PHENOTYPIC CHARACTERIZATION OF INDIGENOUS GOATS AND THEIR PRODUCTION SYSTEM IN EAST GOJJAM ZONE, AMHARA REGION, ETHIOPIA

M.Sc. THESIS

BY:

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Phenotypic Characterization of Indigenous Goats and their Production System in East Gojjam Zone, Amhara Region, Ethiopia

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In partial fulfillment of the requirements for the degree of Master of Science in agriculture (Animal Breeding and Genetics)

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DEDICATION

This thesis is dedicated to my beloved father Simeneh Alameneh who passed away and I deeply wish that God might give her peaceful rest forever.

STATEMENT OF AUTHOR

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BIOGRAPHICAL SKETCH

The author of this thesis, Mr. Getahun Simeneh, was born on September 29, 1993 in Bibugn district of East GojjamZone in Amhara National Regional State, Ethiopia from his father Ato Simeneh Alameneh and mother W/ro Siraneshe Mekonnene. He attended his primary school (Grade 1-4) education in Genetu Medhanialim (1994-1997), junior secondary school Grade (5- 8) inMahel Meda elementary school (1998- 2001) respectively, high school andPreparatory School education (Grade 9-12) in Liywe Aserese Zwede Secondary and Preparatory School (2002-2005). He then joined Adigrat University in 2014 and awarded a BSc degree inAnimal production and technology on July 2016. After his graduation, he was employed by the .Ministry of Education as graduate assistance for newly opening universities and assigned at Raya University.In 2016, he joined the postgraduate program of Jimma University to pursue his MSc studyin Animal Genetics and Breeding in the School of Animal Science.

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LIST OF ABBREVIATION

AFK Age at First Kidding
AnGR Animal Genetic Resources
BL Body Length
BW Body Weight
CBC Cannon Bone Circumference
CBL Cannon Bone Length
CD Chest Depth
CG chest Girth
CIP-UPWARD Conservation and Sustainable Use of Agricultural Biodiversity
CSA Central Statistics Agency
CV Coefficient of Variation
DA's Development Agents
DAGRIS Domestic Animal Genetic Resource Information System
EL Ear length
ESGPIP Ethiopia Sheep and Goat Productivity Improvement Program
ESMDLFROEnbse Sar Midir district livestock and fishery resource office
FAnGR Farm Animal Genetic Resources
FAO Food and Agricultural Organization of the United Nations
FGD Focus Group Discussion
GLM General Linear Model
GSEDLFRO Goncha Siso Enesie district livestock and fishery resource office
HEEDLFRO Hulet Eju Enesie district livestock and fishery resource office
HL Head Length
HrL Horn Length
IBC Institute of Biodiversity Conservation
ILRI International Livestock Research Institute
KI Kidding Intervals
LBMs Linear Body Measurements
LS Liter Size
LSM Least Square Means
PW Pelvic Width
RH Rump Height
RL Rump Length
RW Rump Width
SAS Statistical Analysis System
SC scrotal Circumference
SPSS Statistical Package for Social Science
WH Wither Height

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PHENOTYPIC CHARACTERIZATION OF INDIGENOUS GOATS AND THEIR PRODUCTION SYSTEM IN EAST GOJJAM ZONE, AMHARA REGION, ETHIOPIA

ABSTRACT

*This study was conducted in Hulet Eju Enesie, Goncha Siso Enesie and Enbse Sar Midir districts of East Gojjam Zone with the aim to phenotypically characterize indigenous goat population and their production system.Data were collected through questionnaire, focus group discussion, field observation and measurements. A total of 180 households were selected purposively for characterization of the production practices and 600 goats were sampled randomly for phenotypic characterization of goat population. Data collected through questionnaire were described by descriptive statistics using SPSS. Observation on qualitative traits of goats was analyzed using frequency procedure of SPSS. Quantitative traits data were analyzed using general liner model procedures of SAS versions 9.3(2014). The mean flock size of goats per household was 12.78±1.22, 11.78±0.95 and 13.1 ±1.26 in Hulet Eju Enesie, Goncha Siso Enesie and Enebse Sar Midir districts, respectively.The first objective of keeping goat in all districts was income generation. Natural pasture (shrubs and bushes) and river water were the major sources of feed and water, respectively both in dry and wet season in the study area. Almost half (*56.7%*) of respondents in the study area used separate house with roof for their goats. Majority (73.3%) of respondents practiced uncontrolled mating system.The main sources of breeding buck in the study areas were own flock. In the study area,appearance, growth rate and color were the main criteria's for selection of breeding bucks whereas appearance, litter sizeand growth rate were criteria's for selection of breeding does. The overall mean age at first mating for the female goat's were 7.53±0.06 month and for male 7.26±0.06 month, age at first kidding 12.62±0.06 month, average reproductive life time of doe 7.36±0.09 year and average kidding interval 8.06±0.06 month. The most dominant coat color patterns in the sampled populations were plain and patchy with the most frequently observed coat color type being light red, white with red and white color. Sex of animals had significant effect on all of the body measurements, except ear length, chest depth, and rump length and width. Enbse Sar Midir district had significantly higher body measurement values than other districts. Dentition had significant differences on body weight and most of the linear body measurements. Correlations among body weight and linear body measurements were positive for both sexes. The result of the multiple regression analysis showed that heart girth explained more variation than any other linear body measurements in both does (71%) and bucks (82%). The prediction of body weight could be based on regression equation BW = -37.93 + 0.92CG for female sample population and BW= -44.47 + 1.02CG for male sample goat population. To sustainably utilize these goat population the production constrains should be solved and selective community based breeding strategies should be designed and implemented.*

Key words: Body weight, Inbreeding, Indigenous, Linear Body Measurement, Phenotypic Characterization.

1. INTRODUCTION

1.1. Background Information and Justification

In Ethiopia, more than 85% of the human population depends on agriculture for their livelihoods (Solomon, 2014)and usually keep livestock as pastoralists or in mixed crop livestock systems.Livestockare an important section of agriculture in Ethiopia and provides milk, meat, draught power, transport, manure, hides, skins (Funk *et al*., 2012) and it has served as a source of income for the country (Feki, 2013). Ethiopia is home to genetically diverse goat populations that are widely distributed across all agro-ecologies (Halima *et al*., 2012).

Goats (*Capra hircus*) are an integral part of economic and social life especially in developing countries. Goats also can have a role in tradition, social status, social payments, rituals and ceremonies, bride price, insurance, status display, dispute compensation and as a mobile bank (Berhanu *et al.*, 2012; Arineitwe and Ndyomugyeni, 2013). Compared to other ruminants, goats possess unique abilities to adapt harsh tropical environments and are closely associated with resource-poor households often found in harsh environments (Solomon *et al.*,2014). They are considered most prolific ruminant among all domesticated ruminant species especially under harsh climatic conditions (Yadav and Yadav 2008). Goats provide 3.4 and 1.6 times higher gross margin than sheep and cattle, respectively in dry area of the country (Tatek, 2016).

According to CSA (2017), the number of goats reported in the country isestimated to be about 30.2 million, of which about 70.61% are females and 29.39% are males.With respect to breed, almost all of the goats are indigenous breeds, which account about 99.99 % (CSA,2013).Despite the country has diverse genetics, resistant to harsh environment and large number goat populations, their productivity are below the expectations. The average carcass weight ofEthiopian goats is 10 kg, which is the second lowest in sub-Saharan Africa (FAO, 2009).This is because of feed shortage, disease prevalence, inferior genotype, poor marketing system and infrastructure (Solomon, 2014).

Breed characterization has been recognized as the first approach to the sustainable use of animal genetic resources (Lanari *et al*., 2003). Absence of adequate information on the characteristics of breeds potentially leads to miss decision and genetic erosion through cross breeding, replacement and dilution (Zewdu, 2008). Appropriate design of breeding programs is impossible for breeds that have not been adequately characterized either phenotypically and/or genetically (Mwacharo *et al.*, 2006). Phenotypic characteristics are important in breed identification and classification. In this regard, the first step of characterization of local genetic resources is to assess variation of morphological traits (Delgado *et al*., 2001).Measurements of various body conformations are of value in judging quantitative characteristics and are helpful in developing suitable selection criteria. Moreover, the relative ease in measuring linear dimensions can be used as an indirect way to estimate live weight (Tesfaye, 2008). In addition, knowledge of the adapted goat genetic resources is a pre-requisite for designing appropriate breeding and utilization programs.

Phenotypic characteristics are important in breed identification local genetic resources as it depends on the knowledge of the variation of morphological traits, which play very fundamental role in classification of livestock based on size and shape (Ferra *et al*., 2010; Agga *et.al*., 2010;Leng*et al*, 2010).

The research done so far on phenotypic characterization indicated that there are about 14 goat types in Ethiopia and Eretria (FARM Africa, 1996). However, genetic/molecular characterization revealed only the presence of eight distinctively different breed types or populations in the country (Tesfaye, 2004). According to this author, the eight distinct genetic entities include Arsi Bale, Gumuz, Keffa,Woyto-Guji,Abergelle, Afar, highland goats (previously separated as Central and North-West highland) and the goats from the previously known as Hararghe highland, Short-eared Somali and Long-eared Somali. Recently, the Getinet (2016) regrouped the existing Ethiopian goat breeds, on molecular basis, into seven.

In addition, there are different studies conducted in Ethiopia ,Ahmed (2013) in Horro Guduru Wollega zone Oromia region , Belete (2013) in Bale zone Oromia region, Netsanet (2014) in Meta-Robi district Oromia region and Konso district in Southern Nations, Nationalities and People's region, , Bekalu (2014) in West Gojjam zone Amhara region , Alubel (2015) in north

Gondar zone of Amhara region and Diba (2017) in Guji zone of Oromia region carried out to characterize the indigenous goat found in Ethiopia. However, characterization has not been done so far particularly for indigenous goats found in East Gojjam zone. FARM Africa (1996) based on the physical description study named these populations as western highland goats before two decades. According to FAO (2007) changes in population type and structure need to be documented regularly for all breeds at intervals of about five years for cattle, buffalo, sheep and goats.Goats are the major income source for farmers in East Gojjam zone. In addition, large goat populations are found in the study area. The agro ecology of the area is also suitable for goat production. Breeding objective and selection criteria of goat owners to select breeding buck and does is also not studied previously. Therefore, intensively identifying the goat production system and characterizing the goat population in this area is the prerequisite for designing and implementing sustainable genetic improvement program for indigenous goats. It may further improve production, product quality, cost efficiency and ultimately food security. Therefore, this study was designed to address the following objectives.

1.2. General Objective

- To characterize indigenous goat populations and their production system in East Gojjam Zone

1.2.1. Specific objectives

- ✓ To describe goat production systems in the study area
- ✓ To phenotypically characterize indigenous goats in the study area

2. LITERATURE REVIEW

2.1. Classification and Distribution of Goat Breeds of Ethiopia

Indigenous goat breeds/types are widely distributed and are found in all agro-ecologies of Ethiopia and it appears they have evolved through a process of natural selection (Galal, 2005) that favored adaptation and survival rather than production. Goat breeds found in Ethiopia have been identified and classified based on their differences in physical characteristics and genetic make-up. Identification and classification of breeds based on physical characteristics can be supported by advanced tools. Advanced classification is based on differences between breeds in their genetic make-up. For this purpose, analysis of the genetic material called DNA is required. Such classification results in identification of genetically distinct breeds (Solomon, 2009).

Based on differences in physical characteristics and genetic differences at the DNA level, four families and 12 breeds of goats have been identified in Ethiopia (FARM-Africa, Tesfaye, 2004) (Table 1): - the Somalifamily (Short-eared Somali, Long-eared Somali, and Hararghe Highland), the Nubian family(Nubian), the small Rift valley family (Abergelle, , Afar, Arsi-Bale, andWoyto-Guji) and finally the more heterogeneous Small East African family (WesternHighland, Keffa, Central Highland and West Lowland). Tesfaye (2004) has classified these indigenous goat types of Ethiopia in to 8 distinct genetic entities using genetic DNA markers, These are: -Arsi-Bale, Gumez, Keffa, Woyto-Guji, Abergalle, Afar, Highland goats (previously separated as Central and North West Highland) and the goats from the previously known Hararghe, South eastern Bale and Southern Sidamo provinces (Hararghe Highland, Short-eared Somali and Long-eared Somali goats). However. Getnet, (2016) re-grouped in to seven goat types namely the previous (Gonder and Abergelle) grouped as Tekeze-Vally goat type, (Afar, Long eared Somali, Small eared Somali and Woyto-Guji) as dry lowland goat type, (Ambo and Agew) as North-West central highland goat, (Arsi-Bale and Hararghe highland) as mixed goat, Gumuz as Wet-lowland goat, (Nubian and Barka) as Nubian and Keffa goats.

Getnet *et al.* (2005) identified five morphologically different goat types, namely: Felata, Arab, Gumuz, Oromo and Agew. Felata, Arab and Gumuz goats predominate in semi-arid zones

while Agew and Oromo goats are found in sub humid zones of the region. Halima *et al*. (2012a) identified six morphologically distinct indigenous goat populations in the Amhara region, namely: Gumuz, Begia-Medir, Agew, Bati, Central Abergelle and Abergelle. Gumuz and Agew were distributed in both Amhara and Benishangul Gumuz regions.In the southwestern part of Ethiopia; Tegegne (2012) defined two goat ecotypes: Meanit and Sheko which are most likely ecotypes of Keffa goats previously characterized in the adjoining area.

Table 1: Indigenous goat breeds of Ethiopia with their family, distribution and common name

Family	Breed/ Type	Distribution /Location	Common/ local name
Nubian	Nubian	North-west Ethiopia (Wegera)	Shukria, Langae, Hassen
Rift valley	Afar	Afar Region	Adal, Danakil
	Abergelle	AlongTekezeriver,NotherrnWollo, Gondar	
	Arsi-bale	Highlands of Arsi, Bale and South Shewa	Gishe, Sidama
	Woyto-goji	North and South Omo,Gamu-Gofa and Eastern Sidamo (Guji)	Woyto, Guji, Konso.
Somali	Hararghe Highland	Highlands of Eastern and Western Hararghe	Kotu-Oromo
	Short-eared Somali	Northern and Eastern parts of Ogaden and around Dire Dawa	Issa-Somali, Ogaden, Modugh, Mudugh. Dighier,Deghiyer, DighiYer,Denghier, Agal, Ogaden,Habab, Bimal
	Long-eared Somali	Throughout the Ogden,lowlands of Bale, Borana and Southern Sidamo	Large-White Somali, Digodi,Degheir, Melebo, Boran Somali, Benadir, Gigwain,Ogaden
Small East African	Central High-land	Northern Ethiopia (North Gondar,Wollo,Tigray)	Brown Goat
	Western High-land	Highlands of Western Ethiopia (South Gondar,Gojam,Wellega, and Western Shoa)	Agew
	Western Lowland	Lowlands of Western Ethiopia (Metekel, Asossa and Gambela)	Gumez
	Keffa	Keffa, part of South Shewa,Kembata and Hadiya	

Source: FARM-Africa, 1996; DAGRIS, 2006 and Tesfaye, 2004

2.2. Goat Production Systems in Ethiopia

Goat production in Ethiopia is described under low input production system and is operated by Small holder farmers. This production system accommodates almost all of the goat population of the country (IBC, 2004). The main features of the low input goat production system are its full dependence on natural resources and the limited demand for inputs. This system is constrained by land scarcity, severe resources degradation and recurrent drought (IBC, 2004). In Ethiopia goat production system is broadly classified into pastoral & agro-pastoral, mixed crop-livestock, peri-urban and urban production systems (Solomon *et al.*, 2010).

2.2.1. Mixed crop-livestock farming system

Mixed farming system is predominantly found in highland agro-ecological zones where the climatic factors are conducive for farming of crops and raising livestock. The area has adequate rainfall and moderate temperature and it is suitable for grain production. In this production system, livestock and crops are maintained as complementary enterprises. Goats in the highlands are widely distributed in the mixed crop-livestock production systems with very small flock size as a means of cash earnings and meat (Tesfaye, 2004; Solomon *et al*, 2014). The average land size per household is often less than two hectares (Solomon *et al*., 2008).According to Farm Africa 1996; Umeta *et al*., 2011; Netsanet, 2014; Hussein, 2015: Arsi-Bale Highland, Ambo,Gondar and Arsi-Bale Lowland, goat follow mixed crop–livestock production system respectively.

In a mixed crop–livestock production system, which is prevalent in humid, sub-humid and highland agro–ecological zones, goats are kept by smallholders and graze together with sheep and/or other livestock such as cattle. In these mixed-species grazing systems, goats complement cattle and sheep rather than compete with them for feed, because of their inherent ability to eat a wider variety of plant species (Lebbie, 2004).

2.2.2. Pastoral and Agro pastoral system

The pastoral system is practiced by pastoral people in very dry parts of the country at altitudes below 1500 m. The areas are not suitable for crop production and receive less than

500mm of precipitation. The livelihoods of the pastoral people depend entirely on livestock and more than 50% of the household income and 20% of the food comes from the livestock or livestock related activities. Goats are kept by nearly all pastoralists with higher flock size, often in mixed flocks with sheep. High mobility of animals in search of feed and water is common in the system (IBC, 2004; Solomon *et al*., 2008).

Agro pastoral system is practiced in the semi-arid part of the country. Comparing to the pastoral system the area receives relatively higher rain and people and animals are less mobile. The system is characterized by high degree of dependency on milk and meat production and 10-50% of the income is derived from livestock production. In this system there is some crop agriculture practice along with the livestock production (IBC, 2004; Solomon *et al*., 2008).

2.2.3. Urban and per-urban (landless) goat production system

With the expansion of chat (*Cata edulis*) in almost all parts of the country, goats frequently serve as 'cleaners' of the feed left over. This system involves the production of goats within and at the periphery of cities.Small-scale goat fattening is emerging as an economic activity in many growing cities. The viability of this activity depends on its acceptance into the formal extension services. In most cases, the types of goats available from this system are meat for local consumption, being well-finished, fatty animals demanded by the local Ethiopian market (Solomon *et al*., 2008).

2.3. Flock Size and Structure

Goats are widely found in all climatic zones, with a higher concentration in dry than humid areas of Ethiopia (Solomon *et al*., 2010). The flock structure or flock compositionrefers to the age and sex profile of the flock. The average flock size for Arsi-Bale and western highland goat owners were 13.50 and 7.60 respectively (Belete, 2013; Ahmed, 2013). However, higher flock size (37.65) was reported for short earned Somalia goats in shabele zone (Alefe, 2014), but southern Alaba and Dale districts goats were kept in small flocks (4.5) in mixed farming system (Deribe , 2009). The finding Tsigabu (2015) in Nuer Zone Gambela region, pastoralists in all study districts kept large proportions of female goats than male goats, and this was in agreement with the results of Grum (2010) who reported on short eared Somali

goats. This may be due to the reason the pastoralists sold their male for income generation and the fact that in Nuer zone they did not prefer female goat for meat purpose. Flock sizes are generally larger in the pastoral and smaller in the humid agricultural regions. Keeping of highproportion of female goats, imply the production of larger number of kids which has directimpact on selection intensity (Diba, 2017).

2.4. Goat Breeding Objectives of Farmers

Farmers breeding management decision is determined by the merit of livestock species and breed, farmers breeding objectives and the production environment (Solomon *et al.*, 2010). Goats have high financial and insurance functions in Ethiopia. According to Mohammad and Raed (2009), the breeding objectives of goat keepers differ based on agro ecologies, herd size, housing type and culture of the communities. The primary breeding objectives of goat keepers in many parts of Ethiopia are producing marketable goats for generating income which is used for emergency cases, educational fees and for other household expenses (Tesfaye, 2009; Hulunm, 2014; Ahmed *et al.*, 2015; Alubel, 2015; Tsigabu, 2015). According to Bekalu (2014) in West Gojjam , Ahmed *et al.* (2015) in Horro Guduru Wollega zone of Oromia region, Alubel (2015) in north Gondar zone of Amhara region, Belete (2009) in Jimma zone of Oromia region and Tesfaye (2009) in Metema district of Amhara Region, Solomon (2013) on Abergelle and Western Lowland goat breeds, goat milk is not consumed by the community and milk production is not the breeding objective of goat owners but cash income was the first rank among different goat production objectives, while milk production is the main breeding objectives in other parts of the country (Grum, 2010; Belete, 2013; Alefe, 2014;Tisgabu ,2015 Diba 2017). In contrast to this, Endeshaw (2007) reported that, saving is the primary breeding objectives of goat keepers in Sidama Zone of south Ethiopia.

According to Tsigabu (2015) inNuer zone Gambela region, goat milk is believed to have medicinal value for children and contribute much more for the well-being of human baby due to selective browsing of goat. Breeding objective is the first step to be made in designing of breeding program.

2.5. Goat Feed Resources of and Feeding System

The major feed resources for goat production in Ethiopia are natural pasture, fallow land, concentrate feed, crop residues and browses. Natural pasture is an important source of

livestock feed in Ethiopia. Natural pasture could be utilized as grazing and browsing, conserved in a form of hay or used as cut and carry. According Hulunim (2014) reported that Natural pasture (shrubs and bushes) were the predominant feed resourcein both dry and wet seasons for Borena, Seti and Batie. Most of the respondents stated crop residues were for large animals. Meanwhile, some of respondents also ranked crop residues as goat feed particularly during dry season when there is feed shortage. In line with this many authors (Alefe, 2014 in shabelle zone, Alubel, 2015 in Abergelle and central highland; Yadeta in west Shewa zone adaberke and Ejere district, 2016 and Diba, 2017 in Guji zone adola and shakiso district) indicated that natural pasture is the main feed source for sheep and goats. Natural pasture, *chat geraba*, crop residue and hay are the main feed sources during dry and wet season in east Hararghe (Mahilet, 2012). The availability of natural pasture in the highlands is diminishing due to increase in cropping land associated with increasing human population and poor productivity due to poor grazing land management (Yoseph *et al.,* 2015; Adugna, 2007). On the other hand, bush encroachment and overgrazing have tremendously reduced the availability of grazing resources in the pastoral areas (Quinn *et al*., 2007). Seasonal changes throughout the year caused shortage of feedstuffs and resulted in the fluctuation of animal production and, therefore, many farmers in Ethiopia feed their livestock with crop residues (Xianjun *et al.,* 2012) mainly various straws. Browse has been defined as leaves, shoots and sprouts including tender twigs and stems of woody plants, which are cropped to a varying extent by domestic animals (Gidado *et al.*, 2013).

