COMMUNITY-BASED CHARACTERIZATION OF WOYTO-GUJI GOAT IN LOMA DISTRICT, SOUTHERN NATIONS NATIONALITIES AND PEOPLES REGIONAL STATE OF ETHIOPIA

M.Sc. THESIS

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FEBRUARY 2015

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COMMUNITY-BASED CHARACTERIZATION OF WOYTO-GUJI GOAT IN LOMA DISTRICT, SOUTHERN NATIONS NATIONALITIES AND PEOPLES REGIONAL STATE OF ETHIOPIA

M.Sc. THESIS

SUBMITED TO THE SCHOOL OF GRADUATE STUDIES OF JIMMA UNIVERSITY, COLLEGE OF AGRICULTURE AND VETERINARY MEDICINE,

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN AGRICULTURE (ANIMAL BREEDING AND GENETICS)

By

YAEKOB LORATO

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APPROVAL SHEET OF THESIS

SCHOOL OF GRADUATE STUDIES

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As Thesis Research advisor, I hereby certify that I have read and evaluated this thesis prepared, under my guidance, by **Yaekob Lorato** entiteled **Community Based Characterization of Woyto-Guji Goat in Loma District, Southern Nations Nationalities and Peoples Regional State of Ethiopia**. I recommended that it can be submitted as fulfilling of the Thesis requirement.

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As member of the *Board of examiners of the MSc Thesis open Defense Exammination*, we certify that we have read, evaluated the thesis prepared by **Yaekob Lorato** and examined the candidate. We recommended that the thesis is accepted as fulfilling the Thesis requirement for Degree of Master of Science in Agriculture (**Animal Breeding and Genetics**).

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Chairperson Signature Date

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External Examiner Signature Date

DEDICATION

I dedicat this thesis manuscript to my beloved wife Abezash Menta for her continuous material and moral support till the accomplishment of my education and let this also stand for warm welcome to my Son Paul Yakob whose birth coincide the course of this study.

STATEMENT OF THE AUTHOR

I hereby declare that this thesis is my original 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 M.Sc. degree at Jimma University College of Agriculture and Veterinary Medicine and is deposited at the University Library to be made available to borrowers under the 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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Date of Submission: FEBRUARY 2015

BIOGRAPHICAL SKETCH

The author Yaekob Lorato was born in Southern Nation, Nationalities and People Regional State, Dawuro Zone at Shoat Village on November 20, 1987. He completed his elementary education in Shoat Chawula Elementary School from 1995 to 2001. He attended his junior and secondary education at Loma Junior and Secondary School from 2001 to 2005 and Preparatory education at Waka Senior Secondary School from 2005 to 2007.

In 2007, he joined Jimma University College of Agriculture and Veternary medicene and graduated with Bachelor of Science degree in Animal sceince in 2010. He then joined Southern Nation Nationality and people Regional Agricultural Bureau; Loma Woreda Agricultural Office in 2010, as an expert in Animal Production and Nutrition Development work division and then by 2011 he served the office as a Coordinater of Houshold Asset Building program and Coordinater in Livestock Resource Development work process till he joined the School of Graduate Studies of Jimma University College of Agriculture and Veterinary Medicine for Master of Science in Agriculture majoring in Animal Breeding and Genetics in September 2012.

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LIST OF ABBREVIATIONS

AFK	Age at First Kidding
AFS	Age at First Service
AnGR	Animal Genetic Resource
BCS	Body Condition Score
BL	Body Length
BWT	Body Weight
CBM	Community Based Managment
CCPP	Contagious Caprine Pleuropneumonia
Cm	Cent meter
CSA	Central Statistics Agency
CV	Coefficient of Variation
CW	Chest Width
DA	Development Agent
EL	Ear Length
FAnGR	Farm Animal Genetic Resource
FGD	Focus Group Discussion
GLM	General Linear Model
HG	Heart Girth
HH	Household
HL	Horn Length
HtW	Height at Wither
IBC	Institute of Biodiversity Conservation
ILCA	International Livestock Center for Africa
ILRI	International Livestock Research Institute
Kg	Kilogram
KI	Kidding interval

(LIST OF ABBREVIATIONS CONTINUED)

L.A.R	Loma Annual Report
LSM	Least Square Means
M a.s.l.	Meters above sea level
MOARD	Ministry of Agriculture and Rural development
OADB	Oromiya Agricultural Development Bureau
PI	Parturition Interval
PPI	Pairs of Permanent Incisors
PPT	Pest des Petit Ruminants
PRA	Participatory Rural Appraisal
PW	Pelvic Width
r	Correlation Coefficient
R^2	Coefficient of Determination
RA	Rural Appraisal
RH	Rump Height
RL	Rump Length
SAS	Statistical Analysis System
SC	Scrotum Circumference
SD	Standard Deviation
SE	Standard Error
SGP	Sheep and Goat Pox
SNNPR	Southern Nattions Nationalities and Peoples Regional State
SPSS	Statistical Package for Social Science

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ABSTRACT

Community based Participatory characterization of Woyto-Guji goat population in the Loma district was undertaken to identify breeding objectives and trait preferences, document indigenous knowledge, traditional breeding system and husbandry practice, characterize morphologically Woyto-Guji goat breed in its environment. The district has been stratified in to lowland, midland and highland agro ecologies for this study. Semi-structured questionnaires, PRA tools, field observations, recording morphological characters (body weight and linear body measurements) were employed to collect the data. Descriptive, ranking and inferential statistics were employed to handle survey, qualitative and quantitative data, respectively. The result showed that the overall mean family size per household was 7.75+2.90. The overall mean flock size of goat were 15.47±14.40. The rate of change in inbreeding coefficient per generation when flock is not mixed in lowland, midland and highland were 0.057, 0.068 and 0.075, respectively. Goats were kept for multifaceted purposes ranging from products like meat and live-sale to functions in socio-cultural, milk, financial and ritual state of affairs. The goat production could be improved through exploring the indigenous knowledge in husbandry practices and genetic improvement strategy that considered producers trait preference, breeding objectives and active involvement of the community. The overall index of Body conformation, twining ability, adaptation traits and coat colors of female goat were reason of selection with ranked first, second, third and fourth with index 0.21, 0.18, 0.17, 0.16 in the study area. Body conformation, adaptation and coat color factors were mentioned as high status reasons for choice trait of male goats with ranking first, second and third preferred factors with overall index 0.32, 0.27 and 0.21. The 91.2% goat showed plain colour patterns, 6.3% patched whileas 2.5 were spotted. The head profile exhibited was straight (80.6%), slightly convex (15.2%) and concave (4.2%). The goat population showed either semi-pendulous (69.8%) or horizontal (30.3%) ear type. However, the ear formation was either long ear (97.0%), short ear (2.3%) and rudimentary (0.4%). AFS of female were 8.6±1.37; 8.36±2.46 and 8.6±1.82 month in lowland, midland and highland, respectively and the corresponding age for male were 9.06±3.58, 8.39±2.62 and 10.2±2.92 months respectively. The PI was 7.70±1.85month in highland, 7.27±1.59 month in midland and 7.48±1.66 month in lowland. Litter size of 2.23±1.22, 2.22±1.11 and 1.8±0.9 was observed in lowland, midland and highland, respectively. Disease, labor, land, feed shortage were ranked the first, second, third and fourth major constraints for goat production in the study area with index of 0.31, 0.21, 0.14 and 0.14, respectively. Sex, age and agro ecology had a significant ($p<0.001$) effect on body weight and most of the body measurements. The mean BWT, BC, BL, HG, HW, CW, PW, RH, RL, EL and HL of females are 26.53±2.91kg, 3.01±0.45, 57.48±0.64cm, 70.20±0.21cm, 64.12±0.18cm, 13.74±0.07cm, 13.20±0.19cm, 66.04±0.52cm, 11.97±0.13cm, 13.74±0.16cm and 11.20±0.10cm respectively. The corresponding values for male counterpart were 27.16± 0.70 kg, 3.31± 0.01, 60.13± 1.17cm, 74.98± 0.33cm, 68.34± 0.05cm, 14.48± 0.41cm, 13.25± 0.37cm, 68.37± 0.50cm, 12.83± 0.43cm, 14.02± 0.020cm and 13.22± 0.47cm respectively. Most of the body measurements had positive and high correlation with the body weight and heart girth showed the highest and positive correlation with body weight. HG has been selected across all age groups for both sexes as the first regressor with R^2=0.68; y=0.74x -28.20; R^2=0.78; y=0.88x -39.12 for female and male pooled data (0PPI to 4PPI). This finding indicated that an increase of one cm of HG resulted in an increase of 0.74 and 0.88 kg of live weight, respectively. Eigen value of principal components of one and two were 7.00551756 and 1.0472258 with difference of 5.9583 and 0.207569 respectively. The dendrograms of female and male goat breeds showed that lowland and midland breeds have relatively similar than that of highland breed.

Keywords: Community-based, characterization, Woyto-Guji goat, quantitative trait, qualitative trait, breeding objectives, trait preference

1. INTRODUCTION

Ethiopia is home for diverse indigenous goat populations, numbering 22.8 million heads (CSA, 2011) and 15 breeds of goat (IBC, 2004; Dereje *et al*, 2013) that have traditionally been an integral part of the farming systems in all agro-climatic conditions. It has been estimated that about 70% of the goat population is found in the low lands and the rest 30% is found in the high lands (Alemayehu, 1993, Feki, 2013). Goat and sheep account for about 90% of meat and 92% of skin and hide (Adane and Girma, 2008) export trade value in Ethiopia. Moreover, goats play an important role in the livelihood of resource-poor farmers and they provide a vast range of products and services such as meat, milk, cash income, skin, manure and security (insurance), banking, gifts, etc. (Adane and Girma 2008, Tesfaye, 2010).

Despite the large size of the country's small ruminant population, the productivity per unit of animal and the contribution of this sector to the national economy is relatively low (Zewdu, 2008). This may be due to different factors such as poor nutrition, prevalence of diseases, lack of appropriate breeding strategies, and poor understanding of the production system and local community interests. However, the indigenous goat breeds have relatively a better advantage in their natural habitat (Dereje, 2011). According to Kiwuwa (1992), the broad genetic variability of African small ruminant breeds enables them to survive under stressful environmental conditions, including high disease incidence, poor nutrition and high temperature. Environmental pressure also maintains a wide range of genotypes, each adapted to a specific set of circumstances.

Thus, improvement of local animal genetic resources holds promise for feasible mechanism of conservation through addressing the self-sustaining incentive of improved livelihood for the keepers (Grum, 2010). Identification, Characterization and documentation of local breeds, as well as associated contexts of their development and utilization, is the first step in making well-informed decisions pertaining to genetic improvement interventions (Grum *et al*., 2012). However, the conventional approaches generally failed to recognize the role of local communities on development of the local breeds and neglected to consider their priorities and concepts in studying these genetic resources. In an attempt to fill these methodological gaps, the "people-centered" breed characterization method has recently emerged with a more participatory approach to documenting animal genetic resources (Koehler 2005; Grum *et al.,* 2012). Therefore, Community based animal genetic resource (AnGR) characterization describes and documents existing genetic resources according to their meaning to and based on the knowledge, concept and priorities of the local communities.

Community based characterization is not merely meant to replace the conventional phenotypic characterization; rather, best supplement it by broadening the characterization horizon to include socio-cultural and versatile livelihood contexts (Grum, 2010). In addition to that, Participatory community based breeding strategy which is set with sound breeding objectives might be an option. Breeding objective is an indicator for any production to answer why community keeps the animals. This is very important to set a breeding strategy and over all breeding goal for certain species of animal in a given community for a known production system. In this case identifying and prioritizing producer's trait preferences for each species of livestock is essential factor and a tool in determining breeding objectives and hence designing genetic improvement strategy. So trait preference shows special characteristic feature and genetic advantages that the animals possess under farmers perspective in the given local production environment. Therefore, there is a need to describe and improve the goat genotype under the prevailing environment through community based genetic improvement approach (Dereje, 2011; Grum *et al*, 2012). Goat breeds in Ethiopia were still not well developed and differentiated (Soloman, 2009). This is apparently due to lack of clear-cut morphological descriptions of even the known types (Worken, 1992, Soloman, 2009). In addition, information available on Ethiopian small ruminant is insufficient, some were based on on-station research findings, and this information does not analyze productivity of breeds under producers' management. Looking at a breed from this perspective alone does not consider the keeper's priorities (Kosgey, 2004).

The "*Woyto-Guji*" goat was one of the rift valley goat family in the country maintained in northern Omo and southern pastoral ethnic group. This type of goat with various local names in different localities known as *Woyto, Guji, konso* (FARM Africa, 1996). The present study area, viz: Loma District (one of the northern Omo parts) is endowed with large population of

Woyto-Guji goat, considerably higher than flocks in adjacent woreda. The goats breed are the most important marketable livestock and have their own socio-cultural value in the study area.

The available information of "*Woyto-Guji*" goat breed was not sufficient to describe the breed and morphological characterization carried so far have not covered all the production environments rather have focused on specific areas of the population, besides the information was undertaken before two decades. Indigenous livestock breeds are considered, for diverse reasons, as treasured genetic resources that tend to disappear as a result of new market demands, crossbreeding or breed replacement and mechanized agricultural operations (Salako, 2006). Moreover, identification, characterization and understanding of local goat breed in the Loma district, documentations of its important productive, reproductive and adaptation traits appear scanty. Additionally, essential inputs for designing breeding strategy in the context of community-based management, such as, local trait preferences, traditional systems in managing the gene pool, socio-cultural portfolio of the breeding community, remain untapped. Therefore, community-based characterization of the "Woyto Guji" goat population in Loma district has been conducted for the following objectives:-

I. To document community's indigenous knowledge, traditional breeding system and general husbandry practices
II. To assess local trait preferences and breeding objectives of the community
III. Morphological characterization of Woyto-Guji goat breed in the Loma District

2. LITERATURE REVIEW

2.1 Domestication of goat

Domestic goats (*Capra hircus*) might have played a central role in the Neolithic agricultural revolution and spread of human civilizations around the globe. Archaeological evidence suggests that goat domestication took place approximately 8000 to 7000 BC when hunters and gatherers began to change their way of life (Mason, 1981). Goats spread all over the continents from the slopes of the Zagros Mountains on the border of Iran and Iraq and inhabit all climatic zones (Pieters, 2007). By 5000 BC they were in Syria and from there they migrated to the west and South. The wild species of Capra which are believed to have contributed to the domestic goat include the Ibex *(C. Ibex)* and the Bezoar (*Capra hircus*) (Pieters, 2007). Ethiopia has long been recognized as a gateway of genetic material from Asia to Africa. The Climate of Ethiopia, which is predominantly determined by altitude ranged from below sea level in the Danakil desert to above 4000 meters in the Simien mountains (FAO, 1998) and hence these diverse ecology served to further diversify and develop the genotypes it received (IBC, 2004).

2.2. Classification of Goat types of Ethiopia

Goats in Africa have traditionally been divided into three main families; the Dwarf goats of West and Central Africa, the Savannah goats of sub-Saharan Africa and the Nubian type goat of Northern Africa (Wilson, 1991). Information compiled on physical description and management system revealed that there are 14 goat types in Ethiopia and Eritrea (Farm-Africa, 1996; Gizaw *et al.* 2010a cited in Solomon, 2014). Using a set of morphological characters and multivariate statistical analysis, the goat types of Ethiopia and Eritrea have been classified into four major families, viz: the Somali family (Short eared Somali, Long-eared Somali, and Hararghe Highland), the Nubian family (Nubian and Barka), the small Rift valley family (Abergalle, Worre, Afar, Arsi-Bale, and Woyto-Guji) and finally the more heterogeneous Small East African family (Western Highland, Keffa, Central Highland and West Lowland) (Table 1).

Table 1:Goat families and breeds of Ethiopia

Family name	Breed name	Other local name	Distribution
Nubian family	Nubian	Shukria, Langae, Hassen	North-western Ethiopia,(Wegera)
Rift Valley family	Afar	Adal, Danakil	Rift valley strip, Danakil depression, Gewane, North & Western Hararghe
	Abergelle	NA	Southern Tigray(Tembien,Inderta) Northern Wollo (Wag and Raya Azebo), Eastern Gonder
	Arsi-Bale	Gishe, Sidama	Arsi, Bale, Higher altitude of Sidamo &Western Hararghe
	Woyto-Guji	Woyto, Guji, Konso	North &South Omo, Southern Sidamo,Wolayta
Somali family	Hararghe Highland	NA	Highlands of East and West Hararghe
	Short-eared Somali	Denghier or Deghiyer	North& Eastern Ogaden(Jijiga ,Degeh Bur and Werder)
	Long-eared Somali	Large white Somali, Degheir, Digodi, Melebo	Ogaden, Lowlands of Bale, Borana & Southern Sidamo
Small East African family	Central Highland	Brown goat	Central highland west of Rift valley, Central Tigray, Wollo,Gondar,shoa
	Western Highland	NA	Highland of south Gonder, Gojam, Wellega &western Shoa
	Western Lowland	Gumz	Gojam(metekel),Wellega(Assosa),Illubabor(Gambela)
	Keffa	NA	Lowland of Keffa, South Shoa, kembata &Hadiya

(Farm Africa, 1996) and DAGRIS, 2006 : NA= Not available.

2.3. Goat population and Distribution in Ethiopia

The goat population of Ethiopia was estimated to be 22.8million goats (CSA, 2011) and accounts for 13.5% of the African goats' population (FAO, 1991). Goat is maintained with a very little resource input under the traditional subsistence management system. Goats are important for diversifying production, creating employment, increasing income, building capital, contributing to human nutrition and reducing risk during crop failure, property security and investment (Workneh, 1992). Goats are easily adaptable animal species. They are particularly important in marginal agricultural land especially in arid and semi-arid areas. Goat production is an integral part of all farming system in all agro climatic conditions of Ethiopia (Workneh, 1992).

Goats are hardy and well-adapted to harsh climates. Due to their grazing habits and physiological characteristics, they are able to browse on plants that would normally not be eaten by other livestock species. Thus, the presence of goats in mixed species grazing systems can lead to a more efficient use of the natural resource base and add flexibility to the management of livestock (Safilios-R, 1983). Sheep and goats are important in development because of their ability to convert forages and crops and household residues into meat, fiber, skins and milk (FAO, 1981).

2.4. Importance of Goat in smallholder systems

Goat has been kept since ancient times for meat, milk, hide and fiber (cashmere and mohair) production, control of bush encroachment, as well as for cultural and religious purposes in a large number of countries (De Leeuw *et al*., 1999; Boyazoglu *et al*., 2005). According to recent studies in Southern part of Ethiopia, Getahun (2008) found out that smallholder mixed farming system kept small ruminants mainly for cash generation. They are of great importance as major sources of livelihood (Tembely, 1998) and contribute to the sustenance of landless, smallholder and marginal farmers (Adugna, 1998) especially to the poor in the rural areas throughout the developing countries (Devendra and Burns, 1983). Sheep and goats are very important for resource-poor smallholder systems of rural Ethiopia due to their ease of management and significant role in provision of food (protein, essential micro-nutrients: vitamin A, iodine, and iron) and generation of cash income (Zelalem and Fletcher, 1993; Baars, 1998; EARO 2000; Ewnetu *et al*., 2006). They serve as a living bank for many farmers, closely linked to the social and cultural life of resource poor farmers (Adane and Girma 2008) and provide security in bad crop years (Ehui *et al*., 2000). They are mainly regarded as a valuable and quick source of cash, security and insurance against crop failure and hardship.

In particular, goats are suitable for small scale resource poor farmers: they are cheap to acquire compared to cattle, they require little land, they reproduce quickly, and they are able to feed on a wide range of forages. As a result, goat rearing is an important activity for resource poor farmers under the mixed crop-livestock and Agro pastoral production systems that are commonly practiced in Ethiopia.

2.5. Goat production System in Ethiopia

In the highlands, livestock constitutes a major part of the mixed farming system, providing draft power, producing milk and conferring a certain degree of security against crop failures (FAO, 1995). For the pastoralists in the lowlands, livestock husbandry is their sole means of survival. Rain fed crop production is limited by low and erratic rainfall in arid and semi-arid zones and people in these pastoral areas rely more on livestock for subsistence. The pastoral areas are home for about 40 per cent of the cattle, 75 per cent of goats, 25 per cent of sheep, 20 per cent of equines and nearly all of the camels (Fekadu, 1990). About 20 per cent of the draft oxen for the highland farms and 90 per cent of the graded cattle and sheep for export come from the pastoral regions (Coppock, 1994). Collecting and analyzing data on economically important performance traits and management practices under defined production conditions makes it possible to identify production prospects, as well as different management variables and their effects on the production process (Peters and Horpew, 1989; Tsedeke , 2007).

Livestock production system and the relative importance and potential for increased Production by livestock species in varied areas differ markedly due to differences in resource endowment, climate, population, disease incidence, level of economic development, research support and government economic policies (Beets W.C, 1990). In Ethiopia, sheep and goats are maintained under two broad production systems (Tembely, 1998; EARO, 2000).

2.5.1. Mixed crop-livestock farming system

In this system, small ruminants are confined over-night (to avoid predators and theft) and herded or tethered during the day. Cut-and-carry of local forage resources and crop residues also contribute significantly to animal feed (Sidahmed, 1996). In the central highlands of Ethiopia small ruminants depend mostly on grazing fallow lands, overgrazed natural pasture and crop residues usually with no extra-supplement and receive minimum health care.

Farmers maintain one to three does (depending on the size of the flock) for year round breeding (Tembely, 1998). Productivity is low and is under nutritional stress for much of the year due to cropping intensity (EARO, 2000). In mixed crop-livestock production system which mainly seen in central highland of the country, small ruminant production is characterized by low productivity due to nutritional stress and internal and external parasites (Belete, 2009).

2.5.2. Agro pastoral and pastoral system

Pastoral production system is located in the arid and semi-arid lowland areas below 1500 m.a.s.l. where livestock rearing is the mainstay of people (Markos, 2006). The arid zones of the country are characterized by mean annual rainfall between 100 and 800 mm, mean annual temperature of $21^0C – 27\ ^0C$ and mean annual potential evapo-transpiration of between 1700 and 2600 mm (FDRE, 1998; MOA, 1998). In the more arid regions, pure pastoralism is practiced. Small ruminant production is associated with the purely livestock based nomadic and transhumance pastoral production systems based largely on range, primarily using natural vegetation. In the lowlands of Ethiopia, livestock is comprised of large flocks and herds of sheep and goats, cattle and camels mainly transhumant's, where only surplus are sold at local markets or trekked to major consumption centers. Extensive livestock keeping is the backbone of the lowlands economy (Tembely, 1998; EARO, 2000).

Under the erratic and low rainfall conditions of the tropics livestock are the most efficient convertors of a fragile cover of primary production into animal protein. In the very arid environments the users are extremely mobile where migration is usually in search of water, forage and mineral supplementation (Sidahmed, 1996). In these systems livestock represent the main enterprise for a subsistence livelihood. Pastoralists in more arid regions have adopted a drought risk strategy by raising more goats compared to other animals' species and they diversify their livestock species composition.

The extensive systems include also the semi-nomadic pastoralists and the transhumant system. In the former, livestock is equally important to food cropping in providing subsistence production. Cropping is more important for transhumants than livestock and movement is limited to dry seasons and for short distances. Sometimes movement of transhumant livestock is undertaken to avoid trespassing cultivated lands during the growing season (Sidahmed and Koong, 1984; Sidahmed, 1985).

2.6. Goat and Goat product Marketing

Farmers usually sell goats when they become poor in productivity and/or when there is shortage of money in the household to fulfill immediate household requirements.The primary reason for selling of goat for the Metema goat owners was to pay labour wage followed by food grain purchase, input purchase, school fee and as means of tax in that order with an index of 0.25, 0.15, 0.17, 0.11 and 0.14 in cotton based farming system, respectively (Tesfaye, 2009). Final buyers, which include butchers, meat processing factories, fattening farms or live animal exporters, purchase livestock at any stage. Marketing includes moving products from producers to consumers and comprises exchange activities of buying and selling, the physical activities designed to give the product increased time, place and form utility, and the associated functions of financing, risk bearing and dissemination of information to participants in the marketing process (Jabbar *et al*., 1997).Livestock marketing involves the sale, purchase or exchange of products such as live animals, and livestock products of milk, meat, skins, wool and hides for cash or goods in kind (ILCA,1990). Farmers need to be aware of the preferred characteristics of animals as well as price patterns so that they can plan breeding and fattening programs and breed selection consistent with the best seasonal prices and consumers' preferences (Peters and Horpew, 1989; Ehui et al., 2000).

2.7 Goat genetic resource of Ethiopia

There are about 570 breeds and types of goats in the world, of which 89 are found in Africa (Galal, 2005). Based on differences in physical characteristics, four families and 12 breeds of goats have been identified and distributed (Tables 1) in different agro-climatic regions of Ethiopia (Farm Africa, 1996). Based on microsatelite DNA markers it was classified into nine distinct genetic entities (Tesfaye, 2004). A breed is a group of animals within a species that has a common origin and certain similar physical characteristics, which are easily distinguishable.

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 (Table 1). It should be noted that some breeds are known by different local names in different localities. The goat types existing in Ethiopia are namely; Begayit, Ille, Afar, Hararghe Highland, Arsi-Bale, Short-eared Somali, Woyito-Guji, Long-eared Somali, Central Highland, Abergelle, Western Highland, Widar, Western Lowlands, Maefur and Keffa. Moreover, Felata, Arab, Gumuz, Agew and Oromo sub-types of the western lowlands have been recently reported (Nigatu, 1994; IBC, 2004). Hararghe highland is believed to be derived from Somali goat type (Alemayehu, 1993; Workeneh *et al*., 1994). Hararghe highland goat type is the dominant goat type distributed in Highlands and moist Kolla areas of Hararghe

(Alemayehu, 1993). They are considered to be small size and variable coat color from white, brown or black and commonly polled (Alemayehu, 1993).

2.7.1. Threats to Farm Animal Genetic Resource (FAnGR) Biodiversity

Farm AnGR have not yet been exhaustively identified, described, classified, characterized and documented. Farm AnGR are faced with a multitude of threats - indiscriminate use of exotic genetic resource, absence of a national animal breeding policy, poverty, prolonged draught (Solomon et al., 2008). Genetic erosion within livestock species, including their wild ancestors, is of particular concern because of its implications for the sustainability of locally adapted agricultural practices and the consequent impact on food supply and when a breed becomes extinct an already narrow genetic base shrinks irreversibly. The implication is clear and needs to be addressed in a way that makes the available animal genetic resources used and managed in an effective and sustainable manner. However, the past and present neglect of local knowledge regarding AnGR and traditional breeding practices causes major difficulties.

2.7.2. Animal Genetic Resource Conservation

The Food and Agricultural Organizations of the United Nations (FAO) defines conservation as “the maintenance of live populations of animals in their adaptive environment or as close to it as practically possible” (FAO, 2002). Four reasons for conservation of unprofitable breed are identified namely; genetic stock value, environmental and landscape effects, maintaining traditional life styles and existence value (Mendelsohn, 2003). Various authors have expressed serious concerns about the continuing reduction in the overall pool of domestic breeds of livestock genetic resources (Signorello & pappalardo, 2003; Shrestha, 2004). It has been estimated that since domestication, over 6,379 documented breed populations from 30 species of livestock have been developed globally in the last 12 thousand years (FAO, 2000). It is generally accepted that the highest amount of genetic diversity in these populations of livestock is found in the developing world, where record keeping is poor but the risk of extinction is high and is increasing.

Recently, loss of genetic diversity within indigenous livestock breeds has been a major concern. It is estimated that 35% of mammalian breeds and 63% of avian breeds are at risk of extinction, and that approximately two breeds of livestock and poultry are lost each week (FAO, 2000). More particularly, it is estimated that 22% of known livestock breeds have become extinct in the last 100 years and another 27% are at varying degrees of risk (Rege and Tawah, 1999).Therefore it is important to characterize AnGR from the ground level in order to categorize and conserve the genetic resources according to their genetic merit. Although indigenous breeds, performances are lower than highly selected animals, they are often better adapted to their local environment compared to commercial breeds, which could lead to more efficient use of natural resources (Martante *and* Egito, 2002).

Commercial livestock over the world is bred from relatively narrow genetic base and due to the emphasis placed on production; these breeds are replacing most of the indigenous breeds. An indigenous breed might not be economically viable due to low productivity, but they might contain special characteristics that will be useful for future breed development. Mendelsohn (2003) stated that for conservation to be efficient; the program should prioritize conserving species that best protect the genetic basis of the breed. Iamartino et al., (2005) remarked that the first step for exploitation of domestic animal biodiversity and conservation is “a comprehensive knowledge of the existing genetic variability and the partitioning of this variability among breeds”. Sustainable Utilization of AnGR is the preferred avenue for safeguarding animals’ genetic diversity. Utilization strategies for genotypes that possess high levels of adaptive fitness to specific environments should include breeding programs which maintain or enhance their properties and, in doing so, contribute to the economy of communities depending on them. If this is not the case then the risk for these genotypes of being lost will increase as communities will need to search for other sources of income. In many regions animals are the main and often the only sources of income (Mueller, 2006). In Eastern Europe and Turkey the lack of infrastructure and funding means may stop from taking efficient conservation solutions (Gabiña, 2002). The problem is more serious in tropical countries where there is extreme shortage of resources.

2.7.2.1 Approach to conservation of animal genetic diversity

The two broad approaches through which farm animal genetic resources (FAnGR) can be conserved are the *ex situ* and *in situ* conservation systems. *In-situ* conservation is primarily the active breeding of animal populations for food and agriculture, such that diversity is best utilized in the short term and maintained for the longer term (Hammond, 1993). Exsitu conservation on the other hand refers to either conservation of animals as samples of a breed outside their native production environment or frozen storage of rare breeds in the form of living semen, ova, embryos or tissues (cryopreservation). There are several advantages of *in situ* conservation of farm animal genetic resource. One advantage is that it conserves both the genetic material and the processes that give rise to the diversity (Rege, 2001).

Many authors in the area argued in favor of genetic improvement as the most feasible and realistic means for conservation. The aim of conservation is to maintain a distinct but dynamic gene pool. The aim of production is to improve productivity of desirable products (e.g. milk, meat, hardiness, etc.). These two are not necessarily contradictory (Hagmann and Drews, 2001).

Community-based management of livestock, including breeding, is a bridge connecting the means; genetic improvement, and the end; sustainable conservation. Conservation approaches should not only view breeds as genetic resources for the future, or for humanity as a whole. They should also involve and benefit, as much as possible, the communities that developed the genetic resources in the first place (LPPS and Koehler, 2005). Such approaches need an understanding not only of the performance of breeds, but also of their meaning to rural peoples' lives and livelihoods (FAO, 2007).

Since majority of indigenous breeds are raised by small holders and the poor, in typically communal settings, In-situ conservation and sustainable use of farm animal genetic resource must therefore be community-based in order to be effective (FAO, 2003). FAO (1999b) defines management of FAnGR as the sum total of technical, policy, and logistical operations involved in understanding (characterization), using and developing (utilization), maintaining (conservation), accessing, and sharing the benefits of animal genetic resources. Community based management (CBM) of farm animal genetic resource, hence, refers to a system of FAnGR and ecosystem management in which the farm animal genetic resource keepers are responsible for the decisions on definition, priority setting and the implementation of all aspects of conservation and sustainable use of the farm animal genetic resource (Rege, 2003).

2.8 Conventional breed characterization and documentation approaches

Technically there are two types of breed characterization: phenotypic and genotypic characterization (NRC, 1993). Breed characterization through Phenotype is based on morphological characters such as coat color, horn, ear and other specific visible traits (Kemp, 1992), while genotypic characterization establishes genetic distances to other breeds (Mohammad et al., 2006) and calculates heritability's and genetic correlations of phenotypic traits, enabling the response of the breed to selection to be predicted (NRC, 1993). Physical description of a breed should focus on characters which, in the view of keepers of the breed and local experts, facilitate identification of animals as being members of the breed or strain (Rege and Okeyo, 2006). Scientific breed classification systems usually do not take into account indigenous perceptions and do not correspond to local terminologies (FAO, 2009). For instance, according to scientific opinion, there is only one donkey breed in India. Local people, however, distinguish at least three types that are phenotypically quite distinct and also originate from different regions, which in all probability would therefore, represent different breeds by scientific standards also (LPPS and Kohler Rollefson, 2005).

