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Study of Productive and Reproductive Performances and Farmers' Traits Preferences for Breeding of Small Ruminants in Ada Barga and Ejere Districts of West Shoa Zone, Oromia, Ethiopia

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Abstract
The productive and reproductive performances of small ruminants and producers' traits preferences were studied in the three agro- ecologies (AEZs) of Ada Barga and Ejere districts, West Shoa Zone, Oromia, Ethiopia. The two districts were stratified into highland (HL), midland (ML) and lowland (LL) agro ecologies. A total of 180 households comprising of 69 from HL, 74 from ML and 37 from LL were purposively selected for this study. Detailed structured questionnaires, respondent interviews and farmers' group discussions (FGD) were employed to capture relevant information. The overall age at first lambing (AFL) / age at first kidding (AFK), weaning age, age at sexual maturity of male (ASMM), reproductive life span of both sheep and goat were significantly affected by AEZs. The overall mean of slaughter age and ASMM was 6.43, 8.91 in sheep and 6.27, 8.39 in goat, respectively. High intensive kidding and lambing months was April to June.
Keywords: Small ruminants, Producers' trait preference, production, reproduction, agro-ecologies, Ethiopia.

1. Introduction

More than 85% of the Ethiopian population depends on agriculture for their livelihoods. The subsector contributes about 16.5% of the national Gross Domestic Product (GDP) and 35.6% of the agricultural GDP (Metaferia et al., 2011). It also contributes 15% of export earnings and 30% of agricultural employment (Behnke 2010). The small ruminants (sheep and goat), contribute substantial amounts to income, food (meat and milk), and non-food products like manure, skins and wool in Ethiopia. These small ruminants also serve as means of risk mitigation during crop failures, property security, monetary saving and investment in addition to many other socio-economic and cultural functions (Solomon et al., 2010). The earlier studies have indicated that small ruminant production in Ethiopia needs to be addressed systematically by describing the genetic resource bases, production and marketing systems (Tesfaye et al., 2010, 2011; Zewudu et al., 2012). Some workers suggested that breeding systems or genetic improvement efforts need to consider traits preferences of producers in designing breeding programs (Gemeda et al., 2010and Tadele, 2010).

The productivity levels of available small ruminant populations / breeds in their habitat with active participation of producers and buyers are prerequisites to set up genetic improvement program at smallholder level. The Ada Barga and Ejere districts (Woredas), West Shoa Zone, Oromia Regional State, Ethiopia, have huge potential for small ruminant production, but there is paucity of scientific information on their production systems in these two districts. Thus the present study was carried to assess the production and reproduction performances of small ruminants under farmers' management and to investigate producers' preferences for the different traits in these two districts.

2. Material And Methods

The study area:

Ada Barga district (Woreda) is located at a distance of 60 km, West of Addis Ababa, capital city of Ethiopia. It receives an average annual rainfall ranging from about 887 to 1,194 mm. The minimum, medium and maximum daily temperatures of the area are 10, 15 and 25oC, respectively. The district has relatively high vegetation cover that serves as a source of livestock feed, natural habitat for different wild life and potential area for small

ruminant, dairy, apiculture and irrigated agriculture. Acacia species are major forest tree species in the area. Major vegetable crops produced in the district are onion, potato, cabbage, and garlic to a smaller extent. Garlic is produced only in small plots although it is a high priced vegetable. The major soils of the Ada Barga district are: platy 44%, red 39% and brown (mixture) 17%. The district is situated at an altitude ranging from 1400 to 3,270 m.a.s.l (meters above sea level) and comprises of 29% highland (>2300 m.a.s.l), 34% midland (1500 to 2300 m.a.s.l) and 37% lowland (< 1500 m.a.s.l) areas as per Zonal Basic Data, 2000. The livestock species reared in the district include cattle, sheep, poultry, equines and goats. The small ruminants consist of 57,511 sheep and 43,574 goats (Fanos, 2012). The district has high potential for both sheep and goat production.

