Productive and reproductive performances of Tikur sheep in Gubalafto district of North Wollo Zone, Ethiopia

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ABSTRACT

The study aimed to evaluate the productive and reproductive performance of Tikur sheep. Two villages were purposely selected, whereas 62 households were randomly selected to use their sheep in the monitoring study. A total of 1015 sheep with varied ages were involved. Productive traits were measured using a spring balance scale (50 kg capacity with 100g precision), while reproductive data will be collected by recording animals that gave birth during the monitoring period by trained enumerators. Both productive and reproductive data were analyzed using SAS (9.40). The overall means of birth, weaning, six-month, nine-month, and yearling weights of the sheep were 2.47±0.47, 11.89±2.26, 15.76±1.49, and 16.49±1.25 and 21.33±3.27 kg, respectively, whereas the means of age at first mating, age at first lambing, and lambing interval were 8.36±0.92, 13.94±0.86, and 8.92±1.10 months, respectively. The annual reproductive rate and litter size were 1.44±0.26 lambs per ewe per year and 1.04 lambs per lambing, respectively. Seasons and years of birth, types of birth, and parity of birth significantly affected most of the productive and reproductive traits. The overall lamb mortality was 9.04%, whereas the major causes of mortality included pasteurellosis, parasites, and circling diseases. The study indicates that the performances of Tikur sheep are found to be good for major productive and reproductive traits. The results of the study can serve as baseline information to take necessary actions for sheep genetic improvement and conservation. The sheep flock management should consider significant non-genetic factors.

Keywords: Baseline data, growth traits, monitoring study, mortality, Sheep

INTRODUCTION

Ethiopia is 2nd in Africa and sixth in the world in sheep population (Demelash *et al*., 2006). In the country, there were approximately 40 million sheep of fourteen different breeds (CSA, 2020a). The country is not only rich in livestock numbers but also rich in genetic diversity that has been developed by natural selection (Galal, 1983). Sheep have served as a means of ready cash income to meet immediate needs such as acquiring agricultural inputs, paying school fees or tuition, taxes, medical bills, and purchasing large animals, as well as a reserve against economic and agricultural production hardship or monetary saving and investment, in addition to many other socio-economic and cultural functions (Markos, 2006).

The dominant sheep breed in the highlands of the North Wollo Zone is sub-alpine short fat-tailed (Tikur sheep) (Gizaw *et al*., 2008; Mohammed, 2012). The sheep are widely distributed in the highlands of West Ethiopia (part of Tigray, Gondar, and Wolo) (Gizaw *et al*., 2008). The breed was characterized by a black coat color type, a compact body, a small body size, a predominantly black coat (60%), a majority of short semi-pendulous ears, and 24% rudimentary ears. They are also mostly covered with coarse, medium-length hair with a wooly undercoat. Most rams have curved horns with a backward orientation, while ewes are usually hornless (Gizaw *et al*., 2008; Mohammed, 2012). Moreover, the sheep do have unique features. They can adapt to sub-alpine cool highland weather conditions and live, produce, and reproduce with limited feed and water shortages. The sheep are also disease- and parasite-tolerant and widely used for home consumption during the whole holidays celebrated in North Wollo Zone. According to the farmers interviewed during a preliminary survey in 2012, their meats are lean and tasty (Mohammed, 2012).

However, the productive and reproductive performances of Tikur sheep in the cool highlands of the North Wollo zone were not well studied and documented. No on-farm or on-station monitoring study has been carried out in this regard. Due to these and other factors, developing breeding and conservation strategies for the sheep may not be easy. Therefore, an on-farm monitoring study was performed to understand the productive and reproductive characteristics of the sheep in the environment where they are evolved and to develop a good health intervention and recording system, as this information could aid future decisions on the management, conservation, and genetic improvement of the sheep. However, a good deal of physical, production, reproduction, and genetic characterization is available in the published literature for Horro, Menz, and Black Head Somali sheep (Workeneh *et al.*, 2004). Thus, the study is initiated to evaluate the productive and reproductive performances of Tikur sheep under farmer management conditions.

