PHENOTYPIC CHARACTERIZATION OF INDIGENOUS GOAT TYPE, BREEDING AND HUSBANDRY PRACTICES IN ODO SHAKISO AND ADOLA DISTRICTS

MSC THESIS

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PHENOTYPIC CHARACTERIZATION OF INDIGENOUS GOAT TYPE, BREEDING AND HUSBANDRY PRACTICES IN ODO SHAKISO AND ADOLA DISTRICTS

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As Thesis Research advisors, we here by certify that we have read and evaluated this thesis prepared, under our guidance, by Diba Dedacha Jilo, entitled **Phenotypic Characterization of Indigenous Goat type, Husbandry and Breeding Practices in Odo shakiso and Adola Districts**

We recommend that it can be submitted as fulfilling the Thesis requirement.

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DEDICATION

I dedicate this piece of work to clemency of God and to my lovely family (my father Ato Dedacha Jilo and my mother W/ro Bunjure Bariso) for nursing me with affection and love and for their dedicated partnership in the success of my life.

STATEMENT OF AUTHOR

First, I declare that this thesis is my authentic work and that all sources of materials used for this thesis have been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirements for MSc degree at Haramaya University and is deposited at the University Library to be made available to borrowers under rules of the Library. I solemnly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

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BIOGRAPHICAL SKETCH

The author of this thesis, Mr. Diba Dedacha Jilo, was born on June 5, 1984 in Odo shakiso district of Guji Zone in Oromia National Regional State, south Eastern Ethiopia from his father Ato Dedacha Jilo and mother W/ro Bunjure Bariso. He attended his primary school (Grade 1-5) education in Dibabate (1992-1996), Junior secondary school Grade (6- 8) in Kelacha and Odoshakiso elementary school (1997- 1999) respectively, high school and Preparatory School education (Grade 9-12) in Odo shakiso Secondary and Preparatory School (2001-2004). He then joined Bule Hora University in 2013 and awarded a BSc degree in Animal and Range Science on July 2015. After his graduation, he was employed by the Ministry of Education as graduate assistance for newly opening universities and assigned at Dembi Dolo University.

In 2016, he joined the postgraduate program of Haramaya University to pursue his MSc study in Animal Genetics and Breeding in the School of Animal and Range Science.

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ABBREVIATIONS AND ACRONYMS

ADLCRDO	Adola District Livestock, Crop and Rural Development Office
AFK	Age at First Kidding
AnGR	Animal Genetic Resources
CCPP	Contagious Caprine Pleuro-Pneumonia
CSA	Central Statistics Agency
DA	Development Agents
DAGRIS	Domestic Animal Genetic Resource Information System
FAO	Food and Agricultural Organization of the United Nations
GLM	General Linear Model
ILCA	International Livestock Center for Africa
LBMs	Linear Body Measurements
LSM	Least Square Means
SAS	Statistical Analysais System
SEAG	Small East African Goats
SNNPR	South Nations, Nationalities and Peoples Region
SPSS	Statistical Package for Social Sciences
OSDLCRDO	Odo Shakiso District Livestock, Crop and Rural Development Office

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PHENOTYPIC CHARACTERIZATION OF INDIGENOUS GOAT TYPE, BREEDING AND HUSBANDRY PRACTICES IN ODO SHAKISO AND ADOLA DISTRICTS, GUJI ZONE, ETHIOPIA.

ABSTRACT

This study was conducted in Odoshakiso and Adola districts of Guji Zone, with the objectives to phenotypically characterize indigenous goat type and to identify breeding and husbandry practices. Data were collected through questionnaire, focus group discussion and field measurements. A total of 544 goats (163 adult males and 381 adult females) were used for measurement and 136 households were interviewed. Data were analyzed by descriptive statistics. Chi–square test was employed for categorical data and Index was calculated to provide ranking. Multiple correspondence analyses were carried out on the nine qualitative traits recorded. GLM procedure of SAS versions 9.1 (2008) was employed to analyze quantitative data. The results revealed that agro- pastoral and pastoral were the main production systems with average holding of goats per household 12.2±1.6 in Odoshakiso and 11.7±1.3 for Adola district. The primary reason of keeping goat was cash income, milk, and meat in both districts. Milk yield, meat quality, size, coat color and growth rate were the most preferred traits of goat in study area. Shrubs and bushes, natural pasture and crop residues were the main feed resources in the study area. Labor shortage, predator disease incidence and lack of extension service were the major constraints of goat production. Most frequently observed coat color pattern was plain in both female (54%) and male (58.5%) goats. The overall mean age at sexual maturity for indigenous female goat was 12.6 ± 0.16 months and for male 11.6 ± 0.17 months; age at first kidding 18.4 ± 0.16 months; average reproductive life time of doe 8 ± 0.1 year; and average kidding interval 6.5 ± 0.06 months. Multiple correlations between body weight and linear body measurements showed positive correlations among body weight and linear body measurements for both sexes. Strong positive correlation between heart girth and body weight was observed (r = 0.98, 0.97) for male and female population. As per multiple regression analysis the best fitted models to predict body weight were HG, HW, BL, RH, PW, EL, SC and SL for males whereas HG, HW, RH, BL, PW, EL and RW for females. Therefore this finding can form a baseline for understanding breeding and husbandry practices of goats in the study area as first step in designing a sustainable breeding program

Key words: *Body weight; indigenous goat; linear body measurement; phenotypic characterization, and Breeding and Husbandry practices,*

1. INTRODUCTION

Ethiopia has the largest livestock population in Africa and is endowed with different agro-ecological zones that encompass highlands, sub-humid, semi-arid and arid environments (FARM Africa, 1996).The estimated livestock population of Ethiopia is about 56.71Million cattle, 29.33 million sheep, 29.11 million goats, 0.4 million mules, 7.43 million donkeys, 1.16 million camels, and 56.87 million poultry(CSA, 2015 and ELMP, 2015). The livestock species of the country are abundance and they are an integral part of the country's agricultural system (FAO, 2011). Small ruminants form an important economic and ecological niche in small farm systems and agriculture (Devendra, 2001). In traditional production systems, small ruminants are not bred for a specific purpose rather they are kept for multipurpose functions. They provide multiple roles for their owners such as source of income, food (meat and milk), manure and insurance against crop failure and cultural values (Assen and Aklilu, 2012).

There are approximately 570 breeds and types of goats in the world of which 89 are found in Africa (Galal, 2005). Ethiopia has large goat population that ranks it high both in Africa and the world. According to CSA (2015) the number of goats reported in the country is estimated to be about 29.11 million. Out of these about 71.08% are females and 28.92% are males. With respect to breed, almost all of the goats are indigenous which accounts for 99.99 %.

The growing demands of meat products at the domestic as well as international markets increase the importance of goat in the national economy of the country. According to CSA (2012) out of 5,187,044 slaughtered animals in the year 2012, 1,771,527 are goats. More than 90% of export trade value of live animal/meat and skin also comes from small ruminants.

At optimum level, the county has a potential of annual production of 1.1 million goats for domestic market and 2 million goats for international market but the current annual off take is only 35% with the average 10 kg of carcass weight (Hirpa and Abebe, 2008). This may be due to different factors such as poor nutrition, prevalence of diseases and lack of appropriate breeding strategies and poor understanding of the production system. Among them, lack of systematic breeding programs is an important constraint (Tsegaye, 2009).

Therefore to increase and sustain the productivity of goats so as to respond to the growing domestic and foreign demands for live goats and products, improvement programs is necessary especially for countries like Ethiopia where extensive system of husbandry is common. Characterization are essential for planning improvement, sustainable utilization and conservation strategies of a breed at local, national, regional and global levels (FAO, 2012). Appropriate breeding strategies should be designed to promote conservation and improvement of their unique attributes, such as adaptability, water use efficiency and suitability under harsh climatic conditions.

A preliminary phenotypic characterization of Ethiopian goats was done by Farm Africa and classified indigenous goats based on their geographic location and the ethnic communities belong to them (FARM Africa 1996). Based on the analysis of morphological data along with geographic distribution, the goat populations of the country are phenotypically classified into 12 distinct breeds and 4 major families (Alemayehu 1993; Nigatu 1994; FARM Africa 1996). However, Genetic/molecular characterization revealed the presence of only eight distinctively different breeds in the country (Tesfaye, 2004).

Multi factorial analyses of morphological traits are appropriate to assess phenotypic variation within and between goat populations and to appropriately discriminate different goat types based on the joint consideration of all measured morphological variables (Traore *et al*., 2008).

Several studies have shown that goat keepers have developed their own breeding practices which include selection of bucks or does that are used either in controlled or uncontrolled mating systems. Where selection is practiced, the criteria used are based on maternal (ancestral) history, production performance appraisal and some other traditional systems.

Livestock production in general and small ruminant husbandry in particular has become the major component of the farming system in Odo shakiso and Adola districts. Goats are the major indicator of the wealth of farmers in both districts. Hence large goat populations are found in both districts. These two districts are also ideal places for goat production because of their agro ecology, available feed resource and different types of trees, shrubs and bushes.

Beside these there is high population of goats and most of the farmers are highly dependent on them, which makes the study area potential for goat production. Despite all these

importance, there is no any study carried out on phenotypic characterization, husbandry and breeding practices in Odo shakiso and Adola districts. Therefore, this study was designed to address the following objectives.

General objective

- To phenotypically characterize indigenous goat type, breeding and husbandry practices in Odo shakiso and Adola districts

Specific Objectives

- To describe morphological variation among indigenous goat types found in Odo shakiso and Adola districts through phenotypic characterization;
- To characterize goat husbandry and breeding practices in study area;
- To identify farmers' trait preferences, selection criteria and breeding objectives for indigenous Goat in study Area.

2. LITERATURE REVIEWS

2.1. Origin and Domestication of Goats

Goats (*Capra hircus*) are believed to be the second animal domesticated following the dog and it first reached Egypt around 5000 B.C then spread to south and west throughout Africa. Evidence suggests that this took place before 7000 BC in south-west Asia, on the borders of present-day Iran and Iraq where agriculture was already advanced (Mason, 1984). African goats could be grouped into three main families: the Dwarf goats of West and Central Africa, the Savannah goats of sub-Saharan Africa and the Nubian type goats of North Africa. The parents of the Nubian goats came from Asia. It is assumed that the first wave of goats entered Ethiopia from the north between 2000 and 3000 B.C. The ancestors of Ethiopian goats are closely associated with goat types which migrated from the Middle East and North Africa (Kassahun and Solomon, 2008).

The goat is a member of the Bovidae family and is closely related to the sheep as both are in the goat-antelope subfamily Caprine. There are over three hundred distinct breeds of goat (Hirst and Kris, 2008). According to earlier characterization work, indigenous Ethiopian goats have been phenotypically classified into 12 types while a recent genetic characterization showed only eight distinctively different types (Tesfaye, 2004).

2.2. Classification and Distribution of Goat Breeds of Ethiopia

Goat breeds found in Ethiopia have been identified and classified based on their differences in physical characteristics and genetic make-up. The physical characteristics include body color, size and shape of body parts, and presence or absence of body parts. Many physical features have to be collected and analyzed to identify specific breeds within major groups. 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 (Tesfaye, 2004).

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, 1996; Tesfaye, 2004) (Table 1). A family is a group of breeds that are genetically more related and physically more similar than breeds outside the group. The families and breeds are named after their geographical location, the ethnic communities maintaining them, or based on some identifying physical features (FARM-Africa, 1996).

Table 1.Indigenous goat breeds of Ethiopia with their family, distribution, common name, production system and main use

Family	Breed/Type	Distribution/Location	Common names/Local names	Production System	Main use
Nubian	Nubian	North-west Ethiopia (Wegera)	*Shukria, Langae, Hassen*	Pastoral	Milk, meat and skin
Rift valley	Afar	Afar Region	*Adal, Danakil*	Pastoral	Milk, meat and skin
	Abergelle	Tekeze River in southern Tigray, Northern Wollo and Eastern Gonder	-	Mixed farming agro pastoral	Milk, meat and skin
	Arsi-Bale	Highlands of Arsi, Bale and higher altitudes of Sidamo and western Hararge.	*Gishe, Sidama*	Mixed farming to agro-pastoral	Milk, meat, skin and manure
	Woyto-Guji	North and South Omo,Gamu-Gofa and Eastern Sidamo and Guji	*Woyto, Guji, Konso*	Pastoral to mixed farming	Milk, meat and skin
Somali	Hararghe Highland	Highlands of Eastern and Western Hararghe	*Kotu-Oromo*	Mixed farming	Milk, meat, skin and manure
	Short-eared Somali	Northern and Eastern parts of Ogaden and around Dire Dawa	*Issa-Somali, Ogaden, Modugh, Mudugh, Dighier, Deghiyer, Dighi Yer, Denghier, Agal, Ogaden, Habab, Bimal*	Pastoral	Milk, meat and skin
	Long-eared Somali	distributedThroughout the Ogaden, lowlands of Bale, Borana and Southern Sidamo	*Large-White Somali, Digodi,Degheir, Melebo, Boran Somali, Benadir, Gigwain,Ogaden*	Pastoral	Milk, meat and skin
Small east African	Central Highland	Northern Ethiopia (North Gondar,Wollo,Tigray)	*Brown Goat*	Mixed farming	Meat, skin and manure

	Western Highland	Highlands of Western Ethiopia (South Gondar,Gojam,Wellega, and Western Shoa)	*Agew*	Mixed farming	Meat and skin
	Western Lowland	Lowlands of Western Ethiopia (Metekel, Asossa andGambela	*Gumez*	Agro-pastoral	Milk and meat
	Keffa	Keffa, part of South Shewa, Kembata and Hadiya	-	Mixed farming	Meat, milk, and skin

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

2.3. Flock Size and Structure

Flock structure is the proportion (in terms of number of head) of the flock of a single species which is formed by different age and sex classes of animals (ILCA, 1990). The average flock size for Arsi-Bale and western highland goat owners were 7 and 8 respectively (Workneh, 1992; Nigatu, 1994). However, higher flock size (29) was reported for Worre goats, but Keffa goats were kept in small flocks (6) in mixed farming system (Nigatu, 1994). In general, flock ownership has differences in farmers of highland and low land areas and mixed farming system.

In this regard, individual or family ownerships of lowland areas is greater than highland where the population of farmers greatly outnumber the pastoral people in lowlands and thus the number of flocks owned by the highlander is lower and family ownership pattern also dominates here (Peacock, 1996). Flock structure is also a basis for calculating or forecasting flock productivity. For instance, a relatively low proportion of young stock in a flock would suggest that adult mortality is low or pre-weaning mortality is high, or that kidding percentage is low. Alternatively, it may mean that more kids were sold during the year (Ibrahim, 1998).

2.4. Characterization of Goat Genetic Resource in Ethiopia

Breed characterization is the first step in the urgent task of genetic resource conservation. In order to make a first attempt in identifying the goat types of Ethiopia, FARM-Africa began a national goat breed survey of Ethiopia and Eritrea in 1990. It describes the traditional goat husbandry practices in different production systems, and develops and tests a method for the rapid survey of indigenous livestock. Each description of the goat type includes local names, origins, races, distribution, agro climatic zones, management systems, flock size, flock structure, feeding, housing, major problems, key identifying features, products (milk, meat, skins), productivity (reproduction) (FARM-Africa, 1996).

2.5. Methods of Breed Characterization

Characterization is defined as the distillation of all knowledge, which contribute to the reliable prediction of genetic performances of an animal genetic resource in a defined environment and provides a basis for distinguishing between different animal genetic resources and for assessing available diversity. The classical description of breeds: coat color, horns and humps are based upon phenotype. However, an organism' phenotype is principally a manifestation of

its genotype. Thus, the near ultimate description of an organism is a description of the sequence of nucleotides that comprise its genome (Kemp, 1992). Documentation of existing genetic resources, including the description of the population phenotypic characteristics, performance, cultural importance and genetic uniqueness is one of the main areas of the livestock conservation activities (Duchev and Groeneveld, 2006).

2.6. Phenotypic Characterization

Phenotypic characterization of AnGR refers to the process of identifying distinct populations and describing their characteristics and those of their production environments. In this context, the term “production environment” is taken to include not only the “natural” environment but also management practices and the common uses to which the animals are put, as well as social and economic factors such as market orientation, niche marketing opportunities and gender issues. Recording the geographical distribution of breed populations is here considered to be an integral part of phenotypic characterization. It is an essential, initial step in breed identification (Mekasha, 2007).

The classical description of breeds using the phenotype is based upon morphological characters such as coat color, horn, tails, body measurements and other specific visible traits. Phenotypic relationships, based upon the comparison of morphological characters, are used to estimate variations within breeds and distances between breeds, and are used to describe them in terms of the frequency of most typical characteristics. Morphological or phenotypic characterization has been suggested and used to describe and classify breeds of farm animal species (FARM-Africa, 1996) Morphological data are relatively easily obtained, requiring relatively inexpensive instrumentation in comparison to molecular instruments.

2.7. Reproductive Performance of Goat

Reproductive performance heavily influences genetic improvement through their impact on selection intensity. As a consequence, adequate knowledge on reproductive performances of the indigenous breeds is crucial for planning a feasible breeding scheme. However, information on the reproductive traits of indigenous goat breeds is scarce (Mekasha, 2007). Among the reproductive performances in goats, parameters like age at first kidding, kidding interval, litter size and litter weight are of most important economic implications.

2.7.1. Age at first kidding

Age at first kidding (AFK) can be described as the age at which does give birth for the first time. It is a function of puberty. Age at first breeding and conception and successful completeness of pregnancy are reproductive characteristics that determine Age at First Kidding (AFK) is influenced by many factors such as genetic make-up of an individual, physical environment, nutrition and time of birth (Alexander *et al.*, 1999; Awemu *et al.*, 1999). The use of bucks and does at the right age and weight indicates efficiency of husbandry and management. Bucks are generally ready to breed at the age of 8-12 months and for does 8-16 months for adult individuals of the same breed or variety (Peacock, 1996). However, it was reported that doe attains sexual maturity between 15-18 months of age but this period can be reduced by 3-5 month by proper feeding and care. Therefore, most does attain sexual maturity at one year age (Jagdish, 2004). According to Payne (1999) tropical male goats reach sexual maturity at 132 days. However, from the study of Yitaye (1999) bucks reached for service at about the age of 11 months. On other study (Markos, 2000) in Ethiopia goat breed, 12 months and 7 to 8 months were reported for bucks and does, respectively.

Age at which animals first begin to breed is important for two aspects: early reproduction shortens generation intervals and speed up genetic progress and on the other hand life time reproductive efficiency is greatly increased by early breeding. Age at first kidding in Ethiopian breeds is well known trait at farm level and it ranges from 12 to 24 months (Girma, 2008). 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, age at conception and age at first kidding are also affected by litter size (birth type of doe) in which earlier values are observed in single born does than the multiple born one (Zeshmarani *et al.*, 2007).

2.7.2. Kidding interval

In small ruminants, reproductive efficiency is also related to the length of parturition interval (Ibrahim, 1998). Kidding interval is affected by the breed, season, year of parturition, parity and postpartum weight of the dam (Devendra, 1980). Further, extended kidding interval commonly arise from long post- partum anoestrus intervals, repeated cycles of service interval without conception, embryo death or abortion (Ibrahim, 1998). Management practices and

restriction on breeding also elongate the interval between kidding. Moreover, season of previous birth and period of birth can be the source of variation contributing to differences in kidding interval. Kidding interval in most tropical goats varies from 180-300 days (Banerjee, 1998). Under traditional systems of management, kidding interval for most Small East African goats (SEAG) ranges from 238-265 days (Getnet, 1998). However, study of kidding interval of West African Dwarf goats indicates, an average interval of 210-230 days in traditional system (Wilson and Durkin 1988). Moreover, indifferent parts of the country, average kidding interval of 10.41 ± 0.13 and 11.52 ± 0.96 months was reported respectively (Solomon, 2004 and Samuel, 2005).

2.7.3. Litter size

Litter size is the number of total kids born per kidding per doe. In sheep and goats it is largely determined by the eggs librated by the ovary at the heat period, and by the amount of embryonic mortality. If only one egg is released and fertilized, a single lamb/kid will result unless this egg divides so that twin is produced. Mostly, twins and triplets are produced due to the shedding of more number of eggs which are fertilized and complete their development (Ensminger, 2002). Multiple birth are desirable; they increase the weight of lamb/kid produced per ewe/doe per unit of time, thereby lowering the relative cost of maintenance and lowering cost of production (Ensminger, 2002).

In Ethiopia, study on performance potential of Somali goats and their crosses with Anglo Nubian showed that mean litter size of 1.01 (Girma, 1996). In addition, in western part of the country, litter sizes of 1.8 and 1.55 were reported by Getnet (2001). However, average litter sizes of 3 were reported in the country for Arsi-Bale, Woyto-Guji, Western highland and lowland goats, and Keffa goats (Workeneh, 1992, Farm Africa, 1996).

Various authors reported different values for litter sizes in different breeds. It is affected by numerous factors including parity and/or dam age, year and season (Awemu *et al.*, 1999). Generally, litter size increased with parity. But it is affected by genotype of goat and environmental factors (Cinkulov *et al.*, 2009).

