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Original Article

Traditional Husbandry Practices and Selection Criteria of Goats in Selected Districts of Sidama Zone, Southern Ethiopia

Amsale Hankamo [1] and Tariku Woldeyohannes[2*]

[1] Department of Animal and Range Science, Dilla University, Dilla, Ethiopia

[2] Department of Animal Science, Injibara University, Injibara, Ethiopia

ABSTRACT

Before implementing any development plan, it is critical to understand traditional goat management practices, which allow breeders to create long-term genetic improvement while preserving indigenous goat production. This study aimed to describe the goat husbandry system in two districts of Sidama zone of southern Ethiopia using two production systems. A semi-structured questionnaire was employed to gather information regarding the management activities, purpose of keeping goats, and farmers' selection criteria for breeding animals. A total of 240 households were interviewed to collect relevant information for the study. Data collected were statistically analyzed and summarized into descriptive statistics. Indexes were calculated to clarify rankings by using indexes formula. The number of goat population was more in Loka Abaya than Aroresa. The primary purpose of keeping goats in the study area is mainly for their milk, meat, and income generation. Broad shoulders, compact frame, and short and thick necks of the bucks were considered the most important characteristics for selection. Communal grazing and crop aftermath were the most common feed sources reported by farmers in the study area. River was the major water source for goats in the study districts. The major factors limiting the

Corresponding Author: Tariku Woldeyohannes < tarikuw52@gmail.com >

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productivity of goats are feed shortage, diseases, and labour shortage. The management and husbandry practices are nearly equivalent to the rest of the country with the same agroecology. Planning and implementing goat development and extension services on management, improvement, disease control, and suitable forage production strategies helps farmers in increasing goat production and therefore improving their livelihood.
Keywords: Goat; husbandry practices; selection criteria; purposes.

INTRODUCTION

Goat farming is one of the most important agricultural sectors in developing countries, with Africa accounting for about 35% of the world's goat population (heads), making it the second continent next to Asia (Skapetas & Bampidis, 2016). Ethiopia has rich livestock genetic resources of varied and diversified genetic pools, which are adapted to a wide range of agro-ecologies. The number of goats reported in the country is estimated to be about 52.5 million heads (CSA, 2020). Goat production in Ethiopia accounts for 16.8% of total meat supply and 16.7% of the total milk consumption (Gobena, 2016; Zereu *et al.*, 2016). Goats are found in all agro-ecological zones of Ethiopia, from intensive farming systems to very extensive nomadic pastoralism and over the entire range of production systems. The majority of the goats in the country are maintained under mixed crop-livestock and pastoral and agro pastoral production systems (Tsegaye, 2009). Thanks to their tolerance to heat stress goats can survive and produce in the most marginal regions of the country. Goats traditionally had a strong impact on human populations' socio-economic life, especially among smallholder farmers. They play an important role in the different production systems due to their low initial capital investments, their potential to produce multiple products, high reproductive rates due to the short time they take to attain maturity (Solomon *et al.*, 2014). They have different purposes, such as income generation, serving as household social welfare, accumulation of capital, milk, manure, chevon, skin, and cultural functions (Grum, 2010; Tsegaye, 2009).

Despite the large population of goats and their advantages, the current contribution to the country's economy and producers' livelihoods is still below the total potential production capacity (Solomon *et al.*, 2014). The success and profitability of the goat production system in Ethiopia are limited by many challenges and constraints. The major constraints are the prevalence of diseases and parasites, inadequate and lack of sufficient feed supplies and breeding strategies, unimproved genetic potential of local breeds, poor access to markets and minimal institutional support by actors and services providers, poor access to and utilization of knowledge, information and technologies (Gizaw, 2010; Solomon *et al.*, 2014). Currently, goats face environmental challenges (degradation of rangelands, competition for land use, reduced water availability, etc.) and climate change also poses additional difficulties.

These resulted, failure to earn sufficient income for smallholder goat farmers and pastoralists in Ethiopia.

To increase and sustain the productivity of indigenous goats, it is important to understand traditional goat management practices before implementing any development strategy. Understanding the production system, preferences, and selection criteria would allow breeders to implement sustainable genetic improvement programs that would enable the development and promotion of appropriate genotypes that match the prevailing socio-economic and cultural environment (Bett *et al.*, 2011; Kosgey, 2004). Identification of goat production constraints helps to design management strategy at least to minimize the effects applied on goat production (Tesfahun *et al.*, 2017). However, very little effort has been carried out in assessing goat husbandry practices and selection criteria to improve goat production in the study area. Hence, the objectives of this study were to assess the goat husbandry practices as well as their constraints, and selection criteria of goats in the selected districts of Sidama region, Ethiopia.

MATERIALS AND METHODS

Description of the Study Areas

The Sidama zone is divided into 21 administrative districts. The two districts (Aroresa and Loka Abaya) were selected for their potential for goat distribution and their different production environment. The descriptions of the districts are as follows:

Aroresa district is situated 6^0 20′ North Latitude 39^0 00′ East Longitude. It has variability in topography, with an average rainfall of 733 mm, and a mean annual temperature of 18.5^{0}C. The District occupies an area of about 8,100 Km^2 and has a total of 33 kebeles and 11 of which are highland and the rest are midland. The total goat population in the district's area was estimated at 20,855 heads. The livelihood of the farmers was mainly based on crop production; this is due to the ample rainfall obtained in the “kremt from April-August (Hankamo *et al.*, 2020).