According to Tigabu (2015) in Nuer zone Gambela region, almost all farmers use communal browsing system. There are no sex and age separation during feeding. However, kids were separately herded around back yard and kept until they are able to walk and browse properly, which is in agreement with Tesfaye (2010) who reported that kids were separately herded in shala district.Management with respect to feeding and grazing was different for dry and wet seasons. According to Diba (2017) the browsing methods for majority (78.7 %) of goat owners in dry season in Odo shakiso and Adola district Free and rotational grazing/browsing, while majority (72%) was practiced herded and paddock in wet season. In contrast to this finding in east Hararghe, during the dry season, the majority (62.2%) of goat owners herded their animals whereas 23.7% of the farmers practiced free grazing (Mahilet, 2012).

2.6. Watering Practice

Livestock must have free access to plenty of clean, fresh water at all times to be productive (Hulunim, 2014). Insufficient water supply causes reduced feed intake and lower production. Water requirements of goats varies with environments, type of feed , age, body weight, exercise, status of health , the water content of the feed, milk yield, severity of heat, amount of dry matter intake (Jagdish,2004). According to Ahmed (2013) in Horro Guduru Wollega zone of Oromia region, Damitie*et al. (*2015) Ebnat and Farta districts of Amhara region and Tsigabu (2015) in Nuer zone of Gambela region the major source of water in both dry and wet season was river. In addition to this, Alubel (2015) who reported that rivers were an important source of water during dry and wet season. In contrast to this finding the report of Yadeta (2016) the rain water was the main source of water for goat during wet season in Ada Barga and Ejere Districts of West Shoa Zone. The report of Tigabu (2015) Majority of households in Nuer zone of Gambela region allowed their flock to drink water freely, since movement is always water based. According to Mengistu (2007), Short- eared Somali goats deprived water for about three days in dry season.

2.7. Goat Housing

Good housing enhances production by reducing stress, disease, hazards and making management easier (Dejen, 2010). Pastoralists and agro-pastoralists in both districts had good awareness on importance of housing for rearing of goat in Adele and Gode district (Alefe, 2014). The size and types of livestock shelter may vary and depend on the size of the flock, age group of the animals (Samuel, 2005). Different kinds of housing for goats are commonly used in the tropics. According to (Belete ,2013 ; Ahmed ,2013; Hulunim, 2014; Alubel ,2015; Alefe ,2014 ; Tsigabu, 2015 and Diba, 2017) reported that the most dominant housing system was separate house, in Bale zone, in Horro Guduru Welega zone, in Borena ,Abergelle ,in shabele zone, in Nuer zone of Gambela region, inGuji Zone Oromia region, respectively. In contrast to this study, Mahilet (2012) indicated that the proportion of farmers housing goats in family house were significantly higher compared with separated house.

According to Alubel (2015) in Ziquala districts of Tigray region reported majority of farmers (83.8%) confine their goats without roof and minority of farmer confine their goats in family house (18.18%).

According to Hulunim (2014) reported that most of the observed adult goats' traditional housing systems in Borena and Siti areas do not protect animals from predation, theft, climate extremes (particularly in rainy season) except less extent predator protection. This could result low productivity of the animals. Majority of respondents kept kids separately during night reported by (Ahmed, 2013; Netanet, 2014; Alefe, 2014 and Diba, 2017). According to Alubel (2015) who reported that 61.02% of respondents in Lay Armachiho district housed their goat together with other animals. The finding of Nigatu (2017) indicated that all respondents confine all sex and age groups together including kids in one house. According to Dhaba *et al.* (2012a), reported that majority of households (47%) were housed their goats with sheep.

2.8. Castration Practices

According to Yadeta (2016) reported that Castration of sheep and goats is an important activity for successful production and management system. Castration is the removal or destruction of the testes, epididymis and a portion of each spermatic cord from buck. The purpose of castration can be summarized as to prevent indiscriminate breeding, makes kids more docile, male kids can be raised together with female kids, produces more desirable edible chevron, rapid gain in weight, makes skin of superior quality and profit per goat is more (Jagdish, 2004). Early castration (before six months old) has a much greater effect on growth and development than later castration. In addition, kids castrated at two months of age had higher dressing percentage and lower bone percentage in the carcass. According to Belete (2013) in Bale zone and Tsigabu (2015) in Nuer zone Gambela region Castration of goats was less common. This finding contradicts with the work of Mahilet (2012) who reported that castration was practiced in the sampled household in eastern Hararghe. The major reason for this is possibly lack of awareness on the importance of Castration. The proportion of households who practiced castration and the average age of castration varied from place to place (Hulunim, 2014).

2.9. Breeding Practices of Indigenous goat in Ethiopia

2.9.1. Sources of Breeding bucks and Mating System

According to Belete (2013) reported that majority of respondents have their own buck in Bale zone oromia region. According to this auter also the main source of their breeding buck was

born in the flock (89%). This finding was in agreement with the report of Tesfaye *et al*. (2011) and Solomon *et al*. (2010 reported that the major source of breeding buck for farmers was born with in flock in Adami tulu district (82%). Uncontrolled mating is expected to result in sever inbreeding in the flock Kosgey (2004). Majority pastoralists were not aware about the disadvantage of inbreeding. Some farmers and pastoralists reported that they heard the negative effect of inbreeding but no one tried to avoid except few of smallholder farmer and of pastoralist who revealed that they did not allow mating related goats because the result may be sever inbreeding (Tsigabu 2015).

According to Bekalu (2014) in west Gojjam Mating was predominantly uncontrolled. Majorty of in Bahir dar Zuria ,Yilmana Densa and Gonji Kolea farmers kept their own breeding buck. Likewise, Ahmed(2013) who reported in Horro gudru welega zone the breeding was uncontrolled mating. Similarly, Belete (2013) in Bale zone oromia region reported mating is predominantly uncontrolled. An advantage of uncontrolled mating is that it allows all year round breeding but result in sever inbreeding in the flock (Belete, 2013).

Diba (2017) states thatfor woyto Guji goat in Guji zone of the oromia Region, Ethiopia, (89%) of the respondents practiced Uncontrolled mating system and the buck run with does throughout the year. This study was not concurrent with the report of Feki (2015) who indicated high rate of controlled mating (81.5%) in Aysaita district. The primary reason for uncontrolled mating is the use of communal grazing area where by animals from various households graze together.

2.9.2. Selection Criteria of Goats

Farmers choose differently for different attributes of goats but preferred attributes that were mostly quantitative in nature and economically important (Abdul, 2011). Selection is the prerequisite to replace stocks by considering its own morphological and production characteristics (Tsigabu, 2015). According to Hulunim (2014) reported that age is an important factor in the selection of breeding stock. Selection criteria for goats are depending on production traits like body size, growth rate and reproductive performance.

According toAlefe (2014) in shabele zone somila region, selecting breeding buck based on the appearance, growth rate and age and also to select breeding doe based on appearance

,high milk yield and kid survival. Similarly, Diba (2016) reported that in adola and Ejere district in west Shoa zone to select their breeding doe based on appearance, high Milk yield and kidding interval. In addition,Hulunim (2014) reported thatappearance , high Milk yield and coat color were the best selection criteria for breeding does of long eared Somali goat in Borenadistrict. In contrast to this doe selection twining ability , appearance and age at sexual maturity the commmon selection criteria for western high land goat in west gojjam (Bekalu , 2014).In Horro guderu welega zone breeding bucks were selected based on their growth, appearance/conformation and coat color of goat (Ahmed, 2013). Similarly, the selection of breeding does differ from the above mentioned criteria, the selection criteria of breeding doe goat Litter size, Growth and Size/appearance. According to Ahmed (2013) growth rate was the primary selection criteria for breeding buck this unique from the above listed authors because most of author's appearance was the primary selection criteria for breeding buck.

According to Mahilet (2012), size / appearance, age at 1st sexual maturity, twining ability and high milk yield were considered as the first four reasons for doe selection in Harrerghe highland of Ethiopia. According to Netanet (2014) Farmers in Konso were selecting their does mainly considering Body size, litter size and coat color. They also gave emphasis for disease resistance, milk production and short kidding interval. However, some authors (Belete; 2009; Ahmed *et al*., 2015; Bekalu, 2014) reported that milk yield was not the selection criteria of goat owners to select their breeding does.

2.10. Reproductive Performance of Goat

Reproductive parameters heavily influence genetic improvement through their impact on selection intensity (Yoseph, 2007). 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). Maintaining good reproductive functions in the herd is pivotal to the success of any livestock production system and has to be given priority (Barding *et al.,* 2000). Song *et al*. (2006) stated that reproductive efficiency of goats is determined by age of goats at first kidding, kidding interval, birth type (litter size). The descriptions of each parameter are hereunder.

2.10.1. Age at first kidding

Age at first kidding can be defined as the age at which does give birth for the first time. Age at first kidding is highly variable and dependent on the growth rate and management system used (Song *et al*, 2006). In addition to variation in genotype, management condition,season and year of kidding, reproductive characteristics such as age at puberty, and age atconception (Zeshmarani *et al.*,2007). Age at first kidding of goats (reproductive traits) in Ethiopia appear to be shorter in the traditional systems while efficiency in terms of growth rate, carcass yield, milk yield, litter sizes and survival rate were higher under improved management systems (Dereje *et al.*, 2015). According to Tesfaye (2009) reported that, age at first kidding is a good indicator of sexual maturity in does. According to table2 the long average age at first kidding reported by Hulunim (2014) for Short eared Somali goat breed (20.15±0.12) months. And the short age at first kidding reported by Ahmed (2013) was (12.11±0.02) months for Western high land goat in Horro Guderu Welega zone. This may be due to environmental difference such as, the frequency of disease occurrence, availability of feed and water and the breed difference itself. Age at first kidding of some of Ethiopian goat breeds from different references is summarized in Table 2.

Table 2. Age at first kidding of some indigenous goats in Ethiopia

Breed	Age at 1st kidding (Mean±SD or SE)	Source
Afar	17.1 ± 2.3	Feki (2013)
Western high land	12.11±0.02	Ahmed (2013)
Central highland	14.98±0.24	Hulunim (2014)
Long earned Somali	15.86±0.22	Hulunim (2014)
Short eared Somali	20.15±0.12	Hulunim (2014)
WesternHighland	13.54 ± 2.03	Bekalu(2014)
Western Lowland	16.76±1.1	Tigabu(2015)
Woyto-Guji	18.4±0.16	Yaekob(2015)
Western Highland	13.85±0.12	Yadeta (2016)
Woyto-Guji	18.4±0.16	Diba(2017)

SD = standard deviation; SE= standard error

2.10.2. Kidding interval

Kidding interval (KI) is defined as the number of days between successive parturitions. The longer kidding interval reported from some research stations were mainly due to the result of controlled breeding with the objective to achieve the best breeding season and synchronization of birth for research purpose (Dereje *et al.*, 2015). Many authors reported that KI is influenced by a number of environmental factors including season of birth, year of birth, dam age (parity), litter size at birth (Mesfin *et al*., 2006 and Hailu *et al.*, 2008. Similar to age at first kidding the long average kidding intervalreported by Hulunim (2014) for Short eared Somali goat breeds (8.81±0.18) months. The short kidding intervalreportedby Ahmed (2013) was (5.76± 0.04) months for Western high land goat in Horro Guderu Welega zone. Kidding interval of some of Ethiopian goat breeds from different references is summarized in Table 3.

Table 3. Kidding interval of some indigenous goats in Ethiopia

Breed	kidding interval (Mean±SD or SE)	Source
Afar	8.0 ± 0.97	Feki (2013)
Arsi Bale	8.0±0.12	Belete (2013)
Western high land	5.76± 0.04	Ahmed (2013)
Central highland	7.95±0.19	Hulunim (2014)
Long earned Somali	8.42±0.17	Hulunim (2014)
Short eared Somali	8.81±0.18	Hulunim (2014)
WesternHighland	8.39 ± 1.22	Bekalu(2014)
Western Lowland	7.46±0.65	Tigabu(2015)
Woyto-Guji	6.5±0.06	Yaekob(2015)
Western Highland	8.25±0.52	Yadeta (2016)
Woyto-Guji	6.5±0.06	Diba(2017)

SD = standard deviation; SE= standard error

2.10.3. Litter size

Litter size was defined as the number of total kids born per kidding per doe. Goat is the most prolific ruminant of all domesticated ruminants in tropical and sub-tropical regions. Ahmed (2013) reported the prolificacy rate of about 1.77 for western highland goats In Horro Guderu Welega Zone, which is higher than the reported litter size of 1.26 for goats in Ada Barga and Ejere Districts of West Shoa Zone(Yadeta , 2016). The report of Endeshaw (2007) indicates that the litter size of Arsi Bale goats under traditional management were varies from 1.08 to 1.75 with an average of 1.38 kids born. In the central Ethiopian highlands, LS have been recorded to be 1.21, On the other hand, Dadi *et al*. (2008) reported LS of 1.6 for Arsi-Bale goat kept under station condition. The average LS estimated for local goats in Alaba, Southern Ethiopia, is about 1.47 (Deribe, 2009).variation in genotype, management condition, season and year of kidding, reproductive characteristics such as age at puberty, age at conception and age at first kidding are also affected bylitter size (birth type of doe) in which earlier values are observed in single born does than the multiple born one (Zeshmarani *et al.*, 2007).Goats arelargelydetermined by the eggs librated by the ovary at the heat period. If only one egg is released and fertilized, a single lamb/kid will resultunless this egg divides so that twin is produced. Mostly, twins and triplets are produced due tothe shedding of more number of eggs which are fertilized and complete their development(Ensminger, 2002).

2.11. Major Constraints of Goats

Identifying the constraints of goat production is a base to solve the problems and to improve goat genetic resources and goat productivity (Baker and Gray, 2003). The study of Deribe and Taye (2014) in southern Ethiopia indicated that, non-genetic factors influence reproductive traits and pre-weaning mortality of kids. According to Belete (2013) who reported that disease, predators and feed shortage were the serious problem in Sawenadistrict.

According to Hulunim (2014) around Bati area feed shortage, disease occurrences and drought are the major goat rearing constraints;in contrast to this Tsigabu (2015) reported that in south western Ethiopia (Gambella) mainly in two districts (Lare and Jikawo) of Nuer zone of Feed shortage was not critical issue in this particular study area, the major feed resource throughout the year was natural pasture across the districts , but the major production constraints in the study area were disease, theft and predators. This was similar with the report of Gurmesa *et al.* (2011a) who reported that disease, predators and labor were the serious problem in Arsi Negele *district*. The integration and full utilization of goats is constrained by various factors including high prevalence of diseases, low genetic potential and plane of nutrition, poor management and extensive production systems. Of these factors, diseases have a significant impact on the performance of animals (Gurmessa *et al*., 2011). Feed scarcity (quantity and quality) and access to credit were prioritized as a problem in all villages (Addisu *et al.*, 2012).

2.12. Major Goat Diseases

Disease control is very basic for genetic improvement of livestock (Solomon, 2007). Disease and parasites are source of serious economic losses and one of the main constraints to the development of goat production. According to Netanet (2014) reported that farmers of the study areas were able to identify the type of disease affecting their animals by recognizing the common symptoms through experience. The incidence of disease also become greater where a low level of nutrition causes reduced resistance. Poor sanitation and hygiene also affect the Health and performance of goats. Freedom from major diseases is regarded globally as pre-requisite for genetic improvements as maximum productivity in a given system of production emerges when disease control is in place (Tassew, 2012).

In Ethiopia, many diseases are still uncontrolled and causing devastating effects to both the producers and national economy. Internal parasites, persistent nasal discharge, diarrhea and coughing, trypanosomiasis and anthrax were the major identified health problems of small ruminant in Ilubabora zone (Dhaba *et al*., 2012b). The report of Dinka *et al*. (2010) indicates that GIT parasite, ticks and respiratory problems were the dominant economic problems of Boer goat in Adami Tulu Agricultural Research Center (ATARC). The finding of Girma *et al*. (2011) indicates that majority of Arsi Bale kids in mid rift valley of Ethiopia were died during the wet season and dry season of the years which caused by parasitic disease, infectious disease and cold stress of summer. The work of Gurmessa *et al*. (2011); Girma *et al*. (2013) indicates that goats production in Arsi Negele *woreda* was constrained by disease like; sheep and goat pox, Diarrhea, parasite, anthrax, and mastitis. Netanet (2014) reported that for woyto guji goat in Konso district the major goat diseases were identified as CCPP, Trypanosomiasis, External Parasites, and Liver fluk and brain diseases. Whereas in Meta-Robi, CCPP, External parasite, foot root, PPR and goat pox were the major prevalence disease. According to Bekalu (2014) reported that Sheep pox and anthrax were the most affecting diseases of goat production in west Gojjam zone. The Pastoralist in Odo Shakiso and Adola district reported that pneumonia, anthrax, foot rot, sheep box, diarrhea, thick and mange mites were the serious problem that affect goat in the study area (Diba. 2017).

2.13. Phenotypic characterization

According to FAO (2012) phenotypic characterization is defined as the process of identifying distinct breed populations and describing their external and production characteristics in a given environment and under given management, taking into consideration the social and economic factors that affect them. Phenotypic characterization is description of breeds in terms of external characteristics (such as coat color, ear type and shape, horn shape and type), linear body measurements (such as height at wither, heart girth, body length, ear length), production traits (body weight, milk yield) and reproductive traits (such as age at first kidding, litter size) (Tesfaye, 2004; FAO, 2012). Phenotypic characterization is a comparatively easy and cheap tool of breed characterization but phenotypic characters are highly influenced by environmental effects and by sometimes strong genetic and environmental correlations and interaction.

2.13.1 Qualitative characteristics

This category of traits covers the external physical form, shape, color and appearance of animals which are recorded as discrete or categorical (FAO, 2012). Qualitative are those that can be categorized like coat color, presence/absence of horns, beard, ruff, muzzle, toggle, facial profile, ear form *etc*. Qualitative traits of some Ethiopian indigenous goat's breeds summarize in Table 4.

Table 4.Qualitative traits of some Ethiopian indigenous goats breed

Breed/Type	Location	Coat color pattern	Coat color type	Ear orientation	Horn shape	Horn orientation	Facial profile	Reference
Hararghe Highland	Darolabu	Plain	White	Horizontal	Straight	Backward	Straight	Dereje (2013
Arsi-Bale	Bale zone	Plain	White	Lateral	Straight	Forward	Straight	Belete (2013)
Western Highland	Horro Guduru	Plain	Grey	Lateral	Straight	Upward	Straight	Ahmed (2013)
Woyto Guji	Konso	Patchy	Black& brown	Semi-pendulous	Curved	Backward	Concave	Netsanet(2014)
Short-eared Somali	Siti	Plain	White	Forward Erected	Straight	Back ward	Straight	Hulunim (2014)
Long eared Somali	Borena	Plain	White	lateral	Straight	Back ward	Straight	Hulunim (2014)
Somalia goat	Shabelle	Plain	White	Semi-pendulous	Curved	Back ward	Straight	Alefe(2014)
Western Lowland	Lare and Jikawo	Plain	White	Pendulous	Straight	Back ward	Concave	Tsigabu (2015)
Central Highland	Lay Armachiho	Patchy	White and red	carried horizontally	Curved	Backward	Straight	Alubel (2015)
Abergelle	Ziquala &Tanqua Abergelle	Patchy	Red/brown	carried horizontally	Curved	Backward	Straight	Alubel (2015)
Woyto-Guji	Loma	Plain	Brown	Semi pendulous	Straight	Backward	Straight	Yaekob(2015)
Woyto-Guji	Odo shakiso &Adola	Plain	White	Pendulous	Straight	Back ward	Straight	Diba(2017)

2.13.2. Quantitative characteristics

This category of traits covers the size and dimensions of animals' bodies or body parts, which are more directly correlated to production traits than qualitative traits and have continuous expression because of numerous genes that determine their expression (FAO, 2012). These traits include different body measurements viz. heights (rump, withers), lengths (body, head, ear, horn) and girths, (belly, chest) depths as reported by some other previous researchers. From below table the highest BW in femalegoat (33.11±0.31) reported by Alubel (2015)Central Highlandand male goat reported by (40.04±1.21) Hulunim (2014)longearedSomali. Bodyweight and some linear body measurements summarized in different references Table 5.

Table 5. Body weight and linear bodymeasurements of Ethiopian goat breeds

Breed	Sex	Parameters (Mean±SE or SD)			Source
		BW(Kg)	HW(cm)	CG(cm)	
Hararghe Highland	M	29.6±0.31	60.7±0.34	71.4±0.35	Dereje (2011)
	F	23.74±0.21	57.2±0.23	66.6±0.23	
Western Highland	M	33.0±0.6	69.7±0.4	73.8±0.7	Ahmed(2013)
	F	26.8±0.2	66.2±0.1 6	69.2±0.2	
Arsi-Bale	M	29.28± 0.49	67.07 ±0.52	71.83 ±0.52	Belete (2013)
	F	28.10 ±0.23	65.83 ±0.23	70.81 ±0.23	
Afar	M	26.44±0.39	59.6±0.36	64.8±0.42	Feki (2013)
	F	20.87±0.15	55.4±0.14	59.5±0.16	
Short eared Somali	M	30.62±0.67	64.98±0.67	71.24±0.73	Hulunim(2014)
	F	24.67±0.28	62.88±0.25	67.27±0.28	
Long eared Somali	M	40.04±1.21	74.84±0.66	79.49±0.78	Hulunim(2014)
	F	31.49±0.36	68.91±0.22	73.59±0.27	
Abergelle	M	30.75±0.60	67.79±0.46	72.97±0.52	Alubel(2015)
	F	24.30±0.32	62.84±0.24	67.45±0.28	
Central Highland	M	34.79±0.73	72.17±0.56	75.65±0.63	Alubel(2015)
	F	33.11±0.31	69.87±0.24	74.14±0.27	
Western Lowland	M	23.00±0.24	56.59±0.6	64.07±0.39	Tsigabu(2015)
	F	19.86±0.11	56.48±0.5	62.81±0.18	
Woyto -Guji	M	32.30±0.30	69.50±0.35	75.40±0.38	Diba(2017)
	F	27.1±0.18	65.20±0.20	71.6±0.22	

BW = Body weight; WH = Wither height; CG = Chest girth; SE = Standard error ,M =male, F=female

3. MATERIALS AND METHODS

3.1. Description of the Study Area

This study was conducted in three districts (Hulet Eju Enesie, Goncha Siso Enesie and Enbse SarMidir) in East Gojjam zone of Amhara regional state, Ethiopia.

3.1.1. Hulet Eju Enesie

Hulet Eju Enesie is one of the districts in East Gojjam Zone, it is bordered on the south by Debay Telatgen, on the west by Bibugn and Goncha, on the north by the Abay River (which separates it from the north Gondar Zone), on the east by Goncha Siso Enesie.

