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Phenotypic Characterization of Indigenous Goat Types and Their Production System in Shabelle Zone, South Eastern Ethiopia

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Abstract:
The study was conducted in Shabelle zone, to characterize goat production system, to identify morphological variation among indigenous goat types found in the study area through phenotypic characterization and to gather baseline information for further study and for the development of improvement strategy of goat found in the study area. Data were collected through questionnaire, focal group discussion and field measurements. A total of 650 goats were used for measurement and 126 households for interview. Data collected via questionnaire were analyzed with descriptive statistics. Indices were calculated to provide ranking. Pastoral and agro-pastoral are the main production systems in the study area with large proportion of goats per household (41.24±15.7 for Denan, 36.24±8.4 for Adadle and 35.47±11.7 for Gode district).The primary reason of keeping goat is milk, meat and cash income in all districts. Milk yield, meat quality, size, coat color and growth rate were the most prefered trait of goat in study area. Natural pasture, standing hay, shrubs and bushes were the main feed sources in the study area. Drought occurrence, disease incidence, feed and water shortages were the major constraints of goat production in the study area. Most frequently observed coat color pattern was plain (84.93% and 72.4%) in female and male goat, respectively. The overall mean age at sexual maturity for indigenous female goat was 8.51±0.13 month and for male 8.36±0.14 month; age at first kidding 14.75± 0.12 month; average reproductive life time of doe 8.45 ± 0.11 year; and average kidding interval 7.14±0.05 month. GLM procedure of SAS versions 9.2 (2008) was employed on metric data to study sex, age, district, and sex by age group interaction effects. The key features of the indigenous goat found in the study area are long ear, relatively larger body size, dominantly white coat color type and horned.

Keywords: *Body weight, indigenous goat, linear body measurement, phenotypic characterization, production system*

1. Introduction

Ethiopia has the largest livestock population of any country in Africa, and is endowed with different agro-ecological zones of highlands, sub-humid, semi-arid and arid environments (FARM Africa, 1996). The habitats of the indigenous goat breeds extend from the arid lowlands to the humid highlands covering even the extreme tsetse-infested areas of the country. Farm animals as a whole are an integral part of the country's agricultural system and are raised both in the highland and lowland areas (Workneh, 1992).

Goats (*Capra hircus*) contribute significantly to the livelihood of resource-poor farmers in Ethiopia (IBC, 2004; Halima et al., 2012). It contributes meat, milk, skin and fiber, as well as manure and serves as the sole or subsidiary livelihood for a large number of small and marginal farmers and landless laborers (Thiruvenkadan and Karunanithi, 2006). Small ruminants in general and goats in particular are an under-used and poorly understood resource; an interest in goat production in the tropics has grown in recent years. There is a need for a greater understanding of their role, capabilities and outputs that will contribute to the overall productivity of tropical farming systems (Banerjee et al., 2000).

The goat population of Ethiopia ranks high both in Africa and the world. According to CSA (2013) the number of goats reported in the country is estimated to be about 24.06 million. With respect to breed, almost all of the goats are indigenous which accounts for 99.99 % (CSA, 2013). These goat populations are phenotypically classified into 12 distinct major breeds and five additional sub-types (Solomon Gizaw, 2009).

Identification, characterization and documentation of goat breeds are important for any type of development or improvement work. Without such documentation, it would be difficult to know the animals and their potential (Kassahun and Solomon, 2008). Appropriate design of breeding programmes is impossible for breeds/types that have not been adequately characterized either phenotypically and/or genetically (Mwacharo *et al*., 2006). Phenotypic characterizations are important in breed identification and classification. This study becomes imperative because uncontrolled mating and geographical overlap are leading to the endangerment of breed purity and potentially important reservoir of caprine genetic resources is being put at risk.

There are different studies carried out to characterize the indigenous goat found in Ethiopia. However, characterization has not been done so far particularly for indigenous goat found in Shabelle Zone. In the study area, goat production is the main activity by pastoralist and agro-pastoralist and goats' meat and milk are predominantly preferred by the community. The resources found in Shabelle Zone are not much described. And there is no recent study carried out on phenotypic characterization and their production system. Beside this fact breed characterization is the prerequisite for conservation, documentation, utilization and to design breeding program for sustainable development.

In view of the above morphological and production system characterization study was undertaken in Shabelle Zone, South Eastern Ethiopia with the following objectives:

1. To characterize goat production system in Shabelle Zone.
2. To identify morphological variation among indigenous goat types found in the study area through phenotypic characterization.
3. To gather baseline information for further study and for the development of improvement strategy of goat found in the study area.

2. Materials and Methods

2.1. Description of the Study Area

This study was conducted in three districts (i.e. Gode, Adadle and Denan) of Shabelle Zone (the former Gode Zone) of Ethiopian Somali Regional State. Shabelle Zone is one of the nine zones in the Ethiopian Somali Regional State, named from its major river; Wabi-Shabelle. Shabelle Zone is 600 km and 1228 km far from Jijiga town and Addis Abeba city, respectively. Shabelle Zone is bordered on the south-west by the Afder Zone, on the south by the Oromia Region, on the north by the Fiq Zone and on the north-east by Korahe Zone. It's located at an average altitude of around 300 meter above sea level.

Shabelle Zone is climatically characterized as arid to semi-arid agro-ecology, where livestock is the main occupation and cultivation is undertaken along Wabi-Shabelle river bank. Rainfall pattern is characterized by two rainy seasons. The main rainy season extends from April to June (*Gu)* and the short rainy season stretches from October to December (*Deyr*). And also, have two dry seasons. The long dry season (*Hagaa*), stretch from early July to end of September. The short dry season (*Jilaal*) starts from end December to mid-March. The average annual rainfall is around 250-300 mm and the maximum and minimum temperatures of 40^{o}C and 28^{o}C, respectively.

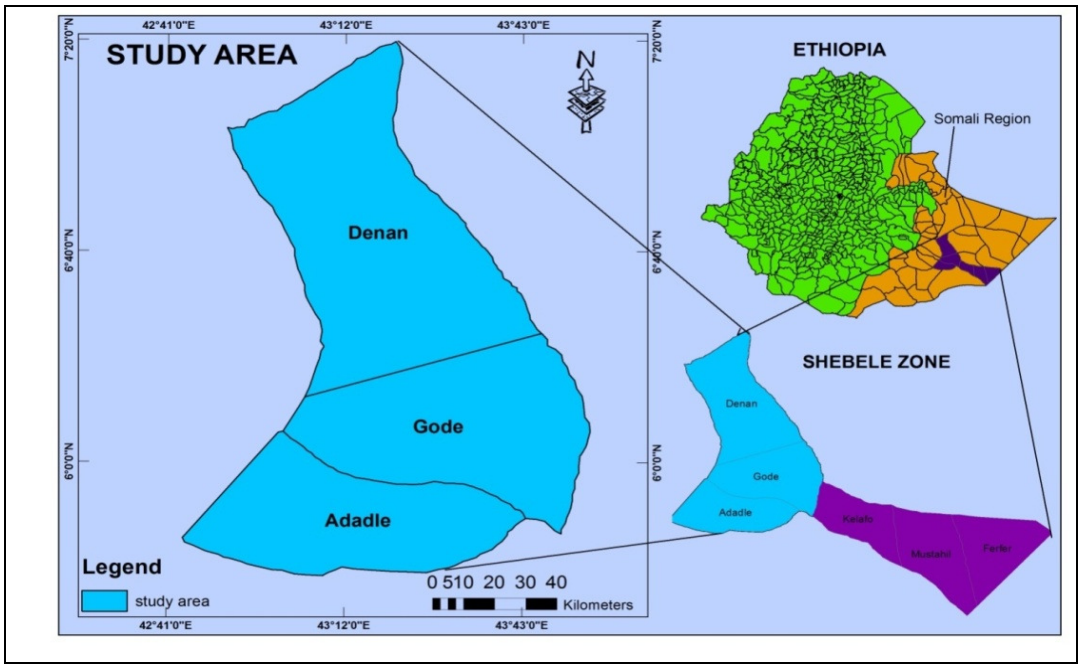

Figure 1: Map of study area

2.2. Methods of Data Collection

2.2.1. Sampling Method

Purposive sampling was applied to select the study districts. The survey was conducted in sample districts which were selected based on the presence of a relatively large proportion of goat population. From each sampling district sampling site were selected based on concentration of goat population and accessibility. Data for linear body measurements (LBMs) were collected that were available in

various villages by walking across each of the sampling site. Sampling was continuing until measurement for 650adult goats have been obtained from all sampling districts (Table 1).

A rapid field survey was done before the main survey to know the distribution and concentration of indigenous goat breed and the production system of the area to establish sampling framework from which sampling site was taken. Information was collected from Woreda livestock, crop and rural development office and Zone Administrative office. Two study sites from each district were selected based on a relatively large goat population size and accessibility.

A total of 126 households (goat owners) one third from each district were randomly selected for interview. For each household survey, structured and pre-tested questionnaires were used. The questionnaire was designed to obtain information from respondents on household socio-economic situation including composition of livestock species, productivity, selection criteria for breeding, management practices, feed resource utilization and availability, trends in population and production constraints.

Group discussions were carried out with two groups per district. The discussion was held with extension workers, livestock experts,village leaders, elders, women and socially respected individuals. Since it is believed that such individuals would have better information about the overall production potential of the breed as well as the production constraints, trend in population, special characters of the breed, cause of mortality, production system, husbandry practice, breeding methods and major constraints to maintain the breed were collected from group discussions.

Districts	**Study Sites**	**Liner Body Measurement**			**Household**	**Group Discussion**
		Adult females	Adult males	Total		
Gode	2	154	64	218	42	2
Adadle	2	152	64	216	42	2
Denan	2	152	64	216	42	2
Total	6	458	192	650	126	6

Table 1: Summary of the total number of samples

2.2.2. Data Collection

Both qualitative and quantitative data were collected in this study. Qualitative data were collected using individual interview, group discussions and observation of animals whereas quantitative data were gathered from field measurements.

Visual observation was made and morphological features were recorded based on breed morphological characteristics descriptor list of FAO (2012) for phenotypic characterization of goat. Each animal was identified by its sex, dentition and sampling site. Dentition record was included, as this was the only reliable means to estimate the approximate age of an animal.