Loka Abaya district is located on the southeastern border of the Guji zone of Oromia region, Woayita zone and Humbo district in the east, Dale and Aleta chuko district in the west, and Boricha district in the north. The district lies between $6^0$14 - $7^0$18 North latitude and 37^0 92 - 39^0 14′East longitude. It is lowland with altitudes ranging between 1170 to 1500 meters above sea level. The district's total agro-ecology is estimated to be 79% lowland, 16% midlands and 5% is desert. The average annual rainfall is 900-1400mm and the annual temperature range from 10-32^{0}c. It is estimated that the population of goats in the district was 123,607 heads (Hankamo *et al.*, 2020).

Sampling Technique and Sample Size

The study employed a purposive multistage sampling strategy. Two districts were selected based on their goat population and production system. From each selected

district three rural kebeles were selected based on the concentration of goat population, suitability, farmers' willingness to participate in the study. Forty (40) households (goat owners) per rural kebeles, (a total of 240 households) were randomly selected for the interview.

Methods of Data Collection

The study was used both primary and secondary data sources. Primary data on respondents' land and livestock holdings, management practices, goat productivity, selection criteria for breeding, and goat production constraints were collected through pretested semi-structured questionnaire from the randomly selected respondents. To strengthen survey data group discussions were also held. Secondary data was collected from the district office, as well as different published unpublished relevant documents.

Data Analysis

All of the collected data were arranged, organized, and analyzed by using simple descriptive statistics such as mean and percentage by using SPSS version 20 and the results were presented in the form of tables. Index was determined by using formula: (Index = sum of (3 X selection criteria ranked 1^{st} + 2 X selection criteria ranked 2^{nd} + 1 X selection criteria ranked 3^{rd}) given for each districts divided by sum of (3 X selection criteria 1^{st} + 2 X selection criteria ranked 2^{nd} + 1 X selection criteria ranked 3^{rd})).

RESULTS AND DISCUSSION

General household information

The results as presented in Table 1 indicate that the average family sizes observed in this study area are in close accordance with the reports of Gatew *et al.*, (2015) (7.68±0.26) from Siti district and there was no variation (P>0.05) between the two studied districts. The large family, especially among the agrarian communities, has many advantages because it provides a large force for agronomic activities. However, over the period larger family sizes would result in the fragmentation of farmland which can have negative consequences over the period (Alemu, 2015). The findings revealed that most of the respondents in the survey were males. The observations are in close accordance with those of Alemu (2015) and Kebede *et al.*, (2017). It can be seen that most of the females in the house were busy doing household work. This is a socio-cultural norm in most developing countries. Studies by Oluwatayo and Oluwatayo (2012), have indicated that most of the husbandry activities such as cleaning barns, feeding, watering, etc. of the small ruminants were carried out by the female members of the houses. The findings also indicate that there were no differences across the two areas for the same. The results related to the respondents

age group show that most of them are from the age group 41-50 years. This indicates that most of the respondents had a good background in livestock farming. However, the results of the respondents' educational status show that most of them were illiterate, the findings are in line with studies from different parts of Ethiopia (Gatew *et al.*, 2015; Grum, 2010; Tsegaye, 2009). Moreover, a higher level of illiteracy among the respondents is a drawback in modern livestock husbandry practices, and the adoption of improved technologies (Ntume *et al.*, 2015; Woldeyohannes, 2020), requires better and appropriate livestock husbandry extension services. Such respondents usually have difficulties in maintaining proper records for their livestock enterprise besides also finding difficulties in properly balancing the feed and also calculating the doses of veterinary drugs.

Table 1: General characteristics of the sampled households

Characteristics	HH responses	Aroresa	Loka Abaya	Overall	X^2 - value
Family size (Mean ±SE)		**7.67±0.25**	**7.62±0.12**	**7.65±0.65**	**0.87**
Sex (%)	Male	89.2	82.5	14.2	2.19^{ns}
	Female	10.8	17.5	85.8	
Age (%)	20-30	0.8	0.0	0.4	6.34^{ns}
	31-40	20.8	29.2	25	
	41-50	44.2	49.2	46.7	
	51-60	25	15.8	20.4	
	> 60	9.2	5.8	7.5	
Educational background (%)	Illiterate	63.3	69.2	66.2	1.826^{ns}
	Read and write	24.2	23.3	23.8	
	Primary school	12.5	7.5	10	

ns= not significantly different, HH=Household.

Land Holding Pattern in the Study Areas

The findings in Table 2 indicate that the total landholding did not vary across the sites studied, the landholdings observed are in close accordance with the report of Belete (2009) from Goma District. The study further indicates that the cropland was higher ($p<0.001$) in Aroresa, while the grazing land was higher ($p<0.001$) in Loka Abaya. This may be ascribed to the cropping and rainfall pattern in the areas; the observations to correspond closely to the reports by Assefa (2007) and Gizaw *et al.*, (2008). Land allocation for cropping can provide the animals with many crop residues in the lean season (Assefa, 2007). The grazing land in Loka Abaya is higher, which indicates that the respondents are dependent on livestock more than on agriculture in the area, which is in close accordance with those of Assefa (2007), Asefa and Kebede (2013), and Alefe (2014). This may be ascribed to poor fertility of the land and/or erratic rainfall. The study also shows that most of the respondents could not access the communal grazing lands in Aroresa and even some of the respondents could access the same, they reported that the grazing land is shrinking over the period due to anthropogenic activities and also an expansion of grazing land by agronomic activities, a similar

trend was also reported by Aune *et al.*, (2001). The respondents also indicated that some of the lands was also used for the establishment of roads and other public facilities like health centers and schools, the findings are in close accordance with those of Alemu (2015).