Major Agro ecologically, in the district is classified as 52% of"Weinadega"(midland), 18% of "Dega" (highland), systems in the study area. 30% of "Kola" (lowland).The altitude of the district ranges from 1288 to 2800 masl and it is located between 11^{o} 04' 48.4'' Nlatitude and 37^{o} 52' 45.8'' Elongitude. The district has annual temperature of 7.5 – 22.5 °C. The amount of rainfall generally varies with altitude but the average ranges between 1100 to 1189 mm.The major local livestock resources are cattle (183,290), goat (106,700), sheep (198,161), chicken (128,427), hive (5,781), donkey (4.988), Mule (4,228), and horse (8,706) (HEEDLFRO, 2017)

3.1.2. Goncha Siso Enesie

Goncha Siso Enesie is one of the districts in East Gojjam Zone; Goncha Siso Enesie is bordered on the south by Enarj Enawga, on the west by Hulet Eju Enesie, on the north by the Abay River which separates it from the Debub Gondar Zone, and on the east by Enbse Sar Midir.The district is located in 10°55'N latitude and 38°05' E longitude.The altitude rangesfrom 700-3,664 meters above sea level. The area receives annual rainfall of 900-1200mm with annualtemperature range from 10.5 to 26^{o}C.Goncha Siso Enesie is 40% lowland, 58% mid-land and 2% highland. The major local livestock resources are cattle (112,073), goat (87,606), sheep (161,127), chicken (55,193), hive (102, 02), donkey (20,745), Mule (436), and horse (1,780) (GSEDLFRO, 2017)

3.1.3. Enebse Sar Midir

Enbse Sar Midir is one of the district in East Gojjam Zone, it is bordered on the south by Enarj Enawga, on the west by Goncha Siso Enesie, and on the north and east by Abay River which separates it from the north Gondar Zone and north Wollo Zone. The area is located at 100 52' N latitude and 380 16' E longitudes at an altitude of 500-3664 masl with annual rain fall of 900-1200 mm which is an erratic type of rainfall. The annual average temperature ranges from 10^0C to 22^0C. Agro-ecologically the district covers 53% lowland, 33% midland and 14% high land. The major local livestock resources are cattle (68,735), goat (107,108), sheep (70,185), chicken (40,666), hive (7,302), donkey (15,899), Mule (80), and horse (63)(ESMDLFRO, 2017).

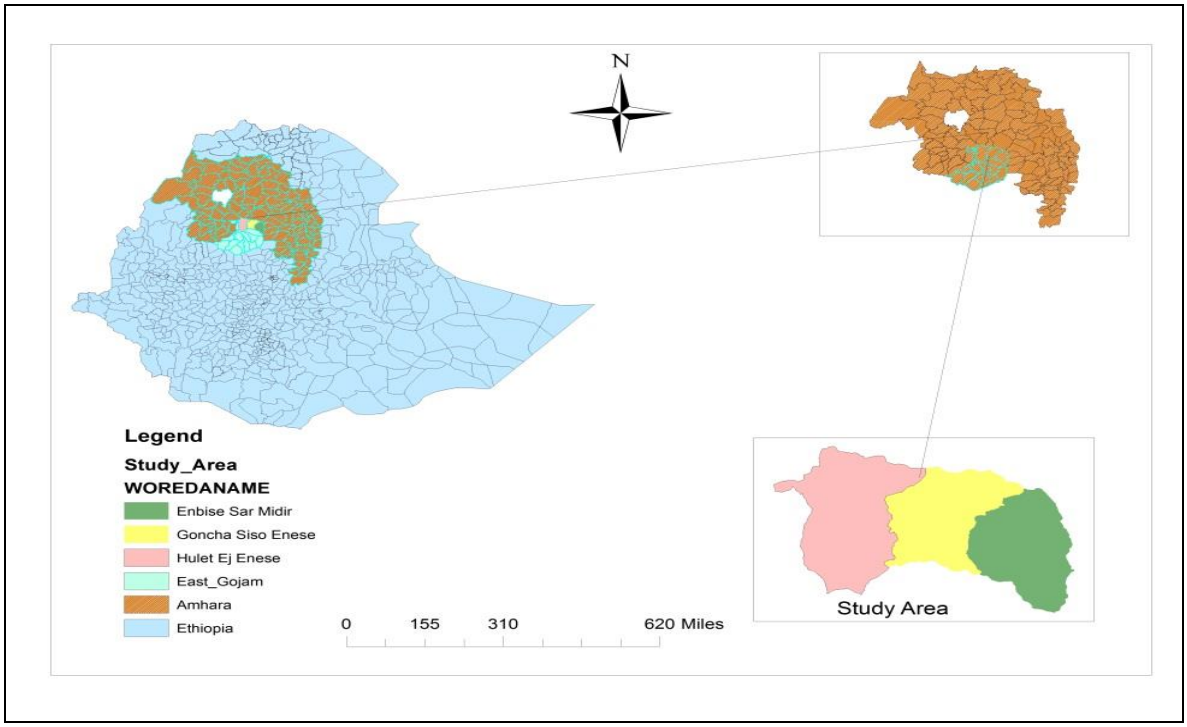

Figure 1.Map of the study area

3.2. Sampling Techniques and Sample Size Determination

3.2. 1. Sampling techniques

A multi-stage sampling technique was employed for the selection of sample households and indigenous goats for this study. Before deciding the sample districts,secondary data

sourceswere used and discussion with East Gojjam zone livestock and fishery resources development office expertswas held to stratify districts based on agro ecological variation. From the discussion, it was confirmed that enough goat population were found only in midland and lowland agro ecologies. In addition, the number of districts considered as lowland agro ecology were few in number than the number of districts in midland agro ecology. Consequently one district from low land agro ecology and two districts from mid land agro ecology were purposively selected based on relatively large goat population. Thus, in the first stage, totally three districts were selected for this study. In the second stage, from each district, three kebeles were purposively selected again based on relatively large goat population and agro-ecology representations. In the third stage, from each sample kebeles households were stratified according to their ownership of goats; goat owners (households which have at least two goats) and not goat owners (households which have $\leq$ one goats). From the total goat owner households, representative sample households were randomly selected for the interview about goat management practices. For sampling goat population, castrated goats, pregnant doe, kids, buck kids and doe kids were not included in the sample goat population to increase accuracy for quantitative traitsand to represent the adult goat population.Subsequently, sample goats were taken by using simple random sampling method.

3.2.2. Sample size determination for households and goats

Sample size of the households was determined according to the formula given by Cochran's (1977).

$$n = \frac{Z^2 * (P)(q)}{e^2}$$

n = sample size
Z = standard normal deviation (1.96 for 95% confidence level)
P = 0.135 (estimated population variability proportion, 13.5%)
q = 1-P i.e. (0.865)
e = level of precision (0.05)
Based on the formula,

$n = \frac{Z^2 \times p(q)}{e^2} = \frac{[(1.96)^2 \times 0.135(1-0.135)]}{(0.05 \times 0.05)} = \frac{3.8416 \times 0.116775}{0.0025}$=180 respondents were selected.

The sample size of indigenous goats was also determined by the formula given by **Cochran's (1977)**as FAO (2012) recommended for phenotypic characterization of livestock for simple random sampling.

$$n = \frac{Z^2 * (P)(q)}{e^2}$$

n = sample size

Z = standard normal deviation (1.96 for 95% confidence level)

P = 0.154 (estimated population variability proportion, 15.4%)

q = 1-P i.e. (0.846)

e = level of precision (0.05)

Based on the formula

$$n = \frac{Z^2 \times p(q)}{e^2} = \frac{[(1.96)^2 \times (0.154)\ (0.846)]}{0.05 \times 0.05} = \frac{3.8416 \times 0.130284}{0.0025} = 200$$

This is for one district, for the three districts 3*200 = 600. Therefore, totally 600 indigenous goats were used for collecting data about qualitative and quantitative traits. For physical description and quantitative traits measurement a total of 60 mature male and 540 mature female goats were used. Based on FAO (2012), from the total sample size 90% of goats were female and the remaining 10% of goats was male

Table 6.Summary of the Sampling Procedure House Hold Number, Goat Number and Group Discussion

District	PA	Survey	Sample of Goat	GD
Hulet Eju Enesie	Tiru selam	20	67	1
	Webekencharite	20	67	1
	Gedamyet	20	66	1
Goncha Siso Enesie	Yekura Rasema	20	67	1
	Eneba	20	67	1
	Getesemane	20	66	1
Enbse Sar Midir	Mezerarata	20	67	1
	Debtenye	20	67	1
	Yemazeta	20	66	1

PA= Peasant association , GD= Group discussion

3.3 .Data Types and Methods of Data Collection

3.3.1 Assessment of management practice of goat owners

The overall data were collected from primary and secondary data sources. Primary data were gathered through semi structured questionnaire and focus group discussion.

A questionnaire was prepared by adopting a questionnaire developed by ILRI (International Livestock Research Institute) for survey of livestock breedsthe questionnaire was pre- tested and administered to collect information on existing goat production and management practices from each selected flock owners. These questionnaires were designed to address socio-economic characteristics of households, description of goat production system, composition of livestock species,trends in livestock population, goat flock size,land size per hectar,feed resource and feeding practices, grazing practice, housing system ,water source and watering point distance, purpose or objective of goat rearing, age of culling and marketing ,castration and fating practice, breeding practices (e.g selection criteria for both bucks and does),reproductive performance of goats, disease, goat production constraint and access and distance of veterinary service (Appendix A1).

To strengthen the information gathered by questioner, focus group discussion was carried out with three groups per district. Members of the discussions were extension workers, livestock experts, development agents (DAs), village leaders, elders, women and socially respected individuals. Information about the overall production potential of the livestock, the production constraints, trend in livestock population, production system, breeding methods ,Communal land utilization**,** Trend in grazing land ,Occurrence and frequency of disease (common and local name), Major feed resources during different seasons **,** Indigenous knowledge in managing the flock**,** Major goat production on constraints**,**Major farming activities**,** Income contribution of the activities in percent**,**Goat population trend**,**purpose of keeping goats were collected from focus group discussions (Appendix A2).

Secondary sources: secondary data was collected from the respective district office of livestock and Fishery resource to complement the production system along with the climatic data, agero ecology data, geographical location, and livestock demography (Appendix A5).

3.3.2. Phenotypic characterization of indigenous goats

The standard breed descriptor list developed for goat by FAO (2012) was closely followed in selecting qualitative and quantitative traits. Data for qualitative variables like coat color pattern, coat color type, hair type ,hair length, head profile, ear orientation, presence or absence of toggle, rump profile, back profile, beard, wattle, horn presence or absence, horn shape, horn orientation ,muzzle and ruff were recorded by visual observation of the animal goat(Appendix A4).

Quantitative trait like body weight (BW), body length (BL), chest girth (CG), wither height (WH), rump height (RH), chest depth(CD), canon bone length(CBL), canon bone circumference(CBC), pelvic width (PW),rump length (RL),rump width(RW),head length(HL),horn length(HOL), ear length (EL) were measured using plastic measuring tape. For males scrotal circumference (SC) was also measured. Body weight was measured using spring balance having 50kg capacity (Appendix A3).

Each animal was identified by its sex, location and dentition.Goat's age classification was made using dentition.Adult goat were classified into four age group; 1PPI (one pair of permanent incisor), 2PPI (two pair of permanent incisor), 3PPI three pair of permanent incisor and ≥4PPI (four pair of permanent incisor).

3.4. Data Management and Analysis

All data gathered during the study period were coded and recorded in Microsoft excel 2007. Then statistical data analysis used depeneds upon the nature of the data.All data were analyzed by SAS version 9.3 (2014), and SPSS version 20.

Data collected through questionnaire and qualitative data from individual observations wereanalyzed by SPSS version 20 and chi-square test was carried out to assess the staticall significance among categorical variables using district as a fixed effect.

Index was calculated to provide ranking of the purpose of keeping goat, types of disease, type of feed in wet and dry season, buck and doe selection criteria and major goat production constraints. Indices were calculated bythe following formulathe following formula.

Index = Σ of [3 for rank 1 + 2 for rank 2+ 1 for rank 3] given for particular qualitative variables divided by Σ of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all qualitative variables considered.

Effective population size and rate of inbreeding for a randomly mated population were calculated using the following formula of Falconer and Mackay (1996). The rate of inbreeding (F) and effective population sizeNe were calculated as;

$$Ne = \frac{4(Nm\ NF)}{(Nm + NF)};$$

$$F = \frac{1}{2}Ne.$$

Where: Ne = effective population size,

Nm = number of breeding males

NF = number of breeding females.

F= rate of inbreeding coefficient

Quantitative data was analyzed using Statistical Analysis System (SAS Version 9.3). A general linear model procedure (PROC GLM) of the Statistical Analysis System (SAS 9.3)

was used for quantitative variables to detect statistical differences among sample goat's populations. Sex, location and age group of the goats were fixed variables while body weight and linear body measurements were fitted as response variables least square means with their corresponding standard errors were calculated for each body trait over sex, age and location to test statically deference by Tukey test.

The model employed for analyses of body weight and other linear body measurements except Scrotum circumference was:

$$Y_{ijkl} = U + A_i + S_j + D_k + Ai*Sj + e_{ijkl,}$$

Where:

$Y_{ijk\,l}$= the observed *k* (body weight or linear body measurements) in the i^{th} age group &j^{th} Sex,

U =Overall mean,

A_i = the effect of i^{th} age group (i = 1, 2, 3, ≥4),

S_j = the effect of j^{th} Sex (j=1 and 2)

Dk= the effect of k^{th} district (Hulet Eju Enesie, Goncha Siso Enesie and Enbse Sar Midir)

A_i*S_j= age by sex interaction and

e_{ijkl}= random residual error.

Live body weight and other body measurements including heart Girth (HG), Body Length (BL), Height at Wither (WH), rump hight(RH), chest depth(CD),rump width (RW) Pelvic Width (PW), horn length (HL) cannon bone circumference (CBC),cannon bone length(CBL),Rump Height (RH), Rump Length (RL), Head Length (HL), and Ear Length (EL) were considered both for male and female goats. In addition, Scrotum Circumference (SC) was included for male.

Correlations of live body weight with different body measurement under consideration were computed for each sex using Pearson correlation coefficient. Stepwise regression procedure of SAS (9.3) was used to estimate body weight for both male and female using PROC REG procedure of SAS in order to determine the best-fitted regression equation for the prediction of live body weight. Best fitting models were selected based on coefficient of determination (R^2), mean square error, and the mallows C parameters C (p), the following models were used for the estimation of body weight from LBMs.

The following models were used for the estimation of body weight from LBMs.

For male:

$Y = \beta o + \beta 1X\ 1 + \beta\ 2X2 + \ldots + \beta nX\ n + ej$

Where:

Y = the response variable (body weight)

βo =the intercept

X1… Xn are the explanatory variables (height at wither, rump height, body length, chest Depth, heart girth, rump length, rump width, cannon bone length, cannon bone circumference, ear length, Horn length, pelvic width, and scrotal circumference)

β1… βn are regression coefficients of the variables X1… Xn

ej =random error

For female:

$Y = \beta o + \beta 1X\ 1 + \beta\ 2X2 + \ldots + \beta nX\ n + ej$

Where:Y = the dependent variable body weight; βo = the intercept; X1,..., Xn are independent variables (height at whither, rump height, body length, chest depth, chest girth, rump length, rump width, pelvic width, cannon bone length, cannon bone circumference, head length, ear length, horn length) and rump length); β1,…, βn are regression coefficients of the variable X1…, Xn

ej =random error

4. RESULTS AND DISCUSSIONS

4.1. General Household Information

The characteristics of respondents in the study area are presented in Table 7. Family size is one of the major factors which determine the socioeconomic status of a family. The average family size of respondents in the study area was 6.22±0.15. There was significant difference ($p<0.05$) between districts in family sizes with the highest in Hulet Eju Enesie (6.76±0.26) and the lowest family size recorded in Goncha Siso Enesie district (5.51±0.23). This might be due to the fact that respondents in Hulet Eju Enesie might not have enough awareness in family planning. The average family size in the present study was lower as compared to the result of Ahmed (2013), 7.4 was the family size of households in Horro GuduruWollega zone.

Majority (90.6%) of respondents in the study area were male headed whereas only few (9.4%) were female headed. The result of the current study was similar with the result of Tesfaye (2008) who reported that 89.2% of respondents in Menz area were male headed. Regarding marital status, the highest proportions of respondents (82.8%) in the study area were married while the rest (11.7%) and (5.6%) of respondents were widowed and divorced, respectively. The highest proportion of married respondents in the study area is an opportunity which aids to accomplish livestock production efficiently than unmarried respondents. Because share responsibility about goat management.

The highest proportion of respondents (37.2 %) in this study was in the age range of 31 to 40 years. This indicated that the communitieswere in the active age group and are the main source of farm labor,In the study area, the majority (55.0%) of respondents were illiterate while the remaining 28.3%, 7.3 % and 9.4% of the respondents could read and write, elementary and high school, respectively.The result of present study is similar to the result of Belete (2013) who reported that 68.6% of respondents in Bale zone were illiterate. However, there was significant difference ($p>0.05$) among districts for educational status of respondents. In Enbse Sar Midir district higher in read and write than Hulet Eju Enesie and Goncha Siso Enesie this might be better for goat management inEnebse Sar Midir district than other districts. According to the respondent discussion in EnbseSar Midir disterict the school was established in earlier than other districtes due to this reason most respondents could write

and read than other districts. Educational status of the farmer is obvious in affecting household income and adopting technologies which is a factor in this study area.

Table 7.Household characteristics of respondents in the study area

Descriptor	District						Overall mean	
	Hulet Eju Enesie		Goncha Siso Enesie		Enebse Sar Midir			
	Mean ± SE		Mean ± SE		Mean ± SE		Mean ± SE	
Family size	6.76 [a] ±0.26		5.51[b]±0.23		6.38[a]±0.26		6.22±0.15	
	N	%	N	%	N	%	N	%
Sex structure								
Male	56	93.3	53	88.3	54	90.0	163	90.6
Female	4	6.7	7	11.7	6	10.0	17	9.4
X^2value								**0.90^{NS}**
Age structure								
20-30	5	8.3	2	3.3	6	10.0	13	7.2
31-40	29	48.3	17	28.3	21	35.0	67	37.2
41-50	15	25.0	15	25.0	18	30.0	26	26.7
51-60	8	13.3	14	23.3	11	18.3	33	18.3
>60	3	5.0	12	20.0	4	6.7	19	10.6
X^2value								**15.03^{NS}**
Marital status								
Widow	4	6.7	8	13.3	9	15.0	21	11.7
Married	51	85.0	50	83.3	48	80.0	149	82.8
Divorced	5	8.3	2	3.3	3	5.0	10	5.6
X^2value								**3.49 ^{NS}**
Educational status								
Illiterate	37	61.7	38	63.3	24	40.0	99	55.0
Read and write	14	23.3	10	16.7	27	45.0	51	28.3
Elementary	6	10.0	4	6.7	3	5.0	13	7.3
high school	3	5.0	8	13.3	6	10.0	17	9.4
X^2value								**16.30***

Means with the same letter within the same row and class are not significantly different at p (0.05)*P<0.05; x^2 = Pearson Chi-square; N = Number of house hold; NS= non-significant; SE= standard error

4.2. Livestock Species in the Study Area

Average numbers of various livestock species per household in the study area are summarized in Table 8. The major livestock species in the study area were cattle, goat, sheep, donkey, and chicken. Respondents in Hulet Eju Enesie district had significantly higher number of sheep, cattle and hive (P< 0.05) than Goncha Siso Enesie and EnebseSar Midir. It is due to the fact that majority of grazing land suitable for cattle and sheep production in Hulet Eju Enesie. However, there was no significant difference (P> 0.05) between the three districts for, goat, chicken and donkey population.

In the study area, the average goats per households were higher followed by cattle, chicken, bee colony, sheep and donkey. This might be due to the fact that goat can thrive well under adverse conditions (feed shortages and drought); have low feed requirement and short generation interval. The mean flock size of goats per household in this study was 12.78±1.22, 11.78±0.95 and 13.1 ±1.26in Hulet Eju Enesie, Goncha Siso Enesie and Enebse Sar Midir districts, respectively. The overall mean goats per household in the study area was 12.55, which was comparable with the report of Bekalu (2014) in west Gojjam where the mean flock size was 12.24 for western high land goat breed. On the contrary, the mean goat flock size per household in the study area was higher than the report of Mahilet (2012) for east Hararghe which was (8.12). These results lower thanstudy of Alefe (2014)the average of Somalia goat in shabele zone was (37.65).

Table 8. Livestock holdings per households in the study area

	District			
	Hulet Eju Enesie	Goncha Siso Enesie	Enebse Sar Midir	Overall
Livestock	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
Goat	12.78±1.22	11.78±0.95	13.1 ±1.26	12.55±0.66
Sheep	3.91^{a}±0.46	1.41^{b} ±0.33	1.43^{b} ±0.29	2.25±0.23
Cattle	6.26^{a}±0.27	5.43^{ab}±0.36	4.88^{b}±0.32	5.52±0.19
Chicken	5.38±0.59	5.01±0.62	3.86 ±0.71	4.75±0.37
Donkey	0.98±0.12	1.15 ±0.10	1.13 ±0.14	1.08±0.07
Hive	6.48^{a}±0.98	3.75^{b}±0.58	2.05^{b} ±0.37	4.09±0.42

SE= standard error, a, bmeans on the same row with different superscripts are significantly different (P<0.05)

4.3. Trend of major livestock population

Trend in livestock population in the study area is presented in Table 9. There was nosignificant difference ($p>0.05$) between districts in trend of livestock population.The trend of livestock in the study area was fluctuating from time to time and from season to season. The trend of goats for Hulet Eju Enesie, Goncha Siso Enesie and Enebse Sar Midir showedan increasing trend. Whereas decreasing trend for cattle (78.3%) and sheep (85.6%). This result was similar with the reportof Bekalu (2014) in westGojjamdecreasing trend for cattle (75.93%) and sheep (61.85%).On the basis of proportion of respondents, the decline in number was highest for sheep (85.6%), followed by cattle (78.3%) and goat (30.37%). The possible reasons reported by respondents for the decline in number were mainly shortage of feed, scarcity of grazing land, frequent occurrence of disease and poor veterinary service.

The goat population increase in the study area was due to the farmers given high emphasize to goat rearing since goats have short generation interval, better in litter size and households used goat as cash for different children expenses such as for exercise book, pen and clothes. In this regard, 63.9 % of the respondents believed that the trend of goat population in the study area was increasing.This indicates that even though the demand for goat and goat product is increasing and decrease the grazing land the farmers must reduce the number of their cattle and sheep they had to shift from large ruminant to small ruminate especially goat production. The increasing trend of goat population in this study was similar with the trend of goat population in Odo shakiso and Adola districts reported by (Diba, 2017).

