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Indigenous breeding practices and selection criteria of sheep breed in central zone of Tigray, Northern Ethiopia

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This study was conducted with the aim to generate organized information on traditional breeding practices and selection criteria for indigenous sheep types in three districts of central zone of Tigray, North Ethiopia. A total of 180 households were randomly sampled for the interview. A semi-structured questionnaire and group discussion were further used to gather information on sheep breeding practices and selection criteria. The primary reason for keeping sheep in Tanqua-Abergelle and Kola-Tembien districts were manure as sources of fertilizer, while in Adwa district cash income. In all the study districts the flock structure were dominated by breeding ewes and they accounted 38.5, 35.9 and 38.7% in Tanqua-Abergelle, Kola-Tembien and Adwa districts, respectively. Sexual maturity of female for Tanqua-Abergelle, Kola-Tembien and Adwa districts were 9.16±0.82, 8.75±1.34, and 8.86±1.04 months, respectively and for male 7.43±0.76, 6.67±0.91, and 6.64±0.95 months, respectively. Tail type and body size in Tanqua-Abergelle and Kola-Tembien were the most frequently reported traits in selecting breeding ram and ewes, while tail type and coat colour in Adwa district. Based on the present result on sheep indigenous breeding practices one may develop selection criteria and productivity schemes of the local sheep in the study districts.

Key words: Adwa, breeding practice, indigenous selection criteria, Kola-Tembien, phenotypes, Tanqua-Abergelle.

INTRODUCTION

Ethiopia is owing to the large sheep population of 29.33 million head (CSA, 2015). At least 9 sheep breeds and 14 traditional sheep population are found in Ethiopia (Gizaw et al., 2007). Environmental pressure also maintains a wide range of genotypes, each adapted to a specific set of circumstances (Getachew et al., 2010). In Ethiopia, the production system and marketing are almost traditional (Legesse et al., 2008). However, sheep productivity is constrained by lack of technical capacity, scarce feed, diseases, insufficient infrastructure and market

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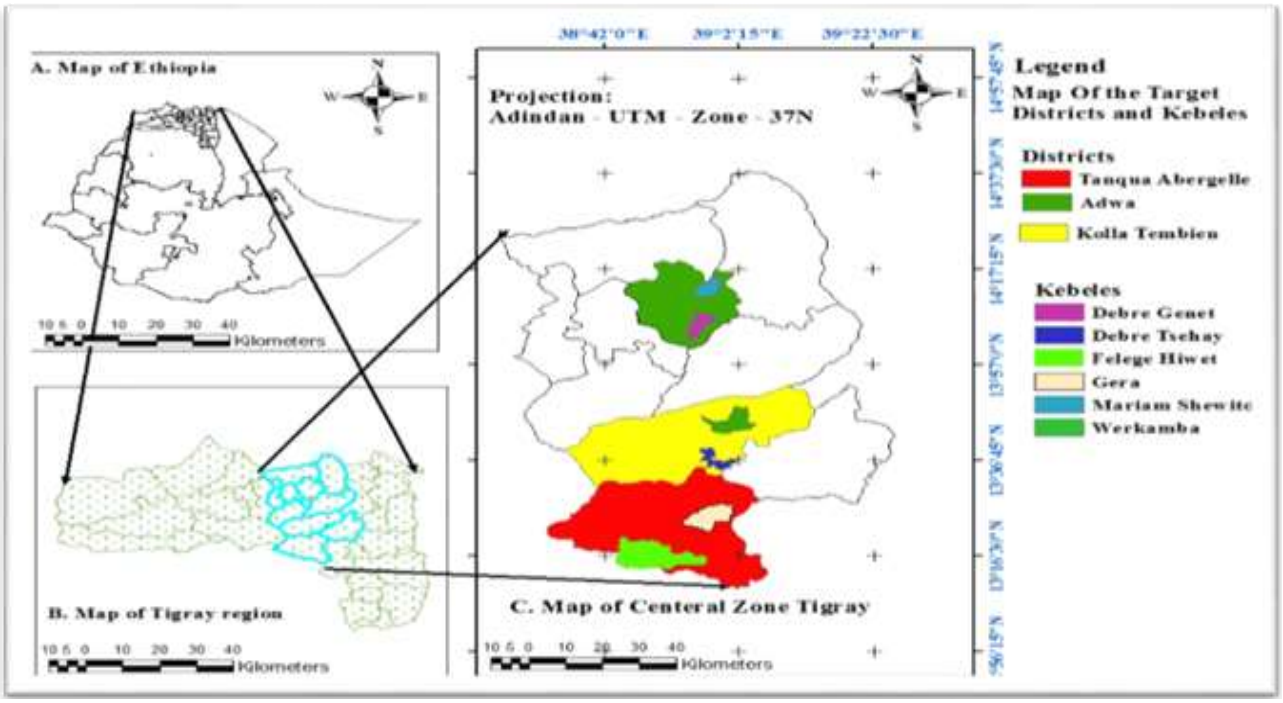