Traditional breeds generate an array of benefits that are more difficult to grasp, and to quantify, than outputs of meat, milk, eggs or wool (FAO, 2003). These include their contribution to social cohesion and identity, their fulfillment of ritual and religious needs, their role in nutrient recycling and as providers of energy, and their capacity to act as savings bank and insurance against droughts and other natural calamities (LPPS and Koehler, 2005). Productivity of these animals cannot be captured with the usual "Products" quantification approach that ignores their far outweighing "functions" (Workneh *et al*., 2004a). Indeed, not much thought has gone into this area and sometimes the animals are unfairly condemned for under-performing, when indeed the whole picture has not been taken into account (Rege and Okeyo, 2006).

2.9. Community Based Characterization and Documentation of goat breed

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 (Kosgey and Okeyo, 2007). Characterization includes a clear definition of genetic attributes of an animal genetic resource and the environments to which it is adapted. It should include physical description, reproduction and adaptations, uses, prevalent breeding system, population trends, predominant production system, description of environments in which it is predominantly found and an indication of performance levels (Rege, 2003; Workneh et al., 2004). The first step of the characterization of local genetic resources is based on the knowledge of variation in the morphological traits.

According to Rodero and Herrera (2000), studies are necessary to characterize, identify and differentiate populations, while origin and history of breeds should be documented, as well as their geographical distribution, qualities and aptitudes, phenotypic description and morpho structural traits (Mariante and Egito, 2002). In any production system, productivity will be uniquely influenced by complex interactions of environmental, biological and socioeconomic variables (Omore, 1998). The variables are interrelated and, therefore, should be looked at holistically to determine their relative importance and how changes in components affect the whole system. Successes of breeding programs are largely related to the level of involvement of the community in the design, implementation and operation of the program (Mueller, 2006).

Livestock improvement program involving smallholder farmers have not been common in the past particularly where crossbreeding is involved, partly because small holders have no infrastructure to support a crossbreeding program. Many attempts to improve indigenous goat genotype based on pure breeding using technologies proved in developed world have also failed due to poor participation of farmers, interruption of high governmental or other institutional subsidy, small flock size, and single sire flocks, lack of animal identification, lack of performance and pedigree recording, low level of literacy and organizational shortcomings (Sölkner *et al.,* 1998; Kosgey *et al.,* 2006). FARM-Africa has introduced an alternative approach, the community based goat improvement program, with smallholder farmers. The objective is to increase the productivity of the local goats and thereby increasing the livelihood and welfare of the smallholder farmers. Sölkner *et al.* (1998) and Kosgey and Okeyo (2007) stated that the community-based breeding schemes are to become viable options for genetic improvement programs of small ruminants in low-input, smallholder production systems.

Productive capacity and success of any livestock population, whether local, introduced or cross-bred, can only be obtained if the assessment is carried out under their normal or intended conditions, in other words in the farmers fields working with the farmers rather than under the more artificial, unrealistic or perhaps optimum conditions of a research station (FARM AFRICA, 2005). Community based goat breeding requires full description of the existing environment, the current level of productivity, selection criteria of goat producers, available indigenous knowledge and breeding practices, and full participation of farmers/pastoralist from the very beginning. Ideally, the steps involved in the design and implementation of a breeding programme (Croston and Pollot, 1985; Baker and Gray, 2003) include following:

i. A good understanding of the production systems and the relative importance of the different constraints in these systems,
ii. Clear definition of the selected breeding objectives supported by farmers.
iii. Accurate methods of identifying superior genotypes.
iv. Practical schemes which allow the superior genetic material to be used advantageously

The general strategy for sustainable *in situ* conservation programs should focus on the optimization of the genetic potential according to environmental factors (e.g., the needs of the market, the ecological environment and future development). Livestock farmers should develop and identify their own breeding objectives, testing schemes and breeding stock based on their own conditions, which are determined by the production environment. Characterization of indigenous populations and comparative performance trials require sufficient and accurate data sources as the choice of the foundation stock for any breeding program is very important. Steps in designing sustainable breeding programs for *in situ* conservation principally to improve overall biological and economic efficiency of livestock production, through the provision of an optimized genetic potential and to fulfill the needs of the market or the subsistence of the farming system (Clemens, 2002) are as under:

I. Identification of production system(s), potential markets or market niches and economic merits of the animal population and its traits.
II. Define breeding goal and objective through a participatory approach.
III. Evaluate available populations for breeding purposes and select the best stock. Ensure identification of potential breeding animals and herds. Estimate critical effective population sizes and their 'cut-off' points, which are both species and population-specific.
IV. Promote and develop adequate structures enabling the conduct of breeding systems (e.g. characterization, multiplication and selection) by the livestock owners. Ensure knowledge at farmer and professional level through applied training.
V. Develop improvement schemes based on testing and selection against the formulated breeding goal.
VI. Ensure gene flow through dissemination of breeding animals using traditional stock sharing system or formal markets to all livestock production herds

2.10. Evolution of Participatory Rural Appraisal

The search for cost-effective ways to learn about the situation, needs and initiatives of rural people and to collect data relevant for planning projects led to the development of Participatory appraisal (PA) (Bernet et al., 2001). PA encompasses Participatory Rural Appraisal (PRA), Rapid Rural Appraisal (RRA) Participatory Learning and Action (PLA) and various similar approaches and methods.

PRA grew out of biases of rural development tourism-the phenomenon of the brief rural visit by the urban-based professionals-of the cost, inaccuracies and delay of large scale questionnaire surveys (Pottier and Viegas, 1998; Bandari, 2003). Useful information for defining breeding objectives and traditional breeding systems can be collected using semi structured interviews and informal focus group discussions with livestock keepers in the specific location. Tesfahun *et al.* (2006) reported that farmers have clear and consistent trait preferences for their animals and that the evaluation of such traits starts at early age of the animal. Nevertheless, farmers/pastoralists knowledge is tacit, to contrast it from the explicit and skillful application of participatory tools is need to make this tacit knowledge an explicit one and hence make use of in development schemes (LPPS and Koehler, 2005).

2.11. Defining a Breeding Goal

In selecting the most desirable breed or breed combination and selecting within a breed; one need to start with defining the breeding objectives. The breeding objective includes all relevant characteristics of an animal (e.g., production, reproduction, fitness and health characteristics) and assigns a value to each trait (Kosgey, 2004). In any livestock production system, setting up a breeding programs involves the definition of breeding goal and the design of scheme that is able to deliver genetic progress in line with this goal (Groen, 2000, cited in Kefena *et al.*, 2009). It involves the management of people and resources as well as the application of the principles of genetics and animal breeding. Formulation of sound breeding strategies for cattle genetic improvement programs needs knowledge of the existing cattle production systems, and the resources it endowed with, existing cattle genetic resources and their peculiar merits (adaptation to the prevailing environmental factors such thermal stress, disease prevalence, and feed scarcity), socio cultural and socio economic importance of cattle in a given production system and market infrastructure both domestic and international (Kefena *et al*, 2009). Description of the production environment, breeding objectives, traits to be selected, decision about breeding method and breeding population has to be considered in designing breeding programs (Sölkner *et al.,* 1998; Kosgey and Okeyo, 2007). Breeding goal is defined as a list of traits to be improved genetically.

2.12. Goat Breed Improvement

Pre planed breeding strategy is essential for sustainable utilization of any livestock species. A planned breeding program may include selection within the indigenous breed and a crossbreeding program between indigenous and adaptive exotic breeds with better genetic potential. When selecting animals, it is important to consider the environment and geographical area where the goats are to be raised and whether they will perform in that environment. In that case productive and reproductive performance of animals in their native environment is essential (Dereje 2011).

2.13. Productivity and Reproductive performance of Indigenous Goat Breeds

Reproductive performance of goat is an important factor which determines the productivity of a breed. The ultimate output or commodity of animals is directly influenced by the reproductive performance of the animals. Reproductive and growth performance of animals varied between breeds, and also within a flock in a population (ILCA, 1990). These factors are once again affected by various factors like genotypes, disease and other husbandry practices. Puberty is one of the important reproductive parameter that determines the productivity of the herd. It is defined as the point of sexual development at which the animal becomes capable of reproduction (first ovulation in female and first spermatozoa in the ejaculate of the male); but often animals are not fully mature at this stage as puberty may be reached without having achieved adequate physical growth to support reproduction. The reproductive efficiency of a goat herd is determined by the kidding and weaning rates and prolificacy or the ability to deliver multiple kids in a herd (Richard, 2009).

2.13.1. Age at first Service of does (AFS)

Age at first service (AFS) is influenced by genetics and environmental factors that determine the age at puberty. Sidama goat types reach AFS at 9.76 ±0.24 month varied with agro ecologies (Endeshaw, 2007). Tesfaye (2009) reported AFS at 8.2 ± 1.64 month around Metema. Wilson (1991) also reported AFS for Afar goat at 24 month. Markos (2000) reported AFS at 7 – 8 months in Awassa Zuria Woreda. Ravimurugan *et al*., (2009) reported AFS at 8.45 ± 19.33 months for Pallai Adu does in India.

2.13.2. Age at first service for bucks (AFS)

Age at first mating or maturity for buck is the age at which spermatozoa appear in the ejaculate and upon mating can cause effective fertilization. Pre weaning and post weaning growth performance influence AFS of bucks. It also fluctuates between agro climatic conditions and production system. Age of puberty for tropical male goat is 97 days (Payne and Wilso, 1999). Twelve month was reported for goats around Awassa woreda (Markos, 2000). Endeshaw(2007) reported that AFS of bucks at Dega, Moist Dega and Moist kola as 11.13, 12.04, and 10.4 months, respectively in his study around Dale district Sidama zone. Metema goat types showed AFS of 7.4 month (Tesfaye, 2009). The AFS of buck of 8.08 ± 0.22 month were reported for Pallai Adu goats in India (Ravimurugan, et al., 2009).

2.13.3. Age at first kidding (AFK)

Many factors affect AFK. Genetic and environmental factors especially nutrition determine pre-pubertal growth rate, reproductive development, onset of puberty and subsequent fertility (Mukasa and Azage, 1991) and birth type (Wilson and Murayi, 1988). The number of (kids) born with multiple litters attained age at first kidding later than their single born counterparts (Wilson, 1986). Study carried in Goma district Jimma zone reported AFK in the area about 12.46 month (Belete, 2009) whereas the study around Dale district of Sidama zone southern Ethiopia reported AFK of 14.88 month (Endeshaw, 2007). AFK is longer in animals living in harsh environment (Wilson, 1991). The mean AFK of local Metema goats was found to be 13.6 months (Tesfaye, 2009). AFK and kidding interval of Pallai Adu goats in India were 12.84 ± 2.95 and 7.75 ± 0.42 months respectively (Ravimurugan et al., 2009).

2.13.4. Kidding Interval (KI)

Kidding interval is the interval between two successive parturitions that determines reproductive efficiency in small ruminant production. Environmental factors which directly or indirectly affect the physiology of animals like nutritional stress, disease problems extend kidding interval of goat. According to Ibrahim (1998) doe/ewe with long kidding/lambing interval has lower reproductive efficiency. Extended KI is caused by long post-partum anoestrus intervals, repeated cycles of estrus intervals without conception, embryo death or abortion (Gatenby, 1986; Ibrahim, 1998). Different studies carried under different management system by different workers revealed variation in KI. The KI reported in these studies were 8.1 month under on farm monitoring system (Tatek et al, 2004), 11.5 month around Yerer and Adaa district (Samuel, 2005), 8.57 month around Dale district (Endeshaw, 2007), 7.87 month in Goma district (Belete, 2009), 11.31 ± 2.21 and 10.3 ±1.42 months for Abergelle and Central highland goat type, respectively (Belay, 2008) . According to Wilson (1991) KI of many tropical goats varies between 180-300 days. Tesfaye (2009), in study around Metema found 8.4 month of KI.

2.13.5. Litter size

Litter size (Prolificacy or the ability to deliver multiple kids) is the number of progeny/kid/lamb/calve born per parturition. It is one of the important factor that determines the reproductive efficiency of a goat herd. The percent herd prolificacy can be calculated by the total number of kids born over the total number of does kidded in a season X 100 (Richard and Browning, 2009). It is affected by a number of genetic and non-genetic factors such as breed, rate of ovulation, age and level of nutrition parity (Wilson, 1986). There is a positive relationship between litter size and age and litter size and parity (Getahun, 2008; Girma, 2008). Litter size of goats in production system study in Dale district was reported as 2.33 in moist kola, 2.21 in Moist Weyina Dega and 1.3 in Moist Dega (Endeshaw, 2007). A 1.7 litter size was reported for goats around Goma district (Belete, 2008) whereas the average number of kidding per life time of doe around Metema is 13.5 (Tesfaye, 2009).

2.13.6. Weaning and Age at Weaning

Tesfaye (2009) has showed that there was variation in the weaning age between male and female kid and reported that mean weaning age of male and female goat as 4 and 4.2 months respectively. Endeshaw (2007) in his finding stated that weaning age of goats in three agro ecologies in Dale District as 6.27 Moist Dega, 5.09 moist Weyina Dega and 4.73 months in moist kola.

2.13.7. Reasons of culling goats

Culling of animals from a flock is determined by many factors like age, Color, poor body condition and conformation. Similarly literature lists a number of reasons for culling in different areas and agro ecologies. Study showed that poor body condition, poor productivity, and older age were the major culling reason in Moist Dega and Weina Dega areas of Dale District of Sidama zone (Endeshaw, 2007). Belete (2008) showed fertility problem and unwanted physical character were the major culling reasons.

2.14. Morphological or phenotypic characterization

According to FAO (2012) phenotypic characterization is defined as the process of identifying distinct breed populations and describing their external and production characteristics in a given environment and under given management, taking into consideration the social and economic factors that affect them. Phenotypic characterization is description of breeds in terms of external characteristics (such as coat color, ear type and shape, horn shape and type), linear body measurements (such as height at wither, heart girth, body length, ear length), production traits (body weight, milk yield) and reproductive traits (such as age at first kidding, litter size) (FAO, 1986; Tesfaye, 2004; FAO, 2012, Solomon, 2014). The phenotypic characterization is a comparatively easy and cheap tool of breed characterization but phenotypic characters are highly influenced by environmental effects and by sometimes strong genetic and environmental correlations and interaction (FAO, 2011; Gizaw *et al*., 2011, cited in Solomon, 2014). The overall LSM ± SE for BWT, BL, HG, HtW, CW, BCS, PW, RH, RL, EL, HL and SC were 23.9 ± 4.66 kgs, 55.9 ± 5.03 cms, 65.2 ± 5.14 cms, 59.0 ± 4.76 cms, 14.8 ± 3.95 cms, 2.72 ± 0.59, 12.8 ± 3.27cms, 63.0 ± 4.27 cms, 14.0 ± 1.31 cms, 12.8 ± 1.12 cms, 8.33 ±2.59 cms and 18.82 ± 4.97 cms respectively and the corresponding CV for these traits were 20.19, 9.10, 7.8, 8.08, 26.71, 21.8 %, 25.44%, 6.76%, 9.4%, 8.7%, 31.26% and 26.4% respectively for Hararghe highland goats (Dereje et al., 2013).

2.14.1 Body weight, Linear Body Measurements and their association

Apart from the conventional use of scales in determining the weight of small ruminant, the weight determination by measuring some linear parameters could be employed (Winrock International, 1992*)*. According to Salako (2006), Body measurement in addition to weight estimate describes more completely an individual or population than do the conventional methods of weighing and grading. These body measurements have been used at various times for the estimation of weights when live weights are measured alongside these parameters. Body dimensions have been used to indicate breed, origin and relationship through the medium of head measurements (Itty *et al*., 1997) or to indicate size.

Thus, live body weight and linear body measurements are highly influenced by sex effects, age effects, agro ecologies effects, and by sometimes strong sex and age, agro ecologies and age correlations and interaction. Sex had significant effect on all body measurements. Male goats showed higher values for all measurements than their female counterparts in Wesetern lowland goat and Abregelle (Solomon, 2014) and Harerghe highland goats (Dereje, 2011). The effect of age strongly influenced ($P<0.001$) body weight and other linear body measurements in Wesetern lowland goat and Abregelle (Solomon, 2014) and Harerghe highland goats (Dereje, 2011). The interaction effect of breed with age affected body weight ($P<0.01$) and chest girth ($P<0.05$) in Wesetern lowland goat and Abregelle (Solomon, 2014) The effect of agro ecology had significant ($p<0.01$) affect on body weight and heart girth of Harerghe highland goat (Dereje, 2011). The study of Grum (2010) in short eared Somali goat showed that effect of agro ecologies was highly significant ($P < 0.01$) on body weight and linear measurements whereas this effect was significant ($P > 0.05$) on body condition score and horn spacing (both at bottom and tips of horns) in the male goat. However in the same studty the effect of agro ecologies was significant ($P < 0.05$) on all the parameters in the female Short eared Somali goats. The body measurements (Height at withers, Chest girth, Ear length and Horn length) and body weight of some of the breeds of Ethiopian goat estimated by various workers have been summarized in **table 2**.

Table 2: Body measurements of some breeds of Ethiopian Goat

Family and breed	Height at withers (cm)		Weight (kg)		Chest girth (cm)		Ear length (cm)		Horn length (cm)		Source
	M	F	M	F	M	F	M	F	M	F	
Rift vally family:											
Afar	64.5±2.9.	60.9±3.3	31.3±3.7	23.7±3.4	74.6±3.8	67.4±3.8	12.4±0.7	12.3±1.8	29.8±6.8	17.4±3.9	Nigatu (1994)
Abergelle	71.4±3.5	65.0±2.8	33.6±5.9	28.4±3.5	79.5±2.9	71.2±3.8	13.0±0.8	12.3±1.8	37.0±9.1	19.6±5.7	Nigatu (1994)
Arsi-Bale	73.2±6.9	66.1±3.5	42.1±9.6	30.4±4.5	85.0±7.0	74.9±4.0	14.1±1.3	14±1.3	23.7±7.2	12.5±3.3	Alemayehu (1993)
Woyto-Guji	72.9±5.0	66.4±3.5	39.0±6.3	28.8±5.0	80.8±6.6	72.5±4.2	12.5±1.3	12.5±1.0	17.6±7.2	10.8±3.7	Workneh & Peacock (1993)
Somali family:											
Hararghe highland	71.5±7.2	62.5±3.5	41.9±7.2	29.1±4.5	80.6±7.9	72.8±4.5	14.4±1.4	13.0±1.1	21.4±6.7	13.1±3.4	Alemayehu (1993)
Short eared Somali	64.9±5.5	61.8±4.1	32.8±6.5	27.8±6.0	72.8±4.7	70.4±4.7	12.1±2.2	12.8±1.8	19.6±6.9	12.2±4.2	Alemayehu (1993)
Long eared Somalia	75.8±4.2	69.4±3.3	42.3±7.4	31.8±5.4	82.3±4.9	74.4±4.0	14.8±1.7	14.6±1.7	13.5±6.2	9.0±3.8	FARM-Africa (1994)
Small east African family:											
Centeral highland	76.3±5.0	67.9±3.2	43.0±7.7	30.1±5.4	84.6±5.6	74.1±4.4	13.5±0.9	13.1±1.1	23.4±5.1	13.7±3.5	Nigatu (1994)
Western highland	80.7±6.5	70.8±4.7	48.4±9.9	33.0±6.0	87.2±7.9	75.8±4.5	14.6±6.0	14.7±1.6	20.7±4.8	12.8±3.6	Nigatu (1994)
Western lowland	67.2±5.0	63.5±3.8	35.5±10.2	33.9±6.9	77.0±9.2	75.9±5.2	14.1±1.6	13.8±1.5	18.5±7.2	12.8±3.6	Nigatu (1994)
Keffa	75.6±6.8	66.7±4.0	40.5±8.4	28.2±5.2	82.7±5.9	72.2±4.5	13.3±1.1	13.0±1.0	20.1±5.5	11.6±3.6	Nigatu (1994)

Source: Farm Africa.1996 http://agtr.ilri.cgiar.org/library/docs/X5457E/x5457e03.htm M= male F- female

3. MATERIAL AND METHODS

3.1. Description of the Study Area

The study was conducted in Loma district, located at 6°55′N and 7°01′30″N latitude, and 37°15′ E and 37°19′E longitude with at altitudinal range between 501-3300 meters above sea level. Loma is one of the administrative districts under Dawuro Zone of Southern Nations, Nationalities and Peoples Region (SNNPRS-BoFED, 2004, Mathewos, 2008). The district is bounded with Maraka district in the North and Northwest, Gena Bossa in the Northeast, Wolayta Zone in the East, Gamo Gofa Zone in the South, and Isara district in the South West. It is also found in between Omo River from North to South. Gessa is the main town located at about 487 kms southwest of Addis Ababa across Shashemene and Wolayta, 282 Kms away from Awassa, town of SNNPR and 207 km from Jimma.

The total surface area of 116,320 ha, with average density of 13 persons per km^2 making the district one of the sparsely populated in lowland (*Kola*) altitude region. The Agro – Ecology of the district comprise of 45.6% kola (Lowland altitude, less than 1500masl), 41.4% Weinadega (Midland altitude, between 1500 to 2300 msal) and 13% Dega (Highland altitude, greater than 2300) out of the total land size of the district. The annual mean temperature ranges between 15.1-29.5^{o}c and the annual mean rainfall ranges from 900-1800mm (LAR, 2013).

According to housing and population census of Ethiopia in 2007 the total population of Loma district was about 109,192 (male 55,214 and female 53,978). The land use pattern followed is 50701 ha cultivated, 36172.17 ha covered by bush shrubs, 16202 ha under settlement, 12060 ha for grazing, 852.33 ha covered under forests and the remaining 332.50 ha is for others. The livestock resource of the District were 91.54 thousand cattle, 28.02 thousand sheep's, 47.08 thousand goats, 19.08 thousand equines and 61.87 thousand poultry (L.A.R, 2013). The Loma district comprised of 3 urban Kebeles and 36 rural kebels. The selection of District is based on its potential for goat production and its holistic agro ecological zone from very lowland agro-ecology to highland areas and wide range of area coverage with different production system.

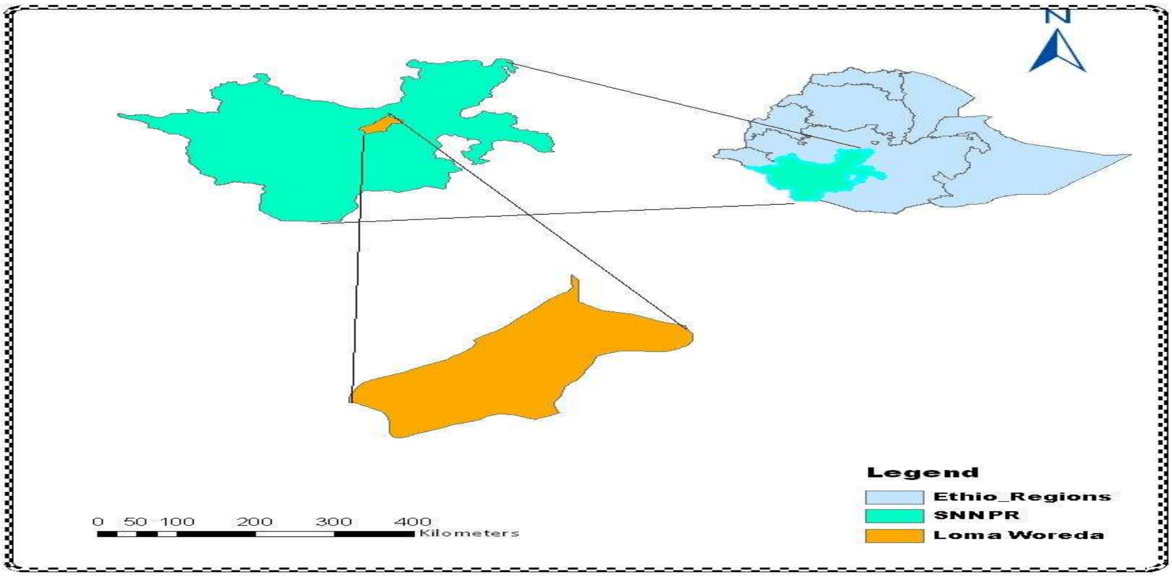

Figure 1: Map of the study area

3.2 Sampling Techniques and sample size

Prior to sampling and data collection, discussions were held with woreda livestock experts to make clear the purpose of the study and ensure collaborations during the study period. Expert consultation and field visits were also conducted to select the study Kebeles. In addition, discussions were held with development agents (DAs) and Kebele representatives. Secondary data on socio-economic characteristics, agricultural production system, livestock population, farming practices and description in terms of agro-ecology, demography and, climate were collected from zone and district Agricultural offices.

Multi-stage stratified sampling technique employed in the present study. In the first stage, district was stratified into three agro ecologies namely lowland with altitude of <1500masl, midland with altitude of 1500-2300masl and highland with > 2300masl (MOA, 2000, Dereje, 2011). In the second stage, two kebeles were randomly selected from each agro-ecology. In the third stage, a total of 230 households (90, 70, 70 from lowland, midland and highland, respectively) having goat stocks were interviewed at randomly in all direction after every eight to twelve households based on the number of household per each Kebels. On average 3, 4 and 4 goats per householdes were measured from lowland, midland and highland, respectively.

Sample of survey depends on funds, costs of organizing the survey, manpower, administrative support, means of transport and ease of access to Kebeles and households. It also depends on the different types of information to be collected. If population estimation is an important objective of a survey then the sampling fraction were need to be increased somewhat towards 1% (Workneh and Rowlands, 2004). The sample size for physical description of a breed depended upon the precision required and the variability in the sample population. Coefficient of variation of mature female goats were observed to be in a range of 10 and 30% (FARM Africa, 1996). For statistical significance (5%), 100 to 300 mature female are required from representative site (Peter, 1985). Total sample size was determined using probability proportional to size sampling technique (Daniel, 1999).

Equation1. formula for sample size determination

$$N = \frac{Z^2 P (1-P)}{d^2} \Longrightarrow n' = \frac{N Z^2 P(1-P)}{d^2 (N-1) + Z^2 P (1-P)}$$

Where;

n' = sample size with finite population correction,
N = Population size,
Z = Z statistic for a level of confidence,
P = Expected proportion (in proportion of one),
d = Precision (in proportion of one)

Therefore, the sample estimate at 95% confidence interval (CI) and proportion (the degree of variability in the attributes being measured refers to the distribution of attributes in the population) value of 0.2 (p=0.2) at precision of 0.05 for population size of 3405 household in sampling frame provided a sample size of 230 households (Equation1). The finite population correction (FPC) factor is routinely used in calculating sample sizes for simple random samples. It has very little effect on the sample size when the sample is small relative to the population, but it is important to apply the FPC when the sample is large (10 percent or more) relative to the population (FAO, 2012; Israel GD, 1992). According to Daniel (1999) sample size formula was adjusted using finite population correction in the equation since calculated sample size is is greater than 5% (n/N >0.05) of population size. The data on total household and total goat owner's were obtained from Woreda Agricultural Office based on their recently conducted census survey (LARD, 2013). The number of households and FGD participants sampled from each kebele in the three agro ecologies are presented in table 3.

Table 3: Sampled households and participants of focus group discussions

Agro ecologies	**Kebeles**	**Total number of HH**	**Total numbers of goat owner HH**	**HH interviewed**	**Key informant**
Lowland	Mantuti	641	616	46	12
	Hala	616	592	44	10
Midland	Sayki	584	517	37	12
	Yeli	527	478	33	9
Highland	Ela	612	454	37	12
	Gessa	425	248	33	11
Total		3405	2905	230	66

Sample goats for body weight and linear measurements were taken randomly from above eight months age *Woyto-Guji* goat*;* 590 female goats and 220 male goats selected. The age of animals was estimated from dentition to support the age information provided by owners. Summarized details of the sample size are shown in table 4. Pregnant animals were excluded from the measurement to avoid over estimation.

Table 4:Sample sizes by age group, agro ecologies and sex for goat breed studied

Age	Agro ecology						Overall	
	Lowland		Midland		Highland			
	Male	Female	Male	Female	Male	Female	Male	Female
0PPI	13	25	13	10	3	16	29	51
1PPI	25	22	19	21	12	37	56	80
2PPI	22	36	10	35	11	64	43	135
3PPI	11	52	9	34	7	44	27	130
4PPI	27	57	21	88	17	49	65	194
Totally	98	192	72	188	50	210	220	590

PPI= Pairs of Permanent incisors

3.3 Data Sources and Methods of Data Collection

Survey, recall data, PRA tools and body measurement were sources and tools of data in the Present study. Data were collected according to four different contexts considered as pillars of community-based participatory resource, system and problem characterization. These include social and cultural context, ecological and production contexts, livelihood contexts as well as indigenous knowledge and traditional systems (LPPS and Köhler-Rollefson, 2005). Participatory Rural Appraisal (PRA) tools were used for group discussion, Informal enquiries and participatory observations, Semi-structured questionnaires was used to collect data including socio-economic characteristics of households and routines in flock management, and measurements. Quantitative measurements of linear traits (cm) and body weight (kg) were measured physically whereas, qualitative trait and body condition score were observed directly. Both the survey and body measurement were collected during November 2013 to April 2014.

3.3.1 Survey of goat production system

In order to characterize the goat production system in the study area, farmers were interviewed using pre-tested and structured questionnaires using trained enumerators. The questionnaire were prepared in accordance with that prepared by ILRI and OADB for Oromia Livestock breed survey (Workneh and Rowlands, 2004). The questionnaire were framed to collect data on breeding system, breeding objectives, trait preferences, breed improvement practices, Indigenous knowledge (IK) in relation to means of controlling inbreeding, castration, flock size, grazing system, housing system, health management, feeding management, productivity and reproductive performances, adaptation traits, marketing system, socio-cultural aspect of goat, economic importance of goat and major production constraints (**Appendix B).** Individual goat was grouped into 5 age groups based on dentition and owners age information to generate morphological data. Goat with no pairs of permanent incisors at ages of below 12-14 month(0 PPI), goat with one pair of permanent incisors age of 15- 24 month (1 PPI), goat with two pairs of permanent incisor age of 24-36 month (2 PPI), three pairs of permanent incisors age of 36-48 month (3 PPI) and with four pairs of permanent incisors at age of over 48 month (4 PPI) (Tatiana Stanton, 1999) and sex groups (Male and female).

3.3.2. Participatory Rural Appraisal (PRA) tools

Participatory rural appraisal (PRA) is an approach that involves local communities as active analysts of their own situations whereby they estimate, quantify, compare, rank/score and list priorities of resources, constraints and opportunities based on their circumstances (Bhandari, 2003). A range of PRA tools were applied to study the social and cultural contexts of goat breeding in the community. The PRA tools employed included;

3.3.2.1. Group Discussions*:*

Discussions were made with a focal-group established at each Agro ecology. Members of the focal groups included individuals communally known to have high quality breeding animals, people believed to be knowledgeable about past and present social and economic status of the area, community elders and story tellers. Two veterinarians and livestock expert from the Woreda agricultural Office and Kebeles agricultural development agents at each Kebels were also participants of the group discussions. Following the survey a group discussions were made in each Kebele with the focal personnel such as, goat owners, elders and female groups that own goat. Guiding points of the group discussions are presented in **appendix C (The FGD Interview).** Groups comprising of 9-12 members of key informants were formed for gathering information. Key informants such as elders, community leaders, women, traditional practitioners, goat owners and development agents were used to collect information..