Table 9. Population trend of major livestock species in the study area

Species	Level	District						Overall	
		Hulet Eju Enesie		Goncha Siso Enesie		Enebse Sar Midir			
		N	%	N	%	N	%	N	%
Goat	Increasing	41	68.3	39	65.0	35	58.3	115	63.9
	Decreasing	15	25.0	16	26.7	19	31.7	50	27.8
	Stable	4	6.7	5	8.3	6	10.0	15	8.3
	X ^{2}value								**1.407^{NS}**
Sheep	Increasing	10	16.7	4	6.7	3	5.0	17	9.4
	Decreasing	45	75.0	54	90.0	55	91.7	154	85.6
	Stable	5	8.3	2	3.3	2	3.3	9	5.0
	X ^{2}value								**8.241^{NS}**
Cattle	Increasing	6	10.0	12	20.0	10	16.7	28	15.6
	Decreasing	50	83.3	47	78.3	44	73.3	141	78.3
	Stable	4	6.7	1	1.7	6	10.0	11	6.1
	X ^{2}value								**5.838^{NS}**

N=Number of household NS=non-significant x^2 = Pearson Chi-square

4.4. Goat Flock Size and Structure

Goat flock structure in the present study is presented in Table 10. The flock owner determines the flock composition on the basis of economic and management considerations. There was no significant difference between districts in goat flock size and structure ($p>0.05$) except Male kid5month to 1 year and breeding doe>1year ($p<0.05$) which are higher in Enebse Sar Midir and Hulet Eju Enesie district, respectively. The number of breeding does observed in Enbse Sar Midir was higher than Hulet Eju Enesie and Goncha Siso Enesiedistricts.

The total proportion of breeding doe (>1year) was 31.30, 38.28 and 36.71 % in Hulet Eju Enesie, Goncha Siso Enesie and Enbse Sar Midir districts respectively. The overallproportion of breeding doe (>1year) was35.38%. This findingrelatively similar withof Diba (2017)around Gujizone (36.3%in Odo Shakiso andAdola Districts) and Grum (2010) around Dire Dawa (35% in Geldesa district). The result of all study areas was smaller than the findings of Feki (2013) in Asaita district of Afar region (53.2%) and Ahmed (2013) in Horro Guduru Wollega zone (47.4%) but greater than the finding of Mahilet (2012) in Eastern Hararghe (22.1%). while the overall, breeding buck (>1year) of the same age made up only 6.61 % of the population, which may be attributed to early castration of bucks for fattening

purpose and selling of does for income generation could not allow the accumulation of the male goats.

The percentage of castrated males was 7.51 % of the whole population while male and female kids less than 5 month of age made up to 13.39 % and 15.05% of the whole flock, respectively. This was in agreement with Netsanet (2014)on central highland goat in metaropi district for male and female kid less than 5 month both sexes (13%) and in castrated goat similar with Woyto Guji goats in Konso district (7%).The proportion of male and female kid of 5 month to 1 year age was 8.68 % and 13.38 % of the whole population, respectively. The flock structure of breeding doe and kids both in male and female were higher in all districts of the study area as compared to other age classes. This might be attributed to the prevalent practice of keeping doe for breeding purpose which accounted the greater portion of the newly born animals while bucks are either castrated or sold when they reach market age.

The ratio between breeding bucks of more than one year of age and their female goatwas 1:5.3. This finding was similar to the result of Grum (2010) who found buck to doe ratios of 1:5 for goat in Dire Dawa. But the result was smaller when the proportion of buck to does compared to the previous finding of Ahmed (2013) in western highland goat (1:12).

Table 10.Goat flock structure by age group in the study area

Goat Flock structure	District							
	Hulet Eju Enesie		Goncha Siso Enesie		Enebse Sar Midir		Overall	
	Mean ±SE	%	Mean ± SE	%	Mean ±SE	%	Mean ±SE	%
Male Kids<5 month	1.74±0.26	13.61	1.56±0.19	13.24	1.74±0.20	13.28	1.68±0.12	13.39
Female kid<5 month	2.36±0.41	18.47	1.38±0.22	11.71	1.91±0.27	14.58	1.89±0.18	15.05
Buck kids (0.5-1yr)	1.41^{a}±0.30	11.03	0.83^{b}±0.14	7.04	1.03^{ab}±0.13	7.86	1.09±0.09	8.68
Doe kids(0.5-1yr)	1.73±0.40	13.53	1.68±0.19	14.26	1.65±0.29	12.59	1.68±0.17	13.38
Breeding buck (>1yr)	0.61±0.10	4.78	0.91±0.14	7.72	0.96±0.16	7.32	0.83±0.09	6.61
Breeding Doe (>1yr)	4.00^{b}±0.50	31.30	4.51^{ab}±0.28	38.28	4.81 ^{a}±0.46	36.71	4.44±0.23	35.38
Castrated	0.93±0.15	7.28	0.91±0.15	7.75	1.00±0.16	7.66	0.95±0.09	7.51
Total	12.78±1.22	100	11.78±0.95	100	13.1 ±1.26	100	12.55±0.66	100

SE= standard error a, b, means on the same row with different superscripts are significantly different (P<0.05) yr =year

Figure 2.Goat flock size and structure of Hulet Eju Enesie (left), Goncha Siso Enesie (center) and Enbse Sar Midir (right)

4.5. Land holding in the study area

The overall mean land size per household in the study area is indicated in Table 11. Land is one of the most important resources required for any agricultural farming activities. The overall mean land size per household was 2.09 ha. Respondents in Enbse Sar Midir district had significantly (P<0.05) higher total land size than respondents in Hulet Eju Enesie and

Goncha Siso Enesie districts. This could be due to parents gave more land for their sons and daughters in Hulet Eju Enesie and Goncha Siso Enesie districts than parents in Enbse Sar Midir district when they reach adult age to be independent financially. In addition, Enbse Sar Midir district had sparse human population per unit area.

From the total land in the study area, only 0.58 hectare (ha) was allocated for grazing of all typesof livestock species while most (1.43 ha) of the remaining land was used for growing food crops. The result of present study was lower than the report of Diba (2017) who reported that the average land holding of the respondents inOdo Shakiso and Adola districts was 8.5 ha. This finding was larger as compared to the report of Belete (2009) who reported that, 1.93 ha was the average land holding of respondents in Goma district. The size of land holding is an important factor that determines availability of feed for livestock.

Table 11. Average land holding (ha) in surveyed households in the study areas

Descriptor	District			Overall
	Hulet Eju Enesie	Goncha Siso Enesie	Enebse Sar Midir	
	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
Total land (ha)	1.86^{b}±0.08	2.0^{b}±0.11	2.43^{a}±0.13	2.09±0.06
Crop land (ha)	1.30±0.09	1.42±0.13	1.59±0.17	1.43±0.07
Fallow land (ha)	0.11±0.02	0.07±0.03	0.04±0.01	0.07±0.01
Grazing land (ha)	0.45^{b}±0.05	0.51^{ab}±0.06	0.80^{a}±0.13	0.58±0.58

a, b, means on the same row with different superscripts are significantly different (P<0.05),

ha=hectareSE= standard error

4.6. Management Practices of Indigenous Goats

4.6.1. Feed resource and Supplementation

Feed resources commonly used in the study area across different seasons are presented in Table 12. The quantity and quality of feed resources available for animals primarily depends upon the climatic and seasonal factors (Zewdu, 2008). The different feed resources reported in all the study districts were natural pasture, fallow land, hay, concentrate and crop aftermath. Natural pasture was the first and the most common feed resources used for all livestock species during wet and dry seasons. The current finding was in agreement with Grum (2010) in Metema district of Amhara region, Biruh (2013) in low land areas of South Omo zone,

Alubel (2015) around Amhara and Tigray National Regional States and Yadeta (2016) in Ada Barga and Ejere districts of West Shoa zone, Oromia region.

In Hulet Eju Enesie district, during dry season, natural pasture (index = 0.40), crop residue (index = 0.24), and fallow land (index = 0.12) were ranked as first, second and third important feed resources, respectivelywhile in Goncha Siso Enesie district, natural pasture (index = 0.38), crop after math (index = 0.24) and crop residue (index = 0.17) were ranked as first, second and third important feed resource during dry season in the indicated order. In Enbse Sar Midir district, the major feed resources during dry season were natural pasture (index = 0.35), crop after math) (index = 0.23) and fallow land (index = 0.14). Feed resources are limited in dry seasons and there are seasonal feed supply fluctuations in the study area.

In Hulet Eju Enesie district, during wet season, natural pasture (index = 0.43), crop residue (index = 0.22), and hay (index = 0.18) were ranked as first, second and third important feed resources, respectively while in Goncha Siso Enesie district, natural pasture (index = 0.48), crop residue (index = 0.19) and crop after math (index = 0.13) were ranked as first, second and third important feed resource during dry season in the indicated order. In Enbse Sar Midir district,the major feed resources during wet season were natural pasture (index = 0.44), crop residue) (index = 0.32) and fallow land (index = 0.08)

When feed scarcity is the main problem of rearing goats, the some farmers used supplements to manage this problem. However, supplementation to growing kid was rare in the study area. Farmers supplementedsalt mixwith cereals to give doe to produce more milk to the new born. Farmers in the study area usually supplement by product from local beverage (byproductsfrom '*tela*' and '*areki*' called*atella*, maize grain, food leftover and salt to their goats.The farmers gave *attala*during morning and night time and they also gave salt to increase the palatability or intake of the feed.

Table 12.Source of feed during dry and wet season in the study area

Feed source	District											
	Hulet Eju Enesie				Goncha Siso Enesie				Enebse Sar Midir			
	R1	R2	R3	Index	R1	R2	R3	Index	R1	R2	R3	Index

Rainy season												
Natural pasture	46	8	0	0.43	53	5	4	0.48	49	4	6	0.44
Concentrate	-	-	6	0.02	-	6	8	0.06	1	-	9	0.03
fallow land	2	-	8	0.04	2	2	3	0.04	7	-	7	0.08
crop residue	3	24	21	0.22	2	22	9	0.19	1	53	6	0.32
Hay	8	13	13	0.18	3	9	10	0.10	3	1	16	0.07
Crop aftermath	1	15	8	0.11	-	16	26	0.13	0	2	16	0.06
Dry season												
Natural pasture	42	5	8	0.40	41	4	6	0.38	38	2	12	0.36
Concentrate	4	-	-	0.03	-	-	3	0.01	5	-	2	0.05
fallow land	4	8	14	0.12	3	13	8	0.12	3	18	6	0.14
crop residue	10	25	8	0.24	9	9	22	0.17	6	3	23	0.13
Hay	-	13	9	0.10	4	4	7	0.08	4	4	13	0.09
Crop aftermath	-	9	21	0.11	3	3	14	0.24	4	33	4	0.23

R1, R2 and R3 = rank 1, 2and 3, respectively. I= index

4.6.1.1. Grazing practice

Grazing practiced in the study area is present in Table 13. Respondents in the study area practiced different grazing/browsing methodsin dry and wet seasons. During dry season, the majority (71%) of goat owners in the study area practiced free grazing whereas 22.3% herded, 5% used rotational grazing and only 1.7% of the farmers practiced tethering. When all the crops harvested, goats browse freely across the villages during the dry season.During wet season 12.7%, 70.6%, 8.9% and 7.8% of respondents practiced free browsing/grazing, herding, rotational grazing and tethering, respectively. During tethering period, the selective feeding behavior of goats became more restricted. In contrast to this study, during dry season, majority (62.2%) of goat owners in eastern Hararghe herded their animals whereas 23.7% of the farmers practiced free grazing (Mahilet, 2012).

Communal grazing land in the study area is declined from time to time and the possible reasons were expansionof cultivation land for crops and the ever increasing human population. Male family members mostly practiced herding.

Table 13. Grazing Method Practiced in the study area

	District							
	Hulet Eju Enesie		Goncha Siso Enesie		Enebse Sar Midir		Overall	
Grazing method	N	%	N	%	N	%	N	%

Dry season								
Free grazing	48	80.0	41	68.3	38	63.3	127	71.0
Herded	12	20.0	14	23.3	15	25.0	41	22.3
Rotational grazing	-	-	3	5.0	6	10.0	9	5.0
Tethering	-	-	2	3.3	1	1.6	3	1.7
X^2value								**11.2***
Wet season								
Free grazing	9	15.0	2	3.3	12	20.0	23	12.7
Herded	36	60.0	49	81.7	42	70.0	127	70.6
Rotational grazing	8	13.3	6	10.0	2	3.3	16	8.9
Tethering	7	11.7	3	5.0	4	6.7	14	7.8
X^2value								**12.86***

N =number of householdsx^2 = Pearson Chi-square;*significant difference at $p < 0.05$;

4.6.1.2. Herding Practice in the study area

Herding practices in the study area is presented in Table 14. The aim of herding is to prevent goat from damaging crops, theft and predators. 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). In the study area, the majority (58.9%) of goat owners were kept their goats separate from other species, 22.2% with sheep, 12% with cattle and 6.7% of owners herded all species together. This indicated that goats were kept with other livestock particularly with sheep in the study areas next to kept separately. However, kids were separately herded around home until weaning. Similar practices were reported for goat production systems by Mahilet (2012) and Biruh (2013).

In Hulet Eju Enesie, about 75.0% of goat owners kept their goats with more than one house hold's goat in the village but the remaining 25.0% did not mix with other goat flocks in the village. In Goncha Siso Enesie,most (88.3%)of respondents were mixed their goat flocks with more than one house hold flock in the village whereas 11.7% were not mixing. About 33.3% of goat owners in Enbse Sar Midir were not mixing their goats, whereas 66.3% were keeping their goats with more than one household herded together in the village. According to focus group discussion said that during herding totogether it is suitable for disease transmission, but there is lack of private grazing /browsing land the solution was herding together in communal grazing land.

Table 14.Herding practices reported on households in the study area

Way of herding practice	District						Overall	
	Hulet Eju Enesie		Goncha Siso Enesie		Enebse Sar Midir			
	N	%	N	%	N	%	N	%
Goat flock is herded								
Together With sheep	20	33.3	9	15.0	11	18.3	40	22.2
Together With cattle	7	11.7	2	3.3	13	21.7	22	12.2
Goats herded Separately	30	50.0	44	73.3	32	53.3	106	58.9
All herded together	3	5.0	5	8.3	4	6.7	12	6.7
x^2value								**17.16***
Way of herding								
Goat of a house hold run as a flock	15	25.0	7	11.7	20	33.3	42	23.3
More than one house hold run as a flock	45	75.0	53	88.3	40	66.7	138	76.7
x^2value								**8.01***

N= number of householdsx^2 = Pearson Chi-square;*significant difference at $p < 0.05$;

4.6.2. Water Source and availability

The major water sources in the study area were borehole, pond, river, spring, and pipe water and rainfall water Table 15. About 30.0 % of the respondents across the study area reported that the major water source in dry season was river while 20.0% of them reported spring. Similarly, during wet season, river (26.7%) was the major source of water followed by spring (21.7%) and pipe water (17.8%). The current study was in agreement with the report of Alubel (2015) who reported that rivers were an important source of water during dry and wet season.Similarly, river water as a major source of water for goats was reported from Ebnat and Farta districts of Amhara region (Damitie *et al.*, 2015). In contrast to this finding, the report of Yadeta (2016) indicated that rain water was the main source of water for goat during wet season in Ada Barga and Ejere districts of west Shoa zone.

Nearly half (53.3%) of respondents in the study area were traveled a distance of 1-5km in dry season while in wet season, 71.1% of goat owners traveled a distance of less than 1 km followed by walking a distance of 1-5 km (10.0%). In contrast to this finding, the result of Teshome *et al*. (2010) indicated that 66.1% of respondents traveled a distance of less than one km in dry season followed by walking a distance of 1-5 km in dry season (25%).

The watering frequency in the study area was different from season to season. During wet season, 63.9% of goat owners watered their goats freely while during dry season,only small proportion (7.8%) of goat owners wateredtheir goats freely.Half of respondents (51.1 %) in dry season in the study areas provided water for their goats once a day. The reason was shortage of surface water during dry season. According to the information gathered from focus group discussion, during dry season most of springs and some rivers get dried.The respondents in all districts watered kids at home. This is because of kids especially below one month are not able to move together with adult goats to distant area.

Table 15. Water source and watering system in the study area

Water source	District							
	Hulet Eju Enesie		Goncha Siso Enesie		Enebse Sar Midir		Overall	
	N	%	N	%	N	%	N	%
dry season								
Water well	11	18.3	15	25.0	4	6.7	30	16.7
Dam/pond	4	6.7	8	13.3	21	35.0	33	18.3
River	19	31.7	21	35.0	14	23.3	54	30.0
Spring	6	10.0	12	20.0	18	30.0	36	20.0
Rainy water	1	1.7	-	-	-	-	1	0.6
Pipe water	19	31.7	4	6.7	3	5.0	26	14.4
X^2value								**48.54***
wet season								
Water well	4	6.7	15	25	7	11.7	26	14.4
Dam/pond	6	10.0	4	6.7	19	31.7	29	16.1
River	19	31.7	14	23.3	15	25.0	48	26.7
Spring	15	25	11	18.3	13	21.7	39	21.7
Rainy water	1	1.7	3	5.0	2	3.3	6	3.3
Pipe water	15	25.0	13	21.7	4	6.7	32	17.8
X^2value								**30.11***
dry season								
Watered at home.	10	16.7	9	15.0	7	11.7	26	14.4
Less than 1km	31	51.7	20	33.3	7	11.7	58	32.2
1km to 5 km	19	31.7	31	51.7	46	76.7	96	53.3
X^2value								**26.90***
Wet season								
Watered at home.	15	25.0	13	21.7	6	10.0	34	18.9
Less than 1km	36	60.0	40	66.7	52	86.7	128	71.1
1km to 5 km	9	15.0	7	11.7	2	3.3	18	10.0
X^2value								**11.52***
dry season								
Freely available	7	11.7	3	5.0	4	6.7	14	7.8
Once a day	22	36.7	39	65.0	31	51.7	92	51.1
Twice a day	31	51.7	18	30.0	25	41.6	74	41.1
X^2value								**10***
Wet season								
Freely available	39	65.0	35	58.3	41	68.3	115	63.9
Once a day	10	16.7	11	18.3	11	18.3	32	17.8
Twice a day	8	13.3	9	15.0	5	8.3	22	12.2
Three times a day	3	5.0	5	8.3	3	5.0	11	6.1
X^2value								**2.45***

N= number of householdsx^2 = Pearson Chi-square;*significant difference at $p < 0.05$;

4.6.3. Goat Housing System

The housing system of goats in the study area is presented in Table 16. Good housing enhances productionby reducing stress, disease, hazards and making management easier (Dejen, 2010). The most dominant housing system in the study area is separate house with roof as reported by 56.7% of respondents. However, the proportion of respondents (40.0%) in Enebse Sar Midir district that used separate house with roof was lower thanthe proportion of respondents in other two districts (70.0% in Goncha Siso Enesie) and (60.0% in Hulet Eju Enesie) because yard without roof was also the main housing systemin Enebse Sar Midir district. The current finding was in agreement with the report of Belete (2013) who reported that58.3% of farmers in Mada Walabu district housed their goats in separate house followed by yard (30%) and kraal (10%).

Goat houses were constructed using locally available materialsmainly grasses, Iron sheet and woods. Goat owners in all districts had good awareness aboutimportance of housing for rearing of goats. The majority (58.9%) of the respondents use iron to cover the roof of goat houses while the remaining (41.1%) of goat owners grass /bushes to over the roof of goat houses. Similar to the current study, the highest proportions (72%) of the households in Bale zone used corrugated iron sheet for the roof of goat houses (Belete, 2013).

In the study area, most (86.7%) of goat owners housed kids separate from adult goats. Newborn kids at least up to one month are separated from their dam and cared at home during the day when goats are taken to either grazing or browsing area and before they get into their house upon their return in the afternoon. This is a common practice in other parts of the country (Ahmed, 2013; Bekalu, 2014; Alubel, 2015). In the study area, farmers use large baskets or construct small fenced area around the house to keep newborn kids and allow kids to be kept dry, clean and warm. Suckling occurs in the morning before the dam leaves for grazing or browsing and when the flocks are back from grazing or browsing in the afternoon. Pregnant does and after gestation new born kids (1-2weeks) or before parturition and after parturition are kept separately to reduce the risk of physical injuries in (1-2weeks).

Table 16. Housing of goat in the study area

Type of house and housing material	District						Overall	
	Hulet Eju Enesie		Goncha Siso Enesie		Enebse Sar Midir			
	N	%	N	%	N	%	N	%
Type of house								
Family house with roof	9	15.0	13	21.7	14	23.3	36	20.0
Separate house with roof	42	70.0	36	60.0	24	40.0	102	56.7
Veranda	2	3.3	3	5.0	5	8.3	10	5.6
Yard without roof	7	11.7	8	13.3	17	28.3	32	17.8
X ^{2}value								**13.19***
Type of housing material								
Iron sheet	32	53.3	38	63.3	36	60.0	106	58.9
Grass /bushes	28	46.7	22	36.7	24	40.0	74	41.1
X ^{2}value								**1.28^{NS}**
Kids housed with adults								
Yes	9	15.0	12	20.0	3	5.0	24	13.3
No	51	85.0	48	80.0	57	95.0	156	86.7
X ^{2}value								**6.05***

N=No of households;*significant difference at p <0.05; NS= non-significantx^2 = Pearson Chi-square

Figure 3. family house in Hulet Eju Enesie (left), separate house Goncha Siso Enesie (center) and Yard without roof in Enbse Sar Midir (right)

4.6.4. Goat breeding practices

Buck management and its mating system in the study area are summarized in Table 17. In the study area, most (90%) of the respondents have their own buck. Among households which had their own buck, 88.9% of them used buck born in the flock followed by purchased from market 9.3% and gift from relatives (1.9%). This finding was in agreement with the report of Tesfaye *et al*. (2011) who reported that the major source of breeding buck for 82%of farmers in Adami tulu district was born with in flock. The main purpose of keeping buck in the study

area was for fatting purpose (47.2%) followed by mating (43.6%) and for socio-cultural purpose (9.2%).Households who had not their own buck wereused neighbor buck (61.1%) and communal grazing area (38.9%) to breed their does.