2.7.4. Litter weight

Total litter weight at birth and at weaning are considered as composite dam traits and used as measures of dam productivity. They comprise a number of component traits right from

conception up to weaning weight. Different authors (Vanimisetti *et al.*, 2007; Snowder, 2008) described them in different forms based on the type and quantity of data available. The expression includes litter weight at birth or weaning per dam parturiated, or per dam exposed to male, or per dam per parturition. Their calculation requires pre-adjustment for different factors such as kid/lamb sex and weaning dates and then calculated as the sum of individual birth or weaning weight new born in the litter.

Total litter weight at birth depends up on number of kids born and litter mean weight at birth. It measures the capacity of dam to produce kid weight at birth. Ideally dam productivity is measured as the total weights of litter weaned per dam exposed as it includes fertility (conception rate).

2.8. Socio-Economic Importance of Goats

Goats are socio–economically important in developing countries, ensuring food and fiber supply and providing income to small households (Lebbie, 2004 and Gurmessa *et al*., 2011a). Due to increased demand for goat products, more livestock producers are raising goats in developing countries, including Ethiopia Solomon, (2004). The increases of human population, increased urban income in several African countries and new opportunities for export has encouraged the marketing of goats from rural households and pastoral communities. Goats have great importance as major sources of livelihood and contribute to the sustenance of landless, smallholder and marginal farmers especially to the poor in the rural areas throughout the developing countries. The ownership of small ruminants is regarded as a safe investment for the family as well as to gain social prestige within the community. They are sold to meet compelling family financial obligations or slaughtered for consumption at home or festivals (Kosgey, 2004).

Goats can also serve as a store of value and a security system. They can be sold to attain immediate cash assets for poor goat holders, helping them improve livestock and crop farming and financing social events (Taye, 2006). Especially during droughts when crops fail, due to their adaptation capabilities, goats can survive on woody browses and infrequent watering; coupled with their high reproductive rate and short generation interval, goats enable their owners to recover quickly and economically (Lebbie, 2004;Peacock, 2005).

2.9. Goat production systems

Goat husbandry practices in Africa follow the diverse agro–ecologies (classified based on altitude and rainfall) prevalent across the continent and broadly classified as mixed and commercial systems, pastoral and agro–pastoral (Lebbie, 2004; Peacock, 2005). Goats are distributed in all agro–ecological zones but dominated in harsh arid and semiarid environments (Silanikove, 2000).

Classification of livestock production systems could be based on the type of resource used (rangeland, crop residues), on the intensity of the use of the resources (extensive, intensive), on the type of producers (nomadic, sedentary), or based on the product generated (milk, meat, dual purpose). The largest percentage of goat production around the world is classified as extensive and based on the subsistence level, (EARO, 2000).

2.10. Goat Housing

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. In Ethiopia, in smallholder systems it is not uncommon for goats to be kept in the owners' house at night or in rudimentary shelters. In southern parts of the country, the Sidama ethnic groups and highland farmers of north Omo use either a separate part of the family home or a shed on its own to house goats (Workeneh, 1992). Similarly, in other areas of the region either goats are housed in a shared- house with the family or in the Kraals outdoors adjacent to the family house (Markos, 2000). On the contrary, western highland goats are housed separate to owners' house (FARM Africa, 1996). In Eastern part, Harerghe highland goats are housed mainly in the owners' house.

In some places of the region (SNNPR), farmers were also observed to house different classes of goats. Kids and adults of Woyto-Guji goats are housed separately and are together only during the morning and evening hours or during or soon after milking. In addition, diseased goats of Woyto-Guji are also isolated so as to prevent the rapid spread of mange mite infestation (Alemayehu, 1993). Similarly, during the rainy season, Arsi-Bale goats remain in the shed for part of the day to avoid cold and diseases like foot rot and Orf (Workeneh, 1992).

Whatever the type of housing, it should be with strong and long lasting floor; it should be well drained and easily cleaned and the house could be constructed with cheap and locally available

materials (Banerjee, 1998). In this regard, in western parts of Ethiopia, goats' house is constructed in specially arranged wooden floor (FARM Africa, 1996).

2.11. Feeding and Feed resources

Goats are energetic and selective in the art of food gathering, which result in a widely varying and opportunistic diet. They travel up to twice as far as cattle in search of desired forge on a daily basis. They have great tendency than cattle and sheep to change their diets with season and available food (Ahmed *et al*., 2000).

Goat is a very efficient ruminant animal taking 80% of its nutritive requirements through browsing mostly on the leaves; fruits and twigs of shrubs and other leguminous plants Moreover, they will eat grass and herbs when there is no alternative, common pastures, many trees are also used to provide nutrient requirement for maintenance & production. The other sources of feed for goats include crop residues, agro-industrial by products and many non-conventional feed resources (Payne, 1990).

2.12. Watering Practice

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). Nevertheless, the watering frequencies of goats differ from place to place in accordance with the availability of water in the vicinity and the potential of goats to stay long without watering (Silanikove, 2000). In this regard, study of (Alemayehu, 1993) indicates 46% of the respondents replied Hararghe highland goats were watering in every day, 15% in every third day and the remainder was daily. Watering frequency of Northwestern lowland goats was 82, 9 and 9% for every day, every other day and every three-days of watering, respectively (Nigatu 1994).

2.13. Castration Practices

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 chevon, rapid gain in weight, makes skin of superior quality and profit per goat is more (Jagdish,2004). Castration can be done in one of two ways: bloodless castration (Burdizzo)

and castration with knife (surgical method). It was addressed that the knife methods were cruder and had greater risk of infection of the wound (Payne and Wilson, 2003).

Early castration (before six months old) has a much greater effect on growth and development than later castration. It was shown (Singh, 2000) that Black Bengal and Jamapari kids castrated at 2 months of age had significantly higher daily gain in body weight during 3-6, 6-9, and 3-9 months of age than those castrated at 3 months of age. In addition, kids castrated at two months of age had higher dressing percentage and lower bone percentage in the carcass. On the other instance, castrated Barbari kids that were supplemented with concentrates had shown improved growth rate and carcass yield (Ameha and Mathur, 2000). Similarly, supplemented Adal goats had shown a significant higher dressing percentage than the entire animals. Also, a significant higher price per kg of body weight paid for castrates increased their market value by 10 % Solomon *et al*.(1994). However, studies in Southern and Western highland parts of Ethiopia showed that some farmers castrated goats at the age of 2.5-3 years (Yitaye, 1999).

2.14. Major Goat Diseases

Disease and parasites are source of serious economic losses and one of the main constraints to the development of goat production. 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. The infectious disease of importance in the tropics includes pestesdespetits ruminants (PPR), contagious caprine pleuro-pneumonia (CCPP) and Hemorrhagic septicemia. Other non-infectious and parasites are also cause of serious problems for goat production in Ethiopia (MOA, 1999). Moreover, some of other diseases that have limited the productivity of small ruminants in tropical Africa include Pneumonia, Ecthyma, Coccidiosis, Foot rot, Brucellosis and Lymphadenitis (Adamsun, 1994).

2.15. Breeding Objectives

Breeding objective is the first step to be made in designing of breeding program. A clear understanding of production objective and breeding goal of the farmers (beneficiaries) is an important component of planning of breeding programs (FAO, 2010). The breeding goal identifies the animal traits that farmers would like to be improved. Breeding objectives must

be set at national (macro), regional or local level by stakeholders (and not by outsiders) to truly reflect the real needs of the area and farmers must support the direction of change (FAO, 2010).

Breeding objectives are affected by many factors and have to be considered the needs and priorities of the animal owners or producers, the consumers of animal products, the food industry, and increasingly also the general public. In smallholder and pastoral communities, breeding goals are multi-functional and include many aspects other than high productivity (Taye, 2006). Thus the breeding goal definition in subsistence system needs to take account the diversity of traits (Mueller, 2006). Therefore, the breeding objective and the selection criteria (traits), on which the livestock keepers wish to, improve and their selection should be identified through the full participation of pastoralist and smallholder farmers.

2.16. Breeding Methods

There are two breeding methods in goat production and management. These are natural service and artificial insemination (Jagdish, 2004). However, in different studies Solomon, (2004) and Samuel (2005) in Ethiopia indicate that natural mating was identified as a means to breed different livestock species and almost all farmers practiced this system. In addition, the authors indicated that most farmers get breeding bucks from their own flock. On other study, farmers could also get breeding bucks from their own flock, borrowed, and free mating. The use of borrowed buck and free mating apparently might be for the reasons of small flock size (Workeneh, 1992). In this regard, rearing of young males and females separately until they are old enough for breeding is one of the recommended breeding practices (Devendra, 1983). However, disposing of poorly reproducing females and extra males by farmers who owned relatively larger flock for breeding purpose was reported in southern parts of the country (Workeneh, 1992). Controlled breeding is one of the common breeding practices to increase goat productivity (Jagdish, 2004). However, studies in the country showed that most farmers were not practiced controlled breeding to improve livestock productivity (Solomon, 2004; Samuel, 2005).

2.17. Selection Practices and Selection Criteria

Selection with in indigenous breeds or types is necessary to understand their potential. Only after this process of selection is undertaken and the need for further improvement is justified through cross breeding can be an option (Payne , 1999; Banerjee *et al.,* 2000). Moreover, the basic objective of a breeding net work should be to achieve a steady genetic gain in the selected population. The process would need the identification of a larger number of genetically superior stocks. Furthermore, selection of goats by score-card method for meat and dairy by considering desirable characteristics of different body parts of animals was reported as acceptable (Jagdish, 2004).

Selection criteria for goats are depend on production traits like body size, growth and reproductive performance were ranked higher than adaptive traits. Major criteria for selection of breeding bucks were body size, fast growth rate, fertility and temperament. Body size and ability of sire to give twins have been reported as main criteria for selecting breeding bucks in rural goat production (Addisu *et al.*, 2012). Breeding does were selected mainly based on body size, birth type, and fertility and kid survival. (Ssewannyana, et.al, 2004)

2.18. Constraints to Goat Production

Despite their value to society as a source of milk, meat, cash and security, goat research and Development was neglected for many years. The integration and full utilization of goats is constrained by various factors including high prevalence of diseases, low genetic potential plane of nutrition, poor management and extensive production systems. Of these factors, diseases are rampant and have a significant impact on the performance of animals (Gurmessa *et al*., 2011a). Besides the productivity potential of goats is constrained by a poor understanding of the value of goats and strategies for improved natural resource management in target environments (Webb and Mamabolo, 2004). The current reproduction status of communal goat does is low, mainly due to high kid mortalities and inbreeding (Markos *et al*, 2004). In traditional livestock management, does and bucks run together all year round. Usually one or two bucks are left in the herd for up to five years resulting in inbreeding (Webb and Mamabolo, 2004).

3. MATERIALS AND METHODS

3.1. Description of the Study Area

This study was conducted in Odoshakiso and Adola districts of Guji Zone, Oromia National Regional State. Guji Zone is one of the twenty zones in Oromia Regional State. It is bordered on the south by Borena Zone, on the west by the Southern Nations, Nationalities, and Peoples Region, on the north by the Ganale Dorya River, which separates it from Bale Zone, and on the east by the Somali Region. It is located 600km from Addis Abeba city in south east.."https://en.wikipedia.org/w/index.php? title=Guji_Zone&oldid=517357930".

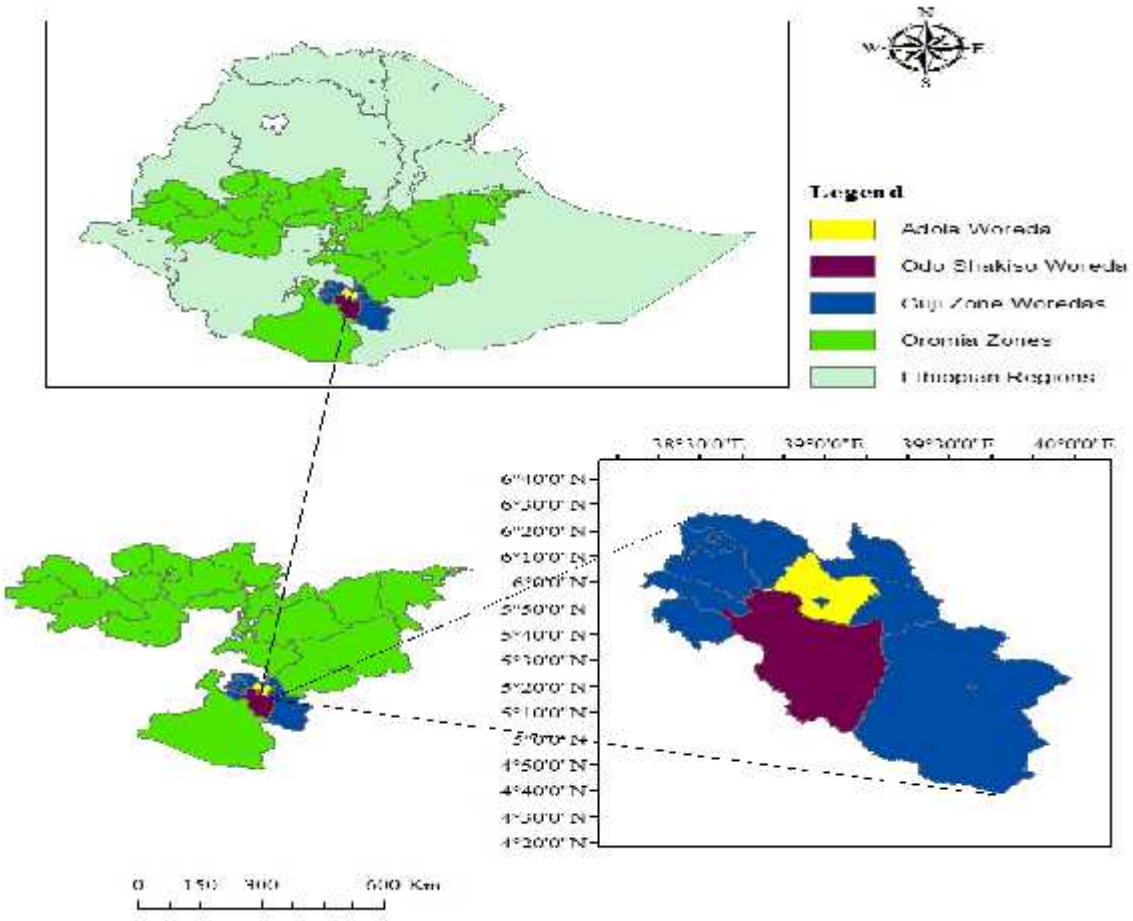

Figure 1. Map of the study area

3.1.1. Odo Shakiso District

Odo Shakiso District is one of the 16 Districts of Guji Zone in Oromia Regional State. It is bordered on the south by the Dawa River which separates it from Arero district of Borena zone on the west by Saba Boru district, on the northeast by Uraga district, on the north by Bore district, on the northeast by Adola district, and on the east by Liben district. It is located at about 139 and 490 km, from zonal town Nagele and the capital city of Ethiopia, Addis Ababa, respectively. The district lies within an altitudinal range between 1500 to 2200 meters above sea level. Temperature of the area ranges between 14℃ and 28℃ with an average of mean annual temperature of about 21℃. The mean annual rainfall is 1800 mm. (OSWLCRDO, 2015). This district is located at latitude and longitude of 5°45′N 38°55′E 5°N 38.917°E .

According to the Central statistical Agency (CSA , 2015), this district has an estimated total population of 133,466, of which 63,954 are men and 69,512 are women; and 31,559 or 23.65% of the population are urban dwellers, which is greater than zone average of 11.6%. With an estimated area of 4,144.53 square kilometers. The district has an estimated population density of 32.2 people/sq km, which is greater than zone average of 21.1 sq/ km. The crops grown in this district include maize, teff, wheat, sorghum, enset and fruits like banana, papaya, and avocado. Coffee is an important cash crop in this district and over 5,000 hectares of coffee in the district were planted. Odo Shakiso has an estimated cattle population of 132990, sheep 28411, goats 47700, horse 8755, mule 6366, donkey 13593, camel 120 and poultry 129600 (OSWLCRDO, 2015) .

3.1.2. Adola District

Adola District is one of the 16 Districts of Guji Zone in Oromia Regional State with an estimated area covering 3,064.22 square kilometers. This district has an estimated total population of 194,574, of which 95,722 are male and 98,852 Female; 43,052 or 22.13% of its population are urban dwellers, which is greater than zone average of 11.6% (CSA, 2015). It has an estimated population density of 63.5 people/ sq km, which is greater than zone average of 21.09. The altitude of this district ranges from 1500 to 2500 meters above sea level. The district has 33%, 24%, 30%, 20% and 17% of arable, under cultivation, pasture, forest, and the other considered as swampy, degraded or otherwise unusable, respectively. State forests

include Wadera, Zenbaba and Anferara. Khat, coffee banana and enset are important cash crops in the district. The district capital town is Adola which is located 120 km away from zonal town of Negele and 470 km from Addis Ababa. It shares border on the south with Liben district, on the southwest with Odoshakiso district, on the west with Ana sora district, on the north with the Southern Nations Nationalities, and Peoples Region, and on the east with Balezone. Temperature of the area ranges between 12℃ and 28℃ with an average of mean annual temperature of about 20℃. The mean annual rainfall is 1700 mm."https://en. wikipedia. org/w/index. php?title= Adola&oldid=639086013. The district has an estimated cattle population of 135893, sheep 6974, goats 84608, horse 2908, mule 2740, donkey 18979, and poultry 69009 (AWLCRDO, 2015). This district is located at latitude and longitude of 6° 0′ 0″ N, 39° 5′ 0″ E.

3.2. Site selection and Sampling Technique

Study sites/districts were selected purposively based on the production system, concentration of goat population, seasonal livestock movement patterns, accessibility and security. A rapid field survey was done before the main survey to know the distribution and concentration of indigenous goat types, breeding and husbandry practices of the area to establish sampling framework from which sampling of kebeles were taken. Information was collected from District Agricultural Office. Four rural kebeles per districts (Korba, Didola, Dibabate and Reji from odoshakiso and Odo buta, Dhadale cana Gunaco and bilu from Adola Districts), with a total of eight rural kebeles having similar production system and Goat population were purposively selected. Seventeen house hold per kebele and a total of 136 households (68 from OdoShakiso and 68 from Adola districts) were randomly selected. Four matured and unrelated goats per household and a total of 544 adult goats (163 adult male and 381 adult female) were selected for linear body measurement from 136 selected households (Table 2). For each household survey, structured and pre-tested questionnaire was used. The structured questionnaires are adopted to collect all the relevant information in a single visit formal survey method (ILCA, 1992).

Table 2 . Summary of the total number of samples

District	Sample site	Liner body measurement			Household	FGD
		Adult Female	Adult male	Total		
OdoShakiso	4	190	82	272	68	4
Adola	4	191	81	272	68	4
Total	8	381	163	544	136	8

** FGD = Focus group discussion

3.3. Data type and Methods of Data Collection

Data was collected using pretested semi-structured questionnaire and focus group discussion with key informants like elders, privileged farmers and development agents.

3.3.1. Focus Group Discussion

A focus group discussion was carried out with four groups per district which have six to ten individuals. The discussions were held with extension workers, livestock experts, development agents (DAs), model pastoralist/agro-pastoralist, village leaders, elders, women and socially respected individuals. Information about the overall production potential of the livestock, the production constraints, information regarding the origin of breed, trend in population, special character of the breed, cause of mortality, production system, husbandry practice, breeding methods and merits and demerits of keeping the breed were collected from focus group discussions using key informant interviews.

3.3.2. Survey

Modified questionnaire was prepared using standard description list developed by FAO (2012).The structured questionnaire was pre- tested and administered to collect information on existing goat production and husbandry practices from each selected flock owners. These questionnaires were designed to address both description of the socio-economic practices of the community, description of the production environment and goat husbandry practices, history of origin, composition of livestock species, productivity, reproductive performance, selection criteria for mating, management practices, feed resource utilization and availability, animal health condition, disease and cause of mortality, trends in population and production

constraint, information on socio-economic condition of each household family size and their major sources of income was collected.

3.3.3. Data on Qualitative and Quantitative Traits

Data on Qualitative and Quantitative Traits on matured unrelated animals were collected as follows.

3.3.3.1. Qualitative traits data collection

The standard breed descriptor list developed for goat by FAO (2012) was closely followed in selecting morphological variables. Data for qualitative variables like coat color pattern, coat color type, head profile, ear orientation, presence or absence of toggle, bear, wattle, horn, horn shape, muzzle and ruff were recorded using individual interviews, focus group discussion and observation of the animal. Each animal was identified by its sex and dentition. Dentition record was taken to estimate the age of the animal.

3.3.3.2. Quantitative trait data collection

The standard breed descriptor list for goat developed by FAO (2012) was closely followed in selecting morphological variables. Quantitative trait like body weight (BW), body length (BL), heart girth (HG), wither height (WH), pelvic width (PW), ear length (EL) were measured using plastic measuring tape. For males scrotal circumference (SC) was also measured. Body weight was measured using suspended spring balance having 50kg capacity with 200g precision. The measurement was made on animals that are classified based on sex, district and age group. Animal's age classification was made using dentition technique supplemented with owner's information. Adult and unrelated goat was classified into three age group; 1PPI (one pair of permanent incisor), 2PPI (two pair of permanent incisor), ≥3PPI (three pair of permanent incisor) based on the description of African goat (Wilson and Durkin,1984).

