COMMUNITY-BASED CHARACTERIZATION OF HARARGHE HIGH LAND GOATS IN DAROLABU DISTRICT WESTERN HARARGHE, ETHIOPIA

M.Sc. THESIS

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BY

DEREJE TSEGAYE

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APPROVAL SHEET OF THESIS
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As Thesis Research advisor, I hereby certify that I have read and evaluated this thesis prepared, under my guidance, by Dereje Tsegaye, entitled **Community-Based characterization of Hararghe HighLand Goats in Darolabu District Western Hararghe Ethiopia.** I recommend 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 Examination, we certify that we have read, evaluated the thesis prepared by Dereje Tsegaye and examined the candidate. We recommended that the thesis is accepted as fulfilling the Thesis requirement for the Degree of Master of Science in Agriculture (Animal Production).

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DEDICATION

I dedicated this thesis manuscript to my family for their continuous material and moral support till the accomplishment of my education, to my friend Mamit Tegegn for her lovely unlimited treat and her good guidance in my success, to Naol Dereje and to God for all things in my life.

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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BIOGRAPHICAL SKETCH

The author Dereje Tsegaye was born in Asella town of Arsi Zone on March 1, 1982. He completed his elementary education in Waji Bilalo Elementary School from 1989 to 1994. He attended his junior and secondary education at Chilalo Terara Senior Secondary School from 1995 to 2001, Asella.

In 2002, he joined Awassa College of Agriculture (Currently Hawassa University) and graduated with Bachelor of Science degree in Animal Production and Range land Management in 2005. He then joined Oromia Agricultural Research Institute; Machara Agricultural Research Center in 2006, as a researcher in Animal feed and nutrition research division and then by 2008 he served the research Center as a Center Director till he joined the school of graduate Studies of Jimma University college of Agriculture and Veterinary Medicine for a Master of Science in Agriculture majoring in Animal Production in September 2009.

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LIST OF ABBREVIATIONS

ANGR	Animal Genetic Resource
BCS	Body condition Score
BL	Body length
BWT	Body Weight
CBPP	Contagious Bovine Pleuropneumonia
CG	Chest Girth
Cm	Cent meter
CSA	Central Statistics Agency
CV	Coefficient of Variation
CW	Chest width
DA	Development agent
EL	Ear Length
ETB	Ethiopian Birr
FGD	Focus Group Discussion
GDP	Gross Domestic product
Ha	Hectare
HL	Horn Length
HW	Height at Wither
IBC	Institute of Biodiversity Conservation
ILRI	International Livestock Research Institute
ILCA	International livestock Center for Africa
Kg	Kilogram
LSD	Lumpy Skin Disease
M a.s.l.	Meters above sea level
MOARD	Ministry of Agriculture and Rural development
OADP	Oromiya Agricultural Development Bureau
PA	Peasant Association
PPI	Pairs of permanent incisors

(LIST OF ABBREVIATIONS CONTINUED)

PPT	Pest des Petit Ruminants
PRA	Participatory Rural Appraisal
PW	Pelvic width
r	Correlation coefficient
R^2	Coefficient of Determination
RH	Rump height
RL	Rump Length
SAS	Statistical Analysis System
SC	Scrotum Circumference
SPSS	Statistical package for Social Science

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ABSTRACT

Goats are important to economic and social livelihoods of smallholders in Darolabu district. The study was conducted from October, 2010 to March, 2011 with an objectives to characterize Hararghe highland goat breed in its environment, to identify breeding objectives and trait preferences and predict body weight from body measurement. The district has been stratified in to lowland, midland and highland agro ecologies for this study. Structured questionnaires, focus group discussion, field observations, recording morphological characters, body weight and linear body measurements were used to collect data. One hundred eighty households were sampled at random and 930 Hararghe highland goats were considered for morphological characterization by categorizing into sex and age groups in different agro ecologies. Descriptive and inferential statistics were employed to handle qualitative and quantitative data, respectively. The main effect of agro ecology, dentition and sex were fitted to the model to analyze quantitative data. The result depicted that the overall mean family size per household was estimated to be 9.68±2.95. The mean flock size of goat in lowland, midland and highland were 34.0±32.02, 10.50±4.73 and 7.0±2.46 respectively. The rate of change in inbreeding coefficient per generation when flock is not mixed in lowland, midland and highland were 0.065, 0.2033 and 0.2165, respectively. Ninetyfive percent of household in lowland, 98.3% in midland and 86.7% in highland fatten goat with finishing period of 12.28±8.2, 12.71±8.87 and 12.31±8.59 month, respectively without significant variation (P>0.05) among the three agro ecologies. White, brown and grey coat colors are the first, second and third preferred colors for both sex with an index values of 0.38, 0.38 and 0.24 respectively. Mean age at first service of female were significantly (P<0.05) shorter in highland than lowland and midland ant it were 14.1±5.6, 13.1±5.7 and 12.0±4.7 month in lowland, midland and highland, respectively and the corresponding age for male were 12.8±4.8, 12.4±5.6 and 13.0±5.2 month, respectively. The average kidding intervals were 8.6±2.28 month in highland, 8.0±1.96 month in midland and 7.6±1.86month in lowland. Litter size of 1.38±0.20, 1.32±0.28 and 1.36±0.35 month was observed in lowland, midland and highland, respectively. Goat milking is practiced by majority of the respondents (90%) with average lactation length of 3.6±1.4 month. Ninety percent of goat owners in the study area practiced uncontrolled breeding. Conformation, milk yield and twining ability were ranked first, second and third for selecting breeding doe with an index of 0.22, 0.18, and 0.17 respectively and the corresponding rank for males was conformation, coat color and pedigree with an index of 0.28, 0.20 and 0.12 respectively. Disease, genotype, feed and water were ranked the first, second, third and fourth constraints for goat production in the study area having an index of 0.30, 0.21, 0.19 and 0.09, respectively. Sex, age and agro ecology had a significant (p<0.001) effect on body weight and most of the body measurements. The mean body weight, body condition, body length, heart girth, height at wither, chest width, pelvic width, rump height, rump length, ear length and horn length for female goat were

23.74±0.21kg, 2.68±0.03,57.2±0.23cm, 66.6±0.23cm, 59.6±0.21cm, 15.02±0.18cm, 13.3±0.15cm, 63.7±0.19cm, 14.3±0.06cm, 13.04±0.05cm and 8.47±0.15cm respectively. The corresponding values for males were 29.6±0.31kg, 3.04±0.04, 60.7±0.34cm, 71.4±0.35cm, 64.4±0.33cm, 16.3±0.26cm, 13.6±0.22cm, 68.8±0.29cm, 14.9±0.09cm, 13.07±0.07cm and 10.25±0.27cm, 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. The prediction equation developed has showed that, heart girt is the body measurement that has revealed higher explanatory power (R^2) to predict live weight. A linear regression equations using heart girth as an explanatory variable showed a prediction equation of ($y = -31.42 + 0.83x$) for female and ($y = -36.21 + 0.92x$) for males, where y and x are body weight and chest girth, respectively. 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 traditional eye ball goat marketing practices has to be changed to live weight based marketing to make the producers beneficial.

1. INTRODUCTION

Ethiopia has the largest livestock population in Africa, and is endowed with different ecological zones that included highlands, sub-humid, semi arid and arid environment (Farm Africa, 1996). The livestock sector in Ethiopia contributes 18% of the Gross Domestic Product (GDP), 40% of the Agricultural GDP and 17% of the export income in 2001 (LMA, 2002). The number of indigenous breeds of livestock identified is estimated at 25, 13, 15, 4, 4, 2, 2 and 5, for cattle, sheep, goats, camels, donkeys, horses, mules and chickens, respectively. And there are 3 dairy cattle, 7 sheep, 7 chickens and 2 goat exotic breeds used for food and agriculture (IBC, 2004). However, the characterization of the indigenous livestock is not exhaustive which implies need of further characterization of indigenous livestock.

The livestock production systems in Ethiopia are characterized by mixed crop-livestock, agro-pastoral and pastoral, and peri-urban and urban. The majority of livestock are kept in low input production system in rural areas, while some livestock species are kept in medium input system mainly in peri-urban and urban areas (IBC, 2004). In Ethiopia goat production has traditionally been an integral part of the farming systems in all agro-climatic conditions (Workneh, 1992). It is 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). In lowlands, they are kept in large flocks by pastoralists, whereas in high lands, goats are integrated into the crop livestock systems with very small flock size playing complementary roles with other species of the livestock (Workneh, 1992). Contrary to the general assumption that goats are associated with arid and semi-arid areas, they tend to replace sheep as the dominant small ruminant species in the highlands, especially most parts of northern, eastern and western highlands of Ethiopia (Aschalew *et al.*, 2000) showing increasing trend of goat over agro ecologies.

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. 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. Therefore, there is a need to describe and improve the goat genotype under the prevailing environment through community based genetic improvement approach.

In that case 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. Therefore, trait preference shows special characteristic feature and genetic advantages that the animals possess under farmers perspective in the given local production environment.

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, 2009). Information available on Ethiopian small ruminant is insufficient and 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).

Ethiopia's domestic demand for goat meat is high (Gryseels & Anderson, 1983) with goat meat realizing higher prices than mutton or beef in eastern parts of the country (Farm Africa, 1996). Ethiopia is also competing in the world market through the exportation of goat meat to a number of Middle East countries (Ethiopian Export Promotion Agency, 2003). However,

the production performances of these goat breeds have not been evaluated (Ameha *et al*., 2007).

The available Information (Alemayehu, 1993 and Nigatu, 1994) on morphological characterization of Hararghe highland goat breeds have not covered all the production environments rather focused on specific areas of the whole population and the information is not updated. Additionally, it is argued that for sustainable genetic improvement of traditionally managed goats, development of community- based strategy which takes into consideration the need, knowledge and aspiration of local community and participation of all stakeholders is important.

Morphological characterization is also crucial for describing the goat breeds in general and linear body measurements data would also help for designing weight based marketing strategy. In order to develop good model for body weight measurement, it is important to measure traits such as live weight with some level of accuracy (Zewdu, 2008). Body weights of animals are usually measured using weighing scale. However, proper measurements of this trait under farmers condition is difficult because of unavailability and high cost of the weighing scale. Therefore, it is important to design alternative ways of measuring live weight of animals. The best method of measuring weight of animals without scale is to regress body weight on certain linear measurements which can be easily measured and interpreted (Adeyinka and Mohammed, 2006). Different studies indicated the possible use of linear measurements in prediction of body weight (Adeyinka and Mohammed, 2006) in sheep and goat.

Therefore, it is with this backdrop the present study has been set with the following objectives.

1. To characterize the Hararghe Highland goat breed in its environment
2. To define trait preferences and breeding objectives of the community
3. To assess community's indigenous knowledge, traditional breeding system and general husbandry practices and
4. To develop a prediction model for body weigh based on body measurements

2. LITERATURE REVIEW

2.1. Origin of Goat

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. Climate which is predominantly determined by altitude which range 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. Goat population and Distribution in Ethiopia

The goat population of Ethiopia in 2004 was estimated to be 23 million goats (CSA, 2004). The country holds 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).

2.3. Goat production System in Ethiopia

In the highlands, livestock constitute 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 grade 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 *et al*., 1990). In Ethiopia, sheep and goats are maintained under two broad production systems (Tembely, 1998; EARO, 2000).

2.3.1. 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).

2.3.2. Agro pastoral and pastoral system

Pastoral production system is located in the arid and semi-arid lowland areas below 1500 m.a.s.l. in which 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 21^0 C – 27^0 C 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 economies of the lowlands (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).

2.4. 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). Today different goat breeds inhabit diverse environments throughout the world with body weight raging from 9 kg to 13 kg for small tropical breeds to 100kg for the European dairy breeds and the Boer goat (Mason, 1981). Meat production of goats is influenced by many factors including sex, breed, age, and nutritional status. Genetic factors and levels of feeding are probably the most important factors influencing growth and thus meat production. 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; Workneh, 1999; 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 (Workneh, 2000) 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 and Goat product Marketing

Livestock marketing in Ethiopia follows a three-tier system: the primary, secondary and terminal markets through which animals go into the hands of small traders and then to large traders (FAO, 1995). 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).

2.6. Genetic Diversity of Goats in 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 in different agro-climatic regions of Ethiopia (Farm Africa, 1996). Based on microsatelite DNA markers it was classified into nine distinct genetic entities (Tesfaye *et al*., 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 (Farm Africa, 1996). It should be noted that some breeds are known by different local names in different localities. Types goat existing in Ethiopia 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).

Table 1 Goat families and breeds of Ethiopia

Family name	Breed name	Other local names	Distribution
Nubian family	Nubian	Shukria, Langae, Hassen	North-western Ethiopia,(Wegera)
	Afar	Adal, Danakil	Rift valley strip, Danakil depression, Gewane, North & Western Hararghe
Rift Valley family	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
	Woito-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,1993,): Website: http://www.esgpip.org. NA= Not available.

2.6.1. Threats to Animal Genetic Resource (ANGR) Biodiversity

If the indiscriminate distribution of the "best performing genotypes" into different parts of the country were to continue unabated at the current pace, the gene pools of indigenous farm animal genetic resources and associated traditional knowledge would then be lost in the near future before they are even fully understood and described. Other factors that contribute to such threats are habitat loss, human population growth, and lack of appropriate policies, conflicts, natural calamities and free marketing that are being introduced without concurrent adjustment in policy, institutions and legal frameworks. Major factors contributing to the loss of diversity are market and intervention failures that affect AnGR in livelihood and market oriented agricultural systems like live animal marketing without intervention. In developing countries the greatest threats to genetic diversity are the increased use of artificial insemination (Chupin and Schuh, 1993), intensification of agriculture (especially for pigs and poultry) and indiscriminate crossbreeding of local breeds.

Farm AnGR are not yet exhaustively identified, described, classified, characterized nor 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.

2.6.2. Animal Genetic 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 as 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 *et a*l., 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. Community Based Goat Breeding and Characterization

Characterization is defined as the distillation of all knowledge, which contribute to the reliable prediction of genetic performances of an animal genetic resource in a defined environment and provides a basis for distinguishing between different animal genetic resources and for assessing available diversity (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 *et al*., 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). Sustainable utilization of AnGR is the preferred avenue for safeguarding animal genetic diversity. Utilization strategies for genotypes that posses' high levels of adaptive fitteness to specific environments should include breeding programs which maintain or enhance their properties and, in doing so, contribute to the economy of the communities depending on them (Mueller, 2006). Proposals on breed utilization strategies should take into account the production environment and the availability of genetic resources in the industry and it is critical that breeds used in the dry areas are adapted to the harsh production environment and it has now become very costly to continue to change the environment to suit the animal.

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 were 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 include (Croston and Pollot, 1985; Baker and Gray, 2003).

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, to fulfill the needs of the market or the subsistence of the farming system (Clemens, 2002).

This includes:

1. Identify production system(s), potential markets or market niches and economic merits of the animal population and its traits.
2. Define breeding goal and objective through a participatory approach.
3. 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.
4. 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.

5. Develop improvement schemes based on testing and selection against the formulated breeding goal.
6. Ensure gene flow through dissemination of breeding animals using traditional stock sharing system or formal markets to all livestock production herds.

2.8. 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.

2.9. 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.

2.10. Herd Size and Flock Structure

Flock structure and herd size of any livestock species varied as a function of agro climatic condition, production system and production objectives and socio-cultural practices of a community (Table 2). The mean flock size per household for Hararghe highland goat was 4.0±4.0 as reported by Alemayew (1993).

Table 2 Flock structure as a percentage of the whole population for male & female Ethiopian goats in their respective sources of each breed.

Breeds	Age groups										Sources
	0PPI		1PPI		2PPI		3PPI		4PPI		
	M	F	M	F	M	F	M	F	M	F	
Afar	4.3	14.4	0.6	10.8	0.5	10.3	0.5	14.8	0.4	43.3	Nigatu (1994).
Abergelle	9.8	23.0	0.6	2.4	0.8	10.5	3.0	10.3	1.7	37.6	Nigatu (1994).
Arsi-Bale	17.4	24.5	2.8	8.2	1.9	5.3	1.8	9.0	1.7	27.3	Alemayehu (1993).
Woyto-Guji	17.6	21.2	3.3	7.8	1.5	6.0	1.8	9.0	1.8	29.6	Workneh (1993).
Hararghe highland	19.9	22.2	2.9	10.4	2.9	7.5	2.0	12.2	1.2	18.8	Alemayehu (1993)
Short eared Somali	10.1	14.0	3.7	10.7	3.8	9.7	2.5	14.0	1.1	30.4	Alemayehu (1994)
Long-eared Somali	9.1	17.5	2.3	9.2	1.1	7.2	1.3	10.9	1.2	40.2	FARM-Africa (1994)
Central highland	17.1	22.9	3.2	7.1	2.5	6.2	3.4	10.9	2.5	24.3	Nigatu (1994).
Western highland	21.1	30.3	1.5	8.4	1.2	7.0	1.4	7.8	1.5	19.9	Nigatu (1994).
Western lowland	18.8	31.3	1.9	8.7	0.2	8.1	0.3	8.0	0.9	22.9	Nigatu (1994).
Keffa	22.2	24.9	2.7	7.8	1.7	6.2	1.4	9.6	1.7	21.6	Nigatu (1994).

Source: Farm Africa. 1996 PPI= permanent pairs of incisors, M=male, F=female

2.11. 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.

2.11.1. 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). Study by Behailu et al (2003) for Arsi Bale goats on farm level, reported that Arsi-bale goat reach AFS at 14 and 16 months in Arsi Negele and Boricha, respectively. Age of puberty for tropical male goat is 97 days (Payne and Wilso, 1999). 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. 8.45 ± 19.33 months for Pallai Adu does in india (Ravimurugan *et al*., 2009).

2.11.2. 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 up on 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. Twelve month was reported for goats around Awassa woreda (Markos, 2000). Endeshaw(2007) reported that age 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 reach at the age of 7.4 month (Tesfaye, 2009). The AFS of buck of 8.08 ± 0.22 month were reported to Pallai Adu goats in india (Ravimurugan, *et al*., 2009).

2.11.3. 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); number of (kids) born with multiple litters attained age at first kidding later than their single born counterparts (Wilson, 1986). Study in Goma district Jimma zone reported AFK in the area about 12.46 month (Belete, 2009); study around Dale district of Sidama zone southern Ethiopia stated as 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).

2.11.4. 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 under different management system shows that KI of 8.1 month (Tatek *et al*, 2004) under on farm monitoring system. Study around Yerer and Adaa district found out that parturition interval of 11.5 month (Samuel, 2005). Study around Dale district stated KI of 8.57 month (Endeshaw, 2007).Study in Goma district stated KI as 7.87 month (Belete, 2009). Belay (2008) also reported KI for

Abergelle and Central highland goat type as to be 11.31 ± 2.21 and 10.3 ±1.42 months respectively. According to Wilson (1991) KI of many tropical goat varies between 180-300 days. Tesfaye (2009), in study around Metema stated 8.4 month.

2.11.5. 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 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 environmental 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 is 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). Average number of kidding per life time of doe around Metema is 13.5 (Tesfaye, 2009).

2.11.6. Weaning and Age at Weaning

Tesfaye (2009) has showed that variation in weaning age between male and female kid. He has reported that mean weaning age of male and female goat as 4 and 4.2 mouths 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.

2.11.7. Reasons of culling goats

Culling of animals from a flock is determined by many factors like age, Color, poor body condition and conformation. Similarly literatures list a number of reasons for culling in different areas and agro iconologies. Poor body condition, poor productivity, 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.

2.12. Body weight, Linear Body Measurements and their association

Apart from the conventional use of scales in determining the weight of small ruminant 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.

Table 3 Body measurements of some breeds of Ethiopian Goat

Family and Breeds	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 valley 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	12.7±0.8	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 (1994).
Long Eared Somali	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											
Central 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. MATERIALS AND METHODS

3.1. Description of the Study Area

The study was conducted in Darolabu districts, located at an altitude that ranged from 1300 to 2450 masl and found in the Eastern part of Ethiopia. It is one of the administrative districts under Western Hararghe Zone of Oromia Regional State. The district is located at about 440 km away from Addis Ababa and 114 km South of Chiro town, the capital of the zone. The district is bordered by Habro district in North, Arsi Zone in North West, Bale Zone in the South, Boke District in the East and South east, Hawwigudina in South East. The District was selected based on its potential for goat production and its holistic agro ecological zone from very low agro ecology to highland areas and wide range of area coverage with different production system such as Agro pastoralism ,in the low land and mixed farming in mid and highland areas. The total surface area of the district is 434,280ha; with the mean annual rainfall of 963mm and rainfall distribution is bimodal and mostly erratic; temperature of the district ranges from 14^0c to 26^oc with an average of 16^oc (MOARD, 2007).

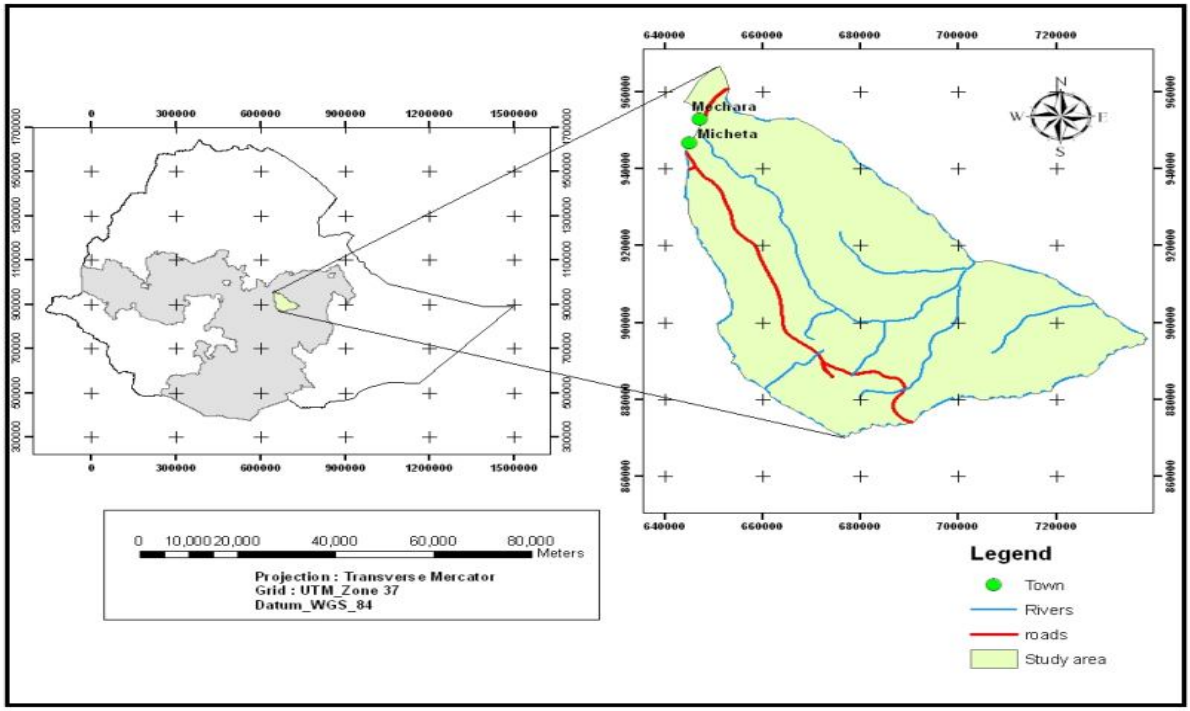

Figure 1 Map of the study area

3.2 Data Sources and Methods of Data Collection

Survey, recall data, focus group discussion and body measurement were sources of data in the present study.

3.3 Sampling Techniques and Sample Size

Prior to sampling and data collection, discussions were made 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 made to select the study Kebeles. In addition, discussions were made with development agents (Das) and Kebele representatives. Secondary data on socio-economic characteristics, agricultural production system, livestock population, farming practices and description of the worked in terms of agro-ecology, demography and, climate were collected from zone and district Agricultural offices.

A multistage sampling procedure was employed in the present study. In the first stage, the district was stratified into three agro ecologies namely lowland with altitude of <1500masl, midland with altitude of 1500-2300masl and highland with > 2300masl. In the second stage, two PAs were randomly selected from each agro-ecology. In the third stage, a total of 180 households (30 individual households per PA) having goat stock were interviewed at random in all direction after every seven to ten households based on the number of household per peasant association. The data on socio-economic characteristics of goat keepers, husbandry practices for goats and resources endowment of goat farmers were collected.

Following the survey a group discussions were made in each PA with the focal personnel such as, goat owners, elders and female groups that own goat. 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). Accordingly a total of 930 goats (331 male and 599 female) were

selected randomly from goat flocks via random goat owners in villages in each PA for morphological characterization (Appendix D).

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 by trained enumerators. The Questioner was prepared based on questioner prepared by ILRI and OADB for Oromia Livestock breed survey (Workneh and Rowlands, 2004). The questionnaire was framed to collect data such as 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).

3.3.2. Focused Group Discussion (FGD)

Focused group discussions were undertaken using checklists to collect information on origins, distribution, special features of goat's production and productivity of goats, trait preferences, breeding and production objectives based on check list (Appendix C). Group composed of 10-15 members of key informants was formed for gathering information. Key informants such as elders, community leaders, women, traditional practitioners, goat owners and development agents were used for the FGD.

3.3.3 Goat Body Measurements for characterization

The following body measurements were made using measuring tape calibrated in centimeters (cm): chest girth (CG- 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 (WH-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); while body weight (BW) was measured using 50kg portable weighing scale graduated at 100gm interval.

Body condition score (BCS) was assessed subjectively and scored 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 back bone with the thumb and the end of the short ribs with finger tips immediately behind the last ribs (Appendix Table 2*)*. Twelve qualitative traits like back profile, coat color pattern and type, presence or absence of horn, ruff, wattle and beard, horn length (categorical), orientation and shape, ear orientation 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, the group discussion and individual goat characterization were made sequentially in that order at the presence of the goat flock.

3.4. Methods of Data Analysis

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

3.4.1. Descriptive statistics

SPSS statistical computer software (SPSS ver.16) was applied to analyze qualitative data obtained from the questionnaire and physical description (SPSS, 2007).

3.4.2. Ranking for traits and indices

There were parameters that has required ranking. Hence, Indices were 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. The indices were calculated as follows;

Index = Sum of (3 X number of household ranked first + 2 X number of household ranked second + 1 X number of household ranked third) given for an individual reason, criteria or preference divided by the sum of (3 X number of household ranked first + 2X number of household ranked second + 1 X number of household ranked third) for overall reasons, criteria or preferences.

Analysis of Variance

The General Linear Model (GLM) procedures of SAS ver.9.2 were employed to analyse quantitative data and ascertain the effect of sex, site (agro ecology) and age (PPI) on quantitative data (SAS, 2008). Mean separation was undertaken to reveal the difference between means using LSD method.

The statistical model is presented as follows;

$Y_{ijkl} = \mu + A_i + S_j + D_k + e_{ijk\,l}$ **Model 1**

Where: Y_{ijkl} = the observation on body weight and linear body measurements;

μ = Overall mean;

Ai = Fixed effect of Agro ecology (i= lowland, midland and Highland)

S_j = Fixed effect of sex (j = male, female);

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

e_{ijkl} = Random error

First order interactions were fitted and retained in the final model when found significant in the preliminary analysis.

Correlations (Pearson's correlation coefficients) between body weight and different linear measurements were determined for the population within each sex and dentition categories.

3.4.3. Regression for body measurements

The stepwise REG procedures of SAS ver.9.2 was employed to predict live weight from body measurements for pooled data, separate sexes and for each age categories (SAS, 2008). The choice of the best fitted regression model was selected using coefficient of determination (R^2) and Mean standard error (MSE). The multiple regression model for female and male are presented as follows;

$$Yj = \beta0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + e_j \quad \text{Model 2}$$

$$Yj = \beta0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + e_j \quad \text{Model 3}$$

Where:

Yj = the dependent variable which is body weight, β0 = the intercept, X_1, X_2, X_3, X_4, X_5 X_6, X_7 X_8 and X_9 are the independent variables; BL, CG, WH, CW, PW, RH, RL, EL and BCS, respectively. β_1, β_2, β_3, β_4, β_5, β_6, β_7, β_8 and β_9 are the regression coefficients of the variables, X_1, X_2, X_3, X_4, X_5, X6, X_7, X_8 and X_9 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 X_{10} is the independent variable scrotal circumference and β_{10} is the coefficients of the variable X_{10}.

ej = the residual error.

3.4.4 Estimation of inbreeding

Rate of change in inbreeding per generation was 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 made 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

4. RESULTS AND DISCUSSION

4.1. Socio-economic Characteristics of the Households

Socio economic characteristics of sampled household namely: sex, age structures, education level, religions of the household and family sizes per household were discussed under this subtopic.

4.1.1 Household sex, age structure and education level

In Darolabu district, the majority of goat owners were male headed. Of the total household interviewed 75, 78.3 and 80 % were male in lowland, midland and highland, respectively (Table 4). The result in the current study is less than the report of (Dereje and Tesfaye, 2008) which reported 95.2% male headed household in the study area. The study pointed out that low frequency of divorce and high proportion of marriage in the community. The study revealed high proportion of married households 88.33% in lowland, 90% in midland and 93.3% in highland and small proportion of divorce 3.33, 3.33 and 1.67 % in lowland, midland and highland, respectively. The proportions of widowed household in lowland, midland and highland were 8.33, 6.67 and 5.0 %, respectively.

The dominant religion in the study area was Muslim and 93.3%, 98.3% and 86.67% of the population follows Muslim religion in lowland, midland and highland, respectively. Age and educational background of the household are presented in Table 4. According to the sampled house hold 50% of the household head were illiterate and the remaining once was at least they can read and write. Illiteracy was higher in low land (60%), followed by midland (50%) and lowest in highland (40%). The high illiteracy rate in low land is attributed to limited availability of infrastructure like schools and poor awareness on the use education in the livelihood of the community. This result is in agreement with the study conducted in Bure district which reported a illiteracy rate of 57% (Adebaby, 2009) and that reported at 46.8% illiteracy in Western Hararghe (Dereje and Tesfaye, 2008). However, the illiteracy rate is considerably lower than the illiteracy level (80%) reported around Mieso district (Kedija, 2007). The high proportions of

illiterate in the community negatively affect any development in that community through improper management and utilization of resources, low acceptance of extension service and training. Regarding age of the household head the study indicated that 53.3% of the household in lowland were in the range of 31-40 year, 40% in midland were in the range of 21-30year and 30.0% in highland were from 31-40 year. This result is consistent with mean age (39.7 year) reported by Kedija (2007) around Mieso district. In general the majority of the populations in the area are illiterate (especially at lowland) at productive age (21-50) and Muslim in religion.