Ejere district (Woreda) is located at a distance of 40 km, West of Addis Ababa, capital city of Ethiopia. The district receives an average annual rainfall ranging from about 900 mm to 1,200 mm. The minimum and maximum daily temperatures of the area are 22 and 28oC, respectively. The district has relatively high vegetation cover that serves as a source of livestock feed, natural habitat for different wild life and also a potential area for small ruminant, dairy, apiculture and irrigated agriculture. Major vegetable crops produced in the district were onion, potato, cabbage, and garlic to a smaller extent. The major soils of the Ejere district are: red soil 58%, black soil 32% and loam soil 10%. The district is situated at an altitude ranging from 2060 to 3,185 m.a.s.l (meters above sea level) and thus comprises of only two agro-ecological zones, viz: highland (>2300 m.a.s.l) and midland (1500 to 2300 m.a.s.l) according to Zonal Basic Data, 2000. The livestock species inhabiting the district include cattle, sheep, poultry, equines and goats. The small ruminant population comprises of 41,368 sheep and 10,197 goats and the district has high potential for both sheep and goat production (Fanos, 2012).

Data sampling procedure and sample size:

Secondary data relating to livestock population, farming practices, demography, etc, collected from the respective District Agricultural Department Offices and Livestock Development Agencies, were used for the present study. The kebeles [Peasant Associations (PA)] in the two districts were stratified into three agro-ecological zones (AEZs), viz: low lands (<1500 masl), midlands (1500-2300 masl) and high lands (>2300 masl) according to Ministry of Agriculture (2000) and Dereje (2011). The discussions with District Livestock Head and experts showed that in Ejere district 12 and 18 kebeles fall in highland and midland agro-ecological zones, respectively. Out of these one kebele (Damotu) and two kebeles (Chiri and Kimoye) falling in highlands and midlands, respectively, were purposively selected on the basis of sheep and goat production potential. Similarly Ada Barga district has been stratified into three agro ecological zones, viz: highland (11 kebeles), midland (13 kebeles) and lowland (15 kebeles). One kebele from each of the three agro-ecological zones, viz: Ulagora (highland), Laku Karsa (midland) and Wogidi (lowland) were selected based on their potential for small ruminant production. Thus a total of six kebeles were selected from two districts for present study.

A total of 180 households were purposively selected owning four or more sheep / goat from the total number of house-holds (1833 rearing small ruminant) in the six kebeles for the present study (Table1). The numbers of households (69, 74 and 37 in HL, ML and LL, respectively) from each selected kebeles were determined according to proportionate sampling technique as indicated below:

$W = [A/B] \times N_o$; Where: W= Number of household to be calculated from singe selected kebele; A=Total number of households per kebele; B= Total number of households all six kebeles; and No = the calculated sample size.

The sample size 180 house hold was determined according to the Arsham (2002) as under:

$N=0.25/SE2$; Where: N= Sample size; and SE= Standard error (0.0373) with 95% confidence level.

However during this study farmers having an average flock size of ≥ 4 sheep or goats were interviewed for this study. The sheep and goat rearing farmers were interviewed separately. However, during this some of the farmers rearing both sheep and goats were interviewed two times and this resulted in the total sum of interviews exceeding sample size of 180 household and total percentages above 100%.

Data collection:

The data on productive and reproductive performances [AFL (age at first lambing), weaning age, slaughter age, age at sexual maturity of male, LI (lambing interval) / KI (kidding interval), LS (litter size) and reproductive life span of female] and farmers traits preferences for breeding of both sheep and goat were collected from selected sheep / goat producers in the study areas using a structured questionnaire. Focused group discussions were also undertaken using checklists to collect information on these traits. Group composed of 6-9 members of key informants was formed for gathering information. Key informants such as elders, community leaders, women representative, animal health technician and development agents were targeted for the FGD.

Data analysis:

The data collected was organized, summarized and analyzed by the Statistical Package for Social Sciences (SPSS ver.20, 2011). Comparison of means by one way ANOVA was done using the SPSS statistical software. The General Leaner Model (GLM) of SPSS ver. 20 was used to compare production system parameters across the agro-ecologies and their significance difference was tested. The following one way model on various

performances parameters of sheep and goat was used.

$Y_{ij} = \mu + AEZ_i + e_{ij}$; where $Y_{ij} = Y^{th}$ observation in i^{th} class, μ = Overall mean, AEZi = effect of agro ecologies, where i =1, 2, 3, eij = Random error

The indices were calculated to provide ranking of trait preferences (for both male and female sheep and goats) as under:

Index = sum of [(3 x number of household rank first) + (2 x number of household rank second) + (1 x number of household rank third)] for a particular cause divided by sum of [(3 x number of household rank first) + (2 x number of household rank second) + (1 x number of household rank third)] for all causes in an agro ecology.