3.3.2.2. **Participatory mapping, Transect walks and seasonal calendars*:***

Map drawing, calendar (yearly cycles) preparation and transect walk activities were undertaken with the focal group members at each Kebele. Simple mapping of major transect routes, grazing areas and water points was undertaken using the ground as a platform and materials like leaves and sticks as point markers.

3.3.2.3. **Ranking experiments*:***

Both explicit and implicit ranking activities were employed in the study. Own flock ranking experiment (implicit ranking) was used to study breeding objectives and trait preferences. Participants of the own flock ranking were asked to rank their first, second, third and least preferred male and female goats within their own flock giving reasons for each preference rank. The own flock rankings was allowed to easy and unguided ranking by participants with a concrete presence of the animals bearing the attributes, as opposed to an "abstract" ranking against predetermined list of traits. Explicit ranking activities were employed to collect data including, livestock species preferences and diseases according to prevalence. During the explicit rankings, respondents were provided with lists of particulars to rank against. For own-flock ranking experiments, reasons for ranking from the open-ended responses were first checked one by one to determine the attribute levels and then coded.

There are parameters that require ranking. Hence, indices are calculated to provide ranking of the reasons of keeping goat, breeding objectives (production objectives), trait preferences (for both male and female goats) and relative importance of different livestock species, disease prevalence in the area, challenges and contribution of different farming activity to the family food production and income generation sources.

3.3.3 Goat Body Measurements for characterization

Linear body measurements (**Appendix 1**) were taken on sample goats using measuring standard plastic tape in centimeters (cm): linear traits are chest girth (HG- taken as the circumference behind the forelegs or circumference of the body immediately behind the shoulder blades in a vertical plane perpendicular to the long axis of the body); body length (BL-measured as the horizontal distance from the point of shoulder to the base of tail or to pin bone); wither height (HtW-taken to be the height of an animal from the bottom of front foot to the highest point of the shoulder at the withers); scrotum circumference (SC- taken by pushing the testicles to the bottom of the scrotum and the greatest circumference was measured); chest width (CW- the width of the chest between the briskets), pelvic width (PW- the distance between the pelvic bones across dorsum); rump height (RH- measured as the vertical distance from the top of the pelvic girdle to the ground), ear length (EL-the length of the ear on its exterior side from its root at the poll to the tip); and body weight (BW- was measured using 100kg portable weighing scale graduated at 100gm interval).

Body condition score (BCS) was assessed subjectively (A**ppendix 2**) and scores using the 5 point scale (1= very thin, 2= thin, 3= average, 4= fat and 5= very fat/obese) for both sexes (Hassamo *et al*., 1986 as cited in Zewdu, 200*8*). BCS of an animal was scored by feeling the backbone with the thumb and the end of the short ribs with fingertips immediately behind the last ribs.

Ten qualitative traits like, coat color pattern and type, presence or absence of ruff, wattle and beard, horn length (categorical), orientation and shape, ear length, ear formation and head profile were used for physical description of the population based on a standard description list developed by FAO (1986) and of ILRI-OADB breed descriptor list (Workneh and Rowlands, 2004). Interviewing with questioner, and individual goat characterization was made sequentially in that order at the presence of the goat flock.

3.3.4. Reproduction and production traits

Parameters of average age at first service in male and female animals, age at first parturition, parturition interval, total number of kids per lifetime and total lifespan of the doe were collected as recalled by respondents. Respondents were asked to recall total number of abortion and twinning incidences per flock during the last twelve months. Life history of the ranking doe focusing on previous reproductive performance (number of lambings, twinning ability, number of lambs born and weaned) were inquired. Owners ranked their goat based on their production and reproduction performances and behavioral traits, viz: temperament, lamb growth, mothering ability, body size, lambing interval, tolerance of water shortages, disease and parasites.

3.4. Methods of Data Analysis

The data generated were analyzed using different statistical methods. Descriptive statistics, ranking techniques and inferential statistics were applied to handle the data in the present study.

3.4.1. Descriptive statistics

The SPSS statistical computer software (SPSS ver.20) was applied to analyze the qualitative data from the questionnaire and physical description of the sample goats (SPSS, 2014). Chi-square was employed when required to test the independence of categories or to assess the statistical significance. F test was carried out as appropriate, following ANOVA, to assess statistical significance of variation at 5% probability level.

3.4.2. Ranking for traits and indices

The indices were calculated as follows;

Index = {[(3 x number of households ranked first) + (2 x number of households ranked second) + (1 x number of households ranked third)] for an individual reason / criterion / preference}/ {[(3 x number of households ranked first) + (2 x number of households ranked second) + (1 x number of households ranked third)] for overall reasons / criteria / preferences}

3.4.3 Estimation of Inbreeding

Rate of change in inbreeding per generation were calculated using the data for effective number of breeding animals assuming each household flock is closed. Estimates of average change in percentage inbreeding per generation was computed and expressed as

$\Delta F = 1 / (2\ Ne)$ (Falconer and Mackay, 1996)

Where: ΔF = Rate of change in inbreeding per generation

Ne = the effective population size;

$Ne = 4\ Nm \times Nf / Nm + Nf$

Where: Nm = number of breedable male, Nf = number of breedable female

3.4.4. Inferential Statistics:

The General Linear Model (GLM) procedures of SAS ver.9.2 were employed to analyze metric data and ascertain the effect of sex, site (agro ecology) and age (PPI) on quantitative data (SAS, 2010). The effects of class were expressed as Least Square Means (LSM) ±SE and means were separated using Tukey-Karamers method. Analysis was done for both sexes, independently.

The statistical model was as follows;

$$Y_{ijkl} = \mu + A_i + S_j + D_k + (AS)_{ij} + (AD)_{ik} + (SD)_{jk} + e_{ijkl}$$

Where:

Y_{ijkl} = l^{th} observation on i^{th} production site, j^{th} sex class and k^{th} age group;

μ = Overall mean;

A_i = Fixed effect of ith Agro ecology (i= 1,2,3 where 1= lowland, 2 = midland and 3= Highland)

S_j = Fixed effect of jth sex (j =1,2 where1= male,2= female);

D_k = Fixed effect of kth dentition (k =1,2,3,4,5 where 1= 0PPI,2= 1PPI,3= 2PPI,4= 3PPI and 5=4PPI);

$(AS)_{ij}$ = fixed effect of interaction between agro ecology and sex
$(AD)_{ik}$ = fixed effect of interaction between agro-ecology and dentition
$(SD)_{jk}$ =fixed effect of interaction between sex and dentition
e_{jik} = Random error

First order interactions were fitted and retained in the final model when found significant in preliminary analysis. Correlations (Pearson's correlation coefficients) between body weight and different linear measurements were computed for the population within each sex and dentition categories.

3.4.4.1. Multivariate Analysis

Multivariate analysis were used to analyze the multiple body measurements of subjects to prediction (a variable or set of variables is identified as the dependent variable to be predicted or explained by other variables known as independent variables), reduce the data dimension and to assign observations to group (involve the simultaneous analysis of all variables in the set, without distinction between dependent variables and independent Variables).

Regression for body measurements:

The stepwise REG procedures of SAS ver.9.2 was used to predict live weight from body measurements for pooled data, separate sexes and for each age categories (SAS, 2010). The choice of the best fitted regression model was made by using coefficient of determination (R^2) and Mean standard error (MSE). The multiple regression models for female and male were presented as follows;

$$Yj = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + ej$$

Model 1

$$Yj = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + \beta_{11}X_{11} + ej$$

Model 2

Where:

Yj = the dependent variable which is body weight,
β_0 = the intercept, X_1, X_2, X_3, X_4, X_5 X_6, X_7, X_8, X_9 and X_{10} are the independent variables; BL, HG, HtW, CW, PW, RH, RL, EL, HL and BCS, respectively.

β_1, β_2, β_3, β_4, β_5, β_6, β_7, β_8, β_9 and β_{10} are the regression coefficients of the variables, X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9 and X_{10} respectively for female in **model 2** and for the corresponding male one more response variable SC has been added to that of female as in **model 3**. Where $\mathbf{X_{11}}$ is the independent variable scrotal circumference and β_{11} is the coefficients of the variable X_{11}.

ej = the residual error.

Principal components analysis

The PRINCOMP procedure (SAS, ver 9.2, 2010) were used for principal components analysis. Phenotypic measurements of quantitative trait of three sample sites (Agro ecologies) of 590 female and 220 male goats each with 11 variables were taken. Principal Component (PC) analysis was used to explore the underlying data structure and form a smaller number of un-correlated components. Only the first two most important PCs were selected for further analysis and classification using Scree plot diagram of the Principal component analysis. The relative importance of the PC was observed from their eigenvalues and their contribution in explaining the overall variance. The eigenvector and loading value identifies how each variable influences its corresponding PC.

Cluster analysis

Hierarchical cluster analysis were performed using quantitative variables of goat breeds in the different agro ecology and dendrogram was constructed based on Squared Euclidean distance between goat population using unweighted pair-group method to group goat population in to their morphological similarity and Average linkage method of clustering technique was used to reveal the relationship of goat breed in different agro-ecology in the set of variable, which was analyzed on PROC CLUSTER Procedure (SAS, ver9.2, 2010).

4. RESULTS AND DISCUSSIONS

4.1. Socio-economic characteristics of households

4.1.1 Household age structure, family size, sex, education level and marital status

The household age structure, family size, sex, education, religious and marital states are presented in table 5. The perusal table showed that age of respondents ranged from 22 to 64 years, with overall mean of 40.81±10.40 years in the three agro ecology. The family size was 7.34±2.83, 7.93±2.93 and 8.0±2.90 in lowland, midland and highland agro ecologies. The overall mean of family size was 7.75±2.90. The finding was comparable with the reported family size of 7.34 in west Hararghe (Dereje and Tesfaye, 2008). However, this finding is higher than the mean family size of 5.00 reported in Oromia region (CSA, 2008), 4.8 at national level (CSA, 2010b) and 5.40±1.85 in Western Lowland (Solomon, 2014). The proportion of female respondents was 32.2%, 25.7% and 32.9% of in the lowland, midland and highland, respectively.

The educational background of the respondents (Table 5) showed that illetracy was 38.9%, 45.7% and 37.1% in lowland, midland and highland, respectively with overall percentage 40.4%. This finding showed that the illiteracy rate in the study area (40.4%) was lower than the study conducted in Darolabu district which reported a illiteracy rate of 57% (Dereje, 2011) and 46.8% illiteracy in Western Hararghe (Dereje and Tesfaye, 2008). The possible reasons for lower illiteracy rate could be the establishment of both missionary and governmental school in the study area. The results (Table 5) showed that dominant religion in the study area was Protestant as 71.1%, 64.3% and 65.7% of the population follows Protestant whereas 18.9%, 21.4% and 22.9% follow cultural religion in lowland, midland and highland, respectively. The results (Table 5) showed that there was low frequency of widowed and high proportion of marriage in the community.

Table 5:Socio-economic characteristics of respondent households

Descriptor		Agro ecology						Overall	
		Lowland(N=90)		Midland(N=70)		Highland(N=70)			
		Mean ± SD		Mean ±SD		Mean ± SD		Mean ± SD	
Respondent age (year)		41.64±10.26		40.41±10.41		40.38±10.50		40.81±10.40	
Family size		7.34±2.83		7.93±2.93		8.0±2.90		7.75±2.90	
		N	%	N	%	N	%	N	%
Sex (%)	Male	61	67.8	52	74.3	47	67.1	160	69.6
	female	29	32.2	18	25.7	23	32.9	70	30.4
Education	Illiterate	35	38.9	32	45.7	26	37.1	93	40.4
	Writing and reading	26	28.9	12	17.1	17	24.3	55	23.9
	Primary(1-8)	25	27.8	15	21.4	18	25.7	58	25.2
	Secondary(9-10+2	4	4.4	11	15.7	9	12.86	24	10.4
Religion	Orthodox	9	10	10	14.3	8	11.4	27	11.7
	Protestant	64	71.1	45	64.3	46	65.7	155	67.4
	Cultural	17	18.9	15	21.4	16	22.9	48	20.9
Marital Status	Married	73	81.1	60	85.7	61	87.1	194	84.3
	Divorced	4	4.4	1	1.4	3	4.3	8	3.5
	Widowed	2	2.2	3	4.3	1	1.4	6	2.6
	unmarried	11	12.2	6	8.6	5	7.1	22	9.6

N= Number of Household, SD = standard deviation

The proportion of married households were 81.7%, 85.7%, and 87.1% in lowland, midland and highland, respectively. The proportion of widowed were small ranging from 1.4 % (Highland) to 4.3 % (Midland) and similarly proportion of divorced households were 4.4, 1.4 and 4.3 % in lowland, midland and highland areas, respectively.

4.1.2 Source of income

The present study (Table 6) revealed diversified farming activities in different agro ecologies to generate income and ensure food security. Goat, cassava, cattle, sorghum and maize were ranked as the first, second, third and fourth major sources of income in lowland with an index of 0.39, 0.26, 0.15 and 0.09 respectively, in midland Teff, maize, goat and cattle were ranked first, second, third and fourth with an index of 0.26, 0.23, 0.22 and 0.10 respectively and in highland *inset*, sheep, goat and cattle ranked one up to four with an index of 0.45, 0.21, 0.20 and 0.14. The farmers during group discussion reported an incremental trend in inset production in the highland area than cattle, goat and other crops due to its fast and year round production with significant economic returns. The result further showed that goat rearing was predominant in all the three agro ecologies compared to other livestock species.

4.2 Social and cultural context

The Christian community, in term of religion, constitutes about 79.1% of the population (Table 5) and remaining 20.9% population comprise of other local religious groups. The population living in the district have their own dialect of the Omotic language. Besides their unique social and/or cultural values and customs have made them a distinct community. The district encircled by Omo river thereby making it a river island and by Kawo Halal wall on all sides isolated the populace from influence of nearby communities and thus contributed to the uniqueness of social, cultural and custom values. The primary social network of self-identification is the clan (shesha) followed by the sub-clans (qommu) and vast branches of minor sub-clans cascading one after another. Members accordingly identify themselves to each minor sub-clan, sub-clans and the main clan by tracing back through the line of paternal descent.

Table 6:Ranking source of income in different agro-ecology (%)

Source of Income	Lowland				Midland				Highland				Overall			
	Rank 1	Rank 2	Rank 3	Index	Rank 1	Rank 2	Rank 3	Index	Rank 1	Rank 2	Rank 3	Index	Rank 1	Rank 2	Rank 3	Index
Goat	44.4	39.3	20.0	0.39	17.1	24.1	31.6	0.22	13.5	27.6	18.5	0.20	25.0	30.33	23.37	0.27
Cattle	12.7	13.9	24.6	0.15	10.8	20.3	17.3	0.15	3.2	22.4	29.6	0.14	8.9	18.87	23.83	0.15
Sheep	-	-	-	-	-	1.3	4.3	0.01	14.2	26.7	28.4	0.21	4.7	9.33	11.00	0.07
chicken	-	3.3	4.1	0.02	5.4	2.7	1.7	0.04	-	-	-	-	1.8	2.00	1.93	0.02
cassava	31.7	23.3	11.5	0.26	-	-	-	-	-	-	-		10.56	7.78	3.83	0.09
Maize	-	13.3	30.5	0.09	40.2	25.3	14.5	0.31	-	-	-	-	13.4	12.87	15.00	0.13
sorghum	11.2	6.8	9.3	0.09	-	-	-	-	-	-	-	-	3.7	2.27	3.10	0.03
Inset	-	-	-	-	-	1.7	2.4	0.01	69.1	21.2	19.7	0.45	23.03	7.63	7.37	0.15
Teff	-	-	-	-	26.5	24.6	28.2	0.26	-	2.1	3.8	0.01	8.83	8.9	10.67	0.09
Total	100	100	100.3	-	100	100	100	1.00	100	100	100	-				1.00

Index = sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for particular species of crop or livestock divided by sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all species of crops or animals in an agro ecology.

The District has strong traditional values and customs including strict laws (Seera) by which all members have to abide. The most autonomous leadership is the Gagarash; supreme clan leader for life, selected by special assembly of clan elders. The traditional leadership follows a hierarchy cascading from the Gagarash to the supreme clan council and then to the different local sub-clan (qommu) chiefs. The Loma community predominantly follows crop-livestock system.

4.2.1. Local myths about origin of the goat breeds

FGD revealed that the local myths (histories) about origin of the goat breed were to some extent supported by the individual interviews. Majority of the FGD participants support or at least know of the histories but only 24.3% (n=56) of the interview respondents had an idea about origin of the breed. The remaining reported to have heard it from their ancestors. This may indicate efficiency on behalf of the focal group member selection which purposefully included story tellers and mainly targeted elders. On the other hand, the finding may also be used as an indicator of the gradual loss of traditional institutions and knowledge of ethno-history.

The FGD showed that the prevalent local myth about origin of Loma goat stated that it came from southern part of Omo river valley as the gift of God that the ancestors of Loma populace received from valley around Omo River. Thus domestication of goat started around Omo river area. Furthermore FGD revealed that goat breeds existing around southern and south eastern range land spread from the Valley of Omo River. The possible reason for this spread were socio–economic relations between pastoralist groups / communities of southern Ethiopia border and around Omo river. These relation facilitated introduction of *Woyto-Guji* (*Halla dysha*) goat breed from Loma district to other pastoralist area. However, Local myths about origin of breeds may not necessarily be used as official evidence of origin.

4.2.2. Socio cultural functions of goat breeds in the community

According to FGD, goats provide several socio cultural functions that allow an owner to socially unite within the community. These include use of goats as mediums of gift exchange in various social circumstances, means to confer social identity and status as well as ceremonial and ritual uses in all agro ecology of the community. There are several social circumstances that depend on ownership of goats for use as medium of social exchange (gift) and social payments. These include groom wealth gift, dowry payments, compensation payments and help to poorer relatives or clan members. Similar report conducted around Dire Dawa (Grum, 2010).

In the community culture, parents of the groom are traditionally obliged to provide the new household head with an initial stock composed mainly of breeding does or cows. This is not only practiced as a customary family gift but also considered as a means of inheriting traditional livelihood and cultural heritage to the next generation. The same parents also provide goats as dowry (*Woytu*) to the bride's family once the later agreed on the proposal. Dowry is critical in the social endeavor of a community family to the extent that it determines the prospects of one's sons being able to marry. Additionally the circumcision ceremony in the family entails that the parents and participants of ceremony were traditionally obliged to provide breeding buck or bull for circumcised sons.

Goat ownership in terms of both flock size and quality of animals is also used as criteria of wealth status and strength. Members with high flock sizes are considered as noble and often possess high social influence and respect. It is equally prestigious to slaughter goats in ceremonies including new births, wedding, sons circumcision ceremony and receiving prestigious guests as well as during funerals. In weddings, goats are slaughtered at the bride's family house at the wedding day. A goat is also slaughtered on the occasion of new birth (Yeleta), but if only a son is born.

4.2.3. Social breeding mechanisms and sense of custodianships

FGD and interviewed farmers indicated that social regulation about exchange of breeding animals among the community existed. Breeding bucks were exchanged within the community and it is unlikely that owner of a superior buck would deny a fellow member an access to. Though there were no explicit rules obliging an owner to share his buck yet a strong culture of sharing characterizes the social network not only in case of goats but also other resources. Goats were exchanged through the various social networks regardless of different sub clans and castes (classes), such as wealth and religious elite and regular groups within the community.

FGD indicated that in addition to socio economic benefit obtained from goat; the community feels a sense of responsibility for holding and looking after the breed similar to the their ancestors. As result, 82.6% of respondants did not agree to replace their breed with others. The reason mentioned were adaptability (66.4%) and quality of breeds (33.6%), specially ability to give multiple births.

The group discussion showed that local community in the distirct has a perception that by rearing goats they are playing a roles in the development of the genetic diversity. Besides a widely held belief in the community is that possession of goats confers an identity and status owners. Thus the community takes goats as a cultural heritage and symbol of social identity. This process eventually leads to a special-association perception towards the breed.

The perceptions of special associations also give rise to some sort of sense of custodianship over the breed in the sense that regardless of the production potential of the breed in the future, loosing the breed may well mean losing their ethno-history and ancestoral culture heritage whereas preserving the breed will equally mean preserving these. This has a paramount implication in conservation of the genetic diversity. While such perception remains a pervasive motive for the community to preserve the breed, the Food and

Agricultural Organization (FAO) itself recognized cultural association with particular community as one of the criteria in prioritizing breeds for conservation (FAO, 2009).

4.2.4. Local terminology and Ethno-taxonomy of flock classes

Community based identification of the flock class in the community were of help to know indigenous knowledge about particular breeds. According to LPPS and Koehler (2005), studying local terminology and ethno-taxonomy of different flock and product classes helps establish rapport with the people, promotes an understanding of their concepts, and facilitates communication. The number of terms used is also a useful indicator of the depth of indigenous knowledge about the breed. In general, the flock was classified based on age, sex, reproductive stage, special features and performance classes (**Appendix 3**). These classes are not, however, necessarily discrete and may overlap; in which case the terminology also differ. For example, two intact males of same age may not be classified under same category and terminology despite being at the same age and sex group. If one is at its first service and the other is not (owing to individual difference in age at sexual maturity), the former will have a new terminology (*Uzee*) due to the overlapping of the three classification basis of age, sex and reproductive stage. Nonetheless, level and type of management including housing was the same for all classes except in case of the age class, in which case kids below 6 months of age were housed in separate house provided flock size was large.

4.3. Ecological and production context

4.3.1. Defining the breeding area

The breeding area (natural breeding tract) of the Woyto- Guji goat breeds was not limited to the political boundary. The Loma ethnic groups perceive that their goats locally known as '*Halla goats'* was not only located in the Loma district but this breed was distributed to other locations including southern and south eastern pastoralist and agro pastoralist area. The group discussions, individual interviews and mapping activities showed that the breeding area of the goat was widely distributed in South Omo Zone, South Eastern and North Omo regions. It does not extend beyond the Segen river to the east, but was observed across the Omo river to the border with the Sudan and Kenya with the Bumie pastoralists. Focus group discussions with community elders showed that, the majority of the goats in the study area are locally called "*Halla dysha*" meaning those goats type with small body size and with brown and / or white color and this variant populations of the goat are also kept in some areas of the North and south Omo river region.

4.3.1.1. Farming activities in the community

The present study has revealed diversified farming activities to generate income and ensure food security. In lowland the farmers depend on mixed livestock and crop farming (94.3%), livestock only (2.3%) and crop only (3.4%). In midland agro ecology 18.3%, 6.7% and 75% farmers depend on crop, livestock and both crop and livestock, respectively; whereas in highland 68.3% depends on both crop and livestock, 25% depend on crop and 6.7% depend on livestock.

The farmers tend to diversify crop production by cultivating field and cash crops (Table 7). The result showed that maize, teff and sorghum (95.6, 90.0 and 83.3%) were major field crops whereas Cassava (97.8) was the cash crop cultivated in lowlands. Similarly maize, teff, sweet potato and sorghum (98.6, 91.4, 12.9 and 8.9%) were main field crops wheras inset (17.1%) was the cash crops grown during main cropping seasons (April to August) in midlands. But in this agro ecology sweet potato (62.9%) and maize (38.6%) was also cultivated during short seasons (February to March and September to October). However, in highland main crop grown was inset (98.6% , cash crop) followed by haricot beans (48.6%), wheat (40.0%), teff (22.9%) and maize (4.3%) during main cropping seasons.

FGD showed that goat production in the area was least integrated with crop farming sub-sector. Use of manure was literally nonexistent even in the lowland. Meanwhile, goats were not supplemented with crop residues and crop aftermaths. The available crop residues and aftermaths were usually preferentially fed to cattle, owing to their inability to withstand feed shortage during the dry seasons. The exceptions may be the limited grazing times goats spent on fallow lands during the dry season in all agro ecology.

Table 7: Major crops grown during main and short rainy season in different agro ecologies (%)

Factors	Agro ecologies						Overall	
	Low lands		Midlands		High lands			
Main season	N	%	N	%	N	%	N	%
Maize	86	95.6	69	98.6	3	4.3	158	68.7
Sorghum	75	83.3	8	8.9	-	-	83	36.1
Teff	81	90.0	64	91.4	16	22.9	161	70.0
Cassava	88	97.8	-	-	-	-	88	38.3
Inset	-	-	12	17.1	69	98.6	81	35.2
Sweet potato	7	7.8	9	12.9	-	-	16	7.0
Haricot bean	-	-	-	-	34	48.6	34	14.8
Wheat	-	-	-	-	28	40.0	28	12.2
Short season								
Sweet potato	-	-	44	62.9	-	-	44	19.1
Maize	-	-	27	38.6	12	17.1	39	17.0

N = number of observation; Main planting season= April, may, June, July, August; Short rainy season= February, March, September and October

4.3.1.2. Local calendar systems

The local calendar system was based on ecological seasons and traditionally delineated months. Accordingly, there are four ecological seasons in the local calendar system and these were similar in three agro ecology. The short dry season known as *Ofenta* would last for three months. The major dry season known as *Boniya* lasts for about 3 months. It is followed by a short rainy season known as *Assura* which may last up to three months. The major rainy season is known as *Balguwa* and may last for about three months. According to the informants, the major dry season (*Boniya*) exhibits the highest temperatures of all seasons exacerbating the feed and water shortage problem during this season. The locals have also reported that the actual length of the rainy and dry season was of equally duration in all agro ecology. This local calendar was in conformity with the calendar followed by MoA (Ministry of Agriculture), FDRE with some minor exceptions. According to LAR (2013), most areas around Loma District received heavey rains (major rain) from June to August and a short rain between March and May. A short dry season, which proceeds the major rainy season, probably happens during the months from September to November, whereas major dry season is exhibited starting December and lasting till February. However, LAR (2013) have also reported variations in rainfall pattern and actual volume of rain received between the humid areas in the mountainous chain in highland and the areas in the low lying flat lands in lowland of the District.

4.3.2. Characterizing the husbandry practice in the community

4.3.2.1. Livestock Holding and flock structure

The study revealed that farmers keep mixed livestock species. The percentage of livestock possession per household is summarized in table 8. The major livestock species in the study area were goats, cattle, sheep, chicken, donkeys, mules and horses. Besides the respondents maintained bee hives in all three agro ecologies. The finding that all (100%) of respondents at all sites owned goats may be attributed to the fact that goat owners were purposefully sampled for the interview.

Table 8:Percentage of household livestock possession by agro ecology (%)

Descriptor	**Percentage of respondent**			**Overall**
	Lowland	Midland	Highland	
Cattle	90.00	92.90	90.00	90.96
Goat	100.00	100.00	100.00	100.00
Sheep	6.7	65.7	78.6	50.33
Donkey	36.7	40.00	58.6	45.10
Mule	8.9	24.3	34.3	22.5
Horse	0.00	5.7	21.4	9.03
Chicken	63.3	58.6	41.4	54.43
Bee hive	37.8	38.6	35.7	37.36

The household preference for livestock species (Table 9) showed that goat and cattle ranked as preference I and II, respectively, in all the three agro ecologies. The indices for goat were 0.47, 0.45 and 0.35 whereas the corresponding indices for cattle were 0.35, 0.36, and 0.30 in lowland, midland and high land agro ecologies, respectively. The results further showed that sheep were not preferred in either lowland or midland but ranked III after goat and cattle in highland area. Contrary to this chicken were preferred in lowland and midland (0.10 and 0.14, respectively) but were not preferred much in highland (0.03). The possible reasons for preference to goats vis-à-vis other species may be high prolificacy, their broad feeding habits and ability to survive in harsh climatic conditions.

The livestock holding per household is presented in table 10. The perusal of table showed that farmers maintain diversified species of livestocks but their composition varies among agro ecologies. An overall minimum number of 5 and maximum of 73 goats were reported per household in present study. The overall livestock holding per house hold was 15.47±14.40, 5.50±3.99, 2.15±3.13, 4.22±4.57, 0.64±0.83, 4.22±4.57, 2.33±3.6, 0.35±0.79 and 0.1±0.33 for goat, cattle, sheep, donkey, chicken, bee hive, mule and horse respectively. The goat were more numerous per household (28.44±15.53, 8.36 ±3.06 and 5.89±1.9) for lowland, midland and highland, respectively followed by cattle 7.7±4.55, 4.4±2.9 and 3.79±2.66 in lowland, midland and highland, respectively. However, sheep was more numerous (5.51±3.58) than cattle per household in highland area. The number of goats, cattle, sheep and donkey per household showed a significant variation ($p<0.01$) among agro ecologies (**Table 10**).

The number of goats per household in the present study (15.47±14.40) were less than the reported numbers of 19.7 goats per household in Metema (Tesfaye, 2009) but were higher than the average goat holding of 6.03 heads per house hold recorded in Mieso area (Kedija, 2007), 7.0 heads of Arsi-Bale goats in the rift valley areas and 6.0 heads of Keffa goats in south western parts of Ethiopia (FARM-Africa, 1996). The higher goat number per house hold in the present study could possibly be ascribed to the availability of large grazing land and abundant shrubs in the district and large area enclosure in which goats can easily access for browsing.

Table 9:Household preference rank for livestock species

Species	Lowland				Midland				Highland				Overall			
	Rank 1	*Rank 2*	*Rank 3*	*Index*	*Rank 1*	*Rank 2*	*Rank 3*	*Index*	*Rank 1*	*Rank 2*	*Rank 3*	*Index*	*Rank 1*	*Rank 2*	*Rank3*	*Index*
Goat	**85.4**	**13.2**	**1.4**	**0.47**	**72.2**	**26.7**	**1.1**	**0.45**	**54.3**	**18.7**	**12.4**	**0.35**	**70.6**	**19.5**	**4.96**	**0.42**
Cattle	**12.6**	**76.5**	**20.9**	**0.35**	**26.4**	**61.5**	**11.8**	**0.36**	**18.4**	**57.0**	**8.0**	**0.30**	**19.1**	**65**	**13.57**	**0.34**
Sheep	**-**	**-**	**-**	**-**	**-**	**-**	**1.8**	**0.003**	**27.3**	**22.2**	**49.6**	**0.29**	**9.1**	**7.4**	**17.13**	**0.10**
Donkey	**-**	**2.0**	**12.3**	**0.07**	**0.4**	**1.1**	**6.8**	**0.017**	**-**	**1.0**	**4.5**	**0.01**	**0.13**	**1.37**	**7.87**	**0.018**
Chicken	**2.0**	**6.8**	**59.7**	**0.10**	**0.9**	**9.6**	**62.8**	**0.14**	**-**	**1.1**	**16.4**	**0.03**	**0.96**	**5.83**	**46.3**	**0.101**
Bee hive	**-**	**1.5**	**5.6**	**0.01**	**-**	**1.2**	**15.8**	**0.03**	**-**	**-**	**2.2**	**0.004**	**-**	**0.9**	**7.87**	**0.015**
mule	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2.3**	**0.004**	**-**	**-**	**0.77**	**0.001**
horse	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**4.6**	**0.008**	**-**	**-**	**1.53**	**0.003**

Index = sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for particular species of livestock divided by sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all species of animals in an agro ecology

Table 10:Livestock holdings per household in the study area

Descriptor	Lowland	Midland	Highland	Overall
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Goat	*28.44±15.53[a]*	*8.36±3.06[b]*	*5.89±1.9[c]*	15.47±14.40
Cattle	*7.7±4.55[a]*	*4.4±2.9[b]*	*3.79±2.66[b]*	*5.50±3.99*
Sheep	*0.16±0.62[a]*	*1.34±1.38[b]*	*5.51*±3.58[c]	*2.15±3.13*
Donkey	*0.39±0.53[a]*	*0.59±0.87[a]*	*1.01±1.00[b]*	*0.64±0.82*
Chicken	*3.97±3.49*	*5.31±5.62*	*3.44±4.49*	*4.22±4.57*
Bee hive	*2.56±3.82*	*2.41±3.59*	*1.94±3.34*	*2.33±3.60*
Mule	*0.09±0.28[a]*	*0.3±0.57[b]*	*0.7±1.18[c]*	*0.35±0.79*
Horse	*0.00±0.00*	*0.06±0.23*	*0.26±0.53*	*0.1±0.336*

[a, b, c] *means on the same row with different superscripts are significant different (p<0.01),*

SD = standard deviation

The agewise and sexwise goat flock structure of the study area is presented in table 11. The results showed that female goat aged greater than one year constituted 28.7, 29.3 and 29.6% of total flock in all three agro ecologies (Lowland, Midland and Highland, respectively) and these proportion were highest among all age and sex class. These proportion were significantly different between lowland –midland and lowland –highland whereas difference between midland – highland were not significant. Flock structure trend in the three agro ecologies were not the same though female goat aged greater than one year were at top of heirrachy in all the three areas. The highest proportion of female greater than one year may be ascribed to the role of female in the multiplication of flock facilitating annual replacement and sale of supplies animal thereby generating income to the farmer. The proportion of male aged 6 month to one year showed significant difference among all pairs of comparision. However among males aged > 1year group, the pairwise comparison between lowland - midland and lowland - ahighland pairs were statistically significant whereas difference between midland – highland were non-significant. The pairwise comparisons for males < 6 months age group were non significant.