MATERIALS AND METHODS

Description of the Study Areas

The study was undertaken at Gubalafto district in Northern Wollo zone of the Amhara National Regional State, Ethiopia (figure 1). It is bordered on the South by the South Wollo Zone, on the West by Delanta and Wadla, on the Northwest by Meket, on the North by Gidan, on the Northeast by the Logiya river which separates it from Kobo, and on the Southeast by Habru. The district has a mountainous landscape with altitude ranging from 1300 to 3900 masl (GWoARD, 2010). The annual rainfall varies from 880 mm to 1,772 mm with a maximum temperature of 44.5^{o}C in the lowland and a minimum temperature of –10^{o}C in the highland (Svein, 2002). It received a bimodal rainfall (GWoARD, 2010), namely the main rainy season and short rainy season. The main rainy season extended from the end of June to mid of September while the short rainy season started at the end of January and lasted up to the end of April.

Figure 1: Map of North Wollo zone showing the study district where monitoring study was undertaken.

Sampling Procedures

Two *kebeles*, namely Tekeste and Shimagloy were strategically selected based on availabilities of large Tikur sheep population, communal grazing land, flock size per household and nearby settlement among households in the village, minimal or no crossbreeding practices in the village and accessibility and 62 households (32 from Tekeste and 30 from Shimagloy) who own sheep were consulted and selected to use their sheep in the monitoring study. A total of 1015 Tikur sheep (515 for year 1 and 500 for year 2) were used (Illustration 1). The sample size for the households was estimated based on the findings of Wondifraw (2010) who proposed that a sample size of 30 households from each *kebele* was sound enough for the survey study. Whilst the number of ewes for carrying out a monitoring study was determined based on the report of Gizaw *et al*. (2009) who reported that a breeding population with 500 breeding females is suggested to be sufficient.

Figure 1. Monitored sheep in the study sites

On-Farm Flock Monitoring and Data Collection

Animal management

All animals were identified using plastic ear tags applied at the beginning of the research and at birth. The sheep were kept under traditional management conditions in such a way that during the wet and cropping season, they were tethered in private grazing land, roadsides and pocket grazing areas (Mohammed, 2012). During the dry season, they were freely grazed on communal grazing areas and crop aftermath or crop stubbles. Breeding is year-round and uncontrolled. However, during the course of data collection, animals was dewormed for internal parasites and sprayed for external parasites two times a year. Vaccinations for prevalent diseases of the areas like pasteurollosis and sheep pox were also given once a year.

Data collection and management

Data on reproductive traits (age at first mating, age at first lambing, lambing interval, annual reproductive rate and litter size), productive traits (birth, weaning, six month, nine month and yearling and postmortem weights) and mortality (pre and post-weaning) were recorded by trained enumerator hired on the study areas for ≥2 years [June/2015-August/2017]. Date of birth, birth weight, type of birth, sex of lamb, dam parity, year and season of births were taken within 24 hours after the birth of the newborn. Animal owners were visited fortnightly by the researchers to supervise the monitoring activities. Entries were recorded as births, purchases, and other reasons, which included loans to farmers, returns from loans made earlier to other farmers, and gifts whereas exits were documented as deaths, sales, shareholding, return to owner (gifts back), slaughter for festivals and ceremonies, and any other reason such as slaughter for home consumption, and theft or loss. Weights other than birth were taken every month using a spring balance scale (50 kg capacity with 100g precision) whereas the reproductive traits were recorded for animals that gave birth during the monitoring period. Disease occurrences were recorded by the data enumerators as per the standard health recording sheet. Moreover, during the monitoring periods, the local names of the diseases were identified by observing disease symptoms in consultation with model farmers whereas the common names of the diseases were given by undertaking key informant discussion with animal health workers of the *kebeles* and district. All data were coded and recorded in Excel sheet of 2013 for both productive and reproductive traits.