3.4. Data Management and Analysis

Preliminary data analysis like homogeneity test, normality test and screening the outliers was employed before conducting the main data analysis. All the collected data was double-checked for any types of errors occurred during data collection and entry. Then statistical data analysis used depends upon the nature of the data and outlined as follows.

3.4.1. Descriptive statistics

Data collected through questionnaire was described by descriptive statistics using statistical package for social sciences (SPPS 20) and chi-square test was employed to test the assumption of equal proportion between the categorical variables in districts. F-test was applied when required to test the statistical significance. Statistical analyses were made separately for male and female animals on variables that varied on sex; otherwise, the data was merged and analyzed together.

Index was calculated for ranked data to provide ranking of the reasons of keeping goats, breeding objective, buck and doe selection criteria, contribution of different farming activities to the family food and income and major goat production constraints. Indices were calculated as Index = Σ of [3× number of household rank first + 2 × number of household rank second + 1× number of household rank third] given for particular purpose of keeping goat divided by Σ of [3× number of household rank first + 2 × number of household rank second + 1× number of household rank third] for over all purpose, criteria or preferences of keeping goat according (Musa et.al. 2006) . 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 (ΔF) and effective population size were calculated as

$\Delta F = \frac{1}{2N}$, Ne= $4(N \times N) / (N + Nm)$

Where ΔF=Rate of change in inbreeding

Ne=the effective population size

NM = number of breeding male population

NF= number of breeding female population

3.4.2. Univariate Analysis

General linear model procedure (PROC GLM) of statistical analysis system (SAS, 9.1, 2008) was employed to analyze quantitative variables to determine effects of class variables (sex, district and age class). Sex, district and age groups of the goat were fitted as independent variables while body weight and other linear body measurements were fitted as dependent

variables. The effect of class variables and their interaction was expressed as least squares means (LSM±SE). When analysis of variance declared significant difference, least squares means was separated by using adjusted Tukey-Kramer test. Only variable with significant differences among fixed effect were discussed.

Model used for male and female to analyze body weight and other linear body measurements (LBMS) using multiple regressions except scrotal circumference (SC) and scrotal length (SL) are:-

$Y_{ijkl} = \mu + A_i + S_j + D_k + A_i*S_j + Ai*Dk + Ai*Sj*Dk + e_{ijkl}$

Where:

Y_{ijkl} = the observiation on l^{th} animal (body weight or LBMs) in the *ith* age group, *jth* sex and *k*th district

μ = overall mean,

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

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

D_k = the effect of k^{th} district (k =Odo shakiso and Adola)

A_i*S_j = age by sex interaction and

Ai*Dk=age by district interaction

Sj*Dk=sex by district interaction

Ai*Sj*Dk= age, sex and district interaction

e_{ijkl} = random residual error

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

$Y_{ikl} = \mu + A_i + D_k + Ai*Dk + e_{ijk}$

Where: Y_{ikl} = the observed *l* (SC or SL) in the *i*th age group and *k*th district

μ = overall mean

A_i = the effect of *i*th age group (i = 0, 1, 2, >3) PPI

D_k = the effect of *k*th district (k = Odoshakiso and Adola) and

Ai*Dk= age by district interaction

e_{ikl}= random residual error

3.4.3. Multivariate Analysis

Multiple correlations were used to estimate the correlation between body weight and linear body measurements. The stepwise multiple linear regression analysis was done to obtain models for estimation of live body weight from other linear body measurements for males and females using stepwise procedure of SAS in order to determine the best fitted regression equation for the prediction of body weight . Selection of variables at ($p \leq 0.05$) was employed by incorporating all variables at the same time to see the order of selected variables and then stepwise regression analysis was made. Best fitted model was selected based on the smaller value of conceptual predictive criterion C (P), Alkaike‟s Information Criteria (AIC), Root Mean square of error (R MSE) and Schwarz Bayesian Criteria (SBC) and the higher value of Adjusted R^2 and simplicity of measurement under field condition to determine those trait that contribute much to response variables (Kaps and Lamberson, 2004).

The quantitative variables from female and male animals were separately subjected to discriminant analysis (PROC DISCRIM of SAS 9.1, 2008) and canonical discriminant analysis (SAS 9.1, version, 2008) to determine the existence of population level phenotypic differences in the study area. The analysis was performed taking individual animals as a unit of classification.

The following models were used For the Analysis of Multiple linear regressions

I. For Females

$Yj = \beta0 + \beta1X1 + \beta2X2 + \beta3X3 + \beta4X4 + \beta5X5 + \beta6X6 + ej$

Where: Yj = the dependent variable body weight

$\beta0$ = the intercept, X1, X2, X3, X4, X5 and X6 are the independent variables; Heart girth, height at wither, body length , pelvic width, ear length and horn length, respectively. $\beta1$, $\beta2$, $\beta3$, $\beta4$, $\beta5$ and $\beta6$ are the regression coefficients of the variables X1, X2, X3, X4, X5 and X6, respectively.

ej = the residual error

II. For Males

$Yj = \beta0 + \beta1X1 + \beta2X2 + \beta3X3 + \beta4X4 + \beta5X5 + \beta6X6 + \beta7X7 + \beta8X8 + ej$

Where: Yj = the dependent variable body weight

$\beta0$ = the intercept, X1, X2 , X3 , X4 , X5, X6, X7 and X8 are the independent variables; Heart girth, height at wither, body length, pelvic width, ear length, horn length, scrotal

circumference and scrotal length, respectively. β1, β2, β3, β4, β5, β6, β7 and β8 are the regression coefficients of the variables X1, X2, X3, X4, X5,X6, X7 and X8, respectively.

e*j* = the residual error

3.4.4. Mahalanobis distances discriminant analysis.

The PROC DISCRIM of SAS 9.1, version 2009 was employed to obtain the Mahalanobis distances and linear discriminant functions. The ability of these functions to identify (both sex inclusive) was indicated as the percentage of individuals correctly classified from the samples that generate the functions. The honesty (reliability testing) of the functions was validated using split-sample validation (cross-validation).

4. RESULTS AND DISCUSSIONS

4.1. General Household Information

Household characteristics in the study area are indicated in Table 3.The average family size in the study area were 9.1±0.45 and 10.5±0.56 for Odo shakiso and Adola disrticts, respectively. This is attributed to high need of labor for rearing of livestock activities. The average family size for both districts (9.8±0.36) was higher as compared to the report of Alefe (2014) where average family size was 6.93 for Gode, Adadle and Denan districts. This could be due to lack of using family planning and change of awareness towards the culture of polygamy in the area.

The majority of the households in the study area were male headed. Female headed were about 25% and 16.2% for Odo shakiso and Adola districts, respectively. In both districts, female headed households were lower than the male headed; which is similar with the report of Tesfaye (2008) in Menz area where 89.2% were male headed while only 10.8% were female headed. Workneh and Rownalds (2004) also reported that the majority of the households (94%) in Oromia region were male headed while the rest 6% were female headed. The occurrence of less percentage of women respondents in the study areas may be due to work load inside the house and as a result the probability of getting them outside of the house is less.

According to respondents in this study, the overall proportions of married, unmarried and divorced households were 97%, 2.2% and 0.8%, respectively. Overall 42.65, 7.35 and 50 % of the respondents were illiterate, religious education and literate, respectively. From the two Districts higher number of respondents with preparatory level of education was found in Odo Shakiso District. Even though, there are primary schools in each peasant association, 42.6% of the respondents do not go to school across both districts. This might be due to presence of different minerals in the area, like Tantalem and gold mining were main activity in both districts which needs daily labor force. The results of the present study were indifferent with illiterate level of education (56.89%) in east Harrerghe Mahilet (2012). Large proportions of respondents were within an age of 31 to 45 years (49.2%). This indicates that the community is in high productive age group. Position of respondents in the household were 83.1% household head, 11.8% spouse of head, 0.75% son of the head and the rest 4.4% are relatives.

Table 3. General household's information

Variable	**Odo shakiso**		**Adola**		**Overall**	
Family size (Mean± SE)	9.1±0.45		10.5±0.56		9.8±0.36	
	N	%	N	%	N	%
Sex of the head of house hold						
Male	51	75	57	83.8	108	79.4
Female	17	25	11	16.2	28	20.6
Position in household						
Household head	56	82.4	57	83.8	113	83.1
Spouse of head	8	11.8	8	11.8	16	11.8
Relatives	3	4.4	3	4.4	6	4.4
Son of the head	1	1.5	-		1	0.75
Marital status						
Married	65	95.6	67	98.5	132	97
Divorced	2	2.9	1	1.5	3	2.2
Single	1	1.5	-	-	1	0.8
Education level						
Illiterate	31	45.6	27	39.7	58	42.65
Religious school	1	1.5	9	13.2	10	7.35
Literate	36	52.9	32	47.05	68	50
Primary (1-8)	21	30.9	25	36.8	46	33.85
Secondary (9-10)	9	13.2	6	8.8	15	11
Preparatory(11-12)	6	8.9	1	1.5	7	5.2
Age structure (year)						
≤30	14	20.6	12	17.6	26	19.1
31-45	31	45.6	36	52.9	67	49.25
46-60	12	17.6	16	23.5	28	20.55
61-75	7	10.3	4	5.9	11	8.1
≥75	4	5.9	-		4	2.95

N= Number of respondents; SE=Standard error. Means with the same letter within the same row and class are not significantly different at p (0.05)

4.2. Farming Activities

Farming activities in the study area is indicated in Table 4. In the study area, livestock rearing and crop productions are the main farming activities for the livelihood of the respondents. Among the farming activities livestock rearing was practiced by 48.5 and 39.7%, of the respondents in Odo shakiso, and Adola districts, respectively. In Odoshakiso both crop and

livestock production were higher than Adola districts. This may be due to in Odo shakiso more favorable agro-ecology for livestock production and large land holding per respondents. This implies that the livelihoods of the society in the study area are based on livestock production. This was due to frequent crop failure by insufficient rainfall. The result was in agreement with Endashaw (2007) in which farmers in the pastoral and agro-pastoral areas give livestock production the highest priority than crop.

Table 4. Farming activities in the study area

Farming activities	Odo shakiso		Adola		Overall	
	N	%	N	%	N	%
Livestock rearing	33	48.5	27	39.7	60	44.1
Crop production	15	22.1	11	16.2	26	19.2
Mixed	20	29.4	30	44.1	50	36.8
Total	68	100	68	100	136	100

N= Number of respondents

4.3. Goat Ownership in the Family

Goat Ownership in the family is shown in Table 5. The whole family owned higher proportions of goats. The proportions of goats owned by husband alone and wife alone were 16.9 and 10.3%, respectively. This study indicates that 48.5% of the respondent owned goat by all family members. This shows that ownership of goat by all family members is the main features of the study area and small ruminant were not owned by female and children as observed in many areas in Ethiopia, but they are the resource of the family**.** This result was indifferent or higher than with the finding of Tesfaye (2009), in which female owned (29%) in Metema district.

Table 5. Goat Ownership in the Family

Member of house hold own goat	**Districts**		**Overall**
	Odo shakiso	**Adola**	**N (%)**
	N (%)	**N (%)**	
Husband	10(14.7)	13(19.1)	23(16.9)
Wife	9(13.2)	5(7.4)	14(10.3)
Husband and Wife	13(19.1)	8(11.8)	21(15.5)
Children	5(7.4)	7(10.3)	12(8.8)
All family members	31(45.6)	35(51.5)	66(48.5)
Total	68(100)	68(100)	136(100)

N= Number of respondents

4.4. Member of Household Responsible for Goat Activities

Labor division for the routine goat Husbandry activities by the household in the study area is presented in Table 6. Work sharing was common and in all activities both male and female can do the job interchangeable, except milking and selling dairy product which are dominated by the female and purchasing and selling activities were for males greater than fifteen years old especially for the household head. This was in agreement with the report of Gurmesa *et al* (2011a) in Arsi Negelle district. This was due to culture of the area, that in the presence of the female, male cannot milk and in case of purchasing and selling activities males household head are believed to be knowledgeable to select the best breeding doe and buck when purchase and can sell animals at best price by negotiation.

Table 6. Member of house hold responsible for goat activities in the study area.

Activity	Family member							
	<15 Year				>15 Year			
	male		Female		male		female	
	N	%	N	%	N	%	N	%
Milking	2	1.4	45	33	-	-	89	65.5
Purchasing goat	22	16.2	7	5.2	80	58.8	27	19.8
Selling goat	17	12.5	10	7.4	85	62.5	24	17.6
Herding	55	40.4	40	29.4	25	18.4	16	11.8
Breeding	25	18.4	18	13.2	60	44.1	33	24.3
Feeding	27	19.8	24	17.6	39	28.7	46	33.8
Caring for sick animals	22	16.2	19	14	40	29.4	55	40.4
Making dairy products	-	-	55	40.4	-	-	81	59.5
Selling dairy product	4	2.9	44	32.4	-	-	88	64.7
Barn cleaning	30	22	39	28.7	40	29.4	27	19.8

N= Number of respondent

4.5. Livestock Species in the Study Area

Livestock species in the study area is indicated in Table 7. The major livestock species in the study area were cattle, goat, sheep, donkey, horse, mule, camel and chicken. In the study area the average goat per households were higher followed by cattle. 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. In this study area camel population was lower and totally absents in Adola district which may be due to agro-ecology and lack of feed availability for camel production in the study area. The mean flock size of goats per household is 12.2 and 11.7 for Odo shakiso and Adola districts, respectively. The overall goats per house hold in the study area was comparable with the report of Tesfaye *et al*(2011b) with flock per household of 12.1 in Adami Tullu Jidu Kombolcha district of central shoa. On the contrary, the present result is higher than the report of Deribe (2009) for southern Alaba and Dale

districts (4.5 to 6.5) and Mahilet (2012) for east Hararghe 8.12.These might be due to agro-ecology and high grazing land per households in this study area

Table 7. Number of the Livestock species in the Study Area

Livestock	**District (Means ± SE)**		
	Odo shakiso	Adola	Overall
Cattle	15.3±1.2	14.9±1.6	15.1±1.4
Goat	12.2±1.6	11.7±1.3	11.9±1.5
Sheep	4.8±1	1.8±0.2	3.3±0.6
Donkey	2.8±0.2	2.4±0.2	2.6±0.2
Horse	-	-	-
Mule	1.3±0.3	1±0.0	1.2±0.2
Camel	0.8±0.1	-	0.4±0.05
Chicken	13±1.5	14.6±1.5	13.8±1.5

SE= standard error

4.5.1. Trend of major livestock population and communal grazing land

Trend in livestock population and communal grazing land in the study area is presented in Table 8. Over all, the respondents explained cattle population as compared to the past were 31.6, 66 and 2.3% increasing, decreasing and stable, respectively. This study indicated that the trend of goat population is increasing as reported by 66.2% of the respondents. This might be due to high rate of reproduction, short generation interval, relative resistance to drought and relative requirement of less feed and water were major reasons for increment in goat population. This study shows that communal grazing was decreasing in the past ten years. The major reason in decreasing communal grazing land in the study area was due to increasing of human population and expansion of crop cultivation.

This finding was congruent with the report of Tesfaye *et al*.(2012), Trend of communal grazing land reported by respondents were 18.4% stable, 7.4% increasing, 61% decreasing and 13.3 % unknown.

In the study areas, goat production is being given higher emphasis today. The primary reasons for this in both districts were due to frequent drought occurrence. In this regard, 66.2% of the respondents believed that the trend of goat population in the study area is increasing. Similar perceptions of increasing trend in goat population were also reported in the study by Mahilet (2012) in eastern Hararghe. In addition to the above mentioned reasons for increasing of goat population in the study area the other factors that contribute for increasing trend of goat were watering point development and expansion of veterinary and vaccination service.

Table 8. Trend of major livestock population, communal grazing land and goat population in the last 10 years in the study area based on respondent response

Trends	Odo shakiso	Adola	Overall
	N (%)	N (%)	N (%)
Goat			
Increase	50(73.5)	40(58.8)	90(66.2)
Decrease	16(23.5)	27(39.7)	43(31.6)
Stable	2(3)	1(1.5)	3(2.3)
Cattle			
Increase	13(19.1)	30(44.1)	43(31.6)
Decrease	53(77.9)	37(54.4)	90(66)
Stable	2(3)	1(1.5)	3(2.3)
Sheep			
Increase	40(58.8)	25(36.8)	65(47.8)
Decrease	26(38.2)	42(61.8)	68(50)
Stable	2(2.9)	1(1.5)	3(2.2)
Camel			
Increase	18(26.5)	22(32.4)	40(29.5)
Decrease	48(70.6)	44(64.7)	92(67.6)
Stable	2(2.9)	2(2.9)	4(2.9)
Goat population in the last 10 years			
Increase	47(61.8)	37(54.4)	84(58.1)
Decrease	17(25)	28(41.2)	45(33.1)
Stable	9(13.2)	3(4.4)	12(8.8)
Communal grazing land			
Increase	4(5.9)	6(8.8)	10(7.4)
Decrease	44(64.7)	39(57.4)	83(61)
Stable	10(14.7)	15(22.1)	25(18.4)
Unknown	10(14.7)	8(11.8)	18(13.3)

N= Number of respondents

4.5.2 Goat Flock Structure

Goat flock structure is presented in Table 9. The flock owner determines the flock composition on the basis of economic and management considerations. The age and sex structure of goat flocks were almost similar across both districts. Overall, females more than one year old constituted 36.3% of the whole population while males of the same age made up only 10% of the population. This is; an agreement with FARM-Africa (1996) who found high proportion of females reflecting the owners' desire for milk.

The ratio of male greater than one year of age and their female counterparts was 1:3.6. This is close to the finding of Wilson and Durkin (1988) who reported that for small ruminants in traditional livestock production systems of Africa the ratio was 1:4 up to 1:6. Keeping of high proportion of female goats, imply the production of larger number of kids which has direct impact on selection intensity. The percentage of castrated males was 6% of the whole population while male and female kids less than 6 month of age made up to 17.4% and 22.5% of the whole flock, respectively. Out of the total kids with less than six months of age 56.4% were female and 43.6% were males. This may be due to cultural practice of selling and slaughtering of male goats and need of female goats for milk consumption and production purpose. This is comparable to the study of Grum (2010), who reported 52.5% female and 47.7% males for DireDawa administration. Within a given flock in the study areas the first and second highest proportions were females greater than one year and kids (both sex) less than six months, respectively, which is in agreement with study of Biruh (2013) on Woyto Guji goats in low land areas of south Omo zone. High proportion of kids within a flock might be an opportunity to increase the selection intensity which in turn increases production and productivity within a short period of time.

Table 9. Goat Flock Structure

Goat flock	Odo shakiso			Adola			Overall		
Structure	Sum	Mean±SD	%	Sum	Mean±SD	%	Sum	Mean± SD	%
< 6 month male kids	145	2.1±0.3	17.4	139	2±0.5	17.4	284	2±0.4	17.4
< 6 month female kids	195	2.8±0.5	23.4	172	2.5±0.6	21.6	367	2.7±0.5	22.5
Male 6 month to 1 year	31	0.4±0.1	3.7	22	0.3±0.1	2.7	53	0.4±0.1	3.25
Female 6 month to 1 year	37	0.5±0.2	4.4	36	0.5±0.15	4.5	73	0.5±0.18	4.47
Male>1 year (Intact)	76	1.1±0.3	9.1	87	1.3±0.7	11	163	1.2±0.5	10
Female>1 year (Intact)	293	4.3±0.9	35.2	298	4.4±1	37.4	591	4.3±0.95	36.3
Castrated male	56	0.8±0.3	6.7	43	0.6±0.25	5.4	99	0.7±0.28	6
Total	833	12±2.6	100	797	11.6±3.3	100	1630	11.8±0.29	100

SD = standard deviation

4.6. Goat Housing System

The most dominant housing system in the study area (Table 10) was separate house (79.5%) followed by open yard (11%) and in family house (7.7%). It was in agreement with the report of Belete (2013), in which the farmers in Mada Walabu district housed their goats in separate house (58.3%) followed by yard (30%) and kraal (10%). 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. They have house for their goat throughout the year in the night time to protect them from rain, cold, predators and theft. In the study area, kids are housed separately from adult (91.1%). Similarly, goats are housed together with sheep (56.7%) but housed separately from cattle (100%). This was higher as compared to the finding of Dhaba *et al*. (2012a), in which majority of household (47%) were housed their goats with sheep.

Table 10. Housing and housing materials for goats in the study area

	Districts					
	Odo shakiso		Adola		Overall	
Type of house	**N**	**%**	**N**	**%**	**N**	**%**
In family house	2	2.9	8	11.8	10	7.3
Separate house	59	86.8	49	72.1	108	79.5
Veranda	-	-	3	4.4	3	2.2
Open yard	7	10.3	8	11.8	15	11
Housing Materials of roof						
Iron sheet	-		-	-	-	-
Grass/bushes	49	72.1	36	53	85	62.6
Wood	19	27.9	29	42.6	48	35.2
Kinda/plastic sheet	-	-	3	4.4	3	2.2
Housing material of wall						
Wood	60	88.2	67	98.5	127	93.4
Stone/bricks	1	1.5	-	-	1	0.75
Mud	7	10.3	1	1.5	8	5.9
Concrete						
Kid housed with adult						
Yes	8	11.8	4	5.9	12	8.9
No	60	88.2	64	94.1	124	91.1
Goat housed with cattle	-	-	-	-	-	-
Yes	68		68	100	136	100
No	100					
Goat housed with sheep						
Yes	40	58.9	37	54.4	77	56.7
No	28	41.1	31	45.6	59	43.3

N= Number of respondents

4.7. Weaning Practices

Milk feeding up to weaning and weaning age of kid in the study area is indicated in Table 11. Over all, most of the house hold practiced restricted milk feeding (82.3%), while the rest 13.3% and 4.4% practiced unrestricted and bucket feeding, respectively. In the study area, the majority of the respondents weaned their kids from 3-4 months. This was because kids were consuming adequate amounts of solid feed during this age and to increase body weight. Hence, weaning age of less than three month is considered to have subsequent effect on kid growth, weights and survival.