Table 4 Number and percentage of household heads by sex, education level, religion and age category in Low land, mid land and high land Agro ecologies.

Factors/level	Agro ecology						Overall	
	Lowland		Midland		highland			
	N	%	N	%	N	%	N	%
Sex								
male	45	75.0	47	78.3	48	80.0	140	77.8
Female	15	25.0	13	21.67	12	20.0	40	22.2
Education								
Illiterate	36	60.0	30	50.0	24	40.0	90	50.0
Writing and reading	13	21.67	18	30.0	26	43.33	57	31.7
Primary (1-8)	10	16.67	12	20.0	10	16.67	32	17.8
Secondary (9-10+2)	1	1.67	0	0	0	0	1	0.6
Age								
<20	1	1.67	0	0.0	1	1.67	2	1.1
21-30	8	13.33	24	40.0	16	26.67	48	26.7
31–40	32	53.3	18	30.0	18	30.0	68	37.8
41–50	14	23.33	13	21.67	14	23.33	41	22.8
51–60	5	8.33	5	8.33	5	8.33	15	8.3
>60	0	0	0	0	6	10.0	6	3.3
Religion								
Muslim	56	93.33	60	100	52	86.67	168	93.3
orthodox	4	6.67	0	0	8	13.33	12	6.7
Marital status								
Married	53	88.33	54	90	56	93.33	163	90.6
Divorced	2	3.33	2	3.33	1	1.67	5	2.8
Widowed	5	8.33	4	6.67	3	5.0	12	6.7

N= Number of Households

4.1.2. Household Family size and Age structure

Detail family size and structure per household was presented by grouping in to sex and age groups. The overall mean family size per household was estimated as 9.68±2.95 and there was no significant difference ($p>0.05$) among the three agro ecologies (Table 5). The present study concurs nearlyl with previous studies conducted in west Hararghe, that has revealed the family size of 7.34 (Dereje and Tesfaye, 2008). The result in the present study is different and higher from report in oromia region which has showed average family size of 5.0 (CSA, 2008). There were a comparable female and male number in the house hold with an average of 4.86 females and 4.82 males in the household. The ratio of male to female for the sampled household in the study area is the same as the estimated value for Oromia region which is 50.4:49.6 (CSA, 2008). This study has also showed higher population size per household and per unit area of land as compared to the Oromia regional state reports. This attributed to early marriage and polygamy in the community, limited access to health extension and low awareness to family planning associated with high illiteracy. This is one of the area which needs intervention through promotion and training in health extension, use of family planning and education as it influence overall productivity in all aspects of agriculture.

Table 5 Average family size and age composition of family members in the district by agro ecology

Family age (year) by sex	Agro ecology						Overall (N=180)		Test	
	Lowland(n=60)		Midland(n=60)		Highland(n=60)				F-value	P value
	Range	Mean ± SD	Range	Mean± SD	Range	Mean ± SD	Range	Mean ± SD		
Total family size	2-20	10.27±3.67	5-17	9.63±2.23	3-16	9.13±2.67	2-20	9.68±2.95	2.253	0.108
Children less than 7	0-7	2.80±1.46	0-6	2.82±1.38	0-7	2.32±1.40	0-7	2.64±1.42	2.650	0.073
Male < 7 year	0-7	1.58±1.25	0-4	1.38±0.96	0-5	1.13±0.98	0-7	1.37±1.08	0.672	0.512
Female < 7yr	0-3	1.22±0.92	0-4	1.43±1.05	0-5	1.32±1.10	0-5	1.32±1.02	2.422	0.092
Children between 7&15	0-11	3.03±1.98	0-7	2.87±1.33	0-7	2.55±1.61	0-11	2.82±1.67	1.192	0.306
Male between 7 and 15	0-4	1.27±0.99	0-4	1.40±0.83	0-5	1.47±1.26	0-5	1.38±1.04	0.576	0.563
Female between 7 &15	0-10	1.75±1.61[a]	0-6	1.47±1.03[a]	0-5	1.05±1.05[ab]	0-10	1.42±1.29	4.685	0.010
Between 16 &30	0-9	2.38±2.16	1-7	2.47±1.35	1-7	2.47±1.27	0-9	2.44±1.63	0.056	0.945
Male between 16 and 30	0-7	1.12±1.17	0-5	1.20±0.92	0-6	1.27±1.01	0-7	1.19±1.03	0.317	0.729
Female between 16 &30	0-5	1.28±1.33	0-4	1.25±0.75	0-3	1.20±0.67	0-5	1.24±0.95	0.115	0.892
Adult between 31 and 60	0-5	2.07±1.27[a]	0-5	1.50±1.33[b]	0-4	1.50±0.97[b]	0-5	1.69±1.22	4.445	0.013
Male between 31 & 60	0-2	1.23±0.66[a]	0-3	0.77±0.72[b]	0-2	0.72±0.49[b]	0-3	0.84±0.64	4.344	0.014
Female between 31 & 60	0-3	1.03±0.71[a]	0-3	0.73±0.69[b]	0-3	0.78±0.56[ab]	0-3	0.85±0.66	3.617	0.029
Adult > 61 years	0-2	0.03±0.26[a]	-	-	0-2	0.18±0.57[b]	0-2	0.07±0.37	4.420	0.013
Male > 61 years	0-2	0.02±0.13[a]	-	-	0-1	0.10±0.30[b]	0-1	0.04±0.19	4.775	0.010
Female > 61 years	0-1	0.02±0.13[a]	-	-	0-1	0.08±0.28[b]	0-1	0.03±0.18	3.710	0.026

[a,b] means on the same row with different superscripts are significantly different (P<0.05) (-) = not available

4.2. Land holding and land use pattern

Average land holding per household was significantly different ($p<0.001$) among the three agro ecologies for all land type except for rented and fallow land. The mean total land size per household in lowland area was significantly larger (2.56 hectare/household) than in midland (1.23 hectare/household) and highland (0.75hectare/house hold). This difference among the three agro ecologies were due to scattered distribution of population density and less availability of infrastructure like market, school and water sources in lowland. Human population was densely populated in highland areas; followed by midland and sparsely populated in lowland as a result area of land owned by farmers was higher in the lowland. The overall average land holding in the study area (1.51ha) is higher than one reported as 1.1 ha in Menze area (Tesfaye, 2008).

The trend of land holding per household was decreasing as perceived by (98.9%) of the respondents. Land holding per house hold and the land allotted to crop land, grazing land and fallow land showed a decreasing trend (Table 6). The decrease in land holding per house hold might be associated to the decreasing trend of land with population increase, settlements, drought and erosion. The land use pattern was in favor of crop production. Farmers allocated 80% for crop and 17.2% for grazing in lowland, 87% for crop and 11.4% for grazing in midland and 92% for crop and 4% for grazing in the highland. The proportion of land allocation for crop cultivation indicated in this study was higher than the one reported in Oromia regional state where thirty percent of land in *dega was* allotted for grazing and two-thirds for cropping. The land use pattern was estimated that one-fifth of the land in *weinadega* and *kolla* was kept for grazing and four-fifths of the land was allocated for crops production (ILRI, 2004). The high proportion crop land allocation in the area is attributed to the intensive cash crop production namely coffee and chat production practices in the area which has a better market access.

Table 6 Average Land holding per household in hectares and the district by agro ecology

Land type	Agro ecology						Overall (N=180)		P value
	Lowland(n=60)		Midland(n=60)		Highland(n=60)				
	Range	Mean ± SD	Range	Mean± SD	Range	Mean ± SD	Range	Mean ± SD	
Total land holding	0.75-8	2.56±1.66[a]	0.25-3	1.23±0.84[b]	0.25-2.5	0.75±0.52[c]	0.25-8	1.51±1.35	0.000
Total own land for crop	0.25-6	2.06±1.29[a]	0.13-3	1.07±0.78[b]	0.13-2.5	0.69±0.46[c]	0.13-6	1.27±1.07	0.000
Total rent land for crop	NA	NA	0-0.5	0.01±0.06	0-0.50	0.02±0.08	0-0.50	0.01±0.06	0.297
Total own fallow land	0-1.25	0.05±0.20	0-1	0.02±0.13	0-0.50	0.01±0.07	0-1.25	0.03±0.14	0.231
Total own grazing land	0-2	0.44±0.61[a]	0-2	0.14±0.30[b]	0-0.25	0.03±0.08[b]	0-2	0.21±0.43	0.000
Total rented grazing land	NA	NA	0-1	0.02±0.13	0-0.20	0.003±0.03	0-1	0.01±0.08	0.448

N = number of observation, SD = standard deviation; NA= Not available [a,b,c] = means on the same row with different superscript are significantly different($p<0.05$)

4.3. Major Farming Activities

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 (88.3%), livestock only (3.3%) and crop only (8.3%). In midland agro ecology 28.3%, 6.7% and 65% farmers depend on crop, livestock and both crop and livestock, respectively; whereas in highland 48.3% depends on both crop and livestock, 45% depend on crop and 6.7% depend on livestock.

The farmers tend to diversify crop production by cultivating field and cash crops. Maize, sorghum, Teff and haricot bean were the major field crops grown in the study area during main season (Table 7). Based on the group discussion made with the farmers main cropping season in the study area is extended from May to early August. Few farmers practiced cropping during short rainy season before main cropping March and April and some at the end of main season in October and December. Haricot bean (16.7%), sweat potato (43.7%), maize (8.9%) and teff (8.3%) were the major field crops that commonly grown in the area during short rainy season. Maize, sweat potato and haricot bean commonly planted before the main season whereas teff planted after main crop harvest at the end of the main season.

Table 7 Major crops grown during main and short rainy season in different agro ecologies

Factor							Overall	
	N	%	N	%	N	%	N	%
Main season								
Maize	59	98.3	60	100.0	57	95.0	176	97.8
Sorghum	59	98.3	59	98.3	59	98.0	177	98.3
Tef	25	41.7	40	66.7	36	60.0	101	56.1
Haricot bean	18	30.0	37	61.7	34	56.7	91	50.6
Coffee	19	31.7	53	88.3	40	66.7	112	62.2
Chat	21	35.0	55	91.7	51	85.0	127	70.6
Sweet potato	3	5.0	0	0	6	10.0	9	5.0
Ground nut	14	23.3	0	0	2	3.3	16	8.9
Hot pepper	14	23.3	0	0	2	3.3	16	8.9
Short rainy season								
Maize	5	8.3	8	13.3	3	5.0	16	8.9
Tef	4	6.7	4	6.7	7	11.7	15	8.3
Haricot bean	8	13.3	3	5.0	19	31.7	30	16.7
Sweet potato	20	33.3	27	45.0	31	51.7	78	43.3
Ground nut	3	5.0	3	5.0	6	10.0	12	6.7
Hot pepper	3	5.0	3	5.0	3	5.0	9	5.0

N = number of observation; Main planting season= may, june, july; Short rainy season= March, April, October and December.

Maize, sorghum, goat and, cattle were ranked as the first second ,third and fourth major sources of income in lowland with an index of 0.19, 0.18, 0.17 and 0.12 respectively, in midland coffee, chat, maize and cattle were ranked first, second, third and fourth with an index of 0.37, 0.24, 0.16 and 0.11 respectively and in highland chat, coffee, sorghum and goat ranked one up to four with an index of 0.38, 0.22, 0.11 and 0.09 in their order (Table 8). The result implied the type of crop related feed resource available in the area and importance of critical evaluation on nutritional aspect and improvements of the feed resources from these crops as animal feed. The result in the current study for lowland is in agreement with one reported in Mieso district which stated sorghum and maize(93.0%) as the major source of income (Kedija,2007); but it is completely different for midland and highland as chat and coffee production is extensively practiced in Darolabu district. Farmer in the group discussion indicated an incremental trend in chat production in the area than coffee, other crops and goat due to its fast and year round production with significant economic return.

Table 7 Ranking of important major farming activities as a source of income in different agro ecologies (%)

Species or crops	Lowland				Midland				Highland				Overall			
	Rank1	Rank2	Rank3	Index	Rank1	Rank2	Rank3	Index	Rank1	Rank2	Rank3	Index	Rank1	Rank2	Rank3	Index
Maize	21.7	16.7	16.7	**0.19**	18.3	16.7	16.7	**0.16**	-	13.3	15.0	**0.07**	13.3	15.6	16.1	**0.15**
Sorghum	23.3	15.0	5.0	**0.18**	11.7	11.7	3.3	**0.103**	10.0	8.3	21.7	**0.11**	15.0	11.7	10.0	**0.13**
Chat	11.7	11.7	3.3	**0.10**	3.3	56.7	18.3	**0.24**	66.7	10.0	8.3	**0.38**	27.2	26.1	10.0	**0.24**
Coffee	10.0	8.3	8.3	**0.09**	65.0	8.3	10.0	**0.37**	11.7	46.7	5.0	**0.22**	28.9	21.1	7.8	**0.23**
Goat	11.7	18.3	31.7	**0.17**	1.7	-	13.3	**0.03**	8.3	6.7	18.3	**0.09**	7.2	8.3	21.1	**0.10**
Cattle	10.0	13.3	16.7	**0.12**	-	1.7	35.0	**0.11**	3.3	8.3	23.3	**0.08**	4.4	7.8	25.0	**0.09**
Sheep	-	-	-	**-**	-	1.7	-	**0.006**	-	-	-	**-**	-	0.6	-	**0.001**
Groundnut	3.3	6.7	5.0	**0.05**	-	1.7	-	**0.006**	-	5.0	5.0	**0.03**	1.1	4.4	3.3	**0.03**
Hot pepper	6.7	6.7	3.3	**0.06**	-	-	-	**-**	-	-	-	**-**	2.2	2.2	1.1	**0.02**
Haricot bean	-		3.3	**0.006**	-	-	1.7	**0.002**	-	-	-	**-**	-	-	1.7	**0.003**
Teff	1.7	1.7	1.7	**0.02**	-	-	1.7	**0.002**	-	-	1.7	**0.003**	0.6	0.6	1.7	**0.01**
chicken	-	1.7	-	**0.006**	-	-	-	**-**	-	1.7	-	**0.006**	-	1.1	-	**0.004**
camel	-	-	3.3	**0.006**	-	-	-	**-**	-	-	1.7	**0.003**	-	-	1.7	**0.003**
mango	-	-	1.7	**0.003**	-	1.7	-	**0.002**	-	-	-	**-**	-	0.6	0.6	**0.003**

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.

4.4. Livestock holding and Species Composition

The farmers keep diversified species of animals and the species composition varies among agro-ecologies. The overall livestock holding per house hold was (17.5±22.40) for goats, (6.40±5.35) for cattle, (1. 56±1.83) for sheep and (0.81±0.72) for camel. The overall average goat number per household was 34.0±32.02, 10.5 ±4.73 and 7.0±2.46 for lowland, midland and highland, respectively. The number of goats, cattle and camel per household showed a significant variation ($p<0.001$) among agro ecologies as shown in (Table 9). This result is more or less similar to the report in Mieso district which had showed numbers of cattle and camel per household to be 5.69 ± 0.35 and 1.83±0.92, respectively (Kedija, 2007). The number of goats per house hold was similar to the reports of Metema that has revealed the goat number per house hold to be 19.7 goats (Tesfaye, 2009). In contrary the mean number of goat per household in the present study was 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 be due to the large grazing land and shrubs in the district and large area enclosure in which goats can easily access for browsing.

The recall data collected from the sampled respondent showed a decreasing trend in all livestock species in all agro ecologies. Majority of the respondent in lowland (71.67%), in midland (75%) and in highland (78.3%) responded the a decreasing trend in goat population . The decrease for goat number per house hold was attributed to a number of factors which has a different magnitude among regions. For example, the major reasons for the decrease in number of goat in low land were perceived by the respondents for diseases prevalence (95.45%), feed shortage (2.27%) and drought (2.27%), in mid land the reasons the decrease in goat number were attributed to disease (93.33%), feed shortage (6.67%), whereas in high land feed shortage (65.96%) and disease (31.91%) were the reasons for the decreasing trend in goat population. Cattle population also showed a decreasing trend as perceived by the respondents which was attributed to diseases, feed shortage, drought, water shortage and combination of these factors.
The magnitudes of the problem in relation to these factors were different in different ago-ecologies. The percent of respondents who attributed disease for the decreasing trend in cattle

population were 8.33% , 1.83% and 1.85% in the lowland, midland and highland respectively, for the other feed shortage were 46.55%, 94.74% and 98.25% respectively. Whereas the contribution of drought to the decreasing trend of cattle population were 13.79% in low land, 3.51% in midland areas and no in highland, water shortage was the other reason for the decline according to 15.52% of the respondent in lowland but it was not a cause in midland and highland. According to 15.51% of the respondent combination of these factors was the reason for decline in cattle population in lowland. Similarly sheep population were also decreases (96.1%) in the study area because of different factors namely low interest and price for sheep (42.8%), drought (6.9%) feed(42.8%), diseases(2.3%) water(2.3%) and sum of the factors together(2.9%) regardless of the agro ecologies. Regarding chicken population 53.9% of the respondents indicated decreasing pattern, 35.6% as increasing trend the rest 10.6% told as stable population. Honey production is increasing (28.9%) in the area most probably due to some awareness created via hive distribution and trainings as a means to diversify source of income in the community. Other respondents (65%) indicated as no improvement in honey bee production due to some pesticide and herbicide utilization.

The farmers have ranked importance of livestock species. The ranking of importance of livestock species followed a similar trend among the three agro ecologies. In all agro ecological zones goat, cattle, chicken and sheep ranked first, second, third and fourth in their importance with an index of 0.44, 0.36, 0.13 and 0.04 respectively. Farmers' preference to different livestock species in lowland, midland, highland and overall rank in the study area is presented in Table 10. The high preference of goat across all agro ecologies is associated with ease of management in terms of feeding feed selection ability; ability of goat to browse over sloppy and gorgy inaccessible area in lowland and browsing over a chain of mountains and area enclosures in highland in relation to absence or limited plain grazing areas for grazing animals and hoe farming practices than using oxen for ploughing in the study area. It also associated with ease of management at backyard that goat require smaller quantity of water, feed (different type), ability to walk long distance over a limited time and fast economic return than large animals, low price of sheep in the area relative to goat as sheep meat is less preferred by the community. This result was in line with IPS (2000) and Kedija (2007) which indicated that the variability and proximity of watering

points as well as the proportion of browse to grasses are the determining factors for the type of animals preferred and dominating the area.

4.5. Goat Flock Structure

Goat flock structure by age group and agro ecology is presented in Table 11. The mean number of goat with different age category was significantly different ($p<0.05$) between lowland and other agro ecologies. However, there was no significant difference ($p>0.05$) between midland and highland for all age groups. The proportion of female and male goat in the flock in the study area were 60.8% and 39.2% .The present findings are slightly higher for male and lower for female but still confirm the report of CSA (2008), which is 69.84% female and 30.16% male goats for the country. The proportion of male in the current study is considerably higher than the one reported by Deribe (2009) in Alaba which estimated 75.6% female and 24.4% male goats.

The females at the age greater than12 month were the highest followed by females between 6 and 12 month in all agro ecologies. These indicate the fact that, farmers tend to retain more females in the flock to ensure reproduction and sustainable supply of goats in the market. The number of castrates per house hold was estimated at 1.27±1.01 (10.6%) in midland and the lowland farmers had highest 4.06±4.07 (11%) castrates per house hold and the highland farmers keep the lowest number 1.13±0.87 (13.3%). The proportion of castrates in the current study was considerably higher than the report of Tesfaye (2009) which indicated the percent of castrates per house hold as 3.35%, (FARM-Africa, 1996) which is.3.5% reported for Arsi-Bale and 4.4% for Keffa goats'. The higher proportion of castrates recorded in the current study might be due to extensive fattening practices of Hararghe farmers as flock structure is a function of production objectives of the producers.

Table 8 Average flock size and composition of livestock per household in the district by agro ecology

Livestock Species	Agro ecology									Overall (N=180)			Sig
	Lowland(n=60)			Midland(n=60)			Highland(n=60)						
	Range	Mean ± SD	%	Range	Mean± SD	%	Range	Mean ± SD	%	Range	Mean± SD	%	
Goat	8-200	34.0±32.02[a]	67.6	2-28	10.5±4.73[b]	56.84	2-16	7.0±2.46[b]	62.76	2-200	17.5±22.42	63.45	0.000
Cattle	4-49	11.22±6.13[a]	25.6	2-21	5.10±3.02[b]	28.75	0-5	2.88±1.47[c]	26.03	0-49	6.40±5.35	25.85	0.000
Sheep	0-7	1.62±1.68	3.12	0-12	1.92±2.16	9.42	0-7	1.15±1.55	8.59	0-12	1.56±1.83	6.30	0.069
Donkey	0-2	1.07±0.66[a]	1.61	0-3	1.02±0.68[a]	5	0-2	0.35±0.58[b]	2.62	0-3	0.81±0.72	3.28	0.000
Camel	0-11	0.83±1.92[a]	2.06	0	0	0	0	0	0	0-11	0.28±1.18	1.12	0.000
Chicken	0-20	6.58±4.97	-	0-20	7.62±5.2	-	0-40	6.28±6.83	-	0-40	6.83±5.75	-	0.414
Bee hive	0-6	0.35±1.05	-	0-7	0.65±1.23	-	0-20	1.13±2.78	-	0-20	0.71±1.87	-	0.069

[a, b, c] means on the same row with different superscripts are significantly different (P<0.0001) N = number of observation, SD = standard deviation, Livestock composition (%) is only for large animals.

Table 9 Ranked livestock species preference according to their importance (%)

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	Rank 3	Index
Cattle	18.3	71.7	10.0	**0.35**	31.7	58.3	10.0	**0.37**	26.7	65.0	1.7	**0.35**	25.6	65.0	7.2	**0.36**
Goat	78.3	21.7	-	**0.46**	61.7	35.0	3.3	**0.43**	71.7	21.7	5.0	**0.44**	70.6	26.1	2.8	**0.44**
Sheep	-	1.7	13.3	**0.03**	-	-	21.7	**0.04**	-	1.7	30.0	**0.06**	-	1.1	21.7	**0.04**
Camel	-	-	11.7	**0.02**	1.7	-	-	**0.008**	-	-	-	**-**	0.6	-	3.9	**0.01**
Chicken	3.3	5.0	58,3	**0.13**	5.0	6.7	58.3	**0.14**	1.7	8.3	51.7	**0.12**	3.3	6.7	56.1	**0.13**
Donkey	-	-	5.0	**0.01**	-	-	-	**-**	-	-	1.7	**0.002**	-	-	2.2	**0.004**
Honeybee	-	-	1.7	**0.002**	-	-	6.7	**0.1**	-	3.3	10.0	**0.03**	-	1.1	6.1	**0.01**

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.

The proportion of intact bucks in this study was (7.4% in lowland, 6.2% in midland and 8.8% in highland. The finding in the present study is comparable with the study by Tsedeke (2007) which reported 6.0% around Alaba; but it is higher than the study around Metema which was estimated at 5.3% (Tesfaye, 2009) and it is lower than 18.9% for Sidama goat (Markos, 2000) and 22.1% for Arsi-Bale goats in rift valley areas and 25.3% for Keffa goats in South Western Ethiopia (FARM-Africa, 1996).

The overall does ownership in a flock was estimated at 6.08±9.0 per house hold with overall proportion estimated as 32.5%. The mean does ownership in lowland, midland and highland were 11.82±15.0, 3.9±1.66 and 2.52±1.03 heads per household respectively. The proportion of breeding does in the study area was 33.3%, 33.2% and 29.5% in lowland, midland and highland areas respectively. This result was similar to the work of Markos (2000) who has estimated 32.2% of does in Sidama zone and Tsedeke (2007) who has reported (39.3%) in Alaba.

The proportion of young age buck (aged between 6 and 12 month) in the current study was lower than the corresponding female counter parts in all agro ecologies. 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. The selling of goats at early age may not allow the goats to express their genetic potential that may lead sale genetically outstanding goats at earlier age, as a result the genetic materials becomes eroded. This will leads into down ward selection through sale of outstanding breeding male. Therefore, it is important to design producers based genetic improvement strategy to revert this situation.

Table 10 Goat Flock Structure by Agro ecology, sex and Age group

Age of goat in month & by sex	Agro ecology												Overall (N=180)			
	Lowland(n=60)				Midland(n=60)				Highland(n=60)							
	Range	N	Mean ±SD	%	Range	n	Mean±SD	%	Range	n	Mean ± SD	%	Range	n	Mean± SD	%
Male <6	0-14	201	3.3±2.96[a]	9.4	0-5	92	1.5±0.98[b]	13	0-6	66	1.1±1.00[b]	13	0-14	359	1.9±2.12	10.7
Female < 6	0-28	282	4.5±5.22[a]	13	0-4	95	1.5±1.01[b]	13.5	0-6	66	1.1±1.13[b]	13	0-28	443	2.3±3.51	13
Male 6 to 12	0-17	219	3.6±3.43[a]	10	0-4	76	1.2±0.92[b]	10.8	0-2	44	0.7±0.69[b]	8.6	0-17	339	1.5±2.43	10
Female 6-12	0-30	348	5.7±5.39[a]	16	0-5	89	1.4±1.27[b]	12.6	0-4	71	1.1±0.91[b]	14	0-30	508	2.5±3.85	15
Male >12	0-14	145	2.30±2.54[a]	7.4	0-4	44	0.73±0.78[b]	6.2	0-2	45	0.75±0.68[b]	8.8	0-14	234	1.3±1.76	7
Female >12	0-103	709	11.5±15.0[a]	33.2	0-8	234	3.9±1.66[b]	33.2	0-5	151	2.52±1.03[b]	29.5	0-103	1094	6.08±9.	32.5
Castrate	0-25	243	4.0±4.07[a]	11	0-4	75	1.27±1.01[b]	10.6	0-3	68	1.13±0.87[b]	13.3	0-25	386	2.1±2.81	11.5
Total		2147		100		705		I00		511		100		3363		100

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

4.6. Mode of Acquisition and Disposal of Goat by households

Major route of goat acquisition and disposal for both sexes in three agro ecologies is presented in Table 12. Farmers mainly possess male goats from their own farm (78.9%), purchase (8.3%) and a combination of farm and purchase sources (10.0%). Farmers in different agro ecologies acquire female goats from different route. Farmers in low land possess female goats mainly from their farm and purchase (60%), whereas in midland and highland the majority of farmers own female goats through purchase (56.7% and 45%) respectively). The respondents in the midland and highland indicated that the sources of female goats are both purchase and their farm as perceived by 23.3% and 32.2% of the farmers in the study area, respectively. The result shows higher intention of purchasing female to that of male attributed to the producers preference to females to initiate goat production and the major purpose of buying goat is for breeding focusing to females.

The major mode of exit of male goats from flock in lowland was by combination of sale, death and slaughter (88.3%), where as 68.3% in midland and 36.7% in highland exit through combination of sale, death and slaughter for domestic consumption and 21.7% in midland and 41.7% in highland exit by sale alone. Exit route for females from the flock in low land areas were mainly by both sale and death together (30%) and the major exit routs were combinations of sale, death and donation (56.7%). The exit trend is similar in the midland goats are leaving the farm through sale (30%), sale and death together (23.3%) and combination of sale, death and donation (36.7%). In the highland sale contribute the highest (48.3%) and followed by combination of sale and death (25%). In all the cases purchase of male goats and slaughter of female goat were not a usual practice in the process of goat possession and disposal. Especially farmers did not practice slaughtering of breeding does for cultural reasons. It was also observed that donation of male goat as gift was not frequent. The limited practice to buy male goats outside the farm reduces the proportion of new incoming and unrelated breeding buck into the flock which might result to induce the risk of inbreeding in the population.

Table 11 Mode of goat acquisition and disposal in different agro ecologies of Darolabu district

Modes of acquisition/Loss	Lowland		Midland		Highland		Overall	
	N	%	N	%	N	%	N	%
Acquisition of male								
On farm born	49	**81.7**	48	**80**	45	**75**	142	**78.9**
Purchased	1	1.7	5	8.3	9	15	15	8.3
Gift	0	0	1	1.7	1	1.7	2	1.1
On farm born and Purchased	10	16.7	4	6.7	4	6.7	18	**10**
On farm born, Purchased & gift	0	0	2	3.3	1	1.7	3	1.7
Acquisition of female								
On farm born	2	3.3	7	11.7	8	13.3	17	9.4
Purchased	13	21.7	34	**56.7**	27	**45**	74	**41.1**
Lone	0	0	0	0	2	3.3	2	1.1
Gift	0	0	3	5	14	23.3	17	9.4
On farm born and Purchased	36	**60**	14	23.3	8	13.3	58	**32.2**
On farm born, Purchased & gift	8	13.3	2	3.3	0	0	10	5.6
On farm born and lone	1	1.7	0	0	1	1.7	2	1.1
Modes of disposal Male								
Sale	1	1.7	13	21.7	25	**41.7**	39	**21.**7
Sale and death	6	10	6	10	8	13.3	20	11.1
Sale and slaughter	0	0	0	0	5	8.3	5	2.8
Sale, death and slaughter	53	**88.3**	41	**68.3**	22	36.7	116	**64.4**
Modes of disposal Female								
Sale	5	8.3	18	**30**	29	**48.3**	52	**28.9**
Death	3	5	6	10	5	8.3	14	7.8
Sale and death	18	**30**	14	23.3	15	25	47	26.1
Sale, death and Donation	34	56.7	22	36.7	11	18.3	67	**32.7**

N= Number of Household

4.7. Grazing management

The type of grazing land used for goat flock, grazing methods practiced in different agro ecologies and indigenous herding practices of goat in dry and wet season in the three agro-ecologies (lowland, midland and highland) is presented and discussed under this subsection.

