ASSESSMENT OF SHEEP AND GOAT PRODUCTION SYSTEM AND EVALUATIONOF CHEMICAL COMPOSITION OF MAJOR FEED RESOURCES IN ESERA DISTRICT, DAWURO ZONE, SOUTHERN ETHIOPIA

M.Sc. THESIS

BY

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Assessment of Sheep and Goat Production System and Evaluation of Chemical composition of Major Feed Resources in Esera District, Dawuro Zone, Southern Ethiopia

By

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DEDICATION

I dedicate this thesis manuscript to my belovedfather Abera Alilo and my mother Aregash Ayele for their dedicated support to all my activity.

STATEMENT OF THE AUTHOR

I declare and affirm that this thesis is my own work. I have followed all ethical and technical principles of scholarship in the preparation, data collection, data analysis and compilation of this Thesis. Any scholarly matter that is included in the thesis has been duly acknowledged. The thesis is deposited in the Jimma University Library and is made available to borrowers under rules of the Library. I solemnly declare that this thesis has not been submitted to any other institution anywhere for the award of any academic degree, diploma or certificate.

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BIOGRAPHICAL SKETCH

The author Afras Abera Alilo was born on September 5, 1990 G.C.in Esera districtof Dawuro Zone of Southern, Ethiopia. He attended his elementary and junior school in Duzi full primary school, secondary high school at Esera Bale seniorsecondaryhigh school and preparatory education at Waka senior secondary and preparatory school in the Dawuro Zone. He successfully passed the Ethiopian School Leaving Certificate Examination and enrolled in Dilla University in September 2008 where he studied Animaland range land Sciences and graduated in 2011.After graduation he was employed in Esera woreda Agricultural office at Dawuro Zone as expert of Animal and forage production and he served there for four and half years. Then he joined to School of Graduate Studies of Jimma University in October 2017 for his MSc degree in the field of Animal Production.

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LIST OF ABBREVIATIONS

AAP	Average age at puberty
ADF	Acid detergent fiber
ADL	Acid detergent lignin
AFK	Age at first kidding
AFL	Age at first lambing
AHEC	Adapt harsh environmental condition
ALS	Average litter size
ANOVA	Analysis of variance
AOAC	Association of official analytical chemistry
CCPP	Contagious Caprine pleura pneumonia
CF	Crud fiber
CP	Crud protein
CSA	Central statistical agency
DM	Dry matter
EE	Ether extract
EWFEDO	Esera woreda finance and economy development office
EWLFDO	Esera woreda livestock and fishery development office
FAO	Food and agricultural organization
FMD	Foot and mouth disease
GDP	Growth development product
GLM	General linear model
HA	Hectare
HL	High land

HMD	High market demand
IPMS	Improving productivity and market Success
IVDM	In vitro Dry matter digestibility
IVOMD	In vitro organic matter digestibility
KI	Kidding interval
LI	Lambing interval
LL	Low land
MA	Marketing age
ME	Metabolizable energy
ML	Mid land
NDF	Nitrogen detergent fiber
RSSIC	Require small space and initial capital
SE	Standard error
SGI	Short generation interval
SNNPR	South nation nationality and people region
SPSS	statistical package for social science
SRSS	Somalia regional state strategy
SSA	Sub- Sahara Africa
TDN	Total digestible nutrient

Assessment of Sheep and Goat Production System and Evaluation of Chemical composition of Major Feed Resources in Esera District, Dawuro Zone, Southern Ethiopia

ABSTRACT

Ethiopia has 30.70 million sheep and 30.20 million goat populations. Unlike the large potential of small ruminants in the country their productivity is low. There are various factors that contribute for low productivity. This study was conducted in Esera district, Dawuro Zone of Southern Ethiopia with the objectives of assessing sheep and goat production systems and evaluating chemical composition of major sheep and goat feed resources. Stratified random and purposive random samplings were applied to select study kebeles and household, respectively. One hundred thirty eight households (HHs) owning sheep and goat were selected randomly from the three agro-ecologies. A semi-structured questionnaire was prepared and used to collect data on sheep and goathusbandry practices, reproductive performances, constraints and opportunities and major available feed resources.The five major feed were collected (one indigenous grass species and 4indigenous browse and legumes tree species) for determinationof DM,CP, ash, CF, EE, NDF, ADF and NFE from each agro-ecology by using the procedure of proximate andVan Soest method.The average family size was 5.23±0.195. Crop-livestock farming was the commonly practiced farming system (100%) with (69.1%) extensive and (30.9%) semi-intensive production system. The mean land holding was 3.1288±0.19 ha per HH and was significantly ($p<0.05$) varied across agro-ecologies. The average sheep and goat flock size per HH was 6.08±0.183 and 5.69±0.236, respectively and was significantly ($p<0.05$) varied across agro-ecologies. The main purposes of keeping sheep and goat in the district were cash income, insurance, meat, manure and wealth with indexes' of 0.32, 0.29, 0.16, 0.13 and 0.08, respectively. Natural mating (100%) was the only used breeding practice in highland, midland and lowland. The first three major feed resources for sheep and goat were natural pasture, river and road side and crop aftermath with index of 0.26, 0.23 and 0.20, respectively. Grazing and browsing on natural pasture was the commonly used feeding system. Majority (80.7%) of HHs kept their sheep and goat in their living house while 19.3% kept in separate house. The sources of water for sheep and goat were river, tap, rain water and spring water. Internal and external parasite was the first and second ranked disease and parasite of sheep and goat in the study area. For sheep, estimated average age at puberty (6.6±0.12 months for male and 7.7±0.16 months for female), age at first lambing (12.7±0.16 month) and lambing interval (8.4±0.17 month) were significantly higher ($p<0.05$) in the HL than in ML and LL. For goats, estimated average age at puberty (7.04±0.10 months for male and 7.40±0.10 months for female), age at first kidding (13.04±0.16 months) and lambing interval (8.5±0.12 months) were significantly Higher ($p<0.05$) in the highland than in midland and lowland agro ecology. The major opportunities of sheep and goat production was short generation interval, high market demand and requires small space and capital for investment with index of 0.26, 0.24 and 0.23 respectively and the major constraints of small ruminant production was disease and parasite, feed and grazing land shortage. The average DM, CP, CF, NDF and ADF content of natural grass species and indigenous browse species was 85.61, 6.9, 45.31, 67.12, 50.02 and 89.5, 17.26, 40.66, 41.36, 56.54, respectively.The result of this study showed that the sheep and goat production system of the area was small holder which was mainly depends up oncrop livestock production system with traditional husbandry practice and available local breeds of sheep and goat. Therefore, provision of strong extension services and training on sheep and goat production system, husbandry practices and potentials of existing breed for sheep and goat production in order to improve the production capacity and productivity of sheep and goat is necessary to enhance income of smallholder society.

Keyword; - Constraints, Esera district, Feed resources, Opportunities, Sheep and Goat productions,

1 INTRODUCTION

1.1 Background

Livestock is an important and integral component of agriculture, which is the pillar of the Ethiopia economy and Ethiopia is believed to have the largest livestock population in Africa (CSA, 2017). Ethiopia's livestock population, estimated as 59.5 million cattle, 30.70 million sheep, 30.20 million goat, 2.16 million horses, 8.44 million donkeys, 0.41 million mules, 1.21 million camels and 56.53 million heeds of chicken, and are widely distributed across the different agro-ecological zones of the country(CSA, 2017). Ethiopia is endowed with huge livestock resources, natural resources and diverse agro-ecological zones suitable for livestock production. These potentials make the country prominent repository for animal genetic diversity (Hussein*et al*; 2015). Livestock productions plays an important role to smallholder farmers and the national economy of the country in generating income to farmers, creating job opportunities, ensuring food security, providing services, contributing to asset, social, cultural and environmental values, and sustainlivelihoods(Behnke, 2010;Endalew and Ayalew, 2016).The subsector is mainly of smallholder farming system having multipurpose use and contributes about 16.5% of the national Gross Domestic Product (GDP), 35.6% of the agricultural GDP, 15% of export earnings and 30% of agricultural employment (Metaferia*et al*., 2011; Duressa*et al*., 2014).

Small ruminants are among the major economically important livestock in Ethiopia, playing an important role in the livelihood of resource-poor farmers and they are integral part of livestock keeping in Sub-Saharan Africa (SSA) that are mainly kept for immediate cash sources, milk, meat, wool, manure, and saving or risk distribution (Kosgey, 2004; Hagos*etal*., 2017;Hagos *etal*., 2018). Small ruminants also have various social and cultural functions that vary among different cultures, socio-economies, agro-ecologies, and locations in tropical and sub-tropical Africa (Markos, 2006).

Mixed crop livestock production practice is common production system of Ethiopia across different agro ecological condition which depends on indigenous breed of small ruminant with low level production and productivity (FAO, 2004;Solomon *et al*., 2010). The estimated contribution of small ruminants' population for economic growth and transformation in

Ethiopia accounts for 21 and 16.8% of the total contribution of ruminant livestock meat outputs respectively, which plays a great role as source of foreign currency (Ameha, 2011).

