Growth Performance of Gumz, Rutana and Gumz-Rutana Crossbred Sheep under On-Farm conditions in Northwestern Lowlands of Amhara Region, Ethiopia

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Abstract: The objective of this study was to evaluate growth performance of indigenous Gumz, exotic Rutana sheep, and their crosses under on-farm conditions as a step towards designing Gumz sheep conservation and improvement strategies in the north western lowlands of Amhara Region, Ethiopia. Data from a total of 180 Gumz, Rutana, and their crosses were collected between 2014 and 2016. The mean birth weights of the Rutana, Gumz and their crosses were 3.75±0.07, 2.86±0.06 and 3.38±0.07 kg, respectively. Sex was an important source of variation in which male lambs were superior over their female contemporaries. Single-born lambs were heavier ($p<0.001$) compared to their twins contemporaries. Rutana lambs had significantly highest (118.05±2.67 g) daily weight gain whereas Gumz lambs had lower (100.21±2.48 g). The daily weight gain of the crosses was 107.78±2.66 g. Single-born lambs grew faster than their multiple twin contemporaries between birth to weaning (110.84±1.97 vs. 106.52±2.27 g/day, $P<0.05$) at three months of age. The Rutana lambs also gained more (59.01±3.44 g/day) than the crossbred (52.15±3.36 g/day) and Gumz (46.34±3.29 g/day) lambs from weaning to six months of age. It can be concluded that Rutana inheritance improve pre-weaning and post-weaning growth performance of the indigenous breed of Gumz sheep. However, Gumz breed is a unique genetic resource and the only thin tailed sheep breed in Ethiopia. Therefore, conservation-based breeding program, including improvement of Gumz sheep through selective breeding should be part of the breed improvement program.

Keywords: *Average daily gain, Body weight, Crossbred, Gumz, On-farm condition, Rutana*

Introduction

Ethiopia has nine genetically diverse sheep breeds (DAGRIS, 2006; Solomon *et al*., 2007) with a population of 28 million heads (CSA, 2015). These sheep serve as a major means of the livelihood improvement of the resources poor smallholder farmers and source of foreign currency through export earnings. While contributing significantly to meat production of the country, similar to other tropical countries, productivity of indigenous sheep is very low (Markos, 2006). Hence, improving the productivity of sheep is essential to meet the high meat demand of the country and export market (Shigdafe *et al*., 2013; Tsegay *et al*., 2013). The strategic location of Ethiopia to Middle East and North African countries offer an opportunity to export live animals to these countries (Mengistie *et al*., 2010; Mesfin *et al*., 2014a).

Gumz sheep are one of the indigenous breeds of Ethiopia which are adapted to hot climate with twin lambing merit (Solomon, 2008; Sisay, 2009; Solomon *et al*., 2011). Rutana is a desert sheep in the Sudan and are kept mainly for meat production. Rutana breed is preferred in border markets in western Ethiopia for export due to its higher growth potential and big size (Ali, 2003; Mohammed, 2015). Hence, farmers in north western Ethiopia use Rutana sires to breed indigenous Gumz ewes in order to improve Gumz sheep productivity for better prices. Both Gumz and Rutana sheep and their crosses are important to the farmers for different reasons. There are, however, no comparative studies on growth traits of Gumz, Rutana, and their crossbred sheep. Monitoring of the growth performance of indigenous Gumz and exotic Rutana sheep, and their crosses under village condition and assessing factors affecting their performances is required to capture a full picture of their contribution. It is, therefore, important to study the comparative growth characteristics of the indigenous Gumz, the exotic Rutana and the crossbred progeny to design effective selective breeding and crossbreeding programs. This knowledge is required to formulate optimum breeding objectives and an effective genetic conservation and improvement program. Hence, the aim of the present study was to investigate potential differences in growth traits among the lambs of Gumz and Rutana sheep and their crosses under on-farm conditions. The information generated out of this investigation is useful in designing breed conservation and improvement programs for Gumz sheep.

Materials and Methods

Study Area Description

The study was conducted in the rural farming villages of Metema and Quara districts, located adjacent to each other in the north western lowlands of Amhara Region, Ethiopia. Metema is located about 60 km east of the Sudanese border, 900 km northwest of Addis Ababa and about 180 km west of Gondar town at the geographical location between 12º40' and 12º58' N latitude and 36º8' and 36º12' E longitudes. It is situated

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at an altitude range of 550-1680 m.a.s.l. It has a uni-modal type of rainfall receiving a mean annual rainfall of 850-1100 mm. The mean maximum and minimum daily temperatures of the area are 43ºC and 22ºC (Solomon *et al*., 2011). Quara is located about 1123 km northwest of Addis Ababa and 324 km southwest of Gondar. It lies between 11º47' and 12º21'N latitude and 35º16' and 35º47'E longitude, respectively, and at an altitude range of 528-654 m.a.s.l and has the mean maximum and minimum daily temperature range of 16.4ºC and 37.5ºC (Tadesse and Afework, 2008).