Statistical Analysis

Both productive and reproductive data were analyzed using GLM procedures of Statistical Analysis System (SAS) version 9.40 (2013). Parity of dam (1-≥6); Birth types (Single, Twin); Seasons of birth (Hot, Wet and Cool); Years of birth (2015/2016, 2017) and Sex of lamb (Male, Female) were fitted as independent variables whereas productive and reproductive performances were fitted as dependent variables; but sex was not fitted as an independent variable for Age at First Lambing, Lambing Interval, Annual Reproductive Rate and Litter Size. Least square means with their corresponding standard errors were calculated for each parameter over these fixed factors. In cool highlands of North Wollo Zone, season is classified as hot (February to May), wet (June to September) and cool (October to January). The classification is based on temperature and rainfall condition. When the analysis of variance (ANOVA) declared a significant difference, least square means were separated using Tukey Kramer test.

The statistical model for growth traits:

$Y_{ijklm} = \mu + S_i + Y_j + P_k + S_l + e_{ijklm}$

Y_{ijklm} = observations of growth traits for each animal

μ = the overall mean

S_i = the fixed effect of i^{th} season of lambing
Y_j = the fixed effect of the j^{th} year of lambing
P_k = the fixed effect of the k^{th} parity at lambing
S_m = the fixed effect of the l^{th} sex of lamb
e_{ijklm} = the random error attributed to the m^{th} lamb/sheep.
Average daily BW gain up to weaning (g) was calculated by $\frac{(AWWT-BWT)}{90}$
Average daily BW gain from weaning to yearling (g) was calculated by $\frac{(AYWT-AWWT)}{365}$
Where, BWT= Birth weight; AWWT= Average weaning weight at 90 days; AYWT= average yearling weight at 365 days.
The statistical model for reproductive traits:
$Y_{ijkl} = \mu + S_i + Y_j + P_k + e_{ijkl}$

Where:
Y_{ijkl} = observations of reproductive traits for each animal
μ = the overall mean
S_i = the fixed effect of i^{th} season of lambing
Y_j = the fixed effect of the j^{th} year of lambing
P_k = the fixed effect of the k^{th} parity at lambing
e_{ijkl} = the random error attributed to the l^{th} lamb/sheep.

Mortality data collected during the monitoring period was analyzed using descriptive statistics and the results were summarized by the frequency and percentages.
Lamb mortality rate (R) = Number of lambs dead/total number of lamb born*100.

RESULTS AND DISCUSSION

Production Performances of Tikur Sheep

For this study, the average daily body weight gains up to weaning (g) and from weaning to yearling (g) was 106 gm/day and 27.72 gm/day, respectively (Table 1). The rate of growth are related to the genetic gain and feed conversion efficiency of the lamb (ARLSDA, 2005; Ayele and Urge, 2019). They are traits of interest for selection of parent ewes and rams. Lambs with daily body gain ≥250-500gm are found to be promising for meat production (ARLSDA, 2005; Mengistie *et al*., 2010). The growth rate up to weaning and from weaning to yearling were found to be low as it was triangulated with the standard growth rate (weight gain per day per head) [≥250-500] in sheep. The present report was lower than the average daily weight gain of Washera sheep, which was 126gm (Getachew *et al.,* 2011). Similarly, higher average daily weight gain [1.175 Kg] was recorded for Washera sheep (Mengistie, 2009) and for sheep in South Africa; it was 0.32 Kg (Price *et al.,* 2009). However, this finding was in the range of Ethiopia sheep lambs' average daily body weight gains [i.e 70-126 gm] that were recorded under grazing condition (Getachew *et al*., 2011; Ayele and Urge, 2019). The big difference in average daily body weight gain observed between Washera and Tikur sheep might be due to breed difference. The Washera sheep had good growth potential.

The overall least squares means [±SE] for birth weight of Tikur sheep in Gubalafto district was 2.47±0.47 kg (Table 1). There is an average birth weight variation in sheep breeds/ populations across Ethiopia. The birth weight finding of the present study was comparable with lamb birth records of Menz sheep [2.40 kg] (Markos, 2006), Afar sheep [2.5 kg] (Galal and Kassahun, 1982) and Farta