Linear body measurements were made on quantitative traits of goats using plastic measuring tape, while body weight of animals was measured using suspended spring. The measurement was made on animals that were classified based on sex and age group. Animal's age classification was made using dentition technique supplemented with owner's information.

2.3. Statistical Data Analysis

The type of statistical data analysis used varied depending upon the nature of the data. All data gathered during the study period were coded and recorded in Microsoft excel 97-2003 and were analyzed using Statistical Analysis System (SAS version 9.2, 2008).

2.3.1. Descriptive Statistics

Quantitative and qualitative data generated from field survey and on farm linear body measurements were analyzed using statistical analysis system (SAS version 9.2, 2008). Indices were calculated for all ranking data according to the formula: Index = sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) given for an individual reason (attribute) divided by the sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for overall reasons (attributes).

2.3.2. Univariate Analysis

For adult animals' sex and age group of the goat were fitted as independent variables while body weight and linear body measurements except scrotal circumference and scrotal length were fitted as dependent variables. A general linear model procedure (PROCGLM) of SAS was used for quantitative variables to detect statistical differences among sample goat populations. Least square means (LSM) with their corresponding standard errors were calculated for each body trait over sex, age, location and age by sex interaction.

The model employed for analyses of body weight and other LBMs except SC and SL was:

$$\mathbf{Y}_{ijkl} = \mu + A_i + S_j + D_k + A_i * S_j + e_{ijkl}$$

Where:

Y_{ijkl} = the observed l(body weight or LBMs) in the i^{th}age group, j^{th}sex and k^{th} district

μ = overall mean,

A_i= the effect of i^{th} age group (i = 0, 1, 2, $\geq$ 3) PPI

S_j = the effect of j^{th} sex (j=female or male)

Dk= the effect of K^{th} district (K =Gode, Adadle and Denan)

A*i**S*j*= age by sex interaction and
e*ijkl* = random residual error

Model used to analyze scrotal circumference (SC) and scrotal length(SL) was:

Y*ikl*= μ + A*i* +D*k* + e*ijk*

Where: Y*ikl*= the observed *l* (SCor SL) in the i^{th} age group and k^{th} district
μ = overall mean
A*i* = the effect of i^{th} age group (*i* = 0, 1, 2, ≥3) PPI
D*k* = the effect of k^{th} district (*k*=Gode, Adadle and Denan)
e*ikl*= random residual error

3. Results and Discussions

3.1. Farming Activities

In the study area, livestock rearing is the main farming activities for their livelihood (Table 2).Among the farming activities livestock rearing was about 100%, 73.8%, and 66.67% of the respondents in Denan, Adadle and Gode districts, respectively. This implies that the livelihood of the community in the study area in based on livestock production. Across all districts, pastoralist and agro-pastoralist were relying on livestock production as source of cash income and food for home consumption. This was due to insufficient rainfall. This was in agreement with Endeshaw (2007) who found farmers in the pastoral and agro-pastoral areas give livestock production higher priority than crop production.

Farming activities	Gode		Adadle		Denn		Overall	
	N	%	N	%	N	%	N	%
Livestock rearing	28	66.67	31	73.8	42	100	101	80.2
Crop production	-	-	-	-	-	-	-	-
Both	14	33.33	11	26.2	-	-	25	19.2
Total	42	100	42	100	42	100	126	100

Table 2: Farming activities in the study area
Key: N= Number of respondents

3.2. Livestock Composition in the Study Area

The major livestock species in the study area are cattle, goat, sheep; camel and donkey (Table 3). The present study revealed that the average flock size per household of goat and sheep in all districts was the highest of all livestock holding recorded. This may be due to the fact that goat and sheep have low feed requirement and short generation interval. In addition, the higher proportion of goat and sheep as compared to cattle, might be due to the fact that goat and sheep can thrive well under adverse conditions (feed shortages and drought) while cattle are considered more sensitive to feed shortages. There is significant difference between districts in goat population ($p<0.05$). The mean flock size of goats per household was 41.24, 36.24, and 35.47 for Denan, Adadle and Gode districts, respectively. The overall meangoats per household in the study area was 37.65, which was comparable with the report of Farm Africa (1996) where the mean flock size owned was 37 for long-eared Somali goat breed. On the contrary, the mean goat flock size per household in the study area is higher than the report of Mahilet (2012) for east Hararghe and Grum (2010) for around Dire Dawa which were 8.12 and 32.8, respectively.

Livestock species	Average Livestock number			
	Gode	Adadle	Denan	Overall
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Cattle	14.38±8.6	18.85±10.7	15.02±12.7	16.08±10.92
Goat	$35.47±11.7^{b}$	$36.24±8.4^{ab}$	$41.24±15.7^{a}$	37.65±12.50
Sheep	$19.85±8.2^{c}$	$26.38±10.8^{b}$	$32.3±10.6^{a}$	26.18±11.15
Camel	8.59±7.5	8.3±13.55	11.14±13.4	9.34±11.82
Donkey	1.73±0.9	2±0.76	1.93±0.77	1.88±0.82

Table 3: Livestock species composition and number of livestock kept
Key: Different superscripts within a row denote significant differences at P<0.05 between districts; SD = standard deviation

The percentage of livestock possession per household is summarized in Table 4. The finding that all (100%) of respondents in all districts had owned goats is attributed to the fact that goat owners were purposefully sampled for the interview were pastoralists and agro-pastoralists who had goats and were selected to get more information on goats. In overall, most of the respondents (99%) had sheep.

Cattle; donkey and camel were the important species owned by 97.6%, 97.6% and 65% of the respondents, respectively. Equines were used for short to medium distance travel and to fetch water from rivers and wells to the village. None of the respondents reported the existence of mules and horses. However, few chickens were observed during the study period in Gode and Adadle district.

Descriptor	Percentage of respondents			Overall
	Gode	Adadle	Denan	
Cattle	100	100	93	97.6
Goat	100	100	100	100
Sheep	100	97.6	100	99
Camel	76	59.5	59.9	65
Equine	95	100	97.6	97.6

Table 4: Percentage of household livestock possession by district

3.3. Trend of major livestock and goat population

In the study areas, small ruminant production is being given higher emphasis today; the primary reason for this in all districts was drought occurrence. With regard to the trend of goat population in the study area, 74% of the overall respondents believed it is increasing, while 19% and 7% considered it stable and decreasing, respectively (Table 5). Proper management (housing, feeding and health care), high rate of reproduction, short generation interval, relative resistance to drought and relative requirement of less feed and water by goat might be the major reasons for increment in goat population. In addition to the above, the reasons for increasing of goat population in the study area are the watering point development and expansion of veterinary and vaccination service.

Trends	Gode	Adadle	Denan	Overall
	HH (%)	HH (%)	HH (%)	HH (%)
Goat				
Increase	34(81)	30(71)	29(69)	93(74)
Decrease	5(12)	2(5)	2(5)	9(7)
Stable	3(7)	10(24)	11(26)	24(19)
Cattle				
Increase	18(43)	25(60)	10(24)	53(42)
Decrease	10(24)	3(7)	9(21)	22(17.5)
Stable	14(33)	14(33)	23(55)	51(40.5)
Sheep				
Increase	18(43)	23(55)	26(62)	67(53.2)
Decrease	10(24)	5(12)	2(5)	17(13.5)
Stable	14(33)	14(33)	14(33)	42(33.3)
Camel				
Increase	8(19)	9(21.4)	13(31)	30(24)
Decrease	19(45)	16(38.1)	12(28.6)	47(37)
Stable	15(36)	17(40.5)	17(40.5)	49(39)

Table 5: Trend of major livestock populationin the study area based on respondant responce
Key: HH=Household, % = percentage

3.4. Goat Flock Structure

Table 6 summarizes the goat flock structure in the study area according to age and sex classes. The age and sex structure of goat flocks were almost similar across all districts, except that there appear to be slightly lower proportion of castrate in Gode district, male kid less than 6 month in Denan district, and female greater than a year in Adadle district. In overall, females more than one year old constituted 29.8% of the whole population while males of the same age made up only 7.1 % of the population. This is an agreement with FARM-Africa (1996) who found high proportion of females reflecting the owners' desire for milk. There appears to be an adequate number of breeding males, and some fattening of excess males as castrates.

The ratio of male greater than one year of age and their female counterparts was 1:4. This is close to the finding of Wilson and Durkin (1988) who reported that for small ruminants in traditional livestock production systems of Africa the ratio was1:4 and 1:6. But there were on average more bucks to does in the results of this study as compared to the report of Nigatu (1994) who mentioned buck to doe ratios of 1:19 for Ethiopian and Eritrean goats in pastoral flocks.

The percentage of castrated males was 12% of the whole population while male and female kids less than 6 month of age made up to 11.6 % and 12.4 % of the whole flock, respectively. The proportion of male and female of 6 month to 1 year age was 13.5 % and 13.6 % of the whole population, respectively.

Out of the total kids with less than six months of age 51.8% were female and 48.2% were males. This is comparable to the report of Grum (2010), who found 52.5% were female and 47.7% males. This may be due to the natural birth which is slightly skewed towards the female sex. This is in agreement with the report of Devendra and McLeroy (1982) for the tropics and subtropics.

Generally, the present study revealed that the flock structure of indigenous goat found in the study area was mainly based on maintaining large number of female goats. The probable reason might be due to cultural practice of selling and slaughtering of male goats and need of female goats for milk consumption.

Goat flock Structure	Gode		Adadle		Denan		Overall	
	Mean ± SD	%	Mean± SD	%	Mean ± SD	%	Mean ± SD	%
< 6 month male kids	4.3±1.7	12.15	4.1+1.4	11.36	4.6±2.1	11.2	4.35±1.7	11.6
<6-month female kids	4.3±2.1	12.35	4.6±1.4	12.7	5+1.8	12.2	4.68±1.86	12.4
Male 6 month to 1 year	4.5±1.6^{b}	12.8	4.9+1.2^{ba}	13.7	5.7+1.9^{a}	13.7	5.1±1.69	13.5
Female 6 month to 1 year	4.7±1.8	13.4	4.9+1.2	13.7	5.6+2	13.7	5.12±1.8	13.6
Male>1 year (Intact)	2.6±0.9^{a}	7.6	2.4+0.9^{a}	6.83	2.9+1^{a}	7	2.69±0.99	7.1
Female>1 year (Intact)	10.9±3.6	30.87	10.7+3.1	29.63	11.9+5	28.9	11.2±4.04	29.8
Castrated male	3.82±2.4^{b}	10.8	4.3+1.7^{ba}	12	5.3+3.2^{a}	12.9	4.5±2.64	12
Total	35.47+11.7^{b}	100	36.24+8.4^{ab}	100	41.24+15.7^{a}	100	37.65±12.5	100

Table 6: Goat flock structures in the study area

Key: Different superscripts within a row denote significant differences at P<0.05 between districts; SD =standard deviation

3.5. Housing

Good housing enhances production by reducing stress, disease, hazards and making management easier(Dejen, 2010). Pastoralists and agro-pastoralists in all districts had good awareness on importance of housing for rearing of goat. They have house for their goat throughout the year in the night time to protect them from predators.