4.7.1 Grazing Land

There are two kinds of grazing lands which included communal and private owned grazing land. The proportion of households that uses communal grazing land showed variation among agro-ecologies. Farmers made use of both communal and private grazing land as responded by 48.3%, 58.3% and 31.7% households in lowland, midland and highland respectively. Proportion of farmers used communal grazing land alone was 46.7% in lowland, 30.0% in midland and 51.7% in highland areas varied with the availability of communal lands. Comparable proportion was reported in Oromia region which stated that, 50%-75% of the sampled households use own and communal land where as in Dega 45% households use both private and communal grazing land (Workeneh and Rowland, 2004). The communal grazing land indicated in high land area were in a form of area enclosures on the chains mountains in which the government assisted enclosed land for rehabilitation purpose, roadside grazing land and riverside grazing lands. In the lowland they mentioned that, there are communal grazing lands around river sides, bushy and shrubby lands at distant semi dry parts of the low land. They are decreasing in size with time because of over population, settlements, cropping and drought. The communal grazing areas are poorly managed this calls participatory communal grazing areas management as to improve the productivity and proper utilization of communal grazing lands.

4.7.2 Grazing Method

Natural pasture was the main feed resources for their animals; this is in agreement with a number of reports in Ethiopia (Alemayehu, 1993; Abule, 2003). Grazing method is significantly different among the agro ecologies both in wet and dry season of a year. In the dry season, majority of the households (81.7%) in lowland, (48.3%) in midland and (40%) in highland allow free grazing in the grazing land herded by family members close to watering points. Some of the households (5%) in low land, (23.3%) in midland and (23.3%) in highland use herded grazing, tethering and zero grazing interchangeably.

In the wet season 41.7% of households in low land use herded grazing alone, 41.67% use combination of herded grazing, tethering and zero grazing (cut and carry system) and the

remaining 16.67% use herded grazing and tethering. On the other hand 41.67% in midland and 46.67% in highland respondents use herded, tether and zero grazing; and 35% of the respondent in midland and highland usually use herded grazing and tether together (Table 13).

The grazing practice in the current study 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. Tethering is a practice used to ensure labor and feed efficiency. The study conducted in sheep in Jimma Zone showed that, tethering is practice during the wet season to control crop damage and as a mechanism of controlling animals (Berhanu, 1998). A preliminary survey in South Western part of Ethiopia showed that more than 70% of farmers practice tethering of sheep during cropping season (Berhanu, 1998). However, a significant weight lose has been observed during this period due to tethering of sheep in a fixed peg for a long period. This was attributed to restricted selective grazing; poor feed intake and higher infestation by parasites (Romney *et al.*, 1996).

Table 12 Percentage of household using different grazing method in the three agro ecologies

Grazing method indifferent season	Lowland		midland		highland	
	N	%	N	%	N	%
In dry Season						
Herded grazing	49	81.7	29	48.3	24	40.0
Tethered	0	0	5	8.33	3	5
Herded, paddock & tethered	3	5	14	23.3	14	23.33
Herded and tethered	8	13.33	12	20.0	19	21.7
In wet Season						
Herded grazing	25	41.7	3	5	1	1.67
Tethered	0	0	5	8.33	4	6.67
Herded, paddock & tethered	25	41.67	25	41.67	28	46.67
Herded and tethered	10	16.67	21	35.0	21	35.0
Total	60	100	60	100	60	100

N = number of observation

4.7.3 Goat herding practices

In the study area all classes of goat are herded together except new born kids who were kept separately in the house. There is no any practice of keeping breeding bucks and does separately; which implies uncontrolled breeding and could induce early conception without physiological development and reduce productive life time of the goats. The proportion of households mixing goat with other flock and species in lowland, midland and highland agro ecology is given in Table 14.

In lowland 61.67% of the farmers keep goat separately from other species and 21.67% mix goat with cattle, sheep and camel. In midland agro ecologies 25% of the goat owners keep goat separately, 50% mix all species and 18% keep them with cattle. In highland 23.3% mix only with cattle, 10% with sheep, 36.67% do not mix with other species and 28.33% do not care about species mixes and they keep with any species. In all agro ecologies the practice of flock mixing is high; especially in lowland and highland areas due to the existence of larger communal grazing areas that goat owners lets their goat to graze. In mid land flock mixing is practiced during dry season and during after math grazing. Numbers of flocks mixed in different agro ecologies was not statistically different (Table.15).

Figure 2 Goat flock at grazing field mixed farming (a) and agro Pastoral area in lowland (b)

Table 13 Percentage of households mixing goat flock with other species and herding practices across agro ecologies

Herding/Mixing	Agro ecology					
	lowland		Midland		highland	
	N	%	N	%	N	%
How goat flock is herded during day time						
Male and female are separated	0	0	1	1.67	1	1.67
Kids are separated	39	65	34	56.67	26	43.33
All classes of goats herded together	21	35	25	41.67	33	55
Mixing with other animals						
With cattle	4	6.67	11	18.33	14	23.33
With sheep	4	6.67	4	6.67	6	10
With camel	1	1.67	0	0	0	0
With calves	1	1.67	0	0	1	1.67
All species herded together	13	21.67	30	50	17	28.33
Goat separately herded	37	61.67	15	25	22	36.67
Mixing with other goat flock						
Goat of a household run as a flock	24	40	19	31.67	29	48.33
Goat of more than one household run as a flock	36	60	41	68.33	31	51.67

N = number of observation

Most of the households (76.7%) in lowland and (61.7%) % in midland and very few in highland (5.0%) moves their animals in searching of feed and water. The proportion of house hold members practicing movement of goats out of their place to search for feed and water during dry period was estimated as 83.7%. Most of the respondent (65.1%) moves all species of animals and 25% of the respondents move only cattle and goat as they are the dominant species in the area. Mean distance and time of stay during movement is presented in (Table 15). Distance and duration of stay of goat owners during movement is larger for households in lowland followed by midland and smaller for those in highland. This difference is related with higher number of animals per household in lowland, medium number in midland and smaller number in highland. House hold feed and water requirement is higher in the lowland attributed to higher livestock number in lowland and scarcity of water in the lowlands which requires traveling long distances.

Table 14 Duration of stay, Distance from home during livestock movement, number of flocks mixed while herding and length of grazing time

Duration of stay/Distance to move	Agro ecology						Overall (N=180)	
	Lowland(n=60)		Midland(n=60)		Highland(n=60)			
	Range	Mean ± SD	Range	Mean± SD	Range	Mean ± SD	Range	Mean± SD
Duration of stay (Month)	2-12	4.32±1.76[a]	1-5	2.8±0.97[b]	2-3	2.3±0.58[b]	1-12	3.6±1.64
Distance from home(Km)	14-70	32.89±15.3[a]	7-50	25.27 ±12.3[a]	6-20	11±7.8[b]	6-70	28.9± 14.7
Number of flocks mixed	0-6	3.45±1.3	2-15	3.71±2.09	2-7	3.35±1.2	0-15	3.53±1.61
Grazing Length at wet season(hrs)	2-12	6.4±2.45	2-10	5.73±1.98	2-10	6.15±2.15	2-12	6.1±2.2
Grazing Length at dry season(hrs)	4-12	8.03±1.86[a]	3-12	6.87±1.94[b]	3-11	7.11±2.29[b]	3-12	7.34±2.1
Distance to water area km	0.5-70	8.27±10.78[a]	0.5-21	4.18±4.4 [b]	1-21	3.0±3.43[b]	0.5-70	5.15±7.3

[a,b] means on the same row with different superscripts are significantly different (P<0.05);N= Number of observation, SD=Standard deviation.

Average grazing length in hours per day for goat in wet season was 6.4 hrs, 5.73hrs and 6.15hrs in lowland, midland and highland, respectively, and the variation among agro-ecologies was not significant (p>0.05), however there was significant variation in dry season. In the dry season there was significant (p<0.05) variation on the distance traveled in search of feed and water and goats can travel up to 8,27 km in the lowland, 4.18 in the midland and 3.0 in the highland. This is because goat owners' travel a long distance to communal grazing areas in lowland so that they stay there till rain comes and this ultimately prolongs the grazing time outside the villages. In contrary in midland and highland producers move with their animals daily in the morning and night this shorten the grazing time per a given day.

4.8. Feed resources and Feeding

Type and seasonal availability of feed resources, crop residues, supplementary feeds and utilization are described under this sub section.

4.8.1. Natural pasture and Browse

Major feed resources used in different agro ecologies during wet and dry seasons are presented in (Table 16 and 17). Accordingly; natural pasture, crop residue and hay (chinki) are the first, second and third feed resources used in wet season with an index of 0.30, 0.27 and 0.07, respectively. Whereas crop residue, natural pasture and Trees/shrubs are the first, second and third during dry season with index of 0.35, 0.27 and 0.15, respectively. The focus group discussion was made on utilization of concentrate and established pasture and it was noted that, in lowland areas the practice of concentrate feeding and established forage was very limited, however, the practice of concentrate feeding and use of established forages is in a better position in the midland and highland agro ecologies. The drought, erratic rain distribution and inaccessibility of producers to extension service in lowland areas has hampered not to use established and improved forages. Similarly many reports (Teshome, 2006; Tsedeke, 2007; Belete, 2009) indicated that natural pasture is the main feed resource for small ruminants and cattle. Trees and shrubs are frequently browsed by goat when there is feed shortage and in the dry season.

The focus group discussion revealed the common trees/shrubs used and preferred by goat in the area were "Wallensu (*Erythrina abyssinica*) Waddessa (*Cordia africana*), Hamarressa (*Carewia bicolor*), Hagamsa (C*arissa edulis*), Shiferaw (*Moringa oleifera*), Jirmee(*Acacia poly acanthi*), Biiqa (*Combretum malle*), Baddano (*Balanites aegyptica*), Grar (*Acacia spp), Ejersa (Oleo Africana),* Ceeka(C*eltis Africana*), Xaxechaa (*Rhus glutinosa*), Obicha (*Vernonia amygdalina*) and Knin Zaaf (*Azadirachta indica)*". Though these trees and shrubs are palatable and preferable by goats and other livestock species in the area; they are endangered and declining from year to year due to deforestation for crop land expansion and for fire wood, population pressure, overgrazing and bush encroachments. Therefore, the soil and water conservation schemes should maintain these shrubs to benefit from dual purpose advantages of the shrubs so that the browse can be used as forage and it can also conserve water and soil in the degraded lands.

4.8.1.1. Crop Residues

Type and utilization of crop residue used in the area across the three agro ecologies are given in (Table 17). As crop residue is the major feed resource in Daraolabu; there are a wider and diversity in terms of type, source and utilization of crop residue. There was also utilization of some non conventional feed sources like chat (*Chata Indulis*) left over (Garaba), sweet potato vines and maize at milking stage and crop tillers (chinki). Based on the response of households, 73.9%, 69.4% and 48.0% fed their animals with maize, sorghum and chat residues respectively. Utilization of chat left over as animals feed is practiced throughout the year as chat is chewed by the family members all year round. Others like maize, sorghum, sweet potato and haricot bean residues are used in dry season after crop harvest; whereas crop tiller is available in wet season.

Different reports shows use of crop tillers as animal feed (Tsedeke, 2007; Yeshitila, 2007; Deribe, 2009) around Alaba and Chat left over (Belete, 2009) around Goma district Jimma zone . Workneh (*2000*) also stated that leftover of chat provides a large amount of browse supplement for livestock, especially for goats.

Table 15 Ranking of Major feed resources in wet and dry season in different agro ecologies (%)

Major feed resources	Lowland				Midland				Highland				Overall		
	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**
I. Wet Season																
Natural pasture	95.0	1.7	-	**0.48**	83.3	1.7	10.0	**0.44**	71.7	15.0	1.7	**0.41**	83.3	6.1	3.9	**0.30**
Established Pasture	-	3.3	3.3	**0.02**	-	11.7	1.7	**0.04**	1.7	5.0	1.7	**0.03**	0.6	6.7	2.2	**0.03**
Hay	1.7	5.0	16.7	**0.05**	3.3	5.0	13.3	**0.06**	-	20.0	16.7	**0.09**	1.7	10.0	15.6	**0.07**
Crop residue	-	66.7	25.0	**0.26**	10.0	63.3	15.0	**0.29**	18.3	41.7	21.7	**0.27**	9.4	57.2	20.6	**0.27**
Fallow land	-	10.0	25.0	**0.08**	3.3	6.7	18.3	**0.07**	-	5.0	10.0	**0.03**	1.1	7.2	17.8	**0.06**
Concentrate	1.7	1.7	23.3	**0.05**	-	8.3	30.0	**0.08**	-	6.7	28.3	**0.07**	0.6	5.6	27.2	**0.07**
Trees/shrubs	1.7	11.7	6.7	**0.06**	-	3.3	11.7	**0.03**	8.3	6.7	20.0	**0.10**	3.3	7.2	12.8	**0.06**
II. Dry season																
Natural pasture	51.7	5.0	21.7	**0.31**	30.0	18.3	26.7	**0.26**	35.0	13.3	8.3	**0.23**	38.9	12.2	18.9	**0.27**
Established pasture	-	-	-	**-**	-	3.3	5.0	**0.02**	1.7	-	-	**0.01**	0.6	1.1	1.7	**0.01**
Hay	-	15.0	1.7	**0.05**	5.0	16.7	10.0	**0.10**	1.7	20.0	16.7	**0.10**	2.2	17.2	9.4	**0.08**
Crop residue	35.0	31.7	16.7	**0.31**	50.0	31.7	10.0	**0.37**	55.0	25.0	11.7	**0.38**	46.7	29.4	12.8	**0.35**
Fallow land	-	1.7	1.7	**0.01**	1.7	-	6.7	**0.02**	-	5.0	5.0	**0.03**	0.6	2.2	4.4	**0.02**
Concentrate	5.0	20.0	23.3	**0.13**	3.3	23.3	6.7	**0.11**	3.3	21.7	28.3	**0.14**	3.9	21.7	19.4	**0.12**
Trees/shrubs	8.3	26.7	35.0	**0.19**	10.0	6.7	35.0	**0.13**	3.3	15.0	30.0	**0.12**	7.2	16.1	33.3	**0.15**

Index = sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for a particular feed type divided by sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all feed resources in an agro ecology

Use of these diverse feed resources is a means to cope up the feed scarcity in the households. The improvement of cereal crop residues is suggested to improve the quality of feed and improve livestock productivity.

Table 16 Types of crop residues commonly used in different agro ecologies

Type of crop residue	Agro ecology						Overall	
	Lowland		Midland		HighLand			
	N	%	N	%	N	%	N	%
Chata Indulis	31	51.7	31	51.7	25	41.7	86	48.0
Sorghum	46	76.7	40	66.7	39	65.0	125	69.4
Maize	47	78.3	44	73.3	42	70.0	133	73.9
Sweet potato	6	10.0	12	20.0	13	21.7	29	16.1
Haricot bean	6	10.0	2	3.3	5	8.3	13	7.2
Crop tillers "Chinki"	5	8.3	5	8.3	10	16.7	20	11.1

N= Number of observation

4.8.1.2. Supplementary feeding

About 97.8% of the respondent in the study area indicated that, the farmers supplement goat in all agro ecologies. The supplementation was practiced in both in dry and wet season for goats as responded by 85.6 % of the house hold and 12.8% of respondent supplement goats in the dry season. Inclusion of salt with supplementary feeds is frequent by all of the households. Goat owners in Hararghe including in Darolabu district use a diverse feed supplements (concentrate) either in mixture or alone. Some of these supplementary feed resources are homemade grain (either fresh or roasted from maize, sorghum and haricot bean), chat left over, maize at milking stage, Oilseed cake (Fagulo), "Abish/Marara/Yeast", local products (Atela, Kitchen leftover), maize floor and boiled grains (i.e. maize, sweet potato, haricot bean) as shown in Table 18. The finding of the present study is in agreement with reports of Deribe (2009) in Alaba Woreda. According to interviewed household 36.7% supplement feeds without mixing, 46.1% supplement as a mixture feed ingredients and 17.2% supplement both way of supplementation (mixed and alone) interchangeably. The households practice preferential supplementation for some classes of goats. About 98.9% of the household preferentially supplement different category of goat. Fattening goat (52.2%) has got priority to be supplemented, followed by lactating goat (20.8%) and 21.7% of the respondent supplement both fattening and lactating goat.

Table 18 Type and ranking of most commonly used supplementary feeds for fattening goat by small holder farmers in different agro ecologies of the study area (%).

Type of concentrate	Lowland				Midland				Highland				Overall			
	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**
Home made grain (Roasted grain)	100.0	-	-	**0.5**	95.0	5.0	-	**0..49**	66.7	23.3	10.0	**0.43**	87.2	9.4	3.3	**0.47**
Oilseed cake (marara/Abish/fagulo	-	13.3	66.7	**0.16**	-	15.0	50.0	**0.13**	6.7	8.3	38.3	**0.13**	2.2	12.2	51.7	**0.14**
local brewery by product(Atela)	-	-	10.0		-	5.0	30.0	**0.07**	8.3	15.0	26.7	**0.14**	2.8	6.7	22.2	**0.07**
Flour by product from maize	-	81.7	16.7	**0.30**	3.3	75.0	20.0	**0.30**	18.3	51.7	25.0	**0.31**	7.2	69.4	20.6	**0.30**
Boiled maize	-	5.0	6.7	**0.0.03**	1.7	-	-	**0.01**	-	1.7	-	**0.01**	0.6	2.2	2.2	**0.01**

Index = sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for a particular feed type divided by sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all feed resources in an agro ecology.

4.8.2. Seasonal Feed resource Availability

According to the respondent there is seasonal variation in feed resource availability in a year. Feed shortage is serious for four months from January to April, as responded by 95.0%, 98.3% and 85.0% of the households in lowland, midland and highland respectively (Table 19). Goat owners take different measures to mitigate the challenges differently in different agro ecologies. The use of crop residue, tree leaves, migration, supplementary feeding are some of the measures taken by producers. The shortage of rainfall as perceived by 79.4 % of the respondents is the major cause of feed shortage and drought (12.8%) is the second reason and the rest indicated the shift of grazing land to cropping and over population which contributed to feed scarcity in the area.

Table 19 Seasonal variation in feed resources and responses during feed shortage

Factors	Lowland		Midland		Highland		Overall	
	N	%	N	%	N	%	N	%
Peak period for feed shortage								
Dry Season	57	95.0	59	98.3	51	85.0	167	92.8
Wet season	1	1.7	1	1.7	6	10	8	4.4
Post rain	2	3.3	0	0.0	3	5.0	5	2.8
Responses to feed shortage								
Use of crop residue	9	15.0	10	16.7	27	45.0	46	25.6
Trees and leaves	10	16.7	9	15.0	7	11.7	26	14.4
Movement	11	18.3	7	11.7	1	1.7	19	10.6
Concentrate feeding	7	11.7	11	18.3	7	11.7	25	13.9
Planting Elephant grass	1	1.7	2	3.3	3	5.0	6	3.3
Both crop residue& tree leaves	7	11.7	14	23.3	7	11.7	28	15.6
Use combination of all of the above	15	25.0	7		8		30	16.7

N= Number of households; Dry season = January, February, March, April; Wet = May, June, July, August; Post rain= September, October, November, December

4.9. Water resources and Utilization

The water source for human and animal consumption was diversified. Water sources were different among agro ecologies in different seasons of a year. Pond water was reported to be the major water source as responded by 45%, 73.3% and 20% of the households in the lowland, midland and highland, respectively during dry season. Other sources of water during dry season

were river water (10% in lowland, 41.7% in highland), spring water (18.3% in highland), both borehole and pond (21.7% in lowland, 16.7% midland and 11.7% highland) and respondents use water from river, pond and borehole in combination as responded by 16.7% in lowland, 10% in midland and 6.7% in highland in the dry season

In wet season the major sources of water in lowland as responded by households were pond (61.7%), borehole & pond (36.7%). Whereas, in midland the main source of water was pond (46.7%), the others are river, spring and both pond and borehole that comprises 13.3%, 1.7% and 38.3% respectively. In highland the main source of water are pond, river, spring and both borehole and pond together in rainy season as responded by 21.7%, 35.0%, 21.7% and 20.0% of the house holds, respectively. In the drier part of the years a number of animals are using the pond , this could have health problem attributed to contaminations and pollution. Therefore, any rural development activity should give emphases in the provision of clean water to both animal and human consumption. The water development projects should involve the community as to sustain clean water supply and maintenance of water points.

The kid management during watering was not consistent among households. About 60% of goat owners separate kids from adult during watering and 40% do not separate while watering. Almost all of the respondent water smaller kids at home. Watering frequency among households and agro-ecologies showed inconsistency. The majority of the respondent provide water to goats once a day (60%) in wet season and (73.3%) in dry season in lowland. The frequency of watering in the midland was once a day as responded by 90% o f the households in wet season and 65.0% in dry season. The highlanders water their goats once a day as responded by 60% of the households in wet season and 58.3% in dry season (Table 20). The proportion of households that water goats once in two days were 16.7%, 28.3% and 18.3% in lowland, midland and highland respectively. The farmers are compelled to provide water after extended period of interval due to poor access to water and long distance to water source which determines the frequency of watering. According to group discussions watering frequency depends on season, availability of water, distance from watering point and labor availability. The present study concurs very well with the findings reported indifferent parts of Ethiopia (Belete, 2009; Deribe, 2009).

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

Factors	Lowland		Midland		Highland		Overall	
	N	%	N	%	N	%	N	%
Frequency of watering in wet season								
Freely available	23	38.3	4	6.7	16	26.7	43	23.9
Once a day	36	60.0	54	90.0	36	60.0	126	70.0
Once in 2 days	1	1.7	1	1.7	3	5.0	5	2.8
Once in 3 days	0	0.0	1	1.7	3	5.0	4	2.2
twice per day	0	0.0	0	0.0	2	3.3	2	1.1
Frequency of watering in dry season								
Freely available	1	1.7	0	0.0	5	8.3	6	3.3
Once a day	44	73.3	39	65.0	35	58.3	118	65.6
Once in 2 days	10	16.7	17	28.3	11	18.3	38	21.1
Once in 3 days	5	8.3	0	0.0	6	10.0	11	6.1
twice per day	0	0.0	4	6.7	3	5.0	7	3.9

N= Number of observation. P –value taken from Chi -square test

The water quality is classified by the community. Respondents classify water into clean (55%), muddy (23.3%), smelly (15.6%) and muddy and smelly at same time (4.4%) during rainy season. During dry season they categorize into clean, muddy, salty, smelly both muddy and smelly as responded by 52.2%, 7.2%, 3.3%, 22.2% and 12.8% of the households, respectively. Muddiness and smell of water in wet season is associated with flood and intrusion of different livestock species. The respondents relate the impurity of water with intrusion of animals, long time storage of water in a pond and high density of livestock population using the watering point and waste mix which can expose animals to water born diseases associated to water contamination.

Distance from the village to watering point is significantly different between lowland and other two agro ecologies at ($p<0.05$). The overall mean distance from the villages to the water points was estimated as 5.15±7.3 kilometers (Table 15). The lowland households travel the longest distance (8.27km), the highlanders travel the shortest distance (3km) and the midland households travel intermediate distances (4.18km).. The distance recorded in the current study is slightly lower than the one reported in southern Ethiopia Alaba which estimated as 7.07km (Deribe, 2009). The trekking of animals for long distance to watering point in the study area could influence performance of the animals through reducing the grazing length, lower feed intake and

energy loss. Loss of energy and time while travelling to and from water points was so reported (Samuel, 2005). Prolonged interval of watering frequency reduced feed intake, declined milk yield and other physiological disorders (Deribe, 2009). Therefore, there is a need to develop watering points as to exploit the genetic potentials of goats and improve productivity and the benefits from the livestock sector.

4.10. Housing system

Housing is a segment of the goats husbandry practices. Different goat housing system is used in the study area to protect goats from predator, theft and uncomfortable weather. The majority (61.7%) of households in lowland use separate hut which is made of grass (68.3%), plastics sheet (8.3%), Iron sheet(18.3%) and soil roofs (5%).The low land households are sharing family house with goats (30%) and uses veranda where the veranda has a shed (8.3%). Family houses shared with goats (53.3%), separate hut with roof (43.3%), fenced barn without roof (3.3%) are common housing system in midland. In highland the majority of the respondent share their family house (58.3%) and 41.7% of the respondent has separate hut with roof for goats. The roofs are mostly made from grass (65% in midland and 71.7% in highland) and corrugated iron sheet (33.3% in midland and 28.3% in highland). The floor of the goat house as responded by 95% of the households is made of soil in all agro ecologies. The sharing of the house depends on the flock size per household. The households with small flock size share their living house and a compartment is created using simple woody materials or they tie goats in the house to restrict their movement. The household with a large flock prepare separate housing unit. The use of open burn 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 reports by Lemma (2002) and Deribe (2009) that poor housing favors disease and other complexes due to overcrowding in traditional production system.

Majority (62.2%) of the household keep kids and milking does separately and milking goats and kids join in morning and in the evening while milking. The households are sheltering goats either alone or mix them with other species of livestock. There farmers shelter goats with other species

as responded by 66.1% of the household and the remaining (33.9%) do not mix goats with other animals during night enclosure. The proportion of households who house goats with sheep and calves were 53.3% and 46.7% of the sampled household in lowland, respectively. In midland 80% of the respondent enclose goats with sheep and 15% shelter with calves and 5% mix all species together. In the highland 57.7% of the respondents house goats with calves, 23.1% with sheep, and 5.5% of the respondents mix all species together and the rest enclose goats separately. Housing of goat with large animals leads to physical injury. Therefore, housing of goats based on age category is recommended to keep the comfort of the goats and reduce injuries.

Figure 3 Barn house without hut (a) and House with hut goat housed with calves (b)

4.11. Castration and Fattening Practices

Castration and fattening is practiced in the study area. Almost all(93.3%) of the sampled households practiced goat fattening. The proportion of farmers who practice fattening are 95% of house hold in lowland, 98.3% in midland and 86.7% in highland. Farmers in low land fatten 1-12(1.86±1.7) goats per year and there was significantly different ($p<0.05$) from other agro ecologies. In midland the farmers fatten 1-3(1.28±0.52) goats per year. The goat owners in highland areas fatten less number of goats 0-4(1.27±0.66) (Table 21). The variation in fattening practice in favor of the farmers in the lowland are due to larger number of flock owned per house hold, possessing larger grazing areas and goat is one of the major sources of cash in low lands. The length of fattening of goat in the study area is not statistically ($p>0.05$) different among the

three agro ecologies. The overall average length of fattening period is about 12.43±8.5 month. The fattening period is longer. The longer finishing period in the present study might be due to poor feed resource base and poor awareness of the demand for fattened goats. Longer finishing period entails high cost of labor and other variable costs. Therefore, it is important to analyze the economic feasibility of the fattening period and decide the time of finishing to benefit from the long standing experiences of fattening of goats in the studied area. The fattening period of 18 month was reported by Deribe (2009) in Alaba which is longer than the current study.

Table 18 Length of supplementation to castrated buck, length of fattening and number of goat fattened in the area

Variable	Lowland(n=60)		Midland(n=60)		Highland(n=60)		Overall (N=180)		sig
	Range	Mean ± SD	Range	Mean± SD	Range	Mean ± SD	Range	Mean± SD	
Minimum number of goat fattened /year	0-12	1.86±1.7[a]	1-3	1.28±0.52[b]	0-4	1.27±0.66[b]	0-12	1.48±1.13	0.005
Maximum number of goat fattened /year	2-13	4.1±2.4[a]	2-5	2.88±0.96[b]	2-6	2.65±0.95[b]	2-13	3.23±1.73	0.000
Length of fattening period(month)	2-36	12.28±8.2	3-36	12.71±8.87	2-36	12.31±8.59	2-36	12.43±8.5	0.95
Age of castration (yr)	1-5	2.1±0.7	1-5	2.1±0.8	1-5	2.0±1.1	1-5	2.1±0.8	0.76
Length of supplement for castrate(days)	1-30	6.5±3.7	3-30	7.5±3.5	2-30	8.1±6.9	1-30	7.3±5.0	0.21

N=Number of observation; SD= Standard deviation; [a, b,] means on the same row with different superscripts are significantly different (P<0.05)

The farmers prefer a certain category of goats for fattening. The type of goats preferred by the farmers for fattening in the three agro ecologies is shown in Appendix Table 4. Wether, buckling and doeling are the first, second and third classes of goat that are preferred to be fattened with an index of 0.40, 0.31 and 0.09 in all agro ecologies respectively. This indicates the fact that, most breeding does are retained in the flock for breeding purpose and are kept for longer period in the herd and as a result the proportion of breeding does are higher in the flock.. The breeding bucks are quickly castrated and immediately sent to fattening at early age and supplied to market. Age of castration for bucks is more or less the same across the three agro ecologies and the age of castration was 2.1±0.7 year in lowland, 2.1±0.8 year in midland and 2.0±1.1 year in highland. Some author reported that buckling at early ages can serve a small number of females in a flock

but at two years of age, bucks are considered adult and capable of serving a large number of does (Richard, 2009). Workneh (1992) estimated age of castration after two to four year of service in Southern Ethiopia which is by far higher than the current study. From the idea rose during group discussion some males with good body conformation, fast growing once are castrated at early age and enter into the fattening program. The castrating and fattening of male goats at early age reduces the opportunity of retaining best breeding buck in a flock and instead weak and undesired breeding bucks increased in a flock this negatively affect the feature of the breed improvement in the next generation. Castration of the lambs and kids for fattening and the consequences of castrating good looking goats and sheep has been reported from different parts of the country (Solomon et al., 2005; Tsedeke, 2007; Belete, 2009; Deribe, 2009).