Feeds are the major factor that determines the production potential of livestock that is used for the fulfillment of nutritional requirement of animals. Small ruminant feed resources in Ethiopia are mainly grazing on communal natural pasture, crop stubble, fallow grazing, road side grazing, crop residues, browses, and non-conventional feeds (household food leftovers, weeds, crop tillers and fillers), improved forages and crop residues (Tsedeke, 2007 ; IPMS, 2010). Similarily, Belete*et al*.(2015),reported that the main feed resource of small ruminantwere pasture grass, shrubs, crop residue, house left over and khat left. The contribution of these feed resources, however, depends up on the agro-ecology, the types of crop produced, accessibility and production system (Azage *et al*., 2013).

The small body size, broad feeding habits, resistance to disease, ability to walk long distance to search feed, highly tolerant to adverse climatic condition with endurance of drought and to low and fluctuating nutrient availability and their short reproductive cycle provide small ruminants with comparative advantage over other species to suit the circumstances of specially resource poor livestock keepers (FAO, 2004; CTA, 2007; Kosgey, 2008; Gurmessa*et al*., 2011).

Despite the large number of small ruminants and their contributions to the livelihood of the farmers and the national economy small ruminants productivity in Ethiopia is low due to different factors including,weak attention from scientists, administrators and legislators (Girma *et. al*, 2000); low genetic potential and policy issues (Zinash *et. al*, 2001); Market and institutional problem and problem of credit facilities (Berhanu *et al.*, 2006*).*

Andalso shortage, seasonal unavailability and low nutritive value of feed (Getahun, 2008; Tesfaye, 2009; Solomon *et. al*, 2010; Yenesewu*et. al*, 2013); prevalence of different diseases and parasites (Tesfaye, 2009; Solomon *et. al*, 2010; Tsegaye *et. al*, 2013;Yenesewu*et. al*, 2013) and labour shortage, lack adequate veterinary service, water shortage, market problem and capital shortage (Yenesewu*et al*., 2013).

Improvements were too slow due to lack of identifying the actual on-farm situations by giving due attention to the socio-economic and social benefits of sheep and goat for smallholder farmers (Deribe, 2009).Absence of adequate baseline information about the production system is considered as one of the bottlenecks for development of strategy for breed improvement and conservation in most developing countries (FAO, 2012). Also in Ethiopia, the small ruminant production system in different agro-ecological zones is not studied fully and farmers' needs and production constraints have not been identified (EARO, 2001).

The agro-ecological condition of Esera district was highly suitable for sheep and goat production. This is because, the area was endowed with various species of vegetation dominated by mixture of perennial and woody plants, trees and shrubs with shifting in composition in response to intensity of grazing and browsing, which can be a good feed sources of small ruminants across different ago ecology(EWLFDO, 2017).

Though sheep and goat production plays an important role to the livelihood of the engaged households in the area through income generation, source of manure and source of meat for home consumption, production system, feed resource and reproductive performance of sheep and goat arenot studied and precisely known andalso constraint and opportunities are not identified and prioritizedin Esera district. Hence,assessment of production systems and feed resources for sheep and goat are necessary in the district in order to plan development and research activities and to achieve improvements in their production and productivity.

1.2 Objectives

1.2.1 General Objective

- To describe sheepand goat production systems and evaluate chemical composition of major feedresources of sheep and goat in Esera district of Dawuro Zone.

1.2.2 Specific Objectives

- To assess husbandry practice, opportunities and constraints of sheep and goat production in Esera district of Dawuro Zone
- To assess reproductive performance of sheep and goat in the study area
- To assess major sheep and goat feed resources
- To evaluatechemical composition of the major sheep and goat feed in wet season in the study area

2. LITERATURE REVIEW

2.1.Sheep and Goat Production System in Ethiopia

Small ruminant production systems vary considerably across the world, and reflect the different local environmental conditions, which determine, to a large extent, breeds, housing, intensification level, management practices, environmental issues, and feeding systems used. The components of the production systems are considered to be most important ones in determining quality in animal production (Sepulveda *et al*., 2011). In several Sub-Saharan African countries including Ethiopia and many other developing countries, mixed crop/livestock production in subsistence manner is the predominant mode of agricultural production system (Tesfaye *et al*., 2004). Farmers/pastoralists choice of agricultural enterprises in Ethiopia depends on the production environment (availability of resources, particularly land, water and climate), long-standing tradition of agricultural production in the community, socio-economic circumstances (awareness and skill, access to inputs and markets), and government support (inputs and services) which stems from agricultural policies. Livestock production systems are identified on the basis of contribution of the livestock sector to the total household revenue (income and food), type and level of crop agriculture practiced types of livestock species kept, mobility and duration of movement.

Getahun (2008) classified traditional small ruminant production systems into four subsystems: small ruminant in annual crop-based system located in northern, northwestern, and central highlands; small ruminant in perennial crop-based, mostly found in southern and southwestern highlands; small ruminants in cattle based systems, these systems usually exist in agro pastoral and semi-arid areas; small ruminant dominated systems found in pastoral and arid areas of eastern and northeastern Ethiopia, where sheep and goats are the dominant livestock species.

On the other hand, Solomon *et al*.(2008), also reported that the sheep and goat production system in Ethiopia into five sub production system based on feeding, veterinary care, housing practices(Subalpine–cereal system which is characterized as medium scale production; semi-intensive/extensive, low-input), highland cereal-livestock system which were characterized as

Small-scale sheep production; semi intensive, low-input), highland perennial crop system which were characterized as minor sheep and goat production; semi intensive, low-input; some practice tethering), lowland crop-livestock system(agro pastoral) by characterizing high level of livestock keeping; extensive/semi-intensive, low-input), and pastoral system which is characterized as rangeland-based large-scale production; extensive, low-input). And also (Ermais, 2014)reported that the sheep and goat production system were about 99% of farmers practice mixed crop-livestock production systemand which is the dominating system in Southern Ethiopia and similar to most parts of the central southern region.

In general, mode of livestock production system in Ethiopia is broadly classified into pastoral, agro-pastoral and mixed crop-livestock, peri-urban and urban production systems (Solomon *et al.,* 2010). There are various factors that should be considered to categorize small ruminant production systems in Ethiopia. In mixed crop-livestock production system which mainly observed in many parts of Ethiopia, small-ruminant production is characterized by low productivity due to nutritional stress and internal and external parasites. The pastoral and agro-pastoral systems which are found in the lowlands are characterized by extensive production based largely on the rangeland (EARO, 2000).

2.2. Housing Management ofSmall Ruminant in Ethiopia

Housing is required to protect animals from extreme temperature (rain, cold,excessive heat and wind), disease, predator, theft and to make management easier and to provide opportunity for intensive feeding and controlled breeding in Bale zone,Oromia,Ethiopia (Belete *et al.*, 2015).According to (Belete, 2009; Sisay and Kefyalew, (2015), small ruminant owners house their sheep and goat to protect them from predators, adverse climatic condition and to provide supplement in the evening in Goma district, Jimma Zone Oromia and in Degahabur Zone, Eastern Ethiopia respectively. Similarily Hundie and Geleta (2015) also reported that respondents shelter their sheep during night time throughout the year to protect them from cold, rain, predators and theft in Horro Guduru and Eastern Wollega Zones west Ethiopia. Andalso Kenfo *et al*., (2018) reported that housing is important to protect animals from extreme temperature, rain, wind, predators and theft in Bensa district of Southern Ethiopia.

According to assessment undertaken in Eastern Ethiopia, about 61.1% of the respondents kept their sheep in kraal without roof houses, while 35.5% kept their sheep in house with roof and 3.3% of respondents kept their sheep with in main house with family members (Helen*etal* ., 2016).