All of the pastoralists and agro-pastoralist (100%) provided separate house (fence or thorny enclosures) for night time shelter. Among some of the houses fence and others thorny enclosures, the former was constructed from wood but without roof while the later constructed from thorny branches of bushes. The pastoralists and agro-pastoralists are skillful in constructing fence and/or thorny enclosures which are kept closed with thorny branches during night time to prevent predator attacks.

Kids were generally housed in separate pens within or side of the fence and/or thorny enclosures provided for the main flock. These pens were well roofed with wooden materials and/or grass. Goats were also seen housed together with sheep either within the same enclosure or the main enclosure separated only with barriers. The fence and thorny enclosures is thoroughly cleaned each morning once the flock leaves for grazing/browsing.

3.6. Weaning Practices

Weaning is the time when kids stop feeding on liquid milk or milk replacer. After weaning, kids depend entirely on dry feed. This change has to be gradual to avoid losses due to faulty feeding management (Girma and Alemu, 2008). In the study area three types of milk feeding up to weaning were practiced (Table 7). In over all, most of house hold practiced restricted milk feeding (68.3%), while the rest 20.6% and 11.1% practiced unrestricted and bucket feeding, respectively. In the study area, the average weaning age of kids was <3 month (41.3%), 3-4 month (32.5 %),4-5 month (23%) and > 5 month (3.2%).

Parameter	Gode		Adadle		Denan		Overall	
	N	%	N	%	N	%	N	%
Milk feeding								
Unrestricted	8	19	4	9.5	14	33.3	26	20.6
Restricted	23	4.8	36	85.7	27	64.3	86	68.3
Bucket feeding	11	26.2	2	4.8	1	2.4	14	11.1
Weaning age								
< 3 month	27	64.3	12	28.6	13	31	52	41.3
3-4 month	7	16.7	17	40.5	17	40.5	41	32.5
4-5 month	5	12	13	31	11	26.2	29	23
>5 month	3	7	0	0	1	2.4	4	3.2

Table 7: Milk feeding up to weaning and weaning age of kid in the study area

Key: N= Number of respondents; % = percentage

3.7. Herding Practice

A good understanding of the community's herding practices is crucial to bring sustainable improvement in the smallholders' flock through community-based strategies (Sölkner-Rollefson, 2003). It was shown that goat was kept with other livestock particularly with sheep in the study areas. In the study area, 85.7% of the respondents herd their goats separated from kids. The reason is that milk is the

main goat product used for human consumption. About 68.3% of the respondents run their flock individually, while 31.7% of the respondents with their neighbor (Table 8).

Parameter	Gode		Adadle		Denan		Overall	
	N	%	N	%	N	%	N	%
Flock herding								
Male and female separated	7	16.7	3	7.1	6	14.3	16	12.7
Kids are separated	33	78.5	39	92.9	36	85.7	108	85.7
All class separated	2	4.8	0	0	0	0	2	1.6
Ways of herding								
Goat of a household run as a flock	34	81	20	47.6	32	76.2	86	68.3
Goat of more than one household run as a flock	8	19	22	52.4	10	23.8	40	31.7

Table 8: Ways of herding and flock herding in the study area
Key: N= Number of respondents; % = percentage

3.8. Goat Market and Age of Culling

The average market and culling age of goats are presented in Table 9.From the interview conducted in Gode, Adadle and Denan districts the average market age of male were 11.05, 11.12 and 10.88 months, respectively whereas their female counterpart were 11.74, 11.62 and 11.71 months, respectively. In overall, the mean market age was 11.01 and 11.69 month for male and female goats, respectively; indicating that male goats reach for market earlier than female goats. According to the respondents, goats were considered as cash. If the pastoral household were in need of money for urgent case male goats were the first to be sold. Only if there are no male goat old female goats would be sold.

Culling in goat flock is an important tool for the development of a good flock. It helps to remove undersized animals and breed those closest to the desired ideal type (Girma and Alemu, 2008). According to the interview conducted all respondents had negative implication for the word 'culling'. The probable reason for this might be the dependency of their life only on the existence of their livestocks. In the studied areas, the reasons for culling of goats were age, long kidding interval and low milk yield. Average culling ages of male goat in Gode, Adadle and Denan district were 6.33, 6.81 and 6.81 years whereas their female counterparts were 7.67, 8.09 and 8.0 years, respectively. In overall, the mean culling age for goats in the study area was 6.65 and 7.92 years for male and female goats, respectively.

Parameter	Gode		Adadle		Denan		Overall	
	N	Mean	N	Mean	N	Mean	N	Mean
Market age (months)								
Male	42	11.05^{aa}	42	11.12^{aa}	42	10.88^{a}	126	11.01
Female	42	11.74^{aa}	42	11.62^{a}	42	11.71^{aa}	126	11.69
Culling age (years)								
Male	42	6.33^{a}	42	6.81^{aa}	42	6.81^{aa}	126	6.65
Female	42	7.67^{a}	42	8.09^{aa}	42	8.0^{aa}	126	7.92

Table 9: Average market and culling age of goat reported by respondants
Key: Different superscripts within a row denote significant differences at P<0.05 between districts; N=Number of observation

3.9. Family Responsibilities in Goat Activities

Labor inputs in goat activities are presented in Table 10. In the Somali-Ogaden society elders, adult men, women and children have different but sometimes also over lapping roles in making their ways of life work.

According to the respondents, there was no complete division of labor in goat activities; all household members are involved in goat management. Women above 15 years are responsible for several important routine tasks. Women engage in goat milking (78 %), care for sick animals (53%), making and selling dairy products (53% and 85%), respectively, barn cleaning (56%) and selling goat (14.3%). They are responsible in child care and makingmats for the house (*aqal)*and together with her neighbors, repair the house, in pastoralist, land preparing and weeding in agro-pastoralist, husbandry of small ruminants and feeding the family. Therefore, women in study area are working for long hours. However, their role in decision-making is very low.

Activities	Respondents responding (%)									
	B	G	B&G	B&M	B&W	G&M	G&W	M	W	M&W
Milking	-	11	1.6	2.4	0.8	-	2.4	6.3	62	13.5
Purchasing goat	2.4	-	-	-	-	-	2.4	85.5	5.6	3.2
Selling goat	4	1.6	0.8	0.8	-	0.8	-	77	14.3	0.8
Herding	26	24.6	16.7	1.6	0.8	2.4	3.2	15.9	8	0.8
Breeding	22.2	27.8	13.5	4	0.8	2.4	1.6	15.9	11.11	0.8
Feeding	21.4	28.6	15	3.2	1.6	1.6	1.6	19	10	1.6
Caring for sick animals	3.2	20.6	3.2	0.8	0.8	-	1.6	14.3	53	2.4
Making dairy products	-	13.5	-	-	0.8	-	1.6	4.8	80.2	0.8
Selling dairy product	-	8	-	-	-	-	-	7	85	-
Bran cleaning	6.3	14.3	-	-	-	-	4	4	44.4	-

Table 10: Details of labor input in goat activities
Key: B=Boy, G=Girl, M=Men and W=Women

3.10. Kidding Pattern

According to the pastoralists and agro-pastoralists reported, kidding occurred at any time of the year but there were seasons when most births occurred (Table 11). In overall, the highest,55.5% births occurred during *Gu*(main rainy season) during which forage availability was increased. The lowest birth of 11% occurred during *Hagaa* (long dry season) during which rangelands depleted. The pastoralists and agro-pastoralists also indicated that if feed were readily available, goats would give birth throughout the year. In one study conducted by Mekasha (2007) breeding is naturally controlled to adjust maximum use of seasonal sexual activity or nutrition availability and ensures greatest likelihood to establish pregnancy, and optimal ovulation.

According to respondents most type of birth in the study area was single (96%) and very rare twin (4%). This is comparable to FARM-Africa (1996), who reported single births accounting for 97% of all births and twins 3% for long-eared Somali breeds. The Somali and Boran pastoralists were reported to deliberately culling does giving birth to twins. This obviously is a successful way of selection for single births which enables good kid survival and milk offtake for human consumption.

Kidding Pattern	Gode		Adadle		Denan		Overall	
	N	%	N	%	N	%	N	%
Season								
Gu	16	38.1	26	62.9	28	66.7	70	55.5
Deyer	6	14.3	11	26.2	8	19	25	20
Jilaal	9	21.4	4	9.5	4	9.5	17	13.5
Hagaa	11	26.2	1	2.4	2	4.8	14	11
Type of birth								
Single	39	92.9	40	95.2	42	100	121	96
Twin	3	7.1	2	4.8	-	-	5	4

Table 11: Season of most births occur in the study area
Key: N = Number of respondents; % = Percentage

3.11. Mobility

Mobility is the main strategy used by pastoralists to manage risk and use the range resources communally and efficiently. Transhumance type of mobility pattern was practiced by 54.8% of the households in the study district, while 45.2% of the respondents were nomadic (Table 12). Mostly migration was practiced during long dry season (*Hagaa*) and short dry season (*Jilaal*) to search for pasture and water. During group discussion, the respondent reported that they mobilize their herd to the Wabi-shabelle River especially during the long dry season. All species of livestock are migrating except lactating cattle and sick animals which are left at home. In difficult years, distant migration may be practiced; entering into other clan territories.

Mobility	Gode		Adadle		Denan		Overall	
	N	%	N	%	N	%	N	%
Sedentary	0	0	0	0	0	0	0	0
Transhumance	25	59.5	32	76	12	28.6	69	54.8
Nomadic	17	40.5	10	24	30	71.4	57	45.2

Table 12: Reported mobility in the study area
Key: N = Number of respondents; % = Percentage

3.12. Milk

3.12.1. Frequency of Milking

Frequency of milking of goat in the study area is presented in Table 13. The respondents in the area reported that goat milking was done twice a day in the morning and evening. According to the respondants the milking frequency of goat in the study area was twice a day (82.5%) and once a day (17.5%). This is an agrement with FARM-Africa (1996), who reported that goats are usually milked before and after grazing.