Castration is practiced by 97.2% of the goat owners in Darolabu district in all agro ecologies. The households have a reason to castrate male goats. The proportion of households were 51.4% relate castration with improving fattening, 5% respondents associate with better temperament, 27.7% of respondents relate with improving both temperament and fattening and 14.1% of the respondents relate with controlling breeding and improve fattening together. The period of fattening is not uniform among households and 44.1% of the respondent made castration during rainy season, 41.2% practice castration in both wet and dry season while the rest 13.6% castrate male goats in the dry season. Season of castration is related with availability of feed resources, water and labor. In the absence of labor in the household bucks are castrated at any time in a year to reduce bad temperament of breeding bucks and ease of management. The farmers use different methods for castration and 71.2% of household use wood made castrating material and 23.3% use iron made hammer to castrate bucks. On average a castrated buck was supplemented with supplemental feed for 7.3±5.0 days during the first week of castration in a similar fashion in all agro ecologies.

Figure 4 Fattened castrate Hararrghe highland Goat

4.12. Origin and Distribution of Goat Breeds in the study Area

Focus group discussions which were made with community elders showed that, the majority of the goats in the study area are locally called “Shanyo” which is to mean those goats type with no horn and with brown and/or white color. From the assessment made with goat owners through questioner most of the farmers (55%) reported that *Shanyo* goat has been kept by these communities for longer period. Few farmers (6%) indicated that, Shanyo goats were introduced from adjacent areas Somali and Afar regions where as 39% of respondent do not know the origin or route of this goat type. The *Shanyo* goats as responded by 35.6% of the interviewed farmers are kept only by Hararghe community and 61.7% indicated the existence of this goat type in the adjacent zones like Arsi, Bale, Somali and Afar regions. The present study indicated that, there is a wide range distribution of goats and the exchange of the genetic material across adjacent regions and zones.

The farmers have indigenous knowledge in classifying goats based on some attribute. In general the community classifies the local goats into four groups based on color, size, and presence of horn and tail type. The first class is “shanyo” those goat with no horn, medium size commonly brown and white coat color and they are the dominant in the studied areas in all agro ecologies. This could be the typical Haraghe highland goat (Alemayhu, 1993 and Farm Africa, 1996) which has been described as Hararghe Highland goat which are predominantly white/brown and with high proportion of poldness characteristics. This shanyo types are dominant goat types in Boke,

Habro and Darolabu districts *(*Dereje and Tesfaye, 2009). The second one is locally called "*Quxaxe*" to mean low milk yielder, very small sized and having different coat color (i.e mixture of brown, white and black).

The third type of goat are locally called "*Mayo*" they are believed to be introduced from low lands of Somale region and they are larger in size, white in color and good milk yielders than "shanyo" type. They are hardly found in highland and midland areas and their distribution is relatively higher in lowland area kept by Somale tribes. These goat types could represent long ear somali goat breed which was reported to be distributed in lowlands of Bale adjacent to the study areas (Farm Africa, 1996; DAGRIS, 2004). The fourth type of goat are called Bale type to mean those goat introduced from Bale area with settlers which are light blue in color , which are medium in size and are rarely found in lowland and kept by settlers.

Figure 5 Typical brown &white color bucks and doe "Shanyo" type

4.13. Social Goat Exchange and Utilization

Producers exchange goat on different occasions in the study area. Some of these occasions are in the moment of Wedding (45%), when relatives face serious problem (11.7%), when married women (relatives) appear as guest(7.2%) and 36.1% of the producers exchange goats in combination of moments mentioned above. The respondent were asked wether they have a preference of goat type for the gift and most of the goat owners (76.7%) do not prefer /select

goat for gift or exchange and 23.3% prefer goat for gift and exchange. From the assessment made with this group it was noted that the farmers are not ready to donate best breeding does like “shanyo” type; instead they donate poor performing does. Female does are the dominant sex group that are exchanged or donated in all of the occasions to be used for breeding and male goats required for slaughter during wedding are preferred for donation.

The farmers initiate goat keeping based on various sources. In most cases (82.8%) the community initiates goat production by breeding does and 15% begins with both breeding does and buck. The farmers initiate goat farming through female goats, and bucks could be shared from the community. There are different sources of goats to start goat keeping. The interviewed households indicated different sources to initiate goat production like gift from parent or relatives (11.1%), groom wealth (41.1%), gift and groom wealth together (21.7%) and multiple sources (25%).

4.14. Community preference of Goat coat color

From the assessment made by group discussions and interviewee, farmers have identified unwanted and preferred coat colors in all agro ecologies. Coat color preference in different agro ecology is not different. The respondent preferred particular coat colors which are associated with socio-cultural preference, market demand and adaptation to environmental factors. Goat owners explained that white and brown colored goat has ability to tolerate heat stress. Coat color preference rank in different agro ecology is presented in Table 22

White, brown and grey coat colors are the first, second and third preferred color with an index of 0.38, 0.38 and 0.24, respectively. Majority of the household (83%) do not prefer black color. Goats with black coat color have low price and lowest demand in the market; the second reason was socio-culturally black color has low acceptance by the community. The other type of coat colors that are not preferred by the farmers were mixed color (i.e. mixture of with black white and brown) (16.0%) and grey (1%) color. This result is in agreement with the work around Bonga and Horro (Zewdu, 2008; Gemeda, 2010) which report similar color preference for sheep.

Therefore it is important to consider coat color as important trait in designing genetic improvement strategy based on the producers' preference.

Table 19 Ranking of goat color preference by small holder farmers in different agro ecologies (%)

Goat color	Lowland				Midland				Highland				Overall			
	R 1	R 2	R 3	**Index**	R1	R 2	R 3	**Index**	R 1	R2	R 3	**Index**	R1	R 2	R 3	**Index**
Brown	38.3	50	11.7	**0.38**	35	48.3	18.3	**0.37**	40.0	45	18.3	**0.38**	37.8	47.8	16.1	**0.38**
White	50.0	25	11.7	**0.39**	55	25.0	18	**0.39**	43.3	25	26.7	**0.35**	49.4	28.9	18.9	**0.39**
Grey	11.7	25	65.0	**0.21**	10	25.0	60	**0.23**	16.7	30	48.3	**0.26**	12.8	22.8	57.8	**0.24**
Black	-	-	-	-	-	1.7	-	**0.01**	-	-	1.7	**0.003**	-	0.6	0.6	**0.003**
Mixed color	-	-	11.7	**0.02**	-	-	3.3	**0.01**	-	-	5.0	**0.01**	-	-	6.7	**0.01**

Index = sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for a specific color divided by sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all colors in an agro ecology.

4.15. Reproductive Performances of the Goat under Farmer condition

Assessing the production and reproductive performance of any livestock species in their respective native areas and production system is important; as it determines the ultimate output or commodity of any livestock species. Reproductive performance is a prerequisite for any successful livestock production program (Tesfaye, 2008). 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). The present study has showed the variations in reproductive and productive performance of goats in different agro-ecologies (Table 23).

4.15.1. Kidding Pattern

Kidding takes place at any time in a year across all agro ecologies; but the respondent classify in to two major kidding season in a year. The first and major kidding season was observed from end of August to October and the second kidding time was from May to early July as shown in Appendix Table 3. In most of the cases services took place during short rainy season and kidding becomes evident at the end of the main rainy season. Kidding time of April to June and October to November was reported in Alaba district (Deribe, 2009). Mating is taking place during the short rainy season which might be attributed to availability of forages following short rainy season. The effect of nutrition in facilitating breeding was also reported as demonstrated in the

increase in conception rate and subsequent kidding and it was also argued that, feed rather than photoperiod dictates breeding activity in the tropics and subtropics (Rosa *et al.* 2002).

4.15.2. Age at first Service for females (AFS)

Female goats are ready for mating at different age depending up on breeds and other environmental factors like nutrition, other husbandry practices. The AFS of female showed a significant ($p<0.05$) variation between agro ecologies (Table 23). The overall age at first service of goat in the study area was 12.4±5.6 month. The goats have reached AFS at (14.1±5.6, 13.1±5.7 and 12.0±4.7 month) in lowland, midland and highland, respectively. The difference between low land and midland is not statistically different at ($P>0.05$); but highland was significantly different from the two agro ecologies. The result revealed that those goats in highland reach at first mating earlier than those in lowland and midland agro-climatic zones. The late mating age in the lowland might be attributed to different environmental factors or stress like heat, drought, water and feed shortage and long distance trekking. The age observed in the current study is lower than the one indicated for Arsi-Bale goats which was 14 month in Arsi Negelle and 16 month in Boricha districts (Bahilu *et al*., 2003); and the age at first service in the present study was higher than the report for Sidama goat types which was estimated at 9.76 ±0.24 month (Endeshaw, 2007) and 8.2 ± 1.64 month in Metema area (Tesfaye, 2009). Majority of the goat owners (90%) do not fix age at first mating and 10% of them fix age at first service of female based on body condition.

4.15.3. Age at first service for bucks (AFS)

The majority of farmers did not fix age at first mating for males (92.2%), and the remaining small proportion of farmers fix age at first mating of male (7.8%). The main factor that dictated to fix age of male goats for breeding is to control the body weight loss during mating. The practice of fixing age of male goats was adopted by those producers that fatten males at early age. The study revealed that male goats reach age at first mating at the age of 12.7±5.2 month and there was no significant variation among the three agro ecologies. AFS for male in the three agro ecologies was estimated at 12.8±4.8, 12.4±5.6 and 13.0±5.2 month for in lowland, midland

and highland, respectively. The AFS for bucks in this study is more or less similar to the reports of Endeshaw (2007) who reported 11.13, 12.04, and 10.4 months of age at first mating in Dega, Moist Dega and Moist kola, respectively of Dale district. It is also in agreement with the work of Markos (2000) who revealed the age at fisrt service of 12 month around Awassa Zuria Woreda and Workneh (1992) who had estimated 7-24 month in southern Ethiopia. In contrary to the present study, the shorter age at first mating was reported by Tsedeke (2007) and Tesfaye (2009) estimated at 6.6 month and 7.4 month of age at first service, respectively.

4.15.4. Age at first kidding (AFK)

The overall mean AFK of Hararghe highland goat is 16.6±4.4 month (Table 23). The mean AFK in lowland, midland and highland ecological zones are 17.2±4.1, 17.1±4.6.and 15.5±4.2 month respectively with no significant variation among the three agro ecologies ($p>0.05$). This result is similar to the report for Communal goat in Mootse of Southern Africa (Mamabolo *et al*, 2005) and West African dwarf goats in Chad (Bertaudiere, 1979; Dumas, 1980) who had reported the age at first kidding between 16 and 18 months. FAO (2002) has reported within the range of 13.5 -17.5 months for goat in mixed production system of sub-Saharan African countries. This study did not conccur with the studies that had reported lower (12.46 month) of age at first kidding (Belete, 2009) in Goma district and 13.6 months reported by (Tesfaye, 2009) in Metema district. The variation in age at first kidding among locations might be due to environmental difference like feed, grazing land, water resources, production system differences and breed differences.

4.15.5. Kidding Interval (KI)

Kidding interval of goats in the study area varied significantly with agro ecologies It is significantly longer ($p<0.05$) in highland areas (8.6±2.28 month) than midland (8.0±1.96 month) and lowland (7.6±1.86 month). The variation in kidding interval might be associates with luck of breeding buck in a flock during heat period (Table 23). The feeding management, number of bucks in a flock and herding practice varied with agro ecologies which might have contributed in the variation in kidding interval. The present study in agreement with the findings which have been reported by different authors and estimated as 6.9± 1.29 month around Alaba (Tsedeke,

2007), 8.1 month for (Tatek *et al*, 2004) and 8.57 month (Endeshaw, 2007). The current study is not confirmatory to the studies that had showed shorter parturition interval of 11.5 month (Samuel, 2005) in Adaa and Yerer District and 9.05+0.08 months observed in Alaba (Deribe, 2009).

4.15.6. Litter size

The overall litter zise is estimated at 1.35±0.3. Litter size did not differ significantly (P>0.05) across the study agro ecologies. Litter size of 1.38±0.20, 1.32±0.28 and 1.36±0.35 month was observed in lowland, midland and highland agro ecologies of the study area respectively. The current study is in agreement with the previous works and who reported litter size which varied between 1.08 and 1.75 with average of 1.38 for African flocks (Wilson, 1991). This finding is also comparable to the litter size of 1.21 which was reported for Arsi-Bale goats in Arsi Negelle (Tatek *et al.,*. 2004). Alemayehu (1993) reported that single births were 85% of all births and twin births are 15% of all births for Hararghe highland goat type. A Similar finding was reported for goat in moist Dega of Dale district with a litter size of 1.3; however a higher litter size estimated as 2.33 in moist kola and 2.21 in moist weyina dega were recorded in the study conducted in Dale district (Endeshaw, 2007). Litter size in the current study is also similar with mean litter size (1.3) for Sidama goat type (Farm Africa, 1996) and 1.47+0.04 in Alaba area (Deribe, 2009). The higher prolificacy recorded in this breed of goat is important to consider prolificacy in the genetic improvement programs.

Life time kidding is significantly ($p<0.05$) different between agro ecological zones. The possible number kidding per reproductive life time of does in the study area was estimated as 19.2±10.0, 18.2±9.1 and 14.2±4.9 in lowland, midland and highland, respectively. This value is significantly ($p<0.05$) lower in highland areas than in midland and lowland; but there is no significant ($p>0.05$) variation between does in lowland and midland agro ecologies. The average reproductive life time of does were in years is estimated at 13.5±4.9, in lowland, 13.7±4.1 in midland and 11.7±3.7 in highlands, which is significantly ($p<0.05$) lower in highland than the other two agro ecologies. This entails the fact that, the farmers in the highland keep goats for shorter time as compared to the farmers in lowland and midland as they do not look for milk

production. The overall number of kidding per does life time and the average age of does reproductive life time are 17.2±8.5, and 13.0±4.3 year respectively. The probable reproductive life time and number of kids recorded in this study is higher than the study in Southern Ethiopia which reported as 8-15 years reproductive life time and 8-12 kidding in their life time (Workneh, 1992). The variation in these reproductive traits could be due to genotypic variation, environmental factors and husbandry management differences. The parturition interval of does was estimated at 7.2±2.7 months which indicates the fact that, the does give about three kids every two years.

4.15.7. Age at Weaning

There was no significant ($p<0.05$) difference in weaning age in three agro ecologies. Majority of (56.1 %) the farmers wean the male goats at the age of 3 - 5 month, 31.67% of the respondents wean goats at the age between 5-7 month and 12.2% wean at age less than three month. The feeding of milk showed a variation among goat farming community, where 80% of the respondents in lowland area are feeding milk up to weaning in a restricted manner, 16.7% of respondents did not restrict suckling and only 3.3 % of the respondents practice bucket feeding. In midland agro ecology 86.7% of respondent restrict suckling, 11.7% do not restrict and 1.7 use bucket feeding. In highland 51.7% of respondent restrict milk feeding, 43.3% of the respondents let the kids to suckle freely and 5% use bucket feeding. Restricted milk feeding is lower in highland areas as compared to other agro ecologies, which might be attributed to the lower experience of goat milk consumption. Age at weaning indicated by the majority of the respondent in this study is comparable with the study conducted at Alaba, Ethiopia which has reported 4 months of weaning age (Tsedeke, 2007).

Table 20 Reproductive performance, litter size, milk yield and lactation length of Hararghe highland goat in different agro ecologies.

Factor	Agro ecology						Overall		sig
	Lowland		Midland		Highland				
	Range	Mean ± SD	Range	Mean± SD	Range	Mean ± SD	Range	Mean± SD	
Average age at first mating male (Months)	6-24	12.8±4.8	5-24	12.4±5.6	5-24	13.0±5.2	5-24	12.7±5.2	0.806
Age at first mating female (Months)	7-24	14.1±5.6[a]	5-24	13.1±5.7[a]	4-24	12.0±4.7[b]	4-24	12.4±5.6	0.000
Age at 1st kidding (month)	12-26	17.2±4.1	10-26	17.1±4.6	9-26	15.5±4.2	9-26	16.6±4.4	0.059
Reproductive lifetime of does (yr)	6-25	13.5±4.9[a]	6-20	13.7±4.1[a]	3-20	11.7±3.7[b]	3-25	13.0±4.3	0.023
Number of kids per does life time	8-50	19.2±10.0[a]	7-52	18.2±9.1[a]	6-25	14.2±4.9[b]	6-52	17.2±8.5	0.003
Kidding interval of does in (month)	6-12	7.6±1.86[a]	6-12	8.0±1.96[ab]	6-18	8.6±2.28[b]	6-18	8.1±2.07	0.006
Litter size	1-2	1.38±0.2	0-2	1.32±0.3	1-2	1.36±0.4	0-2	1.35±0.3	0.463
Culling age male due to old age(yr)	3-15	6.4±3.1	4-15	6.7±3.7	2-13	5.9±2.8	2-15	6.3±2.9	0.299
Milk yield per day per does in (litrs)	0.25-1	0.5±0.2[a]	0-2	0.4±0.3[a]	0.25-0.6	0.3±0.1[b]	0-2	0.4±0.2	0.001
Lactation length for doe in (Month)	2-12	3.5±1.6	1-8	3.5±1.2	1-8	3.6±1.4	1-12	3.6±1.4	0.866

N=Number of observation; SD= Standard deviation; [a, b,] means on the same row with different superscripts are significantly different (P<0.05)

4.15.8. Culling

Almost all of the respondents practice culling of undesired goats for different reasons. Respondents in different agro ecological zones indicated more or less similar reasons for culling goats (Fig. 6). The farmers cull goats attributed to reproductive failure and abortion (46.1%), diseases (20.6%) and poor body condition (weak/thin animals) (17.2%) and the rest of the goats were culled due to a combination of reasons such as abortion, disease, poor body condition, color and older age (16.1%). Similar reasons were reported in Dale district of southern Ethiopia Endeshaw, 2007). Richard Browing Jr (2009) recommended the practice of culling of goats under poor health, does which present frequent prolapsed uterine, lower milk production, does with poor conformation of the udder and teats, does that prevent kids from suckling adequately,

does with poor fertility rates, older aged and does fail to maintain adequate body condition. The overall mean culling age male goat in the area is 6.3±2.9 years. Culling age for male goats is estimated at 6.4±3.1, 6.7±3.7 and 5.9±2.8 years in lowland, midland and highland agro ecologies, respectively. The overall mean culling age for male goat in the area is 6.3±2.9 years.

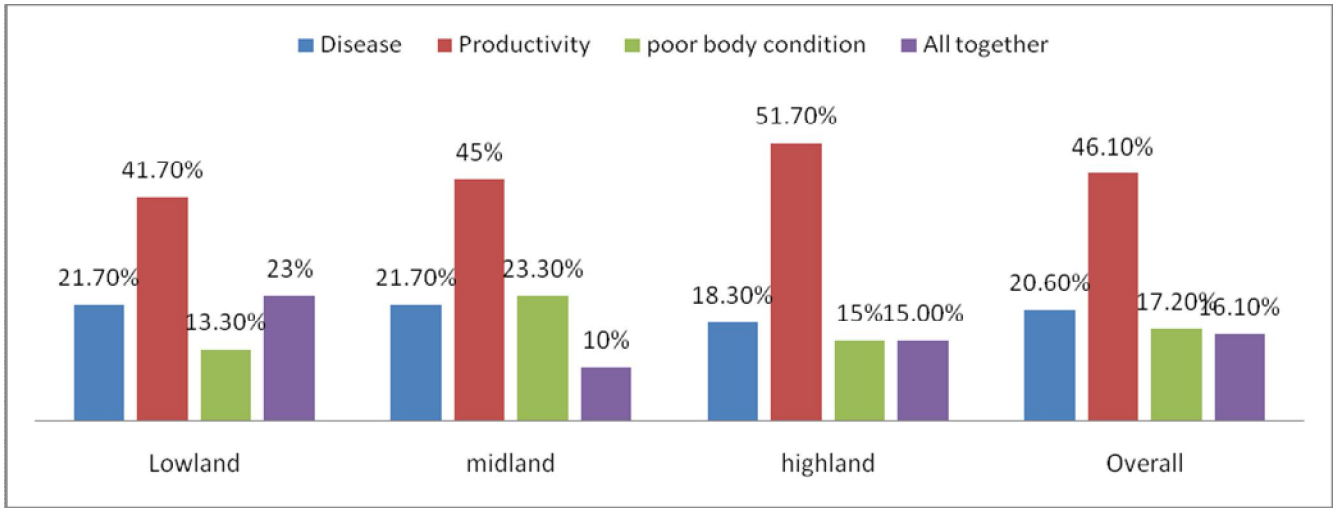

Figure 6 Reason of goat producers for culling goats in different agro ecologies.

4.16. Practice of Milking

Goat milking is practiced by majority of the respondents (90%) and the remaining of the respondents (10%) does not milk their goat. Goat milk is locally called “anan re’e”; commonly used for home consumption (87.8%) of which (75.8%) used as raw milk, 12% is processed and used at home and 12.2% sale goat milk in some markets (Appendix table 3). Milk is widely used to make *hoja (*milk boiled with dried ground coffee leaves). Similar finding was reported in the same area (Alemayehu, 1993). Frequency of milking in a day is the same across all agro ecologies and 92.2% of the household milk goats once per day and 6.7% milk twice per day. Most of the household do not sale milk products as responded by 98.3% of the respondents and only 1.7% of the respondents’ sale butter to their consumers. The focus discussion with women indicated that goat butter is yellowish red in color which is highly preferred by the consumers. They also indicated that goat milk is mixed with cow milk to bring a yellowish (reddish) butter color to fetch better price. The result shows need of further study regarding the effect of mixing milk from different livestock species in terms of color, butter and other milk products. The

farmers commonly fed goat milk to infants and they believe that goat milk protects children from any type of disease. The mothers perceived that 'If they have at least one lactating doe, they do not worry about their infant's health and children are healthy and stronger as compared to the children fed on cow milk. As a result farmers are not selling goat milk to ensure the health of infants and reduce medication cost for child. Workneh (1992) reported that the farmers prefer goat milk for children and family member goat milk in Southern Ethiopia. Goat milk possesses casein and the fat from goat milk is more easily digested than from cow milk. Goat milk is valued for the elderly, sick, babies, children. It is also recommended for people with cow milk allergies, patients with ulcers, and even preferred for raising orphan foals or puppies (Haenlein, 2004.). These indicates the fact that, goat milk has a number of advantages that will be worthy of keeping goats.

The overall mean daily milk yield is 0.4±0.2 liters (Table 23). There is a significant ($p<0.05$) variation in milk yield between agro ecologies. Higher milk yield is recorded in lowland (0.5±0.2) liters but not statistically different from in midland (0.4±0.3). Significantly lower milk yield is estimated in highland (0.3±0.1) liters. The lower milk yield per day in the highland is due to the low feed resources, low restriction of suckling of kids and relatively low interest to goat milk in highland. Average lactation length was estimated as 3.6±1.4 month (Table, 23). Lactation length of does in all agro climatic zones is the same despite slight variation is observed. Comparable milk yield and lactation length were reported by Adugna and Aster (2007) who estimated 0.53+0.32 liters and 2.7+1.9 months in pastoral areas, respectively. Goat milk utilization by households in this study area is by far higher than one reported in Dale district who has reported (70%). Milk yield per animals in the current study is also slightly higher (0.33 liters) milk yield (Endashaw, 2007). Deribe (2009) also reported lower milk yield and lactation length of 150.95+56.03ml per day and 39.02+2.69 days. This higher milk yield and longer lactation in the current study is mainly due to the targeted rearing of two or more lactating does for milk production as well as selection preference of high milk yielding does in the community.

4.17. Management of Breeding Buck

There was a management differences among agro-ecologies for breeding bucks. A special management was offered to breeding bucks as perceived by 48.3%, 43.3% and 36.7% of the received by households in lowland, midland and highland, respectively. The farmers were providing feeding supplements at home like salt, kitchen leftover, chat leftover (Garaba), floor and grains. A similar and higher proportion of households (56.3%) were providing special care for breeding ram in Menze area (Tesfaye, 2008). The offering of a special management for bucks is encouraging to ensure higher reproductive rates of bucks.

4.18. Buck Ownership Pattern

There was a diversified source of bucks for breeding. Out of the goat owners around Darolabu district 76.7% had breeding buck and 23.3% had no breeding buck. Availability of breeding buck in a flock was considerably higher in lowland (91.7%), followed by midland (78.3%) and lower in highland (60%). The number of bucks per flock in the study area is higher for different reasons. The goat owners keep breeding bucks for some time and put in fattening program after castration and goat owners purchase bucks immediately after the sale of castrated and fattened goats for replacement and to continue the next breeding and then fattening. The variation among the three agro ecologies in relation to buck number per flock is associated to as the lower number goat kept by highlanders due to shortage of land and feed in the highland. Hence, the buck contributes 50 percent of the genetic makeup of every kid born and determines overall pregnancy rate of the herd it is important to maintain appropriate number of breeding bucks in a flock with a practice of selection of bucks. The availability of breeding bucks ensures the reproductive rates of the flock. In this regard, it was argued that, the availability of buck in the system considerably affects all biological and financial performances of the flock (Galal *et al.*, 1996; Tesfaye, 2009).

Producers keep bucks for different purpose in different climatic zones. They keep bucks for mating, fattening and for both purpose 15%, 26.7% and 58.3% in lowland, 31.7%, 21.7% and 46.7% in midland and 30%, 25% and 45% in highland respectively. Majority of the households (96.7%) in lowland, 95% in midland and 71.7% in highland uses buck born in the flock. In the

absence of breeding buck as responded by 96.7% of the farmers in lowland, 99% in both midland and highland use bucks from neighbor. The practice of using bucks among neighbors may pave the way to introduce community based genetic improvement program in the villages. The average number of breeding buck per household in the study area was 1.8±1.7. There was significantly ($p<0.05$) higher number of breeding buck per household in lowland (2.7±2.5) followed by highland (1.4±0.6) and midland (1.2 ±0.4). .

4.19. Breeding Practices

Breeding was generally uncontrolled in all agro ecologies. The respondent in lowland (98.3 %), in midland (96.6%) and in highland (81.7%) practiced uncontrolled mating. Goat owners have associated for not controlling mating, the ease of managing goats in a mixing of flocks consisting breeding bucks (68.8%), lack of awareness about the benefit of controlling(8%) and combination of factors (ease of management in mixing a flock, lack of awareness and lack of bucks all together (23.9%). Those farmers that practice control mating use different techniques to control the mating like castration, buck isolation, tying the neck of scrotum, use herbs that reduce libido, and culling of thin bucks. Tesfaye (2008) reported tying the prepuce of breeding ram so as to divert the penis during mating matting. Majority of the goat owners (66.1%) could not identify the sire of a kid while the rest 33.9% of the owners identify the sire of a kid by matching the color/appearance (77%) and comparing the color, season of conception and breeding buck that exist at that moment (23%). The poor identification of sires in the flock will not allow selecting bucks based on the performance of their offspring this may lead to select bucks based on their own performance.

The farmers exchange of breeding buck and prefer bucks in terms of color, conformation and size. The social and culturally norms favor exchange of breeding bucks in the community. The goat farmers volunteer the bucks to be used in a flock. The knowledge of the effect of inbreeding in the performance of a flock is negligible as perceived by 98.3% of the respondents. The majority of the respondents (98.9%) allow mating of buck with his mother, sister and any blood related flock. The mating of bucks with their close pedigree was related to different factors such as purposive mating to multiply buck in the flock (26.1%), lack of awareness about

the effect of inbreeding(27.8%), lack of alternative breeding buck(2.8%) and no control mechanism as flock herded together (43.3%). Farmers have deep indigenous knowledge to identify whether the does are in heat or not. They listed a number of indicators like does temperament and becoming noisy (21.1%), mounting (3.3%), fluid discharge from vagina (2.2%) and all of the aforementioned indicators together (73.3%).

4.20. Selection Criteria

Majority (98.3%) of the goat owners in the study area regardless of the agro ecologies practice and recognize the importance of selection based on farmers own selection criteria's. Farmers list a number of selection criteria's for male and female with slight differences. According to this survey, the breeding process is not completely out of control and outstanding males and females are favored and the undesirable ones are culled.

4.20.1. Selection criteria for breeding Buck

The farmers select bucks at earlier age. The overall average age of breeding buck during the practice of selection was 9.46±3.9 month. Average age of selection for breeding buck in the three agro ecologies were not statistically different ($p>0.05$) with the mean age of breeding buck selection estimated at 9.3±3.4 month in lowland, 8.8±3.7 month in midland and 10.3±4.4 month in highland, respectively (Table 24). The age of selection of buck in the current study is comparable with post weaning selection from age of 6 to 8 month (Richard, 2009).

Table 21 Age of selection of Breeding buck and doe in different Agro ecology

Variables	Lowland		Midland		Highland		Overall		sig
	Range	Mean ± SD	Range	Mean± SD	Range	Mean ± SD	Range	Mean± SD	
Age of selection of breeding buck (mnth)	2-18	9.3±3.4	1-24	8.8±3.7	4-24	10.3±4.4	1-24	9.46±3.9	0.087
Age of selection breeding Doe(month)	2-12	8.4±3.6	2-18	8.1±3.3	1-18	8.9±3.8	2-18	8.4±3.6	0.434

N=Number of observation; SD= Standard deviation; [a, b,] means on the same row with different superscripts are significantly different ($P<0.05$)

The trait preferences as ranked by goat keepers are presented in Table 25. In lowland conformation (appearance),coat color, pedigree of breeding buck, fast growth and absence of horn were ranked first, second, third, fourth and fifth with an index of 0.27, 0.20, 0.15, 0.11, and 0.106, respectively. The ranking showed a similar trend in the lowlands and highlands. In midland area conformation (appearance), coat color, pedigree, litter size, fast growth and absence of horn were ranked first, second, third, fourth, fifth and sixth with an index of 0.27, 0.21, 0.12, 0.11, 0.105 and 0.1 respectively. Similarly in highland conformation (appearance), coat color, fast growth, litter size and pedigree were ranked first, second, third, fourth and fifth with an index of 0.29, 0.19, 0.123, 0.12 and 0.08, respectively.

According to the result from group discussion with goat owners, buck body conformation or appearance is a function of body length, body condition, straight back, height at withers, pelvic width. Hornless buck with white and brown coat color was the most preferred buck for breeding The farmers have associated the presence of horn on buck with the destruction of house, tempering families and other animal. A buck born as twins or triple was preferred as the farmers perceived that multiple births are heritable to next generation. The famers trait preference in the current study is consistent with the study in Afar area which indicated conformation and color as the first and second selection criteria for ram (Tesfaye, 2008; Gemeda, 2010) and similarly conformation was reported for Menze ram (Tesfaye, 2008). Therefore, consideration of these top preferred characteristics in goat genetic improvement strategy would contribute the improvement of goats the flock performance through introducing community based genetic improvement programs.