Table 1.Different housing system of sheep and goat in Ethiopia

Housing system	Percent	Animals kept	Place done	Source
Main house Attached to main house Separate house	58 33 9	Sheep	Burie district North western Ethiopia	(Yenesew*et.al*., 2013)
Main house Separate house	16.67 83.33	Sheep	Horro Guduru and East Wollega zones	Hundie and Geleta, 2015
Family house with roof Separate house with roof	75.76 24.24	sheep	Bensa district , Southern Ethiopia	(Kenfo *et al*., 2018)
Kraal Separate house Yards	45.55 28.1 25.28	goat	Bale zone Oromia Ethiopia	(Belete *et al*., 2015)
Main house Grazing area Separate house	26.4 8.9 64.4	Sheep and goat	Degahabur Zone, EasternEthiopia	(Sisay and Kefyalew, 2015)
Main house Adjoin house Separate house	22.5 39.4 38.1	Sheep and goat	Gome district,Jimma Zone Oromia, Ethiopia	(Belete, 2009)
Main house Separate house No house	98.6 0.7 0.7	Sheep and goat	Alaba Southern, Ethiopia	(Tsedeke, 2007)
Main house Separate house Open barn	82.8 10.3 6.8	Sheep	Doyogena district Southern, Ethiopia	(Taye *et al*., 2017)
Main house House attached to main house Separate	62 10.9 27.1	*Sheep* and *goat*	Jijiga and Shinile Zones of Somali Regional State, Ethiopia.	(Sisay *et al*., 2006)
Family house Partition to family house Separate house	12.6 45.9 41.5	Sheep and goat	Illubabor zones of Oromia regional state	(Dhaba *et al*., 2012)
In family house Separate house Veranda (extend of building)	39.4 29.4 31.2	Sheep and goat	Ada Barga and Ejere Districts of West Shoa Zone	(Yadeta, 2016)

2.3. Feed Resources and Their Nutritive Value

Livestock feed resources in Ethiopia are mainly natural pasture, crop residues, improved pastures, forage crops and agro-industrial by products (Alemayehu, 2004). It is estimated that natural pasture provides from 80-90%, and crop residues 10-15% of the total livestock feed intake in Ethiopia (Alemayehu, 2003).According to Hagos*etal*.(2018)small ruminant feed resource in Ethiopia are mainly naturalpasture, crop residue, fallow land and locally available brewery product (*Atela*) and saltin central zone of Tigray,Northern Ethiopia.Similarly the feed resource for small ruminant in Ethiopia are mainly grazing on communal natural pasture, crop stubble, fallow grazing, road side grazing, crop residues, browses, and non-conventional feeds (household food leftovers, weeds, crop tillers and fillers), improved forages and crop residues (Tsedeke, 2007)and according to IPMS(2010),the major feed resources for small ruminants were natural pasture grazing and browsing, crop stubble, fallow land grazing and browsing, crop residue,non-conventional feeds, brows species and improved forage feed sources and also Assen and Aklilu (2012) identified the major feed resource for small ruminants as natural grazing land, crop aftermath, hay, crop residue,agro-industrial by product, improved forage species and weeds inin different agro-ecological zones in Tigray, Ethiopia,and Tegene *etal*. (2015), reported that the major feed resources of small ruminant feed as natural grazing land (private, communal and hired), crop residue(private and purchased), hay (private and purchased), fodder trees and industrial by product in Shebedino district, Sidama Zone, Southern, Ethiopia

On the other hand, Shewangzaw and Adis(2016) reported that the main feed sources for small ruminant were natural pasture and crop residue with supplementary feed sources of food left over, atela, salt, nuge cake, dashen brewery by product and multiple feed which in north Gondar Zone of Amara Region, Ethiopia.

The major roughage feed resources for livestock across all the different production systems included natural pasture/grasslands, crop residues, non-conventional feed resources (e.g. leaf and stem of Enset, banana and sugarcane; crop thinning) and crop aftermath (with the exception of intensive production). The contribution of these feed resources, however, depends up on the agro-ecology, the types of crop produced, accessibility and production system (Azage *et al*., 2013).

The feeding systems include communal or private natural grazing and browsing, provision of crop residues and cut-and-carry feeding. The feeding system practiced for small ruminants include free grazing and browsing,partly tethered grazing or browsing, fully tethered grazing or browsing and confined grazing in Gedio Southern Ethiopia(Selamawit and Matiwos, 2015), Free grazing and browsing in dry season , tethered grazing and browsing at wet season and cut and carry system of feeding in Illu Abba Bora Zone of the Oromia regional state(Dhaba *etal.*, 2012*)*, Herding, tethering and free grazing of small ruminant feeding system were practice in western and South Western Ethiopia(Zawudu*etal.*, 2012) and only free grazing system of small ruminant feeding practiced in Western Tigray, North Ethiopia(Hagos *et al*., 2017).Livestock are grazed on permanent pastures, fallow land and cropland aftermath (Alemayehu, 2004).

2.3.1. Natural pasture

Natural pastures supply the bulk of livestock feed. They are composed of indigenous forage species and are subject to severe overgrazing. Grazing occurs on permanent grazing areas, fallow land and on land following harvest. The availability and quality of native pasture varies with altitude, rainfall, soil type and cropping intensity.

The herbage yield and nutritional quality of natural pasture is generally low (Adane and Berhan, 2005) due to poor management and utilization. Natural pastures would be adequate for live weight maintenance and weight gain during wet seasons, but would not support maintenance for the rest of the year (Zinash*et al.,* 1995). The energy (ME), crude protein (CP) and dry matter (DM) contents of these natural pastures in most cases have been reported to be below the maintenance requirement of the animal in Bale highlands (Solomon, 2004).Average pasture yield for the highland areas is estimated to be 4 tons/ha. In many areas, natural pastures are invaded by species of low palatability (Solomon and Alemu, 2009).

2.3.2. Cropresidues

Crop residues are fibrous materials which are the by-products of cultivated crops. This is a basic limitation in residues such as straw and stover with crude protein contents around the border-line level of 6-7%. Most residues are deficient in fermentable energy and minerals. Crop residues have low palatability and digestibility that leads to poor intake, particularly when fed as the sole roughage. In the mixed cereal livestock farming systems of the Ethiopian highlands, crop residues provide on average about 50% of the total feed source for ruminant livestock. The contributions of crop residues reach up to 80% during the dry seasons of the year (Adugna, 2007).

According to Gashe*et al*.(2017), major crop residues available for livestock feeding in the area were cereals (teff, oat, maize, wheat and barley), pulses (horse bean and chickpea) and oil seeds (linseed and niger seed), the annual total dry matter (DM) feed produced from crop-residues was 5.2 tons per household and *teff* and *wheat* straw and maize stover are the major crop residue source contributing annual DM production in East Gojjam Zone, Amhara Region, Ethiopia.

The availability of crop residues is closely related to the farming systems, the type of crop produced and the intensity of cultivation. *Teff*, *wheat* and *barley* straws are the major residues available in the highlands while *maize* and *sorghum* are common in the lowlands. Crop residues are often left in the field or accumulated in places where the crop is threshed. Transportation of crop residues, even over short distances, can become difficult and costly because of their bulk. The production of crop residues is also seasonal, available in very large quantities just after harvest and less available thereafter (Solomon and Alemu, 2009).

The species of the plant, the agronomic practice used, soil, temperature, and the stage of growth influence the chemical composition, and palatability of straws. Solomon (2004) alsoreported that there is a considerable variation in the contents of CP and CF. However, the quality varies significantly from crop to crop. Residues from leguminous crops have better quality than the residues from cereals. Legume straws contain less fiber, high digestible protein than cereal straws (Solomon, 2004).

2.3.3. Improved pasture and forage crops

Improved forages yield is higher than the naturally occurring swards and have higher nutritional value. In addition, the length of the productive season is longer for cultivated pastures than for the native pastures, which provide an opportunity for livestock (mainly large and small ruminant) production to develop and use pasture and forage at a large scale. Over the past two decades, several forages have been tested under varying ecological zones for their adaptability. As a result, a number of useful forages have been selected for different zones.

Improved pasture and forages have, therefore, been grown and used in government ranches, state farms, farmers' demonstration plots and dairy and fattening areas (Alemayehu, 2002). Forage crops are commonly grown for feeding livestock with oats and vetch mixtures, fodder beet, elephant grass mixed with siratro and desmodium species, rhodes/lucerne mixture, phalaris/trifolium mixture, hedgerows of sesbania, leucaena and tree-Lucerne being common ones (Alemayehu, 2006). Due to unprecedented population increase, land scarcity and crop dominated farming, there has been limited introduction of improved pasture and forages to smallholder farming communities and the adoption of this technology by smallholder mixed farmers has been generally slow (Abebe*et al*., 2008).

Yield of improved pasture and forage ranges from 6 to 8 tons and 3 to 5 tons of DM per hectare, respectively, while that of tree legumes ranges from 10 to 12 tons of DM per hectare. In suitable areas, yield of oat-vetch mixtures are commonly 8 to 12 tons of DM per hectare. Despite the advantages of improved pasture and forage crops, due to land scarcity and crop-dominated farming, there has been limited spontaneous introduction of improved pasture and forages (Alemayehu, 2002).

In Ethiopia, most improved tropical species can be grown in the lowlands (1,500-2000 meters) except temperate species, which can grow in areas between 2,100 to 3,000 meters above sea level (Alemayehu, 2002). Pasture establishment is relatively difficult in the highlands compared to the humid, warmer and lower areas because of the types of soil and climate.

Besides producing high amount of better quality forage, they have a number of other benefits in the farming system including improvement of soil fertility through biological Nitrogen fixation or when used as mulch (legumes), erosion control when established as conservation structures, fuel wood supply, bee forage and control of weeds, pests and diseases when integrated in crop rotation as break crops. Generally Improved forage crops have diversified functions and play an important role in sustaining the livelihoods of farmers, mainly as a result of their positive effects on livestock production and contribution to economic and environmental sustainability.