Table 2: The land holdings (Mean ±SE) of the households in the study districts

Land size in hectare (ha)	Aroresa	Loka Abaya	Overall	P-value
Total land	1.67±0.33	1.72±0.39	1.69±0.256	0.31
Crop land	1.36±0.28***	1.05±0.27	1.21±0.22	0.00
Fallow land	0.26±0.12	0.28±0.14	0.273±0.01	0.42
Grazing Land	0.28±0.007	0.61±0.24***	0.45±0.17	0.00
Trend of communal grazing land (%)				X^2 - value
Decreasing	26.7	95.8	61.2	135***
Stable	0.00	3.4	1.7	
No communal grazing land	73.3	0.8	37.1	
If decreasing then why (%)				118.856***
Due to land covered by crops	88.3	19.2	53.8	
Due to Governmental control	0.00	30	15	
Anthropogenic causes	11.7	50.8	31.2	

The result observed across the districts significant *** P<0.001.

Income Source of the respondents

The findings in Table 3 show that most of the respondents from Aroresa are dependent on agronomic activities but for Loka Abaya district the reverse is true. The findings are in close accordance with those of Assefa, (2007). Furthermore, the results show that some of the respondents were dependent on both livestock and agronomic activities that minimize the risk associated with either crop or livestock alone. The trend was more or less similar across both districts although the proportion varied (P<0.001). The respondents need to be encouraged to engage in mixed crop-livestock farming as this encourages nutrient recycling and also optimum utilization of farm residues (Assefa, 2007).

Table 3: Major source of income of households in different seasons across the Districts

Seasons	Sources of income	Aroresa (%)	Loka Abaya (%)	Overall (%)	X^2- value
Dry season	Crop	85	0.8	42.9	186.8***
	Livestock	0.0	64.2	32.1	
	Both crop and livestock	10	28.3	19.2	
	Trade	5	6.7	5.8	
Wet season	Crop	50	2.5	26.2	100.5***
	Livestock	17.5	75	46.2	
	Both crop and livestock	28.3	15	21.7	
	Trade	4.2	7.5	5.8	

Livestock composition and holdings

The findings presented in Table 4 indicate that composition of livestock species in the areas was similar, however the proportion of species varied across the locations. The study showed that there were more numbers (P<0.001) of cattle and goats in Loka Abaya. This could be because in Loka Abaya the respondents were more dependent on livestock than in Aroresa, Studies conducted by Alefe, (2014) have also indicated that the proportion of livestock among the communities who are dependent on them is usually higher. The study also shows that the number of cattle is less than that of the goats, as both sites are more suitable for goat production, the observations are in close accordance with those of Desalew, (2008) from Mettema District.

Table 4: Livestock species composition and size per household in the studied districts

Livestock species	Aroresa	Loka Abaya	Overall	P =Value
	Mean±SE	Mean±SE	Mean±SE	
Cattle	7.56 ±0.47	14.37 ±0.8***	10.68 ±0.5	0.001
Goat	4.23 ±0.24	13.016 ±0.8***	8.48 ±0.49	0.001
Sheep	0.94±0.12	0.75 ±0.11	0.85±0.08	0.25
Chicken	4.5 ±0.18	4.4 ±0.17	4.5 ±0.12	0.85
Donkey	0.091 ±0.026	0.29 ±0.53*	0.2 ±0.3	0.01

The result obtained across the districts were significantly different *P<0.05; ***P<0.001.

Flock Structure of Goat in the Study Areas

The results in Table 5 reveal that the flock dynamics varied across the locations with higher numbers in Loka Abaya district. This may be ascribed to the availability of grazing land in the area when compared to Aroresa district. The study also shows that the numbers of does were higher when compared to the bucks, the findings are in close accordance with those of Grum, (2010) and Tsigabu, (2015). This is because the reproduction ability of the does is higher than those of the bucks and as they reach the market age, most of the bucks are sold for various purposes. The findings also indicate that the post-weaning mortality was very high in the study areas which was associated with the decrease in the numbers of buckling and doelings from <6 months of age and also those >6 till <1 year, the observations are also in close accordance with those of Alefe (2014) from Shabelle Zone.

Studies by Assefa (2007) also indicated that there was a high demand for growing doelings and buckling by the restaurant owners, especially those serving "Tibs" as the chevon is very succulent and requires less cooking at that stage. This often contributes to negative selection among the livestock, as the ones which are fast growers are usually slaughtered at an early age (Gemiyu, 2009). Therefore, the respondents need to be appraised about the selection of buckling and doelings at an early age so that the best animals are retained for breeding. The presence of castrated buck indicates that the selection of bucks is being carried out by the respondents to control the breeding.

The observations are in close accordance with result of Alefe (2014) from Shabelle Zone.

Table 5: Flock structure of the goat population in their age category (Mean ±SE)

Goat flock Structure	Age classes	Aroresa	Loka Abaya	Over all	P-Value
Kids	Male kid <6 month	0.8 ±0.06	2.08 ±0.13***	1.4 ±0.08	0.000
	Female Kid <6 month	0.7 ±0.06	2.04 ±0.13***	1.37 ±0.08	0.000
Buck	Buck <1 year	0.41 ±0.04	1.49 ±0.11***	0.95 ±0.07	0.000
	Buck > 1 year	0.32 ±0.04	1.25 ±0.1***	0.78 ±0.06	0.000
Doe	Does <year	0.057 ±0.05	1.85 ±0.11***	1.18 ±0.07	0.000
	Does >1 year	1.2 ±0.06	3.7 ±0.22***	2.49 ±0.14	0.000
Barren	Adult age	0.033 ±0.02	0.06 ±0.02	0.05 ±0.01	0.238
Castrated buck	Adult age	0.23 ±0.052	0.67 ±0.08***	0.45 ±0.05	0.000