Milking frequency	Gode		Adadle		Denan		Overall	
	HH	%	HH	%	HH	%	HH	%
Once a day	7	16.67	4	9.5	11	26.2	22	17.5
Twice a day	35	83.33	38	90.5	31	73.8	104	82.5
Total	42	100	42	100	42	100	126	100

Table 13: Goat milking frequncy in the study area
HH= Households

3.12.2. Milk Production and Lactation Length of Goat

The milk production of goats is affected by different factors, including body size, weight, parity, stage of lactation, udder size, litter size, nutrition, breed and kidding season (Tekele, 2008).The milk production and lactation length of indigenous goat in the study area are summarized in Table 14. According to the respondents, the overall mean milk yield was 0.53 liter per day excluding the milk suckled by the kid. The overall mean of lactation length was 3.6 months.

Parameter	Gode			Adadle			Denan			Overall		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
Milk production per day/doe (lt)	42	0.53	0.08	42	0.55	0.13	42	0.52	0.09	126	0.53	0.1
Lactation length (months)	42	3.36^{bb}	0.63	42	3.55^{ba}	0.67	42	3.84^{aa}	0.62	126	3.6	0.66

Table 14: Milk yield and lactation length of indiginous goat found in the study area
Key: Different superscripts denote significant differences at P<0.05 between means of the districts; N = number of observation, SD = standard deviation

3.12.3. Goat Milk Usage

The goat milk usages in the study area are presented in Table 15. In overall, the goat milk usage was family consumption (raw), family consumption (processed) and sales which were ranked 1^{st}, $2^{nd}$and $3^{rd}$with corresponding index values of 0.45, 0.31, and 0.24, respectively. This report is agreement with FARM-Africa (1996), as per which Somali goats are widely milked and milk is consumed fresh, made into butter and sold.

Goat milk usage	Gode	Adadle	Denan	Overall
	Index	Index	Index	Index
Family consumption (raw)	0.45	0.44	0.46	0.45
Family consumption (processed)	0.30	0.31	0.32	0.31
Sales	0.25	0.25	0.22	0.24

Table 15: Goat milk used as ranked by respondents in the study area
Key: Index = sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for particular goat milk used divided by sum of 3for rank 1 + 2 for rank 2 + 1 for rank 3] for all goat milk used

3.13. Feed Resource and Grazing Method in the Study Area

3.13.1. Feed Resource

Feed resources commonly used by pastoralists in the study area across the different seasons are presented in Table 16. The quantity and quality of feed resources available for animals primarily depends upon the climatic and seasonal factors (Zewdu, 2008). In this study, natural pasture, hay (standing hay), shrubs and bushes and crop residue are the main feed resources during dry season. In Gode district, during dry season, hay (standing hay) (index = 0.26), natural pasture (index = 0.25), shrubs and bushes (index = 0.24), and crop residue (index = 0.21) were ranked as an important feed resource, while in Adadle district, shrubs and bushes (index = 0.42), hay (standing hay) (index = 0.28), crop residue (index = 0.16) and natural pasture (index = 0.11) were ranked as an important during dry season. The major feed resources during dry season, in Denan district were shrubs and bushes (index = 0.45), hay (standing hay) (index = 0.34), and natural pasture (index = 0.2). Feed resources are limited in dry seasons and there are seasonal feed supply fluctuations in the study area. The critical feed shortage seasons are *Hagga* (long dry season) and *Jilaal* (short dry season). To cope with feed shortage pastoralists and agro-pastoralists migrate to wards Wabi-Shabelle River during long dry season.

In the study area, natural pasture and shrubs & bushes are the main feed resources during wet seasons. The major feed recourses during wet season, in Gode district was natural pasture (index = 0.52) followed by shrubs & bushes (index=0.3) while in Adadle district, natural pasture (index = 0.52) was ranked first followed by shrubs and bushes (index = 0.31) during wet season. The major feed resources during wet season, in Denan district like that of Gode and Adadle, were natural pasture (index = 0.59) followed by shrubs and bushes (index = 0.41).

Feed resource	**Gode**		**Adadle**		**Denan**	
	D.S	W. S	D.S	W. S	D.S	W. S
	Index	Index	Index	Index	Index	Index
Natural pasture	0.25	0.52	0.11	0.52	0.21	0.59
Established pasture	0.04	0.02	0.003	0.12	-	-
Hay (standing hay)	0.26	0.01	0.28	0.08	0.34	-
Shrubs and bushes	0.24	0.3	0.42	0.31	0.45	0.41
Crop residues	0.21	0.04	0.16	-	-	-
Fallow land	-	0.11	0.03	0.042	-	-
By product	-	-	-	-	-	-
Concentrate	-	-	-	-	-	-

Table 16: Feed resources in dry and wet season as ranked by respondents in the study area

Key: D. S=Dry Season, W. S=Wet Season, Index = sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for particular feed resource divided by sum of 3for rank 1 + 2 for rank 2 + 1 for rank 3] for all feed resource

3.13.2. Grazing Practice and Response for Feed Shortage

Management with respect to grazing or browsing was similar in both dry and wet seasons while it showed small variation between districts. Majority of goat owners (62 %, 73.8%) in dry and wet seasons at Gode let their flock to freely grazing/browsing, while only 31% and 16.5 % in dry and wet season practiced rotational grazing. In Adadle and Denan, like that of Gode majority of goat owners (62% and 85.7%) and (85.7% and 54.8%) in dry and wet season, respectively, practiced free grazing (Table 17). In overall, 69.8% and 69 % of respondent practiced free grazing in dry and wet season, respectively. This is agreement with FARM-Africa (1996) who reported free grazing on rangeland areas. On the contrary, paddock, tethering and zero-grazing were not practiced in all the districts because of large coverage of grazing land. Grazing land ownership was totally communal in all the districts.

In the study area, routs of migration were determined based on pastoralists' spatial information with regard to availability of pasture and water. The common routs of migration were towards the Wabi-Shabelle river areas.

The major coping mechanisms for feed shortage in the study area were migration and selling their livestock. This is agreement with the report of Grum (2010), who reported migration an integral part of the pastoral livestock production systems serving as a strategy to mitigate the recurrent feed and water shortages.

Grazing method	**Gode (%)**		**Adadle (%)**		**Denan (%)**		**Overall (%)**	
	D.S	W. S	D.S	W. S	D.S	W. S	D.S	W. S
Free grazing/Browsing	62	73.8	62	78.6	85.7	54.8	69.8	69
Rotational grazing	31	16.7	7	9.5	4.8	26.2	14.3	17.5
Herded	7	9.5	31	11.9	9.5	19	15.9	13.5
Paddock	0	0	0	0	0	0	0	0
Tethering	0	0	0	0	0	0	0	0
Zero-grazing	0	0	0	0	0	0	0	0
Total	100	100	100	100	100	100	100	100

Table 17: Grazing method practiced in the study area

Key: D. S=Dry Season, W. S=Wet Season, % = Percentage

3.14. Purpose of Keeping Goat in the Study Areas

The purposes of keeping goat by pastoralists and agro-pastoralists in the study area are presented in Table 18. The primary reason for keeping goat in Gode district was for milk (index=0.42) followed by to derive income (sale) (index=0.37) and meat (index=0.12). In Adadle, like that of Gode, the primary purpose of keeping goat was for milk (index=0.290), to generate incomes (sale) (index=0.270) and meat (index=0.220).In Denan, like that of Gode and Adadle, the primary purpose of keeping goat was for milk (index=0.31),to generate incomes (sale) (index=0.180) and meat (index=0.170).This indicates that Ethiopian goats in the lowland are highly valued and reared mainly for milk and meat production as also reported by (Kassahun and Solomon, 2008).

Purpose of keeping	Gode	Adadle	Denan
	Index	Index	Index
Meat	0.12	0.220	0.170
Milk	0.42	0.290	0.310
Sale (cash income)	0.37	0.274	0.180
By-products(skin)	0.02	0.040	0.060
Traditional identity (way of life)	0.03	0.060	0.095
Social status (sign of wealth & strength)	0.02	0.050	0.095
Savings	0.01	0.063	0.060
Dowry	0.01	-	0.020
Ceremonies, rituals	-	0.004	0.010
Collateral	-	-	-
Manure	-	-	-

Table 18: Purpose of keeping Goat in Gode, Adadle and Denan districts in Shabelle Zone

Key: Index= sum of (3 X purpose of keeping goat ranked first + 2 X purpose of keeping goat ranked second + 1 X purpose of keeping goat ranked third) given for particular purpose of keeping goat divided by sum of (3 X purpose of keeping goat first + 2 X purpose of keeping goat ranked second + 1 X purpose of keeping goat ranked third) for all purpose of keeping goat.

3.15. Goat Breeding Management

3.15.1. Breeding Practices

Type of mating practiced in all study areas were controlled and natural mating or uncontrolled mating within the household's flock and between neighboring flocks. The bucks run with does throughout the year. According to respondents, 66.7% in Gode, 66.7% in Denan and 62% in Adadle practiced control matting. In the study area, 100% of the respondents have their own buck. The main source of their breeding buck was born in their flock.

3.15.2. Selection Criteria for Breeding Buck

Pastoralists in all study areas are well experienced in selection of breeding bucks from own flock of goat. Selection by considering morphological and production characteristics is the prerequisite to replace stocks. Selection criteria for breeding buck in the study area presented in Table 19.Age, growth rate and libido of breeding buck ranked first, second and third for Gode district goat owners with an index of 0.26, 0.19 and 0.12, respectively. Appearance, growth rate and character of breeding buck ranked first, second, and third for Adadle district goat owners with an index of 0.28, 0.16 and 0.14, respectively. Appearance, growth rate and color of breeding buck ranked first, second and third for Denan district goat owners with an index of 0.25, 0.17 and 0.12, respectively.