Table 22 Ranking of goat trait preferences for selection of buck for breeding by farmers in different agro ecologies (%)

Selection criteria	Lowland					Midland					Highland					Overall				
	Rank 1st	Rank 2nd	Rank 3rd	Rank 4rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	Rank 4rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	Rank 4rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	Rank 4rd	**Index**
Conformation	56.7	8.3	6.7	8.3	**0.27**	51.7	11.7	11.7	8.3	**0.27**	48.3	21.7	13.3	1.7	**0.29**	52.2		10.6	6.1	**0.28**
Goat color	6.7	35.0	28.3	13.3	**0.20**	18	30.0	15.0	13.3	**0.21**	23.3	15.0	15.0	25	**0.19**	16.1	26.7	19.4	17.2	**0.20**
Absence of horn	6.7	15.0	15.0	5.0	**0.106**	1.7	13.3	21.7	5.0	**0.1**	5.0	8.3	3.3	6.7	**0.06**	4.4	12.2	13.3	5.2	**0.09**
Character	-	1.7	11.7	15.0	**0.04**	-	6.7	1.7	21.7	**0.05**	-	8.3	5.0	5.0	**0.04**	-	5.6	6.1	13.9	**0.04**
Growth	5.0	16.7	8.3	23.3	**0.11**	10	8.3	16.7	6.7	**0.105**	8.3	16.7	11.7	16.7	**0.123**	7.8	13.9	12.2	15.6	**0.11**
Prolificacy	3.3	1.7	18.3	10.0	**0.06**	3.3	8.3	26.7	15.	**0.11**	11.7	8.3	18.3	13.3	**0.122**	6.1	6.1	21.1	12.8	**0.10**
Age	-	3.3	-	3.3	**0.01**	-	3.3	-	5.0	**0.02**		3.3	8.3	3.3	**0.03**	-	3.3	2.8	3.9	**0.02**
Libido	-	1.7	-	-	**0.003**		-	-	1.7	**0.002**	-	-	-	1.7	**0.002**	-	0.6	-	1.1	**0.013**
Drought tolerance	-	-	-	-	-	-	-	-	1.7	**0.002**	-	1.7	5.0	3.3	**0.018**	-	-	1.7	1.7	**0.01**
Disease tolerance	1.7	3.3	3.3	6.7	**0.03**	3.3	5.0	-	1.7	**0.01**	-	6.7	8.3	5.0	**0.042**	1.7	-	3.9	4.4	**0.03**
Pedigree	20.0	13.3	8.3	13.3	**0.15**	11.7	13.3	6.7	18.3	**0.12**	3.3	10.0	11.7	16.7	**0.08**	11.7	12.2	8.9	16.1	**0.12**

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

4.20.2. Selection Criteria for Breeding Doe

Age of selection of breeding does in the study area range from two to eighteen month with an average age of 8.4±3.6 month (Table 26). According to this study age of selection breeding doe was the same in all agro ecologies with no significant variation ($p>0.05$). The age at selection is estimated to be 8.4±3.6, 8.1±3.3 and 8.9±3.8 month in lowland, midland and highland respectively. Farmers set their own selection criteria for breeding does. The farmers focused on reproduction and survival traits to select a breeding doe in a flock. The trait preference and ranking of goats in doe in different agro ecologies is given in Table 26.

Conformation (appearance) of breeding doe was ranked first in all agro ecologies with the index of 0.23, 0.23 and 0.21 in the lowland, midland and highland, respectively. Milk yield, twining ability, coat color, kidding interval and mothering character were ranked second, third, fourth, fifth and sixth with an index of 0.20, 0.18, 0.14, 0.05 and 0.04 respectively in Lowland. In midland area milk yield, coat color, twining ability, kidding interval and mothering character were ranked second, third, fourth, fifth and sixth with index of 0.21, 0.16, 0.15, 0.04 and 0.04 respectively. Similarly in highland twining ability, milk yield, coat color, mothering character and kidding interval were ranked second, third, fourth, fifth and sixth with an index of 0.21, 0.17, 0.12, 0.09 and 0.05 respectively. Gemeda (2010) found out that mothering character and milk yield were the first and second selection criteria for Afar, Bonga, Menze and Horro ewes.

The focus group discussion of the farmer recognized that long tailed, less twisted tail, wider horn width, bigger and longer udder, widely distributed teats and longer leg does were higher milk yielder than the others. Mothering character was understood as the ability of the doe to enhance growth by allowing suckling, proper suckling, and protecting kids from other animals within flock and species and predators. White and brown coat colors are preferred by the producers and black color was not preferable as it has low market demand and lower price in the area than any other colors. The survey revealed the importance and critical assessment of community preference for morphological and reproductive trait and incorporating these traits in goat genetic improvement scheme is worth considering.

Table 23 Ranking of goat trait preferences in selection of doe for breeding by farmers in different agro ecologies (%)

Selection criteria	Lowland					Midland					Highland					Overall				
	R1	R2	R3	R4	index	R1	R2	R3	R4	index	R1	R2	R3	R4	index	R1	R2	R3	R4	index
Conformation	46.7	5.0	1.7	28.3	**0.23**	45.0	8.3	8.3	8.3	**0.23**	35.0	11.7	11.7	11.7	**0.21**	42.2	8.3	7.2	16.1	**0.22**
Milk yield	23.3	18.3	15.0	13.3	**0.192**	21.7	25.0	11.7	15	**0.20**	11.7	26.7	11.7	3.3	**0.153**	18.9	23.3	12.8	10.6	**0.182**
Disease tolerance	3.3	1.7	6.7	-	**0.032**	1.7	-	3.3	3.3	**0.017**	1.7	1.7	10.0	1.7	**0.033**	2.2	1.1	6.7	1.7	**0.027**
Goat color	5.0	26.7	18.3	10.0	**0.147**	11.7	25.0	13.3	6.7	**0.155**	11.7	11.7	11.7	11.7	**0.117**	9.4	21.1	14.4	9.4	**0.14**
Mothering character	-	6.7	8.3	13.3	**0.05**	-	3.3	16.7	20	**0.063**	1.7	16.7	13.3	13.3	**0.097**	0.6	8.9	12.8	15.6	**0.07**
Kid survival	-	3.3	5.0	13.3	**0.033**	-	1.7	8.3	16.7	**0.038**	3.3	3.3	11.7	6.7	**0.053**	1.1	2.8	8.3	12.2	**0.041**
Kid growth	1.7	5.0	6.7	5.0	**0.04**	3.3	1.7	3.3	5.0	**0.03**	5.0	1.7	10.0	11.7	**0.057**	3.3	2.8	6.7	7.2	**0.042**
Age at 1st maturity	1.7	5.0	-	-	**0.021**	-	5.0	5.0	3.3	**0.028**	-	-	-	3.3	**0.003**	0.6	3.3	1.7	2.2	**0.018**
Kidding Interval	3.3	3.3	11.7	-	**0.047**	5.0	1.7	5.0	6.7	**0.042**	3.3	8.3	1.7	13.3	**0.055**	3.9	4.4	6.1	6.7	**0.044**
Longevity	1.7	-	8.3	1.7	**0.025**	1.7	8.3	3.3	-	**0.032**	-	1.7	8.3	5.0	**0.027**	1.1	3.3	6.7	2.2	**0.03**
Twining ability	13.3	25.0	18.3	15.0	**0.18**	10.0	20.0	21.7	15.0	**0.16**	26.7	16.7	8.3	13.3	**0.19**	16.7	20.6	16.1	14.4	**0.17**
Drought tolerance	-	-	-	-	-	-	-	-	-	-	-	-	1.7	1.7	**0.005**	-	0.6	-	1.1	**0.001**
Water stress	-	-	-	-	-	-	-	-	-	-	-	-	-	3.3	**0.003**	-	-	-	1.1	**0.001**

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.

4.21. Effective Population Size and Level of Inbreeding

The effective population size (Ne) and the rate of inbreeding coefficient per generation (ΔF) are calculated for goat flocks in different agro ecologies considering the existing flock size, herding practices and number of flocks mixed in the communal grazing land. Despite the advantages of inbreeding for gene fixation, it has a tremendous negative effect through erosion of genetic diversity. The breeding practices stated in this study, such as uncontrolled mating, use of bucks born within flock for breeding, practices of crossing a buck with his dam/sister for the purpose of multiplication of that breed type, low awareness of producers about the effect of inbreeding and low practices of flock mixing, may contribute to high incidence of inbreeding in the area. Uncontrolled mating in small animal population leads to accumulation of inbreeding and enhance reduction in animal genetic diversity (Falconer and Mackay, 1996).

The rate of inbreeding coefficient and effective population size changes with the type of practice farmers employed. The farmers may keep goats in isolated flock or mix goats with neighbors in communal grazing areas. The mean number of flocks mixed in lowland, midland and highland agro ecologies were estimated to be 3.45±1.3, 3.71±2.09 and 3.35 ±1.2 respectively. Under a random unmixed flock, effective population size (Ne) in lowland, midland and highland areas were 7.67, 2.46 and 2.31 respectively and the corresponding rate of inbreeding coefficient in lowland, midland and highland were 0.065, 0.203 and 0.217, respectively (Table 27). Effective population size was higher in lowland than the other two agro-ecologies due to high number of goat ownership 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 (0.1) under isolated flock was higher than the standard maximum acceptable level of 0.063 (Armstrong, 2006; cited in Tesfaye, 2008). The overall rate of inbreeding under mixed population was estimated at 0.0267, which is lower than the recommended rate of inbreeding per generation (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 flocks of different household when they are mixed the effective population size showed the increasing trend and the rate of inbreeding (ΔF) was reduced by 70.8% in lowland, 73% in midland and

70.2% in highland. The mixing of the flock in communal grazing land will reduce rate of inbreeding per generation and allows in the design of community based genetic improvement.

Table 24 Effective population size and level of inbreeding for goat flocks in different agro ecologies.

Agro ecology	When flock is not mixed				When flock is mixed				% change in inbreeding due to flock mixing
	Nm	Nf	Ne	ΔF	Nm	Nf	Ne	ΔF	
Low land	2.3	11.65	7.67	0.065	7.94	40.2	27.72	0.0190	70.8
Mid land	0.73	3.9	2.46	0.2033	2.71	14.47	9.13	0.0548	73.0
High land	0.75	2.52	2.31	0.2165	2.51	8.44	7.74	0.0646	70.2
Over all	1.7	6.08	5.31	0.10	6.0	21.46	18.76	0.0267	71.7

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

4.22. Purpose for Keeping Goat

The ranking of farmers towards keeping goat in different agro ecologies is presented in Table 28. The first, second third, fourth and fifth reasons of keeping goat in study areas are income generation, milk production, meat production, means of saving and manure with an index of 0.41, 0.24, 0.20, 0.09 and 0.06 respectively. Similar broad production objectives were reported by goat owners around Alaba Southern Ethiopia (Tsedeke, 2007). The result of this study revealed that goat has a number of multiple functions in all agro ecologies with similar overall production objectives. Goat in the country, playing an important role in the livelihood of resource-poor farmers; they provide their owners with a vast range of products and services such as meat, milk, skin, hair, horns, bones, manure and urine for cash, security, gifts, religious rituals, medicine, etc (IBC, 2004). However, goat producing farmers in Metema Northern Ethiopia reported that they did not keep goat for milk production, though the area is categorized under arid climatic zone (Tesfaye, 2009). This study showed that keeping goat for social and cultural circumstance like gift, donation, ceremonies, rituals and festivals were also have significant role. The study has showed that, goat owners have a specific production objective

while rearing the goats. Knowledge of reasons for keeping animals is a prerequisite for deriving operational breeding goals (Jaitner *et al*., 2001).

4.23. Adaptive Traits of Goat

Lists of adaptation traits as ranked by goat producers in different agro ecologies are presented in Table 29. The result of this study revealed that heat tolerance, drought tolerance, adaptation to feed stress and water stress were the first, second, third and fourth traits that are preferred by farmers with an index of 0.32, 0.24, 0.20 and 0.13 respectively. Goat owners described a variety of adaptation traits in different perspective. The ability of goat to find shade, feed selection ability and smaller hair cover were merits of goats in relation to adaptation as mentioned by goat owners. Drought tolerance of goat type is also associated with the ability of goat to walk longer distance to search for feed and water, feed selection ability (fed green leaves), the ability of goat to feed on irregular/sloppy and inaccessible areas and smaller water requirements according the respondents.

This survey revealed that trend of goat population compared to cattle (55.6%) sheep (64.4%) and camel (79.4%) was increasing associated to the aforementioned adaptation traits. The factors like the requirement of goats for smaller areas and fast reproduction rate is the main reasons for the increasing trend in goats.

Table 28 Ranking of goat production objectives by smallholder farmers in Low land, midland and high land agro ecologies (%)

Production objective	Lowland				Midland				Highland				Overall			
	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**
Meat	11.7	10.0	41.7	**0.16**	18.3	20.0	43.3	**0.23**	11.7	30.0	33.3	**0.21**	13.9	20.0	39.4	**0.20**
Milk	8.3	50.0	33.3	**0.26**	8.3	50.0	30.0	**0.26**	15.0	28.3	26.7	**0.22**	10.6	42.8	30.0	**0.24**
Cash	70.0	16.7	11.7	**0.43**	66.7	10.0	15.0	**0.39**	65.0	16.7	11.7	**0.40**	67.2	14.4	12.8	**0.41**
Saving	8.3	8.3	3.3	**0.09**	6.7	18.3	1.7	**0.10**	6.7	13.3	8.3	**0.09**	7.2	13.3	4.4	**0.09**
Manure	1.7	15	10.0	**0.08**	-	1.7	8.3	**0.02**	-	11.7	20.0	**0.07**	0.6	9.4	12.8	**0.06**
Skin	-	-	-	-	-	-	1.7	**0.003**	-	-	-	**-**	-	-	0.6	**0.001**
Gift	-	-	-	-	-	-	-	-	1.7	-	-	**0.01**	0.6	-	-	**0.003**

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 rank 3] for all commodities in an agro ecology.

Table 29 Ranking of Important adaptation traits of local goat preference by small holder farmers in different agro ecologies (%)

Adaptation traits	Lowland				Midland				Highland				Overall			
	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**
Heat tolerance	36.7	11.7	8.3	**0.24**	63.3	13.3	5.0	**0.37**	53.3	18.3	11.7	**0.35**	51.1	14.4	8.3	**0.32**
Drought tolerance	20.0	40.0	25.0	**0.28**	6.7	51.7	23.3	**0.24**	21.7	36.7	16.7	**0.26**	16.1	42.8	21.7	**0.24**
adaptation to feed shortage	21.7	15.0	45.0	**0.23**	15.0	6.7	36.7	**0.16**	18.3	16.7	35.0	**0.21**	18.3	12.8	38.9	**0.20**
Adaptation to water shortage	11.7	16.7	16.7	**0.14**	10.0	13.3	23.3	**0.13**	5.0	16.7	16.7	**0.11**	8.9	15.6	18.9	**0.13**
Tolerance to parasite	-	1.7	-	**0.01**	-	1.7	-	**0.01**	-	1.7	-	**0.01**	-	1.7	-	**0.01**

Index = sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for a specific adaptation traits divided by sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all adaptation traits in an agro ecology.

Ranking of livestock species based on some adaptive traits are presented in Table 33. The result of ranking based on the farmers perceived notions showed that, goats are resistant and adaptive animal species attribute to the adaptive traits such as resistance to internal parasite, heat stress, feed and water shortage with an index of 0.3, 0.4, 0.43, and 0.33. Camel and goat showed a higher ranking and the most praised animals by farmers for their adaptive merit for heat stress, feed shortage, water scarcity showing the highest rank for this attributes as compared to other animals. These perceptions of farmers towards the adaption of goats under resource scarce environment confirm the importance of these classes of animals in the arid environment and needs the improvement of this animal in their environment.

In general goat, cattle, camel and sheep were the first, second, third and fourth adaptive animal species to the environment they exposed, with an index of 0.42, 0.23, 0.2 and 0.16 in the order as perceived by the farmers. The highest index for goats could be attributed to ease of management, feeding, watering, feed selection and the ability to walk long distance in a short time. The result revealed that sheep is the least adaptive in the study area as perceived by farmers. The reason for low index for sheep might be attributed to absence of plain land that suits the grazing behavior of sheep and a limited feeding habit of sheep to 'chat Garaba' compared to goat. The present study confirmed the previous study and a similar adaptation pattern was observed for goats in Afar area and goat had index of 0.31 followed by camel and cattle with index of 0.28 and 0.23 for adaptation characteristics, respectively (Tesfaye, 2008).

Table 25 Ranking of livestock species in important adaptation traits preference by small holder farmers (%).

Livestock spp	Disease				Internal Parasite				External Parasite				Heat stress			
	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**
Goat	33.3	34.4	19.4	**0.31**	41.1	21.7	12.2	**0.3**	22.2	25.0	23.9	**0.23**	56.1	40.0	2.8	**0.4**
Sheep	5.6	13.3	32.8	**0.13**	6.7	32.2	38.3	**0.2**	8.9	26.7	41.1	**0.2**	1.7	2.2	15.6	**0.04**
Cattle	46.1	21.7	23.9	**0.34**	26.1	23.3	29.4	**0.26**	40.0	23.3	18.3	**0.24**	0.6	6.1	76.1	**0.15**
Camel	15.0	30.6	23.9	**0.22**	26.1	22.8	20.0	**0.24**	28.9	25.0	16.7	**0.26**	41.7	51.7	5.6	**0.4**

(Table 30 Continued).

Livestock spp	Drought				Feed				Water				Environment			
	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**
Goat	49.4	37.2	10.0	**0.39**	71.7	16.1	7.8	**0.43**	16.7	68.9	9.4	**0.33**	71.1	10.0	16.7	**0.42**
Sheep	1.1	2.2	18.3	**0.04**	0.6	11.1	28.3	**0.09**	-	2.2	32.2	**0.06**	-	36.7	20.6	**0.16**
Cattle	0.6	16.1	67.8	**0.08**	2.2	15.0	51.7	**0.15**	-	16.1	56.1	**0.15**	1.1	37.2	60.0	**0.23**
Camel	48.9	44.4	3.9	**0.40**	25.6	57.8	12.2	**0.34**	83.3	12.8	2.2	**0.32**	27.8	16.1	2.8	**0.20**

Index = sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for a specific adaptation traits divided by sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all adaptation traits in an agro ecology.

4.24. Prevalence of diseases and Mortality

Farmers have listed a number of economically important goat diseases in the area and ranked them according to their importance (Table 31). Accordingly the result indicated that Pest des Petit Ruminants (PPR) was the first prevalent disease in all agro ecologies with index of 0.43, 0.42 and 0.42 for lowland, midland and highland, respectively. The second ranked disease was pastrolosis across the agro ecologies with index of 0.21in lowland, 0.23 in midland and 0.32 in highland. Anthrax was ranked third in all agro ecologies with an index 0.16 in lowland, 0.2 in midland and 0.24 in highland. Sheep and goat pox, Lumpy skin Disease (LSD), CBPP and external parasites were some of the diseases and parasite mentioned by interviewed farmers but ranked least. The survey conducted in the past revealed that, Anthrax, Pastrolosis and LSD were the predominate diseases in study area for livestock (Dereje and Tesfaye, 2009). The identification and ranking of diseases in the area warrants devising livestock disease prevention strategies in the district.

There was diversity in the sources of drug to treat animals. The majority of the respondent (93.3%) acquire drugs from government clinics and 0.6% of respondents could get drugs from open markets and shops and 6.1% of the farmers have no any sources of modern drugs. Farmers travel long distance in order to get drugs from government clinics. The respondents travel above 10 km (9.4%), 13.3% of the respondents traveled 6-10 km,23.9% travel 1-5Km and 53.3% obtain drugs within a radius of <1km (Fig 7). The traditional medicines have been used to treat their animals (56.6%) of which 43.9% use herbs, 1.1% of the respondents bleed their animals, 2.8% use fire or hot iron and few farmers use combination (7.8%) of medicament sources. There is also incidence of abortion and 40% of the goat owners experience abortion in a year time. The kid mortality is prevailing and 56.1% of the farmers indicated that kid mortality is prominent in a twin births and 29.4% indicated that mortality of kids is prevailing in triplets and only 14.4% farmers faced mortality in a single birth. The higher mortality in twines and triplets might be the insufficiency of dams to nurse the multiple births. The causes of mortality of kids were ranked as perceived by the farmers. The rank for major causes for the death of goat was disease (0.45), predator (0.30) and abortion (0.13) (Appendix Table 6). Mortality of different age group of goat in the last 12 month in deferent agro ecology is presented in Table 32. There

was a significant ($p<0.05$) effect of agro-ecology on kid mortality. A higher mortality was recorded in lowland agro ecology for all age groups. This might be attributed to overcrowding of goats during housing and herding which might enhance disease transmission, less accessibility to modern health clinics in low land areas and higher prevalence of disease.

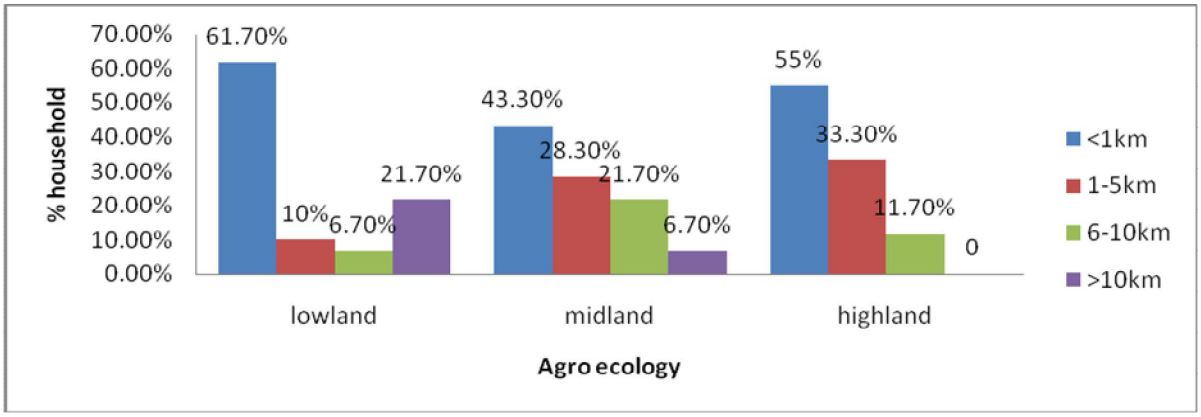

Figure 7 Distance of government veterinary clinics from Households in different agro ecology

Mortality due to disease, parasite, predator and abortion is contributing for higher production losses in the study area. Predators such as foxes and hyenas are also contributing for the losses of young stocks which in agreement with a number of previous reports (Tsedeke, 2007; Belete, 2009; Deribe, 2009). A higher mortality was recorded per year in female (2.4±3.82) than male (2.18±3.74). This is mainly because females are more susceptible to stress due to competition, predators, abortion which is sex specific attribute and diseases due to improper management during pregnancy and parturition. Kids are more susceptible to predators than aged groups. On the other hand higher mortality of kids and female in the area were related with their higher portion in a flock composition along the three agro ecologies. Higher mortality was recorded in lowland and least was recorded in highland. The result implied significant of producers based proper and holistic improvement in management and disease control intervention mechanism to reduce mortality and make use of this genetic resource in sustainable manner in the study area.

Table 26 Ranking of economically important goat diseases by small holder farmers in different agro ecologies of the study area (%)

Goat Diseases	Lowland				Midland				Highland				Overall			
	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**
Pest des Petit Ruminants (PPR)	66.7	26.7	5.0	**0.43**	66.7	25.0	3.3	**0.42**	68.3	15.0	16.7	**0.42**	67.2	22.2	8.3	**0.42**
Sheep& goat pox	3.3	13.3	23.3	**0.10**	5.0	13.3	5.0	**0.07**	1.7	1.7	-	**0.01**	3.3	9.4	9.4	**0.06**
Anthrax	11.7	21.7	18.3	**0.16**	6.7	21.7	58.3	**0.20**	5.0	28.3	61.7	**0.24**	7.8	23.9	46.1	**0.20**
Pastrolosis	11.7	30.0	28.3	**0.21**	13.3	35.0	30.0	**0.23**	21.7	53.3	21.7	**0.32**	15.6	39.4	26.7	**0.25**
LSD	6.7	8.3	23.3	**0.10**	-	1.7	3.3	**0.01**	-	-	-	**-**	2.2	3.3	8.9	**0.04**
External Parasite	-	-	1.7	**0.003**	3.3	3.3	-	**0.03**	-	1.7	-	**0.01**	1.1	1.7	0.6	**0.01**
(CBPP)	-	-	-	**-**	5.0	-	-	**0.03**	3.3	-	-	**0.02**	-	-	-	**0.01**

Index = sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for a specific disease divided by sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all diseases in an agro ecology.

Table 27 Mortality of goat in the study area

Mortality goat in the last 12 month	Agro ecology						Overall (N=180)		sig
	Lowland(n=60)		Midland(n=60)		Highland(n=60)				
	Range	Mean ± SD	Range	Mean± SD	Range	Mean ± SD	Range	Mean± SD	
Young male<12 month	0-9	1.77±2.03[a]	0-4	0.55±0.96[b]	0-2	0.3±0.62[b]	0-9	0.87±1.48	0.000
Young female<12 month	0-11	2.22±2.44[a]	0-5	0.42±0.94[b]	0-3	0.35±0.73[b]	0-11	1±1.79	0.000
Male ≥12 month	0-23	3.2±4.02[a]	0-6	0.55±1.78[b]	0-4	0.22±0.74[b]	0-23	1.3±2.8	0.000
Female ≥12 month	0-19	3.15±4.04[a]	0-5	0.7±1.14[b]	0-4	0.42±0.89[b]	0-19	1.42±2.76	0.000
Total mortality of male	0-24	4.9±5.1[a]	0-10	1.1±1.85[b]	0-4	0.5±0.93[b]	0-24	2.18±3.74	0.000
Total mortality of female	0-25	5.33±5.18[a]	0-9	1.1±1.7[b]	0-4	0.77±1.14[b]	0-25	2.4±3.82	0.000

N= Number of observation, SD= Standard Deviation

4.25. Goat and Goat product marketing

The source of goats in the market is diversified. Goat keepers are the primary supplier of goat at any market to meet their cash demand. Farmers in low land area sell goats to farmers (31.7%), to traders in small town (66.7%) and to both farmers or traders (1.7%). In midland they sell to farmers (10%), traders (80%) and farmers or traders (10%). Where as in highland 13.3% sale to farmers,78.3% to traders and 8.3% sale either to farmer or traders. The market channel involves farmers, brokers (middlemen), traders and end users. Selling and purchasing was based on individual trader eyeball estimation for price fixation as perceived by 98.9 % the respondent. . Similar market participation was also reported from Goma district of Jimma zone and pastoral areas of Borena (Solomon, 2004; Belete, 2009).

4.25.1 Purpose of sales goat

The season of sale of goats showed a variation with the reasons of sale. More than half of the respondents (58.9%) sell goats throughout the years. The farmers sale goats during festival (Easter, New year, Christmas, EID- AL Fatir and EID-AL Arafa) as responded by 53.8% of farmers to benefit from raise in price, 35.8% sale their goats during planting time to purchase of farm inputs (fertilizer, seed, and farm items), to buy grains for home consumption and 10.4% sale during crop harvesting. Though market information is crucial for goat keepers, 61.7% of the interviewed farmers have no market information to sale their animals; and the rest 38.3% get market price information from personal communication. The sources of market information were from traders, middlemen and nearby farmer as responded by 92.8% farmers and only 7.2% obtain market information from development agent. The number of goats sold per household per years was 1.5±3.0 in lowland, 1.3±1.6 in midland and 1.1±1.2 in the highland (Table 33). The number of goats purchased per house hold per years was on the average 1.0±1.5 in lowland, 0.7±0.8 in midland and 0.5±0.8 in highland. These indicate the fact that, there is a flow of gene in the community through purchasing and selling of goats that may require designing genetic improvement programs through the participation of the community.

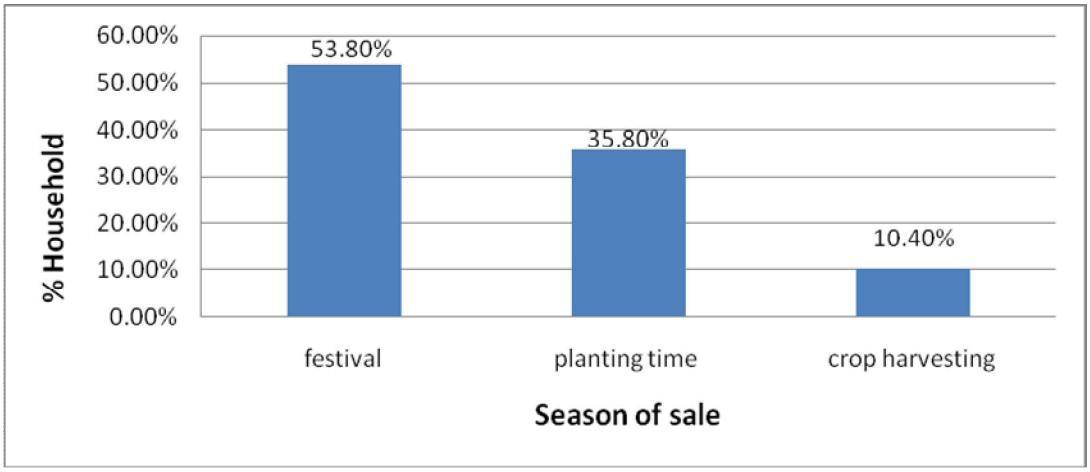

Figure 8 Seasons at which goat owners sale their goats in different agro ecologies

4.25.2 Purpose of purchasing goat

The farmers have a reason to purchase goats from various sources. The majority (79.6 %) of the sampled household purchased goat from nearby small towns and 20.4% of farmers buy from nearby farmers. The farmers purchase goats for breeding purpose (69.9%); for fattening (16.9%), for slaughtering at festival (7.2%) and buy for a combination of reasons (6%) (Fig 9). The study indicated that, the farmers mainly purchase goats for breeding and fattening purposes.