3. Results And Discussion

3.1. Productive and Reproductive Performances:

The results on productive and reproductive performance, viz: AFL (age at first lambing), weaning age, slaughter age, age at sexual maturity of male, LI (lambing interval)/ KI (kidding interval), LS (litter size) and reproductive life span, for both sheep and goat are presented in table 2.

Age at first lambing (AFL) / kidding (AFK):

The differences in both AFL and AFK (age at first kidding) were found to be statistically significant (Table 2) across the three AEZs. The pair-wise comparison showed that HL-LL and ML-LL differences were significant for AFL whereas HL-Ml and HL-LL were significant for AFK. The AFL and AFK is an indication of the overall flock productivity. The AFL of current results was 14.12, 14.36 and 15.22 months for sheep and AFK was 15.33, 13.82 and 13.60 months for goats in high, mid and lowland respectively (Table 2). The present results in respect of both species were lower than the reports of FAO (2002) wherein age at first lambing ranged between 16.2 and 16.9 months in mixed farming systems of sub-Sahara African countries; Mesfin et al. (2014) who reported average AFL of 18.10 at eastern Amhara region and Yisehak et al. (2013) who reported AFL of 15.90, 15.85 and 15.63 months and AFK of 2.09, 2.07 and 2.16 years in Seka, Mana and Dedo districts of South-western Ethiopia. Both AFL and AFK in the current study were indicators of early sexual maturity in ewes and does, respectively. The current result for AFK (Table 2) in highland (15.33) area was similar with the finding of Assen and Aklilu (2012) who reported average age at first kidding of 15.01 months in different agro-ecological zones (high, mid and lowland) in Tigray, Ethiopia. However, the current results were higher than the findings of Tsedeke (2007) who reported 12.7 months for AFL and 12.1 months for AFK in Alaba southern Ethiopia and Fsahatsion et al. (2013) who reported an average AFL of 12.4 months in Gamo Gofa Zone, Southern Ethiopia.

Weaning age:

The differences in weaning age in both species were found to be significant (Table 2) across the three AEZs. The pair-wise comparison showed that HL-LL and ML-LL differences were significant in sheep and goats. The weaning age of lambs were 3.84, 3.93 and 4.44 months in high, mid and lowland of agro-ecologies, respectively, in the present study. The result obtained in all the three agro ecologies for weaning age of lambs were lower than Tsedeke (2007) and Zewudu et al. (2012) in western and south-western Ethiopia who reported that the overall average weaning ages for both sexes and breeds of indigenous sheep was 4.80 months. The weaning age of kids were 4.67, 3.82 and 3.52 months in high, mid and lowland, respectively (Tabele2). These findings were lower than that of Endeshaw (2007) who reported weaning ages of 6.27, 5.09 and 4.73 for goats in moist dega, weyina dega and kola, respectively, in Dale district and report of Tsedeke (2007) in respect of goats in Alaba, southern Ethiopia. However, weaning age of lambs (4.44) and kids (4.67) in low and highland of the current study were in agreement with finding of Assen and Aklilu (2012) who reported 4.4 and 4.7 for lambs and kids in high and midland of Tigray zone, respectively. The possible reasons for lower weaning age in both species in the current study may possibly be (a) ewes / does suckle their lams/kids for short period of time, (b) early weaning allows ewes / does to express estrous cycle earlier resulting in improved reproductive efficiency, and (c) farmers preference for more lamb / kid crop / unit time to earn more income. The latter two reasons impose stress on both lambs and kids affecting their weaning weight. Thus special management is required at this stage for early weaned lambs / kids so that early weaning stress is overcome.

Slaughter age /market age:

The slaughter age for both sexes was significantly influenced by AEZs in sheep (Table 2) but the same influence in goat was non-significant. In sheep the differences between HL-LL and ML-LL were significant. The average slaughter ages were 6.34, 6.37, 7.33 in sheep and 6.5, 6.39, 6.03 months in goats in high, mid and lowland areas, respectively. The results with respect to sheep showed that sheep in HL grow faster than the other two AEZs. Perusal of results showed that in both species young stock were slaughtered at an early age before attaining sexual maturity. Gemeda (2010) also reported that male lambs were sold as early as three to four months in mixed crop-livestock system of Horro and Bonga areas.