The overall proportion of female and male goat in the study area were 66.8% and 33.2%, respectively . This could be due to the marketing of the males at early age to meet the cash demand of the household than that of female.These findings are comparable with the proportion of 60.8% and 39.2% female and male goats of Hararghe (Dereje, 2011) and 69.84% and 30.16% female and male goats, respectively in Ethiopia (CSA, 2008). However, present finding not in agreement of 75.6% female and 24.4% male goats reported in Alaba (Deribe, 2009).

The proportion of castrated goat were 5.4, 3.6 and 2.3 % in lowland, midland and highland area, respectively with overall proportion of 4.14% . The present finding was comparable with the 3.35% castrated per house hold reported by Tesfaye (2009) and 3.5% and 4.4% in Arsi-Bale and Keffa goats' (FARM-Africa, 1996), respectively. The comparable proportion of castrated, recorded in the current study, may be due to extensive fattening practices of Loma farmers as flock structure is a function of production objectives of the producers.

Out of the total kids with less than six months of age, 68.3% were female and 31.7% of them were males. The possible explanation for more proportion of female kids may be the use of male kids for sacrificial purposes during various cultural / religious festivals. Furthermore the present finding was in agreement with the report of Devendra and McLeroy (1982) for the tropics and subtropics.

Table 11: Goat flock structure holdings per household in the study area

Flock class		Agro ecologies												Overall			
		Lowland				Midland				highland							
Sex	Age	*Range*	*sum*	*Mean ± SD*	*%*	*Range*	*sum*	*Mean ±SD*	*%*	*Range*	*sum*	*Mean ±SD*	*%*	*Range*	*sum*	*Mean ±SD*	*%*
Male																	
	< 6 months	0-8	235	2.6 ±1.76	7.4	0-3	105	1.5 ± 1.07	5.6	0-3	143	2.04 ± 1.10	8.7	0-8	483	2.1 ± 1.44	7.2
	6 month to 1 year	0-13	324	3.6 ± 2.7^{a}	10.2	0-4	232	3.31 ± 0.93^{b}	12.32	0-6	141	2.01 ± 1.40^{c}	8.6	0-13	697	3.03 ± 2.15	10.4
	> 1 year	0-12	403	4.48 ± 3.2^{a}	12.7	0-7	183	2.61 ± 1.66^{b}	9.7	0-7	178	2.54 ± 1.72^{b}	10.86	0-12	764	3.32 ± 2.85	11.41
	Sub total Male		*962*		*30.3*		*520*		*27.6*		*462*		*28.17*		*1944*		*29.04*
Fe-male	< 6 months	0-15	464	5.15 ± 3.2^{a}	14.6	0-5	305	4.35 ± 1.63^{b}	16.2	0-6	270	3.86 ± 1.70^{b}	16.46	0-15	1039	4.51 ± 2.77	15.5
	6 month to 1 year	0-16	663	7.36 ± 4.4^{a}	20.9	0-6	438	6.26 ± 1.74^{b}	23.3	0-6	385	5.50 ± 1.68^{b}	23.47	0-16	1486	6.46 ± 3.85	22.2
	> 1 year	0-24	911	10.12 ±5.44^{a}	28.7	0-6	551	7.88 ± 1.70^{b}	29.3	0-5	486	6.94 ± 1.32^{b}	29.63	0-24	1948	8.50 ± 4.71	29.1
	Sub total Female		*2038*		*64.2*		*1294*		*68.7*		*1141*		*69.6*		*4473*		*66.8*
Castrated		0-16	172	1.91± 2.44^{a}	5.4	0-5	68	1.0± 1.27^{b}	3.6	0-4	37	0.53 ± 1.07^{c}	2.3	0-16	277	1.20 ± 1.87	4.14
Pooled Total			3172		100		1882		100		1640		100		6694		100

[a,b,c] *means on the same row with different superscripts are significantly different (P<0.05), SD = standard deviation, Livestock composition(%)*

4.3.2.2. Goat population trend

The FGD and individual interiviewer vis-a-vis trends in goat population showed decreasing trends in goat population in the last ten years. The results (Table 12) showed that 90.4% believed that population of goat is decreasing. However, 6.1 and 3.5 % respondent believed it to be increasing and stable, respectively. The recall data collected from the sample respondents (Table 13) also showed a decreasing trend in goat in the three agro ecologies. The proportion of respondents, supporting the opinion that goat population was decreasing were 91.1, 85.7 and 94.3% in lowland, midland and highland, respectively. The major reason for decrease in goat numbers were disease and parasite prevalence in all the three agro ecologies (48.8, 32.8 and 37.1% in lowland, midland and highland, respectively). However the other reasons for decrease in goat numbers (shortage of grazing land, shortage of feed, predators and labour) showed different order in the three agro ecologies. In lowlands predators, labour, shortage of feed and shortage of grazing land (26.6, 11.1, 8.8 and 4.4 %, respectively) was the order whereas in midland it was shortage of feed, labour, shortage of grazing land and predators (28.6, 20.0, 12.8 and 5.7, respectively). The order in the highlands was shortage of grazing land, shortage of feed and labour (34.3, 17.1 and 11.4, respectively).

Table 12:Goat population trends and the Reasons of the trend in different agro ecologies (%)

Trends	**Agro ecologies**						**Overall**	
	Lowland		Midland		Highland			
	N	%	N	%	N	%	N	%
Decreasing	82	91.1	60	85.7	66	94.3	208	90.4
Increasing	5	5.5	6	8.5	3	4.3	14	6.1
Stable	3	3.3	4	5.7	1	1.4	8	3.5
Total	90		70		70		230	
Reasen of decrease in goat numbers:								
Disease and parasite	44	48.8	23	32.8	26	37.1	93	40.4
Shortage of grazing land	4	4.4	9	12.8	24	34.3	37	16.0
Shortage of feed	8	8.8	20	28.6	12	17.1	40	17.4
Predators	24	26.6	4	5.7	-	-	28	12.2
Labor	10	11.1	14	20.0	8	11.4	32	14.0
Total	90	99.70	70	99.90	70	99.90	230	100

N = number of observation, % =percentage

4.3.2.3. Feeding practice and response to feed shortage

The study area has been endowed with two kinds of grazing lands, viz: communal grazing land and private owned grazing land. The goats were mostly grazed along with sheep and cattle on communial grazing lands for a nine to ten hours per day (**Figure 2**)..

Figure 2: Goat herded during dry season in communal grazing land

The proportion of farmers (respondents) using both communal and private grazing land were 68.3%, 67.4% and 61.6% in lowland, midland and highland, respectively whereas proportions of farmers using only communal grazing land was 31.7%, 32.6% and 38.4% for corresponding agro ecologies, respectively (Table 13). However no respondent used private grazing land alone in all three agro ecologies.The present finding was comparable with the earlier report of 50 -75 % of household using communial grazing land in Oromia region and 45% households using both private and communal grazing land in Dega in the country (Workeneh and Rowland, 2004). Besides the earlier workers (Alemayehu, 1993; Abule, 2003 and Dereje, 2011) have also reported that natural pasture was the main feed resources for their animals in all agro ecologies in Ethiopia. The interaction with respondent also revealed that the grazing lands were decreasing in size with time due to increase in human population, settlements, cropping and drought.

Table 13: Summary of feeding practice and Herding management by Respondents (%)

	Lowland		Midland		Highland	
	N	%	N	%	N	%
(I) Type of grazing land:						
Communal grazing land alone	28	31.1	23	32.9	27	38.6
Private grazing land alone	-	-	-	-	-	-
Both types	62	68.8	47	67.1	43	61.4
Total	**90**	**100**	**70**	**100**	**70**	**100**
(II) Grazing methods in different season:						
(A) Dry seasons:						
Herded grazing	65	72.2	48	68.6	33	47.1
Tethered	0	0	1	1.4	4	5.7
Herded, paddock, tethered	20	22.2	18	25.7	24	34.3
Herded and tethered	5	5.6	3	4.3	9	12.9
Total	**90**	**100**	**70**	**100**	**70**	**100**
(B) Wet season:						
Herded grazing	78	86.7	4	5.7	1	1.4
Tethered	0	0	6	8.6	2	2.9
Herded, paddock, tethered	8	8.9	39	55.7	36	51.4
Herded and tethered	4	4.4	21	30	31	44.3
Total	**90**	**100**	**70**	**100**	**70**	**100**
(III) Practice of supplementation:						
Supplementation practiced	79	87.7	60	85.7	62	88.6
Supplementation not practiced	11	12.2	10	14.3	8	11.4
Total	**90**	**100**	**70**	**100**	**70**	**100**
(IV) Season of supplementation						
Dry season	77	85.5	58	82.9	62	88.6
Wet season	9	10.0	4	5.7	6	8.5
Both seasons	4	4.4	8	11.4	2	2.9
Total	**90**	**100**	**70**	**100**	**70**	**100**

N = number of observation, *% =percentage*

The grazing methods followed in the study area is presented in table 13. The result showed that during dry season herded grazing was followed by 72.2, 68.6 and 47.1% of farmers whereas herded, paddock and tethered method was followed by 22.2, 25.7 and 34.3% of farmers in lowland, midland and highland areas, respectively. Simillary herded grazing was the main feeding practice during wet seasons followed by 86.7% farmers in lowland. The main reason reported for this practice (herded grazing) was to protect their crop from grazing by goats, protect goat from predators and theft in lowland agro ecologies. However, herded, paddock and tethered methods of feeding practice was more prevalent in midland and highland (55.7% and 51.4%, respectively) during wet seasons. The grazing practice in the current study in wet season is similar to the study conducted by Belete (2009) which has reported that herded grazing and tethering is a common practice for small ruminant in Goma district, where as Getahun (2008) reported that, herded grazing is a common management activity in Kofele district of Oromia region. The herded grazing during wet season in midland and highland was followed by low proportion of farmers (5.7% and 1.4%, respectively). The reasen ascribed for this was that during wet season in both midland and highland there was shortage of labor and / or goat keepers due to prevalent crop cultivation practice.

The results (Table 13) showed that supplementation was practiced by 87.7, 85.7 and 88.6 % of respondents in lowland, midland and highland areas. The supplementation was practiced in dry seasons of the year by majority of goat respondents (85.5, 82.9 and 88.6 % in lowland, midland and highland areas, respectively). This may be due to the shortage of forages in grazing land due to harsh climate affecting growth of vegetation and other shrubs / plants.

The FGD revealed that inclusion of salt with supplementary feeds is a frequent practice by all of the households. Goat owners in district use diverse feed supplements (concentrate) either in mixture or alone. Some of these supplementary feed resources are homemade from grains, maize at milking stage, Oilseed cake (*Fagulo*), local starter culture of Engira (*shuquwa/Yeast*), Fenugreek (*Abish*), local products *(Atela),* Kitchen leftover*,* roots of inset, maize floor and boiled grains (i.e. *maize, sweet potato*). In general all classes of goats, except lactating does and kids, were provided with equal access to supplements. However the lactating goats and kids were provided more feed supplementation. The finding of the present study is in agreement with reports of Deribe (2009) in Alaba Woreda and Dereje (2011) in West Hararghe.

The reported response to feed shortage is summarized in table 14. The result showed that majority of farmers (71.4, 62.5 and 76% in lowland, midland and highland, respectively) used tree branches and supplementation of feed to overcome feed shortage during long dry season and scanty rainfall. The second way of overcoming feed shortage was by sale of goat adopted by 23.3, 32.5 and 18.2% of the respondents. The sale of animals facilitated both in reducing pressure on depleted feed resource and generating income to the farmers

Table 14:Summary of reported response to feed shortage by respondents (%)

Response of feed shortage	Lowland	Midland	Highland	Total
Supplementation of feed	1.0	2.0	1.2	1.4
Use of leaf and tree branches	4.3	3.0	4.6	4.0
Sale of livestock	23.3	32.5	18.2	24.6
Use of tree branches and supplementation of feed	71.4	62.5	76	70
Total	**100**	**100**	**100**	**100**

4.3.2.4. Housing

Housing is one of the goat husbandry practices. Different goat housing system were used in the study area to protect goats from predator, theft and uncomfortable weather. The housing/ enclusere and sheltering methods for goats in the study area are presented in table 15. The perusal of table showed that goat were housed in separate house in lowland and highland (81.1 and 51.4 %, respectively) areas whereas in midlands goat were housed in family house (54.3 %). The study further showed that the grass formed main roofing material in all the three agro ecologies (53.3, 55.7 and 51.4 % in lowland, midland and highland, respectively) followed by corrugated iron sheets. In lowlands goats were housed together with either calves (68.8 %) or alone (15.5 %) or with mix of livestock (13.3 %) but never with sheep. This was contrary to the practice in both midlands and highlands where goat were either sheltered with sheep (47.1 and 54.3 % respectively), or calves (22.9 and 30.0 %, respectively), or mix of livestock species (17.1 and 10.0 %, respectively) or alone (12.9 and 5.7 %, respectively). The overall proportion (all three agro ecologies pooled together) of households sheltering goats with other specieces was 88.2% and the remaining 11.8% households house goats alone during night.

Table 15:Goat housing in three agro ecologies (%)

Goat housing	Agro ecologies					
	Lowland		Midland		Highland	
	N	%	N	%	N	%
(A) Housing/ enclosure for goat						
In family house	14	15.5	38	54.3	34	48.6
Separate house with roof	73	81.1	32	45.7	36	51.4
Barn without roof	3	3.3	0	0	0	0
Pooled	**90**	**99.9**	**70**	**100**	**70**	**100**
(B) Type of housing roof						
Thatched	48	53.3	39	55.7	36	51.4
Corrugated Iron sheet	42	46.6	31	44.3	34	48.6
Pooled	**90**	**99.9**	**70**	**100**	**70**	**100**
(C) Sheltering system of goat						
Goat housed alone	16	17.7	9	12.9	4	5.7
Goat sheltered with mix of all livestock	12	13.3	12	17.1	7	10.0
Goat sheltered with calves	62	68.8	16	22.9	21	30.0
Goat sheltered with sheep	0	0	33	47.1	38	54.3
Pooled	**90**	**99.8**	**70**	**100**	**70**	**100**

N = number of observation, % =percentage

The FGD revealed that households with small flock size share their living house and either a separate compartment was created using wooden materials or goats were tied in the house to restrict their movement. The household with a large flock size constructed separate housing unit. The use of open barn for sheltering of goats was not common and farmers recognized that housing of goat in open barn predisposes animals to diseases and draft. Poor housing, sanitation and confinement could cause health problem in the flock. This confirms the earlier finding of Lemma (2002) and Deribe (2009) that poor housing favors diseases. The FGD further revealed that majority of the household (72.4%) keep kids and their dams separately for whole day and night except at milking time in the morning and evening in all agro ecology.

4.3.2.5. Water resource and utilization

The results of water sources for watering of goat are presented in table 16. Perusal of table showed that river was the major source of water for goats in both wet and dry season. The proportion of goat watered from river water were 61.1 % , 47.8 % (wet and dry seasons, respectively) in lowlands, 47.0 , 68.6 % (wet and dry seasons, respectively) in midlands and 34.3, 43.0 % (wet and dry seasons, respectively) in highlands. The other sources of water during wet and dry seasons were spring water, bore hole/water well, river and spring and bore hole and pond. However during dry seasons river, pond and bore hole was an additional source of water. The proportion of goat watered from these different sources showed variations in different seasons and agro ecologies. In lowlands two sources, viz: spring water and bore hole/water well were not used for watering purposes in both seasons. Similarly bore hole and pond was not used as a source of water during wet season in mid and high land areas. During dry season in both mid and highland areas bore hole/water well was not a source of water whereas pond also was not a source of water in midlands in this season. The watering frequency during dry and wet season among three agro ecologies is presented in table 18. The majority of the respondent provide water to goats once a day during both wet (55.6, 61.4 and 65.7 % in wet seasons) and dry seasons (73.3, 75.7 and 77.0 % in dry season) in all three agro ecologies (Lowland, Midland and highland, respectively). The study showed that during dry season a good proportion of respondents provided water once in two days (20.0, 18.6 and 13.0 in lowland, midland and highland, respectively).

Table 16:Water sources during dry and wet seasons

Water source in seasons	Lowland		Midland		Highland		Overall	
	N	%	N	%	N	%	N	%
(A) Water source in Wet seasons:								
River	55	61.1	33	47.0	24	34.3	112	48.6
Spring water	4	4.4	9	13.0	15	21.4	28	12.1
Bore hole/water well	0	0	2	3.0	14	20.0	16	7.0
River and spring	0	0	26	37.0	17	24.3	43	18.7
Bore hole and pond	31	34.4	0	0	0	0	31	13.5
(B) Water source in dry seasons:								
River	43	47.8	48	68.6	30	43.0	121	52.6
Spring water	0	0	3	4.3	19	27.1	22	9.6
Bore hole/water well	0	0	0	0	0	0	0	0
pond	18	20.0	0	0	8	11.4	26	11.3
Bore hole and pond	14	15.5	11	15.7	8	11.4	33	14.3
River, pond and bore hole	15	16.6	8	11.4	5	7.1	28	12.1

N = number of observation, % =percentage

Table 17:Watering frequency during wet and dry season in different agro ecology

Frequency of watering	Lowland		Midland		Highland		overall	
	N	%	N	%	N	%	N	%
(A) Wet seasons:								
Freely availably	40	44.4	27	38.6	21	30.0	88	38.3
Once a day	50	55.6	43	61.4	46	65.7	139	60.4
Once in two day	0	0	0	0	3	4.3	3	1.3
(B) Dry seasons:								
Freely availably	6	6.7	4	5.7	7	10.0	17	7.4
Once a day	66	73.3	53	75.7	54	77	173	75.2
Once in two day	18	20	13	18.6	9	13	40	17.4

N= Number of observation

According to group discussions watering frequency depends on season, availability of water, distance from watering point and labor availability. The present study was comparable with the findings reported in different parts of Ethiopia (Belete, 2009; Deribe, 2009).

The respondents classified water into clean, muddy and smelly in both wet and dry season separately in table 18. During wet season the respondents classified water as clean in lowland (81.1 %) and highland (51.4 %) whereas it was classified as smelly in midland (54.3 %) areas. The possible reason for smelly water in midlands may be slow flow of water and overcrowding of livestock during watering. However during dry season water was classified by majority of respondents as muddy in all three agro ecologies (72.2, 68.6 and 74.3 % in lowland, midland and highland areas, respectively). The possible reason may be limited availability of water and strong competition during watering among the livestock species in dry season.

Table 18:Quality of Water as per respondents (%)

Quality of water	Lowland		Midland		Highland	
(A) During Wet season						
Clean	73	81.1	32	45.7	36	51.4
Muddy	--	--	-	-	-	-
Smelly	17	18.8	38	54.3	34	48.6
Total	**90**		**70**		**70**	
(B) During dry season						
Clean	11	12.2	9	12.9	4	5.7
Muddy	65	72.2	48	68.6	52	74.3
Smelly	14	15.5	13	18	14	20.0
Total	**90**	**100**	**70**	**100**	**70**	**100**

4.3.2.6. Major production constraints

Assessing and prioritizing the widespread livestock production constraints were crucial for any development intervention measures initiated to improve productivity of livestock. Good understanding of the relative importance of the different constraints is fundamental to initiating any genetic improvement programme (Baker and Gray, 2003). Thus, Farmers were asked to rank the existing goat production constraint and the result are summarized in table 19. As a result, disease, predator, feed shortage and labor were ranked the 1st, 2nd, 3rd and 4th in goat production in lowland with index of 0.35, 0.25, 0.15 and 0.12, respectively. Goat owners in midland area ranked labor, disease, feed shortage and land as the 1st, 2nd, 3rd and 4th challenges with an index of 0.32, 0.25, 0.22 and 0.11 respectively. However, in highland disease was ranked first with an index of 0.34, land ranked second (0.31), labor ranked third (0.21) and market ranked fourth (0.07). Though genotype, drought, water shortage and market were ranked lesser yet, result from group discussion showed that they do have a remarkable effect on goat production. According to group discussion, diseases were more pronounced problem in lowland and highland areas which may be associated with low accessibility to infrastructure vis-a-vis veterinary clinics, health technicians, and poor road connectiveity and additionally high level of parasitic infestation in highland area.

The availability of labour was serious problem / constraints in the study area next to disease as the respondent and group discussion revealed acute shortage of labor to guide and shepherd goat flocks in the area. One of the possible reason for shortage of labor as observed during the discussion was that children, who previously herded goats now attend schools for education. Thus, reduction of flock size was one option to mitigate lack of labor in the community concurrently resulting in decreasing of goat population in the last decade. Similarly feed shortage and disease were reported as the first and second sheep production constraint in Menz and Afar area (Tesfaye, 2008). Earlier studies in Alaba, Southern Ethiopia showed diseases and parasites were also contributing for higher production losses, particularly in young stocks (Deribe, 2009). Similarly seasonal feed shortages, both in quality and quantity which associated with reduction in livestock productivity were reported in different parts of the country (Tibbo, 2006; Tsedeke, 2007, Getahun, 2008; Yeshitila, 2008 cited in Dereje, 2011).

Table 19:Household ranking on major production constraints in the area

Constraints	Agro ecologies															
	Lowland				Midland				Highland				Overall			
	R1	R2	R3	I	R1	R2	R3	I	R1	R2	R3	I	R1	R2	R3	I
Disease	48.8	31.4	3.2	0.35	32.3	18.7	14.1	0.25	46.3	26.7	8.6	0.34	42.7	25.6	8.6	0.31
Feed shortage	8.4	22.6	18.7	0.15	18.4	23.8	28.7	0.22	5.4	4.2	6.4	0.05	10.7	16.8	17.9	0.14
Water shortage	1.4	2.0	1.2	0.02	1.6	2	0	0.02	1.4	-	1.3	0.01	1.47	1.3	0.8	0.01
Predator	26.7	17.4	32.2	0.25	12.3	1.2	0	0.07	0	1.7	2.7	0.01	13	6.7	11.6	0.11
Genotype	0	0	0	0	0	0	0	0	0	1.5	2.3	0.01	-	0.5	0.76	0.003
Market	9.3	6	24	0.11	2.4	1.4	0	0.02	2.2	4.3	26	0.07	4.6	3.9	16.6	0.06
Draught	1.4	1.0	2.2	0.01	1	0	0	0.01	0	1.0	-	0.003	0.8	0.6	0.7	0.007
Land	0	0	0	0	3.4	16.7	23.6	0.11	34.5	28.3	24.3	0.31	12.6	15	16.0	0.14
Labor	4	19.6	18.5	0.12	28.6	36.2	33.5	0.32	10.2	32.3	28.4	0.21	14.3	29.3	26.8	0.21

R1, R2 and R3 = rank 1, 2 and 3 respectively. I= index: Index = sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) given for an individual reason (attribute) divided by the sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for overall reasons

Feed shortage and grazing land problem are similar throughout the country, being serious next to disease and labor in high human population areas where land size is diminishing due to intensive crop cultivation and soil degradation especially in highland areas. The challenges related to genotypes were not mentioned as problem in lowland and mid land as group discussion revealed that the community believed that they had genetically superior goat breeds in terms of adaption and production. The current study clearly showed the importance of critical intervention strategy which includes producers' interest and priority. Each of the challenges prioritized in this study requires pre-designed systematic and participatory solutions to alleviate the constraint from the ground level. A good understanding of the existing production constraints in the study region is essential for planning appropriate interventions.

4.3.2.7. Prevalence of goat diseases and mortality in the area

Farmers have listed a number of economically important goat diseases in the area and ranked them according to their importance (Table 20). The results showed that Pest des Petit Ruminants (**PPR**) was the first prevalent disease in low land with index of 0.38, whereas external parasites were the most prevalent in midland and highland with index of 0.32 and 0.38, respectively. The second ranked disease was pastreurellosis across the low land and midland with index of 0.30 and 0.25 whereas mange ranked second in highland with index of 0.27. Anthrax was ranked third in lowland with an index 0.15, but **PPR** was ranked third with an index of 0.16 in highland. The identification and ranking of diseases in the area warranted devising livestock disease prevention strategies in the district.

The list of local names and respective scientific terminology of reported diseases is presented in **appendix 4**. Many of the respondents were able to distinguish between the different diseases and know the symptoms associated with the diseases. Naming of disease was found to refer to symptoms, affected areas and in some cases the causative agents.

Table 20:List of major goat diseases according to prevalence rank by respondents

Goat Diseases	Agro ecologies											
	Lowland				Midland				Highland			
	R1	R2	R3	I	R1	R2	R3	I	R1	R2	R3	I
CCPP	**1**	**4.4**	**5.6**	**0.03**	**-**	**8.6**	**8.6**	**0.04**	**-**	**-**	**-**	**-**
PPR	**42.2**	**37.8**	**28.9**	**0.38**	**24.3**	**22.9**	**28.6**	**0.25**	**12.9**	**17.1**	**22.9**	**0.16**
SGP	**-**	**6.7**	**14.4**	**0.04 6**	**-**	**12.9**	**11.4**	**0.06**	**-**	**10.0**	**4.3**	**0.04**
Pasteurellosis	**36.7**	**26.7**	**18.9**	**0.30**	**30.0**	**25.7**	**11.4**	**0.25**	**-**	**8.6**	**21.4**	**0.06**
External parasite	**2.2**	**11.1**	**15.6**	**0.07**	**37.1**	**27.1**	**25.7**	**0.32**	**51.4**	**28.9**	**15.7**	**0.38**
Mange	**1.2**	**3.3**	**1.0**	**0.02**	**-**	**-**	**-**	**-**	**35.7**	**20**	**17.1**	**0.27**
Anthrax	**16.7**	**11.1**	**15.6**	**0.15**	**8.6**	**2.8**	**14.3**	**0.08**	**-**	**15.7**	**18.6**	**0.08**

R1, R2 and R3 = rank 1, 2 and 3 respectively. I= index:
Index = sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) given for an individual reason (attribute) divided by the sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for overall reasons CCPP= Contagious Caprine Pluero-Pneumonia; SGP= sheep and goat pox, PPR= Pest des Petit Ruminants

Goat mortality during the last 12 months was assessed based on the recall data of respondents in the study area. The results of cause wise and Sex / age wise are presented in tables 21 and 22, respectively. The results (Table 21) showed that deaths were mainly due to disease & parasite, predator, abortion, heat stress and shortage of feed / water, in descending order, in all three agro ecologies. The interaction with respondents revealed that monkey, tiger and hyenas were the main predators and mostly the young goate were the victim in the study area. The earlier reports (Tsedeke, 2007; Belete, 2009; Deribe, 2009) were in agreement with this.

Mortality rates for different sexes and age groups of goats according to respondents are summarized in table 22**.** An overall higher mortality was recorded in female aged greater than one year (1.02 ± 1.19) than corresponding male (0.79 ± 1.20). The possible reasons for this may be that the females were more susceptible to stress due to competition, predators, abortion (a sex specific attribute) and diseases due to improper management during pregnancy and parturition.

Table 21:Causes of mortality of goat in the study area

Cause of mortality	Agro ecologies						Overall	
	Lowland		Midland		Highland			
	N	%	N	%	N	%	N	%
Disease and parasite	47	52.2	36	51.4	39	55.7	122	53.04
Predator	25	27.7	14	20.0	13	18.6	52	22.60
Abortion	12	13.3	11	15.7	11	15.7	34	14.80
Heat stress	4	4.4	6	8.6	5	7.1	15	6.52
Shortage of feed and water	2	2.2	3	4.3	2	2.8	7	3.04
Pooled	**90**	**100**	**70**	**100**	**70**	**100**	**230**	**100**

Table 22:Sexwise and agewise distribution of goat mortality in the study area

Categories		Agro ecologies						Overall	
		Lowland		Midland		Highland			
Sex	**Age**	**Range**	**Mean ± SD**	**Range**	**Mean ± SD**	**Range**	**Mean ± SD**	**Range**	**Mean ± SD**
Male	**< 1 year**	**0-3**	**0.48 ± 0.92**	**0-3**	**0.24 ± 0.71**	**0-3**	**0.26 ± 0.77**	**0-3**	**0.34 ± 0.82**
	> 1 year	**0-5**	**1.00 ± 1.39**	**0-4**	**0.44 ± 0.93**	**0-4**	**0.86 ± 1.12**	**0-5**	**0.79 ± 1.20**
Female	**< 1 year**	**0-4**	**0.57 ± 1.1**	**0-2**	**0.29 ± 0.59**	**0-3**	**0.41 ± 0.69**	**0-4**	**0.43 ± 0.85**
	> 1 year	**0-6**	**1.23 ± 1.27**	**0-5**	**0.9 ± 1.26**	**0-3**	**0.86 ± 0.95**	**0-6**	**1.02 ± 1.19**

SD= Standard Deviation

4.3.2.8. Acquisition and disposal patterns

The various sources of goat acquisition and disposal in three agro ecologies is presented in table 23. Perusal of result showed that main source of replacement of stock is “Farm born” in all three agro ecologies (78.9, 84.3 and 78.6 in lowland, midland and highland, respectively). The other modes of replacement (Purchased, Gift, On farm born and Purchased and On farm born, Purchased & gift) accounted for the remaining proportion of acquisition in the three agro ecologies. Furthermore there was no replacement through exchange in the present study.

The major disposable (Table 23) of goats from flock was on account of a combination of " sale, death and slaughter” mode in the study area (51.1, 54.3 and 62.9 in lowland, midland and highland areas, respectively). This was followed by sale & slaughter, sale & death and sale (alone), in descending order, in low and midland areas but the order in highland was sale & death, sale & slaughter and sale (alone).