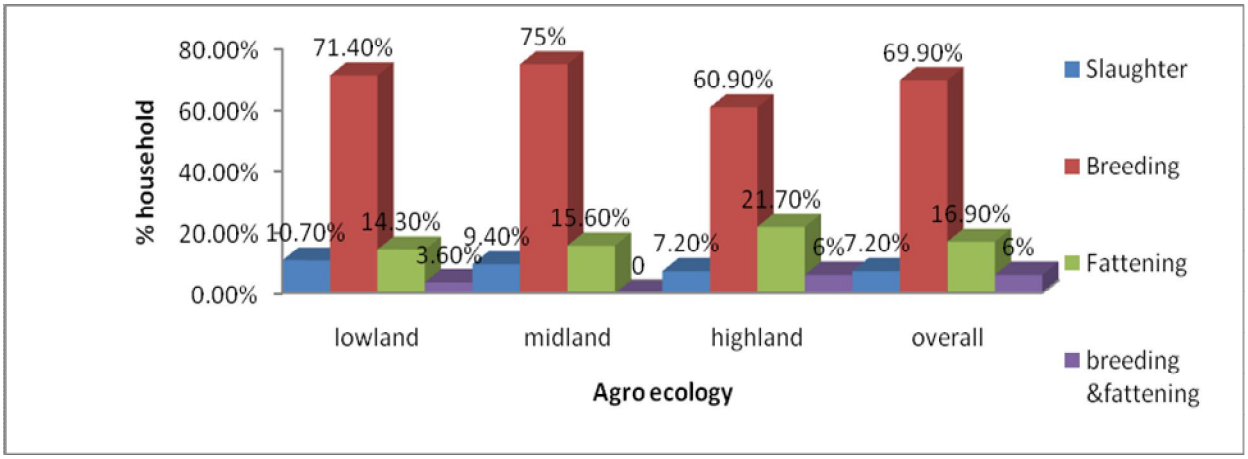

Figure 9 Purpose of purchasing goat by the farmers

Result from focus group discussion indicated that price of goat vary with distance to market, and season of in a year. The price raise during festivals and dry season and during crop harvest,

where as the price drops during planting time (wet season). The drop in price during the wet season is attributed to the sale of more number of goats during the wet season. The price of different age category of goat, goat product, market age of goat and distance from market are presented in Table 36.

4.25.3 Market Places

In Daralabu district, there are four main permanent market places namely Machara, Micata, Gadullo, Milqaye and two small market such as Sakina and Buraksa. There are also two main markets in the adjacent district Balbalet in Habro district and Rimeti in Hawigudina district. All of them function one day per week. These market places were distributed in different agro ecology namely Machara and Balbaleti in highland area, Micata, Sakina and Buraksa in midland and Milqay, Gadullo and Rimeti in the lowland. Goats fetch better price as they trek from lowland market to highland market place mainly Machara and Micata which are 5 km apart.

4.25.4 Price of goat and goat products

The price for each category of goats has shown an increasing trend among the three agro ecologies. The price is also showed increasing trend from lowland to highland, however, the variation among agro-ecologies was not statistically significant ($P>0.05$). The low price in lowland area might be due to high number of goat supplied for market on each market day, the involvement of few traders, lack of price information and high transaction cost because of distance traveled to lowland areas. Farmers listed milk, butter and skin as a marketable commodity. Few numbers of farmers (12.2%) sell goat milk and the farmers did not sell milk, rather the product is used for domestic consumption. The farmers perceived that, goat milk has medicinal value which is worth to use for home consumption. Skin is a product from the goat keeping; however, few (7.2%) farmers practice selling goats' skin. The majority (54.4%) of farmers use for various purposes in a house (i.e. seating or sleeping materials and sometimes as containers) and the remaining (38.3%) throw it away for dogs. The reason for not marketing goat skin was attributed to low demand, low market price and absence of skin traders in the market. The average price of goat skin in lowland, midland and highland agro ecology were estimated to

be 4±0.0, 4±0.0 and 11.0±7.4 birr, respectively. Price of skin was higher in highland area due to the accessibility to market and market information. Farmers point out that lack of market on information on skin, low awareness about skin processing and supply to market ,absence of skin collector in nearby market were some of problems associated with skin marketing. These calls for creating a market chain for goat skin to get additional income and extension agents should link the product with market. The goat skin is processed in the villages to be used for home material and 45% of the households processed skins at home using salt, 31.3% use drying, few farmers apply caster bean(3%) and the majority of the farmers use a combination of drying and salting (61.6%). Price of milk and butter are presented in Table 36. This survey revealed that milk and butter were frequently sold in lowland and midland areas attributed to higher milk production and number of goats in a house hold in lowland. The major problems in traditional management system are that the system is not market oriented, underdeveloped marketing and infrastructure system, and poor financial facility, (Azage *et al*., 2006, Berhanu *et al*., 2006). Long market chains, Poor market information, poor infrastructure like road are some of the barriers of producers that inhibit or reduce the benefit from sale of animals (Berhanu *et al*., 2006; Tibbo, 2006; Endrias and Tsedeke, 2007).

The farmers prefer some category of goats for sell. The ranking by farmers for type of goat supplied for sale is presented in Appendix table 5. This study indicated that castrate, breeding buck, male kid between 6 and 12 month age, and older age does were ranked first, second, third and fourth with a corresponding indices of 0.43, 0.23, 0.15 and 0.11, respectively. Marketing age of both male and female are not significantly varied among the agro ecologies (P>0.05). The overall mean marketing age of male and female were estimated to be 8.0±5.0 and 7.9±5.0 month respectively. The study showed that the farmers did not sale breeding doe across all agro ecologies. The price for different classes of goats is variable. Castrate fetch the highest price 870 ETB followed by buck, doe, male and female kid less than 12 month with price of 447±109, 442±127, 231±63 and 210±63 ETB respectively (Table 33). The price of castrate and bucks recorded in the current study is considerably higher than around Metema and the price was estimated at 590.5 ± 63.74 and 326.4 ± 35.55 birr respectively but the price for does (443.2 ± 46.23) birr was similar to in both Metema and Hararghe highland goats (Tesfaye, 2009).

Table 33 Current price of different category of goats at local market, goat product, age of marketing and distance to near and far market in different agro ecologies of the study area

Current price of Goat& Other products (ETB)	Agro ecology						Overall		**sig**
	Lowland		Midland		Highland				
	Range	Mean ± SD	Range	Mean± SD	Range	Mean ± SD	Range	Mean± SD	
Current price of doe	200-750	365±109	150-600	359±91	200-450	337±55	160-1000	442±127	0.183
Current price of buck	240-800	426±100	160-800	448±119	300-800	465±105	160-800	447±109	0.144
Current price of male kid	100-350	208±53[a]	100-500	239±74[b]	180-350	246±53[b]	100-500	231±63	0.002
Current price of female kid	100-300	203±59	100-450	210±72	120-400	217±59	100-450	210±63	0.511
Current price of castrated fattened	450-1200	866±207	500-1400	865±219	600-1500	879±179	450-1500	870±201	0.918
Price of goat milk/lit	4-7.5	5.4±1.1[a]	5-10	6.3±2.1[b]	-	-	4-12	6.0±2.0	0.001
Price of goat butter/Kg	32-40	36±6.0	-	-	-	-	32-60	44±14.0	0.179
Price of a unit of goat skin	0	4±0.0	0	4±0.0	1-30	11.0±7.4	1-30	9.6±7.1	0.339
Number of days required to take skin to market	1-4	2.5±2.1	2-7	4.0±1.4	2-7	3.7±1.3	1-7	3.7±1.4	0.390
Age of marketing male	3-36	9.3±6.4	3-18	7.8±3.0	3-24	8.2±4.6	3-36	8.0±5.0	0.113
Age of marketing female	3-36	8.6±6.7	3-18	8.0±3.0	3-24	8.5±4.4	3-36	7.9±5.0	0.051
Distance of nearest market in km	0.25-20	3.7±4.6[a]	1-35	6.7±5.6[b]	1-15	7.0±4.5[b]	0.25-35	5.8±5.1	0.000
Distance of farthest market (km)	14-60	35.2±10.7[a]	5-70	24.3±10.4[b]	5-110	29.2±28.7[ab]	5-110	29.6±19	0.007
Total number of goat sold/yr	0-19	1.5±3.0	0-7	1.3±1.6	0-5	1.1±1.2	0-19	1.3±2.0	0.606
Number of goat purchased	0-9	1.0±1.5	0-4	0.7±0.8	0-3	0.5±0.8	0-9	0.7±1.0	0.196

ETB= Ethiopian Birr, SD= Standard deviation,

4.26. Labor Profile and Gender Role in Goat Husbandry

Most of the husbandry and management practices were operated by family members along the three agro ecologies. The roles and responsibilities of each housed members in goat husbandry in Daraolabu district was given in Table 34. The females were the main actors in husbandry and management of goats. Most activities related to milking (93.3%), selling goats (53.9%), health care (42.8%), breeding (26.1%), making dairy product (97.2%) and selling dairy product (97.8%) were operated by females above 15 years of age. These result is different from operation responsibility reported around Adiyo Kaka and Horro for sheep management which has shown that, the main in sheep husbandry were operated by male except for health care (Zewdu, 2008). The involvement of males above 15 years age in goat husbandry was very limited and only 18.3% were involved in breeding, 16.7% in health care and 13.9% in selling of goats. Herding was the responsibility of both male and female and females less than 15 years (37.8%) and males and males less than 15 years old (35%) were responsible in herding. This is in agreement with report of Tsedeke (2009) for activities like herding, breeding and house sanitation which are taken by children and women but disagree for activities like selling and fattening which he reported as overtaken by men reported by same author.

The focus group discussion made with goat owners' reaffirmed the survey result and the involvement of women in decision making, selling; purchasing regulating the flock was prominent. The responsibility of the household head was limited to farm activities namely ploughing, hoe farming, digging (Akafu), planting, weeding and harvesting. Younger females mainly participate in kid management like feeding, watering and barn cleaning. This study is in agreement with a report that, has shown the involvement men in planting and harvesting of crops and small livestock are primarily the responsibility of women and children (Sinn *et al.*.1999). Both husband and wife are deciding on the income generated from sales of animals. The majority of the respondent (49.4%) reported goat was owned by both husband and wife together, 16.1% owned by husband and 21.1% owned by wife and the rest owned by all family members including sons and daughters. The result implied that any improvement strategy, extension service and intervention scheme without the consideration and involvement of women could not be feasible.

Table 28 Household labour division and responsibility for routine husbandry practices in Daro labu district (%)

Husbandry Activities	Male ≤ 15 years	Female ≤ 15 ears	Male > 15 years	Female> 15 years	male & female >15yr	Male and female≤15yr
Milking	0.6	5.0	-	93.3	1.1	-
Selling goats	0.6	0.6	13.9	53.9	30.6	0.6
Herding	35.0	6.7	4.4	11.1	5.0	37.8
Breeding	11.1	0.6	18.3	26.1	31.1	12.8
Health Care of goat	1.1	-	16.7	42.8	38.9	0.6
Making dairy product	-	0.6	0.6	97.2	1.7	-
Selling dairy product	-	-	0.6	97.8	1.7	-
Owner within a flock	4.4	2.2	16.1	21.1	49.4	6.7

N.B. A given activity can be carried out by more than one household member

Figure 10 Women on a field managing kid, herding goat and cattle on grazing land & leading to watering point and child care in lowland Agro pastoral area of Daraolabu district.

4.27. Extension, cooperatives and credit services for goat production

Despite a number of extension activities in various sectors like health and agriculture in general, there has not been any goat specific extension package and a limited credit service provided by government organizations and NGOs. The farmers have no access to credit service as responded by 83.3% of the households. Very few of the respondents (16.7%) get credit from bureau of agriculture, microfinance and NGOs and if credit is available the interest rate is high. Those farmers who were the member of safety net program have the opportunity to get a head of goat through credit services to ensure food security. According to the sampled household most of the extension service provided by bureau of agriculture were farm related training (23.1%), use of drugs (20%), vaccination (16.9%), improved seed supply (crop and forages 9.2%) and a combination of extension services and credit services (23.1%).\

The involvement of the farmers in self help cooperatives is not consistent among farmers. The farmers indicated the existence of cooperatives as perceived by 78.3% respondents and reaming (21.7%) did not indicate the existence of cooperatives. The focus group discussion has revealed the existence of self help cooperatives and formal cooperative supported by the government. The self help cooperatives were locally managed with certain rules and regulations. They are called social unions/association (mehiber) in which 5 to 10 households were a member based on proximity to each other and contribute money so that they handover the collected money for individual members one after the other. These traditional farmers unions are used to commence fattening, where the farmers collect the money in two weeks or in monthly base, buy goats and fatten goats to fetch money.

4.28. Goat Production Constraints

Production constraints, which were ranked by goat owners in all agro ecologies, are presented in Table 38. Assessing and prioritizing the prevailing livestock production constraints are indispensable for any development intervention measures taken to improve productivity in livestock. Good understanding of the relative importance of the different constraints is fundamental prior to initiating any genetic improvement programme (Baker and Gray, 2003).

Farmers were asked to rank the existing goat production constraint. As a result disease, genotype, water and feed were ranked the 1st, 2nd, 3rd and 4th in goat production in lowland with index of 0.36, 0.17, 0.15 and 0.11, respectively. Goat owners in midland area ranked disease, genotype, feed and water as the 1st, 2nd, 3rd and 4th challenges with an index of 0.27, 0.22, 0.20 and 0.11 respectively. Where as in highland feed was ranked first with an index of 0.26, disease ranked second (0.25), genotype ranked third (0.24) and market ranked fourth (0.07). Though drought, market, predator, land and puberty were ranked lesser, result from group discussion displayed that they do have a remarkable effect on goat production. Producers listed a number of problems related to goat production though they are listed at least; like puberty which inhibit improvement in production due to wealth. The result confirmed the earlier report by Tesfaye (2009) who showed a disease as the major constraint and ranked first for goat production in Metema district. Feed shortage and disease were reported as the first and second sheep production constraint in Menz and Afar area (Tesfaye, 2008). Past work in Southern Ethiopia Alaba showed diseases and parasites are 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 (Tessema *et al.,* 2003; Tibbo, 2006; Tsedeke, 2007, Getahun, 2008; Yeshitila, 2008). Feed shortage problem is similar throughout the country, being serious in high human population areas where land size is diminishing due to intensive crop cultivation and soil degradation especially in highland areas. Disease problem is more pronounced in lowland areas which is associated with low accessibility to infrastructure veterinary clinics, health technicians, and road as well in lowland areas. The challenges related to genotypes were almost similar along all agro ecologies due to absence or lack of any genetic improvement intervention in the extension system in the study area. 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.

Table 29 Ranking of goat production constraints under smaller holder farmers in Low land, midland and high land agro ecologies (%)

Constraints	Lowland				Midland				Highland				Overall			
	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**
Drought	3.3	8.3	8.3	**0.06**	6.7	3.3	11.7	**0.06**	3.3	8.3	13.3	**0.05**	4.4	6.7	11.1	**0.06**
puberty	1.7	-	1.7	**0.01**	-	-	-	-	1.7	-	-	**0.01**	1.1	-	0.6	**0.006**
Feed	8.3	11.7	16.7	**0.11**	16.7	21.7	28.3	**0.20**	30.0	23.3	21.7	**0.26**	18.3	18.9	22.2	**0.19**
Water	6.7	18.3	33.3	**0.15**	3.3	20.0	18.3	**0.11**	-	1.7	1.7	**0.01**	3.3	13.3	17.8	**0.09**
Disease	46.7	36.7	11.7	**0.36**	26.7	17.0	26.7	**0.27**	20.0	35.0	20.0	**0.25**	31.1	33.3	19.4	**0.30**
Genotypes	25.0	8.3	11.7	**0.17**	31.7	13.3	8.3	**0.22**	33.3	13.3	18.3	**0.24**	30.0	11.7	12.8	**0.21**
Market	-	5.0	10.0	**0.03**	1.7	6.7	10.0	**0.04**	1.7	8.3	6.7	**0.07**	1.1	6.7	6.7	**0.08**
Predator	1.7	5.0	3.3	**0.03**	1.7	-	-	**0.01**	-	3.3	8.3	**0.03**	1.1	2.8	3.9	**0.02**
Labor	1.7	6.7	1.7	**0.03**	1.7	3.3	1.7	**0.02**	3.3	6.7	6.7	**0.05**	2.2	5.6	3.3	**0.04**
land	5.0	-	1.7	**0.03**	10.0	3.3	1.7	**0.08**	6.7	-	3.3	**0.04**	7.2	1.1	2.2	**0.04**

Index = sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for particular problem divided by sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all constraints in an agro ecology.

4.29. Morphological Characters of Hararghe highland Goat

A morphological character of Hararghe highland buck and does is presented in Table 36. Out of the sampled 930 goat, 654(70.3%) were plain, 250(26.9%) patchy and 26(2.8%) had spotted coat color pattern. White, brown, grey, black and creamy white coat color type were observed in the sampled goat types with the proportions of 26.2%, 34.5%,14% ,15.6% and 9.7% in that order. The proportion of coat color pattern in this study was in agreement with the study conducted in Haraghe (Alemayehu, 1993) and in Eritrea and part of Ethiopia (Nigatu 1994) who had reported plain coat pattern to be the dominant with the proportion of white color (41%) and brown color(23%) in Hararghe highland goat. The color trend in this study is in favor of brown color, this might be attributed to the selection and preference of goat with white and brown color.

The head profile in the study areas showed that, almost all of the goats (98.2%) had straight head profile and only 1.8% posses' slightly convex head profile. Most of the goat had a horizontal ear type (81.9%) and few goats showed a semi pendulous (18.1%) ear type. The ear formation of goats was long ear (93.1%) and short (6.7%). There is also the variability in horn possession where more than half of the goat had horn (56.8%) of which (45.2% straight and 13.8% spiral horn shape; and 41% was polled). The present study is in agreement with the earlier reports by Alemayehu (1993) who had reported 37% goats to be polled. Almost all (95.9 %) sampled goats had no wattle and 99.7% of the goats had no ruff and no bear (78.1%). The absence of ruff and the small proportion of wattle were also reported by Alemayehu (1993). The proportion of bearded male goat in this study is less than the report by Alemayehu (1993) who has reported the proportion of bearded goats to be 72%.

The sources of goats for replacement followed different routes. Out of the 930 goat characterized 71.1% was born in the flock, 27.1% purchased, 0.4% obtained as ribi and 0.3% obtained by donation. The goats with age classification of 0PPI were the once dominating the flock (34.6%) with an average age of 7 ±2.12 month, the proportion of goats with 1PPI were 20.3% with age classification of (16.4± 4.19) month, the proportion of goats with 2PPI age classification were 12.3% with age of (27.11± 5.98) month, the proportion of goats with 3PPI age classification were

13% with the estimated age of (42±6.86) month and the goats with age class of 4PPI were 19.9% of the flock and with the average age of (65.83±14.55) month age.

Table 30 Summary of the qualitative traits in the female and male Hararghe High land goat

Character and factor level	Female		Male		Total	
	N	%	N	%	N	%
Head profile						
Straight	589	98.3	324	97.9	913	98.2
Slightly convex	10	1.7	7	2.1	17	1.8
Ear formation						
Rudimentary	1	0.3	1	0.3	2	0.2
Short ear	36	6.0	26	7.9	62	6.7
Long ear	562	93.8	304	91.8	866	93.1
Ear type						
Semi pendulous	95	15.9	73	22.1	168	18.1
Horizontal	504	84.1	258	77.9	762	81.9
Coat color pattern						
Plain	425	71.0	229	69.2	654	70.3
Patchy	156	26.0	94	28.4	250	26.9
Spotted	18	3.0	8	2.4	26	2.8
Coat color type						
White	150	25.0	94	28.4	244	26.2
Black	99	16.5	46	13.9	145	15.6
Grey	84	14.0	46	13.9	130	14.0
Creamy white	62	10.4	28	8.5	90	9.7
brown	204	34.1	117	35.4	386	34.5
Horn shape						
Straight	256	42.7	164	49.5	420	45.2
spiral	105	17.5	23	6.9	128	13.8
polled	238	39.7	144	43.5	382	41
Horn Orientation						
Rudimentary	2	0.3	2	0.6	4	0.4
Front/Up ward	63	10.5	22	6.6	85	9.1
Backward	296	49.4	164	49.5	460	49.5
Absent	238	39.7	143	43.2	381	41.0
Presence of Wattle						
Present	23	3.8	15	4.5	38	4.1
Absent	576	96.2	316	95.5	892	95.9
Presence of Ruff						
Present	0	0	3	0.9	3	0.3
Absent	599	100.0	328	99.1	927	99.7
Presence of Beard						
Present	84	14.0	120	36.3	204	21.9
Absent	515	86.0	211	63.7	726	78.1

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

The female and male ratio in the flock was in favour of females (Appendix Table 2). The number of males in a flock gets smaller as age advances. This could be attributed to the preference of more females for breeding and the selling and castration of males to cut feeding costs and to increase production efficiency. The selling of male goats at early age for slaughter and early castration of goats leads into negative selection. A similar observation was made in Nigeria and Fajemilehin and Salako (2008) reported that in the forest deciduous zone of South Western Nigeria, goat farmers kept more females than male goats because, majority of the males are preferably castrated or fattened for sale as meat and source of income to the owners in time of financial crisis before celebrating their first or second birth day.

4.30. Body Weight and Linear Body Measurements

Linear body measurements can be used for evaluation of goats for genetic improvement through selection and fix market price and facilitate marketing of goats. It is quite important to note that animals should be valued basing on their weights in the commercial setting rather than eye ball estimations (Semakula *et al*, 2010*).*

Body weight increased with increasing rate between 0PPPI and 1PPI age group, the increase in body weight was gradual between 1PPI and 3PPI and the increase was at decreasing rate till 4PPI (Fig 11a). The increase in other linear measurements also followed similar trend (Fig 11b). The rate of increase in body weight was minimal as the animals aged this might be attributed to the attainment of mature weight at later age (3PPI and 4PPI). In this regard, Sibanda-Majele *et al*.. (2000) reported cyclical changes in does weight which was observed around the breeding cycle, with the younger does gaining faster than older one. Similar findings were reported by Samuel and Salako (2008) who stated a sharp decline in difference between body weight and other traits between age groups 3-4 years and 4-5years in West African Dwarf goat. The result in the current study is also in accordance with the work of Jeffery and Berg (1972) who reported that at maturity, linear body measurements are essentially a constant**,** thereby reflecting heritable size ofthe skeleton.

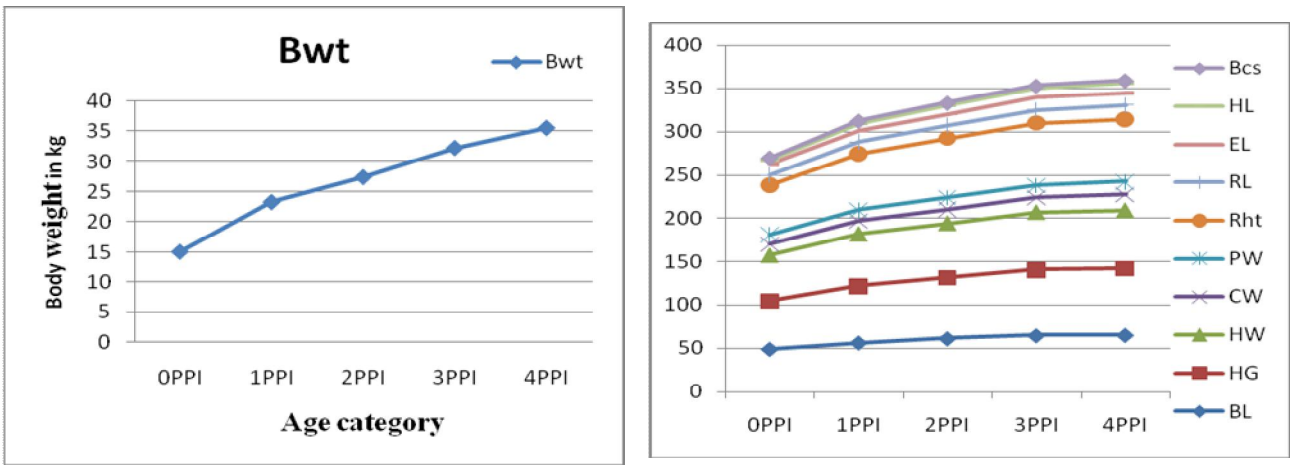

Figure 11 (a,b) Trend in body weight, and other linear body measurement as age advances

Body weight and linear measurements for Hararghe highland goat at various ages and sex are presented in Table 40. Under general condition from pooled data the mean body weight of Haraghe highland goat in the study area is estimated at 22.97±4.66 kg. The overall mean BC, HG, BL, HW, CW, PW, RH, RL, EL , HL and SC are 2.72±0.59cm, 65.16±5.14 cm, 55.86±5.03cm, 58.98±4.76cm, 14.79±3.95cm, 12.8±3.27cm, 63.0±4.27cm, 14.0±1.31cm, 12.8±1.12cm, 8.33±2.59cm and 18.82±4.97cm, respectively. The analyses for body weight and measurements showed a variation which was attributed to some factors like agro ecology, sex and age.

4.30.1 Effect of Agro Ecology

The agro ecology had significant ($p<0.01$) effect on body weight and heart girth. Body condition is affected significantly ($P<0.05$) by agro ecology and rump length, body length and chest width were affected by agro ecology ($p< 0.001$). Height at wither, pelvic width, rump height, ear length, horn length and scrotal circumference of goat were not significantly affected ($p>0.05$) by agro ecological zones (Table 37). The interaction effect of agro ecology by sex group was not significant ($p>0.05$) for live body weight and all other linear body measurements. Similarly the interaction effect of agro ecology with age groups was not significant for live body weight and all other linear body measurements.

4.30.2 Effect of Sex groups

The least squares means and standard errors for the effect of sex, age group and their interaction on body weight and other body measurements are presented in Tables 37. The mean BWT, BC, HG, BL, HW, CW, PW, RH, RL, EL and HL of females are 23.74±0.21cm, 2.68±0.03, 66.6±0.23cm, 57.2±0.23cm, 59.6±0.21cm, 15.02±0.18cm, 13.3±0.15cm, 63.7±0.19cm, 14.3±0.06 cm, 13.1±0.07cm and 8.47±0.15cm respectively. The corresponding values for male counterpart are 29.6±0.31kg, 3.04±0.04, 71.4±0.35cm, 60.7±0.34cm, 64.4±0.33cm, 16.3±0.26cm, 13.6±0.22cm, 68.8±0.29cm, 14.9±0.09cm, 13.07±0.07cm and 10.25±0.27cm respectively. The result in the current study for BWT, HW, HG, EL and HL for both sex are lower than the previous work by Alemayehu (1993) for same breed of goat. This might be attributed to the consideration of goat at different age groups starting at milk teeth to the older once in the current study. Body weight and all the other body measurements were significantly ($P<0.001$) affected by sex groups except PW and EL ($P>0.05$).

All the body measurements in male goats were consistently higher ($p<0.001$) than females for all variables. The effect of sex in favor of males on body weight and body measurements in this study is in agreement with previous results (Semakula et al, 2010). 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).

4.30.3 Effect of Age groups

The least squares analysis (Table 40) indicated that age of the goat had significant ($P<0.001$) effect on BWT, BC, BL, HG, HW, CW, PW, RH, RL, EL, HL and SC. BWT and RL have shown a consistent increase as age increase from the youngest age (0PPI) to the oldest age (4PPI). These consistent increases imply that, BWT and RL reached their maximum measurements at oldest age as compared to other body measurements. In the other measurements such as BL, HG, HW, CW, RH, EL and HL reached maximum at intermediate age (≥3PPI). PW

was significantly ($p<0.001$) higher in oldest age group (4PPI) than all other age groups (0PPI, 1PPI, 2PPI, 3PPI). SC attained the highest size at the age ≥2PPI which has showed a significant effect ($p<0.001$) among age groups. The mean value of SC at age of 0PPI was 17.26±0.39 cm which significantly lower ($P<0.001$) than 1PPI (22.53±0.75cm) and 2PPI (28.88±1.04cm). Contrary to this study, there was no significant difference between 1PPI and 2PPI age groups in SC. This result coincide with Semakula et al (2010) which has reported the increase in live body weight and linear body measurements in all breeds of goat as age of the animal increased.

4.30.3 Effect of Sex by Age groups Interaction

The interaction effect of sex and age group was significant ($P<0.05$) for BWT, BC, BL, HG, HW, PW, RHT, EL and RL; whereas the interaction of sex and age group was not significant ($P>0.05$) for CW and HL (Table 37). This finding in this study is in agreement with Samuel and Salako (2008) which has reported a significant influence of sex and age on body measurements. Hence, this finding should be considered in improvement program to increase meat yield from goat via sex disintegrated improved management. The magnitude of least square mean and standard error of live body weight and other linear body measurement considered by this study for each combination of sex and age group interaction were given in Table 37. In all age groups of males were heavier ($p<0.001$) than females except at the youngest age group (0PPI) which was the same for both male and female. PW in females 0PPI age group was significantly ($P<0.0001$) higher than the corresponding male in same age.

BWT, HG and HW at age 0PPI and ≥ reported in this study are comparable with report of David and Derrick (2003) for Jamaican native/creole goat at similar age of <12 month and above 24 month for both male and female. BWT reported for Hararghe highland male goat in this study agreed with the one reported for male goat around Metema district for all age group (i.e. 1PPI=27.5kg, 3PPI=39.0kg and 4PPI=39.2kg) except at age of 2PPI (35.22kg); whereas it quite less for female in all age groups IPPI, 2PPI, 3PPI and 4PPI with values of 26.83, 32.28, 34.6 and33.96 kg (Tesfaye, 2009). As the result in the current study compared with the earlier study on same breed HW and Ear length are comparable with earlier report (Alemayew,1993; Nigatu,1994); On the other hand BWT, HG and HL are considerably less than the earlier report

in both male and female. This due to the indiscriminate breeding practices, high incidence of inbreeding and random selection of goat owners against horn and the apparent practices of farmers that cross the sire with his dam and his sisters in a flock in intension to multiply the breed type that they think is better as observed by this study.