With regard to mating type practiced in the study area, most of the sampled households (73.3%) practiced uncontrolled mating.The main reasons to practice uncontrolled mating in the study area were doe browsing together with buck (63.3%), insufficient buck (17.8%) and lack of awareness about inbreeding (18.9%). This result was similar with the study indicated by Solomon *et al*. (2010)and Belete (2013) who reported that majority of the respondents in western central rift valley and Bale zone of Ethiopia do not practice controlled mating due to lack of awareness about the effect of inbreeding. This study was not concurrent with the report of Feki (2015) who indicated that 81.5%of respondents in Aysaita districtpracticed controlled mating.

Uncontrolled mating is expected to result in sever inbreeding in the flock (Kosgey, 2004). Respondents in the study area did not know about the effect of inbreeding. In addition, it is very difficult for them to control mating becausethe farmers did not see their goats during communal grazing land.

Table 17. Buck management and its mating system in the study area

Parameter	District						Overall	
	Hulet Eju Enesie		Goncha Siso Enesie		Enebse Sar Midir			
	N	%	N	%	N	%	N	%
Do you have breeding buck								
Yes	52	86.7	57	95.0	53	88.3	162	90.0
No	8	13.3	3	5.0	7	11.7	18	10.0
X^2value								**2.59^{NS}**
Source of breeding buck								
born in the flock	48	92.3	53	93.0	43	81.1	144	88.9
Purchased from market	3	5.8	4	7.0	8	15.1	15	9.3
Gift from relatives	1	1.9	-	-	2	3.8	3	1.9
X^2value								**5.59^{NS}**
Purpose of keeping buck								
Mating	18	34.0	27	47.4	26	49.1	71	43.6
Socio-cultural	7	13.2	5	8.8	3	5.7	15	9.2
Fattening	28	52.8	25	43.9	24	45.3	77	47.2
X^2value								**3.86^{NS}**
Do you make special management for buck								
Yes	5	9.4	8	14.0	12	22.6	25	15.3
No	48	90.6	49	86.0	41	77.4	138	84.7
X^2value								**3.67^{NS}**
If didn't have buck, how do you Mate								
Neighbor buck	5	62.5	2	66.6	4	57.1	11	61.1
Communal grazing	3	37.5	1	33.3	3	42.9	7	38.9
X^2value								**1.56^{NS}**
Mating system								
Controlled	20	33.3	17	28.3	11	18.3	48	26.7
Uncontrolled	40	66.7	43	71.7	49	81.7	132	73.3
X^2value								**1.56^{NS}**
If uncontrolled								
lack of awareness	12	20.0	9	15.0	13	21.7	34	18.9
Goat browse together	40	66.7	36	60.0	38	63.3	114	63.3
insufficient buck	8	13.3	15	25.0	9	15.0	32	17.8
X^2value								**3.66 ^{NS}**

N=Number of household; x2= Pearson Chi-square and NS= non-significant;

4.6.4.1. Selection criteria for breeding buck

A selection criterion for breeding buck in the study area is presented in Table 18. The choice of good breeding buck is important to increase goat production in the study area. Respondents in the study area, well experienced in selection of breeding bucks from own flock.

Appearance, growth rate and color of breeding buck were the first, second and third selection criteria of breeding buck in Hulet Eju Enesie and Goncha Siso Enesie districts in the desending order.However, for Enbse Sar Midir district goat owners ranked color and growth rate were ranked by goat owner vis versaly next to appearance. Black coat colored goat is not selected in the study area. Similar to this result, Belete (2013) indicated that appearance was the first rank as selection criteria in Mada Walabu (index=0.41), for Sawena (index=0.39) and for Rayitu (index=0.37) districts. In contrast to the current study, Ahmed (2013) reported that growth rate was the first ranking for selection of breeding buck for Guduru (index=0.449), Amuru (index=0.449) and for Horro (index=0.42) districts.

Table 18.Selection criteria of breeding buck in the study area

Selection Criteria	District											
	HuletEju Enesie				Goncha Siso Enesie				Enebse Sar Midir			
	R1	R2	R3	Index	R1	R2	R3	Index	R1	R2	R3	Index
Appearance	40	5	7	0.38	37	10	13	0.40	56	2	-	0.48
Color	12	5	23	0.19	12	10	17	0.20	-	26	27	0.21
growth rate	5	49	4	0.33	7	23	16	0.23	4	16	12	0.16
Pedigree	1	1	13	0.05	2	4	3	0.05	-	7	4	0.05
Libido	-	-	-	-	-	-	2	0.01	-	-	4	0.01
Age	2	-	12	0.05	2	13	9	0.11	-	9	13	0.09

R1, R2 and R3 = rank 1, 2and 3, respectively. I= index

4.6.4.2. Selection criteria for breeding doe

A selection criterion for breeding doe is indicated in Table 19. Litter size, appearanceand growth rate of breeding doe ranked first, second and third for Hulet Eju Enesie district goat owners with an index value of 0.33, 0.26 and 0.19, respectively. This finding was similar with the study of Ahmed (2013) described that in Guduru districts, litter size, growth and appearance were selection criteria for breeding does. Appearance, litter size and color ranked first, second and third for Goncha Siso Enesie district goat owners with an index of (0.32, 0.19 and 0.17), respectively andalso the goat owners in Enbse Sar Midir district their major criteria for selection ofbreeding doe were appearance, color and litter size with an index value of 0.37, 0.19 and0.17, respectively. Similar to this study Mahilet, (2012) indicated that appearance, age atsexual maturity and twining ability were considered as the first three

reasons for doe selection across all the study districts in Eastern Hararghe zone.The type of colors select by the goat owners were white and white with red colors together.In Ethiopia, goat coat color has a direct effect on goat marketing value. Due to cultural taboo, for instance, goat with full black coat color is not preferred for slaughtering for home meat consumption (Halima *et al*, 2012).

Table 19. Selection criteria for breeding doe in the study area

Selection Criteria	District											
	HuletEju Enesie				Goncha Siso Enesie				Enbse Sar Midir			
	R1	R2	R3	Index	R1	R2	R3	Index	R1	R2	R3	Index
Appearance	7	35	4	0.26	24	18	8	0.32	34	14	4	0.37
Pedigree	-	2	8	0.03	-	5	9	0.05	-	2	7	0.03
kidding interval	1	4	10	0.06	5	3	3	0.07	-	7	13	0.08
Age first kidding	1	-	5	0.02	4	-	3	0.04	-	3	5	0.03
litter size	36	4	3	0.33	12	12	7	0.19	16	1	11	0.17
Color	7	1	16	0.11	9	14	8	0.17	8	16	14	0.19
growth rate	8	14	14	0.19	6	8	23	0.16	2	17	6	0.13

R1, R2 and R3 = rank 1, 2 and 3, respectively. I= index

4.7. Goat Market and Age of Culling

The average market and culling age of goats are presented in Table 20. Culling is a common practice in livestock production and management program.This study revealed that buck and doe in both Hulet Eju Enesie and Goncha Siso Enesie were late in marketing age ($p<0.05$) than Enbse Sar Midir in both sexes, which might be due to the management system of respondents in these areas.In case of culling age of female goats, there was a significant difference ($p<0.05$)between districts. As the respondents indicated, the overall market ages of goats were 11.58±0.05 and 12.29±0.05 months for male and female goats, respectively.The result indicated that male goats reach market age earlier than female goats because of hormonal effect and male goats more aggressive than female goat during feeding competition. Culling in goat flock is suitable to increase performance goat in the study area. It helps to remove undesired animals and breed those closest to the desired ideal type (Girma and Alemu, 2008).

The overall, mean culling age for goats in the study area was 6.79±0.05 and 7.69±0.05 years for male and female goats, respectively. The result was significantly varied ($P<0.05$) among

the study areas with the lowest value recorded in Enebse SarMidir (6.48±0.07) years in male goats. Similarly, the lowest culling ages of female goats were recorded in Enebse SarMidir district. This result showed that male in the study area culled earlier than females.This might be due to the fact that farmers in the area sold males for different expenses like to purchasefertilizer and to educate their children. Female goats stay for breeding purpose and for increase their flock size. In this study area goat is the back bone of any expenditure.

Table 20.Mean market and culling age of goat in the study area

Parameter	District			Overall
	Hulet Eju Enesie	Goncha Siso Enesie	Enebse Sar Midir	
	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
Market age in month				
Male	11.98^{a}±0.09	11.80^{a}±0.10	10.96^{b}±0.05	11.58±0.05
Female	12.51^{a}±0.07	12.56^{a}±0.06	11.80^{b} ±0.08	12.29±0.05
Culling age in year				
Male	7.01 ^{a} ±.0.09	6.88 ^{a} ±0.10	6.48 ^{b} ±0.07	6.79±0.05
Female	8.13^{a}±0.09	7.68 ^{b} ±0.09	7.26^{c}±0.06	7.69±0.05

Means with the same letter within the same row and class are not significantly different at p (0.05);

SE= standard error

4.8. Purpose of Keeping Goat in the Study Areas

Purpose and ranking of goat keeping in the study area are summarized in Table 21.Rewe *et al*. (2006) mentioned that the knowledge of reasons for keeping animals is prerequisite for deriving operational breeding goals. This suggested that goats have high financial functions in the study area. Besides sale of goats are easy compared to larger animals. This makes them suitable commodity to mobilize in times of compelling and urgent financial needs. The study showed that goats were not milked in the study areas, because no respondents reported using goats for milk. This was similar with the report of FARM Africa (1996) goats were not milked in parts of Gojjam, Keffa and Wollega.

The primary reason for keeping goats for HuletEju Enesie district goat owners was for income source followed by meatconsumption and ceremonies in descending orderwithan index value of (0.49, 0.26 and 0.08), respectively.In case of Goncha Siso Enesie district the primary reason of keeping goat was income source followed by saving, meat consumption with ranking index of (0.46, 0.22and 0.16), respectively. In Enbse Sar Midirdistrict the primary

purpose of keeping goat was for incomefollowed by meat, and saving with an index value of (0.52, 0.23 and 0.12), respectively. Different studies in Ethiopia concerning goat production objectives indicated that cash income is the primary purpose of keeping goat production.Similar to this finding,Mahilet (2012) on Hararghe Highland goat, Belte ,(2013) in Bale zone in Rayitu district,Ahmed (2013) on Ethiopian indigenous goats in Horro Guduru Wollega zone, Tsigabu (2015)Gambela Regional State Western Lowland goat breeds and Diba (2017)in Odo Shakiso and Adola districtsreported that cash income was the first rank among different goat production objectives. In contrary to this finding the study of Tesfaye *et al.* (2011b) who reported that the main purpose of keeping goat was mainly for milk purpose in Adami tuluDistrict. This indicated that Ethiopian goats in the lowland are highly valued and reared mainlyfor milk and meat production.According to Tsigabu (2015) in the Gambela region in Nuer zone goat milk is believed to have medicinal value for children and contribute much more for the well-being of human baby due to selective browsing of goat.The present finding (ranking of meat as second purpose for goat rearing in Hulet Eju Enesie district) was in agreement with the report (Alubel, 2015) and (Yadeta, 2016).

Table 21.Purpose of keeping goat in the study area

Purpose of keeping goat	District											
	Hulet Eju Enesie				Goncha Siso Enesie				Enebse Sar Midir			
	R1	R2	R3	Index	R1	R2	R3	Index	R1	R2	R3	Index
Meat	3	36	13	0.26	4	14	17	0.16	2	28	22	0.23
Ceremony	-	10	9	0.08	1	2	15	0.06	2	8	7	0.08
Gift	-	2	5	0.03	-	1	3	0.01	-	-	3	0.01
Manure	-	5	10	0.06	1	8	9	0.08	1	0	13	0.04
Skin	-	3	2	0.02	-	-	-	0.0	-	-	-	0
Saving	-	1	21	0.06	2	30	12	0.22	-	14	14	0.12
Income	57	3	-	0.49	52	5	3	0.47	55	10	1	0.52
Milk	-	-	-	-	-	-	-	-	-	-	-	-

R1, R2 and R3 = rank 1, 2and 3, respectively. I= index

4.9. Castration Practices

Castration practice of goats in the study area is indicated in Table 22. Castration of goats is an important activity for successful production and management system. Majority of the respondents were practicing castration (74.4%) in the study area. But in contrary with this result, the study of Belete (2013) and Yadeta (2016) reported that majority of respondents

does not practiced castrations because of cultural influence and sold male animals in earlier time. Among the respondents who practiced castration about 70.1%, 14.9%and 9.7% castrate their goats for the purpose of improved fattening, for control breeding and better income, respectively. This wasin agreement with the study of Alefe(2014) reported that pastorals practice castration for the purpose of improved fattening and control breeding were the major reason castrate goats. Male goat of more than 1-2 year old (54.5%) were commonly castrated.this finding was concurrent with Diba (2017) most of the respondents age ofcastration of goat was 1-2 year (53%). This finding was disagreement with the report of Tegegne (2012) Goats were castrated commonly at age range of 6 months to 1 year in Cheta and Surma districts in south western part of Ethiopia.

The majority of respondents use traditional castration method to castrate their buck while, some of the farmers in the districts took their goats to a nearby veterinary clinic to use Burdizo. About 61.1% of the respondents were practicing traditional castration methods by using locally available materials like wood and stones (locally name *allelo*) while 9.9 % practiced modern castration methods by using Burdizo castrator, which is available at veterinary clinic. The result was comparable with the reports from Bati, Borena and Siti area of Amhara, Oromia and Somali regions, respectively (Hulunim, 2014), where more than 50% of the respondents castrates their bucks traditionally. In contrast to this, higher proportion (91%) of respondents had access to modern castration services in Ilu Abba Bora Zone (Dhaba *et al.,* 2012). According to the FGD respondents, the perception of intervention households to modern castration method was wrong by which means the respondents said that if one buck castrate in by veterinarians by using Burdizo do not stop mating of does then to castrate for the second time by traditional method.

Table 22: Castration practices of goats in the study area

Parameter	District						Over all	
	Hulet Eju Enesie		Goncha Siso Enesie		Enebse Sar Midir			
	N	%	N	%	N	%	N	%
Do you castrate								
Yes	52	86.7	43	71.7	39	65.0	134	74.4
No	8	13.3	17	28.3	21	35.0	46	25.6
X^2value								**7.76***
Castration reason								
Control breeding	3	5.8	8	18.6	9	23.1	20	14.9
Better fattening	39	75.0	29	67.4	26	66.7	94	70.1
Better temperament	4	7.7	2	4.7	1	2.6	7	5.2
Better income	6	11.5	4	9.3	3	7.7	13	9.7
X^2value								**6.84 NS**
Age of castration								
3-12month	14	26.9	11	25.6	8	20.5	33	24.6
1-2 years	30	57.7	19	44.2	24	61.5	73	54.5
>2 years	8	15.4	13	30.2	7	17.9	28	20.9
X^2value								**4.39 NS**
Castration method								
Modern	22	42.3	11	25.6	18	46.2	51	38.1
Traditional	30	57.7	32	74.4	21	53.8	83	61.9
X^2value								**4.32NS**

N=No of households;*significant difference at $p < 0.05$ and NS= non-significant x^2 = Pearson Chi-square

4.10. Fattening practice

Fattening practices in the study area is presented Table 23.About 72.8% of the respondents in the study area were practice fattening.In agreement with this result Bekalu (2014) in West Gojjam majority of the goat owners practiced fattening of goats (98.89%). In contrast to this finding, Alefe (2014) in shabele zone reported that most of the respondents did not practice fattening in all of the study districts. About 81.7% of the household in Hulet Eju Enesie was practicing fattening, which is greater ascompared to Goncha Siso Enesie (71.7) and Enbse SarMidir (65%). Respondent in the study area use natural pasture (71%) as main fattening feed. This result was similar with the report of Ahmed (2013)the major feed types used for fattening were natural pasture (grazing/browsing) in Horro GuduruWelega zone. Cereals, concentrates, and feedleft over were also served as animal feed for fattening. Respondents in the study areas practice fattening bothduring wet season (37.4%) and dry season (64.6%).

According to focus group dissection the most common periods of goat fattening in the study areatargets the Ethiopian New Year (September) and Easter (April).Majority of the respondents in the studyarea fatten their goats within 4-6month (48.1%) followed by 3-4 month (36.6%) and <3 month (10.7%). The duration of fattening also takes >6 month (4.6%). This result was in agreement with the report of Nigatu (2017) the most common duration of goat fattening in the study area was 3 to 4 months.According to the focus group discussion in the study area young females were not used for fattening purpose, because they used these animals for reproduction purpose instead of fattening.

Table 23. Fattening practices in the study area

Parameters	District						Over all	
	Hulet Eju Enesie		Goncha Siso Enesie		Enebse Sar Midir			
	N	%	N	%	N	%	N	%
Do you practice fattening								
Yes	49	81.7	43	71.7	39	65.0	131	72.8
No	11	18.3	17	28.3	21	35.0	49	27.2
X ^{2}value								**4.26^{Ns}**
Feed for fattening								
Natural pasture	37	75.5	33	76.7	23	59.0	93	71.0
Feedleft over	-	-	5	11.6	1	2.6	6	4.6
Cereals	10	20.4	2	4.7	9	23.1	21	16.0
Concentrates	2	4.1	3	7.0	6	15.4	11	8.4
X ^{2}value								**17.11***
Season of fattening								
Wet season	21	42.9	15	34.9	13	33.3	49	37.4
Dry season	28	57.1	28	65.1	26	66.7	82	62.6
X ^{2}value								**1.01 ^{Ns}**
Fattening duration								
<3month	1	2.0	4	9.3	9	23.1	14	10.7
3-4month	13	26.5	16	37.2	19	48.7	48	36.6
4-6month	33	67.3	21	48.8	9	23.1	63	48.1
>6month	2	4.1	2	4.7	2	5.1	6	4.6
X ^{2}value								**20.94***

N=No of households;*significant difference at $p < 0.05$ and NS= non-significant x^2 = Pearson Chi-square

4.11. Reproductive performance of Goats

The reproductive performance of goats in all districts as reported by the respondents issummarized in Table 24.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). The overall mean age of male goats at sexual maturity and female goats at first service in the study area was 7.26±0.06 and 7.53±0.06 months, respectively. However, for female goats at first service, there was significant ($p<0.05$) difference between Hulet Eju Enesieand Enbse Sar Midir districts. The current findings with respect to male and female sexual maturity lowerthan the results reported by Hulunim (2014) who reported of 8.21±0.28 months both male and female attain sexual maturity Bati area.

Age at first kidding (AFK) is an indication of the overall flock productivity. The overall average age of female goats at first kidding was 12.62±0.06 months. The present study was in line with 12.11 months reported for goats from Horro Guduru Welega Zone (Ahmed, 2013), but this result higher than 11.9 months reported for indigenous goats in Alaba district of southern Ethiopia (Deribe, 2009) and lower than 16.7 months reported for Lare and Jikawo districts of Gambella region, South-Western part of Ethiopia (Tsigabu, 2015).

The overall mean reproductive life time of female goat in the study area was 7.36±0.09 years. However, goats in Hulet Eju Enesie district had significantly ($p<0.05$) lower mean reproductive life time than goats in Goncha Siso Enesie and Enbse Sar Midir districts.

The litter size in goats was 1.60, 1.76 and 1.91 in Hulet Eju Enesie, Goncha Siso Enesieand EnbseSarMidir districts, respectively. The overall average number of kids that females give per kidding was 1.76.These findingwas similar with Ahmed (2013)the average litter size was (1.77) in Horro Guderu Welega zone.

In the study area, the average offspring per doe is about 11.05 per life span with kidding interval of 8.06 month. These results were lower than the reported,kidding interval for *Short-Eared Somali goats*in Siti area for which 8.81±0.18 months were reported by(Hulunim, 2014).

Table 24. Reproductive performance of goat in the study area

Reproductive Parameters	District			Overall
	Hulet Eju Enesie	Goncha Siso Enesie	Enebse Sar Midir	
	Means ±SE	Means ±SE	Means ±SE	Means ±SE
Age of males at sexual maturity(M)	7.5^{a} ±0.09	7.1^{ab}±0.10	7.1^{b}±0.12	7.2±0.06
Age of females at first service(M)	7.7^{a}±0.14	7.5^{ab}±0.89	7.3^{b}±0.11	7.5±0.06
Age at first kidding(M)	12.8^{a} ±0.14	12.5^{ab}±0.09	12.4^{b} ±0.10	12.6±0.06
Reproductive Life time doe(Y)	6.8^{b}±0.11	7.6^{a}±0.16	7.6^{a}±0.20	7.3±0.09
Average number of kids per Kidding (M)	1.6^{b}±0.07	1.7^{ab}±0.09	1.9^{a} ±0.07	1.7±0.04
Average number of kids Per lifetime (M)	10.5^{b}±0.27	10.8^{ab}±0.24	11.7^{a} ±0.20	11.0±0.14
Kidding interval (M)	8.4^{a}±0.10	8.3^{a} ±0.10	7.4^{b}±0.11	8.0±0.06

SD=Standard Error M=months Y=years

4.12. Effective Population Size and Level of Inbreeding

The effective population size (Ne) and the rate of inbreeding (F) calculated for goat flock inthe study area are presented in Table 25. Effective population size is a measure of genetic variability within a population with large values of Ne indicating more variability and small values indicating less genetic variability (Maiwashe *et al.*, 2006).When flocks were not mixed (Separate herding)in this study, the estimates of Ne were 2.17, 2.06 and 1.31 for Hulet Eju Enesie, Goncha Siso Enesieand Enbse Sar Midir, respectively. The inbreeding coefficient (F)was computed as 0.23, 0.24and 0.38 for Hulet Eju Enesie, Goncha Siso Enesie and Enbse Sar Midir districts, respectively. Similarly, when flocks were mixed (Mixed herding) in this study, the estimates of Ne were 3.59, 2.49 and 2.11 for Hulet Eju Enesie, Goncha Siso Enesie and Enbse Sar Midir, respectively. The inbreeding coefficient (F)was computed as 0.13, 0.20 and 0.23forHulet Eju Enesie, Goncha Siso Enesie and Enbse Sar Midir districts respectively, in mixed flocks in the present study area.The averagerate of inbreeding coefficient (F)in all districts goat flock of a household was not mixed and goat flock of a household was mixed 0.28 and 0.19, respectively. These values were higher thanthe maximum acceptable level of 0.063 (Armstrong, 2006). Therefore, mixing goatflocks is recommended for separate herding and increase the number of breeding buck for mixed herding respondents in this study to decrease therate of inbreeding by increasing the effective population size.