Selection Criteria	Gode	Adadle	Denan
	Index	Index	Index
Appearance	0.11	0.28	0.25
Color	0.10	0.09	0.12
Horn	0.03	0.03	0.04
Character	0.01	0.14	0.08
Adaptability	0.05	0.04	0.07
Growth rate	0.19	0.16	0.17
Age	0.26	0.10	0.10
Libido	0.12	0.08	0.11
Ability to walk long distance	0.06	0.01	0.02
Pedigree	0.07	0.07	0.04

Table 19: Selection criteria of breeding buck in the study area

Key: Index = sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for particular trait divided by sum of 3for rank 1 + 2 for rank 2 + 1 for rank 3] for all traits

3.15.3. Selection Criteria for Breeding Doe

Traits like size(appearance),kid survival,kid growth,age at sexual maturity,kiddding intrval and high milk yieldwere all considered important in all of the districts and given emphasis in selecting of breeding does. Among selection criteria considered,high milk yiled,kiddding intrval and kid growth rate were ranked 1st, 2nd and 3rd by goat owners in Gode with an index of 0.20, 0.17 and 0.15, respectively (Table 20). But for Adadle, high milk yield, kiddding intrval and age at sexual maturity with corresponding index values of 0.19, 0.17 and 0.16were considered. In Denan district, size, kid survival and high milk yield with corresponding index values of 0.230, 0.210 and 0.190were considered.

Selection criteria	Gode	Adadle	Denan
	Index	Index	Index
Size/Appearance	0.12	0.15	0.230
Color	0.04	0.05	0.050
Kid survival	0.10	0.12	0.210
Kid growth rate	0.15	0.12	0.095
Age at sexual maturity	0.14	0.16	0.100
Kidding interval	0.17	0.17	0.100
Twining ability	0.03	0.01	0.008
High milk yield	0.20	0.19	0.190
Ability to walk long distance	0.05	0.03	0.020

Table 20: Selection criteria for breeding doe as ranked by respondents in the study area
Key: Index = sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for particular trait divided by sum of 3for rank 1 + 2 for rank 2 + 1 for rank 3] for all traits

3.15.4. Breed and Trait Preferences in the Study Area

Breed and trait preferences are useful to make better informed decisions in developing interventions to improve the contribution of goat for livelihoods of their keepers. Milk yield, meat quality, size, coat color and growth rate were the most preferred traits of goat in study area.Thus, size (index= 0.200), milk yield (index= 0.190), meat quality (index= 0.150) and coat color (index=0.12)were among the reported preferred traits in their order of importance by the respondents (Table 21) in Gode area whereas in Adadle, meat quality (index= 0.22), milk yield (index= 0.20), growth rate(index= 0.12) and size (index= 0.12) were among the traits considered for improvement intervention. In Denan district,meat quality (index= 0.220), milk yield (index= 0.180), coat color (index= 0.130) and size (index=0.12)were among the reported preferred traits in their order of importance by the respondents.

Trait	Gode	Adadle	Denan
	Index	Index	Index
Size	0.200	0.12	0.120
Color	0.120	0.08	0.130
Horn	0.040	0.03	0.030
Growth rate	0.040	0.12	0.120
Heat resistance	0.004	0.06	0.030
Longevity	0.030	0.01	0.030
Drought resistance ought resistance	0.080	0.04	0.060
Character	0.120	0.05	0.008
Milk yield	0.190	0.20	0.180
Meat quality	0.150	0.22	0.220
Fertility	0.020	0.04	0.080
Adaptability	0.010	0.03	0.01

Table 21: Indigenous goat type important traits perceived (trait preference) by owners in the study area
Key: Index = sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for particular trait divided by sum of 3for rank 1 + 2 for rank 2 + 1 for rank 3] for all traits

3.16. Major Constraints for Goat Production in the Study Area

Goat production and productivity in the study area is constrained by many factors. The major ones are summarized in Table 22. In Gode districts, drought occurrence, disease incidence and feed and water shortage ranked 1st, 2nd and 3rd with indexes of 0.32, 0.26, and 0.23, respectively. In Adadle districts, drought occurrence, feed and water shortage and disease incidence ranked 1st, 2nd and 3rd with indexes of 0.40, 0.18, and 0.15, respectively. In Denan district like that of Adadle, drought occurrence, feed and water shortage and disease incidence ranked 1st, 2nd and 3rd with indexes of 0.35, 0.25, and 0.19, respectively.

Constraints	Gode	Adadle	Denan
	Index	Index	Index
Drought occurrence	0.32	0.40	0.35
Feed and water shortage	0.23	0.18	0.25
Disease incidence	0.26	0.15	0.19
Lack of superior genotypes	0.12	0.03	0.02
Market problem	0.04	0.08	0.13
Predator	0.008	0.07	0.04
Labor shortage	0.02	0.05	0.01
Lack of extension service	0.004	0.04	0.01

Table 22: Major constraints of goat production ranked by respondents in the study area
Key: Index = sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for particular constraint divided by sum of 3for rank 1 + 2 for rank 2 + 1 for rank 3] for all constraints

3.17. Phenotypic Characterization of Indigenous Goat Types in the Study Area

3.17.1. Qualitative Traits of Indigenous Goat Types in the Study Area

Qualitative traits of indigenous goat types found in all district are given in Table 23. The indigenous goat type found in Gode district have mainly plain coat color pattern (83.12% and 70.31%) followed by spotted (12.34% and 20.31) and patchy (4.55% and 9.38%)in female and male, respectively. Among the sampled goat population in Adadle district, 88.16% and 75% had plain coat color pattern followed by spotted (9.87 % and 17.19%) and patchy (1.97%and 7.81%)in female and male, respectively. In Denan district, like that of Gode and Adadle, have mainly plain coat color pattern (83.55% and 70.88%) followed by spotted (14.47% and 21.88%) and patchy(1.97% and 6.25%)in female and male, respectively.

The dominant coat color types were white (78.57%of females and 70.31%of males)followed by white dominant (10.39% of females and 23.44% of males) in Gode district whereas, white (78.95% of female and 73.44% of males) followed by brown (7.24 % of females) and white dominant (23.44% of males)in Adadle district and white (75.66 %of females and 68.75% of males) followed by white dominant (11.84%of females and 28.13% of males) in Denan district.

In overall, the indigenous goat types found in the study area is large white (77.73% in females and 70.83% in males)with a predominantly straight head(facial) profile (51.75% in females and 51.3% in males). Horns shapes are mainly curved (55.07% in males, 46% in females), and straight in 44.93% of females and 48.69% in males. Horn orientation is mainly back ward (71.81% in females' and66.49% in males). Some 25.77% of females and 31.41% of males' horns have a lateral orientation while the rest 2.42% of female and 2.09% of male horns have obliquely upward orientation. A rare incidence of polledness was recorded in female (1.09%) and males (0.52%).

The indigenous goat types found in all district has a short smooth coat color type which is mainly white (77.73% in females,70.83% in males), white dominant (9.38% in female,25% in males),brown (5.89% in female,1.56% in male), brown dominant(3.93%in female,1.56%in male),black (0.87 % in female,1.04 % in male),fawn(6.55% in female), black dominant (1.09% in female) and roan(0.43%) coat color type. A spotted coat pattern was observed in 7.81% of males, but 2.83% in females. Ruffs occur in 68.23% of males but never in females. Beards were observed in 63.54% of males and 3.28% of the females. Wattles were observed in 9.83% of females and 4.69% of females. The ear orientation is semi-pendulous (77.95% in females, 78.64% in males), carried horizontally (18.12% in females, 11.46% in males), and erect (21.83% in females, 1.04% in males) and pendulous (1.75% in female, 8.85% in males).

Traits	Attributes	District						Overall	
		Gode		Adadle		Denan			
		Female N (%)	Male N (%)	Female N (%)	Male N (%)	Female N (%)	Male N (%)	Female N (%)	Male N (%)
Coat Color Pattern	Plain	128*(83.12)	45*(70.31)	134*(88.16)	48*(75)	127*(83.55)	46*(71.88)	389*(84.93)	139*(72.4)
	Patchy	7(4.55)	6(9.38)	3(1.97)	5(7.81)	3(1.97)	4(6.25)	13(2.83)	15(7.81)
	Spotted	19(12.34)	13(20.31)	15(9.87)	11(17.19)	22(14.47)	14(21.88)	56(12.27)	38(19.79)
	X^2 *Value*	173.15	40.53	207.01	50.84	176.06	45.12	554.83	135.96
Coat Color Type	White	121*(78.57)	45*(70.31)	120*(78.95)	47*(73.44)	115*(75.66)	44*(68.75)	356*(77.73)	136*(70.83)
	Black	-	-	2(1.32)	1(1.56)	2(1.32)	1(1.56)	4(0.87)	2(1.04)
	Brown	9(5.84)	1(1.56)	11(7.24)	1(1.56)	7(4.61)	1(1.56)	27(5.90)	3(1.56)
	Fawn	-	-	1(0.66)	-	2(1.32)	-	3(0.66)	-
	Grey	-	-	-	-	-	-	-	-
	Red	-	-	-	-	-	-	-	-
	Roan	-	-	-	-	2(1.32)	-	2(0.44)	-
	White dominant	16(10.39)	15(23.44)	9(5.92)	15(23.44)	18(11.84)	18(28.13)	43(9.39)	48(25)
	Black dominant	2(1.3)	-	3(1.97)	-	-	-	5(0.9)	-
	Brown dominant	6(3.9)	3(4.69)	6(3.95)	-	6(3.95)	-	18(3.93)	3(1.56)
	X^2 *Value*	333.59	77.25	522.76	88.25	476.43	77.37	1807.36	350.23
Hair Coat Type	Glossy	1(0.65)	1(1.56)	-	-	-	-	1(0.22)	1(0.52)
	Smooth hair	153*(99.65)	63*(98.14)	152(100)	64(100)	152(100)	64(100)	457*(99.78)	191*(99.48)
	Long straight hair	-	-	-	-	-	-	-	-
	Curly rough	-	-	-	-	-	-	-	-
	X^2 *Value*	150.02	60.06	-	-	-	-	454	188.02

Table 23: Qualitative traits of indiginous goat types found in Gode, Adadle and Denan district

*Key: N = Number of goat exhibiting a particular qualitative character; X^2 = Pearson chi-square; NS=no significant (p>0.05); *=Significant (p<0.05)*

Table 23(continued)