[2.50±0.02] (Shigdaf, 2011) but it was higher than birth records of Horro sheep [2.06 kg] (Marikos, 2006) and Menz sheep [2.09±0.03] (Mukasa-Mugerwa *et al*., 2000). Similarly, this birth record report was higher than the average birth weight of lambs [2.0 Kg] in Ethiopia (Mukasa and Lahalou, 1995). On the other side, the current birth record was lower than the birth weights of Arsi-Bale [2.8 kg] (Brannang *et al*., 1987), Horro [2.8 kg] (Abegaz, 2002a), Black Head Somalia [2.7 kg] (Galal, 1983), Washera [2.7±0.02] kg [(Mengistie, 2008; (2.61 kg) Shigdaf, 2011)], Simien [3.04±0.05 kg] (Surafel *et al*., 2010), and Gumz [2.79±0.028 kg] (Solomon, 2007). No significant variations were found among birth weights of lambs across sex, seasons and years of birth and parity of dam, (Table 1).
The overall least square mean [±SE] for weaning weight of Tikur sheep in Gubalafto district was 11.89±2.26 kg (Table 1). The current average weaning weight [11.89 kg] was also higher than weaning weight records of Menz sheep [8.30 kg] (Kassahun, 2000; Gezu, 2011; Ayele and Urge, 2019) but it was lower than weaning weights of Horro [15 kg] (Berhe, 2010), Menz sheep (14.83) (Hassen *et al*., 2004) and Doyogena sheep (14.8 kg) (Kebede *et al*., 2022). Weaning weight was significantly (P<0.05) affected by all fixed factors considered in the study (Table 1). Weaning weight was higher for male than female (12.45 kg vs 11.90 kg) and it was also higher for lambs born in wet (12.55 kg) than hot season (11.56 kg) whereas no significant weaning weight variation among lambs born in wet and cool seasons were observed. Similarly, high weaning weight was recorded among lambs born in year 2 (12.22 kg) than year 1 (11.56 kg). The influence of year on the growth for weight of lambs could be the result of changes in management, incidence of disease, herdsman's skills and environmental factors (Birhanu and Aynalem, 2009). Similarly, Mengistie, *et al*. (2010) and Kebede *et al*., (2022) reported that birth year had significant effect on weaning weight. However, Wilson (1986) reported a non-significant effect of year of birth on birth weight and pre-weaning traits.

The average six month weights [±SE] of Tikur sheep in Gubalafto district was 15.76±1.49 kg (table 1). The effects of sex on six month weight were significant; but season of birth, year of birth and parity of dam had insignificant effects on sixth month weight (table 1). Six month weight was higher for male than female (15.77 kg vs 15.42 kg). This might be associated with that ewes have slower rate of growth and reach maturity at smaller size due to the effect of estrogen in restricting the growth of the long bones of the body (Sowande and Sobola, 2007). Similarly, Mengstie *et al*. (2010) reported that male sheep are larger than female sheep with quantitative traits in North Western highlands of the Amhara region.

The overall least square mean [±SE] for nine-month weight of Tikur sheep in Gubalafto district was 16.49±1.25 kg (table 1). Sex of lamb, years of birth and parity of dam excreted significant effects on nine-month weight; however significant variation was not found among nine-month weights of lambs across seasons of birth, in fact there were nine month weight variations among lambs in the population across this fixed factor (table 1). Nine month weight was higher for male lambs (17.10 kg) than female [16.44 kg], whereas those lambs which born in year 1 (17.90 kg) performed better than those born in year 2 (15.07 kg). Lambs born from ewes in 6th parity had high nine month weight (17.76 kg) than other lambs born from Ewes in 1st (16.52 kg), 2nd (16.48 kg), 3rd (16.61 kg) 4th (16.88 kg) and 5th (16.84) parities.