Table 23:Mode of flock entry and exit in the last 12 months (%)

Modes	**Agro ecologies**						**Overall**	
	Lowland		**Midland**		**Highland**			
	N	%	N	%	N	%	N	%
(A) Acquision								
Farm born	71	78.9	59	84.3	55	78.9	185	80.4
Purchased	4	4.4	3	4.3	9	12.8	16	6.9
Gift	6	6.7	0	0	1	1.4	8	3.5
Exchange	0	0.0	0	0	0	0	0	0
On farm born and Purchased	4	4.4	6	8.6	3	4.3	13	5.6
On farm born, Purchased & gift	5	5.6	2	2.9	0	0	7	3
(B) Disposale								
Sale	12	13.3	8	11.4	4	5.7	24	10.4
Sale and death	9	10	6	8.6	13	18.6	28	12.2
Sale and slaughter	23	25.6	18	25.7	9	12.9	50	21.7
Sale, death and slaughter	46	51.1	38	54.3	44	62.9	128	55.6

N=Numbers of observation; %=percentage

4.4 Community's indigenous knowledge on Goat breeds and gene pool management systems

4.4.1 Local concepts about key features and special characteristics of the goat breed

The interaction with sampled respondant and FGD revealed that the community possesses traditional knowledge on gene pool management, animal breeding and conservation of indigenous animal genetic resources. The smallholder livestock breeders have used different phenotypic features and some adaptive attributes to identify and select their breeds, strains or landraces for centuries and they have ensured genetic conservation through utilization. The local concept about key characteristics extended to perceptions about special attributes of the population. The community (Loma ethnic groups) had perceive their goats at the outmost, appropriate. They did have concepts to identify the Woyto-Guji goat, local known as *Halla deysha,* but depended on the context of comparision with other breed. Locals in the study area were also owning some other goat types and these included Arsi-Bale goat, and keffa goats. According to the perception of FGD participants and respondent, the following features have been prioritized, on a dominantly held basis, as key features of the population:

	Features	Description
i.	Coat color type	Predominantly Brown as compared to the Arsi-Bale goats.
ii.	Coat color pattern	Predominance of plain and often marked with brown or black strips along the back as compared to the predominantly patchy Arsi-Bale goat and coarse hair type of Keffa goats
iii.	Body size	Relatively medium size as compared to the Arsi-Bale and Keffa goat.
iv.	Horn orientation	Predominantly straight backward pointing and sharp ended horns (both female and male) compared with Arsi-Bale
v.	Ear length	Short ears as compared to the Keffa and Arsi-Bale goat
vi.	Hair texture	Short, shiny and smooth hair compared to the Arsi-Bale and Keffa goats
vii.	Ruff	High frequency of presence of ruff compared to the Arsi Bale goats
viii.	Head	Small head compared as Arsi-Bale and Keffa goat

These key identification features, listed above, were the basis of comparison of Woyto-Guji goats from all other types existing in and around Loma area.

Based on FGD and interaction was individual interviewees, it was found that multiple birth, ability to resist diseases and parasitic infestation, tolerance of feed and water shortage were mentioned as special attributes of the *Woyto-Guji* goats. Evidences which ranged from routine observations to historic events were also reported to support these claims. The ability of *Woyto* goats to show tolerance / resistance to diseases and parasitic infestations was supported by occurrence of small mortality due to Pest des Petit Ruminants (PPR), mange and external parasitic infestation during heavy rainy season in these goats breed in the study area

The FGD revealed prevalence of perception that *Woyto-Guji* goat can tolerate the recurrent occurrence of both feed and water shortage during main dry season among the community based on the fact that very less mortality occurred in these goat during dry season. The perceived ability to tolerate feed shortage has been related with the ability of these goat to utilize low quality forage such as branches of large tree leaves, thorny shrub trees which are cut and fed to these goats during the dry season. The tendency of these goats to remain active and continue grazing during highest peak temperatures in the afternoons has been cited by local community as indicators of its ability to withstand harsh temperature and an evidence of their heat tolerance potential. The perceived conception about water shortage tolerance about Woyto-Guji goats among the community was supported by the ability of these goat to thrive under prolonged watering frequency of up to once every one to two days, during extreme dry seasons.

Indeed, this study indicated that traditional communities possess the knowledge to describe these indigenous breeds. This knowledge can be further organized to set up and document breed-standards, though it must be unwraled from the conventional knowledge system epistemologically.

4.4.2. Participatory definition of local trait preferences

4.4.2.1 Female goat traits in own-flock ranking experiments:

The results of preferred female traits by farmers from own flock ranking experiments are presented in table 24. Perusal of these results showed that the sampled respondent preference for trait differed in the three agro ecologies. The results pooled overall three agro ecologies showed that body conformation, adaptation, twining ability, coat color, lamb survival, mothering character, short kidding interval and age at first maturity/longevity were ranked as first, second, third, fourth, fifth, sixth and seventh traits with index value of 0.22, 0.18, 0.16, 0.15, 0.12, 0.06, 0.05 and 0.02/0.02, respectively, by farmers for selection of females. The ranking of trait preference by the farmers in the three agro ecologies showed some variance. The ranking of trait preference in order of descent was body conformation (0.25), coat color (0.20), twining ability (0.18), adaptation (0.16), mothering character / lamb suevival / short kidding interval (0.06), age at first maturiry (0.02) and longevity (0.01) in lowland agro ecology. Similarly the sampled respondents in midlands ranked traits in descending order as twining ability (0.21), body conformation (0.19), lamb suevival (0.18), adaptation (0.16), coat colour (0.14), mothering character / short kidding interval (0.04), longevity (0.02) and age at first maturity (0.01). In highlands body conformation / adaptation (0.22), coat colour / lamb survival (0.12), mother character (0.10), twinning ability (0.08), short kidding interval (0.06) and age at first maturity / longevity (0.04) were ranked as I, II, III, IV and V preferred trait in selection. Dereje (2011) and Grum (2010) found out body conformation was first preference to choice doe in West Harerghe and around Dire Dawa.

The results (Table 24) of farmers trait preference showed that four trait (**body conformation, adaptation traits, twining ability and coat colors**) were among the first four preference in the three agro ecologies thereby indicating their importance in the farmer selection for future propagation. This was followed by mother set of three traits (**twinning ability, mother character and lamb survival**) in order of importance for selection as perceived by the farmers. The plausible reasons as perceived by the respondent for body conformation were that bodily strong female goat survived the stress of climate, pregnancy, parturition, mothering, shortage of feed and water in a better way than weak conformed goats. The farmers preference for adaptation trait indicated that survivability and performance during harsh climates was uppermost in their minds.

The interaction with respondent and FGD revealed that brown and/or reddish coat colors were preferred over black and/or white coat color by the producers. The possible reasons, as perceived by respondents, for this were (a) lower market demand and lower sale price, (b) better camaflouge from predator attack (especially when flocks remain unattended during grazing), (c) less parasitic infestation and (d) better heat tolerance by brown and/or reddish coat colors. Similarly the preference of respondents for twinning ability, mothering character and lamb survival as trait of choice, though followed by first set of three traits in order of preference, reflects their concern for ensuring availability of both replacement and surplus stock.

4.4.2.1 Male traits in own-flock ranking experiments

The list of traits preferred by farmers for own ranking of buck within different agro ecologies are presented in table 25. The results pooeld over all agro ecologies showed that body conformation, adaptation, coat color, early maturity, multiple birth and pedigree were ranked as I, II, III, IV, IV and V preferred traits with index of 0.28, 0.24, 0.20, 0.10, 0.10 and 0.08, respectively, by the respondents for selection. The perusal of table 26 further showed that body conformation, adaptation and coat colour were ranked most important (I, II and III, respectively) traits for selection of males by the respondents in all three agro ecologies. The famers trait preference in the current study is consistent with the study in Afar area which indicated conformation as the first selection criteria for buck (Feki, 2013) and similarly conformation was reported by Dereje (2011) and Grum (2010) in West Harerghe and around Dire Dawa.

The possible reasons, as perceived by respondent, for body conformation, ranked as I in all areas, were that heavier body bucks showed superior breeding performance, sire heavily kids and fetch good market price, if sold. However, interaction with respondent revealed that castrated male fetch high market price than intact male bucks. The respondents stated that buck body conformation is a function of body length, body condition, height at withers and pelvic width and the sale and / or purchase price was determined by body conformation of the animal and coat color in central and local villages markets.

Table 24: Own flock ranking for preferred female goats within different agro ecologies (%)

Factors	Lowland						Midland						Highland						Overall
	R1	R2	R3	R4	R5	I	R1	R2	R3	R4	R5	I	R1	R2	R3	R4	R5	I	I
Body Conformation	37.7	31.1	15.6	4.4	3.3	0.25	31.4	14.3	5.7	24.3	5.7	0.19	28.6	24.3	11.4	20	11.4	0.22	0.22
Coat color	22.2	23.3	17.7	21.1	5.5	0.20	20.0	11.4	8.5	12.8	15.6	0.14	12.8	10.0	8.5	24.3	8.5	0.12	0.15
Mothering character	-	-	13.3	23.3	8.9	0.06	-	-	12.8	11.4	-	0.04	8.5	17.1	8.5	2.8	11.4	0.10	0.06
Lamb survival	-	-	15.5	15.6	8.1	0.06	12.8	22.8	24.3	20	-	0.18	15.7	5.7	17.1	5.7	18.8	0.12	0.12
Twining ability	24.4	13.3	9.0	23.3	24.4	0.18	22.8	14.3	30.0	24.3	8.7	0.21	12.8	14.3	-	-	-	0.08	0.16
Short kidding interval	1.3	15.6	4.4	3.3	8.9	0.06	1.4	5.7	8.5	-	11.4	0.04	1.4	7.1	14.3	5.7		0.06	0.05
Age at 1st maturity	-	-	4.4	3.3	12.2	0.02	-	-	-	-	14.3	0.01	-	-	8.5	8.5	14.3	0.04	0.02
Adaptation	14.4	16.6	23.3	5.5	12.2	0.16	11.4	28.5	10.0	7.2	20	0.16	20.0	21.4	25.7	24.3	20	0.22	0.18
Longevity	-	-	-	-	16.6	0.01	-	2.8	-	-	24.3	0.02	-	-	5.7	11.4	15.6	0.04	0.02

R1, R2, R3, R4, R5 = rank 1, 2,3,4 and 5 respectively. I= index : Index = sum of (5for rank1+ 4for rank2+3 for rank 3 + 2 for rank 4 + 1 for rank5) given for an individual reason (attribute) divided by the sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for overall reasons

Table 25:Own flock ranking for preferred male goats within different agro ecologies (%)

Factors	Lowland						Midland						Highland						Overall
	R1	R2	R3	R4	R5	I	R1	R2	R3	R4	R5	I	R1	R2	R3	R4	R5	I	I
Adaptation	34.4	26.6	17.7	23.3	13.3	0.26	32.8	28.6	14.3	17.1	5.7	0.24	25.7	31.4	17.1	15.7	11.4	0.23	0.24
Body conformation	40.0	31.1	13.3	16.6	12.2	0.27	44.3	32.8	25.7	11.4	14.3	0.31	37.1	28.6	11.4	28.6	17.1	0.27	0.28
Coat color	20.0	24.4	27.7	23.3	5.6	0.22	12.8	17.1	10.0	28.6	11.4	0.15	31.4	22.8	20.0	14.3	11.4	0.23	0.20
Early maturity	-	5.5	12.2	13.3	26.6	0.07	-	4.3	18.6	22.8	28.6	0.10	-	-	22.8	18.6	29	0.09	0.10
Pedigree	3.3	7.7	23.3	5.8	18.8	0.10	10.0	11.4	10.0	5.7	7.2	0.10	5.7	5.7	17.1	-	-	0.07	0.08
Multiple birth	2.2	4.4	5.5	17.7	23.3	0.07	-	5.7	17.1	14.3	32.8	0.10	-	11.4	11.4	22.8	31.4	0.10	0.10

R1, R2, R3, R4, R5 = rank 1, 2,3,4 and 5 respectively. I= index : Index = sum of (5for rank1+ 4for rank2+3 for rank 3 + 2 for rank 4 + 1 for rank5) given for an individual reason (attribute) divided by the sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for overall reasons

The adaptation traits, ranked second in all areas, were perceived by farmers to be indication of a higher survival ability of male goat under climatic and other stresses during their life. The interaction with respondents, in all agro ecologies showed that different notation have been associated with various coat colors. It was reported that male goat with black and/or white coat colour were least preferred in the market and fetched less returns. Besides, the less preference of white colored coat patterns was their high risk of exposure to predator attacks due to their poor camouflage whereas black coat colored goats suffered more parasitic infestation and were less tolerant to heat stress. Additionally, black colored male goats were perceived to be associated with bad omen and this discouraged people from keeping such animals. This cultural myth also discouraged their slaughter during social and religious ceremonies and their donation as gift in the community.

4.4.3 Traditional breeding mechanisms

4.4.3.1. Mating systems, castration and culling in the community

Mating system, castration and culling practice in the community are presented in table 26. Perusal of table showed that major proportion of mating was uncontrolled in all three agro ecologies (72.3, 67.2 and 60.0 % in lowland, midland and highland areas, respectively. Dereje (2011) reported breeding was general uncontrolled for West Harerghe goats. The reasons of uncontrolled matings (Table 26) were all types of goats grazing together (53.3, 55.7 and 41.4 % in lowland, midland and highlands, respectively), lack of awareness about benefits of controlled mating (18.9, 20.0 and 30.0 % in lowland, midland and highlands, respectively) and combination of (a) and (b) factors (27.7, 24.3 and 28.6 % lowland, midland and highlands, respectively).

The interaction with the respondent exercising controlled mating revealed that surplus and / or unwanted bucks were prevented from mating any female by either castration (55.5, 51.4 and 49.1 %, in lowland, midland and highlands, respectively) or culling (30.5, 28.6 and 20.4 %, in lowland, midland and highlands, respectively) or both these combined togther (14.1, 20.0 and 30.4 % in lowland, midland and highlands, respectively).

Table 26:Breeding system, castration and culling of Woyto goat in the study area

Factors	Lowland %	Midland %	Highland %	Overall %
(I) Breeding methods:				
Controlled	27.7	32.8	40.0	33.5
Uncontrolled	72.3	67.2	60.0	66.5
(II) Reason of uncontrolled matting:				
Goat grazing together	53.3	55.7	41.4	50.1
Lack of awareness	18.9	20.0	30.0	22.8
Both grazing together & lack of awareness	27.7	24.3	28.6	26.9
(III) Methods of controlled mating :				
Castration	55.5	51.4	49.1	53.0
Culling	30.5	28.6	20.4	25.2
Both	14.1	20.0	30.4	21.8
(IV) Reason of culling:				
Reproductive failure and abortion	12.3	15.7	17.1	15.0
Diseases	32.2	30.0	27.1	29.8
Poor body condition	23.3	5.8	15.7	15.0
Color and older age	20.0	25.7	12.8	19.5
Combination of abortion, disease, poor body condition, color and older age	12.2	22.8	27.1	20.7
(V) Production life:				
	Mean ±SD	*Mean ±SD*	*Mean ±SD*	*Mean ±SD*
Average age of surplus (non selected) male castrated for fattening (year)	2.3±1.12	2.1 ±0.82	1.9±0.82	2.1±0.93
Average age of culling of breeding males (year)	6.9±2.13	6.5±1.84	7.43±2.21	6.94±2.10

SD=standard devation, %= percentage

The overall mean age at castration for fattening of unselected male goats was reported to be 2.1 ± 0.93 years whereas the breeding bucks were culled after attaining age of 6.94 ± 2.1 years. The FGD and respondent interviews showed that breeding bucks after attaing the average age of 6.94 ± 2.1 years were usually castrated or disposed off through sale / slaughter.

The FGD and interview with respondents revealed that goats were culled for different reasons. Perusal table 26 showed that overall proportion of farmers cull goats due to reproductive failure and abortion (15.0 %), diseases (29.8 %), poor body condition (weak/thin animals, 15.0 %), color and old age (19.5%) and a combination of reasons such as abortion, disease, poor body condition, color and older age (20.7%). This was in agreement with earlier study conducted in Dale district of southern Ethiopia (Endeshaw, 2007). Richard Browing Jr (2009) has recommended culling of goats due to (i) poor health, (ii) does which present frequent prolapsed uterine, (iii) does with low milk production, (iv) does with poor conformation of the udder and teats, (v) does that prevent kids from suckling adequately, (vi) does with poor fertility rates, older aged and (vii) does fail to maintain adequate body condition.

4.4.3.2. Sources and social exchange networks of breeding bucks

The summary of respondent households' sources of breeding buck are presented in table 27. Perusal results revealed that the sources of breeding buck in the Loma district was either own-flock (48.6 %) or neighbors (40.6 %) or relatives (11.8 %). The trend in all the three agro ecologies followed this pattern. However respondents reported that purchase of breeding bucks for breeding purpose was not practiced at all but most of the households preferred to have their own breeding buck. A proportion of them (respondent) reported to use breeding buck primarily from other alternative sources. The results showed that 67.7 % (Overall) of goat owners around Loma owned their breeding buck whereas 32.3% (Overall) had no breeding buck. Moreover the availability of breeding buck was considerably higher in lowland (78.8%), followed by midland (70.0%) and lower in highland (54.3%).

The FGD revealed that ownership of breeding buck was related to the flock size as majority of households with small flock size depended on other sources than their own flock for breeding buck and respondents with large flock size depend either on their own or on their neighbours breeding buck. However the choice of the source was also influenced by quality of the breeding buck. The perusal table showed that producers keep bucks for different purpose in different agro ecology zones. They keep bucks for mating, fattening and for both purpose 25.5%, 26.6% and 47.9% in lowland, 28.6%, 31.4% and 40% in midland and 30%, 25.7% and 44.3% in highland, respectively.

Table 27:Summary of respondent households' sources of breeding buck

Categories	Lowland %	Midland %	Highland %	Overall %
(A) Source of Buck:				
Own flock	52.2	44.4	45.7	48.6
Neighbors	38.8	40.0	42.8	40.6
Relatives	9.0	16.6	11.5	11.8
(B) Availabilty of breeding buck:				
Have breeding buck	78.8	70.0	54.3	67.7
Haven't breeding buck	21.2	30.0	45.7	32.3
(C) Purpose of keeping buck:				
Mating	25.5	28.6	30.0	28.0
Fattening	26.6	31.4	25.7	28.0
For both mating & fattening	47.9	40.0	44.3	44.0

%=percentage

4.4.3.3. Genealogy keeping and individual identification systems

Keeping the history of family and the line of descent from their ancestors was culture of Loma community. For that reason, the community practiced mentally memorizing their personal ancestral and also their animals. The interaction with respondent revealed that 88.6%

of overall respondents mentally memorized genealogy of every goat through the maternal line of descent. FGD members also reported that owners can recall up to more than 7 lines of maternal lineages tracing back to superior individuals. Genealogy memorization is used to select breeding animals born to a superior maternal lineage. However, only 30.6% of the respondents reported to recognize the sire of a kid. Identifying paternal lineages may be difficult as uncontrolled mating, where in group of selected breeding bucks are usually run within the flock, is prevalent more while controlled mating was less practiced (Table 26).

FGD revealed that *Loma* childern can recall their paternal lineage linking him to a sub-clan identity up to 7 lines of descent. Method of identifying individual goat ancestors was reported to range from naming every individual; mental memorization by color or other physical feature for each individual family like brown colored goat family known as Damer for female and Daama for male, white colored goat family known as Botale for female and Boreda for male, Black colored goat family known as Daache for female and Dachala for male; and combination of all these (**Appendix 3**). Furthermore FGD revealed that goats were named based on physical characteristics (coat color pattern and type, body size etc), unique behavior or any special events within the family coinciding with kidding (For instance, whenever new birth within the family coincided with kidding of a goat, the later is usually referred as belonging to that child) or birth of typical animal. Naming based on physical feature was, however, the most commonly applied system. Nevertheless, naming an individual in this method usually followed special characteristics of the maternal lineage rather than its own.

The FGD revealed that tattooing, ear tagging, branding, ear cutting (notching) and other ways of identification were not practiced to identify individual animals within the flocks. The community perceived that since majority of households own either small or medium sized flocks thus identification of individual animal within these small / medium flocks was not complex problem.

Methods of individual goat identification in three agro ecologies are presented in table 28. The results showed that households were able to identify their animals just by naming to the extent of 54.4, 58.6 and 55.7 % in lowland, midland and highland, respectively. However, some of them 12.2, 11.4 and 8.6 % in lowland, midland and highland, respectively, could also identify their animals based on just their physical features without the need of naming or branding.

Table 28: Methods of identification individual goats

Method of individual identification	Lowland %	Midland %	Highland %	Overall %
Naming individual	54.4	58.6	55.7	56.2
Physical feature	12.2	11.4	8.6	10.7
Both naming and physical feature	33.4	30.0	35.7	33.0

% = Percentage

4.4.3.4. Selection of breeding animals

The selection practice, stage and age of selection of breeding goats in the study area are presented in table 29. The result showed that both breeding male and female goats were selected by the sampled respondents. However, selection of breeding male was exercised by higher proportion of respondents than the females. In all 71.7, 88.5 and 94.3% of respondents selected breeding males whereas 62.5, 53.7 and 38.57% respondents exercised breeding female selection in lowland, midland and highland agro ecologies, respectively.

The results on stage of selection (Table 29) showed that proportion of buck selection at young age was higher (72.2, 75.7 and 80.0%) in lowland, midland and highland, respectively in the study area. This reflects that respondents were aware about early selection of bucks, though their perception could be different. The mean age of selection of breeding buck was 9.53 ± 1.73 month in lowland, 7.9 ± 1.09 month in midland and 9.41 ± 1.84 month in highland, respectively, whereas age of selection breeding doe was 7.50 ± 1.47, 7.0 ± 1.2 and 8.24 ± 1.68 months in lowland, midland and highland respectively. The stages of selection for breeding males (overall proportions) were early (2.0%), young (76.6%) and adult (21.4%).

Table 29:Summary of selection practice and stage of selection of breeding animals

Factor		Aro ecologies							
		Lowland		Midland		High l;and		Overall	
(A) Selection practice (%)		**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
Selection of breeding male		**71.7**	**28.3**	**88.5**	**11.4**	**94.3**	**5.7**	**84.63**	**13.36**
Selection of breeding female		**62.5**	**37.4**	**53.7**	**46.3**	**38.57**	**61.43**	**52.61**	**47.38**
(B) Stage of selection of bucks (%)									
Early (< 6 months)		**4.4**		**2.8**		**0.0**		**2.0**	
Young (6 – 12 months)		**72.2**		**75.7**		**80.0**		**76.6**	
Adult (> 12 months)		**23.3**		**21.4**		**20.0**		**21.4**	
(C) Age of selection (months)									
Breeding buck	Mean ± SD	**9.53 ± 1.73**		**7.9 ± 1.09**		**10.68 ± 1.55**		**9.41 ± 1.84**	
Breeding female	Mean ± SD	**7.50 ± 1.47**		**7.0 ± 1.20**		**8.24 ± 1.68**		**7.57 ± 1.54**	

%=percentage, SD=standard deviation

4.4.3.5 Effective population size and level of inbreeding

The effective population size was influenced by the actual number of breeding males and females in a flock at a given time and thus this was subject to change due to the variation in flock size, type of rearing practice (Mixed flock grazing in community grazing lands or individual flocks). The rate of inbreeding coefficient per generation changes with any change in the effective population size. The results of effective population size and level of inbreeding are presented in tables 30 togther read with **appendix 5**.

Table 30:Effective population size and level of inbreeding in different agro ecologies

Agro ecologies	Mixed goat population during grazing in community grazing lands				Individual flocks (Not mixed)			
	Nm	*Nf*	*Ne*	*ΔF*	*Nm*	*Nf*	*Ne*	*ΔF*
Lowland	**7.6**	**27.7**	**23.85**	**0.021**	**2.2**	**13.3**	**7.55**	**0.066**
Midland	**4.2**	**18.6**	**13.71**	**0.036**	**1.6**	**7.3**	**5.25**	**0.095**
Highland	**5.2**	**21.1**	**16.77**	**0.029**	**1.9**	**12.6**	**6.60**	**0.075**
Overall	**6.70**	**22.6**	**20.71**	**0.024**	**2.0**	**11.6**	**6.66**	**0.073**

Δ F = coefficient of inbreeding/generation. Ne = Effective population size; Nm = number of male; Nf = number of female

The results in table 30 showed that the mean number of breeding males and females in lowland, midland and highland agro ecologies were 7.6 ± 1.8, 4.2 ± 1.2, 5.2 ± 1.2 (for breeding males) and 27.7 ± 3.22, 18.6 ± 2.45 and 21.1 ± 2.88 (for breeding females) in mixed flock grazing in community grazing lands. Similarly under individual flocks (Not mixed) the mean number of breeding males and females in lowland, midland and highland agro ecologies were 2.2 ± 1.32, 1.6 ± 1.11, 1.9 ± 1.13 (for breeding males) and 13.3 ± 3.23, 7.3 ± 2.88 and 12.6 ± 4.3 (for breeding females).

The results (Table 30) showed that effective population size (Ne) estimated in lowland, midland and highland areas were 21.32, 10.92 and 14.01 and the rate of inbreeding per generation estimated was 0.021, 0.036 and 0.029 in lowland, midland and highland areas, respectively, under mixed flock grazing in community grazing lands. Similarly under individual flocks (Not mixed) the effective population size estimated were 7.55, 5.25 and 6.60 and the corresponding rate of inbreeding coefficient were 0.066, 0.095 and 0.073 in lowland, midland and highland, respectively.

Effective population size was higher in lowland than the other two agro-ecologies due to high number of goat flocks per household. However, rate of inbreeding were higher in midland and highland than in lowland because of the smaller population size. The overall rate of inbreeding, estimated in the present study under individual flocks (Not mixed) of 0.073 was higher whereas the estimate of 0.024 under mixed flock grazing in community grazing lands was lower than the standard maximum acceptable level of 0.063 (Armstrong, 2006). The effect of inbreeding is more pronounced in the highlands where flocks are small in size and free mating are more common (Workneh,1992). The mixing of the flock in communal grazing land would reduce the rate of inbreeding per generation and this facilitate designing of community based genetic improvement.

4.5. Livelihood context

4.5.1 Participatory identification of breeding objectives traits

Breeding objective is defined as the traits to be improved, the cost of production and the revenue from product sales related to a genetic change in each trait. Economic values are the relative importance of traits in a given system and can be derived only if breeding objectives are defined in economic terms (Kahi and Nitter 2004). However, complete economic assessments of costs and revenues for low input systems in developing countries are difficult and are rarely available mainly due to illiteracy, lack of formal performance / pedigree record, small flock sizes, lack of precision and multiple roles animals play in smallholder systems makes it difficult to apportion the overall attributes against the many factors involved (Kosgey et al, 2003).

Thus, definition of the breeding objective was arrived through participatory analysis of priority problems in the community, contribution of goats towards mitigating these problems and most limiting factors in the production system. The FGD revealed food insecurity, prevalence of disease and widening gap between income & expenditure per unit of household were identified as priority problems faced by the community. Goats were significantly contributing to the household food security in terms of chevon (goat meat) / milk and generating household income through sale of live goats and goat products (skin). The breeding objectives were, thus, to ensure improved meat production, increased fertility per flock, and increased number of marketable animals generating increased net income per flock without undermining the adaptation. Risk aversion is thus taken as the most feasible way to forward goat production mode in the system and area.

The households in the study area raise goats for multiple purposes. The ranking of goat breeding objectives by households are presented in table 31. The results revealed that socio-economic (cash, asset, security) and production or yield attribute (meat) were ranked first and second preferred traits by farmers with index of 0.47, 0.44 in lowland; 0.45, 0.42 in midland and 0.47, 0.40 in highland areas. Howevwr the socio-cultural (rites, ceremony, prestige and dowry) purpose was ranked third in all agro ecologies. The purpose of goat keeping in the present study was in complete agreement with the earlier report of Teklyohannes *et al.* (2012) from South Omo wherein households ranked socio-economic and production traits as first and second preference for goat keeping.

Table 31:Participatory Ranking of goat production objectives by households

Objectives	Lowland				Midland				Highland				Overall			
	R1	*R2*	*R3*	*I*	*R1*	*R2*	*R3*	*I*	*R1*	*R2*	*R3*	*I*	*R1*	*R2*	*R3*	*I*
Socio economic	**53.3**	**44.4**	**33.3**	**0.47**	**51.4**	**42.8**	**28.6**	**0.45**	**52.8**	**42.8**	**37.1**	**0.47**	**52.5**	**43.3**	**33**	**0.46**
Production	**44.4**	**46.6**	**40.0**	**0.44**	**42.8**	**40.0**	**45.7**	**0.42**	**42.8**	**34.3**	**40.0**	**0.40**	**43.2**	**40.3**	**42**	**0.42**
Socio-cultural	**3.2**	**8.8**	**26.6**	**0.09**	**5.7**	**17.1**	**25.7**	**0.12**	**4.3**	**22.8**	**22.8**	**0.13**	**4.3**	**16.23**	**25**	**0.12**

R1,2,3 indicate rank 1 to 3, Index = sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for particular commodity divided by sum of [3 for rank 1 + 2 for rank 2 + 1 for rank3] for all commodities in an agro ecology

4.5.1.1 Purpose of goat production and function

The results of respondent preference ranking of goat production objectives are presented in table 32. Perusal of these results showed that rearing of goats was expected to provide multifaceted benefits to farmers. The sale of live goat and meat were ranked first and second preferred production objectives with index of 0.40, 0.48 and 0.44 (sale of live animals) and 0.35, 0.30 and 0.43 (meat) in lowland, midland and highland, respectively. FGD further revealed that pooled income fromsale of live animals, meat, milk and skin were most tangible benefits whereas tradition, social status, saving, social payments, ritual and manure were among the intangible benefits to the farmer

Table 32: Ranks of purpose for keeping goats by smallholder farmers

Purpose of goat keeping	*Lowland*				*Midland*				*Highland*				*Overall*			
	R1	***R2***	***R3***	***I***	***R1***	***R2***	***R3***	***I***	***R1***	***R2***	***R3***	***I***	***R1***	***R2***	***R3***	***I***
Meat	42.2	32.2	16.7	0.35	40.0	21.4	17.1	0.30	44.3	40	44.3	0.43	42.17	31.2	26	0.36
Milk	4.4	12.2	17.8	0.09	2.9	11.4	27.1	0.10	0	6.1	6.1	0.03	2.4	9.9	17	0.07
Sale of live animals	45.6	39	22.1	0.40	52.9	54.3	20.0	0.48	48.6	41.1	38.6	0.44	49.03	44.8	26.9	0.44
Skin	0	1.1	15.6	0.03	0	0	7.1	0.01	0	0	1.4	0.002	0	0.37	8	0.02
Social gift	5.6	11.1	17.8	0.10	4.3	8.6	22.9	0.09	7.1	7.1	5.7	0.07	5.6	8.9	15.5	0.08
Tradition	2.2	4.4	10	0.04	0	4.3	5.7	0.02	0	5.7	3.9	0.03	0.7	4.8	6.5	0.04

R1, R2 and R3 = rank 1, 2 and 3 respectively. I= index: Index = sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) given for an individual reason (attribute) divided by the sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for overall reasons

The preference of farmers of ranking income as first objectives could be ascribed to the fact that sale generates income for the farmers thereby facilitating their livelihood security. Similarly farmers ranked meat as second production objective may be based on the prevailing perception among farmers those Woyto-Guji goats produce good quality meat (chevon) compared with other goat breeds. This is further supported by the finding, based on FGD, that Woyto goat meat is generally consumed during festival and holidays by the community. The FGD further showed that these goats were also used as social gifts, such as dowry etc.

The ranking of milk either third or fourth production objectives could be due to the use of Woyto-Guji goat's milk and butter as a medicine in traditional treatment of sick people (mechanically injured, sick and growing children). However, under normal circumstances milking of goats was not practiced by farmers owning milking cows in the community. The FGD showed existence of a perception among community that feeding of goat milk was associated with poverty. However mothers from poorest families appreciated the crucial role of goat as the only source of milk for their children. The goat keeping was seen in the community as a mark of traditional identity. The skin, rituals and manure were among the least ranked products and/or functions of goats. The use of manure was mentioned only in few cases at lowland and midland.

4.5.1.2 Purpose of selling and buying goats

The results of purpose of goat marketing are presented in table 33. These results showed that the main reasons for sale of goats was to generate income to meet demands of cash in all the three agroecologies (94.4, 92.8 and 91.4 % in lowland, midland and highland, rtespectively). This suggested that goats have high financial and insurance functions in the study area. Besides sale of goats is easy compared to larger animals. This makes them suitable commodity to mobilize in times of compelling and urgent financial needs.

The results (Table 33) further showed that farmers purchased goats mainly for production purpose in all agro ecologies (56.6, 65.7 and 60.0 % in lowland, midland and highland areas, respectively). The other reasons in descendinmg order were fattening, slaughter at festivals and combination of production / fattening/ slaughter at festivals in all the three agro ecologies.The FGD revealed that majority of the household purchased goat from nearby small towns and of farmers buy from nearby farmers. Besides results from FGD indicated that price of goat vary with distance to market and season of year. The prices rise during festivals, dry season and during crop harvest where as the prices drop during planting time (wet season).