Study Animals

The local sheep kept at north-western lowlands of Amhara is locally known as "Gumz". It is being reared by both Gumz and Amhara communities. Solomon (2008) and Sisay (2009) classified this sheep population as thin tailed sheep. According to Sisay (2009) the Gumz sheep is characterized as a thin-tailed and large sized. The coat of Gumz sheep is usually covered with short and smooth hair. It is prolific and highly adapted to the existing harsh environment (Solomon *et al*., 2008; Sisay, 2009; Solomon *et al*., 2011). The Rutana sheep is one of the desert sheep eco-type reared in Sudan and distributed east ward (Sulieman *et al*., 1991; Sisay, 2009). Rutana sheep are raised mainly under dry land farming conditions for meat production. The desert sheep is the predominant breed for marketing purposes in local and export markets (Mohamed *et al*., 2016). Also their meat is in high demand for export because of its large carcass weight (Dahab *et al*., 2014).

Site Selection and Animal Management

Before deciding the monitoring site, discussions were made with the agricultural experts about distribution of the two breeds and their crosses in each *kebeles* of the districts. Visits were made to these *kebeles* for assessment followed by a preliminary survey in the selected *kebeles* of the districts. For the monitoring study, three *kebeles* (Kokite, Shinfa and Tumet) were purposely selected. These *kebeles* were selected based on (1) their representativeness with respect to Gumz and Rutana, and their crossbred sheep population in the area; (2) accessibility of the site for easy and regular monitoring of study animals. Ten farmers from each *kebeles* who have two or more pregnant ewes from each breed were consulted to involve their ewes in the monitoring study. A total of 30 sheep owners and 152 ewes were involved in the monitoring study. Information about the age and parity of dams were determined by examination of eruption of the permanent incisors and also most importantly by questioning of the herd owners. Animals used for this study were owned by smallholder farmers and kept under extensive management systems. Among the lambs born to the ewes involved in the study, a total of 180 (56 Rutana, 69 Gumz, and 55 crossbred) lambs were monitored. Data were collected by trained enumerators recruited from the locality and supervision was made biweekly by researcher on growth record for 12 months.

Traits Studied

Growth records were taken for traits measured from birth to yearling age of the lambs. Litter size at birth, sex of lambs, birth weight, pre-weaning and post-weaning weight and yearling live weight of lambs were recorded. Birth weights of lambs were recorded soon after birth and at every two weeks interval up to 90 days of age and at monthly interval thereafter. Lambs were identified by individual ear tags. Body weight was recorded using a spring balance (50 kg capacity) where the animals were held in a sac and hanged by the balance.

Data Management and Analysis

Growth traits were analyzed using the Mixed Procedure in SAS (2009). Preliminary mixed analyses were applied to identify significant sources of variation. Breed (Rutana, Gumz, and Crossbred lambs), sex (male and female), parity (1, 2, 3, 4 and 5), birth type (single and twins), season of birth mainly rainy season [June-September], dry season [October-May] were included in the model. Tukey-Kramer test was conducted to compare least squares means. "The statistical model used was: $Y_{ijklmn} = \mu + B_i + G_j + P_k + T_l + S_m + e_{ijklmn}$

Where: Y_{ijklmn}: the observation on n^{th} animal belonging to m^{th} season, l^{th} birth type, k^{th} parity, j^{th} gender and i^{th} breed for weights at different ages, μ: overall mean, B_i: fixed effect of breed (i=Gumz, Rutana and Rutana×Gumz crossbreds), G_j: fixed effect of lamb sex (j=male and female), P_k: fixed effect of ewe's parity (k=1,2,3,4 and 5), T_l: fixed effect of lamb birth type (l=single and multiple), S_M: fixed effect of lamb birth season (m=dry and wet) and e_{ijklmn}: random error." In the preliminary analysis the two-way interactions were not significant, and therefore, excluded.

Results and Discussion

Birth Weight

Breed was a significant ($P<0.001$) source of variation for birth weight where the Rutana and Rutana x Gumz crossbred lambs were respectively, 0.87 kg and 0.38 kg heavier at birth than the Gumz lambs (Table 1). The birth weight of Gumz sheep recorded in this study was comparable to the birth weight of Washera sheep (2.69 kg, Mengistie *et al*., 2009), Afar sheep (2.7 kg, Yibrah, 2008) and heavier than that of Horro sheep (2.43 kg, Kassahun, 2000), Blackhead Somali sheep (2.5 kg, Fekerte, 2008) and Farta sheep (2.5 kg, Shigidafe *et al*., 2013). The birth weight of Rutana sheep in the present study is comparable to the desert sheep under range condition in the Sudan (3.72 kg, El Hage *et al*., 2001), but higher than the birth weight reported by Sulieman *et al*. (1991) for desert Sudan sheep (3.62 kg). Mansour *et al*. (1992) reported a birth weight of 4.3, 4.5, and 3.3 kg for Shugor, Dubasi, and Watish eco-types of desert

sheep, respectively. The humid lowland agro-ecology of the study area is markedly different from the desert range condition of the natural habitat of the Rutana breed, and this is expected to affect growth performance of the breed. The birth weights of the Rutana-Gumz crossbred lambs are comparable to earlier reports for Lacaune-Timahdite crossbred lambs (3.06 kg) in Morocco (Boujenane and Kansari, 2002), better than reports for Washera-Farta crossbred lambs (2.59 kg) in north western Ethiopia (Shigidafe *et al.*, 2013), but lighter than that reported by Macit *et al.* (2001) for Awassi-Morkaraman crossbred lambs (2.63 kg). It is well documented that birth weight of lambs is different among breeds (Yimam *et al.*, 2004; Mesfin *et al.*, 2014b). Birth weights of lambs were reported to have a correlation to weight at three months and a lesser correlation with later ages (Muir *et al.*, 2000; Hanford *et al.*, 2003). The higher weaning weight might be explained by the study of Petrovic *et al.* (2013) who indicated that higher body weight of lambs at birth gives greater possible strength for growth in early months of age, in contrast to lambs with less weight and thus less power of growth. Ata and Hamed (2015) also stated that lambs born with greater weight at birth had a higher weaning weight. The present study confirms these findings and indicates that heavier lambs at birth attain larger weights after births, which signify the advantage of having heavier lambs at birth for higher consequent performance of lambs. This is explained by the fact that birth weight has higher correlation with weights at weaning and after weaning.