Age at sexual maturity of male (ASMM):

The ASMM in both species (Table 2) showed highly significant differences among the three AEZs. The

differences between HL-LL and ML-LL were significant in sheep whereas HL-LL and HL-ML differences were significant in goat. The ASMM were 8.79, 8.93 and 9.67 months in rams and 9.67, 8.38 and 8.16 months in bucks in HL, ML and LL, respectively. The current findings with respect to ram were higher than the results reported by Assen and Aklilu (2012) who reported ASMM of 8.42 and 8.8 months in HL and ML of Tigray region, respectively and the average age of 7.1 months reported by Tesfaye (2008) for Afar rams. The age at first sexual maturity may be affected by weaning season and post weaning nutrition and thus through good management age at first sexual maturity could be substantially improved. Galmessa et al. (2003) reported that well fed / supplemented ram lambs of Horro breed reached first sexual maturity at the age of 6-7 months at Bako Agricultural Research Centre.

The comparison of slaughter age and ASMM of the current results (Figure 1) showed that males of both species were slaughtered before they attain sexual maturity. This indicated that a good number of males were eliminated from the flocks at an earlier age and thus narrowing the selection base of males. This reduction in selection base of males will be a limiting factor in the improvement of both these species. Similar trends were reported by earlier workers (Gemeda et al., 2010; Solomon et al., 2010; Tesfaye, 2010 and Yenesew et al., 2013). In order to stop this practice the farmers need counselling / guidance so that male animals were retained after they attain sexual maturity and pass on their genes, if found good, to the next generation. This was important for sustainable utilization of available resources and to improve overall productivity.

Lambing / kidding interval

Lambing or kidding interval is the interval between two consecutive parturitions that determines reproductive efficiency in small ruminant production. The AEZs had highly significant ($P<0.01$) influence on both lambing and kidding interval in the present study. The differences in the lambing interval between HL-LL and ML-LL were significant (Table 2). Similarly differences in the kidding interval between HL-ML and HL-LL were significant. The lambing intervals in the study area were reported to be 8.73, 8.83, 9.56 months and kidding interval was 9.33, 8.22 and 8.10 months in high, mid and lowland, respectively. The lambing /kidding interval in the present study were higher than the earlier reports in small ruminants (Getahun, 2008, Belete, 2009 and Fsahastion et al., 2013).

Litter size:

The litter size in both species was not influenced significantly by AEZs (Table 2). The litter size in sheep was 1.21, 1.18 and 1.16 in high, mid and lowland, respectively. The current results were within the range (1.08 - 1.75) reported by Girma (2008) for tropical breeds. The current litter size were higher than those reported by Tadele et al. (2010) for Menz and Afar sheep breeds (close to one lamb per lambing), Bonga sheep (1.13) and Washera sheep (1.11) reported by Solomon et al. (2010). The litter size in goats was 1.25, 1.32 and 1.21 in HL, ML and LL areas, respectively. These results were within the range (1 -- 1.7) reported by Solomon et al. (2014) from on station, on farm monitoring and breeds survey studies for different Ethiopian goat breeds.

Reproductive life span of female sheep / goat (months):

The variations in the reproductive life span of females in both species were significant due to AEZs (Table 2). The pair-wise comparison showed significant differences between HL- LL and ML – LL areas in both species. The reproductive life spans were 129, 125 and 112 months in sheep and 98, 101 and 120 months in goat in HL, ML and LL AEZs, respectively.

Intensive months of lambing and kidding:

The survey showed that both lambing and kidding were recorded throughout the year. Based on group discussion and interview of individual respondents it was found that higher parturitions occurred from April to June in both species. Survey results (Figure 2) showed that apparent peaks of intensive kidding and lambing were in April and May, respectively. The FGDs confirmed that high intensive kidding and lambing months ranged from April to June and lowest lambing/kidding was November, February and August. This observation (FGD) was in agreement with Dhaba et al. (2013) who reported high lambing/kidding rate was recorded during April to June. The perusal of results in figure 2 revealed that the maximum conception of sheep and goat occurs during the months January and December, respectively. This may be due to availability of sufficient forage in natural pasture and crop residues / crop aftermaths in the fields which results in good flushing of both sheep and goat females. The current finding with respect to goat was in agreement with Mehlet (2008) who reported the highest kidding in May.