Table 11. Milk feeding up to weaning and weaning age of kid in the study area

Parameter	Odo shakiso		Adola		Overall	
	N	%	N	%	N	%
Milk feeding						
Unrestricted	7	10.3	11	16.2	18	13.3
Restricted	59	86.8	53	77.9	112	82.3
Bucket feeding	2	2.9	4	5.9	6	4.4
Weaning age						
< 3 month	19	27.9	22	32.4	41	30.1
3-4 month	37	54.4	30	44.1	67	49.3
4-5 month	11	16.2	9	13.2	20	14.7
>5 month	1	1.5	7	10.3	8	5.9

N= Number of respondents

4.8. Herding Practice

About 67.7% of the respondents herd kids separately from the adult goats. The reason is that milk is the main product for the society, which causes competition with kids. These figures were different from the report of Tesfaye (2010) who reported that about 52% of goats in Adami tulu Jido kombolcha district were mixing kids with adult. This might be due to higher land holding per households and high competition with kids for milk in these study area. About 72 and 28 % of the respondents did not mix their flock with neighbors and mixed their flock with neighbors respectively. This was due to decreasing communal grazing land in the area and most of the respondents herding their flocks in their own enclosure *(kalo).*

A good understanding of the community's herding practices is crucial to bring sustainable improvement in the smallholders flock through community-based strategies (Sölkner-Rollefson, 2003). It was shown that goat was kept with other livestock particularly with sheep in the study areas.

Table 12. Ways of herding and flock herding in the study area

Parameter	Odo shakiso		Adola		Overall	
	N	%	N	%	N	%
Flock herding						
Male and female separated	1	1.5	4	5.9	5	3.7
Kids are separated	47	69.1	45	66.2	92	67.7
All class herded together	20	29.4	19	27.9	39	28.6
Ways of herding						
Goat of a household run as a flock	50	73.5	48	70.6	98	72
Goat of more than one household run as a flock	18	26.5	20	29.4	38	28

N= Number of respondents

4.9. Goat Market and Age of Culling

The average market and culling age of goats are presented in Table 13. From the interview conducted in Odo shakiso and Adola districts the average market age of male were 12.1 and 12.3months, respectively where as their female counterpart were13 and 13.3 months, respectively. The mean overall market age was 12.1 and 13.2 month for male and female goats, respectively; indicating that male goats reach market age earlier than female goats. Culling in goat flock is an important tool for the development of a good flock. It helps to remove undersized animals and breed those closest to the desired ideal type (Girma and Alemu, 2008). Reasons for culling could be different for different systems and agro-ecologies. In the studied areas the reasons for culling of goats were age, long kidding interval and low milk yield. Average culling ages of male goat in Odo shakiso and Adola district were 6.8, and 7 years whereas their female counterparts were 7.5 and 7.6 years, respectively.The overall, the mean culling age for goats in the study area was 6.9 and 7.6 years for male and female goats, respectively. This figure show that male in the study area culled early than females this might be the pastoralist and agro-pastoralist in the area sold males in the needs of money and mitigates for crop failure and stay female in the flock up to it became old, to increase number and productivity of their flocks.

Table 13. Average market and culling age of goat reported by respondents

Parameter	Odo shakiso		Adola		Overall	
	N	Mean	N	Mean	N	Mean
Market age (months)						
Male	68	12.1	68	12.3	136	12.2
Female	68	13	68	13.3	136	13.2
Culling age (years)						
Male	68	6.8	68	7	136	6.9
Female	68	7.5	68	7.6	136	7.6

N= Number of respondents

4.10. Watering Practice

4.10.1. Water source and frequency of watering

Water source and frequency of watering in the study area is shown in Table 14. The major water sources in the study area were borehole, dam/pond, river, spring, pipe water and rainfall water. According to the respondents, 52.9 and 42.6% of the major water sources were pond and river, pond and rain water in dry and wet season respectively in Oda Shakiso district respectively. In Adola district, the major water source was water well and river (47.1%) and Pond and Rain water (50%) in dry and wet season, respectively. Frequency of watering varied according to respondents and seasons. Practice of watering the goat flock was primarily carried out by taking them to the nearby water points. In Odoshakiso district, the major frequencies of watering were once in two days and freely available in dry and wet season, respectively. In Adola district, the major frequencies of watering were once a day and freely available in dry and wet season, respectively. This results was in accordance with the study of (Belete, 2013) described that in Bale zone goats were watered freely and once in two days in wet and dry season respectively. But different with the study of (Mahilet, 2012) in East Hararghe majority of households allowed their flock to drink water freely and once a day. The result of this study shows that in dry season water scarcity was more pronounced in Odo-Shakiso than Adola district.This was due to majority of water sources in odoshakiso was manmade (dam and pond) which were dried during long dry season.

Table 14. Water source and frequency of watering in dry and wet season in the study area

Districts	parameter	Dry Season		Wet Season	
		HH	%	HH	%
	Water Source				
O	Borehole/water well	3	4.4	8	11.8
D	Dam/pond	2	2.9	4	5.9
O	River	9	13.2	-	-
SH	Spring	-	-	-	-
A	Pipe Water	-	-	-	-
K	Rain water	-	-	1	1.5
I	Pond and River	36	52.9	-	-
S	River and Pipe water	18	26.5	-	-
O	Pond and spring	-	-	26	38.2
	Pond and Rain water	-	-	29	42.6
	Total	68	100	68	100
	Frequency of watering				
	Freely available	3	4.4	45	66.2
	Once a day	5	7.4	23	33.8
	Once in 2 day	49	72.1		
	Once in 3 day	11	16.2		
	Total	68	100	68	100
A	**Water Source**				
	Borehole/water well	2	2.9		
D	Dam/pond	1	1.5	10	14.7
	River	1	1.5	4	5.9
O	Spring	1	1.5		
	Pipe Water	-	-		
L	Rain water	-	-		
	Dam/Pond and River	13	19.1		
A	River and Pipe water	18	26.5	20	29.4
	Water well and river	32	47.1		
	Pond and spring	-	-		
	Pond and Rain water	-	-	34	50
	Total	68	100	68	100
	Frequency of watering				
	Freely available	6	8.8	48	70.6
	Once a day	36	52.9	20	29.4
	Once in 2 day	21	30.9	-	-
	Once in 3 day	5	7.4	-	-
	Total	68	100	68	100

HH=Households

4.10.2. Quality and distance of water source

The quality and distance of water in the study area are summarized in Table 15. According to respondents the quality of majority of water sources in both district were: clean and muddy in dry (70.6 and 15.4%) and wet (57.3 and 42.7%) seasons, respectively. The overall distance of water were: majorly categorized between < 1km (20.6 and 77.2%) and1-5 km(58.9 and 15.4%), in dry and wet seasons, respectively. This was in agreement with the report of Teshome *et al*. (2010) who described that in Rayitu district majority of the respondents were traveled a distance of less than one km in wet and 1-5 km in dry season to the watering point.

Table 15. Quality and distance of water in the study area

Parameter	**Odo shakiso N (%)**		**Adola N (%)**		**Overall N(%)**	
	D.S	W.S	D.S	W.S	D.S	W.S
Quality of water						
Clean	46 (67.7)	38(55.9)	50(73.5)	40(58.8)	96(70.6)	78(57.3)
Muddy	10 (14.7)	30(44.1)	11(16.2)	28(41.2)	21(15.4)	58(42.7)
Salty	- -	- -	- -	- -	- -	- -
Smell	12 (17.6)	- -	7(10.3)	- -	19(14)	- -
total	68 (100)	68(100)	68 (100)	68 (100)	136(100)	136(100)
Distance of water						
At home	- -	3(4.4)	- -	7(10.3)	- -	10(7.3)
< 1km	11(16.2)	46(67.6)	17(25)	59(86.8)	28(20.6)	105(77.2)
1-5 km	42(61.8)	19(27.9)	38(55.9)	2(2.9)	80(58.9)	21(15.4)
6-10 km	13(19.1)	- -	10(14.7)	- -	23(16.9)	- -
> 10km	2(2.9)	- -	3(4.4)	- -	5 (3.6)	- -
total	68(100)	68(100)	68(100)	68(100)	136(100)	136(100)

N= Number of respondents, D.S=*Dry Season, W.S=Wet Season*

4.10.3. Grazing lands in the study area

Land holding for cultivation, grazing and fallow land in the study area is present in Table 16. In the study area, land devoted for livestock production including crop land, *Kalo* (grazing land) and fallow land took the highest proportion. The overall land holding per household in the study area was 8.5 hectares (Table 16).

This finding was larger as compared to the report of Belete (2009) (1.93 ha) in Goma district, Tesfaye *et al*. (2012) (1.5-3 ha) in central Shoa, Sisay (2006) in Metema district (6.17 ha) and Tsedeke (2007) in Alaba district

Table 16. Grazing land (ha) in the study area

Types of grazing land	**Districts (MEAN ± SE)**		**Overall (ha)**
	Odo shakiso (ha)	**Adola (ha)**	
Crop land	4.9±0.36	4.7±0.44	4.8±0.28
Fallow land	1.4±0.17	1.4±0.16	1.4±0.13
Grazing land	2.6±0.29	2±0.24	2.3 ±0.19
Total	8.9±0.82	8.1±0.84	8.5±0.83

SE=standard error; ha= hectare,

4.11. Feed Resource and Grazing Method in the Study Area

4.11.1. Feed resource

Feed resources commonly used by pastoralists in the study area across the different seasons are presented in Table 17. The quantity and quality of feed resources available for animals primarily depends upon the climatic and seasonal factors (Zewdu, 2008). In this study, natural pasture, hay (standing hay), shrubs and bushes and crop residue are the main feed resources during dry and wet season. During dry season, shrubs and bushes (index = 0.50) and natural pasture were the major feed resources with an index of 0.5 and 0.33 and 0.48 and 0.32 in Odoshakiso and Adola districts, respectively. Feed resources were scarce in dry seasons and there was a seasonal feed supply fluctuation in the study area. This was caused by the prevailing erratic rainfall patterns in the low lands and lack of experiences by pastoralists to collect and preserve livestock feed for the dry season. Critical feed shortage was observed in *Bona* (long dry season). In the study area natural pasture, shrubs and bushes are the main feed resources during wet seasons.

The major feed resourses during wet season, in Odoshakiso district was natural pasture followed by shrubs and bushes while in Adola district, natural pasture was ranked first followed by shrubs and bushes during wet season. This finding was in agreement with the report of Teshome *et al*. (2010) in Rayitu district; natural pasture and tree branch were the main feed resource during wet and dry season, respectively.

Table 17. Feed resources in dry and wet season as ranked by respondents in the study area

Feed resource	**Odo shakiso**		**Adola**	
	D.S	W.S	D.S	W.S
	Index	Index	Index	Index
Natural pasture	0.33	0.47	0.32	0.48
Established pasture	-	-	-	-
Hay (standing hay)	0.025	0.05	0.025	0.01
Shrubs and bushes	0.50	0.36	0.48	0.34
Crop residues	0.14	-	0.15	-
Fallow land	0.007	0.1	0.025	0.09
By product	-	0.02	-	0.08
Concentrate	-	-	-	-

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

4.11.2. Grazing practice and Coping strategy for Feed Shortage

Management with respect to grazing or browsing was not similar in both dry and wet season. According to the respondents the browsing methods for majority of goat owners in dry season at Odoshakiso and Adola Free and rotational grazing/browsing, while majority was practiced herded and paddock in wet season. The result of this study was in agreement with FARM-Africa (1996) who reported browsing/grazing was the common browsing on rangeland areas. The major coping mechanisms for feed shortage in the study area were migration and selling their livestock. This is in agreement with the report of Grum (2010), who reported migration is an integral part of the pastoral livestock production systems serving as a strategy to mitigate the recurrent feed and water shortages. In the study area, routs of migration were determined based on pastoralists‟ spatial information with regard to availability of pasture and water. Based on group discussion with key informants, the common routs of migration were towards the *Awata, mormora* and Ganale River areas.

Table 18. Grazing practiced in the study area

Grazing method	**Odoshakiso N (%)**		**Adola N (%)**		**Overall N (%)**	
	W.S	D.S	W.S	D.S	W.S	D.S
Free grazing/Browsing	-	12(17.6)	1(1.5)	3(4.4)	1(0.75)	15(11)
Herded	17(25)	-	15(22.1)	3(4.4)	32(23.6)	3(2.2)
Free grazing and rotational grazing	3(4.4)	45(66.2)	-	62(91.2)	3(2.2)	107(78.7)
Free grazing and herded	-	11(16.2)	2(2.9)	-	2(1.5)	11(8.1)
Herded and paddock	48(70.6)	-	50(73.5)	-	98(72)	-
Total	68(100)	68(100)	68(100)	68(100)	136(100)	136 (100)

N= Number of respondents, D.S=Dry Season, W.S=Wet Season

4.12. Castration Practices

A castration practice of goats in the study area is indicated in Table 19. In the study area most of the respondents were practicing castration. From respondents who practice castration about 50.8, 38.2 and 9.6% castrate their goats for the purpose of improved fattening, for better temperament and control breeding respectively. This is in agreement with the study of (Alefe, 2014) reported that pastorals practice castration for the purpose of improved fattening, control breeding and better temperament. But in contrary with the study of (Belete, 2013) reported that majority of the respondents were not practicing castrations because of cultural influence and sold male animals in earlier time. About 88.2% of the respondents were practicing traditional castration methods by using locally available materials like wood and stones. While 11.8% practiced modern castration methods by using Burdizo castrator, which was made available by veterinarian at veterinary clinic. As per most of the respondents age of castration of goat was 1-2 year (53%).

Table 19. Castration practices of goats in the study area

Parameter	Odo shakiso		Adola		Overall	
	HH	%	HH	%	HH	%
Castration practice						
Yes	47	69.1	54	79.4	101	74.3
No	21	30.9	14	20.6	35	25.7
Reasons for castration						
Control breeding	6	8.8	7	10.3	13	9.6
Improve fattening	32	47.1	37	54.4	69	50.8
For Better price	-	-	2	2.9	2	1.4
For better temperament	30	44.1	22	32.4	52	38.2
Castration methods						
Modern	10	14.7	6	8.8	16	11.8
Traditional	58	85.3	62	91.2	120	88.2
Age of castration						
3 month- 1 year	14	20.6	12	17.6	26	19.1
1-2 year	37	54.4	35	51.5	72	53
> 2 year	17	25	21	30.9	38	27.9

HH= household

4.13. Purpose of Keeping Goat in the Study Areas

Purpose and ranking of goat keeping in the study area is indicated in Table 20. In the study area, goats are kept as source of milk, cash and meat for home consumption, manure, insurance against emergency, wealth and dowry. According to the respondents, goat milk is believed to have medicinal value for children and contribute more for the well-being of a human baby. This quality of goat milk was said to be related with their feeding behavior (goats browsed different browse species (Galal, 2005). Knowledge of reasons for keeping animals is a precondition for deriving operational breeding goals (Jaitner *et al*., 2001).

The primary reason for keeping goat in Odoshakiso district was for cash income (sale) followed by meat and milk with an index of 0.4, 0.3 and 0.2 respectively. But in Adola district goat was kept for cash income, milk and meat with an index of 0.4, 0.3 and 0.2 respectively.

The result of this study was in agreement with the study of Tesfaye *et al.* (2011b) who noted that the main purpose of keeping goat was mainly for milk and meat purpose in Adami tulu

District. This indicates that Ethiopian goats in the lowland are highly valued and reared mainly for milk and meat production.

Table 20. Purpose of goat keeping in both districts and ranking of these purposes

Purpose of keeping	Districts							
	Odo shakiso				Adola			
	R1	R2	R3	I	R1	R2	R3	I
Meat	25	26.5	26.5	0.3	20.6	7.4	27.9	0.2
Milk	10.3	26.5	13.5	0.2	32.4	36.8	13.2	0.3
Sale (cash income)	55.9	29.4	10	0.4	35.3	50	8.8	0.4
By-products (skin)	-	2.9	-	0.01	-	2.9	7.4	0.02
Social status	-	-	1.5	0.005	-	-	1.5	0.002
Savings	-	1.5	-	0.005	2.9	1.5	-	0.02
Ceremonies, rituals	1.4	1.4	11.8	0.03	1.5	-	5.9	0.01
Manure	7.4	11.8	33.8	0.1	4.4	1.5	23.5	0.06
Collateral	-	-	2.9	0.005	2.9	-	11.8	0.03

R1, R2 and R3 = rank 1, 2and 3, respectively. I=Index= sum of (3 X purpose of keeping goat ranked first + 2 X purpose of keeping goat ranked second + 1 X purpose of keeping goat ranked third) given for particular purpose of keeping goat divided by sum of (3 X purpose of keeping goat first + 2 X purpose of keeping goat ranked second + 1 X purpose of keeping goat ranked third) for all purpose of keeping goat

4.14. Goat Breeding Management

4.14.1. Breeding practices

Breeding practices and possession of buck in the study area is summarized in Table 21. Among household interviewed the main source of breeding buck was born in the flock followed by purchased from the market and gift from the relatives with 76.5,19 and 4.5% respectively. This finding was in agreement with the report of Tesfaye *et al*. (2011b) who found that the major source of breeding buck for farmers was born with in flock in Adami tulu district (82%). Mating was predominantly uncontrolled. Uncontrolled mating reported 89% by the respondents, in the present study is due to the result of watering point and lack of awareness effect on the impact of mating with related animals or inbreeding. This result is in agreement with the studies Solomon *et al*. (2010), Kebede *et al*. (2011) and Belete (2013) who noted that majority of the respondents in western central rift valley and Bale zone of Ethiopia were not practiced controlled mating due to lack of awareness of inbreeding. This study shows that more than half of the respondents did not give special management for buck

and majority of the respondents practiced selection of male and female goats. Uncontrolled mating was associated with the parturition distributed throughout the year. An advantage of uncontrolled mating is that it allows all year round breeding. Uncontrolled mating and communal grazing are expected to result in sever inbreeding in the flock Kosgey (2004). Majority of the respondents were able to identify the sire of their kids. The main identification methods are by individual characteristics, observing the male that the does herd, housed and similarity with the existing breeding male in the flock. Natural mating is the main feature of the study area and most of the respondents did not know the impacts of mating with related individuals and allows mating with closely related goats. According to Kosgey, (2004) gains from breeding programmes are achieved only when inbreeding depression is well controlled or minimized.

Table 21. Buck management and its selection practices in the study area

Parameters	**Odoshakiso**		**Adola**		**Overall**	
	N	**%**	**N**	**%**	**N**	**%**
Do you have breeding buck?						
Yes	49	72.1	45	66.2	94	69.2
No	19	27.9	23	33.8	42	30.8
Source of breeding buck?						
Born in the flock	50	73.5	54	79.4	104	76.5
Purchased from	14	20.6	12	17.6	26	19
market	4	5.9	2	3	6	4.5
Gift from relatives						
Do you practice special mgt for buck?						
Yes	23	33.8	27	39.7	50	36.8
No	45	66.2	41	60.3	86	63.2
Do you use control mating?						
Yes	5	7.4	10	14.7	15	11
No	63	92.6	58	85.3	121	89
Do you practice selection of (F) and (M)?						
Yes	58	85.3	62	91.2	120	88.3
No	10	14.7	6	8.8	16	11.7

M= male; F= female, mgt=management, *N= Number of respondent*.

4.14.2. Selection criteria for breeding buck

Selection criteria for breeding buck in the study area are presented in Table 22. Appearance, libido and horn of breeding buck ranked first, second and third for Odo shakiso district goat While, Appearance, horn and libido of breeding buck ranked first, second, and third for Adola district goat owners. The selection criteria of these traits are more subjective. But pastorals or farmers may select buck with high libido because they may observe high variation on the mount and sexual feeling among bucks. In this regard, the study of Snowder et al (2002) explained that libido has moderate heritability value and selection is possible to improve sexual feeling of bucks in the successive generations.