Table 25: Effective population size and level of inbreeding in the study area

District	When flocks are not mixed				When flocks are mixed			
	Nm	Nf	Ne	ΔF	Nm	Nf	Ne	ΔF
Hulet Eju Enesie	0.67	2.93	2.17	0.23	0.60	4.36	3.59	0.13
Goncha Siso Enesie	0.57	5.29	2.06	0.24	0.72	4.66	2.49	0.20
Enbse Sar Midir	0.35	5.00	1.31	0.38	0.98	11.02	2.11	0.23
Overall mean	0.53	4.41	1.41	0.28	0.76	6.68	2.73	0.19

Ne = effective population size; F = coefficient of inbreeding; Nm = Number of male; NF = Number of female

4.13. Major Constraints of Goat Production in the Study Area

The major constraints of goat production in study area are presented in Table 26.In any production system before starting any genetic improvement program it is basic to identify the constraints that affect the productivity of goat in the study area. There are a lot of constraints happened due to the occurred drought and change the climate condition of the environment and also most respondents do not manage their goats in a modern way it is difficult because they have subsistence life.

Disease was the main problemin all studied district with an index value of 0.38, 0.29 and 0.36 for Hulet Eju Enesie, Goncha Siso Enesie and Enbse Sar Midir districts, respectively.This might be due to goat herd together is the main factor to increases the occurrence of disease because in day time majority of the respondents herd together due to this reason transmission of disease infected goat to healthy goat, occurrence of drought, absence enough feed and water in the district.In Hulet Eju Enesie and Enbse Sar Midir district, predator ranks 2nd with an index value of 0.24 and 0.25, respectively.But, in Goncha Siso Enesie district, feed shortage took the 2nd rank with an index value (0.26). The present study was in agreement with the study of Belete (2013) who reported that disease, predators and feed shortage were the serious problem in Sawenadistrict. The report of Arse *et al*. (2013) also reported that severe feed shortage, high disease prevalence and predators were the main serious problems in Adami tulu, Arsi Nagelle and Fentale districts. Moreover, consistent with the current study, high prevalence of disease was the most important factors limiting goat production in Metema and Abergelle districts of the Amhara Region (Solomon, 2014). Low

genetic potential of the breed was ranked lowly in all studied areas. This mightbe due to lack of awareness of goat owners about good gene.

Table 26. Major constraints of goat's production in the study area

Constraints	District											
	Hulet Eju Enesie				Goncha Siso Enesie				Enebse Sar Midir			
	R1	R2	R3	Index	R1	R2	R3	Index	R1	R2	R3	Index
poor veterinary service	2	1	4	0.03	1	2	1	0.02	0	1	7	0.03
Disease	36	10	8	0.38	21	17	6	0.29	40	0	8	0.36
lack of feed	0	21	15	0.16	18	16	8	0.26	0	7	16	0.08
Drought	0	3	15	0.06	5	3	14	0.10	3	4	2	0.05
lack of superior genes	0	6	4	0.04	2	2	2	0.03	0	8	0	0.04
Predator	16	15	7	0.24	13	1	20	0.17	6	29	14	0.25
Labor	6	1	2	0.06	0	1	1	0.01	0	5	1	0.03
lack of water	0	3	5	0.03	0	18	8	0.12	11	6	12	0.16

R1, R2 and R3 = rank 1, 2and 3, respectively. I= index

4.14. Major goat diseases in the study area

The major goat diseases in the study area are presented in Table 27.Diseases are a major constraint to the improvement of livestock industry in the tropics as they decrease production and increase mortality (Mwacharo, 2005).Diseases have numerous negative impacts on productivity of herds (Solomon, 2007).

Respondents reported that diseases affect all age groups of goats. Respondents in the study area were able to identify the types of diseases affecting their animals by recognizing the common symptoms through experience from the description of symptoms.The overall list of diseases occurred frequently in the study area as reported by farmers were Diarrhoe, pneumonia, Anthrax, Pasteurollosis, Foot and Mouth Disease, Brucellosis and Fasciollosis. The prevalence of disease was more or less different in the study districts. In Hulet Eju Enesie district, pasteurollosis, Fasciollosis and Anthrax were ranked 1st, 2nd and 3rd while in Goncha Siso Enesiedistrict, sheep pox was the common diseases followed by both Anthraxand Fasciollosis. In Enbse Sar Midir district, sheep pox was the main problem followed by Anthrax and pasteurollosis.Similar to this finding Sheep pox and anthrax were the most

affecting diseases of goat production in West Gojjam (Bekalu, 2014). In other similar study, in Metema woreda pasteurollosis was the most commonly affecting diseases of goats and causing most losses (Tesfaye, 2009).According to the respondents, vaccination services are available. However the vaccine was given for goats after they are affected by the disease, it has no value.

Table 27. List of common diseases in the study area as reported by respondents

Type of Disease		Districts											
		Hulet Eju Enesie				Goncha Siso Enesie				Enebse Sar Midir			
Common name	Local names	R1	R2	R3	Index	R1	R 2	R3	Index	R1	R2	R 3	Index
FMD	*Afemaze*	-	5	5	0.04	-	4	5	0.04	2	1	3	0.03
Sheep Pox	*Agureberebe*	4	2	2	0.05	33	14	9	0.38	27	13	13	0.33
Diarrhea	*Tekimat*	3	5	13	0.09	1	2	5	0.03	6	8	5	0.11
Pastrolosise	*Adifik*	31	11	6	0.34	0	7	6	0.06	3	12	9	0.12
Pneumonia	*Yesanba mich*	-	4	4	0.03	3	1	11	0.06	1	1	4	0.03
Fasciollosis	*Berere*	12	16	10	0.22	11	7	6	0.15	1	10	10	0.09
Brucellosis	*Wurja*	1	4	5	0.04	0	10	6	0.07	-	2	5	0.03
Anthrax	*Mantie*	9	13	15	0.19	12	15	12	0.22	20	13	11	0.27

R1, R2 and R3 = rank 1, 2and 3, respectively. I= index FMD=foot and mouth dissese

4.15. Accesses and distance to the nearest veterinary service in the study area

Veterinary accesses and distance to the nearest veterinary services as reported by respondents in Table 28. The respondents used government veterinary services to treat sick animals in order to get drugs with minimum price. This finding was in agreement with Yadeta of (2016) In Ada Barga and Ejere Districts of West Shoa Zone, oromia region that government veterinary clinics one of the main sources of modern treatment of sick goat.Some farmers in the study area reported that they sometimes use traditional treatments (just dipping them in a river) andbleeding around back leg affected goat. This practice is not supported by science rather they take rapid treatment of the affected goat. Discussion with all districts veterinarians revealed that the facilities and supply of vaccination from government is not good enough to eradicate disease occurrence. The majority (75.0%) of goat owners in the study area were having access to government veterinary services by traveling up to 10 km, (30.6%) of respondents were to travel 1 to 5km to get veterinary service and the highest number of respondents (51.1%) of the goat owners were travelling 6 up to 10 km. In contrast to this study Wossenie (2012) indicated that the majority (66.1%) of the respondents in Metta,

Gorogutu and Deder districts were forced to walk from one up to five kilometers to reach the nearest government veterinary service.

Table 28.Veterinary accesses and distance to the nearest veterinary services

Veterinary accesses	Districts						Overall	
	Hulet Eju Enesie		Goncha Siso Enesie		Enbse Sar Midir			
	N	%	N	%	N	%	N	%
Government veterinary clinic	39	65.0	49	81.7	47	78.3	135	75.0
private veterinary clinic	8	13.3	2	3.3	4	6.7	14	7.8
Both	13	21.7	9	15.0	9	15.0	31	17.2
X ^{2}value								**6.27^{NS}**
distance to veterinary services								
<1 km	5	8.3	13	21.7	15	25.0	33	18.3
1-5 km	22	36.7	20	33.3	13	21.7	55	30.6
6-10 km	33	55.0	27	45.0	32	53.4	92	51.1
X ^{2}value								**8.20^{NS}**

N=No of households; NS= non-significant and x^2 = Pearson Chi-square

4.16. Phenotypic Characterization of Indigenous Goats

4.16. 1 Qualitative traits

Qualitative traits of indigenous goat population in the study area are presented in Table 29. The most dominant coat color patterns observed in the study area were 53.2% plain, 16.8% spotted and 30.0% were patchy coat color. This result is in agreement with FARM-AFRICA (1996) reported that the predominant coat color pattern plain (51%).

In the study area, the main dominant coat color types were Light red (25.3%). The current variation in coat color type of indigenous goat type found in the study area was different from the previous findings of FARM-Africa (1996), who reported the coat color type of western high land breed as white (42%). similar to this finding , in Abergelle goat red dominant coat color was observed, which accounted for 30.98% (Alubel, 2015) and followed by red with white (21.3%) , white (22.2%), dark red (9.5%), brown (5.7%), black with white (5.5%), grey (5%), black (3.5%) and black and red (2.0%) coat color type were observed in the study area .

In all study areas majority of the goat populations had no skin pigmentation (95.8%).Smooth hair coat type was predominant in the study area, which accounted for 71.3%, whereas, glossy hair coat type were 28.7% of the sampled goat population. Majority of the sample goat population had short hair length (77.0%).

About the overall goat in all study area (95%) of goats in the study area had horn, In contrast to this in Gurawa district incidence of polled goat was higher than horned one (Mahilet, 2012). Straight horn shape was the most frequently observed in the study area (51.1%), curved (31.9%), lyre/u shaped (11.2%) and spiral (5.8%). According to Belay and Meseretu (2017) the goat population in Gamo Goffa zone having straight horn shape (78.09%) was higher than the current result. The overall hornorientation from the sample goat population were observed back ward (86.1%) and upward (13.9%).The most dominant ear form was carried horizontal (76.0%) followed by dropped (13.0%) and lateral (11.0%) were observed in the study area. In contrast to this finding Hulunim (2014) reported the majority of Bati and Borena goats were characterized by lateral/sideway ear orientation accounting a total of 59.9 and 78.9%, respectively.

The overall sample population had straight head profile (72.0%), concave (21.8%) and slightly concaves (6.2%), this is difference with FARM-Africa (1996) reported, as a concave facial profile (100%)in Western Highland goat. The present finding similar with the report of Yaekob (2015) in woyto Guji goat (80.6%) have straight head profile.

Majority of goats in the study area do not have toggles (80.2%) and beard (76.8%). About (71.3%) of the goat in the study area has no ruff.In the study area 68.0% of sampled goats had straight back profile. Sloping rump profiles of goat types were frequently observed with 96.2%, whereas Flat rump profile was observed only in 3.8% of the sampled goat population.

The chi-square test of categorical variables in Hulet Eju Enesie , Goncha Siso Enesie and Enbse Sar Midir sample goats population indicated that among the variables considered in this study coat color pattern, coat color type, horn shape, hair length , back profile , skin pigmentation, toggle and ruff were showed significantly difference($P<0.05$). The most observed coat color pattern in all the study districts was plain/uniform (52.5% in Hulet Eju

Enesie, 55.5% in Goncha Siso Enesie and 48.0% in Enbse Sar Midir). The highest plain coat color pattern were recorded in Goncha Siso Enesie and lowest recorded in Enbse Sar MidirOn the other hand, Patchy coat color pattern was frequently observed in Enbse Sar Midir (36.0%) and Goncha Siso Enesie (35.6%) district than in Hulet Eju Enesie district (31.1%).

The dominant coat color types in Hulet Eju Enesie district were white (42.0%) and red and white (14.0%) whereas in Goncha Siso Enesie district, the dominant coat color types were light Red (33%) and Red +white (22%). In Enbse SarMidir district, light red (33%) and red +white (28.0%) were frequently occurred coat color types.

In Enbse Sar Midir district highest number of goat had short hair length (85.5%) than Goncha Siso Ense 974.0%) and Enbse Sar Midir(71.1%) district.

In Enbse Sar Midir higher pigmented than Hulet Eju Enesie and Goncha Siso Enesie.The highest proportion of goat populations had horn inGoncha Siso Enesie 99% than Hulet Eju Enesie(93.9%)and EnbseSar Midir (97.8%).In Hulet Eju Enesie, 53.3% of goats had straighthorn shapeand also in Goncha Siso Enesie straight horn shape but in Enbse Sar Midir distinctcurved horn shape was (50.55%).

The presence of Ruff higher in Hulet Eju Enesie (34.5%) than in Goncha Siso Enesie (30.5%) and in Enbse Sar Midir (21%). In Hulet Eju Enesie (22.2%) higher in toggle presence than Goncha Siso Enesie (15.3%) and Enbse SarMidir (15.55%).

Table 29.Qualitative traits of goats in the study area by sex and district

Qualitative Trait	Districts									Overall N (%)
	Hulet Eju Enesie			Goncha Siso Enesie			Enebse Sar Midir			
	Female	Male	Total	female	Male	Total	female	Male	Total	
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	
Coat color pattern										
Plain	94(52.2)	11(55.0)	105(52.5)	101(56.1)	10(50)	111(55.5)	85(47.2)	11(55)	96(48.0)	319(53.2)
Patchy	49(27.2)	4(20.0)	53(26.5)	56(31.10)	6(30.0)	62(31.0)	64(35.6)	8(40.0)	72(36.0)	180(30.0)
Spotted	37(20.6)	5(25.0)	42(21.0)	23(12.8)	4(20.)	27(13.5)	31(17.2)	1(5.0)	32(16)	101(16.8)
X^2value										**10.71***
Coat color type										
White	74(41.1)	10(50)	84(42.0)	25(13.9)	2(10.)	27(13.5)	12(6.7)	10(50.0)	22(11.0)	133(22.2)
Black	8(4.4)	1(5.0)	9(4.5)	5(2.80	-	5(2.50)	6(3.3)	1(5.0)	7(3.5)	21(3.5)
Brown	10(5.60)	-	10(95.0)	18(10.00	-	18(9.0)	6(3.3)	-	6(3)	34(5.7)
Grey	12(6.7)	2(10.0)	14(7.0)	5(2.8)	1(5.0)	6(3.0)	9(5.0)	1(5.0)	10(5)	30(5)
Dark red	18(10.0)	1(5.0)	19(9.50)	17(9.40)	3(15)	20(10)	17(9.40)	1(5.0)	18(9.0)	57(9.5)
Light red	19(10.6)	1(5.0)	20(10)	58(32.20)	8(40)	66(33)	63(35.0)	3(15.0)	66(33.0)	152(25.3)
Red +white	25(13.9)	3(15.0)	28(14)	38(21.1)	6(30.0)	44(22.00)	52(28.9)	4(20.0)	56(28.0)	128(21.3)
Black +white	10(5.6)	1(5.0)	11(5.5)	10(95.60)	-	10(5.00)	12(6.7)	-	12(6)	33(5.5)
black + red	4(2.2)	-	5(2.5)	4(2.20)	-	4(2)	3(1.7)	-	3(1.5)	12(2.0)
X^2value										**102.32***

Table 29 (continued)

Skin color										
Pigmented	5(2.8)	2(10.0)	7(3.5)	2(1.1)	2(10.0)	4(2.0)	12(6.7)	2(10.0)	14(7.0)	25(4.2)
Not pigmented	175(97.2)	18(90.0)	193(96.5)	178(98.9)	18(90)	196(98.0)	168(93.3)	18(90.0)	186(93.0)	575(95.8)
X^2value										**6.59***
Hair coat type										
Smooth hair	49(27.2)	12(60.0)	143(71.5)	53(29.4)	4(20.0)	143(71.5)	50(27.8)	8(40.0)	142(71.0)	428(71.3)
Glossy	131(72.8)	8(40.0)	57(28.5)	127(70.6)	16(80.)	57(28.5)	130(72.2)	12(60.0)	58(29.0)	172(28.7)
X ^{2}value										**0.16^{NS}**
Hair length										
Short	131(72.8)	12(60.0)	143(71.5)	137(71.1)	11(55.0)	148(74.0)	154(85.6)	17(85.0)	171(85.5)	462(77.0)
Medium	38(21.1)	4(20.0)	42(21.)	33(18.3)	6(30.0)	39(19.5)	21(11.7)	1(5.0)	22(11.0)	103(17.2)
Long	11(6.1)	4(20.0)	15(7.5)	10(5.6)	3(15)	13(6.5)	5(2.8)	2(10.0)	7(3.5)	35(5.8)
X ^{2}value										**12.64***
Horn										
Present	168(93.3)	19(95.0)	187(93.5)	169(93.9)	18(90)	187(93.5)	20(100)	196(97.8)	116(98.9)	570(95)
Absent	12(6.7)	1(5.0)	13(6.5)	11(6.1)	2(10)	13(6.5)	-	4(2.2)	4(2.2)	30(5)
X ^{2}value										**5.68^{NS}**
Horn shape										
Curved	40(23.7)	5(26.3)	45(25)	34(20.0)	4(22.2)	38(21.1)	89(51.1)	10(50.0)	99(50.55)	182(31.9)
Spiral	6(4.1)	1(5.3)	7(6,75)	6(4.1)	-	6(4.1)	4(2.3)	4(20.0)	8(11.15)	33(5.8)
Straight	100(59.2)	12(63.2)	112(61.2)	97(57.1)	9(50.0)	106(53.55)	67(38.5)	6(30.0)	73(34.25)	291(51.1)
lyre/u shaped	22(13.0)	1(5.3)	23(9.15	32(18.8)	5(27)	37(21.4)	14(8.0)	-	14(4.05)	64(11.2)
X ^{2}value										**77.46***

Table 29 (continued)

Horn orientation										
Back ward	148(82.2)	17(85.0)	165(82.5)	154(85.6)	17(85.0)	171(85.5)	170(94.4)	19(95.0)	189(94.5)	491(86.1)
Upward	13(7.2)	1(5.0)	14(7)	16(8.9)	1(5.0)	17(8.5)	-	-	-	79(13.9)
X ^{2}value										**1.19^{NS}**
Ear orientation										
Dropping	21(11.7)	3(15.0)	24(12)	28(15.6)	4(20)	32(16)	18(10.0)	4(20.0)	22(11)	78(13.0)
Lateral	26(14.4)	4(20.0)	30(15)	26(14.4)	1(5)	27(13.5)	7(3.9)	2(10.0)	9(4.5)	66(11.0)
Carried horizontal	133(73.9)	13(65.0)	146(73)	126(70)	15(75)	141(70.5)	155(86.1)	14(70.0)	169(84.5)	456(76.0)
X ^{2}value										**16.81***
Facial profile										
Straight	135(75.0)	16(80.0)	151(75.5)	130(72.2)	12(60.0)	142(71)	124(68.9)	15(75.0)	139(69.5)	432(72.0)
Concave	29(16.1)	4(20.0)	33(16.5)	40(22.2)	5(25.0)	45(22.5)	48(26.7)	5(25.0)	53(26.5)	131(21.8)
slightly concave	16(8.9)	-	16(8)	10(5.6)	3(15.0)	13(6.5)	8(4.4)	-	8(4)	37(6.2)
Convex	-	-	-	-	-	-	-	-	-	
X ^{2}value										**7.8^{NS}**
Beard										
Present	44(24.4)	7(35.0)	51(25.5)	35(19.4)	5(25.0)	40(20)	42)23.3)	6(30.0)	48(24)	139(23.2)
Absent	136(75.6)	13(65.0)	149(74.5)	145(80.6)	15(75.0)	160(80)	138(76.7)	14(70.0)	152(76)	461(76.8)
X ^{2}value										**1.81^{NS}**
Ruff										
Present	59(32.8)	10(50.0)	69(34.5)	57(31.7)	16(80.0)	61(30.5)	38(21.1)	4(20.0)	42(21)	172(28.7)
Absent	121(67.2)	10(50.0)	131(65.5)	123(68.3)	4(20.0)	139(69.5)	142(78.9)	16(80.0)	158(79.0)	428(71.3)
X ^{2}value										**9.40***

Table 29 (continued)

Back profile										
Slops up to rump	55(30.6)	6(30.0)	61(30.5)	76(42.2)	9(45.0)	85(42.5)	39(21.7)	2(10.0)	41(20.5)	187(31.2)
Straight	125(69.4)	14(70.0)	139(69.5)	102(56.7)	10(50.0)	112(56)	139(77.2)	18(90.0)	157(78.5)	408(68.0)
Slops up to the wither	-	-	-	2(1.1)	1(5.0)	3(1.5)	2(1.1)	-	2(1)	5(0.8)
X ^{2}value										**25.91***
Rump profile										
Sloping	173(96.1)	17(85.0)	190(95)	172(95.6)	18(90)	190(95)	177(98.3)	20(100)	197(98.5)	577(96.2)
Flat	7(3.90	3(15)	10(5)	8(4.4)	2(10)	10(5)	3(1.7)	-	3(1.5)	23(3.8)
X^{2}value										**4.43^{NS}**
Wattle										
Present	14(7.8)	2(10)	16(8)	22(12.2)	3(15.0)	25(12.5)	17(9.40)	4(20.00)	21(10.5)	62(10.3)
Absent	166(92.2)	18(90)	184(92)	158(88.8)	17(85)	175(87.50	163(90.6)	16(80.0)	179(89.5)	538(89.7)
X^{2}value										**2.19$^{N S}$**
Toggle										
Present	53(29.4)	3(15.0)	56(22.2)	37(20.6)	2(10)	39(15.3)	20(11.1)	4(20)	24(15.55)	119(19.8)
Absent	127(70.6)	17(85)	144(77.8)	143(79.4)	18(90)	161(84.7)	160(88.9)	16(80)	176(84.45)	481(80.2)
X^{2}value										**16.12***

N = Number of goat exhibiting a particular qualitative character; X^2 = Pearson chi-square;;*significant difference at $p < 0.05$;NS = Non-Significant

Figure 4. Adult indigenous breeding doe (left) and Buck (right) in Hulet Eju Enesie district

Figure 5. Adult indigenous breeding doe (left) and buck (right) in Goncha Siso Enesie district

Figure 6 Adult indigenous breeding doe (left) and buck (right) in Enbse Sar Midir district

4.16. 2. Quantitative traits of indigenous goats

Body weight and liner body measurements are the most important characters, which help to identify the breeds of goat population. The body weight and linear body measurements of indigenous goat in the study area are presented in Table 30.

In the study area overall mean of body weight, Body length, chest girth, height at wither ,pelvic width, rump height, rump length, rump width, head Length, ear length, horn length, chest depth, canone bone circumference, canone bone length and scrotum circumference were 29.05 kg, 61.94 cm, 72.16 cm, 66.77 cm, 9.30 cm, 68.89cm, 14.62 cm,15.64cm, 14.45 cm, 14.33cm, 10.57cm, 29.28 cm , 8.46cm, 12.29cm, and 22.73 cm, respectively. The Result was comparable with Ahmed (2013); Bekalu, (2014) and Diba (2017) indicates that the Average body weight, body length, chest girth, height at withers and ear length were 28.7 kg, 56.9 cm, 70.8 cm, 67.2 cm and 14.9 cm for western highland goat in Horro Gudru Welega, 28.03 kg, 60.19cm, 74.87cm, 64.51 cm,and 13.89cm for western highland goat in west gojjam, 29.7kg, 63.2cm, 73.4cm, 67.3and 17 cm for Woyito Guji goat in Guji zone oromia region, respectively.

