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Community-Based Characterization of Simien Sheep Based on Growth Performance and Farmers' Breeding Objectives in Simien Mountains Region, Ethiopia

[1]Surafel Melaku, [2]Zeleke Mekuriaw, [3]Solomon Gizaw and [2]Mengistie Taye
[1]Gondar Agricultural Research Center, P.O. Box 1337, Gondar, Ethiopia
[2]College of Agricultural and Environmentaal Sciences, Bahir Dar University, P.O. Box 79 Bahir Dar, Ethiopia
[3]Debre Birhan Agricultural Research Center, P.O. Box 12, Debre Birhan, Ethiopia

Abstract: This study was aimed at characterizing Simien sheep based on growth characteristics and farmers' breeding objectives and selection criteria. A total of 63 households and 600 lambs from Miligebsa and Dara districts of Debark and Dabat woredas of North Gondar Zone in Amhara region, Ethiopia were registered and monitored. About 1 year and 5 months monitoring data on growth performance of the sheep was used for the study. Besides, group discussion and proportional piling tools of PRA were used to identify and prioritize farmers' breeding objectives and selection criteria. The overall least square mean birth weight of Simien sheep was 2.976±0.030 kg. The overall least square mean weights of Simien sheep at 3 and 6 months of age were 11.761±0.161 and 15.787±0.330 kg, respectively. The overall average daily gain in g/day between 0-90 days of age was found to be 97.364±1.735; birth to 6 months of age was 72.089±1.729 and weaning to 6 months of age was 52.843±4.662. Parity was significant ($p<0.05$) source of variation on body weight measurements. Birth type affected only birth weight and weaning weight. Body weight gains at early age were significantly affected by district, parity and birth type. Sex showed no significant effect ($p>0.05$) on most of weight traits of Simien sheep except on 6 months weight and ADG between birth to 6 months. The leading farmers' breeding objective was as source of cash income. Family performance took the 1st rank to select breeding rams and wider back area (shint) was considered as the most important criteria for selecting breeding ewes. The facts that the breed is superior to most of the sheep breeds in the country in terms of weight at early age and declines at later age signify that the sheep has good potential but there are influences by management and environmental factors. Thus, improvement of the general management condition can support the breed to express its full genetic potentials consistently at later stages of its growth. Further study on the reproductive performance of the sheep is suggested to investigate more details about the breed. Since, there exists high variations in body weight measurements at different ages within the breed, improvement by selection can be considered as good breeding strategy for Simien sheep.

Key words: Breed characterization, breeding-objectives, community-based, growth-performance, Simien sheep

INTRODUCTION

Animal genetic diversity is critical for food security and rural development. It allows farmers and researchers to select stock or develop new breeds in response to changing conditions including climate change, new or resurgent disease threats, new knowledge of human nutritional requirements, and changing market conditions or societal needs. All of these are largely unpredictable. What is predictable is increased future human demand for food. The effects will be most acute in developing countries where the increase in demand is expected to be at a rate faster than increases in production and will occur where climate change is projected to have its greatest impact. As part of the global biological diversity, there is an urgent need to conserve and preserve African animal genetic resources in order to meet the needs of future generations. Majority of developing countries, particularly in Africa, lack activities related to animal genetic resources. Most conservation activities in Africa have been directed towards plant and wild life genetic resources. Still little information exists on African Small Ruminant Genetic Resources (SRGR) in the FAO data bank. This is due to lack of suitable data recording facilities in most African countries. At present five breeds of sheep are already extinct, three breeds are endangered and 10 breeds are decreasing in number (FAO, 2006).