The overall means [±SE] for yearling weight of Tikur sheep in Gubalafto district was 21.33±3.27 kg (table 1). The study has also indicated average yearling weight performance (21.33±3.27 kg) is in the range of Ethiopian yearling weight record which meant that the minimum and maximum average yearling weights of sheep were 19 kg and 27.80±1.5 kg, respectively (Markos, 2006; Gizaw *et al*., 2008a). The average yearling weight in the present study was in agreement with lambs' yearling weights of Farta sheep [20.08 kg] (Shigdaf, 2011) and Semien sheep [22.87±0.63] (Solomon, 2007); but it was higher than yearling weight of Menz sheep [19 kg] (Markos, 2006). On the other side, the current yearling weight record was lower than the yearling weights of Afar sheep [25.8±0.2] (Brannang *et al*., 1987), Black Head Somalia [25] (Galal, 1983), Bonga sheep [27]

(Solomon *et al*., 2008a), Horro [24] (Abegaz, 2002a), and Washera [24.9] Shigdaf, 2011). The effects of seasons of birth, years of birth and parity of dam significantly affected yearling weight; whereas no significant weaning weight variation among lambs born in wet and cool seasons were observed. However significant variations were not found among yearling weights of lambs across sex of lamb, in fact there were yearling weight variations among lambs in the population across this fixed factor. Those lambs born in year 1 (21.91 kg) performed better than those born in year 2 (20.74 kg). Lambs born from ewes in 5th parity had high yearling weight (22.21kg) than other lambs born from Ewes in 4th (20.48 kg) and 6th (19.54 kg) parities. Yearling weight was also higher for lambs born in hot (21.93 kg) and cool (21.55 kg) than in wet season (20.31 kg). The effect of season is associated with a difference in feed and disease situations. When lambing occurred during the wet season there is a high incidence of parasite infestation impairing growth performance (Birhanu and Aynalem, 2009). The overall mean [±SE] for postpartum weight of Tikur sheep ewes in Gubalafto district was 24.79±3.32 kg (table 1).

Table 1. Least squares means [±SE] for birth, weaning, six month, nine month and yearling weights (kg) of Tikur sheep in Gubalafto district

Effects and levels	N	Birth weight	N	Weaning weight	N	Six month weight	N	Nine month weight	N	Yearling weight	N	Average daily gain
Over all means	1015	2.47±0.47	976	11.89±2.26	677	15.76±1.49	471	16.49±1.25	358	21.33±3.27	730	
CV, %		19.43		18.97		9.59		7.52		15.58		
R^2, %		75.43		46.50		53.61		57.71		16.75		
Birth to Weaning												106 g
Weaning to yearling												27.7 g
Sex of Lamb		NS		**		*		*		NS	-	
Male	456	2.42±0.04	422	12.45±0.22	305	15.77±0.18	176	17.10±.16	104	21.0±0.60		
Female	559	2.39±0.01	554	11.90±0.19	372	15.42±0.17	295	16.44±0.18	254	21.01±0.55		
Seasons of birth		NS		*		NS		NS		*		
Hot season	228	2.36±0.05	225	11.56±0.23[b]	135	15.60±0.36	94	16.59±0.28	77	21.93±1.18[a]	146	
Wet season	508	2.40±0.04	503	12.55±0.21[a]	339	15.52±0.23	235	16.66±0.19	179	20.31±0.63[b]	365	
Cool season	279	2.43±0.06	248	12.26±0.25[ab]	203	15.66±0.22	142	16.81±0.18	102	21.55±0.60[a]	219	
Years of birth		NS		*		NS		**		**		
1 (2015/16)	515	2.51±0.06	501	11.56±2.46	374	15.83±1.77	205	17.90±1.5	186	21.91±3.48	329	
2 (2017)	500	2.43±0.05	475	12.22±0.25	303	15.68±1.12	266	15.07±1.16	172	20.74±1.55	401	
Parity of dam		Ns		*		Ns		*		**		
1	163	2.38±0.05	163	11.91±0.26[bc]	110	15.60±0.31	66	16.52±0.27[b]	68	21.89±0.99[ab]	117	
2	267	2.43±0.05	267	11.90±0.22[bc]	165	15.51±0.20	142	16.48±0.19[b]	91	20.93±0.62[abc]	192	
3	306	2.39±0.04	306	11.70±0.21[c]	224	15.50±0.20	193	16.61±0.19[b]	127	20.62±0.72[abc]	220	
4	163	2.37±0.05	163	12.08±0.24[bc]	104	15.81±0.32	16	16.88±0.39[b]	30	20.48±0.96[bc]	117	
5	41	2.45±0.08	35	12.54±0.42[ab]	53	15.59±0.34	29	16.84±0.28[b]	28	22.21±1.0[a]	29	
≥6	75	2.42±0.07	42	12.88±0.43[a]	21	15.62±0.43	25	17.76±0.34[a]	14	19.54±1.16[c]	54	

