_k=fixed effect of btthbirth type (k=single, twin, triplet), Ks_l=fixed effect of lth kidding season (l=long dry, cool dry and wet/rainy), Bg_m=fixed effect of mthblood level (m=local, 25% boer, 50% boer, and 75% boer), and e_{ijklmn} = residual error variance.

Pre and post weaning mortality of kids were analysed using STATA version 13 (2013). The Pearson Chi-square for two-way tables performed to analyse the differences between the observed and expected frequencies; the expected frequencies computed under the null hypothesis of independence. The Pearson Chi-square statistic computed was as:

$$Q\rho = \sum_i \sum_j \frac{(n_{ij} - e_{ij})^2}{e_{ij}}$$

where Qp is the specified frequencies or specified proportions, n_{ij} is the observed frequency in table cell (i, j) and e_{ij} is the expected frequency for table cell (i, j). The expected frequency computed under the null hypothesis that the row and column variables are independent, and computed as:

$e_{ij} = n_i \times n_j / n$

RESULTS

Pre-weaning growth

The pre-weaning growth performance of Borana goat and their crosses of different blood level of Boer goat is shown in Table 1. Under on-station condition, average birth weight (BWT), weaning weight (WWT) and pre-weaning average daily gain (PWADG) of Borana goat and their crossbred kids ranged from 2.13 ± 0.12 kg, 3.31 ± 0.07 kg, 9.77 ± 0.53 kg to 13.19 ± 0.28 kg and 122.46 ± 6.74 g to 164.07 ± 3.59 g, respectively. Generally, pre-

Table 1. Least square means (means ± SE) of pre-weaning growth traits for Borana goats and their crosses with Boer.

Factors	BWT kg^{-1}	PWADG g^{-1}	WWT kg^{-1}
Overall ± STD	3.27 ± 0.78	138.34 ± 41.87	11.79 ± 2.88
CV (%)	17.87	19.83	18.20
Sex			
Female	2.96±0.071^{b}	134.46±4.30^{a}	10.92±0.34^{a}
Male	3.17±0.073^{a}	137.72±4.29^{a}	11.08±0.33^{a}
Birth type			
Single	3.56±0.07^{a}	148.18±3.48^{a}	12.01±0.27^{a}
Twin	2.82±0.06^{b}	130.64±8.59^{b}	10.57±0.29^{b}
Triple	2.68±0.14^{c}	129.46±3.77^{b}	10.42±0.67^{b}
Blood level			
Local	2.13±0.12^{c}	126.75±5.11^{b}	10.28±0.40^{b}
25% Boer	3.10±0.12^{b}	122.46±6.74^{b}	9.77±0.53^{b}
50% Boer	3.31±0.07^{a}	164.07±3.59^{a}	13.19±0.28^{a}
75% Boer	3.30±0.12^{a}	131.08±7.40^{b}	10.75±0.58^{b}
Parity of dam			
First	2.77±0.08^{b}	123.19±4.65^{b}	10.38±0.36^{b}
Second	3.04±0.07^{a}	119.62±4.58^{b}	9.94±0.36^{b}
Third	3.18±0.11^{a}	152.62±5.48^{a}	11.84±0.43^{a}
Fourth	3.12±0.15^{a}	131.06±6.44^{b}	11.49±0.50^{a}
Fifth	2.99±0.11^{ab}	153.96±5.46^{a}	11.34±0.43^{a}
Season of kidding			
Cool dry	3.10±0.07^{a}	130.45±4.68^{b}	11.02±0.37^{ab}
Long dry	2.83±0.07^{b}	118.49±3.66^{c}	10.42±0.29^{b}
Wet (Rainy)	3.14±0.10^{a}	159.34±7.31^{a}	11.56±0.57^{a}

[abc]Within a column under the same factor identifier, values with different superscript letters (a–c) differ significantly at P < 0.05.

weaning growth traits of the kids was significantly influenced (*p<0.05*) by birth type, blood level of Boer goat, birth season and parity of dam. However, sex of kids significantly affected only (p<0.05) BWT where male kids were heavier at birth than their female counterpart.

Post-weaning growth

Average post weaning growth performance of Borana goat and their cross with Boer is shown in Table 2. The result indicated that except nine month (9MWT) and yearling (YWT) which were not significantly affected *(p>0.05)* by sex of the kids, all traits of interest were significantly influenced *(p<0.05)* by sex of the kids, season of birth and blood level of the kids. Post weaning growth performances of 50 and 75% Boer kids were not different significantly (p>0.05). However, results in Table 2 revealed that there is no difference *(p<0.05)* between pure Borana and 25% Boer kids for all the post weaning traits investigated. On the other hand, kids born during the long dry season were significantly *(p<0.05)* lighter than that born during cool dry and rainy season.