Corresponding Author: Surafel Melaku, Gondar Agricultural Research Center, P.O. Box 1337, Gondar, Ethiopia

Despite the availability of diverse sheep resources in Ethiopia, their productivity is low; the sector has not received a great deal of attention from scientists, administrators and legislators (Girma *et al*., 2000). The research approach has not also invited the end users for active participation. Improvements were too slow due to lack of identifying the actual on-farm situations and weighting the socio-economic and cultural benefits of the animals for the poor farmers. Farmers do make decisions not only from the point of view of profitability but also security, income generation and cultural values (Ayalew *et al*., 2001). The sheep breeds are characterized by low productivity in terms of growth rates, meat and milk production which can be attributed to overcrowding, poor nutrition and associated resultant stresses that provide a rich atmosphere for disease and serious production losses (Lemma, 2008).

Sheep production in the crop/livestock production systems of the highland areas has a very important role in contributing to food security as well as in generating direct cash income. Although, Ethiopia is endowed with the largest livestock genetic resource in Africa, so far very little has been done to identify and characterize the genotypes existing in the country (Setshwaelo, 1990). Study by Gizaw (2008) revealed the presence of high within population genetic diversity in Ethiopian sheep populations. Besides, he also pointed out that Simien sheep was significantly differentiated from all other sub-alpine sheep populations and the largest genetic distance was between Simien and Bonga sheep and the smallest distance was between Farta and Tikur sheep breeds.

Phenotypic characterization of indigenous sheep breeds in Amhara Region including Simien sheep was conducted by Lemma (2008). His study on Simien sheep as part of his study on classification of Sheep breeds in Amhara region concentrated on production system and morphological characterization. Moreover, Gizaw (2008) also included sample linear measurement data from Simien sheep breed while conducting molecular characterization and classification of Ethiopian sheep breeds. Both studies generated important knowledge on sheep breeds found in Ethiopia and Amhara region and on Simien sheep as well which can serve as important pathways for further studies on the sheep resources in the country.

Both studies were basically meant for classification purpose considering many breeds and covering vast areas. However, for full characterization of the breed, a monitoring study conducted through continuous data collection for longer period of time to evaluate the growth performance of the sheep breed through continuous follow up and data recording is lacking in previous studies. Besides, breeding objectives and selection criteria were not explained well. Furthermore, bringing previous results up to date through routine inventories and on-going monitoring are needed since genetic resources and production systems are dynamic (Solkner *et al*., 1998). Hence, it is possible to clearly observe that there were gaps on some details of Simien sheep which is the intention of the current study.

Thus, separate study on Simien sheep by giving due emphasis on growth performance and breeding objectives, selection criteria is of paramount importance to provide insightful knowledge on the breed so that recommendations on future breeding plans for improvement and conservation can be made confidently. Therefore, this study was conducted with the intention of characterizing Simien sheep breed under on farm conditions and full participation of the community with the objectives of characterizing Simien sheep using growth characteristics as well as identifying and defining farmers breeding objectives and selection criteria.

MATERIALS AND METHODS

Description of the study area: The research was conducted in Dabat and Debark districts of North Gondar administrative zone, Amhara region. Dabat and Debark district are found in Northeast direction of Gondar town about 800 and 840 km from Addis Ababa, respectively. The study area is generally situated in the Amhara plateau in the Western Simien Mountains between 13°11'N and 38°04'E with altitude ranging from 2,000-3,900 masl and rugged terrain and thus known as the roof of Africa near Ras Dashen mountains. The mean annual rainfall of the study area is 1,550 mm falling in to two wet seasons from February to March and July to September. Mean annual temperature ranges from a minimum of -2.5-4°C and that of maximum from 11-18°C. There is often dry wind during the day; frosts may occur at night and snow sometimes settles on the summit of Ras Dashen.

Generally, mixed crop livestock production system is practiced in the area where Barley is the dominant crop and sheep are more important animals in the area. The Simen mountains region floristically rich vegetation grows in four belts related to altitude: Afromontane forest, Hypericum woodland, Afromontane grassland and Afro-alpine moorland. Species in the latter two biomes show xeromorphic adaptations to extreme high altitude conditions and much speciation. However, the heavy overgrazing has eroded and degraded the grassland which is now very unproductive. In 1996, of 900 ha of Afro-alpine vegetation, 25% was heavily overgrazed, 60% heavily grazed and 15% more or less natural (Debonnet *et al*., 2006).