2.3.4. Agro-industrial by-products

Agro-industrial by-products produced in Ethiopia include by-products from flour milling, sugar factory, oil processing factories, abattoir, and breweries. These products are mainly used for dairy, fattening and commercial poultry production and the scope for their wider use by smallholder producers is low due to availability and price (Solomon and Alemu, 2009).

Agro-industrial by-products have special value in feeding livestock mainly in urban and peri-urban livestock production system, as well as in situations where the productive potential of the animals is relatively high and require high nutrient supply. The major agro-industrial byproducts commonly used are obtained from flour milling industries, edible oil extracting plants, breweries and sugar factories. The current trends of increasing urban population has a significant effect on the establishment of agro-industries due to the corresponding increasing demand for the edible main products. Agro-industrial by-products are rich in energy and/or protein contents or both. They have low fiber content, high digestibility and energy values compared with the other class of feeds (Zinash and Seyoum, 1991). Alemu *et al.* (1991) also reported more than 35% CP and 50-70% in vitro organic matter digestibility (IVOMD) for oil seed cakes and 18-20% CP and more than 80% IVOMD for flour milling by-products. Supplementing ruminants fed low quality feeds with agro-industrial by-products enables them to perform well due to higher nutrient density to correct the nutrient deficiencies in the basal diet.

2.3.5. Factors affecting feed quality

Freshness, mould, spoilage, taste, moisture and temperature all have an effect on the feed quality and the palatability of a particular feed. High neutral detergent fiber (NDF) in individual feeds and the total diet will restrict the cow's ability to consume a high intake (Azage*et al*., 2013).

Forage testing is necessary because forage quality varies considerably due to several factors, including differences in forage genotype, maturity, season, and management. An understanding of factors affecting forage quality will help producers anticipate and plan for changes in forage quality. When forage quality is low, forages alone may not support desired rates of animal performance. In such cases, it is necessary to provide livestock with supplements for protein and energy (Adesogan*et al*., 2012).

Animal performance, whether growth or milk production, depends upon the animal's potential for production, as well as on how much DM the animal eats and the nutritive value of the DM the animal consumes. Therefore, the two forage-related factors that determine animal performance are forage intake and forage nutritive value. Collectively, these factors determine the quality of the forage. When forage is fed without restriction as the sole feed, forage quality can be an excellent predictor of animal performance (Adesogan,*et al*., 2012).
Forage nutritive value is primarily determined by concentrations of crude protein (CP) and "available" energy in the forage. For many years total digestible nutrients (TDN) has been used as an overall measure of available energy in forages. In the past 20 years, however, measurements of digestible forage, metabolizable energy, and net energy of forage have increasingly been used. However, TDN is still an acceptable and easily understood measure of nutritive value, particularly for beef cattle. Forage quality is affected most by variations in forage genotype, maturity, season, and management. Other "anti-quality" factors may be encountered occasionally.

2.3.5.1.**Genotype**

According to Tesfaye (2008), Grass species have high content of DM, ash, ADF and NDF than fodder tree species and fodder tree species have also high content of CP and ADL than that grass species inMetema district of North Gondar Zone, Ethiopia.Legumes generally have a higher quality than grasses. Legumes have higher CP concentrations and a higher intake by livestock due to a higher percentage of rapidly digestible leaves. However, TDN concentrations of legumes and cool-season grasses are similar. Generalizations about quality of grasses are risky, but temperate or cool-season grasses, such as rye and ryegrass, often have higher quality than tropical or warm-season grasses, such as bermuda grass and bahia grass.

However, there is much variation in forage quality within and among grass genera (Adesogan *et al*., 2012).Similarily Deribe *et al*.(2013), also indicated that the DM, ash and CP content of indigenous browse were higher than indigenous grass species and the ADF and NDF content of indigenous browse species was lower than indigenous grass species in mixed farming System of Southern Ethiopia and according to Emana *et al*.(2017), the average CP and DM content of Browse species was higher than grass species while the average DM, ash, ADF and ADF content of Grass species was higher than browse species in Abol and Lare Districts of Gambella Region, Ethiopia.

2.3.5.2. Maturity

The stage of forage regrowth at the time of utilization whether as hay, haylage, or grazing has a major influence on forage quality. Forage-regrowth stage is determined by the number of days between harvests for hay or haylage and by the rest period in rotational grazing. Forage quality begins to decline as soon as forages start to regrow due to the accumulation of stems and deposition of poorly digested lignin in both leaves and stems. Therefore, forage quality generally declines with increasing length of the interval between harvests of stored forages or with longer rest periods in rotational grazing. Maturity of legumes and cool-season grasses can be assessed by determining the reproductive stage of growth. For warm-season grasses, however, weeks of regrowth are a better indicator of maturity because flowering may begin shortly after regrowth begins (Adesogan*et al*., 2012). The CP content and IVDMD were reduced by 30.2% and 17.8%, respectively with the delay in harvesting from mid-October to late November (Fekede, 2013).

2.3.5.3. Season

According to Sisay(2006), the ash, ADF, NDF, ADL and DM content were higher in October than August and CP content were lower in October than August fornatural pasture grass species. According to Yayneshet (2010), the ADF, NDF and ADL content were higher and CP content were lower in dry season than rainy or wet season of the year for both grass and browse species in Tigray region, northern Ethiopia. The CP content *Cynodon dactylon* reported by Gelayenew (2012), were 9.3 and 7.4% for the wet and dry seasons, respectively. Teka *et al*.(2012) also reported that the CP contents of *C. dactylon* were 11.67% and

6.94% in the early and late rainy seasons, respectively; while for *Panicum maximum* the corresponding values were 7.93 and 5.11 %, respectively.Seasonal effects on forage quality have been noted in grazing trials in Florida, where forage regrowth intervals were kept constant. A "summer slump" was observed in that gains of grazing livestock were less during the summer than in spring and fall. That this slump in cattle weight gain during the summer is an effect of environment on forages and not due to the effect of the environment on animals. Spring harvests are made generally after short re growth periods, while summer harvests are made after long re growth periods because of heavy summer rainfall that delays harvests. Therefore, the quality of Bermuda grass hay is highest when harvested in the spring or early summer (Adesogan *et al.*, 2012).

2.3.5.4. Feed management

Pre-harvest and post-harvest management determine the quality forage. Pre-harvest management for maximum quality of hay or silage involves weed control and frequent cutting. Some producers harvest every four or five weeks throughout the season, making either hay or silage, depending on rainfall (Adesogan *et al*., 2012).

The quality of hay or silage will never increase during harvesting and storage, but post-harvest decreases in quality can be minimized by careful management. Post-harvest management requires avoiding rain damage, as well as proper curing of hay to less than 15% moisture or wilting of silage to 60%–70% moisture, promptly sealing silos and wrapping haylagesand minimizing losses during storage. Leaching of nutrients from weathering decreases forage nutritive value. Therefore, hay bales should be stored under a barn or a tarp whenever possible (Adesogan *et al*., 2012)

2.4. Reproductive Performance of Small Ruminants in Ethiopia

Reproduction determines several aspects of sheep and goat production and an understanding of reproduction is crucial in reproductive management. A high rate of reproductive efficiency is important for herd expansion and replacement, production of (meat, milk, skin and fiber and replacement of breeding stock and reproductive performance is a prerequisite for any successful livestock production system (Merkle and Alemu, 2008).

Assessing of the productive, reproductive and economic performance of small ruminants and their existing level of integration with crop production and other livestock keeping is required to capture a full picture of their contribution and thereby verifying possible intervention areas (Getahun, 2008).

2.4.1. Age at sexual maturity/puberty

Age at first mating (puberty) affects reproductive efficiency. The age at which puberty is attained is determined largely by genotype and environmental factors like nutrition, season and climate (Getahun and Girma, 2008) and also accordingto Merkel and Alemu(2008), age at puberty can be influenced by nutrition, body weight, breed, season of birth and growth rate and Zewudu *etal*.(2012),reported that the age at of puberty of male and female Bonga sheep was 7.5±2.1 and 9.3±2.2 months and that of Horro sheep was 7.1±3 and 7.8±2.4 months respectively in Western and South-Western Ethiopia.

Table 2.Age at puberty of male and female lambs and kids (months)

Age at puberty of lambs		Source	Age at puberty Of kids		Source
Male	Female		Male	Female	
8±2.75	8.06±2.61	(Taye *et al*., 2016)	7.6±0.14	7.9±0.13	Belete *etal.*,2015
--- 8.99±2.5-------		Assen andAkililu,2012	---- 8.90±2.5-----		Assen and Akililu,2012
5.4±0.2	5.5±0.2	(Belete, 2009)	4.9±0.2	4.9±0.2	(Belete, 2009)
8.91±0.04	----	(Yadeta, 2016)	8.39±0.06	----	(Yadeta, 2016)
7.63±0.14	7.24±0.11	(Helene *etal.*, 2015)	11.1±2	12.7±2.1	(Woldeyesus and Rohotash, 2018)
			7.4±1.95	8.2±1.64	(Tesfay, 2009)

2.4.2. Age at first lambing or kidding

Age at first lambing or kidding (AFL/K) can be recorded easily in farmers stock and it is an economically important trait because it determines rate of genetic progress and population turnover rate. It is alsogood indicator of early sexual maturity in does and ewes. FAO (2002) reported age at first lambing ranges between 16.2 and 16.9 months in mixed farming systems of sub-Sahara African countries.