Traits	Attributes	District						Overall	
		Gode		Adadle		Denan			
		Female N (%)	Male N (%)	Female N (%)	Male N (%)	Female N (%)	Male N (%)	Female N (%)	Male N (%)
Hair Length	Short	149*(96.75)	60*(93.75)	152(100)	64(100)	151*(99.34)	64(100)	452*(98.69)	188*(97.92)
	Medium	5(3.25)	4(6.25)	-	-	1(0.66)	-	6(1.31)	4(2.08)
	Long	-	-	-	-	-	-	-	-
	X^2 *Value*	134.64	49	-	-	148.02	-	434.31	176.33
Wattles	Present	11(7.14)	4(6.25)	19(12.5)	4(6.25)	15(9.87)	1(1.56)	45(9.83)	9(4.69)
	Absent	143*(92.86)	60*(93.75)	133*(87.5)	60*(93.75)	137*(90.13)	63*(98.44)	413*(90.17)	183*(95.31)
	X^2 *Value*	113.14	49	85.50	49	97.92	60.06	295.68	157.68
Ruff	Present	-	47*(73.44)	-	43*(67.19)	-	41*(64.06)	-	131*(68.23)
	Absent	154(100)	17(26.56)	152(100)	21(32.81)	152(100)	23(35.94)	458(100)	6(31.77)
	X^2 *Value*	-	14.06	-	7.56	-	5.06	-	25.52
Rump Profile	Flat	4(2.6)	1(1.56)	-	-	-	-	4(0.87)	1(0.52)
	Sloping	148*(96.1)	60*(93.75)	150*(98.68)	64(100)	152(100)	64(100)	450*(98.25)	188*(97.92)
	Roofy	2(1.3)	3(4.69)	2(1.32)	-	-	-	4(0.87)	3(1.56)
	X^2 *Value*	273.09	105.21	144.10	-	-	-	868.62	360.4
Back Profile	Straight	93*(60.39)	51*(79.69)	42(27.63)	49*(76.56)	45(29.61)	62*(96.88)	180(39.3)	162*(84.37)
	Slopes up towards the rump	57(37.01)	12(18.75)	107*(70.39)	14(21.88)	105*(69.08)	2(3.13)	269*(58.73)	28(14.58)
	Slopes down from withers	1(0.65)	1(1.56)	1(0.66)	- (1)	2(1.32)	-	4(0.87)	1(0.52)
	Dipped (curved)	3(1.95)	-	2(1.32)	1(1.56)	-	-	5(1.09)	1(0.52)
	X^2 *Value*	155.29	64.71	195.84	57.78 105	105.64	56.25	457.3	371.12
Beard	Present	5(3.25)	42*(65.63)	7(4.61)	41*(64.06)	3(1.94)	40*(62.5)	15(3.28)	123*(64.06)
	Absent	149*(96.25)	22(34.38)	145*(95.39)	23(35.94)	149*(98.03)	24(35.5)	443*(96.72)	69(35.94)
	X^2 *Value*	134.64	6.25	125.28	5.06	140.23	4	399.96	15.18
Head Profile	Straight Strait	101*(65.58)	43*(67.19)	75*(49.34)	23(35.94)	61(40.13)	18(28.13)	237*(51.75)	84*(43.75)
	Concave	37(24.03)	17(26.56)	60(39.47)	24^{NS}(37.5)	73*(48.03)	21^{NS}(32.81)	170(37.12)	62(32.29)
	Convex	14(9.09)	4(6.25) ()	17(11.18)	17(26.56) ()	16(10.53)	16(25) ()	47(10.26)	37(19.27)
	Markedly convex	2(1.3)	-	-	-	2(1.32)	9(14.06)	4(0.87)	9(4.69)
	X^2 *Value*	151.71	36.96	35.77	1.34	93	4.87	304.39	65.29
Ear Orientation	Erect	8(5.14)	2(3.13)	-	1(1.56)	2(1.32)	-	10(21.83)	3(1.56) ()151
	Semi-pendulous	91*(59.09)	41*(64.06) ()	126*(82.89)	46*(71.88) ()	140*(92.11)	59*(92.19) ()	357*(77.95)	146*(76.04) ()
	Pendulous	1(0.65)	1(1.56)	5(3.29)	-	2(1.32)	-(5)	8(1.75)	1(0.52)
	Carried horizontally	54(35.06)	20(31.25)	21(13.82)	17(26.56)	8(5.26)	5(7.81)	83(18.12)	42(21.88)
	X^2 *Value*	138.51	66.37	170.53	48.71	365.68	45.56	716.69	289.04
Horn Presence	Present	153*(99.35)	64(100)	150*(98.68)	63*(98.44)	150*(98.68)	64(100)	453*(98.91)	191*(99.48)
	Absent	1(0.65)	-	2(1.32)	1(1.56)	2(1.32)	-	5(1.09)	1(0.52)
	X^2 *Value*	150.02	-	144.1	60.06	144.1	-	438.21	188.02
Horn Shape	Scars	-	-	-	-	-	-	-	-
	Straight	38(24.84)	31(48.44)	75(50)	28(44.14)	91^{NS}(60.26)	34^{NS}(53.13)	204(44.93)	93(48.69)
	Curved	115*(75.16)	33^{NS}(51.56)	75(50)	35^{NS}(55.56)	60(39.74)	30(46.88) ()250	250*(55.07)	98^{NS}(51.3)
	Spiral	-	-	-	-	-	-	-	-
	Corkscrew	-	-	-	-	-	-	-	-
	X^2 *Value*	38.75	0.06	-	0.77	6	0.25	48.7	0.13
Horn Orientation	Lateral	20(13.07)	17(26.56) ()	55(36.67)	18(28.57) ()	42(27.81)	25(39.06) ()	117(25.77)	60(31.41) ()
	Obliquely up ward	7(4.58)	1(1.56)	4(2.67)	3(4.76)	-	-(39)	11(2.42)	4(2.09)
	Back ward	126*(82.35)	46*(71.88)	91*(60.67)	42*(66.67)	109*(72.19)	39^{NS}(60.94)	326*(71.81)	127*(66.49)
	X^2 *Value*	167.09	48.78	76.44	36.85	30.82	3.06	340.72	119.13

*Key: N = Number of goat exhibiting a particular qualitative character; X^2 = Pearson chi-square; NS=no significant (p>0.05); *=Significant (p<0.05)*

3.17.2. Reproductive Performance

Reproduction determines several aspects of goat production and understanding of reproduction is crucial in reproductive management. A high rate of reproductive efficiency is important for perpetuation of the species, production of meat, milk, skin, and replacement of breeding stock (Girma, 2008).In this study, more information on reproductive performance was obtained from goat owners and the result is summarized in Table 24. The mean age at sexual maturity in Gode district was 8.97±0.21 month for male and 9.23±0.26 for female goat. The mean age at sexual maturity in Adadle district was 8.61±0.23 for male and 8.23± 0.27 for female goat. In Denan district, unlike that of Gode and Adadle district slightly shorter period was recorded, the mean age at sexual maturity was 7.95± 0.16 for male and 7.62± 0.15 for female goat. According to the respondents most of them could not fix age at first mating for both male and female goats.

Age at first kidding (AFK) can be defined as the age at which does give birth for the first time. The overall AFK of indigenous goat found in the study area was 14.75 months. The overall mean reproductive life span of indigenous female goat was 8.45±0.11 year, provided that the animal did not die, culled for meat purpose or sold. A doe could produce around 13.46 ± 0.20 kids per life span. Average reproductive life span of male goat was 6.53 ± 0.09 year. According to respondents' reproductive life span of male was less than that of females due to the fact that males were culled for the purpose of meat and sold. The overall mean service period of a buck in a flock in the study area was 3.74 ± 0.09 years. The result for Gode and Adadle district was almost similar, while in Denan district pastoralists keep bucks for 3.97± 0.16 year in a flock.

Kidding interval is the number of days between successive parturitions. The overall mean kidding interval in the study area was 7.14 ± 0.05 months.

Parameters	**Gode**	**Adadle**	**Denan**	**Overall**
	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
Average age at sexual maturity in male (months)	8.97 ± 0.21^{aa}	8.61 ± 0.23^{ba}	7.95 ± 0.16^{bb}	8.36± 0.14
Average age at sexual maturity in female (months)	9.23 ± 0.26^{aa}	8.23 ± 0.27^{bb}	7.62 ± 0.15^{bb}	8.51 ± 0.12
Average age at first kidding (months)	15.14 ± 0.16^{aa}	14.96 ± 0.25^{a}	14.15 ± 0.18^{b}	14.75 ± 0.12
Average kidding interval (months)	7.32 ± 0.13^{aa}	7.17 ± 0.07^{ba}	6.92 ± 0.08^{bb}	7.14 ± 0.05
Average reproductive life span of doe (years)	8.28 ± 0.22^{ba}	8.14 ± 0.19^{bb}	8.92 ± 0.15^{aa}	8.45 ± 0.11
Average reproductive life span of buck (years)	6.28± 0.16	6.59 ± 0.18	6.73 ± 0.16	6.53 ± 0.09
Average servicing age of buck in flock (years)	3.64± 0.17	3.61± 0.13	3.97± 0.16	3.74 ± 0.09
Average number of kid crop per doe (Number)	13.40± 0.45	13.88± 0.25	13.09± 0.30	13.46± 0.20

Table 24: Average reproductive performances of goat as reported by respondents

Key: Different superscripts within a row denote significant differences at P<0.05 between districts; SE = standard error;

3.17.3. Live Body Weight and Linear Body Measurements

Information on live body weight and Linear Body Measurements (LBMs) of the existing breed types has mandatory role in the selection programmes. The least squares mean of body weight and LBMs of indigenous goat found in the study area by sex, age, location and sex by age group interaction are presented in Table 25. In the study area, overall mean of live body weight, heart girth, height at wither, body length, pelvic width, horn length, ear length, scrotal circumference, scrotal length, rump height, chest depth and chest width, were 32.93 kg, 74.38 cm,68.24 cm, 65.60 cm, 13.82 cm, 9.37 cm, 14.49 cm, 25.06 cm, 15.48 cm, 70.24 cm, 26.72 cm and 13.49 cm, respectively.