Location effect: Location had significant difference ($P<0.05$) for all quantitative traits except horn length and canone bone circumference.Lower values were observed in alllinear body measurements for Hulet Eju Enesie compared to Enbse Sar Midir and Goncha Siso Enesie districts except scrotum circumference and horn length Table 30. The results of this study revealed that body weight was higher for Enbse Sar Midir (31.15BW)than Hulet Eju Enesie (27.67BW) and Goncha Siso Enesie (29.67BW)districts. This might be explained by different factors such as nutrition, shortage of grazing areas in the site could be implicated, farming system is depend on extensive grazing without supplementation, the incidence of disease, the size and productivity of the grazing land can be taken as the main factors affecting livestock productivity in the study area.Similar to this finding differences in genetic makeup of the animal, availability of feed resource base (in terms of quantity and quality), availability of natural grazing field and the management conditions the animals (Cam *et al.*, 2010).

The effect of Sex: sex is an important source of variation for live body weight and linear body measurements at all age groups. In all three districts sex had significant effect (P<0.05) on body weight, body length, chest girth, height at wither, rump height, cannon bone circumference, head length, cannon bone length, horn length and pelvic width, whereas chest depth, ear length, rump length and rump width were not affected by sex.Male goats were having higher values than femalesthe sex related differences might be partly a function of the sex differential hormonal effect on growth. In addition to that, the differentials obtained in the morphological traits of the sexes could be attributed to sexual dimorphism (Semakula, 2010). They also suggested that males might have a longer season of mass gain each year throughout their lives, while females divert annual resources into reproduction, rather than body mass.

Age effect: -All body measurements were increased as age group increase from 1PPI to ≥4PPI. In the current study body weight (BW) had significant difference(P<0.05) in all age (dentition) groups and the same was true for all linear body measurements. The body weight of goats at ≥4PPI was 33.49±0.43 kg, which is lower than 36.4±0.8 kg reported for indigenous goats in Horro Guduru Wollega (Ahmed, 2013). The linear body measurements increased as animal advances with age (1PPI to ≥4PPI). Increased with increase in dentition class up to the four Dentition and then after it starts to decline or remains as it is. The size and shape of the animal increases until the animal reaches its optimum growth point or until maturity (Yoseph, 2007).

The interaction effect of Sex and age: - The interaction of sex and age group was significant (p<0.05) for body weight, Body length, chest girth, rumpwidth, pelvic width and rumpheight, wither height. The interaction effect Sex and agesignificantly difference (p>0.05) were not observed in ear length, rump length, chest depth, canone bone circumference, head length, canone bone length and horn length.In contrary to this, Alefe (2014) reported that the interaction of sex and age group was significant difference (p<0.05) all liner body measurements. In each age group males were having higher values. The value of body weight for female goat in age group 1PPI, 2PPI, 3PPI and > 4PPI were kg, 23.11 kg, 26.51 kg, 29.85 kg and 32.06 kg, respectively and the values for males in the same age groups were 26.88 kg, 29.25 kg, 31.00 kg and 35.00 kg, respectively. 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. This finding was in agreement with short eared Somali goats and Hararghe Highland goats, where values for male goats were found greater than their female counter parts in all age group and all measurements (Grum, 2010; Mahilet, 2012).but in contrast with the report of Alade *et al*. (2008); Sowande *et al*. (2009); Samakula*et al*. (2010); and Okbeku *et al*. (2011) were female have higher body weight and other body measurements than male counterpart.

Table 30. (Least square mean ± SE) body weight (kg) and other linear body measurements by sex, age and location.

Effect level	CG	BL	WH	RH	CD	EL	RL
	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE
Overall	72.16±0.24	61.94±0.24	66.77 ±0.22	68.89±0.20	29.28±0.12	14.33±0.06	14.62±0.09
CV%	6.48	7.23	6.46	5.98	8.70	10.45	11.32
R^2	0.40	0.42	0.37	0.35	0.31	0.23	0.50
Sex	*	*	*	*	NS	NS	NS
Male	73.84^{a}± 0.62	63.10^{a}±0.59	68.39^{a}±0.57	70.23^{a} ± 0.54	29.96±0.33	14.18± 0.19	14.81±0.24
Female	70.91^{b}± 0.23	60.82^{b}±0.22	65.84^{b}±0.21	68.07^{b} ± 0.20	28.86±0.12	14.19 ± 0.07	14.25±0.09
Age	*	*	*	*	*	*	*
1PPI	68.31^{c}± 0.43	57.97^{c}± 0.41	63.31^{c}±0.40	65.50^{c}±0.38	27.29^{b}±0.23	13.29^{c}± 0.14	12.37^{c}±0.17
2PPI	70.38^{bc}±0.57	60.01^{bc}±0.54	65.80^{bc}±0.53	67.91^{bc}±0.50	28.90^{a}±0.31	13.89^{bc}± 0.18	13.89^{bc}±0.22
3PPI	74.11^{ab}±0.64	63.79^{b}±0.61	68.85^{b}±0.59	70.89^{ab}±0.56	30.36^{a}±0.35	14.58^{b}± 0.20	15.60^{b}±0.25
4PPI	76.68^{a}±0.38	66.06^{a}±0.36	70.50^{a}±0.35	72.29^{a}±0.33	31.10^{a}±0.20	14.95^{a}± 0.12	16.26^{a}±0.15
Location	*	*	*	*	*	*	*
Hulet Eju Enesie	71.68^{b}±0.44	60.51^{c}± 0.42	66.02^{c}±0.40	68.40^{c}±0.38	29.11^{b}±0.24	13.88^{b} ± 0.14	14.30^{b}±0.17
Goncha Siso Enesie	71.95^{b}± 0.43	62.35^{b}±0.41	67.40^{b}±0.40	69.24^{b}±0.38	29.08^{b}±0.23	14.01^{b} ± 0.13	14.34^{b}±0.17
Enebse Sar Midir	73.49$^{a\pm}$ 0.43	63.01^{a}± 0.41	67.92^{a}±0.40	69.80^{a}±0.39	30.05^{a}±0.23	14.65^{a} ± 0.14	14.95^{a}±0.17

Table 30 (continued)

Sex by age	*	*	*	*	NS	NS	NS
Female,1PPI	66.49^{c}±0.42	56.29^{c}±0.40	61.78^{d}±0.38	64.25^{c}±0.36	26.60±0.22	13.29±0.13	12.09±0.17
Female,2PPI	70.11^{bc}±0.93	59.73^{bc}±0.90	64.30^{cd}±0.86	66.30^{bc}±0.81	27.80±0.50	13.97±0.15	13.65±0.19
Female,3PPI	68.95^{c}±0.51	59.00^{bc}±0.49	64.67^{cd}±0.47	66.96^{bc}±0.44	28.41±0.27	14.67±0.19	15.33±0.24
Female,4PPI	72.50^{abc}±2.37	60.50^{abc}±2.29	65.50^{abcd}±2.19	67.25^{bc}±2.07	28.75±1.29	14.85±0.08	15.98±0.11
Male,1PPI	72.64^{bc}±0.62	62.89^{ab}±0.60	67.73^{abc}±0.58	69.89^{b}±0.55	29.91±0.34	12.74±0.29	12.91±0.37
Male,2PPI	75.66^{ab}±1.93	63.00^{b}±1.87	68.83±1^{abc}.79	71.23^{ab}±1.69	30.00 ±1.05	13.08±0.76	13.73±0.96
Male,3PPI	75.37^{a}±0.28	65.09^{a}±0.27	69.27^{b}±0.26	71.33^{b}±0.25	30.58 ±0.15	3.79 ±0.60	15.66±0.75
Male,4PPI	77.66^{a}±0.96	67.12 ^{a}±0.93	72.66^{a}±0.89	74.12^{a}±0.84	32.04±0.52	16.03±0.30	16.52±0.38

Table 30 (continued)

Effect level	PW	HOL	CBL	CBC	RW	HL	BW	Sc
	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE
Overall	9.30±0.07	10.57±0.16	12.29±0.06	8.46±0.04	15.64±0.08	14.45±0.07	29.05±0.27	22.73±0.30
CV%	16.17	31.29	11.88	11.68	12.06	11.53	18.08	5.97
R2	0.31	0.13	0.28	0.18	0.22	0.23	0.37	0.43
Sex	*	*	*	*	NS	*	*	
Male	10.68^{a}±0.20	11.14^{a}±0.45	12.88^{a}±0.19	9.48^{a} ±0.13	15.71±0.25	15.46^{a}±0.22	31.10^{a}±0.69	22.73±0.30
Female	8.97^{b}±0.07	9.97^{b}±0.16	12.11^{b}±0.07	8.27^{b} ±0.04	15.32±0.09	14.19^{b}±0.08	27.89^{b}±0.26	NA
Age	*	*	*	*	*	*	*	*
1PPI	8.78^{b} ±0.14	9.37^{c}± 0.32	11.31^{b}±0.13	8.46^{b}±0.09	14.51^{b}±0.17	13.70^{c}±0.15	25.28^{c}±0.49	21.45^{c}±0.27
2PPI	9.67^{b}±0.18	9.95^{bc}±0.41	12.66^{a}±0.17	8.83^{ab}±0.12	15.25^{ab}±0.23	14.62^{bc}±0.20	27.97^{bc}±0.64	22.50^{bc}±0.70
3PPI	10.18^{b}±0.20	10.68^{b}±0.46	12.80^{a}±0.20	8.99^{ab}±0.13	15.62^{a}±0.26	15.38^{ab}±0.22	31.23^{b}±0.72	22.94^{ab}±0.55
4PPI	10.67^{a}±0.12	12.22^{a}±0.27	13.20^{a}±0.12	9.22^{a}±0.08	16.68^{a}±0.15	15.65^{a}±0.13	33.49^{a}±0.43	24.10^{a}±0.28
Location	*	NS	*	NS	*	*	*	*
Hulet Eju Enesie	9.39^{c}± 0.14	10.60±0.31	11.98^{b} ±0.13	8.82±0.09	15.11^{c} ±0.17	14.55^{c}±0.15	27.67^{c}±0.49	23.33^{a}±0.37
Goncha Siso Enesie	9.83^{b}± 0.14	10.32 ±0.31	12.89^{a}±0.13	8.89±0.09	15.56^{b} ±0.17	14.84^{b}±0.15	29.67^{b}±0.48	22.21^{b}±0.32
Enbse Sar Midir	10.25^{a}±0.14	10.72±0.31	12.62^{a}±0.13	8.91±0.09	15.86^{a} ±0.17	15.0^{a}±0.15	31.15^{a}±0.49	22.69^{ab}±0.36

Table 30 (continued)

Sex by Age	*	NS	NS	NS	*	NS	*	NA
Female,1PPI	7.92^{c}±0.13	7.65±0.33	10.85±0.13	7.97±0.08	14.17^{c}±0.16	13.02±0.14	23.11^{d}±0.48	NA
Female,2PPI	9.00^{bc}±0.30	8.72±0.41	12.31±0.16	8.26±0.10	14.84^{bc}±0.37	14.01±0.18	26.51^{cd}±0.58	NA
Female,3PPI	8.86^{bc}±0.16	9.98±0.50	12.38±0.19	8.38±0.12	15.08^{bc}±0.20	14.70±0.22	29.85^{bcd}±0.72	NA
Female,4PPI	10.25^{b} ±0.76	11.46±0.23	12.84±0.09	8.55±0.05	15.50^{ab}±0.95	15.02 ±0.1	32.06^{a}±0.33	NA
Male,1PPI	9.28^{b}±0.20	8.92±0.75	11.50±0.29	8.42±0.18	15.49^{bc} ±0.25	14.15±0.32	26.88^{cd}±1.06	22.12^{b}±0.34
Male,2PPI	11.50^{ab}±0.62	12.37±1.91	12.75±0.75	8.75±0.48	15.33^{bc} ±0.78	15.00±0.84	29.25^{abcd}±2.71	21.77^{c}±0.86
Male,3PPI	9.81^{b} ±0.09	10.6±1.56	13.66±0.61	9.66±0.39	16.52^{b}±0.11	16.00±0.68	31.0^{abc}±2.21	22.88^{b}±0.69
Male,4PPI	12.16^{a}±0.31	12.75±0.78	13.75±0.30	10.62±0.19	16.83^{a}±0.39	16.54±0.34	35.62^{a}±1.10	23.64^{a}±0.35

a,b,c,d,e,ab,cd, abc ,bcd means on the same column with different superscripts within the specified dentition group are significantly different (P<0.05); Ns = Non significant(P>0.05); *significant at 0.05; N.A= not available, EL= Ear length; RH= rump height; CBL= cannon bone length; RL= Rump length; RW= Rump width; SC= Scrotal circumference; BL= body length; CG= chest girth; HW= height at wither; BW=body weight; 1PPI= 1 Pair of Permanent Incisors; 2 PPI = 2Pairs of Permanent Incisors; 3PPI= 3 Pairs of Permanent Incisors; 4PPI = 4 pair of permanent incisors.

4.16. 3.Correlation between Body Weight and LBMs

The Pearson's correlation coefficient between body weight and linear body measurements for male and female are calculated and presented in Table 31. The presence of strong correlation coefficients recorded between body weight and some of the linear body measurement, suggests that either of these LBMs variables or their combination could provide a good estimate for predicting body weight of indigenous goat found in the study area. Body weight had positive and significant ($P<0.05$) correlation with all continuous traits of both male and female goats.

In this study, strong, Positive and significant correlation between body weight and chest girth suggests that this variables could provide a good estimate in predicting live body weight for the population. In males positive and highly strong association were found between body weight and chest girth (r=0.90), wither height and body length (r=0.87), rump height (r=0.82). Chest depth (0.70). The highest association between chest girth and body weight were observed for male and female goat population. This finding was in agreement with reported by (Grum, 2010; Ahmed, 2013; Alefe., 2014; Alubel, 2015 ,Diba ,2017), correlation between body weight and chest girth for female (r = 0.88) and male (r = 0.89) short-ear Somali goat; for female (r = 0.89) and male (r = 0.81) indigenous goats in Horro Guduru Wollega ; for female (r = 0.93) and male (r = 0.97) for Shabelle Zone**,**for female (r = 0.76) and male (r = 0.84) Abergelle goat, and for female (r = 0.97) and male (r = 0.98) Odo Shakiso and Adola Districts goat ,respectively. These linear body measurements were highly affected by the change in body weight; hence, they are more important in prediction of live body weight of the animal. The rump length (r=0.57), Ear length (r=0.62). and pelvic width (0.50) have moderate and positively correlated with body weight.

In case of females, Body weight had strong correlation with chest girth, whither height, rump height, body length, chest depth with (r=0.85), (0.81), (0.80), (0.80), (0.69) respectively. And moderately (0.52) and (0.51), respectively the correlation coefficient between body weight and all parameters for males and females in the current study were lower than shabele goats which was reported by Alefe (2014).

Table 31.Coefficient of correlations between body weight and linear body measurements (Above diagonal for male and below diagonal for female)

	CG	BL	WH	HR	CD	EL	RL	PW	HOL	CBL	CBC	RW	HL	BW	SC
HG		0.85*	0.82*	0.81*	0.68*	0.64*	0.54*	0.56*	0.38*	0.45*	0.33*	0.48*	0.48*	0.90*	0.58*
BL	0.81*		0.83*	0.82*	0.68*	0.65*	0.54*	0.51*	0.34*	0.30*	0.40*	0.36*	0.39*	0.87*	0.61*
WH	0.83*	0.82*		0.92*	0.65*	0.61*	0.53*	0.43*	0.27*	0.22NS	0.30*	0.29*	0.39*	0.87*	0.59*
HR	0.84*	0.81*	0.98*		0.58*	0.63*	0.50*	0.46*	0.32*	0.30*	0.35*	0.36*	0.39*	0.82*	0.57*
CD	0.72*	0.66*	0.70*	0.71*		0.63*	0.62*	0.49*	0.18NS	0.39*	0.40*	0.51*	0.36*	0.70*	0.47*
EL	0.34*	0.34*	0.33*	0.32*	0.38*		0.52*	0.62*	0.42*	0.33*	0.60*	0.45*	0.48*	0.62*	0.49*
RL	0.56*	0.54*	0.53*	0.53*	0.53*	0.37*		0.52*	0.23NS	0.16NS	0.43*	0.29*	0.41*	0.57*	0.52*
PW	0.48*	0.48*	0.47*	0.46*	0.44*	0.25*	0.39*		0.29*	0.55*	0.50*	0.46*	0.46*	0.50*	0.32*
HOL	0.55*	0.52*	0.52*	0.53*	0.48*	0.22*	0.34*	0.38*		0.35*	0.20NS	0.45*	0.44*	0.31*	0.38*
CBL	0.42*	0.48*	0.41*	0.40*	0.37*	0.19*	0.33*	0.30*	0.29*		0.23NS	0.55*	0.45*	0.40*	0.18NS
CBC	0.39*	0.35*	0.36*	0.37*	0.34*	0.16*	0.26*	0.25*	0.30*	0.21*		0.18*	0.42*	0.30*	0.25*
RW	0.47*	0.48*	0.50*	0.48*	0.40*	0.22*	0.34*	0.37*	0.35*	0.30*	0.26*		0.45*	0.46*	0.37*
HL	0.47*	0.44*	0.46*	0.46*	0.43*	0.25*	0.35*	0.30*	0.34*	0.31*	0.28*	0.28*		0.43*	0.35*
BW	0.85*	0.80*	0.81*	0.80*	0.69*	0.31*	0.51*	0.46*	0.52*	0.43*	0.37*	0.48*	0.45*		0.61*

Ns= non-significant (P>0.05); * significant at 0.05 level; BL=Body Length; HG= Heart Girth; WH= Wither Height; RH= Rump Height; RW = Rump Width; RL= Rump Length; CD=Chest Depth; PW=Pelvic Width; SW=Shoulder Width; HL= Head Length; CBL=Cannon Bone Length; CBC=Cannon Bone Length; HoL=Horn Length; EL= Ear Length; BW= Body Weight; SC = Scrotal Circumference

4.16.4. Prediction of Body Weight from LBMs

Multiple linear regression models for predicting the body weight of goats from linear body measurements are presented in Table 32. Using measurements obtained readily and offered accurate prediction of body weight might be considered as a framework for recording system in rural areas (Farhad *at el*., 2013).Regression analysis is commonly used in animal research to describe quantitative relationships between a response variable and one or more explanatory variables such as body weight and body measurements (chest girth, chest depth, body length and height at wither) especially when there is no access to weighing equipment (Cankaya, 2008).

The small sample size of male goat in this study may decrease the accuracy of the result if separate sex groups are used.Comparable R^2 values were obtained for all relationships existing between BW and other LBMs for both female and male sample goat population.All body measurements were fitted into the model and through elimination procedures, in this study, the optimum model was identified. Chest girth, body length, height at wither, rump width and rump height were the best fitted model for male goat, whereas chest girth, body length, height at withers, rump height, canon bone circumference and rump width were the best fitted model for female goats.

However, predictions of body weight from combinations of LBMs, having these multiple variables posses a practical problem under field settings due to the higher labor and time needed for measurement. Chest girth selected first, which explain more variation than any other linear body measurements in both does (71%) and bucks (82%). Chest girth was more reliable in predicting body weight than other linear body measurements at farmers level when there are no facilitates and difficult to measure the weight and to take the whole measurement.Moreover, the adjusted R^2 due to additionalvariables in the model was not strong strengthening the preceding argument that heart girth alone could serve as a best predictor of body weight under field condition. Measuring chest girth with tape is easy, cheap and rapid. Thus, body weight prediction from heart girth alone would be a practical option under field conditions.

Thus, prediction of body weight could be based on regression equation y = 37.93+0.92 x for female sample population and y = -44.47+1.02 x for male sample goat populationwhere, *y* and *x* are body weight and chest girth, respectively.

In the current study chest girth (CG) was the best predictor variable, which explains more variation than any other linear body measurements in both sexes. This was in agreement with the results of, Grum (2010), Halima *et al*. (2012), Mahilet (2012),Ahmed (2013), Belete (2013), Biruh (2013) , Bekalu(2014) and Hulunim (2014) as heart girth was selected first for prediction of live body weight of animals.

Table 32. Multiple regression analysis of live weight on different body measurements for male and female goats in the study area

Model	Parameters								R^2	CP	A-R^2	MSE
	I	β1	β2	β3	β4	β5	B6	β7				
For female goats												
CG	-37.93	0.92							0.71	126.07	0.7109	11.56
CG+ BL	-40.13	0.63	0.38						0.75	39.95	0.0401	10.24
CG+ BL+ WH	-44.18	0.51	0.27	0.28					0.76	13.19	0.0131	9.63
CG+ BL +WH+ CD	-44.53	0.47	0.26	0.26	0.16				0.76	9.44	0.0026	9.62
CG+ BL+ WH+ HR+ CD	-42.31	0.49	0.26	0.54	-0.32	0.17			0.76	6.89	0.0021	9.61
CG+ BL+ WH+ HR+ CD+ RW	-42.70	0.48	0.25	0.52	-0.31	0.16	0.13		0.78	5.85	0.0014	9.61
CG+ BL+ WH+ HR+CD+CBC+RW	-43.55	0.48	0.25	0.53	-0.32	0.16	0.24	0.12	0.79	5.74	0.0010	9.60
For male goats												
CG	-44.47	1.02							0.82	31.41	0.8262	6 .25
CG+ WH	-42.21	0.65	0.36						0.87	9.24	0.0481	4.66
CG+ BL+ WH	-43.41	0.53	0.24	0.28					0.88	6.60	0.0092	4.41
CG+ BL+ WH+ RW	-43.87	0.45	0.24	0.31	0.27				0.88	5.36	0.0064	4.20
CG+ BL+ WH +RW+ RH	-42.70	0.45	0.27	0.45	-0.20	0.32			0.89	4.70	0.0053	4.08

(I)=intercept; BW= body weight; BL= body length; CG= chest girth; HW = height at withers; RH = rump height; RL=rump width; CBC=cannon bone circumference CD=chest depth; R_2 = R- square; MSE= Mean square of error; A-R_2= adjusted R.2; C (P) = The Mallows C parameters;

5. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary and Conclusions

The major livestock species in the study area were cattle, sheep, goats and chicken. Goat was dominant species in the study area next to crop production and their contribution as income source more than any other livestock production.The composition of goat was 12.78, 11.78and 13.1 in Hulet Eju Enesie, Goncha Siso Enesie and Enbse Sar Midir district, respectively. Goat populations in the study area were reported increasing in all districts.The main purpose farmers keep goat for income.