Table 3.Age at first Lambing/kidding of doe and ewes (months)

Age at first lambing	Source	Age at fist kidding	Source
12.7	(Tsedeke,2007)	12.1	(Tsedeke,2007)
14.6	(Getahun,2008)	14.88±0.3	(Endeshaw, 2007)
12.43±0.1	(Deribe, 2009)	12.9	(Getahun,2008)
13±0.3	(Belete, 2009)	12.5±0.3	(Belete, 2009)
13.46±2.18	(Belay and Aynalem, 2009)	11.95±0.13	(Deribe, 2009)
13.8±0.14	(Helene *etal*., 2015)	15.01±2.39	(Assen and Akililu, 2012)
13±3.1	Selamawit and Matiwos,2015	12.94±2.6	(Selamawit and Matiwos, 2015)
14.29±0.08	(Yadeta, 2016)	13.85±0.12	(Yadeta, 2016)
13.72±2.34	(Taye et *al*., 2016)	21.1±2	(Woldeyesus and Rohotash, 2018)

2.4.3. Lambing and kidding interval

Lambing or kidding interval is the interval between two parturitions that determines reproductive efficiency in small ruminant production. Kidding interval is one of the major components of reproductive performance that has significant influences on production systems. It contributes largely to the productive efficiency and it has been reported to be affected by nutrition, suckling, parity (number of times kidded/lambed) and breed (Banerjee*et al*., 2000). Also according to Ibrahim (1998),the long kidding/lambing interval has lower reproductive efficiency and commonly arises from long post-partum anestrus intervals, repeated cycles of service intervals without conception, embryo death or abortion. Mengistie *etal. (*2013) also reported that the kidding interval of goat was affected by season and litter size per kidding, kidding interval was shorter for does that kidded during cool season and single litter and multiple bearing does and those kidded in the hot season had larger reproductive rate.

Table 4.Lambing/kidding interval of doe and ewe (months)

Lambing interval	Source	Kidding interval	Source
7.84	(Tsedeke,2007)	6.9	(Tsedeke,2007)

8.04	(Belete, 2009)	7.84	(Belete, 2009)
9.19±0.08	(Deribe, 2009)	9.05±0.08	(Deribe, 2009)
8.73±1.78	(Belay and Aynalem, 2009)	13.8±0.03	(Mengistie *etal*.,2013)
8.93±1.42	(Hundie and Geleta, 2015)	8.41±2.35	(Assen and Akililu, 2012)
8.01±2.2	Selamawit and Matiwos,2015	8.3±1.6	(Selamawit and Matiwos, 2015)
8.83±0.44	(Yadeta, 2016)	8.23±0.52	(Yadeta, 2016)
10.94±2.47	(Taye *et al*.,2016)	7.1±0.6	(Woldeyesus and Rohotash,2018)
8.58±0.14	(Helen *et al*.,2015)		

2.4.4. Litter size of doe and ewe

Litter size is a combination of ovulation rate and embryo survival, number of lambs or kids born per parturition. There is a positive relationship between litter size and age and litter size and parity (Getahun and Girma, 2008).Accordingto Mengistie *etal*. (2013), litter size was also affected by parity and season of kidding, does kidded in the hot season and those with higher parities had larger litter. The effect of season on litter size and other traits indicates that the need for supplementation of does during the dry season when the grazing condition is very poor for better reproductive efficiency.

Table 5.Average litter size of doe and ewe

Litter size of doe	Source	Litter size of ewe	Source
1.7	(Tsedeke,2007)	1.75	(Tsedeke,2007)
1.14	(Mugrewa *etal.,* 2000)	2.07	(Endeshaw, 2007)
1.57±0.52	(Hundie and Geleta, 2015)	1.16±0.04	(Mengstie *et al*., 2013)
1.4	(Belete, 2009)	1.7	(Belete, 2009)
1.08-1.75	(Wilson., 1989)	1.02-1.43	(Wilson, 1989)
1.58±0.14	(Helene *etal*., 2015)	0.3±0.05	(Belete*etal*., 2015)
1.78±0.5	Selamawit and Matiwos,2015	1.7±0.63	Selamawit and Matiwos, 2015
1.19±0.42	(Yadeta, 2016)	1.28±0.33	(Yadeta, 2016)
1.42	(Getahun, 2008)	1.24	(Getahun 2008)
1.51±0.04	(Deribe,2009)	1.6	(Hailu *etal*., 2008)
		1.7	(Webb and Mamabolo., 2004)
		1.47±0.04	(Deribe,2009)

2.5. Constraints of Sheep and Goat Production

Different studies showed that despite the large potential of small ruminants in the country their productivity is low. There are various factors that contribute for low productivity of sheep and goat such as health constraints, feed shortage both in quality and quantity, poor feeding and health management (Markos, 2006; Tsedeke, 2007).According to Yenesewu*et al*. (2013), the major constraints of small ruminant production were Lack of adequate vet service, diseases, feed shortage, theft, labour shortage, shortage of capital, water shortage and marketing problem in In Burie District, North Western Ethiopia**.**

In generally, the major constraints that hinder the production performance of small ruminant production are feed and water scarcity, disease and predator, lack of infrastructures and long marketing channelsand climatic condition.

2.5.1. Feed and water shortage

Feed shortage problem was similar throughout the country, being serious in high human population areas where land size is diminishing due to intensive crop cultivation and soil degradation.The availability, quality and cost of feeds have been identified as the major constraints to acceptable livestock productivity across the various regions and agro-ecological zones of Africa (Devendra, 1986 and Ademosun, 1988). The deficiency of good quality and quantity feeds observed in lowlands; which were highly exacerbated by seasonal variation and recently by bush encroachment which become significantly important factors, while pastureland remains abundant. In central rift valley, feed shortage was reported as one of the limiting factors in small ruminant productivity (Abule, 1998).

According toSisay(2006);Getahun (2008); Deribe (2009)*; IPMS (2010) and* Yenesewu*et al*.(2013) inBurie District, NorthWestern Ethiopia), Tegegn *et al*. (2015) in Shebedino District, Sidama Zone of Southern, Ethiopia reported that lack of adequate feed resources is the main constraint of livestock production across different agroecology in different parts of the country mainly in mixed crop livestock production system and being serious in high human population and animal population areas where land size is diminishing due to intensive crop cultivation and soil degradation.

Water is the most critical of all nutrients required by sheep and goats, but it is yet often received a little attention. Inadequate water supply will dramatically decrease the production of livestock. They eat less, digest feedstuff poorly and are more prone to digestive and metabolic problems (Alemu, 2008). In eastern, north-eastern and south-eastern part of the country there is critical shortage of water; however, small ruminants are somehow adapted to these agro-ecologies through their physiological adaptations (Belete, 2009). According to the report of Tsedeke(2007) the long distance travelled by small and large ruminants for searching of water was complicated the productivity of the flocks.

2.5.2. Diseases and predators

Diseases are one of the serious constraints of small ruminant production in Ethiopia. Annual disease losses amount to 8-10%, 14-16% and 11-13% of the cattle, sheep and goat populations, respectively (Sileshi and Kasahun, 2008). Similarly, Markos (2006)pointed that approximately 700 millionEthiopian Birr is lost annually due to helminthes (internal parasite) infestation of domestic animals. High disease prevalence amongst kids and lambs heighten the mortality rate and diminishes the benefits of their high reproductive performance. Further, losses are caused by abortions and stillbirths (Getahun, 2008) and other diseases that limit the productivity of small ruminants in Ethiopia include Pneumonia, Contagious CaprinePleuropneumonia (CCPP), Ecthyma, Caseous Lymphadenitis and Brucellosis.

According to Adane and Girma (2008) about one-half of all lambs/kids born were dyeing due to various causes and annual mortality in all classes of stock averages 23% for sheep and 25% for goats in the central highlands.Also Zemede (2017), indicated that diseases and parasites as the major constraints to small ruminant production by causing high mortality of small ruminant due to inadequate veterinary service delivery and shortage of drugs in Tahtay Adyabo district, Tigray, Ethiopia.

According to Gurmesa *etal.(*2011) and Assen and Akililu (2012); predators are also the main constraints of small ruminant production in East Showa Zoneand different agro-ecological Zones in Tigray, Ethiopia and also Belete(2009) reported thatPredators such as foxes and hyenas are also contributing for the losses of young stocks.