Table 1. Estimated least squares mean of body weights (kg) at birth, one, two, and three months of age across the breeds, sex, parities, type of birth and seasons of birth of lamb

Variables	Sub-class	Birth wt, kg		One month wt, kg		Two month wt, kg		Three month wt, kg	
		N	LSM±SE	N	LSM±SE	N	LSM±SE	N	LSM±SE
	Overall means	180	3.33±0.4	165	6.95±0.75	154	11.32±0.7	147	13.6±0.72
Breed	Rutana	56	3.71±0.07^{a}	51	7.48±0.11^{a}	46	13.52±0.19^{a}	44	14.40±0.23^{a}
	Gumz	69	2.84±0.06^{b}	58	6.37±0.10^{b}	57	9.35±0.17^{b}	54	12.04±0.21^{b}
	Crossbred	55	3.22±0.06^{ab}	56	6.76±0.10^{ab}	51	11.14±0.18^{ab}	49	13.03±0.22^{ab}
			0.001		0.001		0.001		0.001
Sex	Male	100	3.51±0.05^{a}	83	7.14±0.09^{a}	78	11.53±0.15	77	13.44±0.18^{a}
	Female	80	3.00±0.055^{b}	82	6.60±0.08^{b}	76	11.15±0.14	70	12.86±0.17^{b}
			0.001		0.001		Ns		0.020
Parity	1	35	2.57±0.08^{b}	32	6.11±0.13^{b}	31	9.98±0.23^{b}	30	11.32±0.28^{b}
	2	38	2.88±0.08^{b}	35	6.76±0.12^{b}	33	10.29±0.21^{ab}	31	12.54±0.26^{b}
	3	32	3.32±0.08^{ab}	29	7.00±0.14^{ab}	27	11.48±0.24^{ab}	26	12.96±0.29^{ab}
	4	38	3.45±0.08^{ab}	35	7.21±0.13^{a}	34	12.20±0.22^{a}	31	13.90±0.28^{ab}
	5	37	4.04±0.08^{a}	34	7.26±0.13^{a}	29	12.74±0.23^{a}	29	15.04±0.28^{a}
			0.001		0.001		0.001		0.001
Type of birth	Single	124	3.43±0.04^{a}	116	7.03±0.07^{a}	109	11.59±0.12^{a}	106	13.50±0.14^{a}
	Multiple	56	3.08±0.06^{b}	49	6.70±0.10^{b}	45	11.08±0.18^{b}	41	12.81±0.22^{b}
			0.001		0.010		0.021		0.011
Season of birth	Wet season	107	3.33±0.05^{a}	98	7.05±0.07^{a}	91	11.55±0.13^{a}	86	13.43±0.16^{a}
	Dry season	73	3.18±0.05^{b}	67	6.69±0.09^{b}	63	11.12±0.16^{b}	61	12.87±0.19^{b}
			0.046		0.003		0.038		0.029
	SEM		0.06		0.08		0.21		0.19
	CV (%)		14.62	165	10.53	154	10.67	147	10.74

Means with different letter in column within variable are significantly different; CV= Coefficient(s) of variation; N= Number of observations.

Male lambs were heavier than female lambs at birth. Other researchers (Kassahun, 2000; Markos, 2006; Mengistie *et al.*, 2009) have widely documented similar results. The differences in birth weights observed between the sexes might be due to difference in testosterone secretion between male and female. However, sexual dimorphism in body weight is more important during post weaning period than the pre-weaning. Birth weight at parity one and two were significantly (P<0.001) lighter than the other parities. This result was in line with several reports on other breeds (Gbangboche *et al.*, 2006; Bosso *et al.*, 2007). The type of birth also had significant (P<0.001) effect on birth weight in which single born lambs were heavier than their twin (3.42±0.04 kg versus 3.22±0.07 kg) born contemporaries. This could be due to scarcity of resources when the fetus is twins than single in the uterus. Other authors have also obtained similar results for Gumz (Solomon *et al.*, 2011) and Washera sheep (Mengistie *et al.*, 2009; Shigidafe *et al.*, 2013). Lambs born in the wet season were significantly (P<0.05) heavier than those born in the dry seasons. The significant influence of season on birth weight of lambs in this study was consistent with the results from

previous studies (El-Hage *et al*., 2001; Gbangboche *et al*., 2011). The heavier birth weight at wet season was attributed to the presence of feed due to short rainy season at early conception period and during pregnancy period.