Table 37 Least squares means ± standard errors of body weight (kg), body condition score & other body measurements (cm) for effects of agro ecology, sex, age & sex by age for Hararghe Highland Goat

Effects & Level	Body weight		BC	Body length	Heart Girth	HW	Chest width
	N	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE	LSM±SE
Overall	930	22.97±4.66	2.72±0.59	55.86±5.03	65.16±5.14	58.98±4.76	14.79±3.95
CV		20.19	21.79	9.0	7.8	8.08	26. 71
R^2		0.72	0.15	0.64	0.73	0.60	0.24
Age Group		***	***	***	***	***	***
0PPI		15.1±0.24^{a}	2.8±0.03^{a}	48.5±0.27^{a}	56.1±0.27^{a}	52.6±0.25^{a}	12.8±0.21^{a}
1PPI		23.1±0.41^{b}	2.8±0.05^{b}	56.0±0.45^{b}	65.6±0.46^{b}	60.3±0.42^{b}	14.7±0.35^{b}
2PPI		27.4±0.47^{c}	2.85±0.06^{b}	60.9±0.51^{c}	70.4±0.52^{c}	63.0±0.48^{c}	15.9±0.40^{c}
3PPI		32.2±0.50^{d}	2.9±0.06^{b}	64.4±0.54^{d}	76.0±0.56^{d}	66.7±0.51^{d}	16.8±0.42^{cd}
4PPI		35.5±0.44^{e}	3.1±0.05^{c}	64.9±0.48^{d}	76.9±0.49^{d}	67.4±0.46^{d}	17.9±0.38^{d}
AE		**	*	***	**	Ns	***
LL		25.87±0.29^{a}	2.8±0.04^{a}	57.6±0.36^{a}	67.9±0.37^{a}	61.9±0.34	14.4±0.28^{a}
ML		26.96±0.29^{b}	2.9±0.04^{b}	59.2±0.37^{b}	69.5±0.37^{b}	61.6±0.35	14.7±0.28^{a}
HL		27.14±0.28^{b}	2.87±0.04^{b}	59.9±0.35^{b}	69.7±0.35^{b}	62.5±0.33	17.9±0.27^{b}
Sex		***	***	***	***	***	***
M		29.6±0.31	3.04±0.04	60.7±0.34	71.4±0.35	64.4±0.33	16.3±0.26
F		23.74±0.21	2.68±0.03	57.2±0.23	66.6±0.23	59.6±0.21	15.02±0.18
AGE*Sex		***	***	***	***	***	ns
0PPI, M		15.5±0.36^{a}	2.6±0.05^{a}	48.7±0.38^{a}	56.4±0.39^{a}	52.9±0.36^{a}	13.2±0.3
0PPI, F		14.6±0.34^{a}	2.6±0.04^{a}	48.3±0.37^{a}	55.7±0.38^{a}	52.4±0.35^{a}	12.5±0.29
1PPI, M		24.6±0.66^{b}	2.9±0.08^{bc}	56.8±0.72^{b}	67.3±0.73^{b}	62.4±0.68^{b}	14.8±0.56
1PPI, F		21.6±0.50^{c}	2.8±0.06^{ab}	55.2±0.54^{b}	64.0±0.55^{c}	58.2±0.51^{c}	14.7±0.42
2PPI,M		29.5±0.77^{d}	3.0±0.10^{bc}	62.4±0.83^{c}	72.1±0.85^{df}	65.4±0.79^{dg}	16.7±0.65
2PPI, F		25.2±0.55^{b}	2.7±0.07^{ab}	59.5±0.59^{d}	68.7±0.60^{b}	60.6±0.56^{e}	15.0±0.46
3PPI, M		37.5±0.86^{e}	3.1±0.11^{c}	67.9±0.93^{e}	80.7±0.95^{e}	70.4±0.88^{f}	17.5±0.72
3PPI, F		27.0±0.53^{f}	2.7±0.07^{ab}	60.8±0.57^{cd}	71.4±0.58^{d}	62.9±0.54^{bg}	16.1±0.44
4PPI,M		40.7±0.80^{g}	3.7±0.10^{d}	67.6±0.87^{e}	80.5±0.89^{e}	70.8±0.82^{f}	19.1±0.68
4PPI, F		30.3±0.40^{d}	2.6±0.05^{a}	62.2±0.43^{c}	73.4±0.44^{f}	64.0±0.40^{g}	16.7±0.33

Table 37 (Continued)

Factors & Level	Pelvic Width		RH	RL	Ear length	Horn Length		SC	
	N	LSM±SE	LSM±SE	LSM±SE	LSM±SE	N	LSM±SE	N	LSM±SE
Overall	930	12.8±3.27	63.0±4.27	14.0±1.31	12.8±1.12	550	8.33±2.59	240	18.82±4.97
CV		25.44	6.76	9.4	8.7		31.26		26.4
R^2		0.20	0.67	0.56	0.24		0.58		0.20
Age Group		***	***	***	***		***		***
0PPI		11.1±0.17^{a}	56.4±0.23^{a}	12.4±0.07^{a}	12.1±0.05^{a}		5.1±0.18^{a}		17.26±0.39^{a}
1PPI		12.9±0.29^{b}	64.5±0.38^{b}	14.0±0.12^{b}	12.9±0.10^{b}		8.3±0.35^{b}		22.53±0.75^{b}
2PPI		13.9±0.33^{c}	67.7±0.43^{c}	14.9±0.13^{c}	13.0±0.11^{b}		10.2±0.38^{c}		28.88±1.04^{b}
3PPI		14.2±0.35^{c}	71.3±0.46^{d}	15.3±0.14^{d}	13.7±0.12^{c}		11.3±0.42^{d}		-
4PPI		15.1±0.31^{d}	71.3±0.41^{d}	16.5±0.13^{e}	13.6±0.11^{c}		12.0±0.38^{d}		-
AE		Ns	ns	***	Ns		Ns		ns
LL		13.1±0.23	65.8±0.31	14.5±0.09^{a}	13.0±0.08		9.2±0.3		21.43±0.811
ML		13.7±0.24	66.5±0.31	14.9±0.1^{b}	13.1±0.07		9.5±0.28		20.73±0.75
HL		13.5±0.22	66.38±0.29	14.4±0.09^{a}	13.1±0.07		9.3±0.22		20.51±0.76
Sex		Ns	***	***	Ns		***		
M		13.6±0.22	68.8±0.29	14.9±0.09	13.07±0.07		10.25±0.27		
F		13.3±0.15	63.7±0.19	14.3±0.06	13.04±0.05		8.47±0.15		
AGE*SEX		***	***	***	**		ns		
0PPI, M		10.6±0.25^{a}	56.6±0.33^{a}	12.4±0.1^{a}	12.1±0.08^{a}		6.4±0.25		
0PPI, F		11.5±0.24^{b}	56.2±0.31^{a}	12.5±0.1^{a}	12.2±0.08^{a}		3.8±0.27		
1PPI, M		13.0±0.47^{cef}	66.0±0.61^{bf}	14.2±0.19^{b}	12.9±0.16^{b}		9.2±0.59		
1PPI, F		12.8±0.35^{c}	63.0±0.45^{c}	13.8±0.14^{b}	13.0±0.12^{b}		7.3±0.36		
2PPI,M		14.2±0.54^{def}	70.3±0.71^{d}	15.2±0.22^{cd}	12.7±0.18^{b}		10.9±0.62		
2PPI, F		13.7±0.38^{cdf}	65.0±0.50^{b}	14.5±0.16^{b}	13.2±0.13^{bde}		9.4±0.44		
3PPI, M		14.3±0.6^{eh}	76.0±0.79^{e}	15.6±0.24^{c}	13.9±0.21^{c}		12.5±0.76		
3PPI, F		14.1±0.37^{efg}	66.6±0.48^{fg}	15.0±0.15^{d}	13.4±0.13^{df}		10.2±0.37		
4PPI,M		15.7±0.56^{h}	74.9±0.74^{e}	17.3±0.23^{e}	13.7±0.19^{cf}		12.3±0.71		
4PPI, F		14.5±0.28^{gh}	67.7±0.36^{g}	15.6±0.11^{c}	13.4±0.09^{ef}		11.7±0.27		

Means with different superscripts within the same column and class are statistically different (at least p <0.05). Ns = non significant; * significant at 0.05; **significant at 0.01. 0 PPI = 0 pair of permanent incisors; 0PPI, 1PPI, 2PPI, 3PPI and4PPI = 0,1,2,3 and 4 pair of permanent incisor , AE=Agro ecology, LL=Lowland, ML=Midland and GL=Highland

4.31. Correlation between body weight and linear body measurements

The correlation coefficient indicating the relationship between live body weight and other linear measurements in different sex and age group is presented in Table 38. Live weight was significantly (P < 0.001) correlated with all body measurements. Heart girth was the most

correlated trait to body weight for both sexes and at all age groups. The correlation between these two traits in male age groups of 0PPI,1PPI,2PPI,3PPI,4PPI and for all age group1-4PPI were 0.90, 0.90,0.89,0.86, 0.88 and 0.97, respectively; the corresponding values for females were 0.86, 0.81, 0.84,0.83, 0.81 and 0.94, respectively (Table 38). Body measurements such as height at wither, rump height, body length, pelvic width showed a moderate to high positive correlations with one another (0.78–0.0.95) in male and (0.74 - 0.87) in female. However, relatively lowest correlations were obtained between ear length and body weight and body condition and body weight in IPPI male with value 0.57 and 0.59, respectively. In female the lowest correlation was noted with body weight and the correlation coefficient were estimated at 0.18, 0.36, 0.42 and 0.44 for BC, PW, CW and EL, respectively. The high relationship between BWT and HG recorded in study is in agreement with earlier reports about 94% (Afolayan *et al*, 2006).

The higher significant correlation coefficient between live body weight and linear body measurements at all age groups suggests that a combination of body measurements or hearth girth alone would provide a good estimator for predicting live body weight in goats in the fields without weighing scales (Atta and khidir, 2004; Afolayan *et al*., 2006). These morphological measurements can also be used as indirect selection criteria for genetic improvement for live weight (Khan *et al*., 2006; Solomon, 2008, Tesfaye, 2008; Semakula *et al.*, 2010). There was also correlation between live weight and SC with correlation coefficient of 75%, 55% and 61% at age of 0PPI, 1PPI and 2PPI, respectively. This implies the fact that selection of male goats based on SC could be used to improve male animals. It was argued that, measurement of SC is thus an essential to ensure evaluation of breeding males (Yoseph, 2007) and thus selection could be based on testicular circumference (Toe *et al*., 2000 as cited in Tesfaye, 2008).

Table 38 Coefficients of correlation between body weight and other body measurements for Hararghe High land goats breed within age groups and sex

Body measurement		Age Group											
		0PPI		IPPI		2PPI		3PPI		4PPI		1-4PPI	
		M	F	M	F	M	F	M	F	M	F	M	F
Body condition	N	179	189	48	89	37	76	30	85	34	160	331	599
	r	0.227**	0.443***	0.477***	0.489***	0.527***	0.324**	0.676***	0.469***	0.763***	0.378***	0.588***	0.188***
Body length	N	179	189	48	89	37	76	30	85	34	160	331	599
	r	0.734***	0.693***	0.612***	0.533***	0.667***	0.721***	0.18^{NS}	0.558***	0.46**	0.481***	0.879***	0.843***
Heart Girth	N	179	189	48	89	37	76	30	85	34	160	331	599
	r	0.903***	0.855***	0.903***	0.814***	0.892***	0.840***	0.855***	0.828***	0.878***	0.807***	0.965***	0.937***
Height at Wither	N	179	189	48	89	37	76	30	85	34	160	331	599
	r	0.677***	0.745***	0.821***	0.331**	0.838***	0.528***	0.776***	0.695***	0.648***	0.40***	0.884***	0.785***
Chest width	N	179	189	48	89	37	76	30	85	34	160	331	599
	r	0.334***	0.584***	0.455**	0.185^{NS}	0.433**	0.388***	0.181^{NS}	0.301**	0.385*	0.408***	0.602***	0.427***
Pelvic Width	N	179	189	48	89	37	76	30	85	34	160	331	599
	r	0.805***	0.149*	0.756***	0.547***	0.77***	0.606***	0.586***	0.383***	0.678***	0.615***	0.875***	0.364***
Rump height	N	179	189	48	89	37	76	30	85	34	160	331	599
	r	0.834***	0.762***	0.876***	0.619***	0.829***	0.676***	0.63***	0.502***	0.463**	0.56***	0.926***	0.852***
Rump length	N	179	189	48	89	37	76	30	85	34	160	331	599
	r	0.68***	0.649***	0.56***	0.283**	0.776***	0.333**	0.235^{NS}	0.355***	0.613***	0.27***	0.853***	0.692***
Ear length	N	179	189	48	89	37	76	30	85	34	160	331	599**
	r	0.464***	0.269***	0.212^{NS}	0.128^{NS}	0.234^{NS}	0.145^{NS}	0.322^{NS}	0.065^{NS}	0.173^{NS}	0.259**	0.574***	0.444***
Horn Length	N	114	100	21	52	21	43	17	56	15	111	188	362
	r	0.614***	0.661***	0.585**	0.376**	0.452*	0.294^{NS}	0.454^{NS}	0.487***	0.319^{NS}	0.25**	0.779***	0.768***
Scrotal circumference	N	173	NA	43	NA	23	NA	NA	NA	NA	NA	240	NA
	r	0.746***	NA	0.554***	NA	0.611**	NA	NA	NA	NA	NA	0.748***	NA

NS = non-significant; *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; M = Male; F = Female, NA = Not -available; (-) = No value taken; N= number of observation ; r=coefficient of correlation

4. 32. Multiple Regression Analysis

Multiple and simple regression equations were developed in order to predict live weight from ten different linear body measurements for males and nine body measurements for females excluding SC 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. It indicated that HG has been selected across all age groups for both sexes as the first regressor because of its high contribution. It was noted that, in general the R^2 value was higher for bucks than does that ranged from (73% to 91%) in male and (65% to 81%) in female at various age groups.

The multiple regression output and coefficient of determination of goat at different age category and sex are presented in Table 39 and 40. Hearth girth was the best single predictor for body weight. Hearth girth alone explained the total variation in body weight in the range of 0.66 in IPPI age group to 0.73 in age group 0PPI in females and in males it explained the total variation in body weight from 0.73 in 3PPI to 0.82 in age group 0PPI. In the prediction of live body weight of youngest female goats the stepwise regression procedure found BC, RHT, CW and RL to be important additional variables to HG to obtain up to 81% prediction of body weight ($P<0.05$). For male of same age group HG, BC, EL, RHT and RL were significant with 87% prediction. For female goats at dentition class 1PPI, HG, BC and EL were found to be significant ($P<0.05$) with R^2 value of 0.71 and for the corresponding age group of male HG, RHT, BC and PW were included in the model at R^2 value of 0.91. HG, RHT, and BL with R^2 value of 0.80 for female and HG, HW and PW with R^2 value of 0.91 were found to be significant ($P<0.05$) for dentition class of 2PPI. R^2 value of 81% were obtained for female 3PPI age group by inclusion of HG, HW, BC and PW at ($p<0.05$) whereas 88% prediction was obtained for male of the same age group using similar parameters excluding PW. For female in the oldest age group HG, PW,RHT, BL,RL and BC were significant($P<0.05$) with R^2 value of 76%;but for male of same age only two parameters HG and BC were significant($P<0.05$) with 84% prediction. For the pooled data of females of all age groups six independent variables HG, RHT, BC, BL, RL and HW were significantly($P<0.05$) important to get 90% prediction of live body weight. In the case

of male using pooled data (1-4PPI) five parameters namely HG, BC, RL, HW and PW were included in the model with R^2 value of 95%.

The inclusion of more predictor variables revealed an improvement in explanatory power of the model for different sex and age groups (Table 39 an 40). In general the result in the current study depicted that R^2 observed for both pooled data of male and female using heart girth as explanatory variable was higher or more explanatory to predict body weight and nearly equivalent with the other independent age groups (0PPI, 1PPI, 2PPI, 3PPI and 4PPI) in both sex. Therefore, instead of using different linear equations for live body weight prediction for goats in different age category heart girth which has a higher explanatory power could be used an alternative means for estimation of live body weight for both male and female goats independently. As a result a linear regression equation that has used hearth as single predictor variable and expressed as $y = -31.42 + 0.83x$ for female and $y = -36.21 + 0.92x$ for male goat could explain the variation in body weight at 88% and 93%, respectively. The different type of equations which were presented in table 42 and 43 could be useful under different circumstance based on accuracy, cost, time and ease of application. A number of reports have shown the importance of hearth girth as single most important predictor variable for body weight and the use of prediction equation for estimating body weight for the marketing and evaluation of goats has been documented (Atta *et al*., 2004; Afolayan *et al*., 2006; Tesfaye, 2008).

The different equations developed in the current study could be useful for designing weight based goat marketing system in the area by reverting the eye ball or individual based animal marketing in the area which negatively affect or reduced the economic return that producers expected to obtain from their animals.

Table 39 Body weight prediction equations of female at different age groups Hararghe Highland Goat Breed

Age group	Equations	β0	β1	β2	β3	β4	β5	β6	R^2	R^2 Change	MSE
0PP1	HG	-22.8	0.67						0.73	0.000	2.15
	HG+BC	-24.48	0.62	1.65					0.78	0.003	1.95
	HG+BC+RHT	-27.42	0.49	1.55	0.19				0.80	0.003	1.87
	HG+BC+RHT+CW	-27.19	0.46	1.51	0.17	0.23			0.81	0.003	1.83
	HG+BC+RHT+CW+RL	-27.5	0.43	1.4	0.14	0.23	0.32		0.81	0.005	1.80
1PPI	HG	-38.0	0.93						0.66	0.000	2.50
	HG+BC	-36.30	0.84	1.36					0.69	0.007	2.39
	HG+BC+EL	-43.0	0.84	1.39	0.53				0.71	0.01	2.35
2PPI	HG	-31.7	0.83						0.71	0.000	2.74
	HG+RHT	-49.83	0.66	0.46					0.78	0.006	2.38
	HG+RHT+BL	-47.98	0.58	0.35	0.18				0.80	0.01	2.29
3PPI	HG	-29.89	0.80						0.69	0.000	2.57
	HG+HW	-39.83	0.61	0.37					0.76	0.006	2.24
	HG+HW+BC	-38.99	0.57	0.34	1.60				0.80	0.01	2.08
	HG+HW+BC+PW	-48.62	0.56	0.31	1.42	0.37			0.81	0.009	2.03
4PPI	HG	-29.8	0.82						0.65	0.000	2.70
	HG+PW	-31.87	0.68	0.85					0.70	0/004	2.51
	HG+PW+RHT	-42.9	0.61	0.73	0.26				0.73	0.005	2.41
	HG+PW+RHT+BL	-45.71	0.55	0.75	0.25	0.13			0.74	0.007	2.35
	HG+PW+RHT+BL+RL	-49.55	0.53	0.67	0.24	0.16	0.32		0.75	0.008	2.30
	HG+PW+RHT+BL+RL+BC	-48.58	0.50	0.63	0.24	0.16	0.28	0.64	0.76	0.009	2.29
0-4PPI	HG	-31.42	0.83						0.88	0.000	2.67
	HG+RHT	-36.26	0.69	0.22					0.89	0.003	2.58
	HG+RHT+BC	-38.63	0.68	0.22	1.08				0.89	0.001	2.50
	HG+RHT+BC+BL	-38.93	0.62	0.20	1.16	0.10			0.90	0.001	2.48
	HG+RHT+BC+BL+RL	-39.37	0.58	0.17	1.06	0.12	0.29		0.90	0.001	2.45
	HG+RHT+BC+BL+RL+HW	-39.66	0.58	0.13	1.07	0.11	0.28	0.06	0.90	0.001	2.44

BL= Body length; HG = Heart Girth; CW = Chest width HW = Height Wither; PW = Pelvic Width; RHT= 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 31 Body weight prediction equations of male at different age groups Hararghe Highland Goat Breed

Age group	Equations	β0	β1	β2	β3	β4	β5	R^2	R^2 Change	MSE
0PP1	HG	-21.99	0.66					0.82	0.000	1.89
	HG+RL	-23.85	0.58	0.55				0.84	0.002	1.77
	HG+RL+RHT	-26.03	0.46	0.45	0.18			0.85	0.003	1.70
	HG+RL+RHT+BC	-27.14	0.45	0.41	0.18	0.66		0.86	0.003	1.66
	HG+RL+RHT+BC+EL	-29.04	0.45	0.36	0.16	0.72	0.31	0.87	0.004	1.63
1PPI	HG	-41.19	0.98					0.81	0.000	2.15
	HG+ RHT	-50.23	0.61	0.52				0.88	0.005	1.72
	HG+RHT+BC	-49.58	0.49	0.58	1.22			0.90	0.007	1.60
	HG+RHT+BC+PW	-47.0	0.42	0.54	1.04	0.41		0.91	0.008	1.54
2PPI	HG	-33.69	0.88					0.79	0.000	2.97
	HG+HW	-44.51	0.59	0.48				0.87	0.007	2.36
	HG+HW+PW	-40.25	0.51	0.37	0.66			0.91	0.009	2.07
3PPI	HG	-51.7	1.10					0.73	0.000	2.67
	HG+HW	-58.20	0.79	0.46				0.85	0.013	2.04
	HG+HW+BC	-52.79	0.73	0.35	2.26			0.88	0.014	1.88
4PPI	HG	-50/47	1.13					0.77	0.000	3.11
	HG+BC	-38.88	0.85	2.98				0.84	0.01	2.66
0-4PPI	HG	-36.21	0.92					0.93	0.000	2.77
	HG+BC	-37.82	0.86	1.91				0.94	0.0004	2.55
	HG+BC+RL	-38.31	0.77	1.62	0.52			0.95	0.0004	2.44
	HG+BC+RL+HW	-40.0	0.66	1.62	0.48	0.15		0.95	0.0006	2.35
	HG+BC+RL+HW+PW	-39.64	0.64	1.51	0.43	0.14	0.23	0.95	0.0007	2.34

BL= Body length; HG = Heart Girth; CW = Chest width HW = Height Wither; PW = Pelvic Width; RHT = 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 Incisor

5. SUMMARY AND CONCLUSION

5.1. Summary

This study was undertaken to characterize Hararghe highland goat breed in a participatory approach, characterize goat production system and breeding management, define trait preferences, breeding objectives and to develop a prediction equation for body weight based on body measurements. The study was conducted in three agro ecological zones (lowland, midland and highland). A total of 180 goat owners were interviewed using structured questioner at random. For breed morphological characterization and linear body measurements a total of 930 goats were considered.

Mixed crop livestock production system with low inputs and management was practiced in the area. Maize, sorghum, goat and cattle were the first, second, third and fourth important source of income/cash in lowland with an index of 0.19, 0.18, 0.17and 0.12. In midland coffee, chat, maize and cattle ranked 1 to 4 with an index of 0.37, 0.24, 0.16 and 0.11, respectively and in the highland chat, coffee, sorghum and goat were ranked first, second, third and fourth with an index of 0.38, 0.22, 0.11 and 0.09, respectively. The overall mean (mean ±ES) land holding per household was 1.51±1.35 ha with a range of 0.25 – 8 ha. The average private grazing land size of the sampled households was 0.21±0.43h with a range of 0.0-2ha.

The overall average number of goat per household (17.5±22.42) was higher than cattle (6.40±5.35) and sheep (1.56±1.83) which signifies higher preference of the community to goat. The average number of goat per household in highland (7.0±2.46) and midland (10.5±4.73) agro ecologies were nearly equivalent but by far less than that in lowland agro ecology (34.0±32.02). This high number of goat per household shows their significance for livelihood of the community as source of immediate source of cash. The flock structure of goat in the study area was in favor of breeding female goat and the proportion of breeding does was 6.08±9.0 which was followed by female goats between 6-12 month age

(2.82±3.85), female goats < 6 month age (2.46±3.51) and castrate (2.16±2.81). The higher number of castrate per household in the area than any other part of the country is an indication to the production objective of this community toward fattening.

Natural pasture was the main feed resources in the study area. Tethering in combination with herded grazing was the most frequently used management option in wet season. Herded grazing was most common in management system adopted in the dry season. Natural pasture, crop residue including "chat garaba", hay, *chinki* and trees/shrubs were the major feed resources in the district. Roasted grain, maize floor, Oil seed cake(marara/abish/yeast) were ranked as the first, second, and third important supplementary feed that has complemented to fatten goats with index of 0.47, 0.30 and 0.14,respectively.

Almost all (93.3%) sampled households practiced goat fattening for a period of 17 months. Castration was practiced by 97.2% of the goat owners primarily to hasten fattening. The overall mean age at castration was estimated to be 2.1±0.8 year with the rage of 1-5 years. Males with good body conformation and fast growing characteristics are castrated and fattened at early age which may inhibit future genetic improvement in the flock.

White, brown and grey are the first, second and third preferred coat color with an index value of 0.38, 0.38 and 0.24, respectively whereas black and mixed coat colors were not preferred which indicates the importance of considering qualitative traits on top of quantitative traits in genetic improvement strategy based on producers preference.

Female goat reached age at first service at mean age of 14.1±5.6, 13.1±5.7 and 12.0±4.7 month in lowland, midland and highland, respectively where fast growing and good looking doe served earlier than these ages. Bucks reached age at first mating at the mean age of 12.7±5.2 months. The overall mean kidding interval of the doe was estimated at 8.1±2.07 month. Litter size was estimated at 1.38±0.20, 1.32±0.28 and 1.36±0.35 month in the lowland, midland and highland agro ecologies, respectively. The number kids per reproductive life time of does were estimated to be 19.2±10.0, 18.2±9.1 and 14.2±4.9 in lowland, midland and highland, respectively. The average age of reproductive life time of

does were also estimated as 13.5±4.9 in lowland, 13.7±4.1 in midland and 11.7±3.7 years in highland.

Majority of the sampled farmers (76.7%) had breeding buck in their flock and 23% had no breeding buck and depend on sharing with neighbors. Majority of the household (96.7%) in lowland, (95%) in midland and (71.7%) in highland uses buck born in the flock which could induce inbreeding in the flock. Breeding was generally uncontrolled in all agro ecologies. The proportions of households who are following uncontrolled mating are 98.3% in lowland, 91.6% in midland and 81.7% in highland. Almost the entire respondents 98.3% do not have any knowledge about the disadvantage and advantage of inbreeding; moreover, in most cases they practiced mating of best bucks with dams, sister and other related animals in the flock. Uncontrolled mating, use of bucks born in a flock for breeding, low awareness of producers about the effect of inbreeding and low practices of flock mixing, may contribute to high incidence of inbreeding.

The average age of breeding buck for selection in the study area was 9.46±3.9 month and average age of breeding does during selection ranges from two to eighteen month with an average age of 8.4±3.6 month. Conformation (appearance), milk yield, twining ability, coat color, kidding interval and mothering character were ranked first, second, third, fourth, fifth and sixth to select breeding doe with an index of 0.22, 0.18, 0.17, 0.14, 0.07 and 0.04 respectively. Conformation (appearance), coat color, pedigree the buck, fast growth and litter size were ranked first, second, third, fourth and fifth with an index of 0.28, 0.20, 0.12, 0.11, and 0.10, respectively.

The major goat production objectives as perceived by households were income generation, milk production, meat production, means of saving and sources of manure, respectively. Concerning adaptation traits as perceived by the household Haraghe highland goat was most adapted to heat stress followed by drought resistance and feed stress with an index of 0.32, 0.24 and 0.20, respectively and goat was perceived by goat keepers as the most adaptable livestock species in the study area.

Farmers (producers), middlemen, traders at different level and consumers were some of the market actors in goat marketing. Most of the farmers (53.8%) sold goat at festivals and 35.8% sold at planting time. Price fluctuation, distance from market and interruption by middlemen were some of the marketing problems. Women were responsible for most of the husbandry and management goats like feeding, health care, milking, kid management and selling; whereas decision making was made by both women and men. Disease, genotype, feed and water were ranked the first, second, third and fourth pertinent constraints for goat production in the study area having an index of 0.30, 0.21, 0.19 and 0.09, respectively. Pest Petit Ruminants (PPR), pastrolosis and Anthrax were the most important top three goat disease in the area.

Hararghe highland goats are plain (70.3%), patchy (26.9%) and few spotted (2.8%) coat color pattern; with white (26.2%), brown (34.5%), grey (14%), black (15.6%) and creamy white (9.7%) coat color type. The goat has straight head profile (98. 2%),); from which 56.8% had horn and 43.2% of the goat were polled. The majority (81.9%) of the goat had horizontal ear type; 95.9% had no wattle, 99.7% had no ruff and 78.1% had no bear.

Sex and age of the goat had a significant ($p<0.01$) effect on body weight and in almost all linear body measurements and agro ecology had exerted a significant effect on some parameters like HG, BWT, RL, BL and CW. Body weight and other linear body measurements in both sex increased with increasing age with different rate between age groups. The growth rate was fast at early age and slowly decline as the age advances.

Body measurements has a higher correlation with the body weight, this may be used as selection criteria and the study has also showed that although a number of traits measured could be used to predict body weight, heart girth would be the best estimator of body weight in goats. Hearth girth has explained 88% for females and 93% for males of the variation in body weight under pooled age groups. For more accurate estimation of body weight from body measurements, however, a number of body measurements could be combined. In general combining the linear model with conformation as selection criteria could make the marketing system efficient.

5.2. Recommendations

- Careful and appropriate attention has to be given in the genetic improvement of Haraghe highland goat breed for their considerable contribution to the household and/ community as food, cash source, medicinal value and the survival ability of the goats under stress conditions and their ability to adapt the local environments.

- Advancing genetic improvement practices and awareness creation on significance of keeping fast growing and bucks with good body conformation and use them for extended period and culling of undesirable once is important to enhance future genetic improvement in the community.