Figure 1. Map of the study area.

information resulting in inadequate utilization of the indigenous genetic resources. Due to these, a number of like the livestock population trend, distribution and marketing vary across space and time (Samson and Frehiwot, 2014).

Lack of such knowledge leads to the setting up of unrealistic breeding goals in the design of livestock genetic improvement programs and the consequence of which can put in danger the conservation of indigenous animal genetic resources (Wuletaw et al., 2006). The farmers' decision of selection criteria could be affected by breeds, production system and herd size (Thiruvenkadan et al., 2009). However, little is known about traditional breeding practices and selection criteria of sheep improvement in central zone of Tigray. Thus, this study was made to assess indigenous sheep breeding practices, selection criteria and identify trait preference of smallholder farmers in the central zone of Tigray.

MATERIALS AND METHODS

Description of study area

The study was conducted in three districts of central zone of Tigray (Tanqua Abergell, Kola-Tembien, and Adwa), showed in Figure 1.

The central zone of Tigray covers about 9741 km^2 with a total population of 786,271 cattle, 406,018 sheep, 1, 139, 452 goat, 81,468 colonies of honey bee, and 1,390,782 poultry (CSA, 2015). The elevation of the area ranges from 1332 to 2921 m. Annual rainfall varied within the range of 466 to 758 mm. Temperature ranges from 14 to 22°C. Most of the lands are cultivated with some native pasture patchy grazing bottomlands and degraded hilly sites (CSA, 2015).

Sampling procedure

Selection of the study districts and peasant association (kebeles) were done using multi-stage purposive sampling technique in consultation with zonal and district bureau of agriculture experts. Six kebeles were selected based on their suitability for sheep production, road access and willingness of the farmers to participate in the study. A total of 180 households (63 from Tanqua-Abergelle, 60 from Kola-Tembien and 57 from Adwa) were randomly sampled for the interview from within the selected and surrounding Kebeles.

Data type and methods of data collection

Data were collected from primary and secondary data sources. Primary data were collected from pretested semi-structured questionnaire and group discussions (with farmers and development agents).

Secondary data were collected from published and unpublished documents (reports of Bureau of Agricultural and Rural Development (BoARD), Minister of Agriculture (MoA) and Central Statically Agency (CSA)), research publications, journals and internet browsing.

Data for questionnaires survey

Modified questionnaires were prepared by adopting a questionnaire prepared by International Livestock Research Institute (ILRI) for survey of livestock breed and standard breed description list

developed by FAO (2012). The structured questionnaires were pre-tested and administrated to collect information on existing sheep production and husbandry practices from each selected flock owners. Further information was obtained from key informants and secondary sources via interviewee and organizing group discussions. Before commencement of the actual interview with selected farmers, the questionnaires were pre-tested on a small number of selected farmers from each site. Based on the pre-tested information, questionnaires were further improved as per need.

The questionnaires were designed to collect information on: the environment in which the animals are kept (e.g. descriptors of the environment, farming system, husbandry practices, etc.); breed/types of sheep observed in the district, flock structure, population size and physical adaptive traits; main purpose and reasons for keeping the sheep population, major diseases and constraints of sheep production, breeding practice like mating type, sheep production objective, selection criteria, and culling age; and reproductive performance like age of sexual maturity, lambing interval, lamb crop (number of lambs born per ewe life span).