Table 22. Selection criteria of breeding buck in the study area

	Districts							
	Odo shakiso				**Adola**			
Selection criteria	R1	R2	R3	I	R1	R2	R3	I
Appearance /conformation	97.1	2.9	-	0.5	82.4	11.8	2.9	0.46
Color	2.9	1.5	-	0.005	2.9	14.7	5.9	0.07
Horn	-	30.9	11.8	0.12	5.9	25	17.6	0.14
Character	-	-	2.9	0.005	1.5	5.9	-	0.03
Adaptability	-	-	-	-	-	-	-	-
Growth rate	-	16.2	17.7	0.08	1.5	11.8	27.9	0.09
Libido	-	47.1	35.3	0.23	2.9	16.2	30.9	0.12
Ability to walk long distance	-	-	-	-	-	-	-	-
Pedigree/family history	-	1.5	32.4	0.06	2.9	14.7	14.7	0.092

R1, R2 and R3 = rank 1, 2 and 3, respectively. I= index = sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for particular trait divided by sum of 3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all traits

4.14.3. Selection criteria for breeding doe

A selection criterion for breeding doe is indicated in Table 23. This study shows that traits like size (appearance), kid survival, and kid growth, age at sexual maturity, kidding interval and high milk yield were all considered as important traits and respondents given emphasis in selecting of breeding does. Among selection criteria considered, size (appearance), high milk yield and color were ranked 1st, 2nd and 3rd by goat owners in Odo shakiso, but for Adola, size (appearance), high milk yield and kidding interval were employed. This finding was in accordance with the study of Belete (2013) described that in Mada Walabu and Rayitu districts, appearance color and better milk yield were selection criterion for breeding doe.

Table 23. Selection criteria for breeding doe as ranked by respondents in the study area

	Districts							
	Odo shakiso				Adola			
Selection criteria	R1	R2	R3	I	R1	R2	R3	I
Size/Appearance	89.7	10.3	1.5	0.49	75	17.6	1.5	0.44
Color	1.5	25	54.4	0.18	1.5	5.9	7.4	0.04
Kid survival	-	-	-	-	1.5	11.8	20.6	0.08
Kid growth	-	2.9	20.6	0.04	-	5.9	20.6	0.05
Age at first sexual maturity	-	-	-		-	1.5	2.9	0.01
Kidding interval	-	1.5		0.002	5.9	13.2	7.4	0.09
Twining ability	-	2.9	5.9	0.02	-	5.9	14.7	0.04
High milk yield	8.8	58.8	16.2	0.27	16.2	38.2	25	0.25

R1, R2 and R3 = rank 1, 2 and 3, respectively. I= index = sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for particular trait divided by sum of 3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all traits

4.14.4. Trait preferences in the study area

Trait preferences of the respondents for the selection of goat in the study area are shown in Table 24. Trait preferences are useful to make better informed decisions in developing interventions to improve the contribution of goat for livelihoods of their keepers. Milk yield, meat quality, coat color and growth rate were the most preferred traits of goat in study area. Thus, size, milk yield, Meat quality and color ranked 1^{st} to3^{th} and appeared to be among the reported preferred traits in their order of importance by the respondents in Odo shakiso area whereas in Adola size, milk yield, meat quality and growth rate were preferred traits. Farmers in the study area mainly depend on economical traits like milk yield. This was in accordance with the report of (Abdul, 2011) who reported that farmers preferred attributes that were mostly quantitative in nature and economically important.

Table 24. Indigenous goat type important traits perceived (trait preference) by owners in the study area

	Districts							
Trait	**Odo shakiso**				**Adola**			
	R1	R2	R3	I	R1	R2	R3	I
Size/Appearance	29.4	20.6	11.8	0.240	32.4	17.6	8.8	0.240
Color	11.8	8.8	7.4	0.100	8.8	4.4	5.9	0.070
Horn	7.3	4.4	5.9	0.060	5.9	10.3	11.8	0.083
Growth rate	10.3	4.4	5.9	0.076	10.3	11.8	10.3	0.100
Heat resistance	2.9	5.9	8.8	0.050	4.4	1.5	3	0.030
Longevity	-	2.9	1.5	0.010	-	3	2.9	0.015
Drought resistance	7.4	-	5.9	0.046	5.9	4.4	5.9	0.050
Character	2.9	5.9	2.9	0.040	5.9	8.8	4.4	0.070
Milk yield	13.2	25	10.3	0.170	11.8	19.1	13.2	0.140
Meat quality	5.9	8.8	26.5	0.100	7.4	8.8	17.6	0.100
Fertility	7.4	10.3	8.8	0.086	5.9	4.4	13.2	0.070
Adaptability	1.5	3	4.4	0.024	1.5	5.9	3	0.032

R1, R2 and R3 = rank 1, 2 and 3, respectively. I= index = sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for particular trait divided by sum of 3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all traits

4.15. Reproductive performance of Goats

The reproductive performance of goats in both districts as reported by the respondents is summarized in Table 25. Reproduction determines several aspects of goat production and understanding of reproduction is crucial in reproductive management. A high rate of reproductive efficiency is important for perpetuation of the species, production of meat, milk, skin, and replacement of breeding stock (Girma, 2008). The Average age at sexual maturity for male and female goat was 11.6 and 12.6 months, respectively. The Age at first kidding (AFK) can be defined as the age at which does give birth for the first time. The overall AFK of indigenous goat found in the study area was 18.4 months. This was in agreement with the report of Girma (2008) AFK ranges from 12-24 months. The reproductive life span of male and female in the study area was 7and 8years, respectively. It was higher than the finding of

Mahilet (2012) for Hararghae highland goats. However, it was shorter as compared with the report of Kidus (2010) where indigenous does live for 11.7 years and provides an average of 11.9 kids. In the study area, the average offspring per doe is about 14.2 per life span with kidding interval of 6.5 month. This was lower as compared with the report of Markos (2000) where the kidding interval of goat ranges between 9-12 months.

Table 25. Average reproductive performances of goat as reported by respondents

	Districts		
Parameters	**Odo shakiso**	**Adola**	**Overall**
	Mean ± SE	Mean ± SE	Mean ± SE
Average age at sexual maturity in male (months)	11.5±0.203	11.7±0.27	11.6±0.17
Average age at sexual maturity in female (months)	12.6±0.19	12.7±0.25	12.6±0.16
Average age at first kidding (months)	18±0.2	18.8±0.26	18.4±0.16
Average kidding interval (months)	6.3±0.09	6.6±0.08	6.5±0.06
Average reproductive life span of doe (years)	8.1±0.15	8±0.12	8±0.1
Average number of kid crop per doe (Number)	13.7±0.25	14.6±0.23	14.2±0.18
Average reproductive life span of buck (years)	6.8±0.14	7.2±0.13	7±0.1

SE=standard error

4.15.1. Kidding Pattern

According to the pastoralists and agro-pastoralists, kidding occurred at any time of the year but there were seasons when most births occurred (Table.26). Overall, the highest 46.3% births occurred during *Gana* (main rainy season) during which forage availability was increased. The lowest birth of 16.1% occurred during *Bona* (long dry season) during which rangeland grazing depleted. But, according to focus group discussion with key informants, goats would give birth throughout the year if feed were readily available. This was in accordance with the report of Mekasha (2007) who reported that breeding is naturally controlled to adjust maximum use of seasonal sexual activity or nutrition availability and ensures greatest likelihood to establish pregnancy, and optimal ovulation.

According to respondents most type of birth in the study area was single (62.5%) followed by twin (32.3%), triples 4.4% and Quarters 0.8%. This was lower as compared to Alefe (2014) who reported that single births account for 96%. This was a successful way of selection for single births for an area of scarce feed which enables good kid survival and milk off take for human consumption.

Table 26. Season of most births occur and type of birth in the study area

Kidding pattern		**Odo shakiso**		**Adola**		**Overall**	
		N	**%**	**N**	**%**	**N**	**%**
Season	**Local Name**						
Winter	*Gana*	33	48.5	30	44.1	63	46.3
Summer	*Bona*	10	14.7	12	17.6	22	16.1
Spring	*Arfasa*	12	17.6	15	22.1	27	19.9
Autumn	*Bira*	13	19.1	11	16.2	24	17.7
Type of birth							
Single		42	61.7	43	63.2	85	62.5
twin		23	33.8	21	30.9	44	32.3
Triples		2	3	4	5.9	6	4.4
Quarters		1	1.5			1	0.8

N= Number of respondents

4.15.2. Effective Population Size and Rate of Inbreeding

The effective population size (Ne) and the rate of inbreeding (ΔF) calculated for goat flock in the study areas are presented in Table 27. 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). In this study, the estimates of Ne were 3.5 and 4 for Odoshakiso and Adola districts respectively, with mean estimate of 3.75 when a household flock is herded alone. Rate of inbreeding in the study area is beyond the threshold level or maximum acceptable level (0.063) (Armstrong, 2006) .This might be due to small effective population size, using breeding buck born within the flock and herded together and uncontrolled mating practiced in the study area.

Table 27. Effective population size and rate of inbreeding of goats flock in the study area

District	**When flocks are not mixed**			
	NM	NF	Ne	ΔF
Odoshakiso	1.1	4.3	3.5	0.143
Adola	1.3	4.4	4	0.125
Mean	1.2	4.35	3.75	0.134

NM= number of breeding male; NF = number of breeding female; Ne= effective population size; ΔF=rate of inbreeding

4.16. Major Constraints for Goat Production in the Study Area

Goat production and productivity in the study area is constrained by many factors. The major ones are summarized in Table 28. In Odo shakiso district, labor shortage, predator and disease incidence ranked 1st, 2nd and 3rd. In this district labor shortage was 1st, ranked constraint in goat production. This might be due to gold mining which is the main activity in this district which needs high daily labor force. While in Adola district, disease incidence, labor shortage, and lack of extension service ranked 1st, 2nd and 3rd. In this district disease incidence was 1st, ranked constraint in goat production.This might be due to lack of extension service, geographical location, absence of drugs and remoteness of some rural kebels from the district. The present study was in accordance with the study of Gurmesa *et al*. (2011a) who reported that disease, predators and labor were the serious problem in Arsi Negele district. The report of Arse *et al*. (2013) also show that severe feed shortage, high disease prevalence and predatory were the main serious problems in Adami tulu, Arsi Nagelle and Fentale districts.

The great production loss caused by disease problems could be due to climatic condition of the study area, which might exaggerate the prevalence of disease and poor nutrition for goats. Moreover, inadequate health management by farmers and less efficient veterinary service may aggravate the problem (Solomon *et al*., 2010).

Table 28. Major constraints of goat production ranked by respondents in the study area

Constraints	**Odo shakiso**				**Adola**			
	R1	R2	R3	I	R1	R2	R3	I
Drought occurrence	5.9	-	2.9	0.030	4.4	-	-	0.022
Feed shortage	13.2	11.8	13.2	0.130	8.8	2.9	5.9	0.060
Water shortage	2.9	11.8	4.4	0.060	-	1.5	-	0.005
Disease incidence	5.9	16.2	41.2	0.150	33.8	26.5	13.2	0.280
Lack of superior genotypes	-	-	-	-	-	4.4	4.4	0.022
Market problem	-	-	1.5	0.002	-	-	-	0.000
Predator	27.9	13.2	19.1	0.230	4.4	26.5	30.9	0.160
Labor shortage	26.5	38.2	11.8	0.280	23.5	14.7	17.6	0.200
Lack of extension service	2.9	2.9	-	0.024	14.7	17.6	22.1	0.170
Shortage of grazing land	14.7	5.9	5.9	0.100	10.3	5.9	5.9	0.080

R1, R2 and R3 = rank 1, 2 and 3, respectively. I= Index = sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for particular constraint divided by sum of 3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all constraints

4.16.1. Major causes for death of goat

The major causes for death/loss of goats in study area are presented in Table 29. According to the response of the respondents in Odo shakiso and Adola districts, the major causes for death of goats are similar and these were diseases, predator and parasite. This is in agreement with the report of Alefe (2014) who found the major causes for death of goat in Adadle district, were diseases, parasite and drought in that order of importance.

Table 29. Major causes for death/loss of goat as ranked by respondents in the study area

Causes	**Odo shakiso**				**Adola**			
	R1	R2	R3	I	R1	R2	R3	I
Droughts	7.4	1.5	2.9	0.047	5.9	1.5	8.8	0.050
Feed and water shortage	-	5.9	20.6	0.054	8.8	1.5	10.3	0.066
Predators	42.6	41.2	14.7	0.360	35.3	32.4	33.8	0.300
Parasite	-	14.7	47.1	0.130	11.8	42.6	17.6	0.200
Poisoning	-	-	5.9	0.010	1.5	1.5	10.3	0.030
Diseases	50	36.8	8.8	0.400	36.8	20.6	19.1	0.360
Accident	-	-	-	0.000	-	-	-	0.000

R1, R2 and R3 = rank 1, 2and 3, respectively, I= Index = sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for particular cause for death divided by sum of 3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all cause for death

4.16.2. Major goat diseases in the study area

Free 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 (Gatenby, 1986). The major goat diseases found in the study area are presented in Table 30. Diarrhea, internal and external parasite, anthrax, orf, mastitis, liver fluke and Contagious Caprine Pleura Pneumonia (CCPP) were the major reported goat diseases by the respondents. The result of the study revealed that internal and external parasite ranked 1st in Odo shakiso (index = 0.33), which could be attributed to agro- ecology of the area and inadequate health management by farmers, while liver fluke (index = 0.30) in Adola district were major diseases affecting goat production. This might be due to agro-ecology of the area.

The range of diseases was area and season specific and hence requires site and season-specific attention. According to the focus group discussion, majority of goat disease problems occurred during the rainy seasons (Gana), which were related to ticks, foot root and internal and external parasites. But during dry season *(Bona),* disease like orf and mastitis could be major problem. This result was in accordance with the report of Mahilet (2012) who reported that

Disease prevalence is common during the season of onset of rain and off set of rain in the study area.

Table 30.List of common diseases in the study area as reported by respondents

Scientific names	local name	Districts	
		Odo shakiso	Adola
		index	index
Diarrhea	Albaati	0.05	0.11
internal and external parasite	Corroqa	0.33	0.12
bloating	Bokoka	0.09	0.03
anthrax	Abagorba	0.11	0.12
mastitis	Maansa	0.08	0.08
liver fluke	Baale	0.15	0.30
CCPP	-	0.12	0.18
Orf	Habara	0.07	0.05

CCPP = Contagious caprine pleura pneumonia; Index = sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for particular disease divided by sum of 3for rank 1 + 2 for rank 2 + 1 for rank 3] for all diseases.

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

4.17.1. Qualitative traits of indigenous goat types in the study area

Qualitative traits of goat in Odo shakiso and Adola districts are presented in Table 31.The indigenous male and female goat types found in Odoshakiso and Adola districts have mainly plain coat color pattern followed by patchy. The dominant coat color types were white and black in both districts. The indigenous goat types found in both district has a medium and smooth hair coat type. Ruffs occur in 76.3 and 66.5% of male and female goats, respectively. This is comparable with the study of Belete (2013)who noted that 70.63% of the goats found in Bale zone had ruff, which is common both for male and female animals. Beards were observed in 62 and 68% of males and females, respectively.

Table 31. Qualitative traits of indigenous goat types found in Odoshakiso and Adola districts

		Districts					
Trait	**Attributes**	**Odo shakiso**		**Adola**		**Overall**	
		Female N (%)	Male N (%)	Female N (%)	Male N (%)	Female N (%)	Male N (%)
Coat color pattern	Plain	99 (52.1)	51 (62.2)	106 (55.9)	45 (54.9)	205 (54)	96 (58.5)
	Patchy	50 (26.3)	20 (24.4)	54 (28.4)	26 (31.7)	104 (27.3)	46(28.1)
	Spot	41 (21.6)	11 (13.4)	30 (15.8)	11(13.4)	71 (18.7)	22 (13.4)
	X^2 Value						**127.4**
Coat color type	White	72 (37.9)	31 (38)	65(34.2)	25(30.5)	137(36.1)	56(34.3)
	Black	48(26.3)	16 (19.5)	49(25.8)	23(28.1)	97(26.1)	39(23.8)
	Brown	21(11)	16(19.5)	27(14.2)	12(14.6)	48(12.6)	28(17.1)
	Grey	7(3.7)	2(2.4)	5(2.6)	1(1.2)	12(3.2)	3(1.8)
	Red	6(3.2)	5 (6.1)	9(4.7)	4(4.8)	15(4)	9(5.5)
	Roan	12(6.3)	2 (2.4)	10(5.3)	2(2.4)	22((5.8)	4(2.4)
	White (D)	9(4.7)	4(4.9)	11(5.8)	8(9.7)	20(5.3)	13(7.3)
	Black(D)	7(3.7)	3(3.6)	9(4.7)	4(4.8)	16(4.2)	7(4.2)
	Brown(D)	8(3.2)	3(3.6)	5(2.6)	3(3.6)	13(2.9)	6(3.6)
	X^2 Value						**506.68**
Hair length	Short	65(34.2)	42(51.2)	60(31.6	35(42.7)	125(32.9)	77(47)
	Medium	102(53.7)	39(47.5)	116(61.1)	42(51.2)	218(57.4)	81(49.3)
	Long	23(12.1)	1(1.2)	14(7.4)	5(6.1)	37(9.7)	6(3.7)
	X^2 Value						**184.23**

N = Number of goat exhibiting a particular qualitative character; X^2= Pearson chi-square; D=dominant

Table 30(continued)

		Districts					
Trait	**Attributes**	**Odo shakiso**		**Adola**		**Overall**	
		Female N (%)	Male N (%)	Female N (%)	Male N (%)	Female N (%)	Male N (%)
Hair coat type	Glossy	66(34.7)	34(41)	74(39)	34(41.5)	140(36.9)	68(41.5)
	Smooth Hair	87(45.8)	44(53)	99(52.1)	38(46.3)	186(48.9)	82(49.6)
	Long straight	30(15.8)	3(3.6)	17(8.9)	7(8.5)	47(12.4)	10(6)
	Curly rough	7(3.7)	2(2.4)	-	3(3.6)	7(1.8)	5(3)
	X^2 Value						**330.80**
wattle	Present	60(31.6)	29(35.4)	47(24.7)	26(31.7)	107(28.2)	55(33.5)
	Absent	130(68.4)	53(64.6	143(75.3)	56(68.3)	273(71.8)	109(66.5)
	X^2 Value						**88.97**
Ruff	Present	140(73.7)	60(73.2)	150(78.9)	49(59.8)	290(76.3)	109(66.5)
	Absent	50(26.3)	22(26.8)	40(21.1)	33(40.2)	90(23.7)	55(33.5)
	X^2 Value						**118.60**
muzzle	Present	56(29.5)	30(36.6)	53(27.9)	36(43.9)	109(28.7)	66(40)
	Absent	134(70.5)	52(63.4)	137(72.1)	46(56.1)	271(71.3)	98(60)
	X^2 Value						**69.18**

N = Number of goat exhibiting a particular qualitative character; X^2 = Pearson chi-square;

Table 30 (continued)

Trait	Attributes	Districts					
		Odo shakiso		Adola		Overall	
		Female N (%)	Male N (%)	Female N (%)	Male N (%)	Female N (%)	Male N (%)
Rump profile	Flat	97(51.1)	50(61)	86(45.3)	36(44)	183(48.2)	86(52.5)
	Sloping	93(48.9)	32(39)	102(53.7)	45(54.8)	195(51.3)	77(46.9)
	Roofy	-	-	2(1)	1(1.2)	2(0.5)	1(0.6)
	X^2 Value						**263.1**
Back profile	Straight	116(62)	59(72)	113(59.5)	42(51.2)	229(60.7)	101(61.6)
	Slopes up towards	25(13.2)	16(19.5)	34(17.9)	28(34.2)	59(15.5)	44(26.9)
				36(19)	9(11)	85(22.4)	16(9.7)
	Slopes down from	49(25.8	7(8.5)	7(3.7)	3(3.6)	7(1.8)	3(1.8)
	X^2 Value						**410.48**
Head profile	Straight	95(50)	53(64.6)	94(49.5)	29(35.4)	189(49.7)	82(50)
	Concave	53(27.9)	26(31.7)	55(29)	39(47.5)	108(28.5)	65(39.6)
	Convex	6(3.1)	1(1.2)	21(11)	6(7.3)	27(7.1)	7(4.3)
	M (convex)	36(19)	2(2.4)	20(10.5)	8(9.8)	56(14.7)	10(6.1)
	X^2 Value						**256.60**
beard	Present	125(65.8)	48(58.5)	135(71)	53(64.6)	260(68)	101(62)
	Absent	65(34.2)	34(41.5)	55(29)	29(35.4)	120(32	63(38)
	X^2 Value			-	-		**355.37**

N = Number of goat exhibiting a particular qualitative character; X^2 = Pearson chi-square; M= Markedly

Table 30 (continued)

Trait	Attributes	Districts					
		Odo shakiso		Adola		Overall	
		Female N (%)	Male N (%)	Female N (%)	Male N (%)	Female N (%)	Male N (%)
Ear orientation	Erect	34(17.9)	26(31.7)	46(24.2)	34(41.5)	80(21.1)	60(36.6)
	Semi-pendulous	59(31.1)	30(36.6)	89(46.8)	34(41.5)	148(39)	64(39.1)
	Pendulous	78(41.1)	17(20.7)	38(20)	10(12.2)	116(30.5)	27(16.4)
	Carried horizontally	19(10)	9(11)	17(9)	4(4.8)	36(9.5)	13(7.9)
	X^2 Value						**98.60**
Horn	Present	143(75.3)	62(75.6)	140(73.7)	48(58.5)	283(74.5)	110(67.1)
	Absent	47(24.7)	20(24.4)	50(26.3)	34(41.5)	97(25.5)	54(32.9)
	X^2 Value						**107.65**
Horn shape	Scurs	21(11.1)	17(20.7)	28(14.7)	20(24.4)	49(12.9)	37(22.5)
	Straight	98(51.6)	45(54.9)	112(59)	40(48.8)	210(55.3)	85(51.9)
	Curved	23(12.1)	3(3.6)	15(7.9)	8(9.7)	38(10)	11(6.6)
	Spiral	48(25.3)	17(20.7)	35(18.4)	14(17.1)	83(21.8)	31(19)
	Corkscrew	-	-	-	-	-	-
	X^2 Value						**263.48**
Horn Orientation	Lateral	45(23.7)	21(25.6)	37(19.5)	13(15.8)	82(21.6)	34(20.7)
	Obliquely up	23(12.1)	15(18.3)	35(18.4)	23(28.1)	58(15.2)	38(23.2)
	Back ward	122(64.2)	46(56.1)	118(62.1)	46(56.1)	240(63.2)	92(56.1)
	X^2 Value						**188.88**

N = Number of goat exhibiting a particular qualitative character; X^2 = Pearson chi-square;

*a/*Figure 2. Adola district indigenous goat *b/* Figure 3. Odoshakiso district indigenous goat

Figure 4. Breeding buck (left) and doe (right) in adola district

Figure 5. Breeding buck (left) and doe (right) in odoshakiso district

4.17.2. Multiple correspondences Analysis

To understand the typical features of goat of each district morphologically, multiple correspondence analyses was carried out on 9 qualitative traits recorded. Figure 8 shows a bi-dimensional graph representing the associations among the categories of the analyzed qualitative traits. The association is based on points found in approximately the same direction from the origin in approximately the same region of the space. From the figure, it can be shown that 14.23% of the total variations are explained by the first two dimensions (7.30% by the first and 6.93% by the second dimensions).