Pre-weaning mortality

Number of kids born alive, number of kids survived from birth to weaning and percentage of loss that occurred from birth to 90 days is shown in Table 3. Of all kids born, survival rate were not significantly influenced *(p>0.05)* by blood levels of Boer. However, noticeably varied mortality rates of 15 % for Borana goat kids, 12.20% for 25% Boer crossed kids and 22.78% for 50% Boer crossed kids, and 25% for 75% Boer crossed kids were observed. Likewise, sex of kids and season of birth did not significantly influenced *(p>0.05)* mortality rates to weaning of kids. On the contrary, type of birth influenced survival rate of kids;

Table 2. Least square means (means ± SE) of post-weaning growth traits for Borana goats and their crosses with Boer.

Factor	6 MWT kg^{-1}	9 MWT kg^{-1}	PoWADG g^{-1}	YWT kg^{-1}
Overall Mean ± STD	16.64±3.52	19.55±4.63	84.68±29.19	21.62±5.47
CV (%)	19.73	15.88	18.58	27.99
Sex				
Female	15.68±0.31^{a}	18.26±0.47^{a}	78.39±2.58^{b}	22.89±1.03^{a}
Male	16.53±0.32^{b}	18.83±0.44^{a}	86.84±2.54^{a}	23.38±0.01^{a}
Blood Level				
Local	14.12±0.45^{b}	16.11±0.92^{b}	68.47±3.47^{b}	21.86±1.96^{bc}
25 % Boer	13.43±0.66^{b}	15.95±0.85^{b}	70.38±5.53^{b}	19.57±1.04^{c}
50 % Boer	18.83±0.32^{a}	21.95±0.44^{a}	100.38±2.61^{a}	25.77±1.03^{a}
75 % Boer	18.03±0.69^{a}	20.80±0.86^{a}	91.60±5.74^{a}	25.36±2.95^{ab}
Birth Season				
Cool Dry	15.34±0.45^{b}	19.23±0.51^{a}	92.08±3.53^{a}	26.04±1.81^{a}
Long Dry	14.98±0.43^{b}	15.76±0.56^{b}	68.77±3.55^{b}	19.92±1.33^{b}
Wet (Rainy)	17.99±0.45^{a}	20.64±0.90^{a}	86.99±4.64^{ab}	23.45±1.79^{ab}

[abc]Within a column under the same factor identifier, values with different superscript letters (a–c) differ significantly at P < 0.05.

where triple born kids were less likely to survive to weaning than single or twin born kids.

Post-weaning mortality

The effect of birth type, blood proportion of Boer goat, season of kidding and sex on survival rate from weaning to yearling is shown in Table 3. The results of the current study revealed that there was no significant difference *(p>0.05)* on survival rate of kids based on their sex differences and season of birth which is a particular kid born inside. On the contrary, blood level of Boer goat and birth type of kids intend to significantly influence *(p<0.05)* post weaning survival of the kids. Accordingly, 25% Boer crossed kids showed a maximum (35.29%) mortality loss of kids from weaning to yearling followed by 75% Boer crossed kids. Similarly, triplet born kids were less likely to survive further in periods between weaning and yearling than single or twinborn kids.

DISCUSSION

Pre-weaning growth

In general, birth (BWT) and weaning (WWT) weights of Boer crossbred kids were heavier than Borana goats particularly, 50 and 75% Boer crossbred kids. Breed levels, birth type, sex, parity and year of birth had a significant effect (p<0.05) on pre and post weaning weights. The observed mean birth weight for crossbred kids in the present study was higher than previous research results 2.32 kg (Tesfaye et al., 2006), 2.01±0.03 kg (Deribe and Taye, 2013a) for Central Highland kids, 2.34 kg for Borana Somali and 1.5 kg for Mid Rift Valley kids (Tucho et al., 2000). Similarly, weaning weight of cross-bred kids in this study was found heavier than the values of 6.32 kg for Mid Rift Valley kids (Tucho et al., 2000); 6.8 kg for Abergelle kids (Deribe and Taye, 2013a), and 8.4 kg for Arsi Bale (Woldu et al., 2005). In addition, the estimates 7.2 kg (Tucho et al., 2000) and 9.02 kg (Deribe and Taye, 2013a) for Borana Somali kids and 6.72 kg (Tesfaye et al., 2006) for Central Highland kids were lighter than estimates for crosses in this study. However, the average pre-weaning weights of Borana goats were in-line with most of the mentioned values. Average birth to weaning growth of kids g day^{-1} is found to be influenced by type of birth, season of kidding and breed group. Similar statements have been reported by previous studies made by Deribe and Taye (2013b) and Zeleke (2007). While the variation was observed associating with birth type and breed group related with the amount of milk provided by kids dam, whereas season difference is directly related with availability of feed resource for both the dam and kids.

Post-weaning growth

Similar to pre-weaning growth performances, cross-bred kids showed their superiority on post-weaning growth

Table 3. Mortality rate of pre and post weaning growth traits for Borana goats and their crosses with Boer.