2.5.3. Lack of infrastructures and long marketing channels

According to Adane and Girma (2008) infrastructures necessary to transport livestock or its products from remote rural communities, were lacking and sheep and goats were generally trekked long distances for marketing, often without adequate water and feed. There are very limited market centers and stock routes with the necessary facilities such as feeding and watering points. The same author reported that the producers do not have access to market information.

2.5.4. Climatic condition

Climate fluctuation particularly increase in ambient temperature affect livestock production by both direct and indirect means and the production loss of the direct impact of climate change on livestock production mostly comes from the heat stress. Direct impacts include increased ambient temperature, through heat stress by reduction of milk production, reproductive efficiency, feed intake of animal and animal health and indirectly through reduction of feed and water resource availability, increasing disease occurrence by decreasing environmental adaptation mechanism of livestock through this climate change affect the livestock production and productivity which directly affect the farmers that depends up on livestock and use the livestock resources for source of food; wealthy and social well-being. Climate fluctuations can adversely affect productivity, species composition, and quality, with potential impacts not only on forage production but also on other ecological roles of grasslands (Giridhar and Samir, 2015). Due to the wide fluctuations in distribution of rainfall in growing season in several regions of the world, the forage production will be greatly impacted. With the likely emerging scenarios that are already evident from impact of the climate change effects, the livestock production systems are likely to face more of negative than the positive impact.

Also, climatic factor influences the water demand, availability and quality. Changes in temperature and weather may affect the quality, quantity and distribution of rainfall, snow melt, river flow and groundwater. Climate change can result in a higher intensity precipitation that leads to greater peak run-offs and less groundwater recharge. Longer dry periods may reduce ground water recharge, reduce river flow and ultimately affect water availability, agriculture and drinking water supply.

2.6. Opportunities for Sheep and Goat Production

2.6.1. Rising demand for sheep and goats

High demand of the small ruminants in the local market as a result of population increase, urbanization and increase in income are appreciated for the small ruminant producers in the country (Belachew and Jamberu, 2003) and also all household member involvement in their management can be considered as an opportunity for the small ruminant production (Tsedeke, 2009). Based on the export data of 2009/10, Ethiopia exported about 3.4 and 1.4 % of the meat and live small ruminant demand of the Middle East market, respectively (Solomon *et al*., 2010). These are indicating large potentials in expanding animal and animal product exports to the Middle East countries if the value chain actors of Ethiopia meet export market standards. There is also a drastic increase in domestic demand for small ruminant meat, particularly during religious festivals (Amaha, 2011). Increased involvement in small ruminant production is positively supported by the existing government policies that targets production and export of more live animals, meat or mutton and livestock products like skins, hides and leather (Getachew and Jane, 2014).

2.6.2. Low start-up cost

Low start-up cost is another factor that creates an opportunity for the development of a small ruminant production system by a small-scale farmer with limited resources. Start-up cost for meat goat producersis considerably lower than that of cattle producers (Okpebholoand Kahan, 2007). Similar authors reported that sheep and goats requires lesser space than cows and also they can easily kept on low quality forage and thrive in harsh season than cow.

2.6.3. Low labor requirement

Small ruminant production is less labor intensive when compared to the production of larger animals. According to Belete (2009), sheep and goats due to their smaller size women and children in the family can easily handle them. Most sheep and goats are good tempered and the chances of children and women getting injured are limited.SimilarilyTsedeke (2007) and Zawudu*et al*.(2012) in western and south-western Ethiopia, reported, gender participation is another sheep and goat production opportunities.

2.6.4. Prolificacy

A mature doe/ewe can be bred and successfully give birth three times every two years (Girma, 2008). Moreover, sheep and goats have more reproductive cycles than cattle within the same period of time (Okpebholoand Kahan, 2007). The same author reported that, in a period of two years, it is possible for a doe/ewe to give birth to six kids/ewes because of its high twinning rate, whereas a cow is most likely to produce two calves for the same period. This quick turn over rate is an advantage to the producer in terms of cash flow and the buildings up his/her herd size.

3. MATERIALS AND METHODS

3.1.Description of the Study Area

The study was conducted in Esera district of Dawuro Zone, Southern Nation Nationalities and People Region (SNNPR). The district is 522, 575, and 584 kms from Addis Ababa through Hosanna, Shashemane and Jimma roads, respectively and 350 kms from Awassa, the regional capital city. The area is topographically undulating and rugged. The Esera district covers a total area of 1043.1 km^2 and lies between 6^0.7’’-7^0.02’’ latitude and 36.7 to 37.10 longitudes, with an elevation ranging 501-2500 m.a.s.l. The district has 29 *kebeles* (26 rural and 3 urban) with a total population of 89,123 (EWFEDO, 2017). Esera district lies in three agro-ecological regions: *Kola*region (32%), *Woyina Dega* region (52%); and *Dega* region covers(16%) of the district. The annual mean temperature varies from 17.6^0C - 27.5^0C. The rainfall is a bimodal type: the short rainy season is between (February to March) and the long between (May to September). The average annual rainfall ranges between 1401 – 1800 mm.The agricultural production system in the area was mixed crop and livestock production system with the land use plan of the area, 38.4% is cultivated land, 13.39% grazing land 16.81% forest bushes and shrub land, 17.09 % cultivable, and 14.31% is covered by others (Andualem*et al.*, 2015). The livestock resource of the district were 365,019 cattle; 135,180 sheep; 123,110 goats; 11,202 horses, 6,653 mules; 2, 210 donkey; 199, 618 chicken and 67, 437 bee hives (traditional, transitional and modern hives) (EWLFDO, 2017).

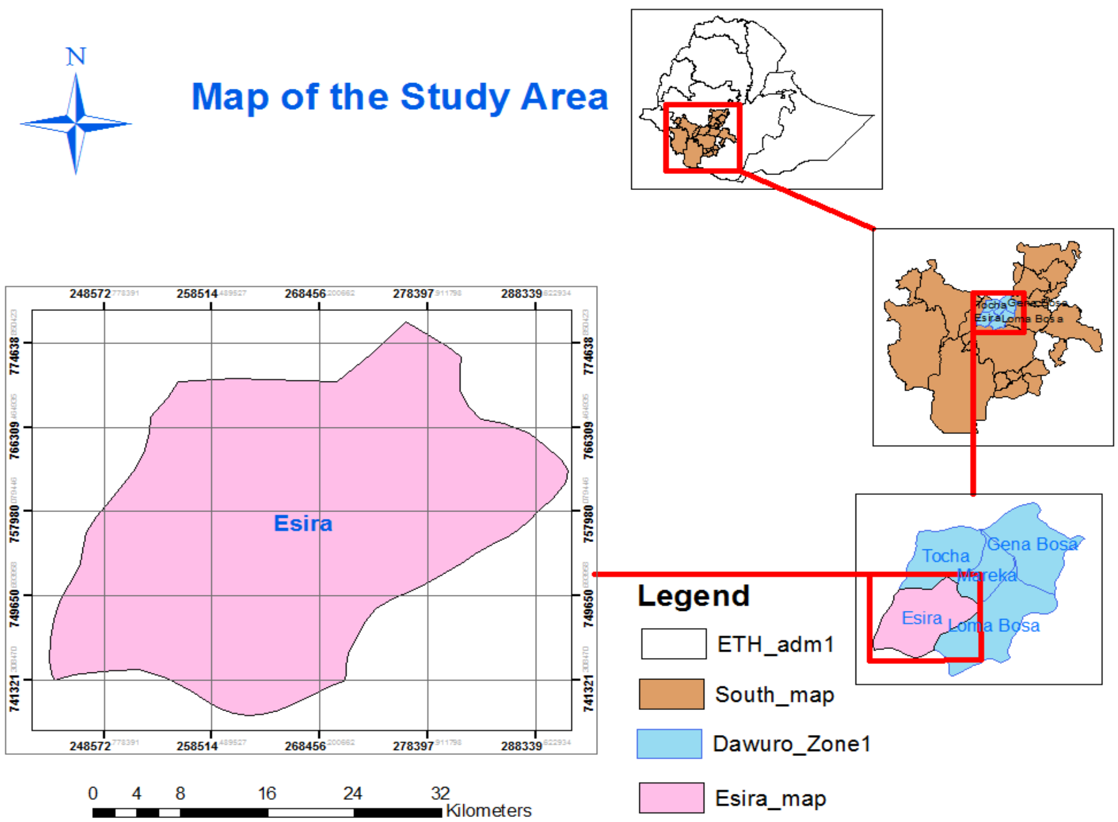

Figure 1.Map of study area

3.2.Study Population and Study Design

All households owning sheep and goat in Esera districts of Dawuro zone werethe study population. The designs involved in this study were cross-sectional studyby applying formal survey, field observation, focus group discussion, key informants discussion and laboratory analysis of collected feed samples.

3.3.Sampling Techniques and Sample Size Determination.