On the identified dimensions, the sample goat population in Odo shakiso district clustered together with spotted coat color pattern, white coat color type, straight back profile, pendulous and carried horizontally ear orientation, spiral horn shape, and back and lateral horn orientation. While, the goat population in Adola district was closely associated with plain coat color pattern black and brown coat color types, glossy and smooth hair, erect and semi-pendulous ear orientation, straight horn shape, back ward and obliquely up ward horn orientation.

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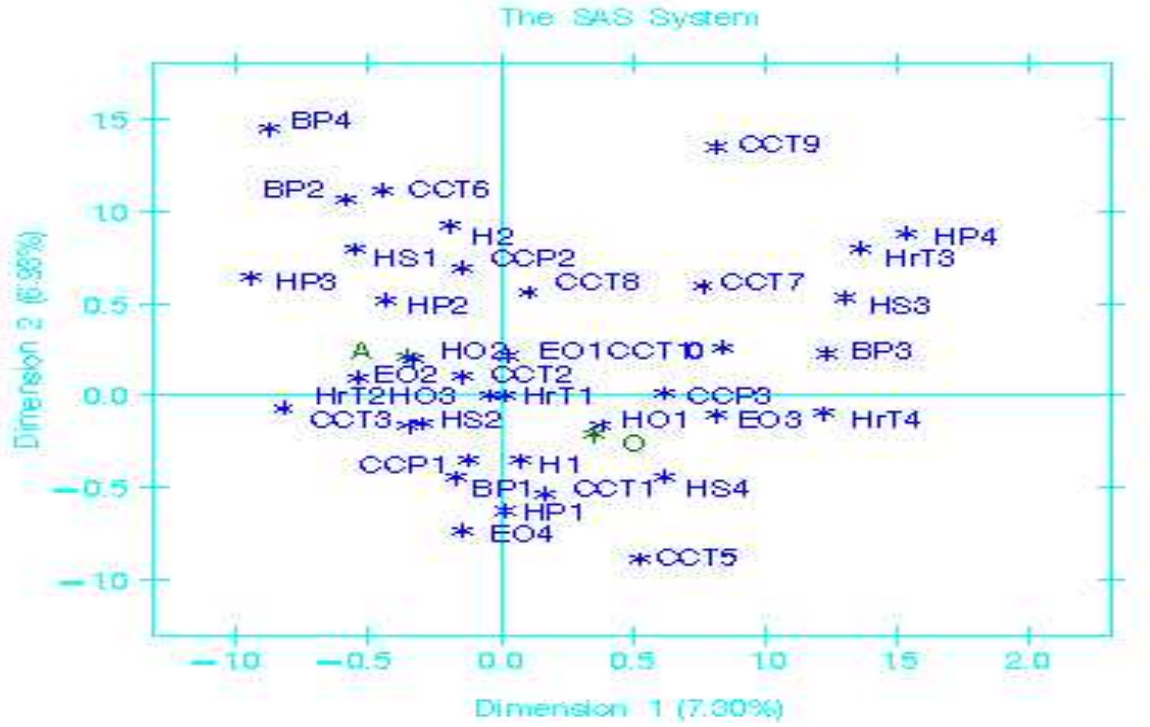

Figure 6. Bi-dimensional plot showing the associations among the categories of the different morphological variables considered.

Legend for figure 8

1. Location O=Odoshakiso , A=adola

2. Coat color pattern CCP1= Plain, CCP2= Patchy, CCP3= Spotted
3. Coat color type CCT1= White, CCT2= Black, CCT3=Brown, CCT4= Fawn, CCT5=Grey, CCT6= Red, CCT7=Roan, CCT8=White dominant, CCT9=Black dominant, CCT10= Brown dominant
4. Hair coat type HrT1= Glossy, HrT2= Smooth hair, HrT3= Long straight hair, HrT4= Curly rough
5. Back profile BP1= Straight, BP2= Slopes up towards the rump, BP3= Slopes down from withers, BP4= Dipped (curved)
6. Head profile HP1= Straight, HP2= Concave, HP3= Convex, HP4= markedly convex
7. Ear orientation EO1=Erect, EO2=Semi-pendulous, EO3= Pendulous, EO4=Carried
8. Horn H1=Present, H2=Absent
9. Horn orientation P1= Lateral, P2= Obliquely upward, P3= Back ward

4.17.3. Live body weight and linear body measurements

The least squares means of body weight and linear body measurements (LBMs) of indigenous goats in the study area are presented in Table 32.

Age effect: - Live body weight and all linear body measurements increased as animal advances with age (1PPI to ≥3PPI). The body weight of goats in the study area at ≥3PPI was 31.7±0.56 kg, which is greater than 27.39±0.34 kg reported for Hararghe Highland goats and 24.75+ 0.53 kg reported for short eared Somali goat types (Grum, 2010; Mahilet, 2012). This was also in accordance with the report of Otoikhian *et al*. (2008) who reported that all body measurements were increased as age group increase from 1PPI to ≥3PPI.

Location effect: - Live body weight (LBW) and all the linear body measurements were significantly affected by location. The variation in body weight and all the linear body measurements between goats of different location could be explained by the different management system, types of farming system.

Sex effect: The result revealed that sex is an important source of variation for live body weight and linear body measurements at all age groups. In the study area male have higher body weight than female ($p<0.05$). This was in agreement with the report of Abdul (2011) who noted that Pakistan male goats have higher morphmetric traits than female counter part. This indicates the presence of sexual dimorphism in goat.

Sex by age group: -The interaction between sex and age group significantly ($p<0.05$) affected body weight and LBMs. The value of body weight for female goat in age group 1PPI, 2PPI and > 3PPI were 26.5kg, 27.8kg, 30.6kg, respectively and the values for males in the same age groups were 29.6 kg, 30.4kg, and 32.8 kg, respectively. This result was in agreement with the report of Alemayehu *et al*. (2012) for Abergelle goat and Adeyinke (2006) where males have higher body weight than female counterpart. 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. The difference in live body weight between male and female across different age classes indicates that these parameters are sex and age dependent. Increase in live body weight and other linear body measurements with advance age were in line with the report of Otoikhian *et al.* (2008). In the study area sex and age differences were apparent for various body measurements.

Table 32. Least squares means (LSM ± SE) of body weight (kg) and LBMs (cm) of goat by sex, age, location and sex by age group

Effect and Level	**LBW**	**HG**	**HW**	**RH**	**BL**	**PW**
	LSM±SE	LSM± SE	LSM ±SE	LSM± SE	LSM ±SE	LSM±SE
Overall	29.7±0.18	73.4±0.21	67.3±0.2	69.2±0.19	63.2±0.31	15.3±0.1
CV%	11.9	5.6	5.7	5.2	9.5	12.1
R^2	0.67	0.59	0.40	0.42	0.24	0.13
Sex	*	*	*	*	*	*
Female	27.1^{b}±0.18	71.6^{b}±0.22	65.2^{b}±0.2	67.1^{b}±0.2	61.7^{b}±0.32	14.7^{b}±0.1
Male	32.3^{a}±0.30	75.4^{a}±0.38	69.5^{a}±0.35	71.3^{a}±0.3	64.8^{a}±0.54	15.8^{a}±0.17
Age	*	*	*	*	*	*
1PPI	24^{c}±0.24	67.8^{c}±0.30	63.8^{c}±0.28	65.7^{c}±0.26	60.3^{c}±0.43	14.5^{c}±0.13
2PPI	27.3^{b}±0.30	71.2^{b}±0.2	65.8^{b}±0.34	67.8^{b}±0.32	61.1^{b}±0.54	15^{b}±0.16
≥3PPI	37.8^{a}±0.37	81.4^{a}±0.45	72.1^{a}±0.41	74.1^{a}±0.39	68.3^{a}±0.64	16.3^{a}±0.20
Location	*	*	*	*	*	*
Odo shakiso	29^{b}±0.21	73.2^{b}±0.29	67^{b}±0.27	68.9^{b}±0.25	62.9^{b}±0.42	15^{b}±0.13
Adola	30^{a}±0.24	73.7^{a}±0.29	67.6^{a}±0.27	69.5^{a}±0.25	63.5^{a}±0.42	15.6^{a}±0.13
Sex by age	*	*	*	*	*	*
Female,1PPI	23.6^{c}±0.35	68^{b}±0.42	62.9^{c}±0.39	64.9^{c}±0.37	59.7^{b}±0.61	14.2^{b}±0.19
Female, 2PPI	25.2^{b}±0.35	69.6^{a}±0.42	63.9^{b}±0.39	65.9^{b}±0.37	59.1^{b}±0.61	14.5^{b}±0.19
Female, ≥ 3PPI	32.4^{a}±0.24	77^{a}±0.29	68.6^{a}±0.27	70.5^{a}±0.26	66.2^{a}±0.43	15.4^{a}±0.13
Male,1PPI	24.3^{f}±0.35	67.6^{be}±0.42	64.7^{f}±0.39	66.5^{f}±0.37	60.8^{e}±0.61	14.8^{e}±0.18
Male, 2PPI	29.3^{e}±0.5	72.7^{d}±0.61	67.6^{e}±0.56	69.6^{e}±0.53	63.1^{d}±0.89	15.6^{d}±0.27
Male, ≥3PPI	43.1^{d}±0.7	85.8^{c}±0.84	76^{d}±0.77	77.8^{d}±0.73	70.3^{c}±1.2	17.2^{c}±0.37

a,b,c,d.e,f, means with different superscripts within the same column and class are significantly different (P<0.05); * significant at (P<0.05) ; LBW=Live Body Weight; HG=Heart Girth; HW= Height at Wither; RH= Rump Height, BL=Body Length; PW= Pelvic Width;1PPI, 2PPI and 3PPI = 1, 2 and 3 pair of permanent incisors, respectively;

Table 31 (continued)

Effect and Level	HL	EL	SC	SL	RW	RL
	LSM±SE	LSM± SE	LSM ±SE	LSM± SE	LSM ±SE	LSM±SE
Overall	13.2±0.19	17±0.1	26.2±0.18	17.4±0.27	21.7±0.11	16.7±0.11
CV%	29	11.7	7.8	17.7	9.8	12.6
R^2	0.29	0.059	0.26	0.025	0.29	0.21
Sex	*	*			*	*
Female	11.3^{b}±0.20	16.9^{b}±0.18	-	-	21.2^{b}±0.11	16^{b}±0.11
Male	15^{a}±0.33	17.8^{a}± 0.1	26.2±0.18	17.4±0.27	22.3^{a}±0.20	17.4^{a}±0.20
Age	*	*	*	*	*	*
1PPI	10.4^{c}±0.26	16.5^{c}±0.15	24.8^{c}±0.2	17^{b}±0.31	20.3^{c}±0.15	15.8^{b}±0.15
2PPI	13.1^{b}±0.33	17^{b}±0.18	25.6^{b}±0.29	17^{b}±0.45	21.1^{b}±0.19	16^{b}±0.18
≥3PPI	15.9^{a}±0.39	17.5^{a}±0.22	28^{a}±0.40	18^{a}±0.62	23.7^{a}±0.23	18.1^{a}±0.22
Location	*	*	*	*	*	*
Odo shakiso	12.9^{b}±0.26	16.8^{b}±0.14	25.8^{b}±0.26	17^{b}±0.39	21.5^{b}±0.15	16.4^{b}±0.14
Adola	13.4^{a}±0.26	17.8^{a}±0.14	26.6^{a}±0.25	17.7^{a}±0.39	22^{a}±0.15	17^{a}±0.14
Sex by age	*	*			*	*
Female,1PPI	9^{c}±0.37	16.7^{b}±0.2	-	-	20.1^{b}±0.21	15.1^{b}±0.21
Female, 2PPI	10.8^{b}±0.37	16.9^{b}±0.2	-	-	20.6^{b}±0.21	15.3^{b}±0.21
Female, ≥ 3PPI	14^{a}±0.26	17.7^{a}±0.15	-	-	22.9c±0.15	17.4^{a}±0.15
Male,1PPI	11.8^{f}±0.37	16.2^{b}±0.2	24.8^{c}±0.2	17^{b}±0.31	20.5^{b}±0.21	16.4^{d}±0.21
Male, 2PPI	15.5^{e}±0.55	17.3^{a}±0.3	25.6^{b}±0.29	17^{b}±0.45	21.7^{d}±0.31	16.9^{d}±0.31
Male, ≥3PPI	17.8^{d}±0.75	17.4^{a}±0.41	28^{a}±0.40	18^{a}±0.62	24.7^{a}±0.43	18.9^{c}±0.42

a,b,c,d.e,f, means with different superscripts within the same column and class are significantly different (P<0.05); *significant at (P<0.05) ; HL= Horn Length; EL=Ear Length; SC=Scrotum Circumference; SL=Scrotum Length; RL= Rump Length, RW= Rump Width 1PPI, 2PPI and 3PPI = 1, 2 and 3 pair of permanent incisors, respectively.

Table 31 (continued)

Effect and Level	**CD**	**NL**	**TL**	**FH**	**FC**
	LSM±SE	LSM± SE	LSM ±SE	LSM± SE	LSM ±SE
Overall	29.6±0.27	28±0.15	18.7±0.19	15.4±0.12	11.8±0.11
CV%	17.6	10.4	14.5	11.5	14.1
R^2	0.1	0.3	0.096	0.07	0.08
Sex	*	*	*	*	*
Female	28.3^{b}±0.28	27.9^{b}±0.16	18^{b}±0.14	14.9^{b}±0.09	11.7^{b}±0.09
Male	31^{a}±0.47	28.3^{a}±0.27	19.4^{a}±0.24	15.9^{a}±0.16	12.3^{a}±0.15
Age	*	*	*	*	*
1PPI	28.7^{b}±0.37	26.1^{c}±0.21	17.7^{c}±0.19	14.9^{b}±0.12	11.6^{a}±0.12
2PPI	28.5^{b}±0.47	27.6^{b}±0.27	18.5^{b}±0.24	15.3^{b}±0.15	11.2^{b}±0.15
≥3PPI	31.7^{a}±0.56	30.5^{a}±0.31	19.8^{a}±0.28	15.9^{a}±0.19	12.6^{a}±0.18
Location	*	*	*	*	*
Odoshakiso	29.4^{a}±0.37	27.9^{b}±0.21	18.4^{b}±0.19	16.2^{a}±0.12	11.7^{b}±0.11
Adola	29.9^{a}±0.37	28.3^{a}±0.21	19^{a}±0.19	15^{b}±0.12	12.1^{a}±0.11
Sex by age	*	*	*	*	*
Female,1PPI	26.5^{f}±0.53	26.4^{e}±0.30	17.5^{d}±0.27	14.6^{d}±0.18	11.3^{d}±0.17
Female, 2PPI	27.8^{e}±0.53	27^{d}±0.30	17.7^{d}±0.27	14.9^{d}±0.18	11.4^{d}±0.17
Female, ≥ 3PPI	30.6^{b}±0.37	30.3^{b}±0.21	18.7^{c}±0.2	15.3^{c}±0.12	12.2^{b}±0.12
Male,1PPI	29.6^{d}±0.53	25.8^{f}±0.30	17.9^{d}±0.27	15.3^{c}±0.18	11.9^{c}±0.17
Male, 2PPI	30.4^{c}±0.77	28.2^{c}±0.43	19.4^{b}±0.39	15.7^{b}±0.26	11.4^{d}±0.25
Male, ≥3PPI	32.8^{a}±1	30.9^{a}±0.60	21^{a}±0.53	16.5^{a}±0.35	12.9^{a}±0.34

a,b,c,d.e,f, means with different superscripts within the same column and class are significantly different (P<0.05); *significant at (P<0.05) ; CD=Chest Depth, NL=Neck Length; TL=Tail Length; FH= Fore canon Height; FC= Fore canon Circumference; 1PPI, 2PPI and 3PPI 1, 2 and 3 pair of permanent incisors, respectively;

4.17.4. Special attributes of indigenous goat types in the study area

The level of tolerance to heat, drought, feed and water shortage, parasite and diseases of the indigenous goat found in the study area are presented in Table 33. Overall; According to the majority of the respondents, the level of heat and drought tolerance of indigenous goat found in the study area was high. The indication may be the trend of increasing goat population number for the past 10 years. According to group discussion goat population in the study area have heat and drought tolerance traits and these were explained by the presence of white coat color type and ability to walk long distance in search of feed and water. According to Adane and Girma (2008) sheep and goat have higher survival rates under drought conditions compared to cattle.

Table 33. Level of tolerance to heat, drought, feed and water shortage, parasite and diseases of the indigenous goat found in the study area

Stress	**Level of tolerance as perceived by the respondents**					
	Low		Medium		High	
	HH	%	HH	%	HH	%
Heat	6	4.4	30	22.1	100	73.5
Drought	2	1.5	53	39	81	59.5
Feed shortage	2	1.5	107	78.7	27	19.8
Water shortage	1	0.75	110	80.9	25	18.4
Parasite	16	11.8	98	72	22	16.2
Disease	22	16.2	98	72	16	11.8

HH=Household

4.18. Multivariate Analysis

Multivariate analysis was conducted using quantitative variables for adult females and males separately. Among the multivariate analysis multiple correlations, multiple linear regression, canonical and discriminant analyses were employed.

4.18.1. Multiple correlation Analysis between body weight and LBMs

The Pearson correlation coefficients between body weight and linear body measurements (LBMs) for female and male goats are presented in Table 34. 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 both districts. Variables such as HG, HW, BL, RH, RW, RL and NL, displayed medium to high positive correlations and were significantly ($p<0.05$) different from live body weight in female ($r = 0.54 - 0.97$) goats. In male goats variables such as HG, HW, BL, PW, HL, RH, RW, NL, and SC displayed medium to high positive correlations and significant ($p<0.05$) with live body weight ($r = 0.51 - 0.98$). In female population, strong and significant ($p<0.05$) positive correlations were observed.

In this study, strong, positive and significant correlation between body weight and heart girth suggests that this variables could provide a good estimate in predicting live body weight for the population. Among the linear body measurements, heart girth had the highest correlation with body weight in females ($r = 0.97$) and males ($r = 0.98$). The highest association between heart girth and body weight were observed for male and female goat population. This finding is in agreement with the result of previous studies (Grum, 2010; Mahilet, 2012; Halima et al., 2012; Seifemichale, 2013)who described that correlation between body weight and heart girth for female ($r = 0.88$) and male ($r = 0.89$) short-ear Somali goat; for female ($r = 0.84$) and male ($r = 0.74$) Hararghe highland goat; ($r = 0.899$) for West Amhara Region goat populations and for female ($r = 0.89$) and male ($r = 0.91$) Afar goat, respectively. Since linear body measurements have high correlation with body weight especially heart girth, this may be used as selection criteria in the breeding strategies and also used to estimate weight where weighing scale is absent. Scrotal circumference is the most heritable components of fertility that should be included for evaluation of breeding soundness (Mekasha, 2007). In this study, scrotal circumference showed significant association ($p<0.05$) with live body weight in all the male age groups ($r = 0.60$). This may imply that selection for scrotal circumference would lead to males with high potential for sperm production and plays a major role in temperature regulation.

Table 34. The coefficient of correlations between body weight and LBMs of indigenous goat (Above diagonal for female goat and below diagonal for male goat)(N= 381 female and N=163 male).