- Sex effect: -Live body weight (LBW) and all the linear body measurements were significantly affected by sex groups. All the body measurements in male goats were consistently higher than females for all variables. The sex related differences might be partly a function of the sex differential hormonal effect growth (Semakula et al., 2010).
- Age effect: - Live body weight and all LBMs were significantly affected by age group.
- Location effect: - Live body weight (LBW) and all the linear body measurements were significantly affected by location except body length and scrotal length.
- Sex by age group: -The interaction between sex and age group significantly (p<0.05) affected body weight and LBMs. The value of body weight for female goat in age group 0PPI, 1PPI, 2PPI and≥ 3PPI were 21.47 kg, 29.66 kg, 35.41 kg and 37.85 kg, respectively and the values for males in the same age groups were 24.66 kg, 34.99 kg, 41.86 kg and 44.77 kg, respectively. This concurred with the results of Thiruvenkadan (2005). Higher body weight of males than that of females at all ages is attributed to aggressive behavior of males during feeding and sucking and male sex hormone, which has an anabolic effect. In all age groups and measurements, male goats performed greater than female goats. Relationship of live body weight with both sex and age of indigenous goat found in the study area is graphically presented in Figure 2:

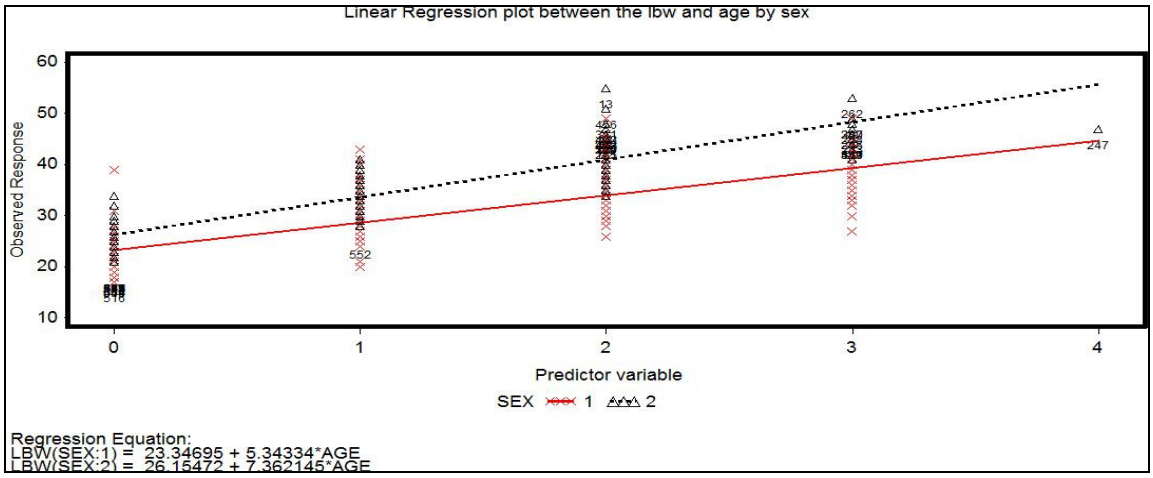

Figure 2: Relationship of live body weight with sex and age of indigenous goat in the study area

0= 0 Pair of Permanent Incisors (milk teeth) ;1= 1 Pair of Permanent Incisors; 2 = 2Pairs of Permanent Incisors; 3= 3Pairs of Permanent Incisors; 4= 4 pair of permanent incisors (Predictor variable); LBW=Live body weight(Observed response variable); 1= Female; 2=Male

Effect and level	**N**	**LBW**	**HG**	**HW**	**BL**	**PW**	**HL**
		LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE
Overall	650	32.93±0.28	74.38±0.23	68.24±0.19	65.60±0.21	13.82±0.05	9.37±0.10
CV%	650	11.56	4.05	4.71	5.41	8.24	19.53
R^2	650	0.73	0.73	0.57	0.58	0.39	0.53
Sex		*	*	*	*	*	*
Female	458	31.09^{b}±0.18	73.00^{b}±0.14	66.61^{b}±0.20	64.53^{b}±0.17	13.64^{a}±0.05	8.65^{b}±0.09
Male	192	36.57^{a}±0.32	76.57^{a}±0.25	71.06^{a}±0.26	67.81^{a}±0.29	14.01^{a}±0.09	10.97^{a}±0.15
Age		*	*	*	*	*	*
0PPI	130	23.06^{d}±0.34	66.06^{d}±0.29	63.28^{c}±0.33	58.96^{d}±0.27	12.31^{c}±0.10	6.87^{c}±0.16
1PPI	192	32.57^{c}±0.29	74.05^{c}±0.23	68.60^{b}±0.25	65.16^{c}±0.26	13.65^{b}±0.08	9.30^{b}±0.14
2PPI	202	38.63^{b}±0.29	78.72^{b}±0.23	71.33^{a}±0.42	69.02^{b}±0.28	14.59^{a}±0.09	11.38^{a}±0.14
≥3PPI	126	41.31^{a}±0.49	80.31^{a}±0.39	72.12^{a}±0.25	71.54^{a}±0.46	14.74^{a}±0.14	11.72^{a}±0.22
Location		*	*	*	**NS**	*	*
Gode	218	33.37^{b}±0.28	74.43^{b}±0.22	67.76^{c}±0.24	65.94^{a}±0.26	13.94^{a}±0.08	10.11^{a}±0.14
Adadle	216	34.34^{a}±0.27	75.19^{a}±0.22	69.01^{b}±0.23	66.54^{a}±0.26	13.87^{ab}±0.08	9.87^{a}±0.13
Denan	216	33.79^{ab}±0.28	74.72^{ab}±0.22	69.73^{a}±0.4	66.03^{a}±0.26	13.66^{b}±0.08	9.47^{b}±0.13
Sex by age		*	*	*	*	*	*
Female,0PPI	75	21.47^{g}±0.44	64.25^{h}±0.35	61.05^{g}±0.37	58.09^{g}±0.41	11.99^{e}±0.13	6.41^{f}±0.21
Female,1PPI	130	29.66^{e}±0.33	72.47^{f}±0.26	66.85^{e}±0.28	63.53^{e}±0.31	13.69^{c}±0.10	8.17^{d}±0.16
Female,2PPI	144	35.41^{d}±0.32	76.89^{d}±0.25	68.53^{d}±0.27	66.95^{d}±0.29	14.29^{b}±0.09	9.42^{c}±0.15
Female, ≥3PPI	109	37.85^{c}±0.36	78.40^{c}±0.29	70.02^{c}±0.31	69.56^{c}±0.34	14.59^{b}±0.11	10.59^{b}±0.17
Male,0PPI	55	24.66^{f}±0.51	67.87^{g}±0.41	65.52^{f}±0.43	59.83^{f}±0.47	12.63^{d}±0.15	7.33^{e}±0.24
Male,1PPI	62	34.99^{d}±0.48	75.64^{e}±0.38	70.35^{c}±0.41	66.78^{d}±0.45	13.61^{c}±0.14	10.43^{b}±0.23
Male, 2PPI	58	41.86^{b}±0.50	80.55^{b}±0.39	72.65^{b}±0.78	71.09^{b}±0.46	14.89^{a}±0.15	13.33^{a}±0.24
Male, ≥3PPI	17	44.77^{a}±0.92	82.21^{a}±0.73	75.71^{a}±0.42	73.53^{a}±0.86	14.88^{a}±0.27	12.84^{a}±0.44

Table 25. Least squares means (LSM ± SE) of body weight (kg) and LBMs(cm) of goat by sex, age, location andsex by age group

Key: $^{a,b,c,d.e,f,g,h}$ means with different superscripts within the same column and class are significantly different (P<0.05); ^{NS}Non-significant(P>0.05); *significant at(P<0.05) ; LBW=Live Body Weight; HG=Heart Girth; HW= Height at Wither; BL=Body Length; PW= Pelvic Width; HL= Horn Length; 0PPI, 1PPI, 2PPI and 3PPI = 0, 1, 2 and 3 pair of permanent incisors, respectively; N = Number of sample goat; for HL(N=644); CV = Coefficient of Variation

Table 25. (Continued)

Effect and level	N	EL	SC	SL	RH	CD	CW
		LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE
Overall	650	14.49±0.03	25.06±0.18	15.48±0.14	70.24±0.18	26.72±0.13	13.49±0.11
CV%	650	6.32	8.6	11.32	4.58	9.22	17.25
R^2	650	0.15	0.32	0.28	0.56	0.50	0.31
Sex		*			*	*	*
Female	458	14.39^{b}±0.04	-	-	68.96^{b}±0.15	25.92^{b}±0.12	13.02^{b}±0.11
Male	192	14.67^{a}±0.07	25.06±0.18	15.48±0.14	72.11^{a}±0.27	28.26^{a}±0.26	13.85^{a}±0.19
Age		*	*	*	*	*	*
0PPI	130	13.99^{c}±0.08	22.95^{c}±0.29	13.87^{c}±0.24	64.80^{c}±0.20	23.09^{d}±0.22	11.34^{c}±0.21
1PPI	192	14.46^{b}±0.07	25.33^{b}±0.28	15.73^{b}±0.22	$70,32^{b}$±0.24	27.17^{c}±0.19	13.31^{b}±0.18
2PPI	202	14.72^{a}±0.07	26.38^{a}±0.28	16.62^{a}±0.23	73.34^{a}±0.42	28.36^{b}±0.19	14.78^{a}±0.18
≥3PPI	126	14.94^{a}±0.12	26.41^{ab}±0.53	16.91^{ab}±0.43	73.67^{a}±0.25	29.74^{a}±0.32	14.67^{a}±0.30
Location		*	*	**NS**	*	*	*
Gode	218	14.36^{b}±0.07	24.69^{b}±0.29	15.52^{a}±0.24	69.20^{c}±0.24	28.36^{a}±0.18	14.02^{a}±0.24
Adadle	216	14.66^{a}±0.05	25.73^{a}±0.28	15.64^{a}±0.22	70.67^{b}±0.23	26.22^{c}±0.17	14.31^{a}±0.16
Denan	216	14.56^{a}±0.06	25.38^{ab}±0.29	15.45^{a}±0.23	71.74^{a}±0.24	26.69^{b}±0.18	12.26^{b}±0.09
Sex by age		*	*	*	*	*	*
Female,0PPI	75	13.76^{d}±0.11	-	-	62.81^{c}±0.24	22.08^{g}±0.28	10.94^{f}±0.21
Female,1PPI	130	14.66^{c}±0.08	-	-	69.04^{d}±0.28	26.05^{e}±0.22	13.57^{de}±0.20
Female,2PPI	144	14.41^{c}±0.07	-	-	71.36^{c}±0.27	27.30^{d}±0.20	14.31^{bc}±0.9
Female, ≥3PPI	109	14.99^{a}±0.08	-	-	71.61^{c}±0.41	28.25^{c}±0.23	14.00^{cd}±0.22
Male,0PPI	55	14.22^{c}±0.12	22.95^{c}±0.29	13.87^{c}±0.24	66.77^{e}±0.43	24.11^{f}±0.33	11.75^{f}±0.31
Male,1PPI	62	14.54^{bc}±0.11	25.33^{b}±0.28	15.73^{b}±0.22	71.61±0.41	28.28^{c}±0.31	13.05^{e}±0.29
Male, 2PPI	58	15.03^{a}±0.12	26.38^{a}±0.28	16.62^{a}±0.23	75.98^{a}±0.42	29.42^{b}±0.32	15.27^{a}±0.30
Male, ≥3PPI	17	14.89^{ab}±0.22	26.41^{ab}±0.53	16.91^{ab}±0.43	74.05^{b}±0.78	31.23^{a}±0.59	15.34^{ab}±0.56