Animal management: All animals were kept under smallholder farmers' management condition. The sheep graze on natural pasture from communal grazing areas. Breeding in almost all cases is natural and uncontrolled and hence usually associated with year-round lambing except more concentrated lambing observed in some months of the year which may be due to feed and disease related differences. In the mean time while data collection, medical treatments including vaccination and drenching were offered for the flocks as incentive to facilitate monitoring and linear measurement data collections.

Data collection: A participatory data collection approach was followed. The community was sensitized about objectives, intentions and use of possible outcomes of the study for their genuine participation which in turn contributed for the quality of the data collected. Accordingly, community meetings were organized at each kebele, at the center of respective villages, before the commencement of actual field work. The local chiefs in each kebele were prior contacted and briefed on the rationale of conducting the meetings. The meetings were then called by and conducted. The meetings generally helped in establishing mutual understanding with the local people while avoiding unrealistic expectations. Besides, secondary data were collected from different sector bureaus in the woreda.

Growth performance data: A 1 year monitoring data (2009-2010) on Simien sheep growth performance was obtained from Gondar Agricultural Research Center and used for this study. Additional data on growth performance of these sheep was collected from the same sites on the same flocks for 5 more months in 2010/11. A total of 63 households were selected for monitoring activity; 32 farmers from Miligebsa and 31 from Dara kebeles were registered and about 378 and 370 lambs from Miligebsa and Dara kebeles, respectively were monitored. Data collected were birth weight, birth date, fortnight weight, parity, sex and birth type. Weight traits studied include birth weight, weaning weight, weight at 6 and 9 months of age and average daily gain from birth to weaning, from birth to 6 months from birth to 9 months from weaning to 6 months and from 6-9 months of age.

Data were collected by trained enumerators with close supervision by the researcher on a monthly basis at both kebeles. Identification was using plastic ear tags applied at birth or purchase of the sheep flocks. Growth performance data were taken every 15 days using Salter balance (50 kg capacity with 200 g precision) for lambs until 6 months of age and monthly for those above 6 months old. Birth date, birth weight, type of birth, sex of lamb and parity were collected within 24 h of lambing.

Parity for ewes that have lambed before the start of the project was recorded by asking the owner (Fig. 1 and 2). Average Daily Gain (ADG) at different ages was calculated using the following equation:

Fig. 1: Phenotypic appearance Simien sheep at younger age

Fig. 2: Phenotypic appearance of mature male and female Simien sheep

$$ADG = \frac{W(kg)-BW(kg)}{A} \times 1000$$

Where:

ADG = Average Daily Gain
W = Weaning weight, 6 and 9 months weight
BW = Birth Weight
A = Age in days or days between weighing dates

Identification of farmers' breeding objectives: Two Participatory Rural Appraisal (PRA) tools were used to define farmers' breeding objectives and selection criteria. The first tool employed was group discussion with focus-groups comprising 20 members established at each kebele. Members of the discussion groups constituted people that are believed to be knowledgeable on past and present social and economic status of the area, community elders, story tellers, all categories of living status and both sexes.

The other tool was a semi-quantitative method known as proportional piling using pebbles by which farmers' breeding objectives and selection criteria were prioritized. Each person was asked to allocate 20 pebbles to some functions of sheep and selection criteria of ewe and rams. While determining ratings of both breeding objectives and selection criteria, the total number of pebbles allocated by farmers for each breeding objective and selection criteria were used as the number of farmers was similar in all cases. Then, ranks were given based on order of obtained ratings. Moreover, Wilcoxon signed test was performed to check if there are significant differences between ratings to assign ranks (Gizaw, 2008).

Data management: The validity of information collected from the monitoring research activity was assessed thoroughly and corrections were made through repeated field visits and eventually the raw data were compiled and summarized using Excel 2007 computer program before analysis.