Data management and analysis

After data were collected and entered into the computer for analysis, preliminary data analysis like homogeneity test, normality test and screening of outliers were employed before conducting the main data analysis. Household survey (questionnaire) data were analyzed using districts as fixed effect.

Questionnaire data:

Data collected through questionnaire were subjected to descriptive statistics using Statistical Package for Social Sciences (SPSS 20.0 for windows, release 20.0 2011) and Chi-square was employed to test for the independence between the categorical variables. F-test was applied when required to test the statistical significance. Indices were calculated for ranked data to provide ranking of the reasons of keeping sheep, sheep breeding objective, ram and ewe selection criteria. Indices were calculated as Index = Sum of (3 × number of household ranked first + 2 × number of household ranked second + 1 × number of household ranked third) given for an individual reason, criteria or preference divided by the sum of (3 × number of household ranked first + 2 × number of household ranked second + 1 × number of household ranked third) for overall reasons, criteria or preferences according Musa et al (2006). The rate of inbreeding from effective population size for a randomly mated population was calculated as Ne = (4 Nm Nf) / (Nm + Nf); where Ne = effective population size, Nm = number of breeding males and Nf = number of breeding females. The rate of inbreeding coefficient (F) was calculated from Ne as ΔF = 1/2Ne (Falconer and Mackay, 1996).

RESULTS AND DISCUSSION

Purpose of sheep keeping

Small ruminants play a significant role in the life of man whether in the rural or urban areas in different ways. As indicated in Table 1, the primary reason for keeping sheep from first to third rank in Tanqua-Abergelle and Kola-Tembien were the same even though the index value for each purpose was different. According to the leading farmers purpose for keeping sheep in Tanqua-Abergelle and Kola-Tembien districts were sources of manure, cash income followed by insurance for risk (rural banking) with the index value of 0.38, 0.35, 0.12 and 0.39, 0.38, and 0.16 rank, respectively. However, cash income, sources of manure and insurance for risk with index value of 0.44, 0.27 and 0.21 rank, respectively in Adwa district.

Obviously, sheep keeping in most part of Ethiopia is primarily to generate income sources. However, the result of the present study (Tanqua-Abergelle and Kola-Tembien) shows keeping sheep was primarily towards manure production. This might be due to the reason to compensate the price of inorganic fertilizer. Similar to this result, Zelealem et al. (2012) also reported in Tanqua-Abergelle and Ganta-Afeshum districts that sheep were primarily kept for manure production. According World Bank Report (2008), the cultivated land of Tigray is characterized with vast land degradation and loss of soil fertility with subsequent loss of productivity and the use of organic fertilizer especially animal manure is inevitable and has been practiced since times in history.

Regarding milk production consumption except sheep keepers in Tanqua-Abergelle district, none of the respondents from Kola-Tembien and Adwa districts reported utilization of sheep and goat milk; this might be as a result of low cultural acceptance. Similar to this finding, Edea et al. (2012) also reported that sheep milk consumption in Southern part of Ethiopia, in Adiyo Kaka and Horro districts were not common. Because of cultural taboo, even in Tanqua-Abergelle district, drinking raw sheep and goat milk for women are not allowed unless, processed in the form of cheese, butter and yogurt. The reason stated by the female respondents for not drinking raw sheep and goat milk was that it was a cultural taboo, that is, drinking raw sheep and goat milk increases female sexual desire. Similar finding was reported for the same district (Desta et al., 2013).

Sheep flock structure

Classes of sheep flock structure by district (Number and Mean ±SD) are presented in Table 2. The average sheep population over each age and sex categories in Tanqua-Abergelle district was significantly ($p<0.0001$) higher than Kola-Tembien and Adwa districts of the same age categories. From the total flocks size, the percentage of female greater than one year (breeding ewes) accounted for 38.5, 35.9 and 38.7% in Tanqua-Abergelle, Kola-Tembien and Adwa districts, respectively. The corresponding value for male is greater than one year which accounted for 8.6, 10.4 and 9.4%, respectively. The results of present finding is in line with the result of previous work done by Mohamed et al. (2014) and Abera et al. (2014) for native sheep types in North Wollo zone, Northern Ethiopia, Habru and Gubalafto districts and in Selale Area, Central Ethiopia, Debre Libanos and Wuchale districts where the sheep flock structure was dominated by breeding ewe at 34.4, 37, 48.43 and

Table 1. Ranking of sheep production objectives by districts.