**Least squares means with different superscript within a column are significantly different *P<0.05; **P<0.01; NS: Non significant; N: number; Avg. DBW: Average daily body weight*, *CV: coefficient of variation, R^2: Coefficient of determination; Kg: Kilogram; SE: standard error.*

Reproductive Performances

The overall least square mean [±SE] for age at first mating (AFM) of Tikur sheep was 8.36±1.23 months (table 2). Age at first mating observed in this study was longer than the values reported for Bonga [7.51 months] and Horro sheep [7.1 months] (Zewdu, 2008) and for Gumuz sheep [7.21 months] (Solomon, 2007). But it was shorter than the values reported for Menz sheep [10.00 months] (Mukasa-Mugrwa, 1995) and Dowuro zone and Konta special woreda sheep (11.09) [Amelmal, 2011]. Seasons of birth, years of birth, sex of lamb and parity of dam had excreted significant effects on AFM at P<0.05 (table 2). The lambs that have born in cool season [8.04 months] reached AFM earlier than those born in the wet season (8.29 months) and hot (8.34 months) seasons. Lambs born in year 1 (8.17 months) reached sexual maturity at younger age than those born in year 2 (8.54 months). The possible reason could be seasonal feed availability difference. Male lambs (8.45 months) attained AFM lately than female lambs (8.14 months). The lambs born in the first to the fourth parity had shorter AFM than lambs born in the fifth and six or more parities.

There is a big variation among production systems and breeds for the trait age at first lambing (12-24 months) (Mohammed, 2012). The overall Mean [±SE] for age at first lambing (AFL) of Tikur sheep was 13.94±0.86 months (table 2). The present AFL finding [13.94±0.86 months] was shorter than the values reported for Menz [15 months] (Mukasa-Mugrwa, 1995) and Washera sheep [15.47±0.47 months] (Mengistie *et al*., 2008). This result is also smaller compared to the report of Wilson (1986) who indicated that age at first lambing ranges from 15 to 18 months for most traditionally managed ewes. But it was in agreement with the values reported for traditionally managed sheep in South Western part of Ethiopia [13.47±2.18 months] (Birhanu and Aynalem, 2009a). The maximum age at 1st lambing (months) of sheep was 23.77 (Alexandre *et al*, 2008) at Martinik-Guadeloupe and the minimum was reported as 12.7 (Tsedeke, 2007) in Ethiopia. For the present study, the effects of seasons of birth, years of birth, and parity of dam were significant (table 2). The ewe lambs that have born in cool (13.77 months) and wet (13.64 months) seasons reached AFL earlier than those born in hot season (14.39 months). Lambs born in year 1 (13.84 months) reached AFL at younger age than those born in year 2 (14.04 months). This might be attributed to the variation in feed supply which in turn is associated to variation in amount and distribution of rain fall which meant that lambs born in wet season and cool seasons grew fast and reached puberty and lambed at younger age. The lambs born in first to the fifth parity had shorter AFL than lambs born in the 6th or more parity.

The overall least square Mean [±SE] for lambing interval (LI) of Tikur sheep was 8.92±1.10 months (table 2). The present finding was longer than the values reported for Menz sheep [8.4 months] (Mukasa-Mugrwa, 1995). But it was in agreement with the values reported for traditionally managed sheep in South Western part of Ethiopia [8.73±1.78 months] (Birhanu and Aynalem, 2009a) and Washera sheep [8.97±0.21 months] (Mengistie *et al*., 2011). None of the fixed effects considered significantly affected LI (table 2).