Analysis of growth traits: Analysis of Variance (ANOVA) of fixed effects on growth performance was done by the General Linear Model (GLM) procedure of Statistical Analysis System. Fixed effects were sex (male, female), birth type (single, multiple), District (Dara and Miligebsa), parity of ewes (1, 2,...,>7) and season (wet, dry) as wet season refers to months from June to October and dry season from November to May. When analysis of variance declared significance, least squares means were separated using Tukey test. The Statistical Model employed for growth performance was as follows:

$$Y_{ijklm} = \mu + D_i + B_{tj} + P_k + S_{nl} + S_{xm} + (PSx)_{km} + (PBt)_{kj} + b\,(Bwt_{ijklm}-Bwt) + e_{ijklm}$$

Where:

Y_{ijklmn} = The observations on birth weight, weight at different ages and ADG at different ages
μ = Overall mean
D_i = Fixed effect of ith district (i = Miligebsa, Dara)
P_k = Fixed effect of kth parity (k = 1, 2,..., 7)
Bt_j = Fixed effect of jth birth type (j = single, twin)
Sn_l = Fixed effect of lth birth season (l = dry, wet)
Sx_m = Fixed effect of mth sex (m = male, female)
$(Pbt)_{jk}$ = Interaction effect of parity and birth type on birth, weaning and 6 months weights
$(Psx)_{jm}$ = Interaction effect of parity and sex on birth, weaning and 6 months weights
b = Linear regression of birth weight on subsequent weights and growth rate
e_{ijklm} = Error effects

RESULTS AND DISCUSSION

Birth weight and weights at specific ages: The birth weight of Simien sheep is shown in Table 1. The overall least square mean birth weight of Simien sheep breed which was 2.97±0.03 kg was found to be superior to birth weight of most of the sheep breeds in the country reported by different researchers (Tibbo, 2006; Guangul, 2007; Taye *et al*., 2010; Shenkute, 2009).

Parity had significant effect ($p<0.05$) on birth weight. Birth weights of lambs born from ewes of 1st parity (2.816±0.054 kg) were significantly smaller ($p<0.001$) than those from 6th and 7th parities (3.053±0.046 kg and 3.021±0.077, respectively). This is in harmony with Awgichew (2000), Duguma *et al.* (2002) and Gardner *et al.* (2007) who reported the increase of lamb birth weight as dam's age increase to 6 years of age. Moreover, Kebede *et al.* (2005) found an increase in birth weight from first to the fourth parity (5 years).

Birth type had highly significant effect ($p<0.0001$) on birth weight. Single born lambs were significantly heavier than twin born lambs (3.103±0.020 vs. 2.849±0.055, respectively) which are in agreement with Tibbo (2006) who found out that lambs which were heavier at birth were usually singles. Moreover, there was highly significant ($p<0.0001$) parity by birth type interaction for lamb birth weight. Single born lambs from higher parity dams had significantly higher birth weight than those of twin born lambs from younger ewes. Sex, however, had no significant interaction with parity.

The overall least square mean weights of Simien sheep at different ages at 3 and 6 months of age obtained