Prior to undertaking any sampling procedure background information on sheep and goat population and potential for their production in Esera district was collected through rapid exploratory field visits together with focus group discussions and available secondary information from published and unpublished sources, so as to devise suitable sampling stages for the study.Esera districthas a total of 29 kebeles which was stratified into three agro-ecologies based on altitudeas *dega*(high altitude),*woyna-dega*(medium altitude) and *kolla*(low altitude), then two*kebeles* were selected using systematic random sampling technique from each stratum.Two *kebeles* namely Duzi and Arussi Bala *kebele* from high land, Guza and Senget *kebel*e from mid land and Shota and Hagel-01 *kebele* from low land were selected by using systematic random sampling technique for study depending upon information gained from Esera district livestock and fishery development office. Householdswereselected randomly from those having sheep and goat based onsecondary data from livestock and fishery development office which was supported by the secondary data from Kebele administrative office. For this study 22, 72 and 44 households were selected by employing purposive random sampling techniques from high land, midland and low land, respectively, based on coverage of agro-ecology in the district (Table 6).

The sample size of house hold wasdetermined by using probability proportional size-sampling techniques formula recommended by Cochran (1977):

$$n = \frac{Z^2 \quad (P) \quad (q)}{d^2}$$

$$\frac{(1.96)^2 \quad (0.1) \quad (0.9)}{(0.05)^2}$$

Where n=desired sample size according to Cochran's (1977) when population greater than 10,000

Z=value of selected alpha level (1.96 for 0.25 in each tail at 95% confidence interval)

p =0.1(estimated proportion of an attribute that present population (10%))

q= (1-p=0.9) estimate of variance

d= acceptable margin of error for proportion being estimated (5%) or degree of accuracy desired.then, 138 respondents wereselected by systematicrandom sampling for survey.

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Table 6.Sampling frame work of study site and house hold in study area

Number	Ago-ecology	*Kebele* selected	HHs selected	FGDH
1	HL (16%)	2	22	2
2	ML (52%)	2	72	2
3	LL (32%)	2	44	2
Total		6	138	6

FGDH= focus group discussion held

3.4.Sources and Methods of Data Collection

Both qualitative and quantitative data were collected by employing the following methods.

3.4.1. Formal survey

A formal survey was conducted with the help of the semi structured questionnaire, with open-ended and closed-ended questions using trained enumerators. A semi structured questionnaire was prepared and pre-tested before administration and some re-arrangement, reframing and correcting in accordance with respondents perception were made. The questionnaire was administered to the randomly selected household by enumerators recruited and trained for this purpose with close supervision by the researcher. The questionnaire was designed to have information on the socio economic characteristics of households (sex, marital status, age and occupation of the respondents), sheep and goat production systems, husbandry practices (feeding, watering, breeding and health condition), reproductiveperformance,major available feed resources, production constraints and opportunities of sheep and goatin the study district.

3.4.2. Secondary data collection

Previous studies, guidelines, manuals, literatures and documented data were reviewed to assesssheep and goat production system, production constraints and opportunities and major feed resources. The secondary data pertaining to the investigation like the number of livestock resources, coverage of district in hectare and agricultural production system were collected from Esera woreda livestock and fishery development office, agricultural office, finance development office and Kebele administrative office

3.4.3. Focus group discussion

Elders, village leaders and individuals who have experience about the sheep and goat production systems, production opportunities and constraintsandmajor sheep and goat feed resource in the area were selected by the help of agricultural extension workers as a complementary to survey work. One focusgroup discussion consisting of 12(involving 8 male and 4 female) people was made per each identified study site to support questionaries' data and the researcher facilitates the discussion at all sites. The main points included in the discussion were, the history of sheep and goat production, productionpractices, feed resources, reproductive performances and production constraints and opportunities of sheep and goat in the study area.

3.4.4. Field observation

Sheep and goat production practice, husbandry practice, major feed resourcesand any other event pertaining to investigations were observed to strengthen the information obtained by using questionnaire.

3.4.5. Key informants interview

Primary data were generated by informal interview with local extension agents. The informal interview were conducted with extension agents intended to gather information about the sheep and goat production system, major available feed resources, productive and reproductive performance, opportunities and constraints of sheep and goat production in the study area.

3.4.6. Identification of the type of disease

Farmers could not differentiate the type of disease occurred but they knew the symptom of disease. The type of sheep and goat disease and parasite occurred were identified by asking the symptom of disease and parasite from the owners of the sheep and goat, then brought to the veterinarian and the type of disease was interpreted by the veterinarian depending upon the symptom of disease and parasite occurred in the study area.

3.5. Determination of Chemical Composition of Feed

3.5.1. Feed sample collection

Before the feed sample collection, interview was made with respondents throughout the study site in order to have a general overview. While surveying, the available feed resources wereidentified using the indigenous knowledge of farmers from the three agro- ecologies. While identifying the available feed resources, the HHs were asked to rank the available natural pasture feeds, crop residues, river and road side grazing feed, crop after math feed, *atela*, hay and cultivated forages based on their preference by sheep and goat, theirpalatabilityand dominance in the study site. Based on the rank five most common feed species from natural pasture (1 natural grass species and 4 indigenous browse and legume tree species) used for feeding sheep and goat were identified for chemical analysis of feed from each agro-ecology. Representative samples of theseidentified feed specieswere collected from different grazing areas, where available with the help of trained and recruited enumerators' from HL,ML and LL. Feed samples were collected on the same day from all study sites and then the collected samples were bulked per feed typesin each agro-ecology. Then samples were dried under shade, and the amount sufficient for lab analysis was sub-sampled to transport to Jimma University Animal Nutrition Laboratory. Then samples were oven dried at 65^{o}C for 72 hours and ground in Willey Mill to pass through 1mm sieve. Feed obtained from grazing area and browseplant, their specimens were collected, pressed, labeled, dried and transported to the Herbarium of Addis Ababa University for proper identification and nomenclature. Identification was done following guidelines given in the Flora of Ethiopia (Hedberg and S. Edwards, Eds., 1989)and the Flora of Tropical East Africa, SRSS (Somali Regional State Strategy, 1997).

3.5.2. Chemical analysis

Analysis of feed samples was undertaken for Dry Matter, Crude Fiber, Ether Extract, and Ash content of feed at animal nutrition laboratory of Jimma University and also Crud protein content of the feed at post-harvest laboratory of Jimma university according to the proximate method (AOAC, 1990) and for Acid detergent fiber and Neutral detergent fiber according to the Van Soest *et al*., (1991) methods were employed. The nitrogen was determined by kejldhahe method, Crude protein (CP) was determined as N x 6.25and theNFE were determined by(DM-(CP+ash+CF+EE).

3.6.Data Analysis

The collected data were entered and stored in Microsoft excel and analyzed by using statistical package for social sciences(SPPS) software, version 20, SPSS, (2013). The descriptive statistical analysis was employed for data analysis, which refers to the use of figures, percentages, means, standard error and charts in the process of examining and describing sheep and goat production practices, production constraints andopportunities,reproductive performance and major available feed resources. The quantitative data means between study agro ecology compared by means of one way analysis of variance (One-Way ANOVA) in SPSS).ANOVA was carried out using GLM procedure of SAS for experimental data.Mean difference were assessed usingTukeys test. Chi-square (X^2) test was employed to see statistical differences between categorical variables. Statistical differences between variables was proclaimed significant at ($p<0.05$).Priority Index value was calculated for purpose of sheep and goat production,feed resources, selection of rams and bucks for castration and fattening, culling of sheep and goat from flock, sheep and goat disease and parasite constraints and opportunities of sheep and goat production.

Statistical Model for surveyand experiment

1. Model statements for survey study regarding the effect of agro-ecologies on various parameters of sheep and goat production practice and sheep and goat feed type;

   $Y_{ij} = \mu + A_i + \varepsilon_{ij}$

   Where

   Y_{ij} = the value of respective variable or response for a given variable for j^{th} sheep and goat andfeed typein i^{th} agro-ecologies.

   μ = overall mean

   A_i= fixed effect of agro-ecology (i=3;High land, mid land and lowland)

   εij= random error

4. RESULTS AND DISCUSSION

4.1.Socio-Economic Characteristics of Households

The socio-economic characteristics of householdswere summarized in Table 7.The proportion of sex of respondents was 72.7 and 27.3%, 69.4 and 20.6%, 90.9 and 9.1% male and female for high land, midland and low land, respectively. In the study area, the majority of the sheep and goat owning households were male headed (77.7%) while (22.3%) were headed by females. This result revealed that most sheep and goat producers in the area were male headed and there was no variation between agro ecology of the study district which implies that majority of femalehas less valueduring decision making and majority of male were act as the only owner of their sheep and goat to use their sheep and goat for different purpose primarily when for generating cash income.This finding was in line with Sisay and Kefyalew (2015)who reported 73.3% and 26.7% of sheep and goat was headed by male and female respectively in Degahabur zone and the ratio of male to female was lower than the finding of *Dhabaet.al*, (2012) in Illu Abba Bora Zone of Oromia regional state.