1	LBW	HG	HW	RH	BL	PW	HL	EL	RW	RL	CD	NL	TL	FH	FC
LBW	1	0.97*	0.66*	0.66*	0.59*	0.43*	0.52*	0.23*	0.61*	0.54*	0.34*	0.55*	0.27*	0.22*	0.41*
HG	0.98*	1	0.76*	0.77*	0.68*	0.53*	0.58*	0.37*	0.65*	0.56*	0.49*	0.61*	0.30*	0.36*	0.51*
HW	0.83*	0.90*	1	0.83*	0.66*	0.51*	0.64*	0.44*	0.66*	0.58*	0.63*	0.53*	0.34*	0.48*	0.57*
RH	0.84*	0.92*	0.89*	1	0.68*	0.54*	0.61*	0.45*	0.67*	0.59*	0.63*	0.58*	0.37*	0.49*	0.59*
BL	0.61*	0.74*	0.78*	0.81*	1	0.51*	0.46*	0.43*	0.66*	0.55*	0.57*	0.53*	0.27*	0.38*	0.47*
PW	0.55*	0.57*	0.57*	0.59*	0.50*	1	0.37*	0.37*	0.59*	0.58*	0.38*	0.47*	0.38*	0.40*	0.49*
HL	0.51*	0.65*	0.64*	0.67*	0.65*	0.39*	1	0.34*	0.48*	0.45*	0.46*	0.48*	0.30*	0.36*	0.43*
EL	0.10NS	0.17*	0.17*	0.22*	0.39*	0.55*	0.29*	1	0.43*	0.39*	0.43*	0.35*	0.30*	0.46*	0.50*
RW	0.66*	0.73*	0.71*	0.63*	0.71*	0.70*	0.60*	0.46*	1	0.85*	0.48*	0.58*	0.37*	0.42*	0.58*
RL	0.47*	0.63*	0.60*	0.73*	0.62*	0.56*	0.56*	0.41*	0.81*	1	0.38*	0.52*	0.41*	0.35*	0.51*
CD	0.29*	0.44*	0.54*	0.57*	0.73*	0.28*	0.62*	0.44*	0.54*	0.49*	1	0.37*	0.27*	0.68*	0.47*
NL	0.64*	0.63*	0.68*	0.70*	0.61*	0.57*	0.40*	0.24*	0.69*	0.49*	0.38*	1	0.38*	0.37*	0.54*
TL	0.43*	0.51*	0.43*	0.46*	0.42*	0.74*	0.27*	0.40*	0.51*	0.41*	0.13*	0.51*	1	0.34*	0.42*
FH	0.31*	0.37*	0.40*	0.45*	0.46*	0.52*	0.43*	0.44*	0.55*	0.46*	0.55*	0.55*	0.48*	1	0.63*
FC	0.19*	0.28*	0.34*	0.36*	0.35*	0.48*	0.40*	0.51*	0.51*	0.58*	0.38*	0.38*	0.41*	0.70*	1
SC	0.60*	0.55*	0.58*	0.60*	0.57*	0.70*	0.55*	0.57*	0.70*	0.55*	0.43*	0.48*	0.46*	0.47*	0.44*
SL	0.25*	0.34*	0.42*	0.44*	0.54*	0.45*	0.39*	0.57*	0.57*	0.52*	0.63*	0.33*	0.29*	0.43*	0.50*

LBW=Live Body Weight; HG=Heart Girth; HW= Height at Wither; BL=Body Length; PW= Pelvic Width; HL= Horn Length; EL=Ear Length; SC=Scrotum Circumference; SL=Scrotum Length, RH= Rump Height, CD=Chest Depth ,RL= Rump Length, RW= Rump Width, NL=Neck Length; TL=Tail Length; FH= Fore canon Height; FC= Fore canon Circumference, * Correlation is significantly different (P<0.05). NS Correlation is non- significant at the 0.05.

4.18.2. Multiple linear regression analysis

Multiple linear regression of live body weight on different LBMs for male and female goats in the study area are shown in Table 35. Multiple linear regression equations were developed for predicting live body weight (LBW) from other linear body measurements (LBMs). In order to predict live body weight from LBMs multiple regressions procedure was carried out within both sex based on independent variables which had positive correlation with body weight.

In this study, regression equation was developed for estimation of live body weight using 8 LBMs (HG, HW, BL, PW, HL, EL, SC and SL) in males and 7 LBMs (HG, HW, BL, PW, HL, EL and RW) in females (Table 35). The small sample size of male goat in this study may decrease the accuracy of the result if separate age groups are used. Thus instead of using separate equation for different age groups, it seems logical to pool age groups for the prediction of live body weight which could be based on regression equation **y** = -25.99+0.63x for female goats and

y = -51.17+0.70x for male goats, where y and x are live body weight and heart girth, respectively. The better association of body weight with heart girth was possibly due to relatively larger contribution of heart girth to body weight which consists of bones, muscles and viscera Thiruvenkadan (2005).

The best fitted variables were selected using higher value of adjusted R^2 and smaller value of C(P), AIC, R MSE and SBC. For male goats heart girth among the variables (HW, BL, RH, PW, EL ,SC and SL) was the best fitted variable for prediction of body weight. For female goats heart girth among the variables (HW, RH, BL, PW, EL and RW) was again the best fitted variables for prediction of body weight. This was in accordance with the report of Alefe (2014) described that regression equation was developed for estimation of live body weight using HG, HW, BL, PW, HL, EL, SC and SL in males and HG, HW, BL, PW, HL and EL in females in shabbele zone.

LBW= -50.87+0.70HG-0.063HW-0.15BL+0.32RH -0.06PW-0.18EL-1.2SC-0.4SL for male goat

LBW= -25.81+0.63HG+0.15HW-0.026RH+0.024BL-0.12PW+0.065EL+0.34RW for female goat

Table 35. Multiple linear regression analysis of live body weight on different LBMs for male and female goat in the study area in all age groups.

Model	**I**	**Parameters**							**R^2**	**Adj. R^2**	**C(P)**	**AIC**	**R MSE**	**SBC**
	(β0)	β1	β2	β3	β4	β5	β6	β7 β8						
Male														
HG	-51.17	0.70							0.79	0.79	135.8	394.3	3.33	400.5
HG+HW	-48.45	0.74	0.24						0.79	0.79	129.3	391.5	3.29	400.8
HG+HW+BL	-48.45	0.74	0.24	-0.10					0.81	0.81	109.65	380.7	3.17	393.08
HG+HW+BL+RH	-50.97	0.70	0.038	-0.11	0.315				0.81	0.81	110.23	381.8	3.17	397.30
HG+HW+BL+RH+PW	-51.76	0.69	0.058	-0.116	0.313	-0.14			0.81	0.81	108.57	381.5	3.16	400.11
HG+HW+BL+RH+PW+EL	-50.87	0.70	-0.063	-0.14	0.32	- 0.06	-0.18		0.81	0.81	107.80	381.8	3.15	403.46
HG+HW+BL+RH+PW+EL+SC	-50.87	0.70	-0.063	-0.14	0.32	-0.06	-0.18	-1.2	0.86	0.85	52.68	343.1	2.78	370.99
HG+HW+BL+RH+PW+EL+SC+SL	**50.87**	**0.70**	**-0.063**	**-0.15**	**0.32**	**-0.06**	**-0.18**	**-1.2,0.4**	**0.87**	**0.87**	**30.39**	**323.7**	**2.62**	**354.71**
Female														
HG	-25.99	0.63							0.68	0.68	48.39	825.04	2.94	832.93
HG+HW	-25.99	0.63	0.13						0.69	0.69	46.90	823.91	2.93	835.74
HG+BL+RH	-25.83	0.63	0.15	-0.32					0.69	0.68	48.60	825.63	2.93	841.41
HG+HW+RH+BL	-25.74	0.62	0.16	-0.04	0.021				0.69	0.69	50.30	827.37	2.94	847.08
HG+HW+RH+BL+PW	-25.81	0.63	0.15	-0.026	0.024	-0.12			0.69	0.69	51.70	828.82	2.94	852.48
HG+HW+RH+BL+PW+HL	-25.81	0.63	0.15	-0.026	0.024	-0.12	0.065		0.69	0.68	52.34	829.59	2.94	857.19
HG+HW+RH+BL+PW+HL+EL	-25.81	0.62	0.15	-0.026	0.024	-0.12	0. 065	-0.30	0.70	0.69	38.63	817.00	2.89	848.00
HG+HW+RH+BL+PW+EL+RW	**-25.81**	**0.63**	**0.15**	**-0.026**	**0.024**	**-0.12**	**0.065**	**0.34**	**0.71**	**0.71**	**24.56**	**803.52**	**2.84**	**835.06**

HG= Heart Girth; HW= Height at wither; BL=Body Length; PW = Pelvic Width; EL= Ear length; RW= Rump Width, HL= Horn length; SC=Scrotum Circumference; SL=Scrotum Length, I(β0) = Intercept; β1- β8 = Regression coefficients ;R^2=R-square; Adj.R^2=Adjusted R^2; C (P) =The Mallows C parameters; AIC=Alkaike‟s Information Criteria; Root MSE=Root Mean square of error; SBC=Schwarrz Bayesian Criteria, The bold one = the best fitted model

4.18.3. Discriminant analysis

Percent classified into each district (hit rate) for female and male populations are indicated in Table 36 and 37. The discriminant analysis carried to classify male and female sample populations. The overall classification rates (hit rate) of female and male sample population were 42 and 41.7%, respectively. For females, most individuals were classified into their source population (58.6% for Odo shakiso and 57.4% for Adola. While the Odoshakiso individuals classified as Adola individual was 41.4% and Adola individuals classified as odo shakiso individuals was 42.6%.

Table 36 presents percent classified female populations into each district (hit rate). The overall classification rates (hit rate) of female and male sample population were 42% and 41.7%, respectively. For females, most individuals were classified into their source population (58.6% for Odo shakiso and 57.4% for Adola. While the Odo shakiso individuals classified as Adola individual was 41.4% and Adola individuals classified as odo shakiso individuals was 42.6%.

Table 36. Percent classified into each district (hit rate) for female populations using discriminant analysis

District	Odoshakiso	Adola	Overall
Odo shakiso	112 (58.6)	79(41.4)	191(100)
Adola	81(42.6)	109(57.4)	190(100)
Total	193 (50.7)	188(49.3	381 (100)
Rate	0.4136	0.4263	0.4200
Prior	0.5000	0.5000	

As indicated in Table 37 the classification of males also more or less similar to females whereas most individuals were classified into their source population (59.3% for Odoshakiso, 57.3% for Adola. The odoshakiso individuals classified as Adola individual was 40.7% and Adola individuals classified as odo shakiso individuals was 42.7%.

Table 37. Percent classified into each district (hit rate) for male populations using discriminant analysis

District	Odo shakiso	Adola	Overall
Odo shakiso	48(59.3)	33(40.7)	81 (100)
Adola	35(42.7)	47(57.3)	82 (100)
Total	83(50.9)	80 (40.1)	163 (100)
Rate	0.4074	0.4268	0.4171
Prior	0.5000	0.5000	

4.18.4. Mahalanobis discriminant analysis

Squared Mahalanobis' distances obtained between districts populations for female and male were significant (P<0.05), indicating the existence of measurable differences between the two districts for male and female populations (Table 38). In male and female sample goat population, the Mahalanobis' distance 0.185 and 0.124 were seen between these two districts respectively. This results was lower as compared with the study of Mahilet (2012) who reported that longer distance was found between Babile and Gurawa (15.5) for female goat population followed by Meta and Gurawa (12.5). This may be due to high migration in goat population between two districts. All multivariate tests that is, Wilk's Lambda, Pillia's Trace, Hotelling-Lawley Trace and Ray's Greatest Root obtained from canonical discriminant analysis showed significant differences (P<0.05) among districts.

Table 38. Squared Mahalanobis' distance among district populations for male and female sampled Goat population.

	Male		**Female**	
From District	**Adola**	**Odoshakiso**	**Adola**	**Odoshakiso**
Adola	***		***	
Odo shakiso	0.185	***	0.124	***

5. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary and Conclusions

The present study was carried out to characterize indigenous goat type, breeding and husbandry practices in Odoshakiso and Adola districts and to identify morphological variation among indigenous goat types found in the study area through phenotypic characterization. The study was conducted in Odoshakiso and Adola district of Guji zone by implementing questionnaire, recording goat morphological characters, body weight and linear body measurements. A total of 136 households were selected for identification of breeding and husbandry practices and 544 adult goats were sampled for phenotypic characterization of goat population (both qualitative and quantitative characters). Dentition was used to estimate the age of goats.SAS software version 9.1 (2009) and SPPS 20 was used for analysis of all data collected.

The production system was pastoralist and agro-pastoralist in both districts. The mean flock size of goat was 12.2±1.6 and 11.7±1.3 in Odoshakiso and Adola district, respectively. Goat populations in the study area were reported a trend of increasing for the past ten years and shifting from grazers to browser species in both districts because of recurrent drought, scarcity of grazing land. Pastoralist and agro-pastoralist keep goat for multipurpose such as meat, milk, income, by- product, social status, saving, dowery, ceremonies and rituals.

The traits appearance, horn and libido were for buck, size (appearance), high milk yield and color were for does were ranked in their order of importance. Responsibilities related to decision making on sales, purchasing and setting breeding objectives, of goats was dominated by male.The most dominant goat housing system in the study area was separate house followed by open yard and in family house. In the study area three types of milk feeding up to weaning were practiced restricted milk feeding, unrestricted and bucket feeding. It was shown that goat was kept with other livestock particularly with sheep in the study areas, while the respondents were herd kids separately from the adult goats because milk is the main product for the society, which causes competition with kids.

The source of water, frequency of watering, quality of water and distance travelled to obtain water were varied among seasons. The major water sources in the study area were

borehole/water well, dam/pond, river and rain water. Feed resources were scarce in dry season and there were seasonal feed supply fluctuations in the study area which was caused by the prevailing erratic rainfall patterns in the low lands and lack of experiences by pastoralists to collect and preserve feed for the dry season. Shrubs and bushes, natural pasture and crop residues were the main feed resources during dry season while natural pasture, shrubs and bushes were the main feed resources during wet season in the study area.

The most common grazing practice in the study area was free grazing and browsing, rotational grazing and browsing in dry and herded and paddock in wet seasons. In the study area most of the respondents (74.3%) were practicing castration commonly. The purpose of castration was to improve fattening, temperament and control breeding. The primary reason of keeping goat in study area was for earning cash income from sale, meat and milk. Goat production and productivity in the study area was constrained by many factors including drought occurrence, feed and water shortage, disease incidence, lack of superior genotypes, market problem, predator, labor shortage and others. The major goat diseases found in the study area were internal and external parasite, trypanosomiasis, anthrax, liver fluke Peste, Contagious Caprine Pleura Pneumonia (CCPP).

Goats in the study area were characterized as having dominantly plain coat color pattern, white and black coat color, smooth hair coat type, medium hair length, flat rump profile and ruff presents in both sex. The most dominant ear form was semi-pendulous followed by erect. The most frequently observed horn orientation was backward followed by lateral and obliquely up. Multiple correspondence analyses were carried out on nine qualitative traits recorded and it can be shown that 14.23% of the total variations are explained by the first two dimensions (7.30% by the first and 6.93% by the second dimensions).

The least squares means for the effect of sex was significant ($p<0.05$) in all quantitative variables. Male goats were consistently higher than females in all significantly affected variables. District had significant effect ($p<0.05$) on all quantitative variables. Body weight and all LBMs were significantly affected ($p<0.05$) by age group and sex by age group interaction. According to the respondents in the study area the overall mean age of males and

females at sexual maturity were found to be 11.6 and 12.6 months, respectively. The overall mean age at first kidding and kidding interval of goats in the study area were found to be 18.7 and 6.5 months, respectively.

In male and female, the highest correlation was for heart girth (r = 0.98, 0.97) respectively. Multiple regression equations were developed for predicting live body weight from LBMs. The best fitted models to predict body weight were HW, BL, RH, PW, EL, SC and SL for males whereas HW, RH, BL, PW, EL and RW for females. The discriminant analysis carried to classify male and female sample population represents percent classified female populations into each district (hit rate). The overall classification rates (hit rate) of female and male sample population were 42% and 41.7%. All squared Mahalanobis' distances obtained among districts populations for females and males were significant ($P<0.05$) indicating the existence of measurable differences between the two districts for male and female populations.

One of the main conclusions to be drawn from this study was goats in the study area play a significant role for pastoralists and agro-pastoralists as source of home consumption and income generation throughout the year. But, goat production system was constrained by labor shortage, predator, disease incidence and lack of extension service. There is less focus by concerned agencies on breed and breeding system to improve productivity and production of goats. The results further reveal that the pastoralists and agro-pastoralists have relatively similar production and breeding objectives in both districts studied. Therefore, this finding can form a baseline for understanding breeding and husbandry practices of goats in the study area as first step in designing a sustainable breeding program.

5.2. Recommendations

- To improve the productivity of goats in both districts, community based genetic improvement program should be designed.
- Community based animal health management programs and strengthening animal health centers will maximize the productivity of goats.
- Further research is recommended to estimate the genetic potential of the indigenous goat type in study area at production and reproduction levels.
- Genetic characterization at molecular level is necessary to identify the genetic distance among the types and their similarity and differences at gene level for a better understanding of their utility.

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7. APPENDICES

Appendix A. Questionnaire

Phenotypic Characterization of Indigenous Goat Type, Breeding and Husbandry Practices in Odo shakiso and Adola Districts

Enumerator Name _____Region _____Zone _____
District_____Kebele_____Productionsystem_____Code_____
Date_____ Starting time_____ Ending time_____

Notes to the enumerator:-

1. Politely introduce yourself to farmers/pastoralists.
2. Tell them briefly the objective of the study.
3. Administer questionnaires politely.
4. The respondents should be thanked for his/her time.
5. Record the response carefully.

Fill the responses in the space provided or mark alternative response(s) where appropriate with an “x “.or circle on the options

A. I General House Hold Information

1. Region_____ zone _____district_____ PA or kebele_____
2. Interviewee (name) _____ Sex_____ Age_____
3. Position in household: A. Household head B. Spouse of head C. Relative D. Children
4. Marital status:- A. Married B. Divorced C. Single
5. Educational Level: A. Illiterate B. Religious school

C. Primary (1-8) D. Secondary (9-10) E. PPS (11-12) F. Above

6. Ethnicity (clan and sub clan): _____, _____
7. House Hold head Sex; A. Male B. Female
8. Occupation: A. Pastoralist B. Agro-pastoralist C. House wife

D. Trader E. Handicraft

9. Family size (number) living in the house by age and sex :Male ___Female ___Total___
10. What is your major farming activity?

A. Livestock production B. Crop production C. Mixed D. Others

11. Number of livestock kept

Livestock	**Number**	**In order of importance**
Cattle		
Goat		
Sheep		
Camel		
Equine		
Others		

12. What is your major source of household income _____?

13. Who is responsible for the following jobs? (tick one or more boxes in each column and row)

S/No.		≤15 years		>15 years		Husband only	Wife only
		Male	Female	Male	Female		
1	Milking						
2	Purchasing the Goat						
3	Selling the goat						
4	Herding						
5	Breeding						
6	Feeding						
7	Caring for sick Animal						
8	Selling Dairy Products						
9	Barn cleaning						
10	Others						

13. Do you cultivate crop? A. Yes B. No

14. If say yes, list the major cultivate crop _____

II. Production System and Housing

1. Goat number according to age, sex and breeding category.(Flock structure)

Flock structure	Numbers
< 6 m h m k	
< 6 m h f e k	
Male 6 month to 1 year(Bucks)	
Male> 1 y (i)(B B)	
Female> 1y (i)(B)	
Castrated Male	

2. Population trend for the past 10 years in major livestock species

Livestock species	Increasing	Decreasing	Stable	Reason

Cattle				
Goat				
Sheep				
Camel				

3. Purpose of keeping goats? (Ranking)

Purpose of keeping Goat	Yes	Rank
Meat		
Milk		
Sale(cash income)		
By product (skin)		
Traditional identity way of life		
Social status (sign of wealth and strength		
Savings		
Ceremonies, rituals		
Manure		
Collateral (for loan ,disputes compensation		
Others		

4. Do you plan to expand your goat flock? A. Yes B. No

If not, reason _____

If yes, reason_____

5. Type of management: - A. Extensive B. Semi- intensive

C Intensive / back yard D. other_____

6. Member of household who own goat? A. husband B. wife C. both husband and wife D. children E. All family members

7. Do you keep more species of animal A. Yes B. No

If yes why_____

8. Do you keep your goat flock together with other species? A. Yes B. No

9. Do you provide night time shelter to the flock? A. Yes B. No

10. If yes what type of shelter. A. In family house B. Separate house C. Verenda D. Yard

11. Type of housing materials

Housing materials	Roof	Wall
Iron sheet		
Grass/bush		
Wood		
Stone /bricks		
Mud		
Concrete		
Kinda (plastic sheet)		

11. Are kids housed with adults? A. Yes B. No
If no why_____
12. Are goats housed with? A. Cattle B. Sheep C. Camel D. None

III. Feeding, Watering and Grazing
1. Watering frequency

Frequency of watering	Dry season	Wet Season
Freely available		
Once a day		
Once in two days		
Once in three days		
Others		

2. Do you provide water to the flock? A. Yes B. No

3. What is your water source?

Source of Water	**Dry Season**		**Wet Season**	
	Yes	Rank	Yes	Rank
Bore hole/water well				
Dam/Pond				
River				
Spring				
Pipe water				
Rain water				
Others (specify)				

Distance to watering point	**Dry Season**	**Wet Season**	**Quality of water**	
			Dry season	Wet season
At home				
< 1km				
1-5km				
6-10km				
≥10km				

5. What is your feed source?

Type of Feed	**Dry season**	**Rank**	**Wet season**	**Rank**
Natural pasture				
Established pasture				
Hay (standing hay				
Shrubs and Bushes				
Crop Residues				
Fallow land				
By product				
concentrate				

6. How is goat flock herded during the day time?

A. Male and female separated C. All class herded together

B. Kids are separated D. Other___

7. What is your grazing/Browsing method?

Grazing/Browsing method	Dry Season	Rank	Wet Season	Rank
Free grazing /Browsing				

Rotational grazing				
Herded				
Paddock				
Tethering				
Zero- grazing				
Others				

8. Trend in communal grazing areas?

A. Decreasing B. Increasing C. Stable D. Unknown

Reason _____

9. Way of herding:

A. Goat of a household run as a flock C. Other (specify) _____

B. Goat of more than one household run as a flock

10. Is there seasonal feed shortage? A. Yes B. No

11. If you say yes, at what Season. _____

12. What is your copping mechanism during feed shortage? _____

IV. Goat Population Trend

1. Population / number of your goat in the last 10 years?

A. Increased B. Decreased C. Stable

2. If you say "A" list the major important factors that responsible increasing of your goat population in the last 10 years.