Table 1: Factors affecting birth, weaning and six month weights of simien sheep

	Birth weight (kg)		90 days weight (kg)		180 days weight (kg)	
Sources of variation	N	LSM±SE	N	LSM±SE	N	LSM±SE
Overall	600	2.97±0.03	585	11.76±0.16	318	15.78±0.33
R^2	-	19	-	21	-	15
CV%	-	4.15	-	17.7	-	13.48
District	-	NS	-	**	-	NS
Dara	260	2.99±0.03	258	11.50±0.19	152	15.65±0.38
Miligebsa	340	2.96±0.03	327	12.02±0.18	166	15.92±0.40
Birth Season		NS		NS		NS
Dry	247	2.99±0.03	246	11.74±0.18	93	15.80±0.32
Wet	353	2.96±0.03	339	11.78±0.19	225	15.77±0.42
Parity	-	*	-	**	-	*
1	75	2.81 ± 0.05^{b}	71	11.05 ± 0.289^{b}	39	14.35±0.49
2	86	3.00 ± 0.05^{ab}	83	11.84 ± 0.28^{ab}	50	15.85±0.54
3	61	3.01 ± 0.06^{ab}	60	11.83 ± 0.31^{ab}	27	16.51±0.43
4	95	2.97 ± 0.05^{ab}	94	11.58 ± 0.28^{ab}	55	15.59±0.42
5	145	2.96 ± 0.04^{ab}	143	11.83 ± 0.21^{ab}	85	15.73±0.33
6	105	3.05 ± 0.04^{a}	101	12.40 ± 0.24^{a}	50	16.28±0.49
7	33	3.02 ± 0.07^{a}	33	11.78 ± 0.40^{ab}	12	16.19±1.39
Sex		NS	-	NS	-	*
Female	300	2.97±0.03	292	11.73±0.18	145	15.42±0.36
Male	300	2.97±0.03	293	11.79±0.19	173	16.15±0.3
Birth type		****	-	****	-	NS
Single	550	3.10±0.02	538	12.54±0.10	289	16.08±0.25
Multiple	50	2.85±0.05	47	10.98±0.30	29	15.49±0.54
Parity x Sex	-	NS	-	NS	-	***
Parity x Birth type	-	***	-	***	-	**
b (Bwt_{ijklm}- Bwt)	-	-	-	***	-	***

Means with different superscripts within the same column and class are statistically different; NS = Non Significant (p>0.05); *p<0.05; **p<0.01; ***p<0.001; ****p<0.0001; N = Number of observations

in this study are shown in Table 1. Birth type, district and parity had significant effect on weaning weight (p<0.01). Similarly, parity and sex significantly affected (p<0.05) 6 months weight. Unlike birth weight and weaning weight, 6 months weigh was not affected by birth type. Weaning weight of the Simien sheep were influenced by parity and birth type (p<0.0001) and weight at 6 months of age by birth type and district. The lightest weaning weight (11.051 kg) was found from ewes of 1st parity and weaning weight increased at 6th parity (12.403 kg). About 6 months weight of males was significantly higher (p<0.05) than those of females 16.148±0.367 vs. 15.427±0.364.

Single born lambs had significantly higher (p<0.0001) weaning and 6 months weight than their twin contemporaries (12.542±0.104 kg vs. 10.980±0.300 kg and 16.087±0.249 vs. 15.488±0.540 kg, respectively). The influence of birth type on weaning weight was depicted by many researchers (Awgichew, 2000; Duguma *et al*., 2002; Gbangboche *et al*., 2006).

Growth rates: The Average Daily weight Gains (ADG) of Simien sheep from birth to weaning, birth to 6 months, birth to 9 months, weaning to 6-9 months, of age are shown in Table 2. The overall ADG in gram per day (g/day) between birth age to weaning (0-90 days of age) was 97.364±1.735; birth to 6 months of age was 72.089±1.729 and 3-6 months of age was 52.843±4.662. The ADG of Simien sheep from birth to 3 months of age was found to be comparable with Washera, Afar and Black Head Somali breed (103.7, 98.5 and 97.8 g day^{-1}, respectively) according to Taye *et al*. (2010) and Yacob (2008) but much higher than Horro (78.0 g day^{-1}) and Menz sheep (72.6 g day^{-1}) as reported by Tibbo (2006).

Parity significantly affected pre-weaning weight gain (p<0.05) where the highest weight gain of lambs (103.586 g day^{-1}) was at 6th parity and the smallest at 1st parity. On the other hand, there was no significant parity effect on post-weaning weight gains (weaning to 6 months age). As far as sex is concerned, there was no significant difference (p>0.05) in body weight gain between male and female animals in Simien sheep at ages of birth to weaning and weaning to 6 month. But weight gain of males was significantly superior (p<0.05) to females at age of birth to 6 month weight. However, reports by many researchers revealed that, male lambs had consistent superiority over females (Duguma *et al*., 2002; Tibbo, 2006). But this agrees with the similar body weight gains observed between rams and ewes of Adilo sheep at different ages (Getahun, 2008). District affected body weight gain significantly (p<0.01) at age of birth to weaning.