Objective	Tanqua-Abergelle				Kola-Tembien				Adwa			
	R2	R2	R3	I	R1	R2	R3	I	R1	R2	R3	I
Sale cash income	24	24	14	0.35	28	22	8	0.38	38	17	3	0.44
Meat for home use	0	2	12	0.04	0	2	11	0.04	0	3	18	0.07
Manure as fertilizer	33	21	4	0.38	31	21	7	0.39	17	15	11	0.27
Milk	4	3	7	0.07	0	0	0	0	0	0	0	0
Hide for home use	2	0	4	0.03	0	0	5	0.01	0	0	0	0
Insurance for risk	0	13	19	0.12	1	15	23	0.16	2	22	21	0.21
Ceremonies (gift wedding)	0	0	3	0.01	0	0	6	0.02	0	0	4	0.01

Index = Sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for particular production objective divided by sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for all objective.

Table 2. Average sheep flock structure in surveyed households in the study areas.

Sheep classes by age and sex	Tanqua-Abergelle [N (63)]			Kola-Tembien [N (60)]			Adwa [N (57)]		
	n	Mean ± SD	%	n	Mean ± SD	%	n	Mean ± SD	%
ML <6months	134	2.21 ± 0.7^{a}	10.6	119	1.98± 0.6^{b}	11.9	87	1.49± 0.7^{c}	9.4
FL<6months	191	3.13 ± 0.8^{a}	15.1	155	2.58± 0.9^{b}	15.5	171	2.87 ± 0.7^{b}	18.5
ML from 6month to one year	132	2.19± 0.7^{a}	10.5	94	1.57 ± 0.6^{b}	9.4	77	1.29 ± 0.9^{c}	8.3
FL from 6month to one year	211	3.46 ± 0.9^{a}	16.7	169	2.82± 0.7^{b}	16.9	144	2.44 ± 0.9^{c}	15.6
M> than 1year	108	1.79± 0.7^{a}	8.6	104	1.73± 0.7^{a}	10.4	87	1.46± 0 .9^{b}	9.4
F> than1year	486	7.97 ± 1.1^{a}	38.5	359	5.97 ± 1.5^{b}	35.9	358	6.12 ± 0.2^{b}	38.7
Total	1262	20.8±4.9	100	1000	16.7±5	100	924	15.7±4.3	100

^{a,b,c}Values with different subscript are significant at (p<0.000) level, N=number of respondents, n=number of animal, SD=standard deviation, %=percentage of animals by sex and age group, ML=male lambs, FL=female lambs, M=male, F=female.

49.89%, respectively. Therefore, sheep composition and sheep holding per household might be affected by production objective and demand, requirement of breeding female, feed availability and the occurrence of disease and natural calamities. This is because of male greater than one year is frequently sold whenever cash is needed in the household. Therefore, here intervention is needed to control negative selection to improve the reproductive and productivity of sheep particularly for males because farmers usually sell in good body condition (which may have good genetic makeup) to get high price. The ratio of ram to ewe in the study districts (Tanqua-Abergelle, Kola-Tembien and Adwa) was 1:4.5, 1:3.5 and 1:4.1, respectively. This ratio is higher than the normal range which is about 1:35 though it varies based on several aspects including age and mating experience of the ram and feed availability (Susan, 2011).

The result from the study areas showed, with such ratio rams have maximum contact with ewes and ewe lambs and mate them efficiently without missing any estrus. A sex ratio similar to the present study had been reported in different part of Ethiopia. For example a sex ratio in Abergelle and Keffa and Benchmaji which were 1:4.87 and 1:5.21 (Tajebe et al., 2011; Dejene, 2010), but higher than 1:8.03, 1:8.3 and 1:17.4 reported for Debre Libanos, Wuchale, Menz and Afar (Mohamed et al., 2014; Getachew et al., 2010).