*** P<0.001. The result observed across the districts significantly different

Purpose of keeping goat in the study areas

The study as presented in Table 6 shows that the goats in both the study locations are primarily raised for their meat, milk and as a source of income which is similar across the study areas, however, the ranking varied slightly. The findings are in close accordance with those of Hassen *et al.*, (2012). The use of chevon is quite popular in the lowlands of the country as the meat is relatively leaner when compared to mutton (Assefa, 2007; Madruga *et al.*, 2008). Moreover, the meat from small ruminants is popular in areas where there are no refrigeration facilities as the whole carcass can be consumed by the family members in a day or two (Oluwatayo & Oluwatayo, 2012). The rearing of small ruminants for milk purposes as observed in the study is in close accordance with the findings of Gatew *et al.*, (2015) from Siti District. This is because the small ruminants are easier to rear when compared to the bovines and the milk from goats is easily digestible by the old and young alike (Wodajo *et al.*, 2020).

Table 6: Major Purpose of keeping Goat across the districts in the study areas

Purpose	Aroresa				Loka Abaya			
	Rankings			Index	Rankings			Index
	1st	2nd	3rd		1st	2nd	3rd	
Milk	102	12	3	0.46	72	0	7	0.31
Meat	9	29	55	0.19	25	22	51	0.24
Income source	3	48	20	0.17	12	93	16	0.33
Saving	1	4	13	0.04	7	1	14	0.05
Manure	5	27	29	0.14	4	4	31	0.07
Social status	0	0	0	0.00	0	0	1	0.00

The importance of goats among the pastoralists as milk animals have been reported by Tsegahun *et al.*, (2000). The study further indicates that the goats are reared also as a source of income, which corresponds with the findings of Oluwatayo and Oluwatayo (2012) results, which show that small ruminants are easily sold when compared with bovines. Contrary to its difficulty in finding purchasers for bovines among the villagers or neighbors, small ruminants are preferred to meet the immediate needs for cash by the farmers (Kosgey, 2004).

Reproductive Performance of Goats

The results in Table 7 show the breeding and reproduction potential of the does and bucks. The average age at first mating of the does rear at Aroresa district was higher ($P<0.001$). Higher age at first mating is not desirable hence; it leads to fewer numbers of kids born in lifetime. The study further indicates that the reproduction potential of the does and bucks reared in Aroresa district was lower which may be ascribed to poor nutrition. The average age at first mating of the does as obtained in the study is in close accordance with the findings of Gatew *et al.*, (2015). However, the values are higher than those reported by Belete (2009) for Keffa breed.

Table 7: Averages of some reproductive performance traits of goats in the studied districts

Average Reproductive performance	Aroresa	Loka Abaya	Overall	P-value
	Mean± SE	Mean± SE	Mean± SE	
Does age at first mating (months)	9.36±0.83*	8.97±0.17	9.16±0.07	0.006
Bucks age at first mating (months)	11.06±0.18***	9.65±0.10	10.36±0.11	0.000
Age of first kidding (months)	14.73±0.71***	14.12±0.52	14.42±0.05	0.000
Kidding interval (months)	8.52±0.063***	7.53±0.035	8.02±0.05	0.000
No of kids born in life time per doe	10.97±0.21	11.24±0.2	11.10±0.14	0.36
Reproductive Age of doe (years)	6.46±0.087	6.81±0.08**	6.64±0.05	0.003
Frequent type of birth (%)	%	%	%	X^2-value
Single	73.3	71.7	72.5	0.08^{ns}
Twin	26.7	28.3	27.5	

The result observed across the districts significantly different * P<0.01, ***P<0.001, ns=not significant (P>0.05)

The results about the age at first mating of the bucks reared in the studied areas also indicated that the average age at maturity was lower in Loka Abaya district, which may be ascribed to proper feeding and management of the bucks, the findings are in close accordance with the report of Gatew *et al.*, (2015). The average age of the first mating of the bucks as observed in the study is in close accordance with those of Gatew *et al.*, (2015). However, the values are higher than those reported by Tsigabu (2015) for Nuer goats; the differences in age at first kidding across the locations may be ascribed to the fertility of the does and bucks which are seriously influenced by nutrition and diseases. The study also indicates that the average kidding interval

agreed with the findings of Tsegaye (2009) from Mettema District Amhara Region. The average number of kids born from the does indicate that there is ample scope to improve the same which can make goat rearing a very successful venture (Banerjee *et al.*, 2000) The average numbers of kids born are lower than those reported by Tsegaye (2009). The influence of nutrition on the lifetime production of the does is also evident, where the average reproductive life of the does is quite lower than those reported by Asefa and Kebede (2013) from Bale Zone of Oromia Region. The study further indicates that irrespective of the locations most do were not prolific, this can be a breed character, thus within breed selection can help in the identification of does that can be profitable for the farmers. The differences in prolificacy as observed may be ascribed to a low level of nutrition prior to mating (lack of flushing ration).

Selection criteria for breeding bucks

The results as presented in Table 8 indicate that the appearance (bright eyes, broad shoulders, compact body, short and thick necks) of the bucks were considered the primordial trait for their selection. The observance is in close accordance with those from Bale Zone of Oromia Region by Asefa and Kebede, (2013). The traits as indicated correlate with masculinity. The study also indicates that bucks with strong legs are preferred as such animals can graze for long distances (Banerjee *et al.*, 2000). The study also indicates that coat color is considered an important criterion for selecting the animals (Woldeyohannes, 2020), which can be ascribed to socio-cultural value to the owners (Asefa & Kebede, 2013), besides it has been recorded that animals with lighter coats color can thrive well in warm locations, especially in the lowlands (Nuramo, 2018). Pedigree of the bucks is generally from their maternal lines and is not formally maintained (Banerjee *et al.*, 2000; Grum, 2010). However, studies by Banerjee *et al.*, (2014) have indicated that farmers maintain oral records of their animals which are often questionable.