Pre-weaning Weights

Variation among breeds in lamb weight at one month, two months, and three months were significant (P<0.001) (Table 1). As noted in the current study, the weight of Rutana breed at one month of age was higher than the values reported by Sulieman *et al.* (1991) for desert sheep. The values for Gumz sheep is close to those previously reported for the same breed by Solomon *et al.* (2011). Weaning weight obtained for Gumz sheep in the present study were also in comparison with Afar and Washera sheep (Yibrah, 2008; Mengistie *et al*., 2009), while heavier than Horro and Menz sheep breeds (Markos *et al*., 2004). The growth rate of young lambs depends almost entirely on the ewes' milk yield, lamb milk intake, and quality and quantity of feed available for ewes and lambs. This indicated that providing Rutana lambs with supplementary feeds and adequate management during pre-weaning growth period could increase weaning weights.

Sex was important sources of variation at weaning age and male were superior to females, while its effect was not significant at two months of age. The sex differences are consistent with results from previous studies (Yilmaz *et al*., 2007; Idris *et al*., 2011). On the contrary, Mengistie *et al.* (2009) and El-Toum (2005) indicated that lamb sex had no significant effect at one month, two month, and three month of ages. Single born lambs also maintained high body weights at ages of one and two months with significant difference. Several researchers reported effect of type of birth on body weight at different ages (El-Toum, 2005; Cloete *et al*., 2007; Idris, 2008). This difference could be due to the fact that single born lambs are the sole users of the milk from their dam in comparison with twins (Markos, 2006). Lambs born during the wet season had heavier weights at weaning age due to accessibility of a variety of grasses in the large areas of the rangelands and hence better milk yield of dams during later parts of the wet season. Yimam *et al.* (2004) showed that lambs born in the wet season were heavier at weaning and grew faster than those born in the light rainfall and the dry season.

Post-weaning Weights

Estimates of least squares means of body weights of lambs at six month, nine month and yearling age are presented in Table 2. The live weight of Gumz sheep at six month was higher than that reported for Menz sheep (Niftalem, 1990) under on-farm conditions and similar to that for Washera under on-farm and Horro under on-station management (Solomon *et al*., 2002). Rutana-Gumz crossbred lambs were heavier than the Gumz lambs at six months of age. This could indicate the benefit of heterosis in crossbreeding to improve the performance of Gumz sheep. Therefore, alternative breeding strategies need to be assessed to improve the growth performance of the adapted Gumz breed.

The advantage of crossbreds over the pure Gumz in six month weight (1.68 kg) could be narrowed through selective breeding. The study of Solomon *et al.* (2014) indicated the importance of selective breeding. In their work on village-based selective breeding of Menz sheep, they obtained about 2.46 kg improvement in six month weight at the third generation over the base generation. The results obtained for Rutana sheep at nine month of age from present study was similar with the study of Mansour *et al.* (1993) for desert sheep. The live weight at nine month of age for crossbred sheep was higher than body weights of Washera-Farta crossbred sheep at nine months of age, but it was lower than the Awassi and Dorper crossbred sheep (Yimam *et al*., 2004; Shigdafe *et al*., 2013). The differences in live weights between the results of this study and those reported in the literature may be attributed to the breed differences in terms of their growth potential and level of management.

The yearling weights (24.17 kg) of Gumz in the present study is higher than Horro (19.98±0.12 kg), Hararghe Highland (17.9±0.37kg), Blackhead Ogaden (17.3±0.52 kg) and comparable with Begait yearling sheep (24.2±1.1 kg) under on-farm management (Bahran, 2014; Tagaynesh, 2014; Abraham, 2015; Fasil, 2015). Likewise, the yearling weight of Rutana was comparable to the results of Mohammed and Yagoub *et al.* (2016) who reported 27 kg yearling weight for Sudan desert sheep. The finding indicated that the Rutana and their crossbred have comparative and encouraging yearling weight and show that the breeds could attain the required export market weight if the management practice is improved.

The influence of breed was significant (P<0.001) at yearling ages in which the Rutana lambs were heavier than the Gumz and their crosses. Even though growth performance of Gumz sheep is lower than Rutana, it had higher growth performance than most local sheep breeds and comparable with Begait sheep breed. The effect of breed on yearling weight is also documented (Solomon *et al*., 2002; Yimam *et al*., 2004; Shigdafe *et al*., 2013, Mesfin *et al*., 2014b). Sex of lambs was an important factor affecting weight, with males being 0.9 kg and 1.3 kg heavier than females at six month and yearling, respectively.

The significant influence of sex observed in the present study was in agreement with results of previous studies at various locations in different breeds of sheep (Gemeda *et al.,* 2002; Markos, 2006; Yilmaz *et al*., 2007; Mengistie *et al*., 2009; Tibin and Bushara, 2011). The difference between live weights by sexes at the given age may be attributed to the action of sex hormones that favor male growth performance. Single born lambs had maintained their weight superiority to twins at six month and yearling age, which is in line with other reports (Morsy, 2002; Yilmaz *et al*., 2007; Mengistie *et*

al., 2009). Lambs born in wet season were heavier than lambs born in the dry season at six month and yearling ages. The heavier weight for lambs born in wet season is due to the feed availability during wet season in the rangelands of the north western lowlands (Tesfaye *et al*., 2010).