Feed resources and grazing management

Available feed resources for sheep, seasonal fluctuations, coping mechanisms and management type for grazing and herding of sheep in study area is presented in Table 3. Based on the finding in the present study, the main source of feed for sheep throughout the year were natural pasture from the communal range land, grazing on fallow lands and crop residue (35, 31.1 and 27.8%), respectively. In comparison, Kola-Tembien and Adwa districts had better in feed availability than Tanqua-Abergelle district. Locally available feed like local beverage ('*Hatela*' by product of '*tela*') and mineral like common salt ('*Chew*') supplementation were also common in Kola-Tembien and Adwa districts. Majority of the respondents above 75% in the study areas reported that there was seasonal fluctuation in feed availability and apply different coping mechanisms to cope with the feed shortage.

From the total respondents, 58.7% in Tanqua-Abergelle and 38.7% in Kola-Tembien explore feed resources

Table 3. Feed resources for sheep, seasonal fluctuation and coping mechanisms during feed shortage in the study areas as reported by respondents (%).

Feed resources	Tanqua-Abergelle		Kola-Tembien		Adwa		Overall		χ2	P-value
	N	%	N	%	N	%	N	%		
Natural pasture	28	44.4	21	35	14	24.6	63	35	15.8	0.015
Crop residues	8	12.7	9	15	33	58.9	50	27.8		
Fallow lands	27	42.9	26	43.3	3	5.3	56	31.1		
Locally available like 'Hatela' and salt	0	0	4	6.7	7	12.3	11	6.1		
Seasonal fluctuation of feed availability										
Yes	61	96.8	55	91.7	44	77.2	160	88.9	11.0	0.004
No	2	3.2	5	8.3	13	22.8	20	11.1		
Coping mechanisms when feed shortage happen										
Purchasing feed	10	15.9	22	36.7	33	58.9	65	36.1	46.5	0.000
Moving to search feed and water	37	58.7	23	38.3	1	1.8	61	32.7		
Destocking	16	25.4	15	25	23	40.4	54	30		

*P<0.05 significant, χ^2=person chi square, N (%)=number of respondent in percentage.

(move their flock to distant area) (Tekezie basin) during the dry season to search feed and water. However, in Adwa district, 58.9% of the respondents reported that they purchased feed while, the rest 40.4% of the respondents were forced to sell their sheep when there is feed shortage. This result is in agreement with that of Nigussiea et al. (2015) who reported mixed crop-livestock production system, Jijiga, Shinile and east Hararghe zones, in Eastern Ethiopia.

Herding practice

Management in relation to grazing and herding were significantly (p<0.001) different across the study districts (Table 4). The degree of tethering practiced in the study area varied highly from district to district and this might result in animal population density per household. In agreement to the present study, Alemayehu et al. (2015) reported that tethering practiced vary across season and across districts of Dawuro zone and Konta special Wereda in Southern region of Ethiopia. About 68, 60 and 45% of the respondents in Tanqua-Abergelle, Kola-Tembien and Adwa districts mixed their flock with other flocks during grazing and watering. In line with the current result, Nigussiea et al. (2015) reported that mixing of sheep flocks of several households was practiced by most of the sheep owners in both mixed crop-livestock 70.0% and agro-pastoral 55.6% production system.

Indigenous knowledge of sheep breeding and management practices

Breeding male

Most of the respondents in the surveyed districts 93.7, 91.46 and 86% in Tanqua-Abergelle, Kola-Tembien and Adwa districts, respectively had their own indigenous breeding ram. In contrast to this result, Abera et al. (2014) reported that above 23 and 50% native sheep keepers in Gubalafto and Habru lacked breeding rams types in North Wollo zone, Northern Ethiopia.

Above 70% sources of breeding ram in all the study districts were from own flock. The purpose of keeping ram was mainly for breeding purpose as 77.8, 42 and 44% in Tanqua-Abergelle, Kola-Tembien, and Adwa districts, respectively. This finding substantiated the finding of Getachew et al. (2010) who reported 65.5 and 3.5% sheep keepers in Menz breed ram for breeding purpose and socio-cultural benefits, respectively. In all the study districts, natural and uncontrolled mating system was practiced throughout the year. It is difficult to introduce controlled breeding as communal herding is practiced during grazing and watering. This finding is inconsistent with the result of Tajebe et al. (2011), Zelealem et al. (2012), and bera et al. (2014) who reported that mating system within the flock and between the flock in Abergelle, Gubalafto and Habru sheep population were uncontrolled. All sheep populations were pure indigenous (Table 5).