- Developing the level of awareness in goat producing community about inbreeding and its consequences as whole is indispensable to reduce the incidence of inbreeding in the flock and selection of breeding buck from other flock instead of using buck from own flock and enhancing flock mixing among households and between villages may reduce risk of inbreeding by increasing number of effective population in the flock.

- Designing community based breeding strategy and implementing this community based goat improvement program should be considered. Any genetic improvement program and extension delivery service for goat owners has to focus not only economically important traits but also some morphological and qualitative traits preferred by the community.

- Training on goat health management and strengthening animal health extension and even distribution of animal health centers into isolated (lowland) areas are required to reduce loss of goat and goat productivity caused by diseases.

- Packaging the indigenous goat fattening practices and experiences of Hararge farmers with different feeding system and local feed resources to shorten the fattening period and to further scale out this indigenous knowledge is recommended. Assessing the economic feasibility of indigenous Hararghe fattening practices under farmers' condition is important to fully package the practices in the area.

- The high loss of goat skin in the area need a quick intervention strategy focusing on facilitating marketing like organizing skin collectors at different level which may contribute in reducing this huge economic loss.

- Eye ball estimation is practice in marketing of goats. The marketing system should be changed into body weight based marketing systems. A prediction equation using heart girth can be used to facilitate goat marketing instead of eye ball estimation. To make it practical under farmers condition a table that consists of body measurements and corresponding body weight should be available.

- Training and capacitating the goat producers and goat traders as well as middlemen about weight based marketing and practicing and demonstrating use of linear models of body weight prediction are crucial.

- Community based genetic improvement strategy has to be designed for sustainable utilization and conservation.

- Further Evaluation of these goats for their meat and milk yield as well quality at different location and age is important.

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7. APPENDIX

7.1. Appendix A. Analysis of Variance (ANOVA) and different Tables

Appendix Table 1 Description of body condition score

Score		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 to feel	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 Table 2 Sample sizes by age group, breed group and sex for goats studied

Age	Agro Ecology									Overall		
	Lowland			Midland			Highland					
	Male	female	Total	Male	Female	Total	male	female	Total	Male	Female	Total
0PPI	41	53	94	60	61	121	55	50	105	156	164	320
1PPI	22	34	56	25	39	64	26	41	67	73	114	187
2PPI	12	18	30	10	27	37	16	31	47	38	76	114
3PPI	8	42	50	11	18	29	11	34	45	30	94	124
4PPI	13	72	85	10	47	57	11	32	43	34	151	185
Total	**96**	**219**	**315**	**116**	**192**	**308**	**119**	**188**	**307**	**331**	**599**	**930**

0PPI, 1PPI,2PPI,3PPI and 4PPI= Zero, one, two, three and four pairs of permanent Incisor respectively.

Appendix Table 3 Ranking of most kidding month in a year in different agro ecologies (%)

Kidding time/month	Lowland				Midland				Highland				Overall			
	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**
May, June , July	48.3	41.7	8.3	**0.39**	28.3	53.3	10.0	**0.34**	26.7	40.0	18.3	**0.30**	34.4	45.0	12.2	**0.34**
August, September, October	46.7	38.3	15.0	**0.38**	58.3	28.3	18.3	**0.42**	53.3	26.7	16.7	**0.38**	52.8	31.1	16.7	**0.40**
November, December, January	-	8.3	56.7	**0.12**	-	5.0	40.0	**0.08**	1.7	13.3	30.0	**0.10**	0.6	8.9	42.2	**0.10**
February, March, April	5.0	11.7	20.0	**0.10**	13.3	13.3	31.7	**0.16**	18.3	20.0	35.0	**0.22**	12.2	15.0	28.9	**0.16**

Index = sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for a given month divided by sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all seasons/month in an agro ecology

Appendix Table 4 Ranking of goat type for fattening by smallholder farmers in different agro ecologies (%).

Type of Goat	Lowland				Midland				Highland				Overall			
	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**
Culled young female	-	-	-	**-**	1.7	-	-	**0.008**	-	-	1.7	**0.003**	0.6	-	0.6	**0.004**
Culled young male	1.7	3.3	8.3	**0.03**	-	5.0	1.7	**0.02**	3.3	3.3	3.3	**0.03**	1.7	3.9	4.4	**0.03**
Young female	-	13.3	30.0	**0.09**	-	11.7	41.7	**0.12**	3.3	5.0	25.0	**0.08**	1.1	10.0	32.2	**0.09**
Young male	16.7	73.3	5.0	**0.34**	21.7	63.3	6.7	**0.33**	20.0	48.3	3.3	**0.27**	19.4	61.7	5.0	**0.31**
Castrate	76.7	1.7	15.0	**0.41**	73.3	10.0	13.3	**0.42**	58.3	16.7	11.7	**0.37**	69.4	9.4	13.3	**0.40**
Older male	-	5.0	36.7	**0.08**	-	5.0	28.3	**0.06**	1.7	10.0	30.0	**0.09**	0.6	6.7	31.7	**0.08**
Older female	1.7	-	1.7	**0.01**	-	1.7	5.0	**0.01**	-	3.3	11.7	**0.03**	0,6	1.7	6.1	**0.02**

Index = sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for specific category of goat divided by sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all category of goat in an agro ecology.

Appendix Table 5 Ranking of goat supplied for sale by farmers when cash is needed in different agro ecologies. (%)

Different class of Goat	Lowland				Midland				Highland				**Overall**			
	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**	**Rank 1st**	**Rank 2nd**	**Rank 3rd**	**Index**
Breeding buck	13.3	41.7	33.3	**0.26**	5.0	41.7	31.7	**0.22**	10.0	28.3	31.7	**0.20**	37.2	37.2	32.2	**0.23**
Breeding doe	1.7	11.7	10.0	**0.06**	-	5.0	1.7	**0.02**	-	3.3	5.0	**0.03**	6.7	6.7	5.6	**0.03**
Castrate	75.0	11.7	6.7	**0.43**	75.0	18.3	3.3	**0.44**	73.3	11.7	8.3	**0.42**	13.9	13.9	6.1	**0.43**
Old does	5.0	15.0	1.7	**0.08**	11.7	10.0	8.3	**0.11**	6.7	26.7	8.3	**0.14**	17.2	17.2	6.1	**0.11**
Buck 6-12 month	5.0	18.3	36.7	**0.15**	5.0	20.0	45.0	**0.17**	3.3	18.3	31.7	**0.13**	18.9	18.9	37.8	**0.15**
Doe 6-12month	-	-	1.7	**0.003**	1.7	-	5.0	**0.02**	1.7	6.7	10.0	**0.05**	2.2	2.2	5.6	**0.02**
Male kid<6 month	-	1.7	10.0	**0.02**	1;7	5.0	5.0	**0.03**	5.0	3.3	3.3	**0.04**	3.3	3.3	6.1	**0.03**
Female kid < 6 month	-	-	-	**-**	-	-	-	**-**	-	1.7	1.7	**0.01**	0.6	0.6	0.6	**0.003**

Index = sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for a given class of goat divided by sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all classes of goat in an agro ecology.

Appendix Table 6 Ranking of Major causes of goat death in different agro ecologies of the study area (%)

Causes Goat death	Lowland				Midland				Highland				Overall			
	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**	Rank 1st	Rank 2nd	Rank 3rd	**Index**
Predators	1.7	71.7	21.7	**0.28**	3.3	76.7	18.3	**0.30**	16.7	53.3	25.0	**0.30**	7.2	67.2	21.7	**0.30**
Disease	93.3	3.3	1.7	**0.48**	93.3	6.7	-	**0.49**	51.7	31.7	16.7	**0.39**	79.4	13.9	6.1	**0.45**
Accident	1.7	10.0	26.7	**0.09**	1.7	8.3	38.3	**0.10**	13.3	1.7	28.3	**0.12**	5.6	6.7	31.1	**0.10**
Abortion	3.3	11.7	45.0	**0.13**	1.7	6.7	21.7	**0.07**	18.3	11.7	30.0	**0.18**	7.8	10.0	32.2	**0.13**
Poisoning	-	3.3	5.0	**0.02**	-	1.7	21.7	**0.04**	-	1.7	-	**0.01**	-	2.2	8.9	**0.02**

Index = sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for a particular cause divided by sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all causes in an agro ecology.

Appendix Table 7 Goat milk and milk product utilization and marketing

Description	Lowland		Midland		Highland		overall	
	N	%	N	%	N	%	N	%
Use of goat milk?								
yes	56	93.3	55	91.7	52	91.7	163	90
no	4	6.67	5	8.3	8	13.3	17	10
Do your family sales goat milk								
Yes	15	25.0	6	10.0	1	1.7	22	12.2
No	45	75.0	54	90.0	59	98.3	158	87.8
Do you sale goat milk products?								
Yes	2	3.3	0	0.0	1	1.7	3	1.7
No	58	96.7	60	100.0	59	98.3	177	98.3
Frequency of milking per day								
Once a day	56	93.3	54	90.0	56	93.3	166	92.2
Twice a day	3	5.0	6	10.0	3	5.0	12	6.7
Three times a day	1	1.7	0	0.0	1	1.7	2	1.1

Appendix Table 8 ANOVA for body weight of Hararghe Highland goat for the effect of sex, age, agro ecology and sex by age interaction

Source	DF	Type III SS	Mean Square	F Value	Pr > F
AgroE	2	284.36270	142.18135	6.60	0.0014
Age	4	49773.28758	12443.32190	577.99	<.0001
Sex	1	5196.36289	5196.36289	241.37	<.0001
Age*Sex	4	3085.41297	771.35324	35.83	<.0001
Error	918	19763.22358	21.52857		

Appendix Table 9 ANOVA for body condition of Hararghe Highland goat for the effect of sex, age, agro ecology and sex by age interaction

Source	DF	Type III SS	Mean Square	F Value	Pr > F
AgroE	2	2.87901047	1.43950523	4.10	0.0169
Age	4	22.50733477	5.62683369	16.01	<.0001
Sex	1	20.76149473	20.76149473	59.08	<.0001
Age*Sex	4	31.84883353	7.96220838	22.66	<.0001
Error	918	322.6115974	0.3514288		

Appendix Table 10 ANOVA for ear length of Haraghe Highland goat for the effect of sex, age, agro ecology and sex by age interaction

Source	DF	Type III SS	Mean Square	F Value	Pr > F
AgroE	2	1.6962061	0.8481030	0.68	0.5080
Age	4	293.4739008	73.3684752	58.64	<.0001
Sex	1	0.1228519	0.1228519	0.10	0.7541
Age*Sex	4	16.7311907	4.1827977	3.34	0.0099
Error	918	1148.633997	1.251235		

Appendix Table 11 ANOVA for body length of Hararghe Highland goat for the effect of sex, age, agro ecology and sex by age interaction

Source	DF	Type III SS	Mean Square	F Value	Pr > F
AgroE	2	515.58617	257.79309	10.14	<.0001
Age	4	38036.75472	9509.18868	373.88	<.0001
Sex	1	1874.61583	1874.61583	73.71	<.0001
Age*Sex	4	1137.68661	284.42165	11.18	<.0001
Error	918	23348.08901	25.43365		

Appendix Table 12 ANOVA for heart girth of Hararghe Highland goat for the effect of sex, age, agro ecology and sex by age interaction

Source	DF	Type III SS	Mean Square	F Value	Pr > F
AgroE	2	530.08415	265.04207	10.08	<.0001
Age	4	58502.35113	14625.58778	556.33	<.0001
Sex	1	3420.67728	3420.67728	130.12	<.0001
Age*Sex	4	1894.88472	473.72118	18.02	<.0001
Error	918	24133.53633	26.28926		

Appendix Table 13 ANOVA for height at wither of Hararghe Highland goat for effect of sex, age, agro ecology and sex by age interaction

Source	DF	Type III SS	Mean Square	F Value	Pr > F
AgroE	2	81.38709	40.69354	1.79	0.1675
Age	4	29138.32774	7284.58194	320.44	<.0001
Sex	1	3468.56887	3468.56887	152.58	<.0001
Age*Sex	4	1579.20939	394.80235	17.37	<.0001
Error	918	20869.00388	22.73312		

Appendix Table 14 ANOVA for chest width of Hararghe Highland goat for the effect of sex, age, agro ecology and sex by age interaction

Source	DF	Type III SS	Mean Square	F Value	Pr > F
AgroE	2	1579.875465	789.937733	50.65	<.0001
Age	4	2921.949949	730.487487	46.84	<.0001
Sex	1	204.031892	204.031892	13.08	0.0003
Age*Sex	4	121.574717	30.393679	1.95	0.1003
Error	918	14316.27357	15.59507		

Appendix Table 15 ANOVA for pelvic width of Hararghe Highland goat for the effect of sex, age, agro ecology and sex by age interaction

Source	DF	Type III SS	Mean Square	F Value	Pr > F
AgroE	2	16.930047	8.465024	0.80	0.4502
Age	4	1971.163307	492.790827	46.50	<.0001
Sex	1	12.058992	12.058992	1.14	0.2864
Age*Sex	4	119.124090	29.781022	2.81	0.0246
Error	918	9727.97279	10.59692		

Appendix Table 16 ANOVA for rump height of Hararghe Highland goat for the effect of sex, age, agro ecology and sex by age interaction

Source	DF	Type III SS	Mean Square	F Value	Pr > F
AgroE	2	101.20211	50.60106	2.79	0.0620
Age	4	31971.10843	7992.77711	440.58	<.0001
Sex	1	3866.31311	3866.31311	213.12	<.0001
Age*Sex	4	2092.88520	523.22130	28.84	<.0001
Error	918	16653.87326	18.14147		

Appendix Table 17 ANOVA for rump length of Haraghe Highland goat for the effect of sex, age, agro ecology and sex by age interaction

Source	DF	Type III SS	Mean Square	F Value	Pr > F
AgroE	2	37.550814	18.775407	10.76	<.0001
Age	4	1817.349957	454.337489	260.46	<.0001
Sex	1	59.630956	59.630956	34.19	<.0001
Age*Sex	4	68.755731	17.188933	9.85	<.0001
Error	918	1601.303138	1.744339		

Appendix Table 18 ANOVA for horn length of Hararghe highland goat for the effect of sex, age, agro ecology and sex by age interaction

Source	DF	Type III SS	Mean Square	F Value	Pr > F
AgroE	2	13.612738	6.806369	1.00	0.3672
Age	4	3362.438250	840.609563	123.98	<.0001
Sex	1	248.563404	248.563404	36.66	<.0001
Age*Sex	4	58.325335	14.581334	2.15	0.0734
Error	538	3647.885987	6.780457		

Appendix Table 19 ANOVA for scrotal circumference of Haraghe Highland goat for the effect of age, agro ecology

Source	DF	Type III SS	Mean Square	F Value	Pr > F
AgroE	2	3.975616	1.987808	0.08	0.9227
Age	2	1361.687519	680.843760	27.58	<.0001
Error	235	5801.867796	24.688799		

7.2 Appendix B. Questionnaire

GENERAL

1. Interviewee (Farmer Name)_____ 2. Household ID number _____
3. Peasant association (PA): 1. Gadullo 2. Milqay 3.Haro adi 4.Xuxis 5.Kotora 6. Café hara
4. Agro ecology: 1. Low land 2. Mid land 3. High land

A. Socio-economic characteristics of Households

5. Age of the head (yrs) 1. <20 2. 21–30 3. 31–40 4. 41–50 5. 51–60 6. .> 60
6. Sex of the head 1. Male 2. Female
7. Marital status 1. Married 2. Divorced 3. Widow ed level
8. Education level 1. Illiterate 2. Writing and reading (not attended formal education)
3. Primary (1-8) 4. Secondary (9-10+2) 5. Other _____
9. Religion 1. Muslim 2. Orthodox 3. Protestant 4. Any other----------
10. Family size (number):

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

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

13.1. Crops _____ _____ _____
13.2. Fallow land _____ _____ _____
13.3. Grazing _____ _____ _____
13.4. Others (specify) _____

12. Trend in land holding/HH 1. Decreasing 2. Increasing 3. Stable

13. Reason if any: 1st _____

2nd _____

3rd _____

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

Sources of income	Ranking

B. Flock Characteristics

15. 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(1,2&3)
Goats				
Cattle				
Sheep				
Camel				
Chicken				
Donkey				
Mule				
Horse				
Traditional hive				
Modern hive				

16. Goat flock structure by age

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

17. 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)--------- ----------		

18. 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		
8	Others----------		

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

1. Livestock production 2. Crop production 3. Both

20. On which do you depend more for Food?

1. Livestock production 2. Crop production 3. Both

21. *O*n which do you depend more for Income source

1. Livestock production 2. Crop production 3. Both

22. Major crop grown

Crop type	Main season	Rank	Short rain	rank

C. Production and Management systems

I. **General**

23. Do you intend to expand your Goat flock? 1. Yes 2. No

24. If not, reason _____

25. If yes, reason _____

26. 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)_____

27. Who is responsible for the following jobs?

	<= 15 years		> 15 years	
	M	F	M	F
a. Milking				
b. Selling goat				
c. Herding				
d. Breeding				
e. Caring for sick animals				
f. Making dairy products				
g. Selling dairy products				

Others (specify) _____

28. Production system

1. Crop–livestock system 2. Agro-pastoralists 3. Pastoralists 4. Others (specify)

29. Do you practice of moving with livestock? 1. Yes 2. No
30. If yes, which classes of livestock are moving?
1. Cattle 2. Goat 3.sheep 4.Other _____
31. Which age category is in a mobile herd? 1. Mature 2. Young 3. Both
32. Which season/months do you move 1. Wet 2. Dry
33. For how long do you stay there? _____ Month.
34. Distance from the home area? _____ Km (local unit)
35. What is the reason for mobility?
1. Feed shortage 2.Water shortage 3.Other (_____

D. Feeding, grazing and watering

36. Grazing land ownership 1. Communal 2. Private 3. Both private & communal
37. Which grazing land contributes more to provide feed 1. Communal 2. Private
38. Trend in private grazing areas*?* 1. Decreasing 2. Increasing 3. Stable
39. Reason for any _____
40. Trend in communal grazing areas*?* 1. Decreasing 2. Increasing 3. Stable
41. Reason if any _____

42. 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)	_____		_____	

43. Grazing method

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

44. Length of grazing time during wet season _____ hrs/day
45. Length of grazing time during dry season _____hrs/day
46. 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) _____
47. 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

48. 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) _____

49. If the answer is 2, how many household mix their goat together _____

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

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

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

53. What kind of supplementation do you offer? 1. Salt 2. Chinki 3. Grain supplementation 4. Kitchen left over 5. Other (specify)

54. Ways of supplementations 1. At its natural source 2. Supplied as mix 3.other _____

55. Do you practice preferential supplementation for goat? 1. Yes 2. No

56. If yes for preferential supplementation which type of animal? 1. Kids 2. Lactating goat 3. Older goats 4. Other _____

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

58. 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		

59. 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)_____

60. List the five most important crop residues used during the:

	Wet season	Dry season
1.	_____	_____
2.	_____	_____

61. Concentrates used for goat Rank Type

1. Homemade grain
2. Oil seed cakes
3. Local brewery by-products
4. Flour by-products

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

Rank	Season (Holidays)	Number of goat fattened/yr/HH	
		minimum	maximum
1st			
2nd			
3rd			
4th			

63. For how long do you fatten? ----------

64. Which months do you think there is a shortage of feed? _____

65. What is the reason for feed shortage in the area _____

66. Responses to feed shortage in the area _____

67. Sources of water

Sources	Dry season		Wet season	
	Mark(√)	Rank	Mark(√)	Rank
1. Borehole/water well				
2. Dam/pond				
3. River				
4. Spring				
5. Pipe water				

68. Distance to the nearest water source (in terms of walk/track hours)? _____

69. Are kids watered with the adults? 1. Yes 2. No

70. If no, how kids watered? _____

71. 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) _____		

72. Water quality

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

E. Housing

73. 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) _____

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

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

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

77. If no; specify_____

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

79. If yes, describe _____

F. Health.

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

	Young <1 yr	Adults>1 yrs	Total
Male			
Female			

81. Reasons for death

1. Predators	Yes	Rank
2. Disease		
3. Accident		
4. Poisoning		
5. Unknown		

82. 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

Age group 1. Adult medium age 2. Kids 3. Older age

83. Access to veterinary services *(circle one or more)*

1**.** Government veterinarian 3. Shop or market

2. Private veterinarian 4. Others (specify) _____

84. Distance to nearest veterinary services

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

85. Disease, parasite, heat, frost, drought tolerance of Goat compared with other species

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

Rank across the Row based on tolerance

G. Breeding

I. Socio-cultural context of goat breeding

86. 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

87. If yes Why? _____

_____

88. If no, Why? _____

_____

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

_____

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

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

_____

_____

92. 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 (*Guma*)		
Other		

93. Which class of goat did you receive to initiate a goat keeping? 1. Kid 2. Doe 3. Buck 4.2&3

94. Mention social events and occasions worth sacrificing goats? _____

_____

95. In case of gifts for social events like dowry or bride do you accept/give goats of other breeds than the Adolo goats? (Is there breed preferences)? 1. Yes 2. No

96. If yes Why? _____

97. If yes, which Breed is Preferred? _____

98. If no, Why? _____

II. Special attributes of the goat type

99. 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				

100. Any other outstanding characteristics /special attributes/?

_____

_____

101. Explain how you diagnose (support) these special attribute claims if any.

_____

_____

III. Breeding practices *(Circle one/more Choices)*

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

103. If yes, how many? ___

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

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

106. If yes, specify type of management_____

_____

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

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

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

110. Age of selection for breeding male _____ months

111. Age of selection for breeding female _____ Months

112. 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		

113. Source of buck? 1. Born in the flock 2. Purchased, private

3. Purchased in partner 4. Rent

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

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

115. List top preferred colors

1. _____
2. _____
3. _____

116. List Unwanted colours

. 1. _____ 2. _____

117. Selection criteria for breeding does?

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

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

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

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

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

121. If controlled mating what are the ranges of methods?
1. Physical restraint 2. Culling undesirable male
3. Castration 4. (Others specify) _____

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

123. If yes, specify the criteria used to identify _____

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

	1. yes	**2.No**	**Reason**
1. Mother			
2. Daughter			
3. Sister			

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

126. If yes what is the reason _____ _____

127. Do you allow your does to be served by anyone else buck other than "shanyo" breed?
1. Yes 2. No

128. If yes, reason _____

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

130. If yes, mention circumstances _____ _____

131. What are the usual methods of heat detection? And signs of estrus you considered?
1. _____ 2. _____ 3. _____ 4. _____

H. Castration and culling

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

133. If yes, reasons for castration
1. Control breeding 2. Improve fattening 3. Better temperament
4. Better price 5. Others (specify) _____

134. If no, give reason _____, _____,

135. At what age do you castrate *(month/year)* _____

136. Season of castration _____

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

138. If yes, type of supplementary feed
1. _____ 2. _____ 3. _____

139. For how long do you supplement castrated goat? _____

140. Castration method 1. Modern 2. Traditional

141. If traditional method Specify _____

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

143. If yes, why? 1. _____ 2. _____ 3. _____

144. Average culling age due to old age Male _____

145. Average culling age due to old age Female _____ _____

146. 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		

I. PRODUCTION CHARACTERISTICS (Reproductive and survival traits)

147. Average age at sexual maturity. Male ____ Months
148. Average age at sexual maturity. Female ____ Months
149. Average Age at 1st kidding; _____ month
150. Do you fix age at first mating for the females? 1. Yes 2. No
151. Do you fix age at first mating for the males? 1. Yes 2. No
152. Average reproductive lifetime of does (in years) _____
153. Average number of kids per does life time _____
154. Can you tell us the average parturition interval of your does? _____
155. What is the average reproductive lifetime for a buck? _____
156. How many parturitions occurred in your flock during the last 12 months? _____
157. Of these parturitions how many were, Male__
158. How many were, Female___
159. How many were, Single birth_____
160. How many were, Twins_____
161. How many were, Triplets _____
162. Did you face abortion problem in the flock? 1. Yes 2. No
163. How many abortion cases occurred in your flock over the last 12 months? _____
164. Offspring mortality in the last 12 months: Male_____, Female_____
165. In which type of birth is kid mortality more prominent?
    1. Single, 2. Twins, 3. Triple
166. Lambing pattern, occurrence of most births(*Tick one/r more then rank top three)*

	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		

J. Livelihood significance

167. How is goat milk used?	Mark	Rank
1. Family consumption (raw)		
2. Family consumption (processed)		
3. Sales		
4. Others _____		

168. 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		

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

170. 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		

171. Average Milk production per day per does; _____ Liters
172. Average Lactation length_____ Month
173. Frequency of milking 1. Once a day 2. Twice a day 3. Three times a day
174. Average weaning age of kids 1. < 3 months 2. 3–4 months
3. 5–6 months 4. > 6 months
175. Milk feeding up to weaning
1. Unrestricted suckling 2. Restricted suckling
3. Bucket feeding 4. Others (specify) _____

K. Goat Production constraints

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

	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* _____		

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

177. Where you sell your animals?

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

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

179. Why did you purchase goats?

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

180. If yes, from where did you purchase?

1. Farmers in the same village 2. Farmers in nearby village 3. Other Towns specify _____

181. 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						
	Total						

During; 1. *Festivals (specify) 2. Crop planting 3. Crop harvesting 4. Others, specify*

182. Why you prefer this mode of marketing?

1. Incentive prices 2. Traders make mischief with weighing scale 3. Purchasers like this it 4. Reliable and saves my time 5. Other, specify _____

183. How you sales or purchases your animals?

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

184. Do you get animal price and market information? 1. Yes 2. No

185. If yes, from where? 1. DAs 2. GOs specify------- 3. NGOs 4. Others, specify

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

187. 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_____

190. Do your family sales goat milk? 1. Yes 2. No
191. If yes, what is the price per local unit_____ birr
192. Do your family sales milk products from goats? 1. Yes 2. No
193. If yes, what is the price per local unit (approximated in kg?) butter _____ Birr
194. 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 _____

195. 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 _____

196. If sold, how much was the average prices?
1. Sheepskins _____ Birr 2. Goat skins _____Total prices
197. Do you preserve/process skins at home immediately after flaying? 1. Yes 2. No
198. If yes, how? 1. Apply salts 2. Dry 3. Others, specify
199. After how many days (usually) you take the skins to the traders or collectors____days
200. Where and to whom you usually sales skins?
1. Sub-agents in my locality 2. In nearby town for any traders
3. Others, specify _____

201. What are the common problems you encounter in skin production and marketing?
1. Lack of market information and markets
2. Lack of capacity building on skin production, preservations and marketing
3. Lack of local organization (farmers' coops) in preservation, storage and marketing
4. Animals produce poor quality skins
5. Others, specify _____

202. Average market age in months for Male _____
203. Average market age in months for Female _____
204. Distance of nearest market _____km
205. Distance of farthest market _____km
206. Is there price variation between near and far market 1. Yes 2. No

M. Institutions and innovations in development of sheep and goats production

207. Do you receive credit in recent years? 1. Yes 2.No
208. If yes in what form? 1. Cash 2.Kind (goats) 3.Both
209. If you receive what is the source 1.micro-finances 2.Private banks
3. Credit institutions 4.Governmental offices (OoARD, etc)
5. NGOs 6.Cooperatives 7.Others, specify_____

210. What do you do with the credit? 1. Crop production 2.cattle fattening
3. Small ruminant fattening 3.trading 4.other_____

211. Who receive credit in your family? 1. Husband 2.Wife 3.young boy's 4.young girls
212. How did you make credit recovery arrangements? 1. Cash 2. Kind or Goat 3. Other
213. Do you satisfy with the lending regulations & terms to repay the credit? 1.Yes 2.No
214. Do you give your goat for someone else as ribi'? a. Yes b. No
215. If yes, why do you give as 'ribi'?

	Rank
a. Shortage of labor	
b. Feed shortage	
c. Large flock size	
d. Others (specify)	

216. How was the income sharing agreements made?
1. ---------- 2. ----------
3.----------
217. Is there any cooperative in your area? 1. Yes 2.No
218. If yes, in what sector is so active
    1. Crop production (storage, marketing, deliver inputs to members, etc)
    2. Livestock (Marketing, deliver inputs, assemble products, etc)
    3. Inputs (deliver different inputs, credits, insurance, etc)
    4. Others, species_____-
219. Do you have Extension service in goats? 1. Yes 2. No
220. What service are you getting?
_____
_____

7.3 Appendix C. Focal Group Discussion Check List

Part I. Socio-cultural underpinnings of breeding

1. Myth (local perception) about the origin of the goat type
2. Is the "Sannyo" 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 II. 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 migration

Part III. 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 IV. Local key characteristic concepts

1.Do the community identify individual members of the 'Shanyo' 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 V. 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 Appendix D. Characterization and Body Measurements of Goats

Goat body measurement and physical description format

Zone _____ District_____Agro ecology_____ PA _____ HH Name _____

Id No	Flock No	Sex	Castration	source	Body Wt kg	Body condition	Coat color		Head profile	Wattle	Ruff	Bear	Age	Dentation	Ear			Horn			Body Length	Heart Girth	Hat at wither	Chest width	pelvic width	Rump ht	Rump length	Scrotm Cf
							Pattern	Type							Formation	type	Length	Length	Shape	Oreintation							
1																											
2																											
3																											
4																											
5																											

Note 1. Coat color pattern: 1= plain 2= Patchy 3= Spotted

2. Coat color type: 1 = White, 2= Brown, 3 = Black, 4= Grey, 5 = Creamy white

3. Head profile: 1 = Straight 2 = slightly convex 3=concave

4. Horn: 1= Present 2= Absent 3= Rudimentary

5. Ear Type: 1= Semi-pendulous 2 = Horizontal

6. Ear formation; 1= Rudimentary 2= Short ear 3= long ear

7. Wattle: 1= Present 2= Absent

8. Ruff: 1= Present 2= Absent

9. Bears 1= Present 2=Absent

10. Sex 1. Male, 2. Female

11. 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

12. Source of animal: 1 = Born 2 = Purchased 3 = Ribi 4 = Gift 5 = Inherited

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