Table 33:Purpose of goat marketing (%)

Factors	Lowland (%)	Midland (%)	Highland (%)	Total (%)
(A) Sale of live goat:				
Cash	94.4	92.8	91.4	93
Culling	2.2	2.8	4.3	3
Cash and culling	3.4	4.3	4.3	4
(B) Purchase of live goat:				
Production purpose	56.6	65.7	60	60.7
Fattening	26.6	17.1	18.6	20.7
Slaughter at festival	11.1	8.6	11.4	10.4
Combination of production, fattening and festival	5.6	8.6	10	8.2

The results of ranking of goat sold by faremers are presented in **appendix 6**. The pooled results over all agro ecologies showed that castrated males, breeding bucks / does, old age and kids (< 6months age) were first, second, third and fourth choices with index of 0.48, 0.30. 0.16, 0.06, respectively, for sale by the farmers. However in midlands and highlands kids (< 6months age) were not sold by the farmers.

4.6. Goat Reproductive performances

The reproductive performance of goat population in the study area, based on recall data by respondent farmers, are presented in table 34 and **appendix 8.** Perusal of results showed that AFS of female showed a significant ($p < 0.05$) variation among the three agro ecologies. The overall AFS of female goat in the study area was 8.5±1.89 months. The female goats reached AFS at 8.6±1.37, 8.36±2.46 and 8.6±1.82 month in lowland, midland and highland, respectively. The pairwise comparison showed that difference between lowland and highland was statistically non-significant whereas differences between midland & lowland and midland & highland were statistically significant ($P< 0.05$). The AFS of females in the present study was comparable with the reported estimate of 9.76 ±0.24 month for Sidama goat types (Endeshaw, 2007) and 8.2 ± 1.64 month in Metema area (Tesfaye, 2009). The result revealed that goats in midland attained AFS earlier than those in lowland and highland agro-climatic zones. The late mating age in the lowland and highland might be attributed to environmental factors or stress like heat, drought, water and feed shortage and long distance trekking. The results showed that AFS in male goats were 9.06 ± 3.58, 8.39 ± 2.62 and 10.2 ± 2.92 months in lowland, midland and highland, respectively. The differences in the AFS among three agro ecologies were significant ($P <0.05$).

The mean AFK in lowland, midland and highland agro ecologies were 13.06 ± 2.5, 13.3 ± 2.3.and 14.3 ± 3.17 months, respectively, and these differences were statistically significant ($P < 0.05$) among the three agro ecologies. This finding was higher than the earlier report of 12.46 month of age at first kidding in Goma district (Belete, 2009) wheras present finding was in agreement with the report of 13.6 months in Metema district (Tesfaye, 2009).

Kidding interval (KI) of goats in the study area were not significantly different ($p<0.05$) in the three agro ecologies. The KI estimated in the present study were 7.48±1.66, 7.27±1.59 and 7.7±1.85 months in lowland, midland and highland areas, respectively. The estimated KI was comparable with the earlier findings of 6.9 ± 1.29 month around Alaba (Tsedeke, 2007), 8.1 month under farm monitoring system (Tatek *et al,* 2004) and 8.57 month in Dale district (Endeshaw, 2007).

The overall average reproductive life span of doe was 12.27 ± 2.66 years in the three agro ecologies. The differences in average reproductive life span of doe among the three agro ecologies were non-significant ($P< 0.05$). The results on life span kid crop (Table 34) showed that the overall (pooled) mean was 18.35 ± 6.55 kids. The differences among the three agro ecologies were statistically significant ($P< 0.05$).

The overall (pooled) average litter size was estimated as 2.11±1.07 kids. The differences in litter size of the three agro ecologies were significant ($P< 0.05$). The differences in the litter size among lowland & highland and midland & highland were significant whereas this was non-significant between lowland & midland agro ecologies. The present estimates were comparable with the estimated litter size of goats in moist kola (2.33), moist Weyina Dega (2.21) and in Moist Dega (1.3) in Dale district (Endeshaw, 2007).

Table 34: Average of some reproductive performances as recalled by respondents

Parameters	Lowland		Midland		Highland		Overall	
	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD
Age at first service in male (month); (AFS)	**6-22**	**9.06 ± 3.58[a]**	**5-19**	**8.39 ± 2.62[b]**	**7-18**	**10.2 ± 2.92[c]**	**5-22**	**9.2 ± 3.2**
Age at first service in female (month); (AFS)	**7-16**	**8.6 ± 1.37[a]**	**5-17**	**8.36 ± 2.46[b]**	**6-16**	**8.6 ± 1.82[ac]**	**5-17**	**8.5 ±1.89**
Age at first kidding (month); (AFK)	**10-24**	**13.06 ± 2.53[a]**	**12-24**	**13.3 ± 2.3[b]**	**12-26**	**14.29 ± 3.17[c]**	**10-26**	**13.5 ± 2.72**
Average reproductive life span of doe (year)	**5-19**	**12.57 ± 2.64[a]**	**8-19**	**12.51± 2.36[a]**	**5-19**	**11.66 ± 2.90[a]**	**5-19**	**12.27±2.66**
Life span kid crop (Number)	**11-32**	**20.03 ± 6.74[a]**	**9-32**	**17.99± 6.63[a]**	**9-30**	**16.54 ± 5.70[a]**	**9-32**	**18.35±6.55**
Kidding interval (months) ;(KI)	**5-12**	**7.48 ± 1.66[a]**	**5-12**	**7.27 ± 1.59[a]**	**5-12**	**7.70 ± 1.85[a]**	**5-12**	**7.48 ± 1.69**
Litter size (number)	**1-4**	**2.23 ± 1.22[a]**	**1-3**	**2.22 ± 1.11[b]**	**1-2**	**1.8± 0.9[ac]**	**1-4**	**2.11±1.07**

SD=standard deviation

The interview with respondents showed that kidding occurs at any time in a year across all agro ecologies (**Appendix 7**). The respondent farmers classified four seasons of kidding and these were December to Febraury, March to May, June to august and September to November in the study area. The overall (pooled) results showed that first and major kidding season was observed from March to May and the second kidding time was from September to early November in the study area with index of 0.33 and 0.28. However it was found that during June – August lowest kidding occurred in all areas. The present finding were in agreement with the earlier studies in Alaba district (Deribe, 2009).

4.7. Morphological Characters of Goat population in Loma district

4.7.1. Qualitative characteristics

The participatory description of qualitative characters for both female and male goats are presented in table 35. The result showed that both femal and male goat exhibited white, brown, black, grey and cream white coat color type (**Figure 3**) but in varying proportion in either same sex or across two sexes. In all white, brown, black, grey and creamy white coat color type were observed in the sampled goats. The overall (pooled) results showed that proportion of brown, black, white, cream white and grey coat colour were in descending order in the sampled goats. The highest proportion of brown coat colour indicated that farmers prefer this coat colour and have selected these animals favourably. Three coat colour patterns, viz: plain, patchy and spotted, were found in sampled goats. The plain coat colour pattern was dominant with 91.2 % (overall / pooled) occurrence in the sampled goats. The other two coat colour patterns (patch and spotted) were less common.

The head profile observed were straight, slightly convex and concave among the sampled goats in the present study. The straight head profile is dominant (overall average = 80.6 %) followed by slightly convex (overall average = 15.2 %) and concave (overall average = 4.2 %). The ear formation showed that long ear were highly predominant (overall average = 97.0 %) in population of goats studied. Similar finding were reported by FARM-Africa (1996).

Table 35:Summary of the qualitative traits in the female and male sample goats

Characters	Factors level	Female		Male		Total	
		N	%	N	%	N	%
Coat color type	White	125	21.2	36	16.4	161	19.9
	Brown	259	43.9	111	50.5	370	45.7
	Black	124	21.0	39	17.4	163	20.1
	Grey	39	6.6	14	6.4	53	6.5
	Cream white	43	7.3	20	9.1	63	7.8
Coat color pattern	Plain	541	91.7	198	90.0	739	91.2
	Patchy	40	6.8	11	5.0	51	6.3
	Spotted	9	1.5	11	5.0	20	2.5
Head profile	Straight	473	80.2	180	81.8	653	80.6
	Slightly convex	93	15.8	30	13.6	123	15.2
	Concave	24	4.1	10	4.5	34	4.2
Ear formation	Rudimentary	2	0.3	1	0.5	3	0.4
	Short ear	8	1.4	11	5.0	19	2.3
	Long ear	578	98.0	208	94.5	786	97.0
Ear type	Semi pendulous	411	69.7	154	70.0	565	69.8
	Horizontal	179	30.3	66	30	245	30.3
Horn orientation	Rudimentary	58	9.8	13	5.9	71	8.8
	Front	57	9.7	21	9.5	78	9.6
	Backward	428	72.5	159	72.3	587	72.5
	Lateral	47	8.0	27	12.3	74	9.1
Horn shape	Straight	403	68.3	175	79.5	578	71.4
	Polled	64	10.8	16	7.3	80	9.9
	Spiral	123	20.8	29	13.2	152	18.8
Beard	Present	521	88.3	215	97.7	736	90.9
	Absent	69	11.7	5	2.3	74	9.1
Wattle	Present	51	8.6	52	23.6	103	12.7
	Absent	539	91.4	168	76.4	707	87.3
Ruff	Present	531	90.0	201	91.4	732	90.3
	Absent	59	10.0	19	8.6	78	9.6

N= Number of observation; %= percent of house hold

(a) All Female Goate

(b) Breeding buck and Doe

(c) Breeding buck

Figure 3: Unique plain Coat color type of Woyto-Guji (Halla deysha) goat breeds

Two ear types, viz: semi pendulous and horizontal, were observed in population studied. The semi pendulous ear type was more numerous in the two sexes (69.8 and 70.0 % in female and male, respectively) whereas horizontal ear type was less numerous (30.3 ans 30.0 % in femle and male, respectively).

The horn orientations observed in the present study were rudimentary, front, backward and lateral. Among these horn orientations, the backward orientation was most dominant in the two sexes (overall average = 72.5 %) followed by front, lateral and rudimentary (overall average were 9.6, 9.1 and 8.8 %, respectively) orientation. Similarly straight, polled and spiral shapes of the horn were observed in the present study and their overall (pooled) proportion were 71.4, 9.9 and 18.8 %, respectively.

The beard was present in both sexes with the proportion of 88.3 % and 97.7 % in female and male goats in the present study. The wattle was absent in 91.4 and 76.4 % of female and male goats in the present study. The ruff was present in 90.0 and 91.4 % in female and male goats in the present investigation. Similar finding w.r.t beard, wattle and ruff were reported by FARM-Africa (1996).

4.7.2 Quantitative Characteristics

According to Salako (2006), body measurements in addition to body weight estimates described more completely an individual or population than do the conventional methods of weighing and grading. Thus body measurements have been used at various times for the estimation of weights when live weights are measured alongside these parameters. Body dimensions have been used to indicate breed, origin and relationship through the medium of head measurements (Itty *et al.*, 1997) or to indicate size.

The least square means and least square ANOVA for quantitative traits (body weight, body length, heart girth, height at withers, chest width, body condition score, pelvic width, rump height, rumph length, ear length and horn length) in both sexes and scrotal circumference in male *Woyto guji* goat are presented in table 36 and **appendix 9**. The overall means along with standard error for body weight, body length, heart girth, height at withers, chest width, BCS, pelvic width, rumph height, rumph length, ear length, horn length and scrotal circumference were 25.3 ± 3 .10 kgs, 58.20 ± 4.73 cms, 73.11 ± 4.37 cms, 66.65 ± 4.011 cms, 14.34 ± 1.68 cms, 3.09 ± 0.45 cms, 13.21 ± 1.46 cms, 66.67 ± 3.94 cms, 12.53 ± 1.80 cms, 13.81 ± 1.19 cms, 12.48 ± 2.24 cms and 16.56 ± 2.77 cms, respectively. The corresponding coefficient of variation (CV) for these traits were 11.62, 8.13, 5.97, 6.02, 11.77, 14.53, 11.07, 5.91, 14.41, 8.66, 17.94 and 16.74 %, respectively. The CV estimates showed that some of these traits (body weight, Cest width, pelvic width, rumph length, ear length and horn length) have CV more than 10.00 % indicating opportunity for their improvement. In addition to these scrotal circumference, a highly heritable trait having high correlation with sperm production, with highest CV (16.74 %) in male goat could be improved. The mean values in the present study were higher for BWT, BL, HG, HtW, BCS, PW, RH, EL and HL whereas these were lower for CW, RL and SC reported in Hararghe highland goats (Dereje *et al.,* 2013).

4.7.2.1 Effect of Sex:

The Effect of sex was either highly significant (P < 0.001) or significant (P < 0.005) on body weight and all body measurements (**appendix 9**). Perusal of least square means (Table 36) showed that body weight and all body measurements in male goats were consistently higher in magnitude than the corresponding values in females. The mean BWT, BCS, BL, HG, HW, CW, PW, RH, RL, EL and HL of females were 23.74 ± 0.14 kg, 2.89 ± 0.021, 55.64 ± 0.22cm, 70.07 ± 0.20 cm, 64.03 ± 0.18 cm, 13.68 ± 0.07cm, 12.47 ± 0.06cm, 64.23 ± 0.18 cm, 11.90 ± 0.08 cm, 13.45 ± 0.05cm and 11.19 ± 0.14cm respectively. The corresponding values for male counterpart are 26.34±0.21kg, 3.17±0.033, 59.72±0.34cm, 74.37±0.31cm, 68.03±0.05cm, 14.27±0.12cm, 13.00±0.10cm, 68.10±0.12cm, 12.52±0.13cm, 13.86±0.08cm, and 12.99±0.16cm, respectively.

The result in the present study for BWT, HtW, and HG were lower (Both sexes) and horn length (Males, only), whereas ear length (Both sexes) and horn length (Females) were higher, than the earlier report for the same breed of goat (Workneh & Peacock,1993 cited in Farm Africa, 1996). This might be due to the variations in study area, husbandry practice and environmental factors. The effect of sex in favor of males on body weight and body measurements in present study was in agreement with previous results (Semakula et al, 2010, Dereje et al, 2013, Solomon, 2014). The sex related differences might be partly a function of the sex differential hormonal effect on growth (Semakula et al, 2010). It was reported that, ewes have slower rate of growth and reach maturity at smaller size due to the effect of estrogen in restricting the growth of the long bones of the body (Sowande and Sobola, 2007 as cited in Tesfaye, 2008). In addition to that, the differentials obtained in the morphological traits of the sexes could be attributed to sexual dimorphism. Peter T. *et al*., (2012) reported that most dimorphism developed post-weaning because of faster mass gain by males during the age of 1–2 years. They also suggested that males might have a longer season of mass gain each year throughout their lives, while females divert annual resources into reproduction, rather than body mass.

4.7.2.2 Effect of Age groups

The effect of age was highly significant ($P < 0.001$) on body weight and all other body measurements (**Appendix 9**). Perusal of least square means showed that both body weight and linear body measurements have shown a consistent increase with advancement in age from the youngest age (0PPI) to the oldest age (4PPI) in the present study. These results were in agreement with earilier reports of increase in live body weight and linear body measurements with increase in age of animal in all breeds of goat as (Semakula et al., 2010, Solomon, 2014). The pairwise comparison of least square means showed that there were significant differences among all pairs in all traits studied except in pelvic width, rumph weight, rumph length, ear length and horn length.

4.7.2.3 Effect of Agro Ecology

The effect of agro ecologies was either highly significant ($P < 0.001$) or significant ($P < 0.005$) for all traits, studied, except ear length and scrotal circumference (**Appendix 9**). Perusal of least square means showed a consistently ascending trend in the measurements from lowland to highland agro ecologies for BL, HG, HtW, CW, PW and RH. In other traits no such consistant trend was observed. The present finding reflected that there were wide variations among the three agro ecologies which influencd all the quantitative traits studied. The present results were in agreement with earlier study showed that the effects of agro ecologies was significantly affected on body measurements in two indigenous goat breeds, viz: Wesetern lowland goat and Abregelle (Solomon, 2014) and short ear Somalia goats (Grum, 2011).

4.7.2.4 Effect of Sex x Age groups Interaction

The interaction between sex and age groups was either highly significant (P < 0.001) or significant (P < 0.005) on body weight and all body measurements (**appendix 9**) except scrotal circumference which was not studied. The results (Table 36) showed that the magnitude of values of body weight and all other body measurements were consistently higher in males of different age groups than corresponding values for female of various age groups. The pairwise comparison of means showed variable trends in all the traits studied. The present findings were in agreement with earlier studies of Samuel and Salako (2008) and Dereje (2011) which reported significant influence of sex and age interaction on body measurements. Hence, this finding should be considered in improvement program to increase meat yield from goat via sex disintegrated improved management.

4.7.2.5 Effect of Agro ecology by age group Interaction

The interaction between agro ecologies and age groups was either highly significant (P < 0.001) on HG, HtW, CW PW, RHt and RL or significant (P < 0.005) on body weight, body length , body condition score, and ear length (**appendix 9**). But there was no significant (P < 0.005) agro ecologies by age intraction effects on horn length and scrotal circumference. Lowland and highland goats at young age (0PPI up to 2PPI) had highest Body weight compared with midland agro ecologies by age interaction groups whereas Lowland and highland goats at older age (3PPI and 4PPI) had lowest body weight compared with midland goats in these age groups. These results indicated that effect of agro ecologies was different in different age groups and thus variation in the agro ecologies have a strong effect on quantitative traits.

Table 36:Least squares means ± standard errors of body weight (kg), body condition score & other body measurements (cm) for Woyto-Guji Goat

Effects and levels	N	Body Weight	Body Length	Heart girth	Height at Wither	Chest Width	Body Condition score
		LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE
Overall	810	25.3±3.10	58.20 ± 4.73	73.11±4.37	66.65±4.011	14.34 ±1.68	3.09±0.45
CV		11.62	8.13	5.97	6.02	11.77	14.53
R^2		0.79	0.48	0.63	0.588	0.45	0.54
Sex		***	***	***	***	***	***
Male	220	26.34±0.21	59.72±0.34	74.37±0.31	68.03±0.29	14.27±0.12	3.17±0.033
Female	590	23.74±0.14	55.64±0.22	70.07±0.20	64.03±0.18	13.68±0.07	2.89±0.021
Age group		***	***	***	***	***	***
0PPI	80	14.40±0.36^{a}	48.66±0.57^{a}	61.58±0.53^{a}	56.83±0.48^{a}	11.11±0.20^{a}	2.44±0.05^{a}
1PPI	136	20.38±0.26^{b}	55.98± 0.41^{b}	69.98±0.38^{b}	64.45±0.35^{b}	13.39±0.14^{b}	2.70±0.04^{b}
2PPI	178	27.06±.24^{c}	59.51±0.41^{c}	73.55±0.38^{c}	67.36±0.35^{c}	14.42±0.14^{c}	2.88±0.04^{c}
3PPI	157	30.25±0.26^{d}	61.44±0.50^{d}	76.63±0.46^{d}	70.06±0.42^{d}	15.01±0.17^{d}	3.25±0.05^{d}
4PPI	259	33.11±0.20^{e}	62.81±0.34^{e}	79.37±0.31^{e}	71.42±0.28^{e}	15.94±0.12^{e}	3.88±0.03^{f}
Agro ecology		**	***	***	***	***	**
Lowland	290	25.31±0.19^{a}	56.05±0.30^{a}	71.17±0.27^{a}	64.73±0.25^{a}	13.44±0.10^{a}	3.08±0.028^{a}
Midland	260	24.74±0.22^{b}	57.46±0.34^{b}	71.44±0.31^{a}	65.54±0.28^{b}	13.73±0.12^{ab}	3.03±0.032^{a}
Highland	260	25.07±0.23^{a}	59.52±0.35^{c}	74.05±0.33^{b}	67.80±0.30^{c}	14.75±0.13^{b}	2.97±0.033^{b}
Sex *Age		***	**	***	**	***	***
0PPI	M	14.52±0.59^{b}	49.59±0.92^{b}	63.43±0.85^{b}	58.99±0.78^{b}	10.94±0.33^{a}	2.36±0.08^{a}
0PPI	F	13.74±0.43^{a}	47.72±0.68^{a}	59.73±0.62^{a}	54.67±0.57^{a}	11.27±0.24^{b}	2.51±0.06^{a}
1PPI	M	21.12±0.41^{c}	57.82 ±0.64^{c}	71.57±0.59^{d}	65.84±0.54^{d}	13.70±0.23^{c}	2.76±0.06^{b}
1PPI	F	19.49±0.34^{bc}	54.14 ±0.54^{cb}	68.40±0.49^{c}	63.05±0.45^{c}	13.09±0.19^{c}	2.64±0.05^{b}
2PPI	M	27.16±0.46^{d}	61.60±0.73^{d}	74.95±0.67^{e}	68.85±0.62^{e}	14.71±0.26^{d}	2.89±0.07^{c}
2PPI	F	26.15±0.26^{d}	57.42±0.41^{c}	72.15±0.38^{d}	65.88±0.35^{de}	14.12±0.14^{d}	2.87±0.04^{c}
3PPI	M	31.37±0.58^{e}	63.70 ±0.91^{e}	79.03±0.43^{f}	72.34±0.77^{f}	15.15±0.32^{e}	3.42±0.08^{d}
3PPI	F	28.99±0.26^{ed}	59.17±0.41^{dc}	74.23±0.39^{e}	67.78±0.35^{e}	14.87±0.15^{d}	3.09±0.04^{d}
4PPI	M	36.17±0.37^{f}	65.88±0.58^{f}	82.88±0.54^{f}	74.11±0.49^{f}	16.86±0.21^{f}	4.40±0.05^{e}
4PPI	F	31.20±0.22^{e}	59.74±0.34^{dc}	75.86±0.32^{e}	68.74±0.29^{e}	15.01±0.12^{e}	3.35±0.03^{d}
Agro eco*Age		**	**	***	***	***	**
Lowland	0PPI	14.57 ± 0.50^{a}	46.88±0.79^{a}	58.79±0.73^{a}	54.36±0.67^{a}	10.55±0.28^{a}	2.46±0.07^{a}
	1PPI	21.20±0.44^{b}	53.40 ± 0.69^{b}	67.43±0.63^{b}	62.21±0.58^{b}	12.58±0.24^{b}	2.83±0.06^{b}
	2PPI	26.56 ±0.40^{c}	57.97±0.63^{c}	73.06±0.58^{c}	66.18±0.53^{c}	14.00±0.22^{c}	2.90±0.06^{b}
	3PPI	30.21±0.43^{d}	60.75±0.67^{d}	77.01± 0.62^{d}	69.73±0.57^{d}	14.95±0.24^{c}	3.26±0.06^{c}
	4PPI	33.94±0.33^{e}	61.24 ± 0.52^{e}	79.57±0.48^{e}	71.14±0.44^{e}	15.12±0.18^{c}	3.94±0.05^{d}
Midland	0PPI	13.50 ± 0.61^{a}	47.80±0.90^{a}	58.96 ±0.89^{a}	54.67±0.81^{a}	10.46±0.34^{a}	2.55±0.09^{a}
	1PPI	19.46 ± 0.47^{b}	55.17 ±0.74^{bc}	68.95± 0.69^{b}	63.85±0.63^{b}	13.18±0.26^{b}	2.64±0.07^{b}
	2PPI	26.25 ± 0.45^{c}	58.96 ±0.71^{c}	72.67±0.66^{c}	66.74±0.60^{c}	13.82±0.25^{c}	2.87±0.06^{b}
	3PPI	30.41±0.50^{d}	61.36 ±0.79^{e}	76.7±0.73^{d}	70.60±0.67^{d}	14.75±0.28^{c}	3.29±0.07^{c}
	4PPI	34.36±0.32^{e}	64.02 ±0.51^{f}	79.95±0.47^{e}	71.86±0.43^{e}	16.46±0.18^{d}	3.79±0.04^{d}
Highland	0PPI	14.33 ± 0.73^{a}	51.30 ±0.15^{ab}	67.00±0.66^{b}	61.45±0.97^{b}	12.31±0.41^{b}	2.29±0.11^{a}
	1PPI	20.25±0.45^{b}	59.36 ±0.71^{d}	73.57±0.65^{c}	67.29±0.60^{c}	14.43±0.25^{c}	2.62±0.06^{b}
	2PPI	27.15±0.40^{c}	61.60±0.63^{e}	74.91±0.58^{cd}	69.17±0.53^{d}	15.34±0.22^{cd}	2.86±0.06^{b}
	3PPI	29.93 ± 0.48^{d}	62.21 ± 0.75^{ef}	76.19±0.69^{d}	69.84±0.63^{d}	15.43±0.26^{cd}	3.21±0.07^{c}
	4PPI	32.74±0.37^{e}	63.16±0.59^{f}	78.59±0.54^{e}	71.26±0.50^{e}	16.22±0.21^{d}	3.90±0.05^{d}

*^{a,b,c,d,e,f} means on the same column with different superscripts, within the specified class variable, are significantly different (p<0.05); Ns = non-significant; **P< 0.05; *** P< 0.01; 0PPI = 0 Pair of Permanent Incisors, 1PPI =1 Pair of permanent Incisors; 2 PPI = 2Pairs of Permanent Incisors; 3PPI = 3 Pairs of Permanent Incisors; 4PPI = 4 Pairs of Permanent Incisors; AE =agro ecology; CV=Coefficient of Variation, R= coefficient of determination*

Table 36: (Continued)

Effects and levels	N	Pelvic Width	Rump height	Rump Length	Ear Length	Horn Length	SC (N=220)
		LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE
Overall	810	13.21±1.46	66.67±3.94	12.53±1.80	13.81±1.19	12.48±2.24	16.56±2.77
CV		11.07	5.91	14.41	8.66	17.94	16.74
R^2-square		0.56	0.57	0.45	0.28	0.53	0.29
Sex		***	***	***	***	****	
Male	220	13.00 ±0.10	68.10 ±0.28	12.52 ± 0.13	13.86±0.08	12.99±0.16	
Female	590	12.47±0.06	64.23±0.18	11.90±0.08	13.45±0.05	11.19±0.14	
Age group		***	***	***	***	***	***
0PPI	80	9.83±0.17^{a}	57.31±0.48^{a}	9.70±0.21^{a}	12.12±0.14^{a}	7.38±0.27^{a}	14.10±0.44^{a}
1PPI	136	11.62±0.12^{b}	64.76±0.34^{b}	10.98±0.15^{b}	13.39±0.10^{b}	10.96±0.19^{b}	15.40±0.30^{b}
2PPI	178	13.25±0.13^{c}	67.42±0.34^{c}	12.36±0.16^{c}	13.84±0.10^{bc}	12.97±0.20^{c}	16.95±0.40^{c}
3PPI	157	14.01±0.15^{c}	70.02±0.42^{cd}	13.94±0.19^{d}	14.34±0.12^{c}	14.33±0.23^{d}	17.29±0.50^{d}
4PPI	259	14.95±0.10^{c}	71.32±0.28^{d}	14.07±0.13^{d}	14.60±0.08^{c}	14.80±0.16^{d}	18.50±0.34^{e}
Agro ecology		***	***	***	Ns	***	Ns
Lowland	290	12.51±0.09^{a}	64.57±0.25^{a}	12.56±0.11^{a}	13.74±0.07	12.00±0.14	15.86±0.29
Midland	260	12.61±0.10^{a}	65.87±0.28^{b}	12.57±0.12^{a}	13.61±0.08	11.16±0.16	16.74±0.34
Highland	260	13.09±0.11^{b}	68.05±0.29^{c}	11.50±0.13^{b}	13.62±0.08	12.86±0.16	16.75±0.44
Age*Sex		**	***	***	**	**	
0PPI	M	9.95±0.28^{a}	59.04±0.77^{b}	9.54±0.35^{a}	12.13±0.23^{a}	8.32±0.43^{b}	
0PPI	F	9.71±0.21^{a}	55.58±0.56^{a}	9.86±0.26^{a}	12.10±0.17^{a}	6.44±0.32^{a}	
1PPI	M	11.93±0.19^{b}	65.92±0.53^{c}	11.08±0.24^{b}	13.49±0.16^{b}	11.55±0.30^{c}	
1PPI	F	11.31±0.16^{b}	63.61±0.45^{c}	10.86±0.20^{b}	13.29±0.13^{b}	10.38±0.25^{c}	
2PPI	M	13.50±0.22^{c}	68.84±0.61^{d}	12.42±0.28^{c}	13.93±0.18^{c}	13.55±0.34^{d}	
2PPI	F	13.00±0.12^{c}	65.99±0.34^{c}	12.30±0.15^{c}	13.75±0.10^{c}	12.40±0.19^{cd}	
3PPI	M	13.98±0.28^{d}	72.60±0.76^{e}	14.36±0.34^{d}	14.69±0.23^{d}	15.53±0.43^{e}	
3PPI	F	14.07±0.13^{d}	67.43±0.35^{d}	13.53±0.16^{d}	13.99±0.10^{c}	13.14±0.19^{d}	
4PPI	M	15.63±0.18^{f}	74.12±0.49^{f}	15.19±0.22^{e}	15.09±0.14^{e}	15.99±0.27^{e}	
4PPI	F	14.28±0.10^{d}	68.52±0.29^{d}	12.94±0.13^{cd}	14.10±0.08^{d}	13.62±0.16^{d}	
Agro eco*Age		***	***	***	**	Ns	Ns
Lowland	0PPI	9.67±0.24^{a}	54.61±0.66^{a}	10.31±0.30^{a}	12.19±0.20^{a}	6.82±0.37	13.30±0.70
	1PPI	11.50±0.21^{b}	62.20±0.57^{b}	11.57±0.26^{b}	13.13±0.17^{b}	10.66±0.32	14.56±0.55
	2PPI	12.99±0.19^{c}	65.87±0.52^{c}	12.86±0.24^{c}	13.94±0.16^{b}	13.11±0.30	16.22±0.58
	3PPI	13.95±0.20^{d}	69.27±0.56^{d}	14.68±0.25^{d}	14.67±0.17^{c}	14.38±0.32	17.18±0.83
	4PPI	14.44±0.16^{d}	70.90±0.44^{e}	13.37±0.20^{cd}	14.79±0.13^{c}	15.01±0.25	18.03±0.53
Midland	0PPI	9.51±0.29^{a}	55.83±0.80^{a}	9.86±0.36^{a}	12.04±0.24^{a}	6.37±0.45	14.00±0.34
	1PPI	11.05±0.23^{b}	64.49±0.62^{c}	10.57±0.28^{a}	13.29±0.18^{b}	10.32±0.35	15.15±0.63
	2PPI	12.93±0.22^{c}	67.03±0.59^{d}	12.32±0.27^{bc}	13.68±0.18^{b}	12.09±0.33	16.40±0.63
	3PPI	14.12±0.24^{d}	70.43±0.65^{e}	14.79±0.30^{d}	14.34±0.20^{c}	13.94±0.37	18.00±0.87
	4PPI	15.42±0.15^{d}	71.58±0.42^{e}	15.30±0.19^{e}	14.69±0.12^{c}	14.33±0.24	19.57±0.60
Highland	0PPI	10.32±0.32^{a}	61.49±0.96^{b}	8.93±0.44^{a}	12.12±0.29^{a}	8.94±0.54	14.00±0.60
	1PPI	12.30±0.21^{c}	67.61±0.60^{d}	10.78±0.27^{a}	13.76±0.17^{b}	11.92±0.33	16.50±0.83
	2PPI	13.83±0.19^{d}	69.35±0.52^{d}	11.90±0.24^{b}	13.89±0.16^{b}	13.72±0.30	16.63±0.46
	3PPI	13.97±0.23^{d}	70.34±0.62^{e}	12.35±0.28^{bc}	14.02±0.19^{c}	14.69±0.35	17.89±0.40
	4PPI	15.00±0.18^{e}	71.48±0.50^{e}	13.53±0.22^{cd}	14.31±0.14^{c}	15.07±0.27	18.71±0.47

^{a,b,c,d,e,f} means on the same column with different superscripts, within the specified class variable, are significantly different ($p < 0.05$); Ns = non-significant; **P< 0.05; *** P< 0.01; 0PPI = 0 Pair of Permanent Incisors, 1PPI =1 Pair of permanent Incisors; 2 PPI = 2Pairs of Permanent Incisors; 3PPI = 3 Pairs of Permanent Incisors; 4PPI = 4 Pairs of Permanent Incisors; AE =agro ecology; CV=Coefficient of Variation, R= coefficient of determination, N=Numbers of goat, SC = Scrotal circumference

4.7.3. Correlation between body weight and body measurements

The coefficient of correlation between body weight and all other body measurement in the two sexes and different age group is presented in table 37. Perusal of these results showed that all body measurements were positively correlated with the body weight in both sexes. The magnitude of correlation coefficients differed for each combination and majority of these estimates were either significant ($P < 0.05$) or highly significant ($P < 0.01$) in both sexes. However eight out of a total of 50 and nine out of a total of 55 correlation coefficients in female and male, respectively, were found to be statistically non significant.