The average litter size (LS) [±SE] of Tikur sheep was 1.04±0.20 lamb per ewe per lambing (table 2). The present litter size finding [1.04±0.20] was smaller than the LS values reported for Horro [1.34 lamb/ewe] (Abegaz and Gemeda, 2000b), Arsi-Bale sheep [1.70] (Tsedeke, 2007), Washera sheep [1.11 lamb/ewe] (Mengistie *et al*., 2008; Shigdaf, 2011) and Gumz sheep [1.17 lamb/ewe] (Abegaz, 2007). This result is also smaller compared to the report of Birhanu and Aynalem (2009b) who reported LS of 1.21±1.45 lambs/ewe for traditionally managed ewes in South West part of Ethiopia. But it was in agreement with the LS values reported for Black Head Somalia [1.04] (Galal, 1983), Menz sheep [1.03]

(Markos, 2006). It can be increased by 10-40% through premating ewe nutrition management or treatment with gonadotropins (Mukasa-Mugerwa, 1995). Except for seasons of birth (P<0.05) and parity of dam (P<0.01), none of the fixed effects considered had significant effects P>0.05) on LS. The ewes that lambed during the cool and wet season had more subsequent LS than ewes lambed during hot season. The ewe lambs born in the hot/dry season were inferior to lambs born in cool rains by 10.0 %. The difference in litter size between ewes that lambed in the hot season and those which lambed in cool season was 0.04 (1.28 %). There was a general tendency that litter size increased with an increase in parity up to fifth parity and dropped at the six and more parities (Abegaz and Gemeda, 2000b; Birhanu and Aynalem, 2009a). A polynomial analysis of litter size in relation to parity in ewes showed also the increase in litter size to be linear from first to fourth parity (Sulieman *et al,* 1990). For this study, high litter size was recorded at the fifth parity (1.13±0.03) and the lowest litter size was recorded at 6th parity (1.0±0.04). This can be justified that, the lambs born from multi-parous ewes had a higher growth rate and reached sexual maturity at an early age and this might be associated with a better mothering ability of the ewes. It is well documented that the litter size improves with advance in age through increased ovulation rate, uterine capacity and maternal traits affecting reproduction efficiency of ewes (Fahumy 1990; As cited Birhanu and Aynalem, 2009a).

The overall least square mean [±SE] for annual reproductive rate (ARR) of Tikur sheep was 1.44±0.26 lambs/ewe/a year (Table 2). The ARR finding was smaller than the ARR values reported for traditionally managed sheep in South West part of Ethiopia [1.82±0.44 lambs/ewe] (Birhanu and Aynalem, 2009a). However, it was in agreement with the ARR value reported for Menz sheep [1.40 lambs/ewe] (Mukasa-Mugrwa, 1995). The effects of seasons of birth and parity of dam on ARR were significant at P<0.01, P<0.5 and P<0.01, respectively (Table 2). The ewe-lambs/ewes in 6th, 1st and 2nd parity had more ARR than ewe-lambs/ewes in 3rd, 4th and 5th parities.

Table 2. Least squares means (±SE) for age at first mating, age at first lambing, lambing interval, and annual reproductive rate and litter size of Tikur sheep in Gubalafto district

Effects and Levels	N	Age first mating (months)	N	Age first lambing (months)	N	Lambing interval (months)	N	Annual reproductive rate (number)	N	Litter size (number)
Overall means	471	8.36±0.92	253	13.94±0.86	253	8.92±1.10	252	1.44±0.26	1420	1.04±0.20
CV, %		11.10		6.17		12.34		18.22		19.32
R^2, %		64.67		69.55		77.19		47.81		32.10
Seasons of birth		*****		*****		**Ns**		******		*****
Hot season	94	8.34±0.21[a]	56	14.39±0.21[a]	56	8.82±0.69	55	1.5±0.17[a]	227	1.03±0.01[b]
Wet season	235	8.29±0.14[a]	127	13.64±0.21[b]	127	8.95±0.28	127	1.39±0.07[b]	508	1.04±0.02[ab]
Cool season	142	8.04±0.13[b]	70	13.77±0.55[b]	70	8.78±0.28	70	1.45±0.08[ab]	279	1.07±0.02[a]
Years of birth		*****		******		**NS**		**NS**		**NS**
1 [2015/2016]	186	8.17±1.23	186	13.84±1.55	121	8.85±1.12	121	1.45±0.33	501	1.03±0.17
2 [2017]	285	8.54±1.12	67	14.04±1.17	132	8.98±1.07	132	1.42±0.06	513	1.04±0.01
Parity of dam		*		**		NS		**		**
1	66	8.05±0.20[b]	54	13.83±0.47[b]	54	9.11±0.63	53	1.46±0.15[ab]	163	1.02±0.02[bc]
2	142	8.13±0.14[b]	58	13.98±0.26[b]	58	9.03±0.31	58	1.43±0.07[ab]	267	1.04±0.01[bc]
3	193	8.34±0.14[b]	90	13.84±0.26[b]	90	8.87±0.31	90	1.41±0.05[b]	306	1.07±0.01[b]
4	16	8.0±0.29[b]	23	13.57±0.33[b]	23	8.80±0.42	23	1.41±0.10[b]	163	1.03±0.02[bc]
5	29	8.44±0.21[ab]	18	13.72±0.35[b]	18	8.79±0.44	18	1.40±0.11[b]	40	1.13±0.03[a]
≥6	25	8.84±0.25[a]	10	14.70±0.38[a]	10	8.50±0.49	10	1.58±0.12[a]	75	1.0±0.04[c]