Table 8: Trait preference for selecting the breeding bucks in the study areas

Preference traits for selecting breeding buck	Aroresa				Loka Abaya			
	Ranking			Index	Ranking			Index
	1st	2nd	3rd		1st	2nd	3rd	
Appearance	93	7	0	0.41	88	8	1	0.39
Coat color	7	23	21	0.12	10	29	21	0.15
Testicular character	13	5	2	0.07	12	6	8	0.08
Growth rate	2	18	29	0.10	1	16	26	0.08
Pedigree	2	18	39	0.11	5	20	38	0.13
Sexual ability	0	0	9	0.04	0	6	7	0.03
Other (tail & hoof)	3	40	20	0.15	4	36	19	0.14

Selection criteria for selecting breeding does

The results as presented in Table 9 indicate that phenotypic selection (appearance) of the does are mostly considered as a primordial criterion for their selection, the

observations are in close accordance with the results of Asefa and Kebede, (2013). The does with a thin and long neck, deep body, and well-developed udder are considered as criteria for their selection. The other important trait that is considered for selection is the mothering ability of the does and their lactal yield (Abraham *et al.*, 2017). Does with good lactal yield are expected to nurse strong and healthy kids (Gemiyu, 2009), goat milk is also an important part of the diets of the people residing in many parts of the country (Park, 2007). The importance of coat color as a selection criterion has already been discussed ahead.

Table 9: Trait preference for selecting the breeding does in the study areas

Preferrence traits for selecting breeding doe	Aroresa				Loka Abaya			
	1st	2nd	3rd	Index	1st	2nd	3rd	Index
Appearance	93	24	3	0.45	78	27	3	0.40
Coat color	24	23	15	0.18	36	33	17	0.27
Mothering Ability	0	9	5	0.03	1	7	5	0.03
Kids Survival	0	5	4	0.02	0	3	7	0.02
Pedigree	0	9	16	0.05	0	16	21	0.07
Milk Yield	0	34	51	0.17	0	16	39	0.10
Twinning Ability	0	3	7	0.02	0	3	6	0.02
Other (hoof, tail & ear)	3	13	19	0.08	4	15	22	0.09

The feed source of goats in the study areas

The feed resources for the goats reared in the study areas have been presented in Table 10. The study shows that during the dry season ample crop aftermaths are available in the agriculturally productive Aroresa district, the importance of crop aftermath as a source of fodder for goats is in close accordance with those of Abraham *et al.*, (2017) from Western Tigray, North Ethiopia. The crop aftermaths at times have a good amount of grains as a result of shattering. This is supplemented by cutting and carrying grasses and browses which are in close accordance with those of Gatew *et al.*, (2015). The cut grasses are usually provided to the sick, infirm, pregnant and nursing does (Abraham *et al.*, 2017). The presence of private grazing land and low intensification of agriculture allows Loka Abaya respondents to get access to communal grazing lands, the results are very similar to those of Tsigabu (2015) from Nuer Zone. However, the quality of the forage and pasture is deteriorating over time, which can be ascribed to encroachment by invasive species and also overgrazing (Mihertu, 2018). In the wet season besides communal grazing land, the goats are grazed on the private grazing lands; this is because the crop aftermaths are not available during this season. The cut and carry system of feeding is prevalent in the wet season (irrespective of the location) as many times the goats especially the old, infirm, pregnant and nursing bucks/does are usually reared indoors because of vagaries of nature especially during the rains (Gemiyu, 2009). The respondents also indicated that there was variation in the availability of fodder, across the study areas,

the observations were in close accordance with those of Assefa (2007). The shortage was higher in wet season for Aroresa district, because in district the lands are usually cultivated and hence it's expected that there will be shortage of forage and fodder under such circumstances, while reverse was true for Loka Abaya district.

Table 10: The feed source of goats and the seasonal feed availability in the study areas

Feed sources	Aroresa				Loka Abaya			
Feed Source in dry season	1st	2nd	3rd	Index	1st	2nd	3rd	Index
Communal grazing Land	27	27	15	0.21	75	36	7	0.42
Crop Aftermath	85	23	0	0.42	36	39	10	0.27
Cut grass and browse	8	47	45	0.23	5	23	50	0.15
Grazing fallow Land	0	23	0	0.06	1	18	1	0.06
Crop residue	0	0	60	0.08	3	4	52	0.10
Feed Source in wet season								
Communal grazing Land	1	4	24	0.05	59	13	18	0.31
Private grazing Land	4	70	29	0.27	2	58	26	0.21
Grazing fallow land	12	15	8	0.11	13	16	7	0.10
Crop residue	0	27	10	0.09	2	33	24	0.13
Cut grass and brows	103	2	13	0.48	44	0	45	0.25