The correlation between body weight and pelvic width was highest in both sexes (0.84 and 0.82 in females and males, respectively) in 0PP1 age group. The correlation coefficients between body weight and heart girth in three age groups (1PPI, 2PPI and 4PPI) were highest (0.80, 0.83 and 0.84, respectively) wheras body weight showed highest correlation with BCS (0.68) in 3PPI age group in female sex. Howevwer in male goats correlation coefficients between body weight and heart girth were highest (0.81, 0.83, 0.79 and 0.88, respectively) in the four age groups (1PPI, 2PPI, 3PPI and 4PPI).

The high correlation between body weight and heart girth, observed in majority of age groups, in present study suggested that heart girth may be used to obtain more reliable prediction estimate of body weight for the population. The present results were also supported by reports of Badi *et al,* (2002), Grum, (2010), Dereje, (2011) and Slippers *et al* (2000) where in they found that chest girth was best parameter for estimating body weight due to high correlation estimates.

Table 37: Coefficients of correlation (r) between body weight and other body measurements within sex and age groups.

Measurements		Body weights									
		Female Age groups					Male Age Groups				
		0PPI	1PPI	2PPI	3PPI	4PPI	0PPI	1PPI	2PPI	3PPI	4PPI
BL	r	0.58^{**}	0.51^{**}	0.30^{**}	0.46^{**}	0.64^{**}	0.49^{**}	0.26*	0.44^{**}	0.76^{**}	0.45^{**}
	N	51	80	135	130	194	29	56	43	27	65
BCS	r	0.13^{NS}	0.23^{*}	0.05^{NS}	0.68^{**}	0.44^{**}	0.63^{**}	0.15^{NS}	0.46^{**}	0.31^{**}	0.37*
	N	51	80	135	130	194	29	56	43	27	65
HG	r	0.26^{NS}	0.80^{**}	0.83^{**}	0.53^{**}	0.86^{**}	0.71^{**}	0.81^{**}	0.83^{**}	0.79^{**}	0.88^{**}
	N	51	80	135	130	194	29	56	43	27	65
HtW	r	0.29*	0.43^{**}	0.37^{**}	0.44^{**}	0.36^{**}	0.80**	0.48^{**}	0.65^{**}	0.38^{*}	0.62^{**}
	N	51	80	135	130	194	29	56	43	27	65
RH	r	0.22^{NS}	0.40^{**}	0.29^{**}	0.39^{**}	0.31^{**}	0.75^{**}	0.48^{**}	0.65^{**}	0.37^{*}	0.62^{**}
	N	51	80	135	130	194	29	56	43	27	65
RL	r	0.63^{**}	0.65^{**}	0.15^{NS}	0.48^{**}	0.13^{NS}	0.49*	0.40*	0.41^{**}	0.12^{NS}	0.40^{*}
	N	51	80	135	130	194	29	56	43	27	65
CW	r	0.27^{*}	0.28^{*}	0.15^{NS}	0.27^{**}	0.43^{**}	0.49*	0.23*	0.37^{**}	0.31^{*}	0.40*
	N	51	80	135	130	194	29	56	43	27	65
PW	r	0.84^{**}	0.54^{**}	0.53^{**}	0.36^{**}	0.23^{**}	0.82^{**}	0.43**	0.51^{**}	0.26^{*}	0.51^{**}
	N	51	80	135	130	194	29	56	43	27	65
EL	r	0.06^{NS}	0.26^{*}	0.19^{*}	0.31^{**}	0.13^{NS}	0.25^{NS}	0.24^{NS}	0.22^{NS}	0.24^{NS}	0.17^{NS}
	N	51	80	135	130	194	29	56	43	27	65
HL	r	0.63^{**}	0.70^{**}	0.50^{**}	0.40^{**}	0.24^{**}	0.68	0.45^{**}	0.60^{**}	0.45^{*}	0.18^{NS}
	N	51	80	135	130	194	29	56	43	27	65
SC	r	NA	NA	NA	NA	NA	0.35^{NS}	0.31^{*}	0.33^{**}	0.37*	0.24*
	N						29	56	43	27	65

*P<0.05; ** P<0.01;

1PPI = 1 Pair of Permanent Incisors; 2 PPI = 2 Pair of Permanent Incisors; 3PPI = 3 Pair of Permanent Incisors; 4PPI = 4 Pair of Permanent Incisors;

BL =Body Length; BCS = Body condition score, HG= Heart Girth, HtW=Height at wither, RH=Rump Height, RL= Rump Length, CW= Chest Width, PW=Pelvic width, EL=Ear Length, HL=Horn Length, SC=Scrotal circumference; NS = non-significant; NA = Not -available; N= number of observation ; r=coefficient of correlation

4. 7.4 Multiple Regression Analysis

Multiple regression were developed in order to predict live weight from ten different linear body measurements for females and eleven body measurements for males after checking the linearity of the body measurements against body weight. A stepwise multiple regression analysis was carried out to predict body weight from body measurements. The coefficient of determination (R^2) and mean square error (MSE) were used in fitting the best model. The live weight prediction equation at different age groups in both females and males are presented in **tables 38** and **39**, respectively. Based on coefficient of determination (**R^2**) and **MSE** values of the live weight prediction equation in age group 0PPI , being non significant, were not estimated in female goats.

Perusal of results revealed that heart girth (HG) has been selected across four age groups in female (1PPI, 2PPI, 3PPI and 4PPI), five age groups in male (0PPI, 1PPI, 2PPI, 3PPI and 4PPI) and pooled overall age groups in both sexes as the first regressor because of its high contribution in terms of R^2 values. The regression equation for pooled overall age groups was estimated as **Y= (- 28.20) + 0.74 X** ; (where X stands for HG), with **R^2** value of **0.68** for female and **Y= (-39.12) + 0.88 X** ; (where X stands for HG), with **R^2** value of **0.78** for male goat in the present study. This finding showed that an increase of one cm of HG resulted in an increase of 0.74 and 0.78 kg of live weight in female and male goats, respectively. The role of other body measuremerts in predicting live body weight differed in different age groups across the two sexes vis-à-vis their order in these equations. Thus it seems that body measurements other than HG may not possibly be used in general prediction equations. However the parameter estimates in multiple linear regression models showed that subsequent inclusions of other body measurements together with heart girth (First variable in all equatuions) kept the R^2 values improving although the change had a pattern of diminishing marginal rate. This suggested that body weight could be more accurately predicted by combinations of two or more measurements than heart girth alone.

Table 38:Live weight prediction equations at different age groups in female

Age group	Equation	β_0	β_1	β_2	β_3	β_4	β_5	β_6	R^2	R^2 change	MSE
1PPI	HG	-36.94	0.82						0.64	0.000	2.87
	HG+RH	-63.42	0.73	0.52					0.75	0.003	2.23
	HG+RH+PW	-52.9	0.58	0.38	0.74				0.84	0.004	1.67
2PPI	HG	-25.60	0.72						0.65	0.000	2.22
	HG+RH	-45.23	0.54	0.49					0.71	0.005	1.89
	HG+RH+PW	-38.21	0.47	0.38	0.44				0.76	0.005	1.66
	HG+RH+PW+CW	-38.11	0.43	0.34	0.39	0.41			0.83	0.007	1.53
3PPI	HG	-20.02	0.66						0.28	0.000	2.56
	HG+BC	-18.80	0.62	0.57					0.44	0.006	2.13
	HG+BC+PW	-22.13	0.55	0.43	0.63				0.59	0.01	1.55
	HG+BC+PW+HW	-57.72	0.44	0.36	0.53	0.67			0.68	0.001	1.43
	HG+BC+PW+HtW+BL	-38.66	0.34	0.33	0.43	0.24	0.32		0.81	0.006	1.16
4PPI	HG	-28.33	0.78						0.74	0.000	3.18
	HG+BC	-25.73	0.72	0.68					0.81	0.001	2.24
0-4PPI	HG	-28.20	0.74						0.68	000	3.51
	HG+PW	-23.80	0.44	1.34					0.75	0.07	2.62
	HG+PW+BC	-16.39	0.34	1.19	0.53				0.78	0.001	2.48
	HG+PW+BC+RH	-55.22	0.32	0.98	0.46	0.67			0.84	0.001	2.22
	HG+PW+BC+RH+HtW	-76.44	0.30	0.96	0.39	0.57	0.46		0.88	0.001	2.13
	HG+PW+BC+RH+HtW+RL	-70.59	0.26	0.89	0.32	0.54	0.43	0.16	0.94	0.005	1.60

BL= Body length; HG = Heart Girth; CW = Chest width HW = Height Wither; PW = Pelvic Width; RH= Rump height, RL=Rump length; EL= ear length, BC = Body Condition Score; 0PPI = 0 Pair of Permanent Incisors, 1PPI =1 Pair of Permanent Incisors; 2 PPI = 2Pairs of Permanent Incisors; 3PPI = 3 Pairs of Permanent Incisors; 4PPI = 4 Pairs of Permanent Incisors.

Table 39: Live weight prediction equations at different age groups in male goat

Age group	Equation	β_0	β_1	β_2	β_3	β_4	β_5	β_6	R^2	R^2 change	MSE
0PPI	HG	-28.1	0.68						0.50	0.000	2.66
	HG+PW	-29.55	0.61	0.57					0.68	0.005	1.93
	HG+PW+HtW	-30.9	0.48	0.32	0.21				0.77	0.003	1.45
1PPI	HG	-6.02	0.38						0.66	0.000	2.11
	HG+RL	-5.60	0.34	0.42					0.69	0.002	1.56
2PPI	HG	-10.33	0.50						0.69	0.000	2.68
	HG+BC	-9.70	0.46	0.85					0.73	0.001	2.42
	HG+BC+PW	-9.81	0.37	0.71	0.54				0.78	0.001	2.02
	HG+BC+PW+BL	-37.51	0.33	0.63	0.46	0.52			0.80	0.002	1.85
3PPI	HG	-19.20	0.64						0.62	0.000	2.33
	HG+RH	-48.86	0.51	0.55					0.71	0.001	1.89
	HG+RH+HtW	-68.82	0.46	0.53	0.35				0.78	0.003	1.64
	HG+RH+HtW+PW	-58.02	0.42	0.44	0.28	0.26			0.88	0.004	2.14
	HG+RH+HtW+PW+BL	-55.45	0.41	0.32	0.24	0.23	0.16		0.93	0.005	2.44
4PPI	HG	-17.14	0. 64						0.77	0.000	1.65
	HG+PW	-12.84	0.54	0.26					0.86	0.001	1.44
0-4PPI	HG	-39.12	0.88						0.78	0.000	2.44
	HG+BC	-17.48	0.55	0.92					0.80	0.001	2.34
	HG+ BC + PW	-15.28	0.36	0.70	0.97				0.83	0.002	1.66
	HG+ BC + PW +RL	-35.20	0.34	0.67	0.74	0.44			0.94	0.002	1.33
	HG+ BC + PW +RL+HtW	-30.13	0.32	0.53	0.62	0.38	0.26		0.96	0.004	1.24
	HG+ BC + PW +RL+HtW+BL	-33.21	0.26	0.43	0.52	0.23	0.21	0.25	0.97	0.007	1.12

BL= Body length; HG = Heart Girth; CW = Chest width HW = Height at Wither; PW = Pelvic Width; RH= Rump height, RL=Rump length; BC = Body Condition Score; 0PPI = 0 Pair of Permanent Incisors, 1PPI =1 Pair of Permanent Incisors; 2 PPI = 2Pairs of Permanent Incisors; 3PPI = 3; Pairs of Permanent Incisors; 4PPI = 4 Pairs of Permanent Incisors.

The earlier reports have also shown improvement in R^2 values with subsequent addition of more linear measurements (Gul *et al.*, 2005; Fikrte, 2008; Zewdu, 2008). Nevertheless, measurement of traits also has cost implications and it will be impractical to consider many traits under farmers conditions. Under such conditions, the most practical prediction accuracy may be obtained through the use of heart girth alone.

4.7.5 Principal components analysis

Principal components analysis, a multivariate technique, for examining relationships among eleven quantitative variables of Woyto-Guji female and male goats in three agro ecologies were extracted. These principal components are orthogonal to each other and explored in a better way the interdependence in the original eleven quantitative traits. Based on their associated eigenvalue of eleven variables of correlation matrix the Principal component one and Principal component two were selected in both sexes (**Table 40**). This reduces the variables numbers from 11 to 7 and these were quite satisfactory for the analysis. This result comparable with earlier study showed that the variables numbers reduced from 46 to 26 in Northwestern goat types (Sneath and Sokal, 1973, Pimental, 1979; cited *Getinet, 2005*).

The eigen vectors on principal component one and two of female and male goat are presented in **table 41**. Perusal of table showed relative importance of the Principal Components (PC) from their eigen values and their contribution in explaining the overall variance. The eigen vector or loading value identifies how each measurement variable influenced its corresponding PC by display on the screen plot profile (**Figures 6 and 7**). The graph indicated, PC 1 had highest variance and PC 2 was the next highest variance in the data for both sexes.

In the present study, PCA Axis1 or PC1 appeared to have large loading on the HG, HtW RHt, BWT, BL and PW variables and PC2 was most strongly influenced by BCS in female. Thus, PC1, which accounted for 58.38% of the variability, appeared to be strongly associated with these six variables. In male goat, PC1 appeared to have large loading on the HG, HtW, RHt, BWT, PW and HL whereas PC2 has large loading on the EL variables. The cumulative eigenvalues of PC1 and PC2, which represent sum of the proportion varience in the original variables, increased from 0.58 (PC1) to 0.67 (PC1 + PC2) for female and from 0.70 (PC1) to 0.78 (PC1 + PC2) for male goat.

Table 40:Eigenvalues for the first two highest principal components of the Loma female and male goat breeds

Factors		Eigenvalue	Difference	Proportion	Cumulative
Female	Prin1	7.00551756	5.9582916	0.5838	0.5838
	Prin2	1.04722588	0.20756878	0.0873	0.6711
Male	Prin1	8.4611	7.4558	0.7051	0.7051
	Prin2	1.0053	0.2505	0.0759	0.7810

Table 41:Eigenvectors on principal component one and two of female and male goat

Variable	Female		Male	
	Prin1	Prin2	Prin1	Prin2
BCS	0.221157	-0.287833	0.2619	0.0856
BWT	0.325671	-0.047251	0.3136	0.0696
EL	0.231817	0.005776	0.2492	-0.3848
HL	0.304478	- 0.02103	0.3006	-0.2962
BL	0.322359	- 0.028239	0.2931	-0.1055
HG	0.345607	0.114346	0.3260	-0.0676
HtW	0.345494	0.160099	0.3212	-0.1131
CW	0.273616	-0.012569	0.2893	0.1381
PW	0.321356	0.002335	0.3054	0.1229
RHt	0.337949	0.166199	0.3185	-0.1056
RL	0.251859	0.181215	0.2720	0.1478

BL= Body length; HG = Heart Girth; CW = Chest width HtW = Height at Wither; PW = Pelvic Width; RH= Rump height, RL= Rump length; EL= ear length, BCond = Body Condition Score, BWT=Body weight, HL=horn length

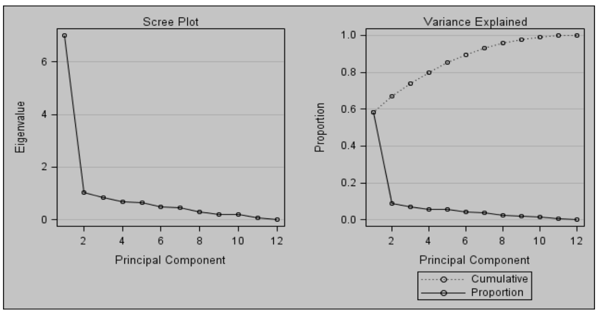

Figure 4: Screen plot of eigenvalue to component number for female goats

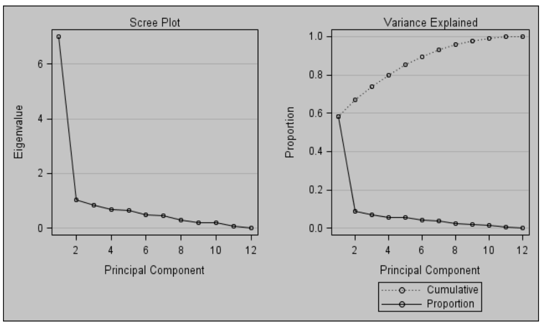

Figure 7: Screen plot of eigenvalue to component number for male goats

4.7.6 Cluster analysis

The results of **cluster analysis** using Unweighted Pair-Group Method (UPGM) (**Figures 4 and 5**) revealed existence of three different clusters for goat population (lowland, midland and highland goat population) in both sexes but the length of the branch in the dendogram formed was to some extent different for the two sexes was the difference may be attributed to differences in sample size and other sex-linked characters such as body weight, heart girth, height at wither, rump height and pelvic width. The dendrogram tree constructed for females and males seems to represent the true difference among agro ecology on sample populations because on the formation of clusters go with the geographical proximity of the populations. The dendrograms of average linkage distance between production site of female and male goat breeds for quantitative traits studied showed that the lowland and midland agro ecologies have relatively similar goat population of the two sexes whereas highland goat had more pronounced difference on the traits studied. The similarity between lowland and midland goat population were indicated that there is higher gene flow between the two agro ecologies whereas lowland to highland and midland to highland were low gene flow among production site. The clusters derived from linear measurements and live body weights data further showed that the gene flow were linked to an important productive or adaptive trait

The FGD and goat owners in the study area believed that the best animal in low land agro ecology was not necessarily the best in highland agro ecology. Accordingly the lowland community was not purchasing goats and other animals from highland agro ecology for production purpose and vice versa was true for highland agro ecology. The farmers, on the basis of their habitation have developed practical knowledge about agro ecological zone, revealed that production site have comparative advantages within genotypes. Similar finding showed that the performance data into characterization studies to understand which genotypes have comparative advantages within an agro-ecological zone in indigenous goat population of Ethiopia (Halima et al., 2012) and on farm phenotypic characterization of cattle genetic resource in south and north Wollo Zone (Dereje et al., 2008). Earlier study showed that the phenotypic similarity reveals the functional or adaptation similarity of types (Sneath and Sokal, 1973). Differences may be due to the different evolution paths of goats adapted to different ecology along with human interference in selection for breeding (Getinet, 2005).

Dendrogram of linear and BWT measurement in different agro ecologies by average Linkage cluster

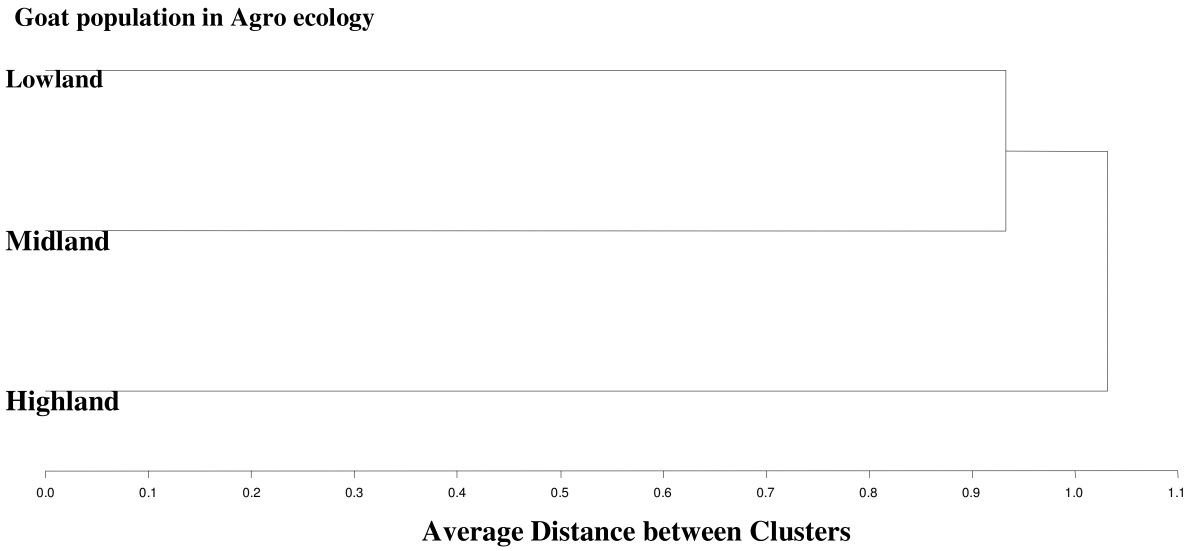

Figure 5:Dendogram based on average linkage distance between Agro ecology using body measurements (female goat)

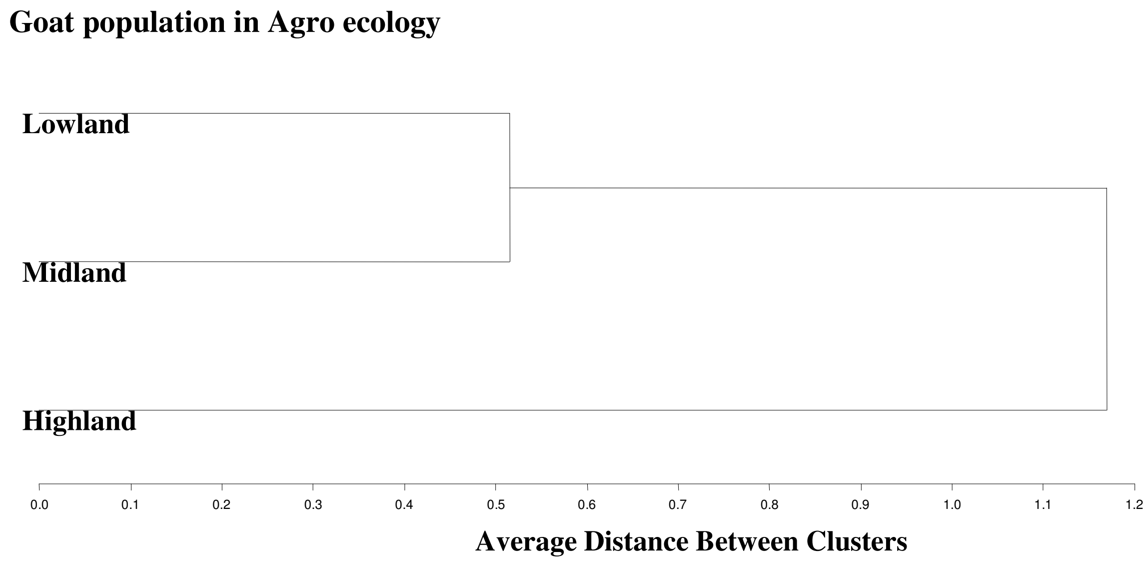

Figure 6: Dendogram based on average linkage distance between Agro ecology using body measurements (Male goat)

5. SUMMARY AND CONCLUSIONS

5.1 Summary

Community based characterization of *Woyto-Guji* goat in Loma district was aimed to describe and document existing genetic resources of the breeds based on the knowledge, concept, priorities of the local communities and to characterize the breeds in its native environment. The study has been conducted in three agro ecology using participatory approach to assess socio-economic / socio-cultural portfolio of the breeding community, describe goat production system / traditional breeding system / general husbandry practice, identify local trait preference and breeding objectives of the community, and description of breeds in terms of external characteristics and reproductive traits.

The *Loma* community maintains a perception of special association with the *Woyto-Guji* goat type claiming a historic role in its development and adaptation. There are local myths about origin of the breed which were associated with the community ethno-history. The community have local concepts which were employed to differentiate and mechanism of keeping genealogy of every animal and employ range of methods to classify the flock as well as to identify individual animals. They have the Knowledge and traditional systems in managing the gene pool and in responding to environmental rigors such as diseases, parasite and drought. The community generally practices selective pure breeding where by the own flock, flocks in the neighborhood as well as flocks of distantly located community members (relatives) were the units of selection.

The goats owned per household were higher than cattle and sheep. Natural pasture was the main feed resources for their goats in all agro ecologies. The households owning a large flock had separate housing unit for goats whereas households with small flock size shared their living house with goat. The major production constraints were diseases and external parasites, predators, feed shortage and lack of goat keeper or labor. The study further showed that PPR, external parasite, CCPP, Pasteurellosis, Mange and Anthrax were highly prevalent diseases, in descending order, in the study area.

Body conformation, adaptation traits, twining ability, coat colors and lamb survival were ranked first, second, third, fourth and fifth preference of female goat whearas body conformation, adaptation and coat color factors were mentioned as high status reasons for choice trait of male goats with ranking first, second and third. The major goat production objectives as perceived by households were socio-economic (cash, asset, security) and production or yield attribute (meat) and were ranked first and second traits preferred by farmers.

The effective population size was higher in lowland than the other two agro-ecologies due to high number of goat ownership per household. The rate of inbreeding was higher in midland and highland than in lowland because of the smaller population size. The overall rate of inbreeding, estimated in the present study under individual flocks (Not mixed) was 0.073 whereas the estimate under mixed flock grazing was 0.024.

The goat population in the study area was characterized by higher proportion of plain coat patterns with brown coat color, straight head profile, semi pendulous ear formation and long ear type. The horns were characterized by backward orientation with a straight shape. Besides the studied population of goat showed presence of beard and ruff but absence of wattle.absent.

The overall mean of AFS, AFK, KI and litter size were 8.5 ± 1.89 months, 13.5 ± 2.72 months, 7.48 ± 1.69 months and 2.11 ± 1.07 in the present study, respectively. All the body measurements in male goats were consistently higher than females for all variables. The effect of age was highly significant ($P < 0.001$) on body weight and all other body measurements. The effect of agro ecologies was either highly significant ($P < 0.001$) or significant ($P < 0.005$) for all traits, studied, except ear length and scrotal circumference. The interaction between sex and age groups was either highly significant ($P < 0.001$) or significant ($P < 0.005$) on body weight and all body measurements except scrotal circumference which was not studied. The interaction between agro ecologies and age groups was either highly significant ($P < 0.001$) or significant ($P < 0.005$) on body weight and all body measurements except horn length and scrotal circumference.

The present study showed that all body measurements were positively correlated with the body weight in both sexes. The magnitude of correlation coefficients differed for each combination and majority of these estimates were either significant ($P < 0.05$) or highly significant ($P < 0.01$) in both sexes. However eight out of a total of 50 and nine out of a total of 55 correlation coefficients in female and male, respectively, were found to be statistically non significant. The high correlation between body weight and heart girth, observed in majority of age groups, in present study suggested that heart girth may be used to obtain more reliable prediction estimate of body weight for the population.

The results revealed that heart girth (HG) has been selected across four age groups in female (1PPI, 2PPI, 3PPI and 4PPI), five age groups in male (0PPI, 1PPI, 2PPI, 3PPI and 4PPI) and pooled overall age groups in both sexes as the first regressor because of its high contribution in terms of R^2 values. The regression equation for pooled overall age groups was estimated as **Y= (- 28.20) + 0.74 X** with R^2 value of **0.68** for female and **Y= (-39.12) + 0.88 X** with R^2 value of **0.88** for male goat in the present study. This finding showed that an increase of one cm of HG resulted in an increase of 0.74 and 0.88 kg of live weight in female and male goats, respectively.

The present study showed that PCA Axis1 or PC1 appeared to have large loading on the HG, HtW and RHt variables in both sexes. PC2 were most strongly influenced by BCS in female whereas large loading on the EL variables in male goat. The cumulative eigenvalues of PC1 and PC2, which represent sum of the proportion varience in the original variables, increased from 0.58 (PC1) to 0.67 (PC1 + PC2) for female and from 0.70 (PC1) to 0.78 (PC1 + PC2) for male goat.

The dendrograms of average linkage distance between production site of female and male goat breeds for quantitative traits studied showed that lowland and midland agro ecologies have relatively similar but lower influence on goat breed of the two sexes whereas highland agro ecology had more pronounced influence on the traits studied.

5.2 Recommendations

I. A comprehensive scheme for productivity (milk yield and meat quality) and genetic characterization of Woyto-Guji goats in its natural habitat and on station needs to be initiated to validate the present findings of phenotypic variation.

II. The community based genetic improvement strategy, based on ranking of goat breeding objectives and selection criteria by farmers, should be given consideration while planning schemes for conservation, genetic improvement and sustainable utilization of Woyto-Guji goats

III. Community needs to be educated about benefits of controlled breeding, using selected bucks based on community' trait preference, and proper selection of male and female breeding animals;

IV. A comprehensive conservation and improvement scheme encompassing all aspects of goat production system (community based genetic improvement, qualitative / quantitative improvement of grazing lands, health cover to reduce disease occurrence, marketing facilities etc) needs to be initiated to stop declining population trend and also improving productivity potential of Woyto-Guji goats so that these are functionally viable and competitive.