Trait preference for selection of breeding ram and ewe

Selection criteria for breeding ram

Prior to prioritizing, the beneficiaries were asked to list the traits used as selection criteria for both ram and ewe breeding. Ranks of beneficiaries' selection criteria for breeding rams are present in Table 6. Tail type, body size and pedigree with index value of 0.24, 0.22, 0.21 and 0.30, 0.23 and 0.12 were the major selection criteria for

Table 4. Percent of respondents used different management type for grazing and herding of sheep in the three districts.

Parameter	Tanqua-Abergelle		Kola-Tembien		Adwa		Overall		χ^2	p-value
	N (%)		N (%)		N (%)		N (%)			
Grazing management										
Free grazing	20	31.7	10	16.7	5	8.8	35	19.4		
Herding	42	66.7	37	61.7	30	52.6	109	60.6	28.6	0.000
Tethering	1	1.6	13	21.7	22	38.6	36	20.0		
Herding										
Within sheep flock										
Lambs are separate	52	82.5	32	53.3	14	24.6	98	53.3	42.1	0.000
All classes of sheep	11	17.5	28	46.7	43	75.4	82	46.7		
Sheep flock is herded										
Together with cattle	27	42.9	18	30	31	54.4	76	42.2		
Together with goat	36	57.1	28	46.7	23	40.4	87	48.3	29.14	0.000
Sheep separately	0	0	14	23.3	3	5.3	17	9.4		
Way of herding										
Only one HH run as a flock	20	31.7	23	38.3	31	54.4	74	41.1	5.83	0.054
More than one HH run as a flock	43	68.3	37	61.7	26	45.6	106	58.9		

*P<0.05 significant, χ^2=person chi square; N (%)=number of respondents in percentage, HH=Household head.

Table 5. Breeding management in the study districts.

Parameter	Tanqua-Abergelle		Kola-Tembien		Adwa	
	N	%	N	%	N	%
Ram possession						
Having one ram	6	9.52	11	18.13	19	33.33
Having More than one ram	53	84.13	44	73.33	30	52.63
Having no ram	4	6.35	5	8.33	8	14.04
Purpose of keeping breeding ram						
For breeding only	49	77.8	42	70	44	77.2
For fattening	-	-	-	-	13	22.8
For breeding and socio -cultural vale	14	22.2	18	30	0	0
Sources of breeding ram						
From own flock	48	76.2	47	78.3	40	70.2
Neighboring	9	14.3	10	16.7	10	17.5
Purchased from market or farm	6	9.5	3	5	7	12.3

N = Number of respondents, %=percentage of respondents.

breeding rams reported by the respondents in Tanqua-Abergelle and Kola-Tembien districts, while tail type, coat colour, and pedigree with index value 0.24, 0.19 and 0.13 were ranked in its order, respectively in Adwa district. Besides libido, body conformation and drought resistance were also considered as selection criteria for breeding ram but less emphasis was given by the respondents in all study districts.

Most of the respondents in Tanqua-Abergelle and Kola-Tembien districts gave more emphasis for the first two top traits (tail type and body size) which might be related with the purpose of keeping sheep, while in Adwa district tail type and coat color were given more emphasis for selection of breeding ram, which might be related with market price and preference attraction.

Selection criteria for breeding ewe

As indicated in Table 7, tail type, body size and pedigree in Tanqua-Abergelle and Kola Tembien with index value 0.24, 0.22, 21 and 0.30,23 and 12 were major selection criteria for breeding female ranked first, second and third, respectively, while tail type, coat color and pedigree with

Table 6. Trait preference for selection breeding rams in the study districts.