Table 2. Estimated least squares means of body weights (kg) at six, nine and 12 months of age across the breeds, sex, parities, type of birth and seasons of birth of lamb

Variables	Subclass	Six month wt, kg		Nine month wt, kg		Yearling wt, kg	
		N	LSM±SE	N	LSM±SE	N	LSM±SE
	Overall means	142	17.52±1.82	139	21.77±0.08	135	26.27±0.08
Breed	Rutana	44	18.93±0.29^{a}	41	23.29±0.37^{a}	40	27.62±0.36^{a}
	Gumz	53	15.77±0.28^{b}	53	19.96±0.35^{b}	52	24.17±0.34^{b}
	Crossbred	45	17.45±0.29^{ab}	45	21.91±0.37^{ab}	43	26.31±0.37^{ab}
			0.001		0.001		0.001
Sex	Male	74	17.83±0.24^{a}	73	22.40±0.30^{a}	71	26.70±0.29^{a}
	Female	68	16.94±0.23^{b}	66	21.04±0.29^{b}	64	25.36±0.28^{b}
			0.007		0.001		0.001
Parity	1	30	16.86±0.36^{b}	29	20.25±0.45^{b}	27	25.37±0.45^{b}
	2	29	16.9±0.35^{b}	29	21.12±0.43^{b}	29	25.56±0.41^{b}
	3	26	17.17±0.37^{ab}	25	21.37±0.47^{ab}	23	25.66±0.47^{b}
	4	29	17.64±0.37^{ab}	28	22.73±0.46^{ab}	28	26.13±0.46^{ab}
	5	28	18.33±0.37^{a}	28	23.13±0.46^{a}	28	27.44±0.44^{a}
			0.047		0.002		0.015
Type of birth	Single	103	17.74±0.18^{a}	101	22.06±0.23	99	26.52±0.22^{a}
	Multiple	39	17.05±0.29^{b}	38	21.37±0.36	36	25.54±0.36^{b}
			0.043		0.12		0.026
Season of birth	Wet season	83	17.73±0.22^{a}	80	21.67±0.27	79	26.597±0.27^{a}
	Dry season	59	17.03±0.25^{b}	59	21.77±0.31	56	25.47±0.31^{b}
			0.031		0.80		0.005
	SEM		0.21		0.25		0.26
	CV (%)	142	10.43	139	10.32	135	8.36

Means with different letter in column within variable are significantly different; CV= Coefficient(s) of variation; N= Number of observations.

Pre-weaning Growth Rate

The pre-weaning average daily weight gain of lambs was significantly (P<0.05) affected by breed. The Rutana lambs gained more than the Gumz and crossbred lambs from birth to one-month of age. This is in accordance with Shigdafe *et al.* (2013) who found significant breed effects on daily weight gain during pre-weaning growth rates. The rate of weight gain from birth to one month of age for the present breeds were lower than weight gain reported for Washera lambs (Mengistie *et al*., 2009) but higher than 84.79±4.65 g, 64.53±9.75 g and 82.21±5.61 g reported for Washera, Farta, and their crosses, respectively under traditional management (Shigdafe *et al*., 2013).

The pre-weaning average daily weight gain for Gumz lambs in this study is lower than 109 g reported by Solomon *et al.* (2011). This indicates that sheep in the present study had suboptimal conditions in nutrition and management compared to previous studies. Birth type has significant effect (P<0.05) on pre-weaning growth rate from birth to one month of age. It may be attributed to availability of more milk to lambs as single vis-à-vis twins. Markos (2006), Mengistie *et al.* (2009), Shigdafe *et al.* (2013) and Tsegay *et al.* (2013) also documented the significant influence of birth type on pre-weaning daily weight gain of lambs.

Post-weaning Growth Rate

The post-weaning growth rate from weaning to six months was lower than on-farm performance results of Washera, Farta, and their crossbred sheep (Shigdafe *et al*., 2013). The Rutana lambs gained higher than the Gumz, and crossbred sheep from weaning to six months of age. Similar findings of the effect of breed on average daily weight gain were reported by Marzouk and Mousa (1998) and Abd-Allah (2005).

Despite the superiority of males, there was no significant difference between males and females in average daily weight gain during the post-weaning period. These results are in agreement with Sulieman *et al.* (1991) and Marzouk and Mousa (1998) who found that the effect of sex on daily weight gain was not significant. Single and twins born lambs were not significantly different (P>0.05) during post-weaning average daily weight gain. The overall mean daily weight gain from birth to yearling was higher than the values reported for Washera, Menz, and Horro sheep (Kassahun, 2000; Mengistie *et al*., 2009). The present study revealed that breed effect was statistically significant (P<0.001) for overall growth rate in which the Rutana lambs gained higher than Gumz and their crossbred sheep. Average daily weight gain for Gumz lambs from birth to yearling were lower than the values reported for Washera but higher than the Farta sheep

and their crosses with Washera (Shigdafe *et al*., 2013). Sex has also significant (P<0.01) influence on daily weight gain of lambs from six months up to yearling. This might be due to the high amount of testosterone hormone produced in male lambs which may increase the quantity of feed taken by lambs. Single born lambs and twins were not significantly different (P >0.05) in pre-weaning average daily weight gain. This confirms the influence of birth weight on subsequent growth performance of lambs, which is also related to birth type. Birth season was also significant source of variation (P<0.01) for overall growth rate.