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7. APPENDICES

7.1 APPENDICES A: Tables

Appendix 1:Characterization and Body Measurements of Goats

Goat body measurement and physical description format

Zone _________ District________Agro ecology________ kebels __________ HH Name ______________

Id No	Flock No	Sex	Castration	Source	BWT	BC	Coat color		Head profile	wattle	ruff	Bear	Age	dentation	Ear			Horn			BL	HG	HtW	CW	PW	RHt	RL	SC
							Pattern	type							Formation	Type	length	orientation	Shape	length								
1																												
2																												
3																												
4																												
5																												
Note:																												

1. Source of animal:
   1 = Born 2 = Purchased 3 = Ribi 4 = Gift 5 = Inherited
2. Dentition classes:
   - ➔ 0PPI = with milk teeth
   - ➔ 1PPI = with erupted and growing 1st pair of permanent incisors
   - ➔ 2PPI = with erupted ad growing 2st pair of permanent incisors
   - ➔ 3PPI = with erupted ad growing 3st pair of permanent incisors
   - ➔ 4PPI = with erupted ad growing 4st pair of permanent incisors
3. Coat color pattern: 1= plain 2= Patchy 3= Spotted
4. Coat color type:
   1 = White, 2= Brown, 3 = Black, 4= Grey, 5 =Creamy white
5. Head profile: 1 = Straight 2 = slightly convex 3=concave
6. . Horn: 1= Present 2= Absent 3= Rudimentary
7. Ear Type: 1= Semi-pendulous 2 = Horizontal
8. Ear formation; 1= Rudimentary 2= Short ear 3= long ear
9. Wattle: 1= Present 2= Absent
10. Ruff: 1= Present 2= Absent
11. Bears 1= Present 2=Absent
12. Sex 1. Male, 2. Female
13. Body condition: 1 = Very thin 2 = Thin 3 = Average 4 = Fat 5= Obese
14. Horn Shape: 1=straight, 2=polled, 3=spiral

15 Horn Oreintation: 1= Rudimentary, 2= Front, 3= backward, 4=lateral

Appendix 2:Description of body condition score

Score	Description	Spinous process	Rib cage	Loin eye
1	**Very thin**	Easy to see and feel, sharp	Easy to feel and can feel under	No fat covering
2	**Thin**	Easy to feel, but smooth	Smooth, slightly rounded, need to use slight pressure	Smooth, even fat Cover
3	**Good Condition**	Smooth and rounded	Smooth, even feel	Smooth, even fat cover
4	**Fat**	Can feel with firm pressure, no points can be felt	Individual ribs cannot be felt, but can still feel indent between ribs	Thick fat
5	**Obese**	Smooth, no individual vertebra can be felt	Individual ribs cannot be felt. No separation of ribs felt	Thick fat covering, may be lumpy and "jiggly"

Appendix 3:Local classifications and terminology of flock classes

Local Terminology	Classification Basis	Class Descriptions
Mara	Age	Kid goats (both sexes) below6 months of age
Ayiy	Age	Old goats in both sex
Mirgiyo	Sex and sexual Stage	Young female before reaching sexual maturity
Uziya	Sex and sexual Stage	Breeding doe
Orgiya	Sex and sexual Stage	Breeding buck
Korbiya	Sex	Intact male
Sanga	Sex	Castrate
Daamiriya	Coat color type	Brown
Bootaliya	Coat color type	White
Daalacha	Coat color type	Grey
Anqara	Body size	Large body size
Gashiya	Body size	Small body size

Appendix 4:Local names and scientific equivalents of reported major diseases in the study area

Scientific Name	Local names
CCPP	**Magaynow**
PPR	**Bazo harge, Deysh Banchuw**
SGP	**Deysha Ajajiya**
Pasteurellosis	**Gussuwa, deysha mada**
External parasite	**Boxiya, woynaniya**
Mange	**Banchuwa**
Anthrax	**Deysh**

Appendix 5:Number of breeding males and females in the respondents goat flock

Agro ecologies	Mixed goat population during grazing in community grazing lands						Individual flocks (Not mixed)					
	Nm			*Nf*			*Nm*			*Nf*		
	N	*n*	*Mean ±SD*	*N*	*n*	*Mean ±SD*	*N*	*n*	*Mean ±SD*	*N*	*n*	*Mean ±SD*
Lowland	*65*	*429*	*6.6±1.8*	*65*	*1800*	*27.7±3.22*	*25*	*55*	*2.2±1.32*	*25*	*332*	*13.3±3.23*
Midland	*52*	*166*	*3.2±1.2*	*52*	*967*	*18.6±2.45*	*18*	*29*	*1.6±1.11*	*18*	*131*	*7.3±2.88*
High-land	*55*	*231*	*4.2±1.4*	*55*	*1161*	*21.1±2.88*	*15*	*29*	*1.9±1.13*	*15*	*189*	*12.6±4.3*
Overall	*172*	*826*	*6.70±1.6*	*172*	*3928*	*22.6±2.96*	*58*	*113*	*2.0±1.22*	*58*	*652*	*11.6±3.2*

N=numbers of respondents, n=numbers of goats, Nm=numbers of breeding male, Nf=numbers of breeding female, SD= standard deviation

Appendix 6:Ranking of goat sold by farmers in different agro ecologies (%)

Class of goat sold	Lowland					Midland					Highland					Overall				
	R1	R2	R3	R4	I	R1	R2	R3	R4	I	R1	R2	R3	R4	I	R1	R2	R3	R4	I
Breeding doe and buck	15.3	40	33.3	27.7	0.27	21.4	37.1	35.7	27.1	0.29	8.5	61.4	40.1	37.1	0.34	15.0	46.1	36.4	30.6	0.30
Castrated	73.6	27.7	15.5	23.3	0.43	74.3	40.1	37.1	31.5	0.52	85.7	25.7	18.6	25.8	0.48	77.8	31.2	23.7	26.8	0.48
Old age	2.3	13.3	27.7	32.2	0.14	4.3	22.8	27.1	41.4	0.19	5.7	13	41.3	37.1	0.18	4.1	16.4	32.0	37	0.16
Kid less than 6 month	8.7	19.0	23.3	16.6	0.16	-	-	-	-	-	-	-				3.0	6.3	7.8	5.5	0.06

Index = sum of [4 for rank 1 + 3 for rank 2 + 2 for rank 3 + 1 for rank 4] for particular trait divided by sum of [4 for rank 1 + 3 for rank 2 + 2 for rank 3 + 1 for rank 4] for all traits in an agro ecology; R1, R2, R3 and R4 = Rank 1 to rank

Appendix 7:Ranking of kidding month in a year in different agro ecologies (%)

Kidding time / month	Lowland					Midland					Highland					Overall				
	R1	R2	R3	R4	I	R1	R2	R3	R4	I	R1	R2	R3	R4	I	R1	R2	R3	R4	I
September, October , November	21.1	33.3	16.6	15.5	0.23	30	28.6	31.4	35.7	0.30	37.1	28.6	20.2	31.4	0.32	29.4	30.1	22.7	27.5	0.28
December, January, February	34.4	37.7	27.7	27.7	0.34	18.7	31.4	11.3	18.7	0.21	14.3	27.1	18.5	28.6	0.20	22.4	32.1	19.1	25	0.25
March, April, May	42.2	13.3	38.8	26.8	0.31	40	35.7	37.1	27.1	0.37	37.1	31.4	34.2	11.3	0.32	39.7	26.8	36.7	21.7	0.33
June, Jullay, Augest	2.3	15.7	16.9	30	0.12	11.3	4.3	20.2	18.5	0.12	11.5	12.9	27.1	28.6	0.16	8.4	10.9	21.4	25.7	0.14

Index = sum of [4 for rank 1 + 3 for rank 2 + 2 for rank 3 + 1 for rank 4] for particular trait divided by sum of [4 for rank 1 + 3 for rank 2 + 2 for rank 3 + 1 for rank 4] for all traits in an agro ecology; R1, R2, R3 and R4 = Rank 1 to rank 4.

Appendix 8:ANOVA for reproductive performance

Parameters	ANOVA					
	Source of variance	**DF**	**T SS**	**Mean Square**	**F Value**	**Pr > F**
Age at first service (AFS) of male	Between Agro ecologies	2	118.3	59.14	6.09	0.003
	Within agro ecologies	227	2202.5	9.70		
Age at first service (AFS) of female	Between Agro ecologies	2	220.7	110.35	15.32	0.001
	Within agro ecologies	227	1634.6	7.20		
Age at first kidding (AFK)	Between Agro ecologies	2	63.788	31.89	4.43	0.001
	Within agro ecologies	227	1633.70	7.197		
Average reproductive life span of doe	Between Agro ecologies	2	38.38	19.193	2.74	0.066
	Within agro ecologies	227	1587.4	6.99		
Life span kid crop	Between Agro ecologies	2	492.9	246.458	6.003	0.003
	Within agro ecologies	227	9319.25	41.05		
Kidding interval (KI)	Between Agro ecologies	2	6.43	3.216	1.12	0.329
	Within agro ecologies	227	652.99	2.877		
Litter size	Between Agro ecologies	2	9.41	4.706	9.567	0.001
	Within agro ecologies	227	111.67	0.492		

Appendix 9:Least Square ANOVA for Quantitative Traits

Source	DF	Type III SS	Mean Square	F Value	Pr > F
(1) Body Weight:					
Agro ecologies	2	34.52	17.26	1.89	0.0015
Sex	1	610.05	610.05	66.81	< 0.0001
Age	4	26469.73	6617.43	724.74	< 0.0001
Sex*age	4	433.38	108.34	11.87	<0.0001
Agro*age	8	197.86	24.73	2.71	0.00060
Error	790	7213.34	9.13		
(2) Body Length:					
Agro ecologies	2	1366.99	683.49	30.48	< 0.0001
Sex	1	2190.23	2190.23	97.68	< 0.0001
Age	4	11757.33	2939.33	131.09	< 0.0001
Sex*age	4	269.92	67.48	3.01	0.0176
Agro*age	8	615.89	76.98	3.43	0.0007
Error	790	17713.14	22.42		
(3) Heart Girth:					
Agro ecologies	2	1063.77	531.88	27.83	< 0.0001
Sex	1	2430.29	2430.29	127.14	< 0.0001
Age	4	18669.14	4667.28	244.17	< 0.0001
Sex*age	4	456.333	114.08	5.97	< 0.0001
Agro*age	8	1640.87	205.10	10.73	< 0.0001
Error	790	15101.03	19.11		
(4) Height at Wither:					
Agro ecologies	2	110.55	551.77	34.29	< 0.0001
Sex	1	2106.11	2106.11	130.89	< 0.0001
Age	4	12406.58	3101.64	192.76	< 0.0001
Sex*age	4	174.75	43.68	2.71	0.00289
Agro*age	8	950.09	118.76	7.38	< 0.0001
Error	790	12711.54	16.09		
(5) Chest Width:					
Agro ecologies	2	202.20	101.10	35.42	< 0.0001
Sex	1	46.68	46.68	16.36	< 0.0001
Age	4	1351.41	337.85	118.37	< 0.0001
Sex*age	4	82.00	20.50	7.18	<0.0001
Agro*age	8	119.24	14.90	5.22	< 0.0001
Error	790	2254	2.85		
(6) Body Condition Scores:					
Agro ecologies	2	1.279	0.639	3.15	0.0435
Sex	1	9.908	9.908	48.78	< 0.0001
Age	4	173.52	43.381	213.43	< 0.0001
Sex*age	4	31.974	7.993	39.33	<0.0001
Agro*age	8	2.052	0.256	1.26	0.0260
Error	790	160.57	0.20		

Appendix 9: (Continued)

Source	DF	Type III SS	Mean Square	F Value	Pr > F
(7) Pelvic Width:					
Agro ecologies	2	40.69	20.34	9.49	< 0.0001
Sex	1	36.93	36.93	17.23	< 0.0001
Age	4	1744	436.03	203.45	< 0.0001
Sex*age	4	38.03	9.50	4.44	0.0015
Agro*age	8	74.93	9.36	4.37	< 0.0001
Error	790	1693.13	2.14		
(8) Rumph Height:					
Agro ecologies	2	1378.177	689.088	44.26	< 0.0001
Sex	1	1974.833	1974.833	126.85	< 0.0001
Age	4	11337.58	2834.39	182.06	< 0.0001
Sex*age	4	286.475	71.62	4.60	<0.0011
Agro*age	8	705.12	88.14	5.66	< 0.0001
Error	790	12299.04	15.56		
(9) Rump Length:					
Agro ecologies	2	156.40	78.20	23.95	< 0.0001
Sex	1	50.43	50.43	15.45	< 0.0001
Age	4	1491.45	372.86	114.19	< 0.0001
Sex*age	4	145.97	36.49	11.18	<0.0001
Agro*age	8	271.08	33.88	10.38	< 0.0001
Error	790	2579.47	3.26		
(10) Ear Length					
Agro ecologies	2	2.777	1.388	0.97	0.3801
Sex	1	22.90	22.90	15.98	< 0.0001
Age	4	358.83	89.70	62.56	< 0.0001
Sex*age	4	21.54	5.38	3.76	0.0049
Agro*age	8	28.49	3.56	2.48	0.0115
Error	790	1132.86	1.43		
(11) Horn Length					
Agro ecologies	2	212.26	106.13	21.15	< 0.0001
Sex	1	422.80	422.80	84.24	< 0.0001
Age	4	3404.96	851.24	169.61	< 0.0001
Sex*age	4	48.85	12.21	2.43	0.0460
Agro*age	8	62.86	7.85	1.57	0.1313
Error	790	3964.91	5.01		
(12) Scrotal Circumference:					
Agro ecologies	2	36.10	18.05	2.35	0.0980
Age	4	424.60	106.15	13.81	< 0.0001
Agro*age	8	89.40	11.17	1.45	0.1759
Error	205	1575.31	7.68		

7.2. Appendices B: **The Questionnaire**

1. Interviewee (Farmer Name)……………Kebele………..……. Agro ecology. …………………..

I. Socio-economic characteristics of Households

1.1. Age of the head (yrs) 1. <20 2.21–40 3. 41–60 4.> 61

1.2. Sex of the head 1. Male 2. Female

1.3. Marital status 1. Marrie 2. Divorced 3. Widow ed 4. Unmarried.

1.4. Education level 1. Illiterate 2. Writing and reading (not attended formal education)

3. Primary (1-8) 4. Secondary (9-10+2) 5. Other

1.5. Religion 1. Muslim 2. Orthodox 3. Protestant 4. Any other

1.6. Family size (number):

Sex	Age group					Total
	<7	7-15	16-30	31-60	>61	
Female						
Male						
total						

1.7. Land use pattern (in ha = Local unit) Own Rented Total

11.1. Crops _________ _____________ ________

11.2. Fallow land _________ _____________ ________

11.3. Grazing _________ _____________ ________

11.4. Others (specify) ____

1.8 List major sources of your HH cash income? (Rank in order of importance)

Source of income	Ranking

II. Production system

2.1 Flock characteristics

2.1.1 please tell us the livestock number by species owned/ HH, importance & Trend in the last 10yr

Livestock	Number per HH	Rank	Trend (1=Increase, 2=Decrease, 3=Stable)	Reason for any(1,2and 3)
Goats				
Cattle				
Sheep				
Camel				
Chicken				
Donkey				
Mule				
Horse				
Bee hive				

2.1.2. Please tell us the goat floack stracture at different age

No	Age group (month)	Sex		Total
		M	F	
1	< 6			
2	6-12			
3	> 12(intact male)			
4	Castrated			
5	Total			

2.1.3. Acquisition (possession) modes of goats for HH

No	**Acquisition mode**	**Male**	**Female**
1	Own farm born		
2	Purchase		
3	Lone		
4	Gift		
5	Exchanged		
6	Others (mention)		

2.1.4. Disposal mode (Loss of Animals from the flock) of goats

No	**Disposal mode**	**Male**	**Female**
1	Sold		
2	Slaughtered		
3	Exchanged		
4	Donated/gift		
5	Died		
6	Predator		
7	Lost		

2.1.5. What is your major farming activity? *(Tick one)*

1. Livestock production   2. Crop production   3. Both

3. Husbandary practice

3.1. Feeding, grazing and watering

3.1.1. Do you intend to expand your Goat flock? 1. Yes 2. No
3.1.2. If not, reason ___________________________________
3.1.3. If yes, reason ___________________________________
3.1.4. Members of household who own Goat *(circle one or more)*
1. Head 2. Spouse 3. Head/spouse together 4. Sons
5. Daughters 6. The whole family 7. Others (specify)_____________

3.1.5. Grazing land ownership 1. Communal 2. Private 3. Both private & communal
3.1.6. Which grazing land contributes more to provide feed 1. Communal 2. Private
3.1.7. Trend in private grazing areas*?* 1. Decreasing 2. Increasing 3. Stable
3.1.8. Reason for any ____
3.1.9. Trend in communal grazing areas*?* 1. Decreasing 2. Increasing 3. Stable
3.1.10. Reason if any ____

3.2. Feed source

source	Wet season		Dry season	
	Mark(×)	Rank	Mark(×)	rank
1. Natural pasture				
2. Established pasture				
3. Hay				
4. Crop residues				
5. Fallow land				
6. Concentrate				
7. Others (Specify)				

3.3. Grazing method

Method	Wet season	Dry season
1. Free grazing		
2. Herded		
3. Paddock		
4. Tethered		
5. Zero-grazing		
6. Others (specify)		

3.3.1. Length of grazing time during wet season _______________ hrs/day

3.3.2. Length of grazing time during dry season ______________hrs/day

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

1. Male and female are separated 2. Kids are separated
3. All classes goat herded together 4. Others (specify) __________________

3.3.4. Goat flock is herded 1. Together with cattle 2.Together with sheep

3. Together with camel 4.Together with calves 5. Together with equines
6. All herded together 7. Goat herded separately

3.3.5. Way of herding

1. Goat of a household run as a flock
2. Goat of more than one household run as a flock
3. Others (specify) ___________________

3.3.6. Do breeding male & female goats herded separately in day time? 1. Yes 2. No

3.3.7. Do you practice supplementation 1. Yes 2. No

3.3.8. If yes, season of supplementation 1. Dry 2. Wet 3. Both

3.3.9. What kind of supplementation do you offer? 1. Salt 2. Chinki

3. Grain supplementation 4. Kitchen left over 5. Other (specify)

3.3.10. Ways of supplementations 1. At its natural source 2. Supplied as mix 3.other …….

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

3.3.12. If yes, which categories of goat do you fatten?

categories of animals	Mark	Rank
1. Culled young female		
2. Culled young male		
3. Young females		
4. Young males		
5. Castrates		
6. Older males		
7. Older female		

3.3.13. Can you tell us the type of feed resources you use to fatten goat?

1. Natural pasture 2. Concentrate 3. Crop residues 4. Others (specify)_________________

3.3.14. List the most important crop residues used during the:

Wet season	Dry season
1. _________________	__________________
2. _________________	__________________
3. _________________	__________________
4. _________________	__________________

3.3.15. Concentrates used for goat	Rank	Type
1. Homemade grain	……………….	…………………………….
2. Oil seed cakes	……………………	…………………………..
3. Local brewery by-products	……………………..	…………………………..
4. Flour by-products	……………………	………………………..

3.3.16. At which periods of the year do you commonly fatten goat?

Rank	Season(holiday)	Numbers of goat fattened/yr/HH	
		Minimum	Maximum
1st			
2nd			
3rd			
4th			

3.3.17. For how long do you fatten? --
3.3.18. Which months do you think there is a shortage of feed? ________________________
3.3.19. What is the reason for feed shortage in the area _____________________________
3.3.20. Responses to feed shortage in the area _____________________________________

3.4. Sources of water

Source	**Dry season**		**Wet season**	
	Mark(X)	**Rank**	**Mark(x)**	**Rank**
1. Borehole/water well				
2. Dam/pond				
3. River				
4. Spring				
5. Pipe water				

3.5. Frequency of watering for adult animals

Frequency	Wet season	Dry season
1. Freely available		
2. Once a day		
3. Once in 2 days		
4. Once in 3 days		
5. Others (specify)		

3.6. water quality

Quality	Wet season	Dry season
1. Clean		
2. Muddy		
3. Salty		
4. Smelly		

3.7. Housing

3.7.1. Housing/enclosure for adult goat (circle)

1. In family house   2. Separate house with roof
3.Veranda with roof   4. Kraal without roof
5. Yard without roof   6. Barn with no roof
7. Others (specify) ___________________

3.7.2. Type of housing materials Roof 1. Grass   2. Plastics
3. Corrugated Iron sheet   4. Others (specify) _________

3.7.3. Type of housing materials used for the floor 1. Concrete   2. Earth/mud
3 others (specify) _________________________

3.7.3. Do kids housed with adults? 1. Yes   2. No

3.7.4. If no; specify____

3.7.5**.** Are goats housed together with other animals? 1. Yes   2. No

3.7.6. If yes, describe ____

3.8. Health.

3.8.1. Mortality of goat in the last 12 months (number)

	Young <1yr	Adult>1yrs	total
Male			
Female			

3.8.1. Reasons for death

Reasons for death	Yes	Rank
1.Predators		
2.disease		
Accident		
Poisoning		
unknown		

3.8.2. List types of diseases which occur frequently and affect the productivity of Goat in the area and rank them based on importance at least five.

Type of disease	symptoms	Season of occurrence	Susceptible age group	Rank	Traditional treatment

3.8.3. Distance to nearest veterinary services

1. < 1km or (_________walking hrs)
2. 1–5 km or (_________walking hrs)
3. 6-10km or (_________walking hrs)
4. Other __________________________

85. Disease, parasite, heat, frost, drought tolerance of Goat compared with other species. *Rank across the Row based on tolerance*

Health	Goat	Sheep	Cattle	Camel	Poultry
Disease					
Internal parasite					
External parasite					
Heat					
Frost					
Drought					
Feed shortage					
Water shortage					
Adaptability					

4. Breeding

4.1. Socio-cultural context of goat breeding

4.1.1. Will you still keep goat flocks if you are given the access to high milk producing or early growing exotic goat breeds? 1. Yes 2. No

4.1.2. If yes Why? ___________________________________

____

4.1.3. If no, Why? ___________________________________

____

4.1.4. Where do you think is the origin of the goat?

____

4.1.5. Do you think this goat type is maintained only by your community? 1. Yes 2. No

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

____

____

4.1.7. Where do you get your initial goat flock? What does its composition look like?

Mode	Mark	Rank
Dowry (gift)		
Groom wealth		
Help from relatives		
Compensation (*kassa*)		
Other		

4.1.8. Which class of goat did you receive to initiate a goat keeping? 1. Kid 2. Doe 3. Buck 4. Doe and buck

4.1.9. Mention social events and occasions worth sacrificing goats? __________________________

____

____

4.2. Special attributes of the goat type

4.2.1. How do you describe level of resistance/tolerance of the goat to some stress?

Stress Factors	1.yes	2. No	Description	Rank(1-3)
a. Heat tolerance				
b. drought tolerance				
c. feed shortage				
d. water shortage				
e. Tolerance to parasites				
f. Resistance to disease				
g. walk ability				

4.2.1. Any other outstanding characteristics /special attributes/?

____

____

4.3. Breeding practices in the community *(Circle one/more Choices)*

4.3.1. Do you have local buck? 1. Yes 2. No

4.3.2. If yes, how many?--

4.3.3. For how many years on the average is the same breeding buck? Serving in your Flock? ……………………………………………………………

4.3.4. Is there any special management for breeding buck? 1. Yes 2. No

4.3.5. If yes, specify type of management_________________________________

____

4.3.6. Purpose of keeping buck? 1. Mating 2. Socio-cultural
3. For fattening 4. Others (specify) ____________________

4.3.7. Do you practice selection for breeding male? 1. Yes 2. No

4.3.8. Do you practice selection for breeding Female? 1. Yes 2. No

4.3.9. Age of selection for breeding male ………………………. months

4.3.10. Age of selection for breeding female …………………….. Months

4.3.11. Selection criteria for breeding buck?

Criteria	Mark	Rank(1-5)
1.Appearance/conformation		
2. Color		
3. Horns		
4. Character		
5. Growth		
6. Prolificacy (Multiple birth)		
7. Age		
8. Libido		
9. Drought/heat Tolerance		
10.Disease Tolerance		
11. Tolerance to Water stress		
12. Ability to walk long distance		
13. Pedgree		

4.3.12. Source of buck? 1. Born in the flock 2. Purchased, private
3. Purchased in partner 4. Rent

4.3.13. If you do not have breeding buck, how do you mate your does?

1. Neighboring buck 2. Unknown 3. Others (Specify) ___________

4.3.14. List top preferred colors

1. ___________________________
2. ___________________________
3. ___________________________

4.3.15. List Unwanted colours

1. _________________________ 2. ___________________________

4.3.16. Selection criteria for breeding does?

Criteria	Mark	Rank(1-5)
1.Appearance/conformation		
2. Color		
3. Mothering character		
4 Lamb survival		
5. Lamb growth		
6. Age at first sexual maturity		
7. kidding interval		
8.Longivity		
9. Twining ability		
10. Milk yield		
11. Drought/heat Tolerance		
12.Disease Tolerance		
13. Tolerance to Water stress		
14. Adaptation to Feed shortage		

4.3.17. Breeding/mating method 1. Controlled 2. Uncontrolled

4.3.18**.** If uncontrolled, what is the reason?

1. Goat graze together 2. Lack of awareness
3. Lack/insufficient number of buck 4. Others (specify) _____________________

4.3.19. Do you use family history to select breeding goats? 1. Yes 2. No

4.3.20. If controlled mating what are the ranges of methods?

1. Physical restraint 2. Culling undesirable male
3. Castration 4. (Others specify) ______________________________

4.3.21. Could you able to identify the sire of a kid? 1. Yes 2. No

4.3.22. If yes, specify the criteria used to identify _________________

4.3.23. Do you allow a male/buck to mate his?

	Yes	**No`**	**Reason**
Mother			
Daughter			
Sister			

4.3.24**.** Do you allow your male/buck to serve female/ doe other than yours? 1. Yes 2. No

4.3.25. If yes what is the reason ___________________ ___________________

4.3.26. Do you allow your does to be served by anyone else buck other than “Woyto” breed?

1. Yes 2. No

4.3.27. If yes, reason _____________________________

4.3.28. Do you exchange breeding buck with your relatives? 1. Yes 2. No

If yes, mention circumstances ___________________ ____________________________

4.4. Castration and culling

4.4.1. Do you castrate? 1. Yes 2. No

4.4.2. If yes, reasons for castration

1. Control breeding 2. Improve fattening 3. Better temperament
4. Better price 5. Others (specify)_________________________________

4.4.3. If no, give reason _____________________________, ________________________,

4.4.5. At what age do you castrate *(month/year)* ______________

4.4.6. Season of castration _______________

4.4.7. Do you give supplementary feed for castrated goat 1. Yes 2. No

4.4.8. If yes, type of supplementary feed

1. _______________ 2. ____________________ 3. _____________________

4.4.9. For how long do you supplement castrated goat? _____________________

4.4.10. Castration method 1. Modern 2. Traditional

4.4.11. Do you sell breeding goats, male and/or female? 1. Yes 2. No

4.4.12. If yes, why? 1. ____________ 2. ______________ 3. _____________________

4.4.13. Average culling age due to old age Male _____________

4.4.14. Average culling age due to old age Female _________ _______

4.4.15. What is the trend compared with other livestock

Livestock	Trend/increased=1/decreased=2/stable=3/	reasons
a. Compared with cattle		
b. Compared with sheep		
c. Compared with camel		
d. poultry		

5. PRODUCTION CHARACTERISTICS (Reproductive and survival traits)

5.1. Average age at sexual maturity. Male …………………….. Months

5.2. Average age at sexual maturity. Female……………………. Months

5.3. Average Age at 1st kidding; …………………………………month

5.4. Average reproductive lifetime of does (in years) ____________

5.5. Average number of kids per does life time _________________________

5.6. Can you tell us the average parturition interval of your does? _____________

5.7. What is the average reproductive lifetime for a buck? __________

5.8. How many parturitions occurred in your flock during the last 12 months? ______

a. How many were, Single birth……………………………………….
b. How many were, Twins_____...
c. How many were, Triplets ……………………………………

5.9. Did you face abortion problem in the flock? 1. Yes 2. No

5.10. How many abortion cases occurred in your flock over the last 12 months? _________

166. Lambing pattern, occurrence of most births(*Tick one/r more then rank top three)*

monthes	**mark**	***rank top three***
1. January		
2. February		
3. March		
4. April		
5. May		
6. June		
7. July		
8. August		
9. September		
10. October		
11. November		
12. December		

6. Livelihood significance

6.1. How is goat milk used?

Goat milk used	*Mark*	*rank*
1. Family consumption (raw)		
2. Family consumption (processed)		
3. Sales		
4. Others		

6.2. What are the ranges of products and functions you get from keeping goats?

Particulars	√	Rank(1-5)
1. Meat		
2. Milk		
3. Sale (cash income)		
4. Byproducts (skin)		
5. Traditional identity (way of life)		
6. Social status (sign of wealth & strength)		
7. Savings		
8. Collateral (for lone, dispute compensation etc)		
9. Dowry (gift)		
10. Manure		

6.3. Reasons for selling goat 1. Cash needed
2. Disposal/culling 3. Mitigation against drought loss

6.4. Which class of goat do you sell first in case of cash needed?

Goat class	Tick(√)	Rank
1. Male kids less than 6 months		
2. Female kids less than 6 months		
3. Buck kids between 6 months and one year		
4. Doe kids between 6 months and one year		
5. Breeding bucks		
6. Breeding does		
7.. Castrated		
8. Old does		

7. Goat Production constraints

7.1. What are the main constraints of goat production? Rank according to their significance

Constraint	Yes	Rank
1. Drought		
2. Feed shortage		
3. Water shortage		
4. Disease		
5. Lack of superior genotypes		
6. Market		
7. Predator		
8. Labor		
9. *Others* ____________		

8. Marketing of goats, their products and by-products

8.1. Where you sell your animals?

1. Farmers in the same village 2. Farmers in nearby village
3. Others small towns specify___________________________

8.2. Have you purchased goats in the last 12 months? 1= Yes 2= No

8.3. Why did you purchase goats?

1. Slaughter for festivals 2.slaughter for ceremonies/rituals
3.Breeding 4. Fattening 5=others

8.4. If yes, from where did you purchase?

1. Farmers in the same village 2. Farmers in nearby village
3. Other towns specify ______________________

8.5. How many goats have you sold and purchased in the past 12 months and how much?

SN	Class of Goats	Sold			Purchased		
		Number	When/month	Unit price	Number	When/month	Unit price
1	Doe						
2	Buck						
3	Male kid						
4	Female kid						
5	Castrate/fatten						
6	Total						

8.6. How you sales or purchases your animals?

1. Live weight basis 2. 'Eye ball' Estimation 3. Both

8.7. Do you face any problem in marketing of your animals? 1. Yes 2. No

8.8. If yes, what? 1. Tax burden

2. Unwanted broker disorder& high commission fees

3. Seasonality of market demand and prices

4. Lack of market road from my areas

5. Lack of market and price information 6. Others, specify____________

8.9. Do your family sales goat milk? 1. Yes 2. No

8.10. If yes, what is the price per local unit_______ birr

8.11. Do your family sales milk products from goats? 1. Yes 2. No

8.12. If yes, what is the price per local unit (approximated in kg?) butter _________ Birr

8.13. If not, market your products, why not?

1. Not produce at all 2. Produce but consume at home

3. Not fetches reasonable price 4. Don't have any market demand in my locality

5. Others, specify ______________

8.14. What do you do with the skin(s)? 1. Sales

2. Used for making household materials (seat, bed materials, containers)

3. Used for ride horse/mule seat 4. Others, specify _________________

8.15. If sold, how much was the average prices?

1. Sheepskins ________ Birr 2. Goat skins _________Total prices

8.16. Do you preserve/process skins at home immediately after flaying? 1. Yes 2. No

If yes, how? 1. Apply salts 2. Dry 3. Others, specify

8.17. After how many days (usually) you take the skins to the traders or collectors____days

7.3. Appendices C: The FGD Interview

Part 1. Socio-cultural underpinnings of breeding

1. Myth (local perception) about the origin of the goat type

……
………………………………………………………………………………………………..

2. Is the "Woyto" goat considered as cultural heritage by your community?

……
……
……………..

3. Special feature of the local goat breeds (by types)

……
……

4. Major loss of livestock specifically Goat in the past. Reason

……
……
……………………………………………

Part 2. Ecological and production context

1. Major farming activities

……
……

2. Local calendar systems

……
……

3. Seasonal availability of forage species & rank based on preferences of goat

……
…………………………………………………………………………………….

4. Describe the concentration and distribution of the goat in the area

……
……

5. Do you think the population is decreasing or increasing?

……
……………………………………………………………

6. What do you think are the possible reasons?

……………………., ……………………., …………………………………………………
…………………………………………………………………………………………….

7. Herding and breeding practices during wet and dry season

……
……
…………………………………………………………

Part 3. Breeding objectives and trait preferences

1. Describe range of traits preferred by goat breeding community members for further improvement (Both male and Female)?

……
……
…………………………………………

2. List and Rnaking of breeding objectives

……
……
………………………………………………………..…

Part 4. Local key characteristic concepts

1.Do the community identify individual members of the 'Woyto' goat population among members of other goat breeds (strains)?..

2. If yes, what are the key characteristics features employed to differentiate members (flock group specific) of the goat population from other breeds or sub types?

……
………………………………………………………………………………..

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

……
……………………………………………………………………………………………

4. Extinct Goat breed type or any loss in genetic diversity if any

……
………………………………………………………………………………………………………

Part 5. Constraints for goat production and local coping mechanisms

1. What do you think external agents can and need to contribute in this regard?

……
…………………………………………….

2. Is your community interested in potential genetic improvement endeavor?

……
…………………

3. Goat population trend in the last 10 years?

……
……………………………………………………………………………….

4. What are challenges in goat production?

……
……………………………………………………………………………………………

7.4. Appendices D: The Figures

Appendix figure 1:Adult female goat browsing on short to medium height shurbs in highland

Appendix figure 2:Goat house for large flock size