Goats flocks herding mechanisms

Table 11 results indicate that the goats were rarely reared together with other livestock which is a good venture. The goats reared in Aroresa were herded alone, this is in close accordance with those of Tsegaye (2009) from Metema. Rearing goats alone has some positive and also some negative consequences, grazing the flock alone can prevent the spread of many diseases across the flocks (Animut & Goetsch, 2008). However, rearing the flocks aside the other goats (from the neighbors) can often lead to inbreeding within the flocks (Kosgey *et al.*, 2006). The study further indicates that the goats are provided with adequate housing, provision of housing protects the goats against dangers, apart from predators (Asefa & Kebede, 2013). The study also indicates that in areas where land and labour shortages exists the respondents preferred to reduce their flock size, this is in accordance with the findings of Legesse *et al.*, (2008) from Southern Ethiopia. Land shortages often lead to lack of fodder and forage (which was observed in Aroresa district) and therefore, in such conditions the flock sizes are usually minimized (Assefa, 2007). The study also indicates that farmers are aware of the importance of minerals in livestock diets; similar findings were also reported by Gebrechristos and Dugma (2013) around Jimma. Minerals play important roles in various physiological processes and hence it is imperative that feeding of minerals can play significant role in production and reproduction processes of livestock (Zeleke *et al.*, 2016). Studies also show that Bole (mineral soil) is the most preferred means of provision, which is also in close accordance with those of Zeleke *et al.*, (2016). However, care has to be taken to make sure that the mineral soil is not further contaminated and hence, therefore, the region where this soil present needs to

be fenced off. The study also indicated that the respondents from Loka Abaya purchase the mineral supplement which is usually in form of table salt; these observations to are in close accordance with the findings of Gatew *et al.*, (2015).

Table 11: The herding mechanism and sources of minerals supplement for goats (%)

Parameters	Choices	Aroresa	Loka Abaya	Overall	X^2-value
How do you keep your goats?	Together with other species	11.7	20	15.8	3.13^{ns}
	Separately	88.3	80	84.2	
Way of herding	Alone	89.2	5	47.1	170***
	With neighboring goat	10.8	95	52.9	
Source of Mineral	Bole	91.7	34.2	62.9	85.02***
	Purchased	8.3	65.8	37.1	
Reason of supplying mineral	To improve growth rate	1.7	0.00	0.8	69.9***
	To improve body condition	15	61.2	37.7	
	To increase milk yield	41.7	6.9	24.6	
	All	41.7	31.9	36.9	

The result observed across the districts were significantly different *** P<0.001, ns=not significant (p>0.05).

The findings also indicate that the respondents provide minerals for improving the milk yield of the does besides the overall body condition and their growth, these findings are also in close accordance with the findings of Yadessa (2015) and Zeleke *et al.*, (2016). Feeding of minerals also tends to improve the immune system of the animals and therefore, assist in overall improvement of the production and reproduction potential of the animals (Yadessa, 2015).

Housing system for the goats

The result about the housing system of the goats presented in Table 12 shows that in most of the cases the goats were housed along with their owners, these findings are in close accordance with those of Desalew (2008) and Gemiyu (2009). The housing of the goats along with their owners might be ascribed to preventing goats from being theft (Gemiyu, 2009). However, housing goats alone can help prevent the spread of zoonotic diseases. The study also indicates that in most cases the floor is made up of mud with proper slope and drainage mechanism, which helps in absorbing the urine of the goats. However, such floors are difficult to clean and can help in the spreading of diseases and parasites. The walls in most cases made of wood, which is a locally available material, which is in accordance with the result of Abraham *et al.*, (2017). The wooden walls can keep the room warm during colder days, but wood is also prone to ectoparasites and fire alike. The roof of the houses is made of grass, which is locally available and cheap (Abraham *et al.*, 2017). However, proneness to fire and also predators should be considered when such houses are being constructed.

Table 12: Housing /Enclosure/ of goat both dry and wet season in the study areas (%)

Parameters	Response of HH	Aroresa	Loka Abaya	Overall	X^2-value
Housing in dry season	In family house	84.2	76.7	80.4	2.14^{ns}
	Separate house	15.8	23.3	19.6	
Housing in wet season	In family house	83.3	74.2	78.8	3.013^{ns}
	Separate house	16.7	25.8	21.2	
		Floor	Wall	Roof	
Housing materials	Mud	100	-	-	
	Wood	-	100		
	Grass	-	-	100	

The results observed across the districts are not different (P>0.05) ns =not significant.

Water source and watering frequency

The results in Table 13 show that in Aroresa district water from the river is the major source across both the dry and wet seasons, these observations are in close accordance with those of Alemu (2015). Water from the rivers is permanent so care has to be taken not to contaminate it with upstream carcasses. Water from bore well is also provided to the goats in Loka Abaya district, this is in close accordance with those of Asefa and Kebede (2013). Rainwater is used for the goats during the rainy season in Loka Abaya district.

Table 13: Water sources and watering frequency of goats in different seasons (%)

Source of water	Response of HH	Aroresa	Loka Abaya	Overall	X^2-value
Major water sources in dry season	River	100	30	65	129.23***
	Bore well	0.00	70	35	
Source of water in wet season	River	100	48.3	74.2	83.59***
	Rain Water	0.00	51.7	25.8	
Watering frequency (dry season)	Once a day	60.8	82.5	71.7	15.49***
	Once in two days	38.8	17.5	26.7	
	Once in three days	3.3	0.00	1.7	
Watering frequency (wet season)	Feely Available	60	37.5	48.8	68.103***
	Once a day	1.7	0.00	0.8	
	Once in two days	5	31.7	28.3	
	Once in three days	33.3	10.8	22.1	

The result observed across the districts significantly different **P<0.001. HH= Household

However, care has to be taken to ensure that the water is clean and that the rainwater is not too old and contaminated. The study further indicates that water is provided to the goats at least once a day, which is in close accordance with those of Gatew *et al.*, (2015) from Bati area. During the dry season, the forage usually lack moisture and hence the animals need water quite frequently; the goats should be provided with water adlib (Gatew *et al.*, 2015). The results also indicate that during the dry season the water is mostly made available adlib across both study locations, which also corresponds to the result of Alemu (Alemu, 2015). However, in some cases, water is

made available once in two or three days, under such condition the animals are quite stressed and hence can influence their productive and reproduction capacity adversely.