3.2. Farmers' trait preference for small ruminant breeding:

Source of rams and bucks:

The results (Table 3) showed that there were only two sources for rams and bucks, viz: owned ram / buck and neighbour's ram / buck, in the three AEZs. The majority of respondents were using neighbours ram for mating and the values were 24.4, 13.9 and 3.3 % in HL, ML and LL, respectively. Similarly majority of respondents used neighbours buck in HL and ML (2.2 and 17.2 %, respectively) whereas in LL majority (9.4 %) used their own buck for mating. The current results were in disagreement with that of Tesfaye et al. (2010); (2011) and

Fsahatsion et al. (2013) who reported majority of farmers reared their own ram in on-farm studies. The FGD showed that there were no cross or pure exotic sheep and goat breeds in the study areas.

Traits preferred by farmers for selection of breeding rams and bucks:

The criteria for selection of breeding rams and bucks by farmers are presented in table 4. The respondents ranked body conformation (size) as number one for selecting a breeding ram in all the three AEZs (0.51, 0.53 and 0.48 in HL, ML and LL, respectively). However second and third rank for selecting breeding ram differed in the three AEZs. In HL second and third rank was tail and age at maturity (0.27 and 0.13). However in ML and LL AEZs colour (0.25, 0.29 in ML and LL, respectively) and tail (0.10 and 0.11 in ML and LL, respectively) were ranked as second and third by the farmers. This finding was in consonance with the results of Tesfaye (2008) who reported that body size is a primary ram selection criteria in both crop-livestock (0.29) and pastoral (0.35) production systems in Menz and Afar areas; Zewudu et al. (2012) in Adiyo Kaka district of Kaffa zone of Southern Nations, Nationalities of Ethiopia reported ram selection based on body size with an index (0.34) , colour (0.28) and tail formation (0.27) ; Fsahatsion (2013) in Gamo Gofa zone reported body size as primary criteria in ram selection in weyna-dega.

The respondents ranked bucks (Table 4) on the basis of body conformation (size), colour and age at first maturity as first, second and third rank in all three AEZs in the present investigation. The indices estimated were 0.43, 0.51, 0.52 for body conformation; 0.34, 0.27, 0.40 for colour and 0.20, 0.17, 0.05 for age at first maturity in HL, ML and LL, respectively. The current finding was in agreement with Solomon (2014) who reported body conformation (size) followed by coat colour were found as the most important selection criteria of breeding bucks with the index values of 0.33 and 0.22 for Western Lowland goat keepers and 0 .31 and 0.25 for Abergelle, respectively.

The results revealed that in all the three agro-ecologies body size was the primary selection criteria for both ram and buck selection as parents of next generation. The possible reason may be that body size was an important economic trait that influenced market price, particularly in the traditional markets of Ethiopia. The body size of rams and bucks, which most of the owners associated with high carcass output and premium price across all the production systems, included wide chest, conformation and long body size.

Traits preferred by farmers for selection of breeding ewes and does:

The farmers ranked (Table 5) body size, coat colour and lamb survival as first, second and third for selection of breeding ewes in all three AEZs, with indices of 0.45, 0.44, 0.44 for body size; 0.28, 0.31, 0.39 for coat colour; and 0.10, 0.17 and 0.17 for lamb survival in HL, ML and LL areas, respectively. The present results were in agreement with Helen et al. (2013) who reported body size (0.46), coat colour (0.17) and lamb survival (0.15) were the three criteria in ewe selection in eastern Ethiopia.

The criteria of doe selection showed minor variation in the ranking across three AEZs in present study (Table 5). In HL coat colour followed by body size and kidding interval were ranked first, second and third (0.36, 0.28 and 0.18, respectively) by the respondents. In ML body size, coat colour and kidding interval were ranked first, second and third with index of 0.47, 0.26 and 0.11, respectively. However in LL body size, coat colour and kidding survival with index values of 0.47, 0.30 and 0.08 ranked first, second and third, respectively.

The current study indicated that overall attention was focused on observable traits, like body size, coat colour and twining ability / lamb survival (sheep) and body size, coat colour, kidding interval / kidding survival (goat), compared to production and reproduction traits in selecting breeding ewes and does. The possible reason may be absence of animal recording, illiteracy and other infrastructure (weighing balances etc) in Ethiopia.