Key: $^{a,b,c,d.e,f,g,}$ means with different superscripts within the same column and class are significantly different (P<0.05); ^{NS}Non-significant(P>0.05); *significant at(P<0.05) ;EL=Ear Length; SC=Scrotum Circumference; SL=Scrotum Length, RH= Rump Height, CD=Chest Depth, CW= Chest Width; 0PPI, 1PPI, 2PPI and 3PPI = 0, 1, 2 and 3 pair of permanent incisors, respectively; N = Number of sample goat; for SC and SL (N=192); CV = Coefficient of Variation

3.17. 4. Key Features and Special Attributes of Indigenous Goat Types in the Study Area

The key features of the indigenous goat found in the study area are the following:

1. Ear length: Long ears as compared to the short-eared Somali breed (*Issa goats).*
2. Body size: Relatively larger (including width seen from the front, height and length from the side) as compared to the short-eared Somali breed.
3. Coat color type: White and predominantly white as compared to the Hararghe high land goats.
4. Coat color pattern: Dominantly plain white as compared to the *Issa* goat with brown and black patches.
5. Hair length and coat type: Short and smooth hair compared to the Hararghe high land goats.
6. High frequency of presence of horn: compared to the Hararghe high land goats.

Special character/attributes of indigenous goat found in the study area according to group discussion were high level of heat and drought resistance because of their white coat color type and ability to walk long distance in search of feed and water, respectively. According to Adane and Girma (2008) sheep and goat have higher survival rates under drought conditions compared to cattle.

4. Conclusions and Recommendations

4.1. Conclusions

Generally, goats in the study area play a significant role for pastoralists and agro-pastoralists as source of home consumption and income generation throughout the year. But, goat production system is extensive, which is constrained by drought, disease incidence, feed and water shortage. There is less focus by concerned agencies on breed and breeding system to improve productivity and production of goats. The results further reveal that the pastoralists and agro-pastoralists have relatively similar production and breeding objectives in all the districts studied. Therefore, this finding can form abaseline for understanding production and breeding practices of goats in the study area as first step in designing a sustainable breeding programme.

4.2. Recommendations

- To improve the productivity of goats in Shabelle Zone, community based genetic improvement program should be designed.
- Strengthening the existing extension and veterinary service is required to reduce losses of goat caused by diseases.

- Further research is recommended to estimate the genetic potential of the indigenous goat type in study area at production and reproduction levels. Genetic characterization at molecular level is necessary to identify the genetic distance among the types and their similarity and differences at gene level for a better understanding of their utility.

5. References

i. Adane Hirpa and Girma Abebe. (2008). Economic significance of sheep and goat. pp 1-4. In: Alemu Yami and R.C. Merkel (eds.). Sheep and goat production handbook for Ethiopia. Ethiopian sheep and goat productivity improvement program, USAID.

ii. Banerjee, A.K., G. Animut and E. Ermias. (2000). Selection and breeding strategies for increased productivity of goats in Ethiopia. In: R.C. Merkel, G. Abebe and A.L. Goetsch (eds.). The Opportunities and Challenges of Enhancing Goat Production in East Africa. Proceedings of a conference held at Debub University, Awassa, Ethiopia from November 10 to 12, 2000. E (Kika) de la Garza Institute for Goat Research, Langston University, Langston, OK pp. 70-79.

iii. CSA (Central Statistics Agency).(2013). Agricultural sample survey, 2012/13 (2005 E.C). Volume II, Report on livestock and livestock characteristics. Statistical bulletin, 570, April 2013, Addis Ababa, Ethiopia.

iv. Dejen Assefa.(2010). Phenotypic characterization of indigenous sheep types in Keffa and Bench-Maji Zone of Southern Ethiopia. An MSc Thesis Presented to School of Graduate Studies of Haramaya University, Ethiopia. 25-35p.

v. Devendra, C and G.B. McLeroy.(1982). Goat and sheep production in the tropics. In: Intermediate Tropical Agricultural Series. Longman, London/New York, 271p.

vi. Endeshaw Assefa.(2007). Assessment of Production and Marketing System of Goat in Dal District, Sidam Zone. An MSC Thesis submitted to the school of graduate studies. Hawasa University, Hawasa.

vii. FAO. (2012). Phenotypic characterization of animal genetic resources. FAO Animal Production and Health Guidelines No. 11. Rome.

viii. FARM-Africa.(1996). Goat Types of Ethiopia and Eritrea. Physical description and management systems. Published jointly by FARM-Africa, London, UK, and ILRI (International Livestock Research Institute), Nairobi, Kenya. 76 pp.

ix. Girma Abebe.(2008). Reproduction in sheep and goats. pp 57-77. In: Alemu Yami and R.C. Merkel (eds.). Sheep and goat production handbook for Ethiopia. Ethiopian sheep and goat productivity improvement program, USAID.

x. Girma Abebe and Alemu Yami.(2008). Sheep and goat management. pp 33-56. In: Alemu Yami and R.C. Merkel (eds.). Sheep and goat production handbook for Ethiopia. Ethiopian sheep and goat productivity improvement program, USAID.

xi. Grum Geberyesus, (2010).Community-based participatory characterization of the short eared Somali goat population around Dire Dawa. AnMSc Thesis submitted to the school of graduate studies. Haramaya University, Haramaya.

xii. Halima Hassen, Michael Baum, Barbara Rischkowsky and Markos Tibbo M. (2012). Phenotypic characterization of Ethiopian indigenous goat populations. African Journal of Biotechnology Vol. 11(73), pp. 13838-13846

xiii. IBC (Institute of Biodiversity Conservation).(2004). The State of Ethiopia's Farm Animal Genetic Resources: Country Report. A Contribution to the First Report on the State of the World's Animal Genetic Resources. IBC, May 2004. Addis Ababa, Ethiopia.

xiv. Kassahun Awgichew and Solomon Abegaz.(2008). Breeds of sheep and goats. pp 5-26. In: Alemu Yami and R.C. Merkel (eds.). Sheep and goat production handbook for Ethiopia. Ethiopian sheep and goat productivity improvement program, USAID.

xv. Mahilet Dawit.(2012). Characterization of Haraghe Highland Goat and Their Production System in Eastern Haraghe. An MSc Thesis submitted to the school of graduate studies. Haramaya University, Haramaya.

xvi. Mekasha, Y.(2007). Reproductive traits in Ethiopian male goats, with special reference to breed and nutrition. PhD dissertation. Department of Clinical Sciences, Faculty of Veterinary Medicine and Animal Sciences, Swedish University of Agricultural Science (SLU), Uppsala, Sweden. 56p

xvii. Mwacharo JM, Okeyo AM, Kamande GK, Rege JEO. (2006). The small east African shorthorn zebu cows in Kenya:I- Linear body measurements. Trop. Anim. Health Prod. J. 38:65–76.

xviii. Nigatu Alemayehu.(1994). Characterization of indigenous goat types of Eritrea, Northern and Western Ethiopia. M.Sc. Thesis, Alemaya University of Agriculture. Alemaya, Ethiopia. 136p

xix. SAS (Statistical Analysis System).(2008). SAS for windows, Release 9.2. SAS Institute, Inc., Cary, NC, USA.

xx. Semakula Jimmy, Mutetikka David, R. Donald and Mpairwe Dennis.(2010). Variability in Body Morphometric Measurements and Their Application in Predicting Live Body Weight of Mubende and Small East African Goat Breeds in Uganda. Mukono Zonal Agricultural Research and Development Institute-NARO, P.O Box 164, Mukono, Uganda.

xxi. Sölkner-Rollefson, J. (2003). Community-based management of animal genetic resources with special references to pastoralists. pp. 14-26. In: Proceedings of the Workshop on Community-based Management of Animal Genetic Resources, 7-11 May, 2001, Mbabane, Swaziland.

xxii. Solomon Gizaw. (2009). Goat Breeds of Ethiopia: A guide for Identification and Utilization. (eds) Alemu Yami, Kassahun Awgichew, T.A. Gipson and R.C. Merkel. Technical buleting no.27. Ethiopian sheep and goat production improvement program (ESGPIP).
xxiii. Tekle Zeleke.(2008). Sheep and goat products and by-products. pp 273-294. In: Alemu Yami and R.C. Merkel (eds.). Sheep and goat production handbook for Ethiopia. Ethiopian sheep and goat productivity improvement program, USAID.
xxiv. Thiruvenkadan A.K.(2005). Determination of best fitted regression model for estimation of body weight in Kanni Adu kids under farmer's management system. Livest. Res. Rural Dev. 17(7):76–87.
xxv. Thiruvenkadan, A.K. and Karunanithi, K.(2006). Characterization of Salem Black goats in their home tract. Animal Genetic Resources Information, 38: 67-75.
xxvi. Wilson, R.T. and J.W. Durkin. (1988). Livestock production in central Mali: Reproductive components in traditionally managed sheep and goat. Livestock Production Science., 9: 523-529.
xxvii. Workneh Ayalew.(1992). Preliminary survey of indigenous goat types and goat husbandry practices in Southern Ethiopia. M.Sc. Thesis, Alemaya University of Agriculture. Alemaya, Ethiopia. 156p.
xxviii. Zewdu Edea.(2008). Characterization of Horro and Bonga indigenous sheep breeds of smallholders for designing community based-breeding strategies. An MSC Thesis Presented to Shool of Graduate Studies of Haramaya University, Ethiopia. 81p.