Trait	Tanqua-Abergelle				Kola-Tembien				Adwa			
	R1	R2	R3	I	R1	R2	R3	I	R1	R2	R3	I
Appearance	0	5	1	0.02	3	9	7	0.10	4	5	7	0.09
Coat colour	5	9	4	0.10	0	2	1	0.01	11	11	10	0.19
Growth rate	7	1	5	0.07	2	8	5	0.08	4	5	3	0.07
Libido	1	5	10	0.06	4	4	9	0.08	8	3	7	0.11
Tail type	14	18	11	0.24	24	9	15	0.30	16	10	13	0.24
Pedigree	15	13	7	0.21	7	6	8	0.12	3	14	9	0.13
Body Size	18	10	10	0.22	17	12	7	0.23	0	6	0	0.04
Resistance to diseases	2	2	15	0.07	3	10	0	0.08	11	3	5	0.13

Index = Sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for particular trait divided by sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for all traits.

Table 7. Trait preference for selection breeding ewe in the study districts.

Trait	Tanqua-Abergelle				Kola-Tembien				Adwa			
	R1	R2	R3	I	R1	R2	R3	I	R1	R2	R3	I
Growth rate	5	3	0	0.06	1	1	1	0.02	0	1	4	0.02
Mothering ability	3	9	8	0.09	4	14	9	0.14	3	8	1	0.08
Age at first sexual maturity	5	8	10	0.11	10	8	15	0.17	10	11	9	0.18
Lamb weight	6	12	8	0.13	11	13	12	0.20	12	7	10	0.18
Lambing interval	5	5	11	0.10	10	5	6	0.13	11	3	8	0.14
Tail type	15	1	5	0.14	10	4	3	0.11	13	3	3	0.14
Resistance to diseases	3	3	3	0.05	3	1	3	0.04	5	4	1	0.07
Milk yield	11	4	3	0.12	0	1	0	0.01	0	0	0	0
Longevity	3	4	3	0.05	4	4	1	0.06	3	4	5	0.06
Body confirmation	1	4	3	0.04	2	2	1	0.03	0	7	1	0.04
Coat colour	6	2	5	0.07	5	1	8	0.07	0	6	6	0.05
Pedigree	0	8	4	0.05	0	6	1	0.04	0	3	9	0.04

Index = Sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for particular trait divided by sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all traits.

an index value 0.24, 0.19 and 0.13 were reported first, second and third, respectively in Adwa district.

Effective population size and level of inbreeding

The observed ram to ewe ratio in Tanqua-Abergelle, Kola-Tembien and Adwa districts of sheep flock population may be sufficient if we consider only the capacity of male to female. But as revealed in the study districts, uncontrolled utilization of breeding rams born within the flock for mating, lack of awareness about inbreeding and small flock size, may lead to accumulation of inbreeding and decreased genetic diversity (Falconer and MacKay, 1996; Jainer et al., 2001; Kosgey, 2004). However, communal herding practiced by the sheep keepers in all the study districts obtained in this study allows females to mix with males from other flock and this can minimize the risk of inbreeding (Jaitner et al., 2001) by increasing the effective population size.

Effective population size (Ne) and the rate of inbreeding coefficient (ΔF) calculated for the sampled sheep flock of Tanqua-Abergelle, Kola-Tembien and Adwa districts considering the existing flock size and inbreeding practiced are presented in Table 8. When sheep flock of a household were not mixed, ΔF for sheep in Tanqua-Abergelle, Kola-Tembien and Adwa were 0.085, 0.093 and 0.11, respectively. The value was higher than the maximum acceptable level of 0.063 (Armstrong, 2006). For Tanqua-Abergelle sheep, Ne was higher than the Ne of the other two districts, but ΔF was higher (0.11) for Adwa sheep. However, the present results were smaller than what had been reported for Tocha, Mareka and Konta, which were 0.17, 0.20, and 0.18, respectively by Alemayehu et al. (2015).

Reproductive performance

Average reproductive performance (Mean±SD) of the

Table 8. Effective population size and level of inbreeding when flocks of sheep are not mixed in Tanqua-Abergelle, Kola-Tembien and Adwa districts.

District	When flocks are not mixed			
	Nm	Nf	Ne	ΔF
Tanqua-Abergelle	1.79	7.97	5.85	0.085
Kola-Tembien	1.73	5.97	5.37	0.093
Adwa	1.46	6.12	4.72	0.11

Ne = Effective population size; ΔF = coefficient of inbreeding. Nm = number of male; Nf = number of female.

Table 9. Average reproductive performance (Mean±SD) of indigenous sheep population in the study districts.