4. Summary And Recommendations

This study was conducted in Ada Barga and Ejere districts of west Shoa Zone of Oromia Regional State based on their potential for small ruminant production. Age at first lambing (AFL) / age at first kidding (AFK), weaning age, ASMM, Lambing / Kidding interval and reproductive life spans were significantly affected by AEZs in both sheep and goat. The slaughter age showed significant difference across three AEZs in sheep whereas these differences were non-significant in goat across AEZs. However there were no significant differences in the litter size of both sheep and goat across the three AEZs. The criterion for selection of breeding ram by farmers was body conformation (size) as number one in all three AEZs. However in HL second and third rank was tail and age at maturity whereas colour and tail were ranked as second and third by the farmers in ML and LL AEZs. Similarly respondents ranked bucks on the basis of body conformation (size), colour and age at first maturity as rank first, second and third in all three AEZs. In selecting a breeding ewe's body size and coat colour were ranked first and second across all AEZs. The twining ability was ranked third in HL whereas lamb survival was ranked as third criterion of selection of breeding female in ML and LL areas. For does in HL coat colour followed by body size followed by kidding interval were ranked first, second and third whereas in ML body size, coat colour and kidding interval were ranked first, second and third. However in LL body size, coat colour and kidding survival were ranked first, second and third, respectively. The farmers practiced weaning of lambs / kids at early age and may impose stress on them affecting their weaning weight. Thus special management is

required for early weaned lambs / kids. Good numbers of males were eliminated from the flocks at an earlier age thus narrowing the selection base of males. Accordingly farmers need counseling / guidance so that sufficient number male animals were retained until they attain sexual maturity. This will broaden selection base of males.

5. Acknowledgement

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Table 1: Number of households selected per six kebeles**.**

Agro ecological zone (AEZs)	Selected kebeles	Total number of household possessing small ruminants	Proportionate number of households selected/kebele
Highland	Damotu	413	41
	Ulagora	290	28
Midland	Kimoye	178	17
	Chiri	249	24
	Laku Karsa	331	33
Lowland	Wogidi	372	37
Total	6 Kebeles	1833	180

Table 2: Average of productive and reproductive performance of sheep and goats in three AEZs

Parameters (in months)	High land (N=69)	Midland (N=74)	Lowland (N=37)	Overall mean	P-value
	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	
Sheep					
Age at first lambing (months)	14.12±0.11[a]	14.36±0.10[a]	15.22±0.32[b]	14.29±0.08	0.001
Weaning age (months)	3.84±0.44[a]	3.93±0.40[a]	4.44±0.52[c]	3.92±0.46	0.001
Slaughter age (months)	6.34±0.50[a]	6.37±0.53[a]	7.33±0.70[c]	6.43±0.59	0.000
Age at sexual maturity of male (months)	8.79±0.05[a]	8.93±0.04[a]	9.67±0.16[b]	8.91±0.04	0.000
Lambing interval (months)	8.73±0.55[a]	8.83±0.58[a]	9.56±0.17[c]	8.83±0.44	0.000
Litter size(in number)	1.21±0.49	1.18±0.45	1.16±0.43	1.19±0.42	0.458
Reproductive life span of female (months)	129.49±14.55[a]	124.57±16.54[a]	112.00±14.69[c]	126.41±15.89	0.005
Goats					
Age at first kidding (months)	15.33±0.42[a]	13.82±0.15[b]	13.60±0.19[b]	13.85±0.12	0.002
Weaning age (months)	4.67±0.51[a]	3.82±0.39[b]	3.52±0.50[c]	3.77±0.52	0.000
Slaughter age (months)	6.50±0.54	6.39±0.53	6.03±0.49	6.27±0.54	0.011
Age at sexual maturity of male (months)	9.67±0.21[a]	8.38±0.06[b]	8.16±0.07[b]	8.39±0.06	0.000
Kidding interval (months)	9.33±0.21[a]	8.22±0.59[b]	8.10±0.54[b]	8.25±0.52	0.000
Litter size(in number)	1.25±0.41	1.32±0.33	1.21±0.31	1.28±0.33	0.151
Reproductive life span of female (months)	98.00±9.03[a]	100.65±17.46[a]	120.41±13.78[c]	107.29±18.37	0.000

N=Number of respondents, SD= standard deviation,

Same superscript indicate non-significant differences, Different superscript indicate significant differences at P<0.05 level