Goat health management in the study areas

The findings (Table 14) show the most common goat disease is a form of accidental death locally called *"Godosha"* which causes damage to the liver of the goats, diarrhea, and oral inflammation locally known as *"Fetele"*, affects the young and old aged goats particularly, coughing, and nasal discharge locally called *"Gansho"*, skin wound and inflammation locally called *"Bijajisha"*. The study also indicates most of the respondents preferred to take the sick animals to the veterinary clinic near the kebeles, the observations are also in close accordance with those of Abraham *et al.*, (2017). The results indicate that respondents also use traditional ethno-veterinary treatment methods using medicinal herbs to treat their goats those who are very far away from veterinary clinics. Hence, there is a need for either establishing veterinary clinics at shorter distances or allowing private veterinary practitioner's in the area.

Table 14: Goats health management systems across the districts in the study areas

Methods	Response of HH	Aroresa	Loka Abaya	Overall	X^2-value
What do you do if goat becomes sick?	Treat with ethno-veterinary	32.5	15	23.8	10.14**
	Take to veterinary center	67.5	85	76.2	
Do you have veterinary service	Yes	100	100	100	
	No	0.0	0.0	0.0	
Distance to Veterinary service	< 1 km	25	42.5	33.8	8.21**
	1-5 km	75	57.5	66.2	
Vaccination timing	After report of disease	60	70.8	65.4	10.44**
	After certain animal died	10	0.8	5.4	
	Before Out break	30	28.3	29.2	

The result observed across the districts were significantly different **P<0.01. HH= Household.

The study further indicates that vaccinations are provided to all the goats, which is a welcome gesture and needs to be replicated in other areas too. However, regarding the timings of the vaccination, most of the respondents indicated that the vaccinations are provided after incidences have been reported in the area, similar reports have also been indicated by Tsegaye (2009). Thus, the zonal and regional veterinary officials should develop an annual vaccination calendar for their livestock.

Castration and fattening practice

The results in Table 15 indicate that most of the respondents from Aroresa district did not castrate their bucks, while the reverse was true for the goats reared in Loka Abaya district. Society considered castration as not giving birth and which was deviate from nature and not allowed by their cultures, those observation was in agreement with the finding of Asefa and Kebede (2013). The study further shows that most of the bucks

are castrated using traditional methods, which are naturally painful and may lead to their death too. The traditional method of castration methods has also been known to lead to infections as the wound is usually exposed and prone to infections during the castration season (Abebe *et al.*, 2013). The study also indicates that the majority of the bucks are castrated after they attain maturity, which of course defies the reason for controlling their breeding ability; these observations are in close accordance with those of Gatew *et al.*, (2015).

Table 15: Castration and Fattening Practice of Goat in the study areas (%)

Castration Practices	Responses of HH	Aroresa	Loka Abaya	Overall %
Do you Castrate your buck	Yes	40	80	60
	No	60	20	40
Method of Castration	Modern method	29.2	38.5	35.4
	Traditional method	74.8	61.5	64.6
Age of Castration	<1 year	4.2	17.7	13.2
	>1 year	95.5	82.3	86.8
Reason of castration	Control breeding	0.0	19.4	13
	Improve fattening	33.3	18.4	23.3
	For better price	66.7	62.2	63.7
Season of Castration	Dry	91.7	63.2	72.7
	Wet	8.3	36.8	27.3
Mean-time duration for providing supplementary feed for Castrated buck (months) (Mean ±SE)		3.23±0.1	3.17±0.08	3.19±0.06

The result observed across the districts significantly different * ($P<0.05$), ***$P<0.001$, ns=not significant ($p>0.05$).

As observed in the report, the reason for castrating the bucks is generally for obtaining a better price which is also in close accordance with those of Gatew *et al.*, (2015). The castrates usually tend to fatten well if provided with proper feeding and care. The study also shows that most of the respondents castrate their bucks in the dry season, during the dry season the risk of infection at the site of the castrate site is low. However, during the dry season, the availability of the feed and fodder too is less and hence can influence the chances of wound healing. The study also shows that the castrates are provided with supplementary feed to facilitate wound healing (Desalew, 2008). The study also indicates that the period of providing the supplements usually lasts around 3 months, typically enough to cure the wound. The results reveal that the supplemental feeding is supplied to the castrates as well as to the expended does (who are also supposed to carry children) and may later be sold out, these conclusions are also in near agreement with those of the castrates (Asefa & Kebede, 2013). The results also show that young does are also provided with supplementary feed to facilitate conception and lactal yield of the does.

Breeding systems of goats in the study areas

The findings as presented in Table 16 are indicative that the majority of the respondents in Loka Abata district prefer to rear bucks, the findings are also in close accordance with the observations of Tesfahun and Kebede (2013). However, those from Aroresa district do not rear bucks in the flock, this is evident from the fewer numbers of kids born from the does. The study further indicates that there are higher chances of inbreeding in Aroresa district as the numbers of bucks are fewer and sharing of bucks is commonly observed. Sharing of bucks and fewer numbers of bucks can often lead to high incidences of inbreeding and also it does not allow genetic improvement (Jaitner *et al.*, 2001; Kosgey *et al.*, 2006). However, there are a few respondents who reared more than one buck which is desirable as it can facilitate flock selection.

The study also indicated that the bucks are usually home-born, they still lead flock to inbreed, which of course is not desirable in the flock for prolonged period (Abegaz, 2014). The study further indicates that the reason given by the respondents varied across the locations, while those in the Loka Abaya district reported that the reason was because of their whole flock structure, which may also be ascribed to the fact that predatory attacks are common in the area.