A. _____

B. _____

C. _____

3.If you say "B" list the major important factors that responsible for decreasing of your goat population in the last 10 years.

A. _____

B. _____

C. _____

4.What is your interest in the future for your goat population A. increasing B. decreasing C. remain constant

V. Socio- Cultural Context of Goat Breeding

1. Common/local breed name _____

2. Where do you think the origin of your indigenous goat? _____

3. Do you have different type of goat in your flock/district? A. Yes B. No

If yes how do you differentiate the different goat type?_____

3. Is there special goat color or other typology preferences for respective social, cultural or religious events and devotions involving goats and goat products? A. Yes B. No

4. Mention if yes_____

5. Mention social relationship circumstances involving exchange of goats as a gift._____

6. Where did you get your initial goat flock? What does its composition look like?

mode	Yes	How many ?			
		Kid	Breeding bucks	Breeding does	Others
Dowry					
Groom Wealth					
Helpfrom relatives					
Compensation					
Others					

VI. Special Attributes of the Goat Type

1. How do you describe level of resistance/tolerance of your indigenous goat to some stress?

Stress	**Level of Resistance /Tolerance**		
	Low	**Medium**	**High**
Heat			
Drought			
Feed shortage			
Water shortage			
Parasite			
Disease			

2. Is there other outstanding characteristics / special attribute? A. Yes B. No

3. How do you understand the special attribute? _____

4. What are the important traits perceived by owner for these breed/types of goat?

Trait	**Yes**	**Rank**
Size		
Color		
Horn		
Growth rate		
Heat resistance		
Longevity		
Drought Resistance		
Character		
Milk yield		
Meat quality		
Fertility		
Adaptability		
Others (specify)		

VII. Goat Health Management

1. List types of disease frequently occurred and affect the productivity of goat in the area and rank them based on the importance

No.	**Disease type**	**Symptom**	**Season of occurrence**	**Treatment**	
				Modern	**Tradition**
1					
2.					
3.					
4.					
5.					

2. Which age group susceptible to the respective disease? _____

.3. What would you do when your goat sick?

A. Treat with ethno veterinary practices D. Sales immediately

B. Slaughters immediately E. Takes to veterinary center

C. Treat with treatments from local traders F. Others _____

4. Do you have veterinary service? A. Yes B. No

5. If yes, distance to veterinary service?_____ Km

6. Did your goats get vaccine in recent times? A. Yes B. No

7. If yes, how? A. After report of disease cases B. After certain animals died

C. Before outbreaks

8. Has there been any death of your goat over the last 12 months? A. Yes B. No

9. If yes, (specify total number) _____

10. What were the major causes for death/loss of your goats? (Rank)

No.	Factors that causes death	Rank
1	Droughts	
2	Feed and water shortage	
3	Predators	
4	Parasites	
5	Poisoning	
6	Diseases	
7	Accident	
8	Others, specify	

VIII. Castration and Culling

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

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

3. If no, give reason_____

4. At what age do you castrate? A. < 3 months B. 3- 6 months C. > 6 months

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

If say traditional specify its method _____

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

Culling Mode	Male	Female
Sold		
Slaughtered		
Exchanged		
Donated/gift		

7. Average market age in month: Male _____ Female _____

IX. Breeding Mechanisms and Strategies

1. Do you have cross breed buck? A. Yes B. No

2. If yes source of buck_____?

3. Do you have local breeding buck in your flock? A. Yes B. No

4. If yes, what is the number of buck in your flock? A. 1 B. 2. C.3 D. More than 3

5. If more than one why do you keep more than one buck? _____

6. For how many years on the average is the same breeding buck serving in your flock_____

A. 2-3 B. 3-4 C. 4-5 D. more than 5

7. Do you select goats for breeding purpose in/for your flock (male / female)? A. Yes B. No

8. If yes at which stage or age do you select breeding goat (male / female) A. early age B. puberty C. mature age

9. How do you identify individual goat for selection? _____

10. Do you use family story to select breeding goat? A. Yes B. No

11. Do you give special management for breeding male goat? A. yes B. No

If yes what are the special management for breeding buck?_____ for breeding female_____?

12. Do you use control mating? A.Yes B. No

13. If yes how do you control mating? _____

14.Do you know the impact of mating related individuals? A. Yes B. No

15.Do you use mating(buck) from your own flock? A.Yes B. No

16.If yes do you allow a buck to mate his Mother, sister and daughter? A. Yes B. No

17. If no, why_____ and where do you bring breeding buck? A. neighbor B. buys from market C. other

18. If you don‟t have breeding buck, how do you mate your doe? _____

19. Could you able to identify the sire of a kid? A. Yes B. No

20. If yes, how_____

21. Do you select for breeding males and females? A. Yes B. No

22. Selection criteria/trait preferences for breeding buck and Doe? (Rank)

Breeding buck			Breeding doe		
	Selection criteria	Rank		Selection criteria	Rank
1	Appearance/conformation		1	Size/appearance	
2	Color		2	Color	
3	Horn		3	Kid survival	
4	Character		4	Kid growth	
5	Adaptability		5	Age at first sexual maturity	
6	Growth		6	Kidding interval	
7	Libido		7	Twining ability	
8	Ability to walk long distance		8	High milk yield	
9	Pedigree		9	Ability to walk long distance	
10	Others		10	Others	

23. Do you identify heat sign in female goat? A. Yes B. No

24. If yes ,list the heat sign show from your female goat,_____

25. What are the usual methods of heat detection? And signs of estrus duly considered?

X. Production Characteristics , Reproductive and Survival Traits

1. Average age at sexual maturity:- Male _____ months ; Female _____ months

2. Age at first kidding: - Average _____ months; Max. _____ months; Min. _____months

3. Kidding interval: - Average _____ months; Max. _____ months ;Min. _____months

4. Do you fix age at first mating for the females? A. Yes B. No

5. Do you fix age at first mating for the males? A. Yes B. No

6. Average reproductive life span of doe (in years)_____

7. Average number of kid crop per doe life span _____

8. Average reproductive life span of buck_____

9. Occurrence of most births(type of birth) and season of most birth occurs. A. Single B. Twin

C. Single & Twin D. Others _____

10. How much parturition occurred with your flock during the last 1 year? _____

11. How much abortion cases occur in your flock in the last 1 year? _____

12. Offspring mortality in the last 2 months_____

13. Average weaning age of kids *(Tick one box)*

A. < 3 months C. 4-5 months

B. 3-4 months D. >5 months

14. Milk feeding up to weaning

A. Unrestricted suckling C. Bucket feeding

B. Restricted suckling D. Others_____

XI. Constraints for Goat production

1. What are the main constraints for goat production? (Rank)

Constraints	Yes	Rank	Improvement Option
Drought occurrence			
Feed shortage			
Water shortage			
Disease incidence			
Lack of superior genotype			
Market problem			
Predator			
Labor shortage			
Lack of extension service			
Others (specify)			

1. Guidelines for the Focal Group Discussion

1. Origin of indigenous goat found in the study area)?

2. Is goat perceived as a heritage of community?

3. Social laws

- Herding

- Communal land use

- Mobility

4. Traditional management system of goat in the area?

- Breed identification
Special quality of the breed

- Good and undesirable character of the goat compared to the other breed

- Trait preference

5. Population trend of goat in the last 10 years? If it's decreasing or increasing why?

6. What is the special attribute of indigenous goat found in the study area)?

7. Do you like to change your goat with other breed like exotic? Why?

8. What is your objective of goat breeding?

9. How do you select your breeding animal to be the next generation?

10. If you face water and feed shortage for your goat what is your coping mechanism to cope up this problem.

11. Major constraints of goat production in the area.

12. Do you identify your goat from other breed?

13. If yes, what are the characteristics to differentiate members of goat population form other breed.

14. How do you describe level of resistance / tolerance of the indigenous goat to some stress factors (such as heat tolerance, drought tolerance, feed shortage, water shortage, tolerance to parasites, resistance to disease, walk ability, etc)

15. How do you manage your grazing land?

16. Improving mechanisms of goat production?

2. Secondary Data Collection Format

1. Region_____ Zone _____

2. District _____Total Kebele of District _____

3. Production system :

- Pastoral (number of Kebele) _____

- Agro – pastoral (number of kebele) _____

4. Human population of the district : Male _____ Female _____Total_____

5. Climatic data:

-Temperature (℃): Minimum _____ Maximum _____

-Annual rainfall (mm): Minimum _____ Maximum _____

6. Total area coverage of the district (ha) _____

7. Agro ecological zone _____

8. Topography of the area (percentage):

- Plain _____ , Plateau _____ ,Mountain_____

9. Land use pattern: Cultivated Land _____, Arable Land _____,
Forest Land _____, Grazing Land _____,Others _____

10. Major crops grown in the district _____, _____, _____, _____

11. Livestock population in the district:

- Cattle _____ - Chicken_____

_ Goat _____ Others_____

- Sheep _____

- Camel _____

- Equine _____

12. Pure breed of indigenous goat breed concentration in the district

_____

_

_____

13. What are the main causes of genetic erosion and what do you suggest is appropriate to maintain this breed? And what the local community should do to maintain purity of the breed and to change the existing situation of genetic erosion?

_____

_____

3. Quantitative Data collection format

Region_____ Zone_____ District

_____

Kebele _____Production system_____

Measurement date_____

Farmer/ pastoralist Name	SS	Goat Id.No	Sex	Dent	HG	HW	BL	LBW	PW	HL	EL	SC	SL	RH	CD	RW	NL	TL	FH	FC	RL

SS= Study Site; Goat ID.No= Identification Number; Dent. = Dentition; HG=Heart Girth; HW= Height at Wither; BL=Live Body Length; LBW=Live Body Weight; PW= Pelvic Width; HL= Horn Length; EL=Ear Length; SC=Scrotum Circumference; SL=Scrotum Length, RH= Rump Height, CD=Chest Depth, RL= Rump Length, RW= Rump Width, NL=Neck Length; TL=Tail Length; FH= Fore canon Height; FC= Fore canon Circumference, and BCS=Body Condition Score

NB:- Live body weight in **Kg** and Linear body measurements in **cm.**

III. Qualitative Data Collection Format

Region_____ Zone_____ District _____

Kebele _____Production system_____

Measurement date_____

Farmer/PAS name	SS	sex	CC		SC	H		W	R	M	RP	BP	HP	EF	B	US	TL	Horn		
			type	pattern		Type	length											Pr	sh	O

PAs. =Pastoralist; SS=Study Site, CC=Coat color, SC=Skin color, H=hair, W=wattles, R=ruff, M=Muzzles, RP=rump profile, BP=back profile, HP=head profile, EF=ear form, B=beard, US=udder size, TL=teat length, Pr=presence, Sh=shape, O =orientation

. Description of qualitative trait and respective code will be as the following

Parameters Codes

Location	1=O/shakiso 2= Adola
Sex of the animal	1= Female 2= Male
Coat color pattern	1= Plain 2= Patchy 3= Spotted
Coat color type	1= White 2= Black 3=Brown 4= Fawn 5=Grey 6= Red 7=Roan 8=White dominant 9=Black dominant 10= Brown dominant
Skin color	1= No pigment 2= Pigmented
Hair coat type	1= Glossy 2= Smooth hair 3= Long straight hair 4= Curly rough
Hair length	1=Short(<1mm)2=Medium(1-2mm) 3= Long(>2mm)
Wattles	1= Present 2= Absent
Ruff	1= Present 2= Absent
Muzzle	1= Present 2= Absent
Rump profile	1= Flat 2= Sloping 3=Roofy
Back profile	1= Straight 2= Slopes up towards the rump 3=

	Slopes down from withers 4= Dipped (curved)
Head (Facial) profile	1= Straight 2= Concave 3= Convex 4= Markedly convex
Ear orientation	1=Erect 2=Semi-pendulous 3= Pendulous 4=Carried horizontally
Beard	1= Present 2= Absent
Udder size	1= Large 2= Medium 3= Small
Teat length	1=Long 2= Medium 3= Short
Horn presence	1=Present 2= Absent
Horn shape	1= Scurs 2= Straight 3= Curved 4= Spiral 5= Corkscrew
Horn orientation	1= Lateral 2= Obliquely upward 3= Back ward
Dentition classes	
0 PPI	0 Pair of permanent incisors (Milk teeth)
1 PPI	1 Pair of permanent incisors
2 PPI	2 Pair of permanent incisors
3 PPI	3 Pair of permanent incisors
4 PPI	4 Pair of permanent incisors

. Quantitative traits will be recorded for each sample animal by f/f description

Parameter	**Units**	**Descriptin**
Body weight (BW)	kg	Taken early in the morning using 100 kg spring balance
Body length (BL)	cm	The horizontal distance from the point of shoulder to the pin bone to the nearest centimeter.
Heart girth (HG)	Cm	The height from the bottom of the front foot to the highest point of the shoulder between the withers to the nearest centimeter.
Height at wither (HW)	Cm	The distance around the animal measured directly behind the front leg to the nearest centimeter.
Horn length (HL)	Cm	Length of the horn (in centimeters) on its exterior side from its root at the poll to the tip.

Pelvic width (PW)	Cm	The distance between the pelvic bones, across dorsum to the nearest centimeter.
Ear length(EL)	Cm	The length of the ear on its exterior side from its root at the poll to the tip to the nearest centimeter.
Scrotal circumference (SC)	Cm	The circumference of the testis at the widest part to the nearest centimeter.
Scrotal length (SL)	Cm	The length of the scrotum in centimeters from the base to the tip of its tail.
Tail length (TL)	Cm	From the point of attachment to the tip, to the nearest cm using tape meter
Fore canon circumference (FC)	Cm	A circumference measurement taken in centimeter at the narrowest part of the bone jointing fetlock and knee joint.

Appendix. B Table

Appendix Table 1 Types of mating practiced in the study area

Parameter	Odo shakiso		Adola		Overall	
	N	%	N	%	N	%
Types of mating						
Natural mating(SB)	5	7.4	3	4.4	8	5.9
Natural mating(USB)	63	92.6	65	95.6	128	94.1
Reason of un controlled mating						
Goats graze together	30	44.1	34	50	64	47
Lack of awareness effect of(I)	26	38.2	28	41.2	54	39.7
Insufficient number of buck	4	5.9	2	2.9	6	4.4
Shortage of grazing land	8	11.8	4	5.9	12	8.9
Do you use mating buck from your own flock?						
Yes	62	91.2	56	82.4	118	86.8
No	6	8.8	12	17.6	18	13.2
Do you allow your buck mate His mother, daughter and sister	40	58.8	54	79.4	94	69.1
	28	41.2	14	20.6	42	30.9
Yes						
No						
Do you know the impacts of mating related individuals?						
Yes	30	44.1	27	39.7	57	41.9
No	38	55.9	41	60.3	79	58.1
Could you identify the sire of kid?						
Yes	50	73.5	54	79.4	104	76.5
No	18	26.5	14	20.6	32	23.5
Identification mechanisms						
color of goats	20	29.4	25	36.8	45	33.1
Individual	15	22.1	13	19.1	28	20.6
characteristics	2	2.9	1	1.5	3	2.2
Unique marks on the goats	31	45.6	29	42.6	60	44.1
By observation						

N= number of respondents; I= inbreeding, SB= selective buck, USB= unselective buck

Appendix Table 2 ANOVA of Heart girth of Odo shakiso and Adola Districts

Source	DF	Type III SS	MS	F Value	Pr > F
Age	2	10931.40936	5465.70468	321.75	<.0001
Sex	1	1294.95711	1294.95711	76.23	<.0001
Loc	1	29.43646	30.11765	1.73	<.0001
Sex*Age	2	1247.92735	623.96367	36.73	<.0001
Error	534	9071.18277	16.98723		
Corrected Total	543	22257.40441			

Appendix Table 3 ANOVA of Height at wither of Odoshakiso and Adola districts

Source	DF	Type III SS	MS	F Value	Pr > F
Age	2	4311.694857	2155.847428	148.47	<.0001
Sex	1	1648.419014	1648.419014	113.52	<.0001
Loc	1	31.890882	31.890882	2.20	<.0001
Sex*Age	2	485.093101	242.546550	16.70	<.0001
Error	534	7754.08714	14.52076		
Corrected Total	543	13023.15993			

Appendix Table 4 . ANOVA of rump height of Odoshakiso and Adola districts

Source	DF	Type III SS	MS	F Value	Pr > F
Age	2	4185.714264	2092.857132	163.14	<.0001
Sex	1	1547.762309	1547.762309	120.65	<.0001
Loc	1	24.832082	24.832082	1.94	<.0001
Sex*Age	2	482.768374	241.384187	18.82	<.0001
Error	534	6850.37928	12.82843		
Corrected Total	543	11918.55882			

Appendix Table 5 ANOVA of Body length of Odoshakiso and Adola districts

Source	DF	Type III SS	MS	F Value	Pr > F
Age	2	3985.091213	1992.54560	55.88	<.0001
Sex	1	839.399745	839.399745	23.54	<.0001
Loc	1	30.689333	30.689333	0.86	<.0001
Sex*Age	2	209.362067	104.681033	2.94	<.0001
Error	534	19041.76807	35.65874		
Corrected Total	543	25206.33640			

Appendix Table 6 ANOVA of live body weight of Odoshakiso and Adola districts

Source	DF	Type III SS	MS	F Value	Pr > F
Age	2	11252.33544	5626.16772	486.93	<.0001
Sex	1	2340.85669	2340.85669	202.59	<.0001
Loc	1	28.71533	28.71533	2.49	<.0001
Sex*Age	2	1469.80546	734.90273	63.60	<.0001
Error	534	6170.05066	11.55440		
Corrected Total	543	19209.99816			

Appendix Table 7 . ANOVA of Pelvic width of Odoshakiso and Adola districts

Source	DF	Type III SS	MS	F Value	Pr > F
Age	2	187.8401536	93.9200768	28.05	<.0001
Sex	1	121.2309063	121.2309063	36.21	<.0001
Distr	1	25.8228246	25.8228246	7.71	<.0001
Sex*Age	2	23.1100383	11.5550191	3.45	<.0001
Error	534	1787.743353	3.347834		
Corrected Total	543	2065.875000			

Appendix Table 8 ANOVA of horn length of Odoshakiso and Adola districts

Source	DF	Type III SS	MS	F Value	Pr > F
Age	2	1857.039788	928.519894	68.87	<.0001
Sex	1	1237.171781	1237.171781	91.76	<.0001
Loc	1	25.784576	25.784576	1.91	<.0001
Sex*Age	2	69.701567	34.850784	2.58	0.0763
Error	534	7199.46467	13.48214		
Corrected Total	543	10225.63971			

Appendix Table 9. ANOVA of Ear lenght of Odoshakiso and Adola district

Source	DF	Type III SS	MS	F Value	Pr > F
Age	2	53.39289733	26.69644867	6.52	<.0001
Sex	1	1.54183379	1.54183379	0.38	<.0001
Loc	1	25.48226302	25.48226302	6.22	<.0001
Sex*Age	2	14.35446915	7.17723457	1.75	<.0001
Error	534	2186.059780	4.093745		
Corrected Total	543	2325.101103			

Appendix Table 10 ANOVA of chest depth of Odoshakiso and Adola district

Source	DF	Type III SS	MS	F Value	Pr > F
Age	2	659.7512826	329.8756413	12.32	<.0001
Sex	1	628.0052037	628.0052037	23.46	<.0001
Loc	1	27.8952721	27.8952721	1.04	<.0001
Sex*Age	2	83.7320994	41.8660497	1.56	<.0001
Error	534	14296.51366	26.77250		
Corrected Total	543	16006.77757			

Appendix Table 11. ANOVA of Neck length of Odoshakiso and Adola district

Source	DF	Type III SS	MS	F Value	Pr > F
Age	2	1168.452920	584.226460	67.18	<.0001
Sex	1	12.514806	12.514806	1.44	<.0001
Loc	1	23.240844	23.240844	2.67	<.0001
Sex*Age	2	69.872085	34.936042	4.02	<.0001
Error	534	4643.608408	8.695896		
Corrected Total	543	6653.500000			

Appendix C Figures

1 Goat flock at watering point and browsing on bushes and tree branches

2 Goats grazing Natural pastures

3 Questioner interview with respondents

4 Goat herding in the study area; goat flock only (right) and goat flock with sheep flock (left)

5 Adult goat and kid house in the study Area