Table 3: Source of breeding ram and buck (in percentage) in three AEZs

Particulars	HL N (%)	ML N (%)	LL N (%)	Total
Source of breeding ram				
Own	23 (12.8)	17 (9.4)	3 (1.7)	43 (23.9)
Neighbours	44 (24.4)	25 (13.9)	6 (3.3)	75 (41.7)
Total	67 (37.2)	42 (23.3)	9 (5.0)	118 (65.6)
Source of breeding buck				
Own	3 (1.7)	18 (10.0)	17 (9.4)	38 (21.1)
Neighbours	4 (2.2)	31 (17.2)	13 (7.2)	48 (26.7)
Total	7 (3.9)	49 (27.2)	30 (16.6)	86 (47.8)

Table 4: Rank of desirable traits for selecting breeding rams and bucks formating

Trait for	High land				Midland				Lowland				Over-all
	R1	R2	R3	I	R1	R2	R3	I	R1	R2	R3	I	I
(A) Rams													
Body conformation (size)	32.2	4.4	0	0.51	20.6	2.8	0	0.53	4.4	0.6	0	0.48	0.51
Age at first maturity	0	0	27.2	0.13	1.1	1.1	5	0.08	0.6	0	0	0.06	0.09
Colour	2.2	1.1	0	0.04	0	15	1.1	0.25	0	4.4	0	0.29	0.19
Libido	2.8	0	0	0.04	0.6	0	0	0.01	0	0	1.1	0.04	0.03
Adaptability	0	0	1.1	0.01	1.1	0	0	0.03	0	0	0.6	0.02	0.02
Tail	0	27.8	0	0.27	0	4.4	3.3	0.10	0	0	3.3	0.11	0.16
(B) Bucks													
Body conformation (size)	2.8	0	0	0.43	25.6	1.7	0	0.51	12.8	3.9	0	0.52	0.48
Colour	0	3.3	0	0.34	1.7	18.9	0	0.27	3.3	12.8	0	0.40	0.33
Age at first maturity	1.1	0	1.1	0.20	0	6.7	12.8	0.17	0.6	0	2.2	0.05	0.14
Libido	0	0	0.6	0.03	0	0	6.7	0.04	0	0	1.7	0.02	0.03
Adaptability	0	0	1.1	0.05	0	0	2.2	0.01	0	0	1.1	0.01	0.02

Table 5: Rank of desirable characteristics for selecting ewes and does for breeding

Traits for	High land				Midland				Lowland				Overall
	R1	R2	R3	I	R1	R2	R3	I	R1	R2	R3	I	I
Ewes													
Body size	32.2	0	0	0.45	20.6	0	0	0.44	4.4	0	0	0.44	0.44
Colour	0	30	0	0.28	1.1	20	0	0.31	0.6	5	0	0.39	0.32
Twining ability	2.2	2.8	6.7	0.09	0	1.1	0	0.03	0	0	0	0.00	0.04
Age at first lambing	2.8	0.6	0.6	0.05	0.6	1.7	0	0.04	0	0	0	0.00	0.03
Lamb survival	0	0	21.1	0.10	1.1	0	21.1	0.17	0	0	5	0.17	0.16
Lambing interval	0	3.3	1.7	0.03	0	0	0	0.00	0	0	0	0.00	0.01
Adaptability	0	0	0.6	0.00	0	0	0.6	0.00	0	0	0	0.00	0.00
Tail	0	0	0.6	0.00	0	0.6	1.7	0.01	0	0	0	0.00	0.00
Does													
Body size	1.7	0.6	0	0.28	22.2	4.4	0	0.47	12.2	4.4	0	0.47	0.41
Colour	1.1	2.2	0	0.36	2.2	17.2	0	0.26	2.8	10	0.6	0.30	0.31
Twining ability	1.1	0	0	0.15	1.1	2.2	0	0.05	0	0	3.3	0.03	0.06
Age at first kidding	0	0	0.6	0.03	0	1.1	3.3	0.03	0	0.6	0.6	0.02	0.04
kids survival	0	0	0	0.00	1.7	1.1	1.1	0.05	1.7	0.6	1.7	0.08	0.04
kidding interval	0	0.6	2.8	0.18	0	0	17.8	0.11	0	0	7.2	0.07	0.13
Adaptability	0	0	0	0.00	0	1.1	1.1	0.02	0	1.1	0	0.02	0.01