Table 3. Estimated least squares means of average daily gain (g/day) in body weights from birth to 30, birth to 90, 90 to 180 days, and birth to 360 days of age across the breeds, sex, parities, type of birth and seasons of birth of lamb

Variables	Sub-class	Birth to 30 days		Birth to 90 days		90 to 180 days		Birth to 360 days	
		N	LSM±SE	N	LSM±SE	N	LSM±SE	N	LSM±SE
	Overall means	165	117.18±27.8	147	110.16±16.3	142	51.79±21	135	62.76±5.99
Breed	Rutana	51	122.91±4.19[a]	44	118.05±2.67[a]	44	59.01±3.44[a]	42	65.41±1.01[a]
	Gumz	58	108.76±3.97[b]	58	100.21±2.48[c]	53	46.34±3.29[c]	52	58.45±0.94[c]
	Crossbred	56	112.35±4.03[b]	45	107.78±2.66[b]	45	52.15±3.36[b]	41	62.82±1.02[b]
			0.039		0.001		0.033		0.001
Sex	Male	83	116.30±3.42	77	110.19±2.16	74	53.79±2.8	71	63.58±0.82[a]
	Female	82	113.05±3.19	70	107.18±2.10	68	51.22±2.7	64	60.87±0.79[b]
			0.472		0.300		0.492		0.015
Type of birth	Single	115	119.45±2.66[a]	107	110.84±1.97[a]	104	51.85±2.2	99	63.27±0.63
	Multiple	50	109.90±4.05[b]	40	106.52±2.27[b]		53.1±3.4	36	61.19±1.01
			0.048		0.037		0.749		0.086
Season of birth	Wet season	98	118.22±3.01	86	112.01±1.66	83	50.89±2.5	79	63.52±0.74[a]
	Dry season	67	111.13±3.62	61	105.34±2.68	59	54.11±2.9	56	60.93±0.85[b]
			0.124		0.135		0.389		0.018
	SEM		2.26		1.77		185		1.18
	CV (%)	165	23.7	147	14.8	142	40.6	135	9.54

Means with different letter in the column within variables are significantly different; CV= Coefficient(s) of variation; N= Number of observations.

Conclusion

Results of this study indicated that Rutana sheep has better growth performance as compared to Gumz sheep breed. The pre-weaning and post-weaning growth rates of Rutana lambs are higher than Gumz lambs. The growth performance of crossbred lambs was better than Gumz but lower than Rutana sheep. These characteristics make the Rutana and their crossbred sheep to be economically more important, and may affect the interest of keeping Gumz sheep breed by the community. It is likely that the Gumz sheep breed will be threatened in the near future due to dominance of the Rutana sheep in the mixed flock and preference of Rutana and its crosses in the local and international markets. Gumz breed is a unique genetic resource and the only thin tailed sheep breed in Ethiopia. Hence, conservation-based breeding program including improvement of local Gumz sheep through selective breeding needs to be designed.

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Conflict of Interests

The authors declare that they have no competing interests.

References

Abd-Allah, M. (2005). Effects of crossbreeding between Chios and Rahmani sheep on some productive and reproductive traits, MSc Thesis, El-Minia University, Egypt.

Abraham Teklehaymanot (2015). Supplementation of tsara (*Pterocarpus lucens*) and pigeon pea (*Cajanes cajan*) leaves and concentrate mixture on growth performance and carcass characteristics of Begait sheep fed hay as a basal diet, MSc Thesis, Haramaya University, Haramaya, Ethiopia.

Ali, M. A. (2003). Body measurements, performance and meat characteristics of the desert sheep in the Sudan, PhD Thesis, University of Gezira, Wad Medani, Sudan.

Ata, M. & Hamed, H. (2015). Relationship between birth weight and body growth of Awassi lambs during early weaning. *Journal of Biology, Agriculture and Healthcare*, 3: 5-9.

Bahran Fikrae (2014). Effect of cassava leaf meal substitution on feed intake, digestibility, body weight gain and carcass parameters in Horo yearling sheep, MSc Thesis, Haramaya University, Haramaya, Ethiopia.

Bosso, N. A., Cisse, M. F., vander Waaij, E. H., Fall, A. & van Arendonk, J. A. M. (2007). Genetic and phenotypic parameters of body weight in West Africa Dwarf goat and Djallonke sheep. *Small Ruminant Research*, 67: 271-278.

Boujenane, I. & Kansari, J. (2002). Lamb production and its components from purebred and crossbred mating types. *Small Ruminant Research*, 43 (1): 15-20.

Cloete, J. J. E., Cloete, S.W. P., Olivier, J. J. & Hoffman, L. C. (2007). Terminal crossbreeding of Dorper ewes to Ile de France, Merino Landsheep and SA mutton Merino sires: Ewe production and lamb performance. *Small Ruminant Research*, 69: 28-35.

CSA (Central Statistics Agency) (2015). Agricultural Sample Survey 2014/15. Volume II report on livestock and livestock characteristics (private peasant holdings). Central Statistical Agency (CSA), Addis Ababa, Ethiopia.

DAGRIS (The Domestic Animal Genetic Resources System) 2006. Retrived from http://dagris.ilri.cgiar.org/distlist.aspSC=1&GC=&BN=&RC=&SRC=&CC=70

Dahab, O. A., Ishag, I. A. & Ahmed, M. K. (2014). The Hamari sheep production systems in Darfur and Kordofan. *Merit Research Journal of Agricultural Science and Soil Sciences*, 2 (4): 057-063.

El-Hage, F. M., Fadlalla, B. & Mukhrar, H. K. (2001). Some production characteristics of Sudanese desert sheep under range condition in North Kordofan, Sudan. *Tropical Animal Health and Production*, 33: 229-239.