Growth stage	Risk factors	Level (N)	Kids Died	Mortality (%)	$\chi 2$	P<0.05
Birth to weaning	Sex	Female (190)	35	18.42	0.21	0.6466
		Male (258)	52	20.16		
	Birth type	Single (154)	36	23.38	16.56	0.0003
		Twin (237)	31	13.08		
		Triple (57)	20	35.09		
	Breed group	Local (123)	15	15.00	7.66	0.0637
		25% Boer(40)	6	12.20		
		50% Boer (237)	54	22.78		
		75% Boer (48)	12	25.00		
	Kidding season	Cool dry (44)	8	18.18	5.09	0.0783
		Long dry (315)	69	21.90		
		Wet (Rainy) (89)	10	11.24		
Weaning to 1 year	Sex	Female (155)	40	25.81	1.22	0.2703
		Male (206)	43	20.87		
	Birth type	Single (118)	31	26.27	7.73	0.0210
		Twin (206)	38	18.45		
		Triplet (37)	14	37.35		
	Breed group	Local (108)	14	12.96	10.68	0.0136
		25% Boer (34)	12	35.29		
		50% Boer (183)	46	25.14		
		75% Boer (36)	11	30.26		
	Kidding season	Cool dry (246)	12	33.33	2.57	0.2773
		Long dry (36)	55	22.36		
		Wet (Rainy) (79)	16	20.25		

performances of six months (6MWT), nine months (9MWT) and yearling (YWT) weights. The least square mean weights of Borana goats 14.12 kg for six months and 21.86 kg for yearling in the present study were comparable with respective values 13.82 and 20.69 kg for Central Highland goats (Deribe and Taye, 2013b) and 13.61 and 20.15 kg reported for the same breed (Tesfaye et al., 2006). On the other hand, lighter six months and yearling weight values of 7.87 and 12.85 kg for Mid Rift Valley and 9.3 and 13 kg for Borana goats (Tucho et al., 2000), 9.1 and 14.2 kg for Abergelle goats (Deribe and Taye, 2013b) and 11 and 16 kg for Afar goats (Awgichew et al., 1989) reported at different locations. On the other hand, the overall least square means of six month weight (13.54 kg) and yearling weight (19.53 kg) for Boer cross with Central High Land goat were (Deribe et al., 2015), respectively lower than the values obtained under the current study for Boer cross Borana goats. Factors such as sex, birth type and breed group had effects on post-weaning growth rate. Single born kids, 50% Boer and 75% Boer crossbred kids and kids born during wet/rainy and long dry season significantly *($p<0.05$*) resulted in higher daily average post-weaning growth than their corresponding factor levels.

Pre-weaning mortality

Birth to weaning mortality rate (MR) was high in crossbred goats particularly for higher grade cross kids 50% Boer (MR = 22.78%) and 75% Boer kids (MR = 25%). Considering the inconsistent and seasonal management given to the crossbred kids, the identified estimates were somehow better. The current result is in line with the reasons that mortality increases in response to increased exotic blood level, which was expected to have difficulty in resisting environmental stress compared to local breeds (Barbind and Dandewar, 2004). However, lower mortality rates than the present estimates were reported by Petros et al. (2014) (MR = 46.8%) and Debele et al. (2011) (MR=34.2%) for different breeds in Ethiopia. The result obtained for sex effect in the present study was in contrast with previous estimates where male kids were more likely to die from birth to weaning than female (Aganga et al., 2005; Hailu et al*.,* 2006; Bushara et al*.,* 2013; Debele et al*.,* 2011).

Post-weaning mortality

Weaning to one year mortalities appears to be variant due to birth type and breed group. The frequently associated reasoning feed shortage appeared to be the cofactor that contributed to the mortality of post weaning in this study. The current result is in agreement with previous studies that confirmed poor management was the most limiting factor for goats post weaning survival and productivity (Markos, 2000; Tsedeke, 2007). Overall, the current mortality values obtained with considering every factor ranged from 12.96 to 37.35% was in agreement with several research findings for various types of goat breeds 13.3% (Endeshaw, 2007), 14.2% (Belete, 2009) and 25.4% to 50% (Grum, 2010). Similarly, the mortality rate (MR = 45%) reported for Borana goat under traditional management system (Hailu et al., 2006) is higher than the current values and in line with 26.7% post weaning MR for Arsi Bale Goat reported by Girma et al. (2011). Moreover, post weaning MR figures of the current study are closer to those reported for other African goats (Mtenga et al*.,* 1994; Ikwuegbu et al*.,* 1995; Manjeli et al*.,* 1996).

CONCLUSIONS AND RECOMMENDATIONS

Overall, cross breeding with Boer goats increased pre and post weaning growth traits including birth weight, average pre weaning growth rate, weaning weight, six months, nine months and yearling weight in Borana goats. Generally, kids with higher blood levels (50 and 75%) Boer outperformed the local and 25% Boer crossbred kids. From the result, terminal cross breeding system recommended that it can improve the productivity of Borana Goat until improvement of the local breed is achieved at the end. However, in terms of survival, the local breed appeared to be better than the cross breeds. Given the versatility of Boer crossbred kids and high survive ability of local (Borana goats), the following points need to be considered to maximize the merits of the two breeds. The first consideration should be avoiding utilization of Boer for other breeding system except for terminal crossing. The second attention is employing the buck that has low or no genetic potential of giving twin or multiple births. The next point is considering prevention of higher blood level production under extensive system. Moreover, further research work is required to understand response of breed groups in relation to various management systems and a solution to reduce mortality.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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