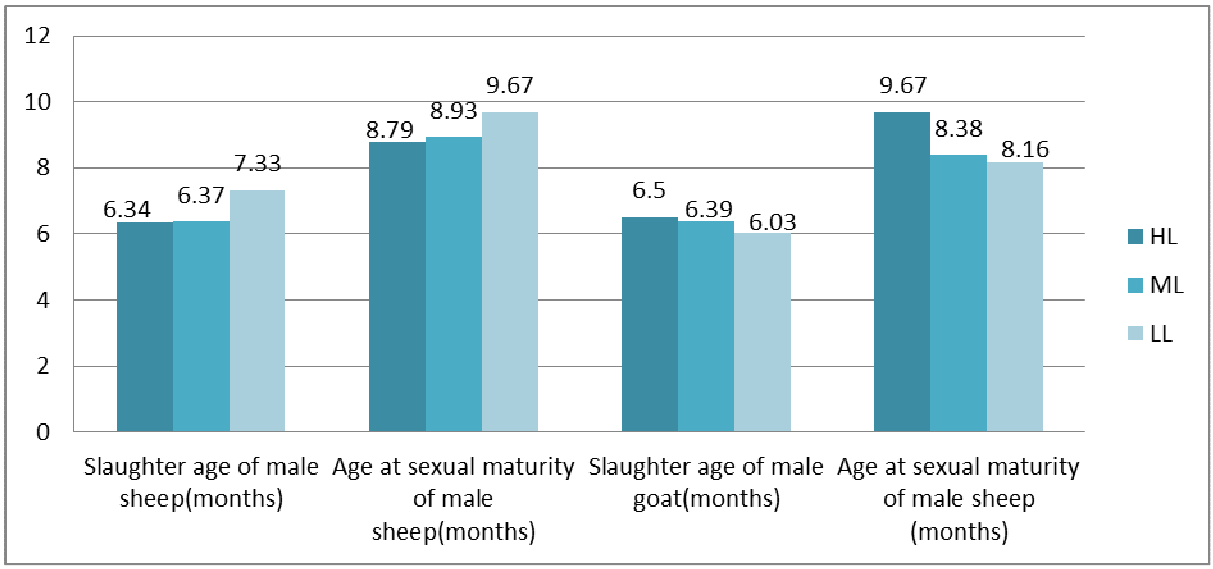

Figure 1: Comparison of Slaughter age and ASMM of male sheep and goat in three AEZs

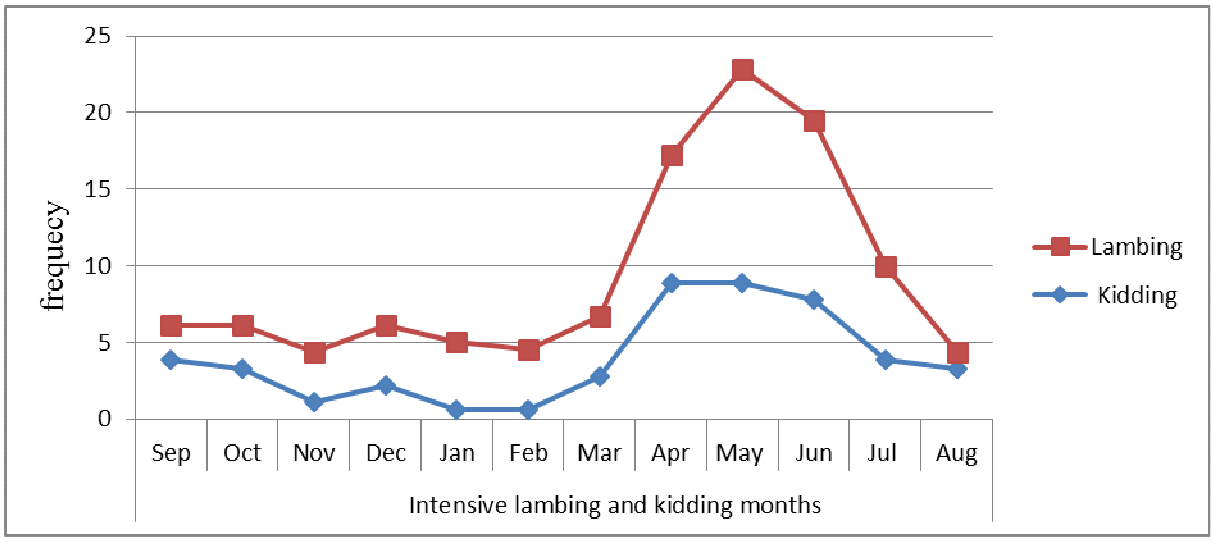

Figure 2: Intensive lambing and kidding month of sheep and goat in study area.