*Least squares means with different superscript in the same column indicates significance and superscripts are significantly different *P<0.05; **P<0.01; NS: Non significant; N: number; CV: coefficient of variation, R^2: Coefficient of determination; m: month; SE: standard error*

Mortality

Freedom from major disease is regarded a pre-requisite for genetic improvement as maximum productivity in a given system of production can be attained when disease control is in place. Mortality of lambs is one of the main factors adversely affecting sheep production. It is indicated that the overall lamb mortality rate was 9.0% (Table 3), which is not far from the accepted mortality rate of 10%. High pre-weaning mortality (14.4%) than post weaning mortality (3.7%) was observed in the study areas (Table 3). However, the mortality rate was relatively higher in Shimagloy than Tekeste (Table 3). The decrease in lamb mortality was directly related to the training and veterinary services provided by the research and extension system and by the farmers' efforts.

Table 3. Pre-and post-weaning mortality rate of Tikur sheep lambs in the monitoring villages

No.	Mortality kind	Mortality rate (%)			Causes
		Tekeste	Shimagloy	Overall	
1	Pre-weaning mortality	11.5	17.4	14.4	Diseases
2	Post-weaning	3.1	4.26	3.7	Diseases
Overall		7.3	10.8	9.0	

The common diseases observed in the areas are presented in Table 4. The major causes of death or mortality were pasteurellosis whereas parasites and circling disease were the second and third important diseases reported in the monitoring areas.

Table 4. The local and common names and symptoms of common diseases in the study area

No.	Local name (Amharic)	Common name	Symptoms of the diseases	Number of lambs dead	Seasons of occurrence
1	*Tekmat*	Diarrhea	Diarrhea, weight loss	5	Wet and cool seasons
2	*Azurit*	Coenuruses/ Circling disease	Unbalance, bend back left and right, circling, isolating it from the flock	15	Hot, wet and cool seasons
3	*Yewust na yewuch tigegna beshita*	Internal and external parasites infestation	Weight loss, deep coughing/breathing/	29	Wet and sometimes cool seasons
4	*Gifaw*	Pasteurelosis	Rapid breathing, nasal discharges and depression	59	Hot and cool seasons
5	*Fentata*	Sheep pox	Swelling on the external parts of the body [nose, mouth, face and legs	20	Hot season

CONCLUSIONS

The findings indicate the growth and reproductive performances of Tikur sheep to be good. Sex of lamb exerted significant influences on 3-month weight, 6-month weight and 9-month weight whereas season of birth had significant effects on 3-month weight and yearling weight. The 3-month, 9-month and yearling weights were significantly affected by the year of birth and parity of ewe. The effects of season of birth and parity of ewe on age first lambing, annual reproductive rate, litter size and age at first mating were significant. The variations among values of growth and reproductive performance traits indicated the presence of within-breed variation, which provides a good opportunity to undertake selection for genetic improvement, conservation and further research on the sheep. The flock management should consider the significant non-genetic factors so as to minimize the direct obscuring effects of them on the expression of the actual genetic worth of the sheep.

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