In all study area the major feed source throughout the year was natural pasture across all studied districts.The main water source was river water during dry and wet seasons. According to the survey result, 58.9% of the households were using corrugated iron sheet for construction of roof while the remaining 41.1% used grasses/bushes.

The most common practice of grazing method was free grazing in dry season but in wet season majority of the respondent practiced herded.A type of mating practiced in study areas were almost uncontrolled mating within the household's flock and between neighboring flocks.In the study area castration was the common practice.Majority (72.8%) of the goat owners were practicing fattening of goats in the study area.

In study areas appearance, color, growth rate and age were the main criteria's for selectionof breeding bucks, whereas, appearance, litter size, color andgrowth rate were for does. In the study area the overall mean age of males and females reaching sexual maturity were found to be 7.26 and 7.53months, respectively. The overall mean age at first kidding and kidding interval of goats in the study area were found to be 12.62 and 8.06 months, respectively.

The study showed that disease was ranked as first constraint for goat in all study districts. Feed shortage, water shortage, predator were ranked either second, third or vice versa in the three districts.Sheep pox,Pastrolosise and anthrax were the most affecting diseases of goat production in the study area.

Goats were characterized as having dominantly plain coat color pattern, light red coat color type, smooth hair coat type, short hair length, sloping rump profile. The most dominant ear form carried horizontal. The most frequently observed horn orientation was backward followed by upward.

The least square means for the effect of sex was significant ($p<0.05$) on majority quantitative variables except CD, EL, RL and RW. Male goats were higher than females in all variables except ear length. District had significant effect ($p<0.05$) on all quantitative variables except horn length and canone bone circumference. Body weight and all LBMs were significantly affected ($p<0.05$) by age group.

Positive and significant correlations between LBMs and body weight were observed. Multiple regression equations were developed for predicting live body weight from LBMs. Chest girth was selected first, which explain more variation than any other linear body measurements in both does (71%) and bucks (82%). The prediction of body weight could be based on regression equation y = - 37.93 + 0.92CGfor female sample population and y = -44.47 + 1.02CGfor male sample goat population where y is body weight.

One of the main conclusions to be drawn from this study is that Goats in the study area play a significant role for farmers as source of home consumption and income generation throughout the year. But, goat production system is extensive production system, which is constrained by diseasefeed shortage, water shortageand predator. In the study area goat milk is not consumed by respondents. There is less focus by concerned improved breed and breeding system to increase productivity and production of goats. The mating system is almost uncontrolled. The inbreeding coefficient is high or above the maximum acceptable level inbreeding coefficient.In all study area goats have shown inferior performance in body weight and other linear body measurements as compared to the previous carecterztion.

5.2. Recommendation

- To alleviate the possibility of inbreeding and to maintain the productivity and genetic diversity of goats buck exchanging system should be considered by farmers.
- To improve the productivity of indigenous goats in the study area, goat production constraints should be solved.
- Colour is one of selection criteria used by farmers to select breeding buck and does, training should be given to farmers to remove colour from their criteria list.
- Training should be implementing about community-based animal health management programs and increase animal health centers for better animal health care will maximize the productivity of goats in studied areas.

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7. APPENDICES

Jimma University College of Agriculture and Veterinary Medicine
Phenotypic Characterization and production system of Indigenous Goats in east Gojjam Zone in Amhara region

Appendix A 1.Questionnaire
Name of Enumerator _____ District_____Kebele/PA/_____Date _____

1. Household Characteristics

1.1. Age of the respondent/years _____ sex ____
1. 2. Marital Status 1.Married 2.Divorced 3. Widowed
1.3. Educational status? 1. Illiterate 2. Literate
1.4. If there are literate 1. Read and write 2. Elementary 3.High school
1.5. Household size and category of age group

Sex	Age group in years				
	20-30	31-40	41-50	51-60	>60
Male					
Female					
Total					

2) Production characteristics and livestock holding (in number)

2. 1.Farming practice
a. Livestock production
b. Crop production
c. Both
2.2. Livestock composition

Species	Total animals	Rank based on income generate
Cattle		
Goats		
Sheep		
Donkey		
Chicken		
Horse		
Hive		
Other(specify)/		

2.3. Population trend in major livestock species

Species	Increasing	Decreasing	Stable	Unknown	Reason
Sheep					
Cattle					
Goat					
Others					

2. 4. Goat number by age group

	Age group					
	Kids < 6 months	6 months - 1 yr	Breeding Buck	Breeding doe	Castrated male	
Male						
Female						
Total						

2.5. Land holding in ha

Land holding	Own	Rented
Crops (including fallow land)		
Fallow land		
Grazing		
Others		

2.6. Trend in land holding

1. Increasing 2. Decreasing 3. Stable Reason

_____

2.7. Breeding objectives of goat owners

	Objectives							
	Income	Meat	Saving	Ceremonies	Manure	Wealth status	Skin	Other
Mark								
Rank								

3. FEEDING AND WATERING

3.1. Feed sources used for goat in wet season

Feed sources	Mark (x)	Rank
Natural pasture		
Crop residue		
Crop aftermath		
Fallow land		
Other		

3.2. Feed sources used for goat in dry season

Feed sources	Mark(x)	Rank
Natural pasture		
Crop residue		

Crop aftermath		
Fallow land		
Other		

3.3. How do you feed your goats in wet season?
1. grazing natural pasture 2. Tethering 3.Herding 4. Rotational grazing

3. 4. How do you feed your goats in dry season?
1. grazing natural pasture 2. Tethering 3.Herding 4. Rotational grazing

3.5. Is there any seasonal shortage in the supply of feed? 1. Yes 2.No

3. 6. If yes, in which seasons of the year
(specify_____

3.7. If there is shortage, how do you overcome this problem? _____

3. 8. Do you conserve the feed for dry season? 1. Yes 2.No

3.9. If yes, which feed do you conserve?
_____

3.10. Is there any improved forage introduced by agricultural office or other organization? 1. Yes 2. No

3.11. Have you used these forages as feed for goats? 1. Yes 2. No

3.12. Source of water

Source	Dry season	Wet season
Bore hole/water well		
Dam/pond		
River		
Spring		
Rain water		
Others(specify)/		

3.13. Distance to the nearest watering point?

Distance	Dry season	Wet season
Watered at home/		
<1km		
1-5km		
6-10km		
>10km		

3. 14. Frequency of watering?

Availability	Dry season	Wet season
Freely available		
Once a day		
Twice a day		
Others (specify)		

3.15. Housing /enclosure/ for adult goat/

With roof	Mark		Without roof	Mark
In family house			Kraal	
Separate house			Yard	
Veranda			None	
Others (specify)			Others (specify)	

3. 16. If you used separate house, type of house
1. Wooden wall with grass roof 2. Stone with grass roof 3. Wooden wall with iron sheet roof 4. Other (specify) _____

3. 17. Are kids housed with adults? 1. Yes 2. No, If not specify_____

3. 18. Are goats housed together with cattle/sheep? 1. Yes 2. No

3. 19. How is the goat flock herded during the day time?
1. with sheep
2. with cattle
3. Goats herded separately
4. All herded together
5. Others (specify) _____

3.20. Way of herding
1. Goat of a household run as a flock
2. Goat of more than one household run as a flock
3. Others (specify)/_____

3.21. If your answer is '2'how many household mix their goat together_____

4. CASTRATION, FATTING, CULLING AND MARKETING OF GOATES

4. 1. Do you castrate? A. Yes B. No

4.2. If yes, reasons for castration A. Control breeding B. Improve fattening C. Better Temperament D. for better price

4.3.If no, give reason_____

4. 4. At what age do you castrate? A. <6 months B. 1- 2 years C. > 2 months

4.5. Castration method: - A. Modern B. Traditional

If say traditional specify its method _____

4.6. Do you practice fattening of goat? 1. Yes 2.No

4.7.If yes, which categories of goats do you fatten?

	Older female	Castrates	Others
Mark			
Rank			

4. 8. Can you tell us the type of supplementary feed you used to fatten goats?

4. 9. At which periods of the year do you commonly fatten?

Season	Fattening duration	Reason
1. ----------	----------	----------
2. ----------	----------	----------
3. ----------	----------	

3.22. Average weaning age of kids
1. <2months 2.2-4 months 3.4-6 months 4.> 6months
6. Do you practice culling for your goats? A. Yes B. No
7. If yes why for female? 1._____ 2._____ 3. _____ and why for male?
1._____ 2._____ 3._____
8. If age is one of the reasons for culling at what age: Male _____ Female _____
What are the different culling modes? Or Mention the different culling mode

9. What were the reasons for culling of goats?

Traits	Mark	Rank
Reproductive problem		
Sickness		
Unwanted physical characteristics		
physical defect		
Productivity problems		
persistent poor body condition		
Others		

10. If the reason for culling was old age, average culling age? Male/ _____
Female _____
11. How did you remove unproductive goats? 1. Selling to market 2. Slaughtering 3. If other _____

12. Average market age in month: Male _____ Female _____
13. Do you intend to expand your goat flock? 1. Yes 2. No Reason

5. BREEDING
5. 1. Do you have breeding bucks by your own? a. Yes b. No
5. 2. If yes, how many_____?
5.3 . Source of buck

	Source			
	Born in the flock	Purchased in market	Gift from relatives	Other
Mark				
Rank				

5.4 .If more than one bucks, why you need to keep more than one buck?
_____
Do you allow your doe to be served by anyone else buck? 1. Yes 2. No
Reason_____
5.5 . Do you allow your buck to serve does other than yours? / 1. Yes 2. No
Reason_____
5.6. If you do not have breeding buck how do you breed your doe
1. Neighboring buck2. Communal grazing area 3. Others (specify)
5.7. Type of mating? 1. Controlled 2. Uncontrolled
5.8. If uncontrolled could you able to identify a sire of a kid? 1. Yes 2. No

5.9. If yes, the criteria used to identify_____

_____

5.10. Do you practice selection for breeding male and breeding female? 1. Yes 2. No

5.11. Selection criteria for buck

	Colour	Growth rate	size /appearance	Docility	Libido	Horns presence	family history
Mark							
Rank							

5.12.Selection criteria for doe

	Colour	age at first kidding	liter size	Growth rate	kidding interval	size /appearance	family history
Mark							
Rank							

6. Reproductive traits

6. 1 Reproductive performance of goats

Reproductive traits	Year/months
Age at first kidding	
Age at first mating for the males	
Kidding interval	
age at first sexual maturity of for the females	
Average reproductive life time	
Average number of kids per life time	
Average number of kids per kidding (litter size)	

7. CONSTRAINT OF GOAT PRODUCTION

7.1 CONSTRAINTs

Traits	Mark	Rank
Disease		
Feed shortage		
Capital problem		
Predator		
Poor veterinary service		
Limited extension service		
Others		

8. DISEASE and ACCESEC OF VETERINARY SERVICES

8.1. List type of disease which occur frequently and affect productivity of goats in the area and rank based on importance.

Type of disease	Rank	Symptom	Season of occurrence	Susceptible age group	Treatment	
					Modern	Traditional

8.2.Access to veterinary services

	Service			
	Government veterinary service	Private veterinary service	Shop	Others(specify)
Mark				

8. 3. Distance to nearest veterinary service

	Distance			
	<1 km	1-5 km	6-10 km	>10km
Mark				

Appendix A 2.Focused Group Discussion

1.How goats herded across different seasons
2. Communal land utilization
3. Trend in grazing land
4.Major loss of livestock specifically goat in the past. Reason?
5.Occurrence and frequency of disease (common and local name), drought, conflict, Flood and other disasters
6. Copping mechanism during these problems
7. Major feed resources during different seasons
8. Indigenous knowledge in managing the herd
9. Major goat production constraints
10. Major farming activities
11. Income contribution of the activities in percent
12.Type of services in goat husbandry
13. Goat population trend in the last 10 years
14. Major reasons for keeping goat
15. Quality of traits perceived by owner for the goat type
    - ✓ Selection criteria, breeding objective and breeding practices

Appendix A 3.QuantitativeData collection format

Region_____ Zone_____ District _____

Keble _____Production system_____

Measurement date_____

Farmer Name	SS	Sex	Dent	HG	HW	BL	RH	CD	EL	RL	PW	HOL	CBL	CBC	RW	HL	BW	SC

SS= Study Site;; Dent. = Dentition; HG=Heart Girth; HW= Height at Wither; BL= Body Length;; RH= Rump Height, CD=Chest Depth , EL=Ear Length , , RL= Rump Length, PW= Pelvic Width; HL= Horn Length;;; CBL=cannon bone length , CB=cannon bone Circumference
, RW= Rump Width; HL=Head Length;; BW=Body Weight , SC=Scrotum Circumference
NB: - Live body weight in **Kg** and Linear body measurements in **cm.**

Appendix A 4 Qualitative Data Collection Format

Region_____ Zone_____ District_____Kebele _____

Farmer Name	SS	SEX	CC		H		HP	HS	HO	EO	HEP	BP	RP	BAP	RP	WP	TP
			Type	Pattern	type e	length											

SS=Study Site, CC=Coat color, , H=hair, , Hs= horn shape, ho= horn orientation, EO=ear orientation, HEP=head profile, BAP=back profile, B=beard, RP=rump profile, WP=wattles presence, TP= toggle presence, SC=Skin color

Qualitative trait	**Description and level**
Coat color Pattern	A1= plain A2= patch A3= spotted
Coat color type	B1= white B2= black B3 = brown B4 grey = B5 = dark red B6 = light red B7 = roan B8 = red + white B9 = black + white B10 = black + red
Skin color	D1 = pigmented D2= not pigmented
Hair coat type	H1= Smooth hair H2 = Long straight hair H3 = Curly rough hair H4 = Glossy H5 = Dull
Hair length	C1 = short C2= medium C2 = long
Horn	F1= absent F2 = present
Horn shape	L1= curved L2 = spiral L3 = straight
Horn orientation	D1 = backward D2 = obliquely upward D3=lateral
Ear orientation	C1 = dropping C2 = lateral C3 = forward G4 = upright
Head profile	P1 = straight P2 = concave P3=convex P4=slightly concave
Beard	F1 = present F2 = absent
Ruff	R1 = absent R2 = present
Back profile	E1= slops up to rump E2 = straight E3 = slopes toward the wither
Rump profile	R1 = sloping R2 = flat
Wattle	N1 = present N2 = absent

Appendix A 5Secondary Data Collection Format

1. Region_____ Zone _____
2. District _____Total Kebelle of District _____
3. Production system:
- Pastoral (number of Kebelle) _____
- Agro – pastoral (number of kebelle) _____
4. Human population of the district: Male _____ Female _____Total_____
5. Climatic data:

-Temperature ($_{o}$c): Minimum _____ Maximum _____
-Annual rainfall (mm): Minimum _____ Maximum _____

6. Agro ecological zone _____
7. Land use pattern: Cultivated Land _____, Arable Land _____, Forest Land _____, Grazing Land _____, Others _____
8. Livestock population in the district:
- Cattle _____
- Goat _____
- Sheep _____
- Camel _____
- Equine _____
- Chicken_____

Appendex Table 1. ANOVA of heart girth for Hulet Eju Enesie, Goncha Siso Enesie and Enbse Sar Midir districts goats for the effect of district, sex and age

Source	DF	Type III SS	Mean square	F value	Pr>F
District	2	365.867595	182.933798	8.35	0.0003
Sex	1	454.621319	454.621319	20.74	<.0001
Age	3	7688.622884	2562.874295	116.92	<.0001
Error	593	12999.03045	21.92079		
Corrected total	599	22022.66500			

Appendex Table 2. ANOVAof body length for Hulet Eju Enesie, Goncha Siso Enesie and Enbse Sar Midir districts goats for the effect of district, sex and age

Source	DF	Type III SS	Mean square	F value	Pr>F
District	2	648.549809	324.274904	119.29	<.0001
Sex	1	273.610215	273.610215	13.63	0.0002
Age	3	7184.370860	2394.790287	119.29	<.0001
Error	593	11904.44247	20.07495		
Corrected total	599	20802.29333			

Appendex Table 3. ANOVA of wither height for Hulet Eju Enesie, Goncha Siso Enesie and Enbse Sar Midir districts goats for the effect of district, sex and age

Source	DF	Type III SS	Mean square	F value	Pr>F
District	2	373.721145	186.860572	10.01	<.0001
Sex	1	342.791508	342.791508	18.37	<.0001
Age	3	5425.412796	1808.470932	96.90	<.0001
Error	593	11067.84720	18.66416		
Corrected total	599	17699.17333			

Appendex Table 4. ANOVA of rump height for Hulet Eju Enesie, Goncha Siso Enesie and Enbse Sar Midir districts goats for the effect of district, sex and age

Source	DF	Type III SS	Mean square	F value	Pr>F
District	2	191.429692	95.714846	95.02	0.0038
Sex	1	246.582716	246.582716	14.51	0.0002
Age	3	4845.505759	1615.168586	95.02	<.0001
Error	593	10079.88757	5665.118333		
Corrected total	599	15716.38500			

Appendex Table 5. ANOVA of chest depth for Hulet Eju Enesie, Goncha Siso Enesie and Enbse Sar Midir districts goats for the effect of district, sex and age

Source	DF	Type III SS	Mean square	F value	Pr>F
District	2	119.040724	495.210750	9.15	<.0001
Sex	1	63.586682	63.586682	9.77	0.0019
Age	3	1485.632249	495.210750	76.10	<.0001
Error	593	3858.847751	3858.847751		
Corrected total	599	5665.118333			

Appendex Table 6.ANOVA of ear length for Hulet Eju Enesie, Goncha Siso Enesie and Enbse Sar Midir districts goats for the effect of district, sex and age

Source	DF	Type III SS	Mean square	F value	Pr>F
District	2	66.7660011	33.3830005	14.86	<.0001
Sex	1	0.0003484	0.0003484	0.05	0.9901
Age	3	287.6489428	95.8829809	42.69	<.0001
Error	593	1332.024761	2.246247		
Corrected total	599	1747.993333			

Appendex Table 7. ANOVA of rump length for Hulet Eju Enesie, Goncha Siso Enesie and Enbse Sar Midir districts goats for the effect of district, sex and age

Source	DF	Type III SS	Mean square	F value	Pr>F
District	2	52.343809	26.171904	7.77	0.0005
Sex	1	16.132368	16.132368	4.79	0.0290
Age	3	1571.918795	523.972932	155.55	<.0001
Error	593	1997.594538	3.368625		
Corrected total	599	3768.118333			

Appendex Table 8. ANOVA of pelvic width for Hulet Eju Enesie, Goncha Siso Enesie and Enbse Sar Midir districts goats for the effect of district, sex and age

Source	DF	Type III SS	Mean square	F value	Pr>F
District	2	71.1318402	35.5659201	15.70	<.0001
Sex	1	155.9164090	155.9164090	68.81	<.0001
Age	3	354.0537223	118.0179074	52.09	<.0001
Error	593	1343.639611	2.265834		
Corrected total	599	1957.185000			

Appendex Table 9. ANOVA of cannon bone length for Hulet Eju Enesie, Goncha Siso Enesie and Enbse Sar Midir districts goats for the effect of district, sex and age

Source	DF	Type III SS	Mean square	F value	Pr>F
District	2	86.1990969	43.0995485	20.19	<.0001
Sex	1	31.8898096	31.8898096	14.94	0.0001
Age	3	346.3602027	115.4534009	54.09	<.0001
Error	593	1265.669057	2.134349		
Corrected total	599	1773.958333			

Appendex Table 10.ANOVA of cannon bone circumference for Hulet Eju Enesie, Goncha Siso Enesie and Enbse Sar Midir districts goats for the effect of district, sex and age

Source	DF	Type III SS	Mean square	F value	Pr>F
District	2	0.99318533	0.49659267	0.51	0.6021
Sex	1	77.07865653	77.07865653	78.82	<.0001
Age	3	56.78452899	18.92817633	19.36	<.0001
Error	593	579.9188043	0.9779406		
Corrected total	599	707.2650000			

Appendex Table 11. ANOVA of rump width for Hulet Eju Enesie, Goncha Siso Enesie and Enbse Sar Midir districts goats for the effect of district, sex and age

Source	DF	Type III SS	Mean square	F value	Pr>F
District	2	54.2512402	27.1256201	7.61	<.0001
Sex	1	8.0885382	8.0885382	2.27	0.1324
Age	3	482.0985279	160.6995093	45.11	<.0001
Error	593	2112.486287	3.562371		
Corrected total	599	2725.958333			

Appendex Table 12. ANOVA of head length for Hulet Eju Enesie, Goncha Siso Enesie and Enbse Sar Midir districts goats for the effect of district, sex and age

Source	DF	Type III SS	Mean square	F value	Pr>F
District	2	382.2147170	13.7510272	4.95	0.0074
Sex	1	86.3687403	86.3687403	31.07	<.0001
Age	3	382.2147170	127.4049057	45.83	<.0001
Error	593	1648.525653	2.779976		
Corrected total	599	2164.958333			

Appendex Table 13. ANOVA of body weight for Hulet Eju Enesie, Goncha Siso Enesie and Enbse Sar Midir districts goats for the effect of district, sex and age

Source	DF	Type III SS	Mean square	F value	Pr>F
District	2	1167.471881	583.735940	21.15	<.0001
Sex	1	544.293011	544.293011	19.72	<.0001
Age	3	7103.167491	2367.722497	85.79	<.0001
Error	593	16366.57584	27.66062		
Corrected total	599	26201.18500			

Appendex Table 14.ANOVA of horn length for Hulet Eju Enesie, Goncha Siso Enesie and Enbse Sar Midir districts goats for the effect of district, sex and age

Source	DF	Type III SS	Mean Square	F Value	Pr > F
District	2	13.3837345	6.6918672	0.61	0.5434
SEX	1	68.9184363	68.9184363	6.29	0.0124
AGE	3	852.6502539	284.2167513	25.93	<.0001
Error	593	6171.074867	10.961057		
Corrected total	599	7104.947368			

Appendex table 15. ANOVA of scrotum circumference for Hulet Eju Enesie, Goncha Siso Enesie and Enbse SAR Midir districts goats for the effect of district, sex and age

Source	DF	Type III SS	Mean Square	F Value	Pr > F

Source	DF	Type III SS	Mean Square	F Value	Pr > F
District	2	10.84968741	5.42484370	2.94	0.0613
AGE	3	76.52340536	25.50780179	13.83	<.0001
Error	54	99.5765946	1.8440110		
Corrected total	59	177.733333			