Table 16: Breeding mechanisms of goats across the districts in the study areas (%)

Characteristics	Response of HH	Aroresa	Loka Abaya	Overall	X^2 -value
Do you have breeding buck	Yes	28.3	82.5	55.4	71.25***
	No	71.7	17.5	44.6	
If yes, how many bucks do you have	One	64.7	50.4	50.4	4.97^{ns}
	Two	23.5	27.3	26.3	
	More than two	11.7	27.3	23.3	
Source of these bucks	From own flock born	91.2	90.9	91	0.002^{ns}
	From market	8.8	9.1	9	
Why do you keep more than one buck	Having a large flock size	0.0	50	41.4	12.8**
	For social status	0.0	6.9	5.7	
	For both fattening and mating	100	43.1	52.9	
Do you fix age at first mating	Yes	1.7	3.3	2.5	0.68^{ns}
	No	98.3	96.7	97.5	
Average year of buck serving in a flock		2.5±0.08	2.8±0.07	2.7±0.06	0.7

The results observed across the districts were significantly different * (P<0.05), ***P<0.001, ns=not significant

The study from Aroresa district indicates that most of the respondents preferred to rear extra bucks for fattening purposes, typically they were usually either outlived their productive life or castrates. The study further indicates that the primordial reason for rearing the bucks was for breeding purposes, while those which were old and/or incapable of mating were usually used for fattening purposes. The study further indicates that mating is panmictic (random mating) and the age of the bucks is not

monitored for the purposive of breeding; the findings are in close accordance with those of Banerjee *et al.*, (2014) from Southern Ethiopia. Allowing the bucks to serve at a very young age can adversely influence their growth and therefore the respondents need to be made informed and prevented from using the bucks at an early age.

Constrains of goat production in the study areas

The findings of the major constraints of rearing goats in the study areas across the two seasons are presented in Table 17. The results indicated that the constraints varied across the locations, which are in close accordance with those of Assefa (2007) who reported that every location has its unique problems. The feed shortage has been reported as the primordial reason in the Aroresa district irrespective of the season, this can be ascribed to shortages of land and those allotted for grazing too. Fodder deficiency leads to late maturity of the goats which also leads to poor body weight and low immunity (Mogas & Bogale, 2012). The shortage of labor was also considered a significant constraint, which can be due to lack of employment opportunities and also migration of young people to the cities. The findings from Loka Abaya district indicated that water shortages as the most important constraint, water is one of the nutrients constraints which can lead to serious consequences. The availability of water is not only essential, but also the water should be clean and free from any foreign debris and parasites alike. Moreover, the watering point should be selected so that feces and animal carcass are not pulled, as this can lead to spread of diseases among the flock (Bekele & Kebede, 2016). This is evident from high incidences of diseases among the flocks in the study areas; this can be minimized by two approaches, management of the animals and vaccination of the animals for those diseases which are vaccine-preventable (Gemiyu, 2009). Therefore, the veterinary professionals from the areas are expected to chart out the vaccination schedule for different classes of livestock and ensure that the same has been strictly adhered.

The study also shows that there were incidences of predators in Loka Abaya district during the wet season, which is why the respondents need to ensure separate coating and, if possible, provide food and water for the young, nursing, and pregnant animals (who are the most vulnerable classes). The predators can also cause enormous damage to the flock if they are not provided with proper housing (Alemu, 2015). Therefore, it is important that the flocks are properly housed at the night and that the houses are strong and properly ventilated. The drainage system of the houses needs to be properly constructed so that it ensures proper outflow of urine and that the houses are dry even in the wet season (Ayalew *et al.*, 2013). Lack of market in Loka Abaya district may be ascribed to inadequate local connectivity and many respondents undergo distress selling which in turn benefits the middlemen. This can be solved by improving the accessibility of sellers and buyers alike to infrastructure development.

Table 17: Major constrains for goat production with respect to season in the study areas

Major constraints in different season	Aroresa				Loka Abaya			
	Ranking			Index	Ranking			Index
Dry season	1st	2nd	3rd		1st	2nd	3rd	
Feed shortage	62	33	18	0.37	7	19	12	0.1
Water shortage	2	7	5	0.04	82	30	6	0.43
Disease	5	9	38	0.1	9	16	44	0.14
Drought	0	0	0	0.0	13	20	15	0.13
Lack of market	1	6	5	0.03	0	5	12	0.04
Lack of superior genotype	15	15	30	0.15	3	10	9	0.05
Predator	0	0	10	0.01	2	10	15	0.06
Labor	35	50	14	0.30	4	10	7	0.05
Wet season								
Feed shortage	87	27	6	0.44	2	1	0	0.01
Disease	7	21	23	0.12	70	29	20	0.40
Market	0	11	28	0.07	8	30	39	0.17
Lack of superior genotype	0	18	48	0.12	11	19	20	0.13
Predator	0	0	0	0.00	25	24	14	0.19
Labor	26	43	15	0.25	4	17	27	0.10

CONCLUSION AND RECOMMENDATION

The present study evaluated goat husbandry and management practices in selected districts of Sidama zone as well as the challenges for the production of goats. The management system is nearly similar to that of the rest of the country with the same agroecology. Goats were kept in both study areas for multiple purposes and keepers have their established criteria for selecting breeding does and bucks. The major production constraints were feed shortage, water shortage, diseases, and labour shortage in both dry and wet seasons. Planning and executing goat development and extension services on management improvement, disease prevention, and appropriate forage development strategies assist the smallholder goat farmers to increase goat production as a means of sustaining their livelihood.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest. All co-authors have seen and agree with the contents of the manuscript.

ETHICAL STANDARDS

The manuscript does not contain clinical trials or patient data.

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