Table 2: Factors affecting average daily gain (g day) from birth to 9 months of age

	ADG (0-90 days)		ADG (0-180 days)		ADG (90-180 days)	
Source of variation	N	LSM±SE	N	LSM±SE	N	LSM±SE
Overall	585	97.36±1.73	318	72.09±1.73	318	52.84±4.66
R^2	-	48.9	-	37.1	-	35.4
CV%	-	12.23	-	15.24	-	18.87
District	-	**	-	NS	-	NS
Dara	258	94.28±2.05	166	71.53±2.02	152	56.97±5.25
Miligebsa	327	100.45±1.99	152	72.64±2.11	166	48.71±6.33
Birth season	-	NS	-	NS	-	NS
Dry	246	96.90±2.00	93	71.40±1.69	93	52.07±4.87
Wet	339	89.89±2.05	225	72.77±2.23	225	53.61±6.25
Parity	-	*	-	*	-	NS
1	71	91.31 ± 3.10^{b}	39	65.48 ± 2.62^{b}	39	52.54±8.21
2	83	97.88 ± 3.03^{ab}	50	71.82 ± 2.83^{ab}	50	53.83±8.89
3	60	97.84 ± 3.33^{ab}	27	75.58 ± 2.28^{a}	27	49.01±7.14
4	94	95.21 ± 3.04^{ab}	55	71.09 ± 2.19^{ab}	55	58.17±7.17
5	143	98.52 ± 2.31^{ab}	85	71.67 ± 1.75^{ab}	85	54.72±5.69
6	101	103.58 ± 2.65^{a}	50	74.98 ± 2.57^{a}	50	48.78±7.82
7	33	97.18 ± 4.31^{ab}	-	-	-	-
Sex	-	NS	-	*	-	NS
Female	293	97.74±0.08	173	70.00±1.90	173	49.12±5.16
Male	292	96.98±0.09	145	74.17±1.92	145	56.56±5.56
Birth type	-	****	-	NS	-	NS
Single	538	104.83±1.11	289	72.83±1.30	289	52.43±3.30
Twin	47	89.89±3.22	29	71.34±2.83	29	53.25±8.46
Parity x Sex	-	NS	-	***	-	NS
Parity x Birth type	-	***	-	**	-	***
b (Bwt_{ijklm}-Bwt)	-	***	-	NS	-	NS

Means with different superscripts within the same column and class are statistically different at indicated p-value; NS = Non Significant (p>0.05); *p<0.05; **p<0.01; ****p<0.0001; N = Number of observations

Single born lambs gained more significantly than their twin contemporaries (104.83 vs. 89.89 g day^{-1}; p<0.0001) only at ages before weaning. Afterwards, no difference was observed between twin and single lambs in weight gain. Additionally, no significant effect of season on body weight gain of lambs was observed at all stages of growth.

Breeding objectives of Simien sheep: The sheep breeding objectives are ranked based on ratings given by farmers in Table 3. Accordingly, the leading farmers' purpose of sheep rearing is as source of cash income followed by insurance for risks. Furthermore, prestige or socio-cultural value, home consumption, manure as organic fertilizer, hides and fleece took third to seventh ranks based on sheep owners priority for objectives of sheep raring. The fact that farmers keep sheep mainly as source of cash income and as insurance against emergency is because they can be sold at any time for quick cash demand at the local markets (Moses, 2006). Sheep production in the study area contributes less to the diet of farmers as they are slaughtered occasionally for only some religious ceremonies in a year in harmony with Gizaw (2008).