El-Toum, A. (2005). Effect of pre-partum supplementary feeding on desert ewe productivity under rangelands in North Kordofan, Sudan, MSc Thesis (Animal production), University of Khartoum, Sudan.

Fasil Negussie (2015). Effects of different feeding regimes on the performance of Blackhead Ogaden sheep, PhD Dissertation, Haramaya University, Haramaya, Ethiopia.

Fekerte Ferew (2008). On-farm characterization of Blackhead Somali sheep breed and its production system in Shinile and Erer districts of Shinile Zone, MSc Thesis, Haramaya University, Haramaya, Ethiopia.

Gbangboche, A. B., Adamou, M., Youssao, A. K., Farnir, F., Detilleux, J., Abiola, F. A. & Leroy, P. L. (2006). Non-genetic factors affecting the reproduction performance, lamb growth and productivity indices of Djallonke sheep. *Small Ruminant Research*, 64: 133-142.

Gbangboche, A. B., Alkoiret, T. L., Salifou, S., Leroy, O. L. & Abiola, F. A. (2011). Growth pattern of purebred West African Dwarf sheep and its crosses with the West African Long Legged. *Research Journal of Animal Sciences*, 5: 6-13.

Gemeda Duguma, Schoeman, S. J., Cloete, S. W. P. & Jordan, G. F. (2002). The influence of non-genetic factors on early growth traits in the Tygerhoek Merino lambs. *Ethiopian Journal of Animal Production*, 2: 127-141.

Hanford, K. J., Van Vleck, L. D. & Snowde, G. D. (2003). Estimates of genetic parameters and genetic change for reproduction, weight, and wool characteristics of Targhee sheep. *Journal of Animal Science*, 81: 630-640.

Idris, A. Osman (2008). The effect of feed supplementation strategies on productive and reproductive performance of desert sheep in the rangeland of Kordofan, Sudan, PhD Thesis, University of Khartoum.

Idris, A., Kijora, C., El-Hag, F., Salih, A. & Bushara, I. (2011). The effect of feed supplementation on the productive and reproductive performance of desert ewes in rangeland of Kordofan, Sudan, conference on International Research on Food Security, Natural Resource Management and Rural Development.

Kassahun Awgichew (2000). Comparative performance evaluation of Horro and Menz sheep of Ethiopia under grazing and intensive feeding condition, PhD Dissertation, Humboldt University.

Macit, M., Karaoglu, M., Esenbuga, N., Kopuzlu, S. & Dayioglu, H. (2001). Growth performance of purebred Awassi, Morkaraman and Tushin lambs and their crosses under semi-intensive management in Turkey. *Small Ruminant Research*, 41: 77-180.

Mansour, M. A., Sulieman, A. H. & Ali, T. E. (1993). The effect of breed and different ratios of groundnut haydura on performance and carcass composition of Sudan desert sheep. *Sudan Journal of Animal Production*, 6: 1-11.

Mansour, M. E., Sulieman, A. H. & Ali, I. E. (1992). A note on growth of some different types of Sudan lambs from birth to weaning. *Sudan Journal of Animal Production*, 5: 87-91.

Markos Tibbo (2006). Productivity and health of indigenous sheep breeds and crossbreds in the central Ethiopian highlands, PhD Thesis, Swedish University of Agricultural Sciences, Uppsala.

Markos Tibbo, Workeneh Ayalew, Kassahun Awgichew, Ewenetu Ermias & Rege, J. E. O. (2004). On-station characterisation of indigenous Menz and Horro sheep breeds in the central highlands of Ethiopia. *FAO/UNEP. Animal Genetic Resources Information*, 35: 61-74.

Marzouk, K. M. & Mousa, M. T. (1998). A study on some economic characteristics in Awassi sheep in Egypt. *Journal of Agricultural Sciences*, 23: 4773-4780.

Mengistie Taye, Girma Abebe, Solomon Gizaw, Sisay Lemma, Abebe Mekoya & Markose Tibbo (2009). Growth performances of Washera sheep under small holder management systems in Yilmanadensa

and Quarit districts, Ethiopia. *Tropical Animal Health and Production*, 42 (4): 659-667.

Mengiste Taye, Girma Abebe, Solomon Gizaw, Sisay Lemma, Abebe Mekoya & Markos Tibbo (2010). Traditional management systems and linear body measurements of Washera sheep in the Western highlands of the Amhara National Regional State, Ethiopia. *Livestock Research Rural Development,* 22 (169).

Mesfin Lakew, Mussie Haile-Melekot, Getinet Mekuriaw, Solomon Abreha & Haimanot Setotaw (2014a). Reproductive performance and mortality rate in local and Dorper × local crossbred sheep following controlled breeding in Ethiopia. *Open Journal of Animal Sciences*, 4: 278-284.

Mesfin Lakew, Mussie Haile-melekote & Getinet Mekuriaw (2014b). Evaluation of growth performance of local and Dorper x local crossbred sheep in Eastern Amhara Region, Ethiopia. *Iranian Journal of Applied Animal Science*, 4: 123-126.

Mohammed, A. (2015). Study of sheep mortality, under traditional management in North Kordofan State, Sudan. *International Journal of Education and Research*, 3: 1-9.