Traits	Tanqua-Abergelle [N (63)]	Kola-Tembien [N (60)]	Adwa [N (57)]	Overall [N (180)]
Average age male giving serves (year)	1.71±2.5[a]	1.51±0.49[b]	1.95±0.66[a]	2.97±0.8
Age of male sexual maturity (months)	7.43±0.76[a]	6.67±0.91[b]	6.64±0.95[b]	6.93±0.95
Age of female sexual maturity (months)	9.16±0.82[b]	8.75±1.34[a]	8.63±0.81[a]	8.86±1.04
Female age at first lambing (months)	15.12±1.17[b]	14.87±0.87[a]	14.58±0.91[a]	14.86±1.01
Lambing interval (months)	7.81±0.83[a]	7.57±0.97[a]	7.65±0.82[a]	7.68±0.88
Life span lamb crop (number)	10.73±2.3[a]	10.35±1.89[a]	8.77±1.38[b]	9.98±2.08

N=Number of respondent, SD= standard deviation, value with different subscript are significant ($p<0.05$), values with the same subscript are non-significant ($p<0.05$)

studied sheep population in Tanqua-Abergelle, Kola-Tembien and Adwa districts are presented in Table 9. Reproductive performance such as age of sexual maturity for both sexes, average life crop, age at first lambing and male giving service sampled sheep in Adwa district were significantly ($p<0.05$) smaller than the sampled sheep of Tanqua-Abergelle district, but comparable with Kola-Tembien sampled sheep, while lambing interval across the three districts had not shown significant ($p>0.05$) difference. The mean age of at first lambing of ewes in months was 15.12±1.17, 14.87±0.87 and 14.58±0.91, respectively for Tanqua-Abergelle, Kola-Tembien and Adwa districts, respectively. The present result in the study districts mean age of at first lambing was comparable with the previous work done on other sampled sheep population in different parts of Ethiopia. For example, age of at first lambing for Raya-Azebo, Tahtay-Adiyabo and Tsegede was 15.2±0.2, 15.5±0.2, 14.1±0.3 months, respectively (Zelealem et al., 2014). The reported average ages of lambing for semi-arid and sub-humid sub-Saharan countries were 16.9 and 16.2 months, respectively (Otte and Chilonda, 2002). This indicates that the sheep breeds in the current study area have acceptable age range for breeding though they are late compared with temperate breeds that reach puberty at the age range of 5 to 12 months (Susan, 2011).

However, this finding should be dealt carefully since there are many other factors affecting the age of sexual maturity and the age at first lambing. Lambing interval of the sampled female sheep in Tanqua-Abergelle, Kola-Tembien and Adwa districts were 7.81±0.83, 7.57±0.97 and 7.65±0.82 months, respectively, which is within the ranges of the previous work done reported by Hailemariam et al. (2013) for Gamogofa zone 7.34±0.13 months. Almost all respondents in all the study districts reported that overall the reproductive performance of the animal is not fixed rather it depends on the feed availability of the area and management of growing ram lambs and ewe lambs.

Conclusions

Within a given household, ewes greater than one year accounted for the largest proportion 38.5% in Tanqua-Abergelle, 35.9% in Kola-Tembien and 38.7% in Adwa district, while male greater than one year accounted for the smallest proportion of 8.6% in Tanqua-Abergelle, 10.4% in Kola-Tembien and 9.4% in Adwa district. The primary reason for keeping sheep in Tanqua-Abergelle and Kola-Tembien from first to third rank was for manure as fertilizer, besides cash income and insurance for risk (rural banking). In Adwa district, income generation ranked first, using manure as fertilizer ranked second and insurance for risk ranked third for the purpose of keeping sheep. Natural pasture, fallow lands and crop residues were the main source of feed for sheep throughout the year in all the study districts and transhumance was identified in Tanqua-Abergelle and Kola-Tembien. Most of the sheep keepers in the study districts emphasize

traits tail type and coat colour type as selection criteria for breeding rams. The major sheep diseases hindering sheep productivity and survivability frequently encountered in the study area were pasteurellosis, pest des petit ruminants, anthrax, sheep and goat pox, foot and mouth diseases and mange mites.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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