Selection criteria for breeding rams: Prior to prioritizing, farmers were asked to list the traits used as selection criteria for both breeding rams and ewes. The ratings and ranks of farmers' selection criteria for breeding rams are displayed in Table 4. Family performance took the leading rank to select breeding rams according to farmers who rare Simien sheep. Good conformation or long height and attractive coat color are the next traits selected to be 2nd and 3rd selection criteria. Besides, large tail, large ears and long face are also considered as selection criteria for breeding rams but are less important traits.

Selection criteria of breeding ewes: Table 5 shows the priorities given by farmers for selecting breeding ewes. The first rated selection criteria was wider back area (shint) followed by attractive coat color. Good conformation, big udder size and short lambing interval in their order of importance were the other traits used by farmers to select their ewes that will mother their flock.

Twinning capacity of ewes was the list preferred trait by farmers which may be related to poor performance of twin lambs compared to singles due to incapability of ewes to nourish twins. Based on the growth monitoring data, litter size of Simien sheep was found to be 1.11 and the most commonly and frequently born lambs (88.6%) were single.

The fact that overall least square mean birth weight of Simien sheep breed was found to be superior to birth weight of most of the sheep breeds in the country reported by different researchers (Tibbo, 2006;

Table 3: Sheep producers' ratings and ranks for breeding objectives

Breeding objectives	Min.	Max.	Rating[1]	Rank[2]
Cash income source	4	7	113	1
Insurance for risks	2	5	81	2
Prestige/Socio-cultural values	3	4	68	3
Meat (home consumption)	1	4	55	4
Manure as fertilizer	1	3	36	5
Hides for home use	1	3	25	6
Fleece for hats and mattresses	0	4	22	7

Table 4: Ranking selection criteria for breeding rams

Ram selection criteria	Min.	Max.	Rating[1]	Rank[2]
Family performance	3	8	102	1
Body conformation or height (qumena)	2	7	100	2
Coat color	2	7	96	3
Tail length	0	5	43	4
Ear length	0	6	31	5
Long face	0	4	28	6

Table 5: Ranking selection criteria for breeding ewes

Ewe selection criteria	Min.	Max.	Rating[1]	Rank[2]
Back area (shint')	3	7	86	1
Coat color	0	7	73	2
Body conformation and height (qumena)	0	6	62	3
Udder size	1	6	55	4
Shot lambing interval	0	5	53	5
Ears length	1	5	40	6
Twinning capacity	0	6	31	7

[1]Number of pebbles allocated for each selection criteria; Min. = Minimum; Max. = Maximum; [2]Ranks were assigned to ratings based on significance tests of Wilcoxon signed rank tests ($p<0.05$)

Guangul, 2007; Taye *et al*., 2010; Shenkute, 2009) is of considerable advantage that larger lambs at birth will have an improved chance to be heavier at weaning. Awgichew (2000) revealed that flock management practices undertaken, particularly management practices of the breeding ewes, influence birth weight of lambs greatly.

The heavier birth weight at late parities can be due to heavier weight and larger size of dams as age increases (Awgichew, 2000). Gardner *et al*. (2007) on the other hand, stated that physiological effects of the first pregnancy in the uterus contribute to relatively better uterine environment and greater fetal growth in successive pregnancies. Moreover, less developed reproductive organs of first parity ewes to bear large fetus affect birth weight, according to Tibbo (2006) and competition for nutrients between the fetus and the dam as younger ewes are still growing (Duguma *et al*., 2002).

Significantly heavier body weight of single born lambs than twin born lambs was described by Gardner *et al*. (2007) as reduction in birth weight is presumably due to competition between fetuses for a limited supply of nutrients and because of the inadequate capacity of the maternal uterine space to the offspring. Simien sheep was found to be heavier than Menz and Horro (Tibbo, 2006) but comparable with Afar and Black Head Somali (Yacob, 2008) when weaning weight is concerned. While compared with Washera and Gumuz breeds, Simien sheep had lighter weaning weight (Guangul, 2007; Taye *et al*., 2010). Besides, 6 months weight of Simien sheep was higher than Horro and smaller than Afar, BHS, Washera and Gumuz (Tibbo, 2006; Guangul, 2007; Yacob, 2008; Taye *et al*., 2010).