Mohammed, A. H. & Yagoub, M. Y. (2016). Effect of Concentrate supplementation on the performance and carcass characteristics of natural grazing Sudanese desert lambs. *Journal of Agricultural Science and Engineering*, 2 (1): 1-4.

Morsy, A. H. (2002). Evaluation of prolific and non-prolific breeds of sheep under the environmental condition of middle Egypt, PhD Thesis, Faculty of Agriculture, El-Minia University.

Muir, P. D., Smith, N. B., Wallace, G. L., Fugle, C. J. & Bown, M. D. (2000). Maximizing lamb growth rates. In: Proceedings of the New Zealand Grassland Association, 62: 55-58.

Niftalem Dibessa (1990). On-farm study of the reproduction and growth performance of Menz sheep around Debre Brhan area, MSc Thesis, Alemaya University, Dire Dawa, Ethiopia.

Petrovic, V. C., Ilic, Z. Z., Petrovic, A. M. P., Spasic, Z. L. J., Petrovic, M. M. & Muslic, D. (2013). Study of the growth traits relationship of lambs in the postnatal development. *Bulgarian Journal of Science*, 19: 801-805.

SAS (2009). Statistical Analysis Systems for mixed models. SAS Institute Inc., Cary, USA.

Shigdafe Mekuriaw, Zeleke Mekuriaw, Asresu Yitayewu, Mengistie Taye, Habetemariam Assefa & Aynalem Haile (2013). Growth performance and linear body measurements of Washera, Farta and their crossbreed sheep under farmers management system in Western highland of Amhara Region. *Scientific Journal of Veterinary Advances*, 9: 132-143.

Sisay Lemma (2009). Phenotypic classification and description of indigenous sheep type in the Amhara National Regional State of Ethiopia, MSc Thesis, Haramaya University, Haramaya, Ethiopia.

Solomon Abegaz, Gemeda Duguma, Nigussie, E., Ulfina Gelmesa, Terefe, F. & Rege, J. E. O. (2002). Factors affecting reproductive performance and estimates of genetic parameters of litter size in Horro sheep. *Journal of Agricultural Science*, 139: 79-85.

Solomon Abegaz, Hegde, B. P. & Mengistie Taye (2011). Growth and physical body characteristics of Gumuz sheep under traditional management systems in Amhara Regional State, Ethiopia. *Livestock Research for Rural Development*, 23: 1-5.

Solomon Gizaw (2008). Sheep resources of ethiopia: genetic diversity and breeding strategy, PhD Thesis, Wageningen University, Wageningen.

Solomon Gizaw, Van Arendonk, J. A. M., Komen, M. H., Windig, J. J. & Hanotte, O. (2007). Population structure, genetic variation and morphological diversity in indigenous sheep of Ethiopia. *Animal Genetics*, 38: 621-628.

Solomon Gizaw, van Arendonk, J. A. M, Valle, Z. A., Haile, A., Rischkowsky, B., Taddele Dessie & Mwai, A. O. (2014). Breeding programmes for smallholder sheep farming systems: II. Optimization of cooperative village breeding schemes. *Journal of Animal Breeding and Genetics*, 14: 1-8.

Sulieman, A. H., Sayers, A. R. & Wilson, T. R. (1991). Evaluation of Shugor, Dubasi and Watish of Sudan desert sheep at El-Huda National Sheep Research Station, Gezira Province, Sudan, ILCA Research Report No. 18, ILCA, Addis Ababa, Ethiopia.

Tadesse Habtamu & Afework Bekele (2008). Habitat association of insectivores and rodents of Alatish National Park, Northwestern Ethiopia. *Tropical Ecology*, 49: 1-11.

Tagaynesh Alemayoh (2014). Supplementation of sole wheat bran or its mixture with safflower seed cake on performance of Hararghe highland sheep fed grass hay basal diet, MSc Thesis, Haramaya University, Haramaya, Ethiopia.

Tesfaye Getachew, Ayinalem Haile, Markos Tibbo, Sharma, A. K., Sölkner, J. & Wurzinger, M. (2010). Herd management and breeding practices of sheep owners in a mixed crop-livestock and a pastoral system of Ethiopia. *African Journal of Agricultural Research*, 5: 685-691.

Tibin, I. M. & Bushara, I. (2011). Growth performance of desert sheep under grazing conditions in North Kordofan State. *Online Journal of Animal and Feed Research*, 2 (1): 45-49.

Tsegay Tekleberhane, Mengistu Urge, Yoseph Mekasha & Merga Bayesa (2013). Pre-weaning growth performance of crossbred lambs (Dorper × indigenous sheep breeds) under semi-intensive management in Eastern Ethiopia. *Tropical Animal Health and Production*, 46: 455-460.

Yibrah Yacob (2008). Environmental and genetic parameters of growth, reproductive and survival performance of Afar and Blackhead Somali sheep at Werer Agricultural Research Center, Fellowship report submitted to International Livestock

Research Institute (ILRI) and Ethiopian Institute of Agricultural Research (EIAR). Ethiopia.

Yilmaz, O., Denk, H. & Bayram, D. (2007). Effects of lambing season, sex and birth type on growth performance in Norduz lambs. *Small Ruminant Research*, 68: 336-339.

Yimam Hassen, Sölkner, J. & Fuerst-Waltl, B. (2004). Body weight of Awassi and indigenous Ethiopian sheep and their crosses. *Small Ruminant Research*, 4: 51-56.