The reason why effect of birth type was not observed on 6 months weight, unlike birth and weaning weight could be related to weaning shock when the lambs are transferred from highly nutritious feed (milk) to poor nutrition (roughage) reflecting environmental effect. Besides, superiority of males over females at 6 months weight may be due to faster post-weaning growth of males.

As parity of ewes increase, the weaning weight also rises which is in line with previous findings of Gbangboche *et al*. (2006) who found out that parity had significantly influenced weaning weight and dams with higher parity produced heavier lambs at weaning. It could be reflection of enhanced mothering ability of ewes as age increases and failure of young ewes to provide sufficient nourishment for the growth of fetuses.

The effect of birth type can be explained by failure of ewes to provide sufficient nourishment for the growth of twins (having to share pre-natal uterine environment and post-natal milk supply) according to Tibbo (2006). This could also be due to the carry-over effect of the heavier weight of single-born lambs at birth (Duguma *et al*., 2002).

The highest weight gain of Simien sheep lambs at largest parity of ewes and smallest at early age of ewes agreed with Inyangala *et al*. (1992) who reported that older ewes offer superior maternal nourishment which in turn is expected to be converted into better lamb performance up to weaning. Besides, no effect of parity on post weaning growth is most probably due to dependence of lambs on milk from their mothers. Effect of district on weight gain of lambs before weaning can imply presence of differences in dam management after parturition between the two districts. Although, there are other causative factors, estimate of type of birth on daily body weight gain is essentially a reflection of the magnitude of pre-weaning nutritional handicap resulting from twins having to share pre-natal uterine environment and post-natal milk supply.

In general, the growth rate of lambs decreased as age advances from 0-9 months which is in agreement with the findings of Taye *et al*. (2010). The reason behind could be related with the natural growth phenomenon where there is reduction in weight gain of animals as they get older. Primary breeding objective of Simien sheep farmers as

source of cash income concurs with findings of Moses (2006) who reported that sheep and goats for many of the small farm holders are the major or only source of income and wealth whereas for farmers that also produce crops, small ruminants are considered as insurance against crop failure. This is because they can be sold at any time for quick cash demand at the local markets. Moreover, Gizaw (2008) also reported similar results that cash income source and insurance are the principal objectives why farmers in sheep-barley system keep sheep. This also holds true for tropical sheep rearing farmers according to Kosgey (2004).

The reason why family performance was chosen as the primary criteria to select a breeding ram probably is because it is difficult to judge many production traits of a ram unless the potential inherited from its parents is known. The twinning potential of the breed is poor. This may be related to farmers' low preference for twinning as single born lambs were significantly heavier than twin born lambs associated with the high maintenance requirement of lambs in the cold environment compared with the scarce feed resources.

Moreover, litter size of Simien sheep (1.11) and single lambs were the most commonly and frequently born (88.6%) indicates the poor twinning potential of the breed. This can indicate that farmers minimized ewes with twinning potential using different methods of culling which is in harmony with the result obtained from the PRA study when prioritizing the selection criteria for breeding ewes.

CONCLUSION

Since, Simien sheep have better growth performance at early age compared to many indigenous breeds, improvement of the general management conditions can enable the breed to express its full genetic potentials consistently at later stages of its growth and benefit the farmers keeping the breed. There exists variation in body weight with-in the breed which can be good potential for selection improvement.

Though qualitative traits like coat color type have little contribution for animal productivity, they influenced the decision of farmers in choosing animals. So determination of economic values for such traits can support decisions of future interventions. The existing variations in body weight with in the breed are good potential for selection. Thus, selection can be considered as good option for improving the breed. Further study on the reproductive performance of the breed by collecting data from few generations for longer duration is suggested to investigate more details about the breed.

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