The overall average family size of the respondents was 5.23±0.195 persons per household which was in line with average family size (5.54±0.16) per household reported by Belete (2009) in Goma district of Jimma Zone and lower than average family size (11±0.55) per household reported by Sisay and Kefyalew (2015) in Degahabur Zone of Eastern Ethiopia. Relatively small family size reported in current study might be due to awareness creation for family planning measures and by changing the local perception of respondents on large family size to make better life of households. The difference in the number of households across all agro ecology has positive influence on sheep and goat production due to efficient and effective use of labour for different husbandry practice (feeding, herding, housing,watering, marketing and during the time of breeding).

The average age of respondents was 39±1.382, 32±0.924 and 41±1.079 years in HL; ML and LL agro-ecology, respectively, with overall average ages of the respondents in the study district was 36±0.717 years.

On average (72.7, 73.6 and 84.1%) of the respondents were illiterate, (9.1, 5.6 and 4.5%) were read and write only, (0, 1.4 and 0%) have attended primary school, (4.5, 5.6 and 6.8%) have attended junior primary school, (9.1, 9.7 and 2.3 %) completed secondary school and (4.5, 4.2 and 2.3%) were higher education for highland, midland and lowland agro ecology, respectively.

According to the respondents the overall average education status of respondents were 76.8, 6.4, 0.47, 5.6, 7.0 and 3.7 % illiterate, read and write only, primary school, junior primary school, completed secondary school and college and above respectively in study area. This current study revealed that on average majority of sheep and goat keepers in study area was illiterate followed respondents who completed secondary school and attended primary school. Majority of sheep and goat owners being illiterate have negative influence onaccepting different extension system for improvement of sheep and goat husbandry practice like better feeding, watering, housing, disease and parasite control and selection of superior one to be the parent of next generation.It has also been stated that low level of education of the households can have an influence on the transfer of agricultural technologies and their participation in development (Mulugeta, 2005).

The marital status of household in study area were (9.1, 13.9 and 4.5%, 72.7, 70.8 and 86.4%, 9.1, 9.7 and 4.5%, 9.1, 5.6 and 4.5 %) single, married, widowed and divorced in HL, MLand LL agro-ecology respectively with overall average percentage of the marital status of respondents were9.1% single, 76.6% married, 7.8% widowedand 6.4% divorced in the study area. This result shows that majority of sheep and goat waskept by the person who were married.

The occupation of the households in study area was (81.8, 81.9 and 93.5%, 4.5, 4.2 and 2.3%, 4.5, 9.7 and 2.5%, 4.5, 0 and 0%, 4.5, 4.2 and 2.3%) with overall percentage of occupation of house hold was 85.6, 3.6, 5.6, 1.5 and 3.7%) of farmer, housewife, student, trader and government employed in HL, ML and LL agro-ecology, respectively,in the study area. Majority ofsheep and goat keepers were farmers who use sheep and goatas a source of cash income, saving, manure and meatpurpose followed by students who use sheep and goat as a source of cash income for different aspects of their social life (to buy schooling materials like clothes, exercise book, pens and pencil)in the *study area.*Majority of occupation of the sheep and goat owner were being farmers have advantage of having time for close supervision and different husbandry practice.

Table 7.Socio-economic characteristics of respondents

variables	Agro- ecology			
	HL(n=22)	ML(n=72)	LL(n=44)	Overall(N=138)
Age of the respondents (year)	39±1.382	32±0.924	41±1.079	36±0.71
Family size (number)	6.23^{b}±0.5	4.35^{a}±0.29	6.18^{b}±0.18	5.23±.19
Sex of the respondents (%)				
Male	72.7	69.4	90.9	77.7
Female	27.3	30.6	9.1	22.3
total	100	100	100	100
Education status (%)				
Illiterate	72.7	73.6	84.1	76.8
Read and write only	9.1	5.6	4.5	6.4
Primary school	0	1.4	0	0.47
Junior primary school	4.5	5.6	6.8	5.6
Secondary school	9.1	9.7	2.3	7.0
College and above	4.5	4.2	2.3	3.7
total	100	100	100	100
Marital status (%)				
Single	9.1	13.9	4.5	9.1
Married	72.7	70.8	86.4	76.6
Widowed	9.1	9.7	4.5	7.8
Divorced	9.1	5.6	4.5	6.4
Total	100	100	100	100
Occupation of the respondents(%)				
Farmer	81.8	81.9	93.2	85.6
House wife	4.5	4.2	2.3	3.6
Student	4.5	9.7	2.5	5.6
Trader	4.5	0	0	1.5
Government employed	4.5	4.2	2.3	3.7
Total	100	100	100	100

Means with the same letter within the same row are not significantly different at (p>0.05); n=number of sample per agro- ecology, N= total sample

4.2.Land Holding and Land Use Pattern in Study Area

The average land holding and use pattern were summarized in Table 8.The average land holding per household in the study area were 3.16±0.69, 2.26±0.20 and 4.52±0.28 hectares in HL, ML and LL agro-ecology, respectively, with 3.1288±0.19 ha overall average landholding per household in study district.This result was in line with3.23 ha reported by Dawit and Ajebu (2013) in Adami Tulu, of Oromia Region, but in contrary, this result was higher than 2.5 and 1.29 hectare reported by Belay *et.al (*2012) and Beyero *et.al* (2010) inDandi district of Oromia Region and Badawacho district of Hadiya Zone, Southern Ethiopia, respectively. On the other hand, this resultwas lower than 3.6 and 3.68 ha reported by Seidand Berhan, (2014) and Sisay and Kefyalew (2015) in Burji district, Southern Ethiopia and Degahabur Zone of Eastern Ethiopia, respectively.The average land allocated for crop production, grazing land and fallow land per HHs were 1.93±0.13, 1.07±0.07and 0.09±0.02 respectively.

The average landholding was significantly high($p<0.01$) in LL(4.5284±.28ha),than in HL (3.1625±0.69 ha) and ML (2.2632±0.20 ha) in the study area. Similarly the land size allocated for cropland was significantly higher ($p<0.01$) in LL (2.84±0.20 ha) agro-ecology than that of HL (1.87±0.42ha) and ML (1.39±0.13ha) agro-ecology but land size allocated for crop in HL and ML was not significantly different in study area. The average land size allocated for grazing was significantly ($P<0.01$) higherin LL (1.50±0.10ha) thanML (0.78±0.06ha) and HL (1.17±0.29)in the study area. .

Table 8.Land holding and land use pattern in Esera district (M±SE)

varvariables	Agro- ecAgro ecologyo				
	HL n=22	ML n=72	LL n=44	Overall N=138	p-value
Total land holding (ha)	3.16^{b}±0.69	2.26^{a}±0.20	4.52^{c}±.28	3.12±0.19	0.001
Crop land (ha)	1.87^{a}±0.42	1.39^{a}±0.13	2.84^{b}±0.20	1.93±0.13	0.001
Grazing land (ha)	1.17^{ab}±0.29	0.78^{a}±0.06	1.50^{b}±0.10	1.07±0.07	0.001
Fallow land (ha)	0.11^{b}±0.09	0.04^{a}±0.02	0.18^{c}±0.05	0.09±0.02	0.041

Means with the same letter within the same row are not significantly different ($p>0.05$); M=mean; SE=standard errorha=hectare, n=sample population per agro-ecology, N=total sample.

4.3.Livestock Holding and Composition

The average livestock holding per household was summarized inTable.9.Farmers in the study area keep a mix of different livestock species namely cattle, sheep, goats, equines and chicken, integrated with crop farming and also engaged in off-farm activities.The average number of cattle holding per households was 7.9±0.647, 5.95±0.336 and 9.855±0.64 forHL, ML and LL altitude respectively. The average number of cattle was significantly different between different agro-ecologies. The highest number of cattle was found from LL and significantly lowest number of cattle was foundfrom ML.This difference might be due to relatively high natural grazing land, high requirement for oxen to use for traction power in LL agro ecology. The overall average cattle herd size per households was 7.51 in the study district. This result was higher than 2.4 reported bySelamawit and Matiwos(2015) in Gedio Zone of Southern Ethiopia, 6.5 reported by Deriba(2009) in Alaba Southern Ethiopia,3.3 reported by Abera *et.al (*2014) in Baresa Watershed, Ethiopia and lower than 14.8reported by Kassahun(2011) in Chilega woreda, North Gondar, Ethiopia.

The overall average flock size of sheep and goat per households was 6.08±0.183 and 5.69±0.236, respectively, in the study district and also the average number of sheep and goat flock size was 7.27±0.551, 6.60±0.225 and 4.64±0.216 and 2.90±0.293, 4.90±0.257 and 8.38±0.278 in HL, ML and LL agro ecology, respectively. The average number of both sheep and goat was significantly different between different agro-ecology. The highest number of sheep and goat were foundfrom HL and LL agro-ecology respectively; on the other hand, significantly lowest number of goat and sheep wasfound from HL and LL agro-ecology, respectively, in the study area. This current finding was in line with average sheep flock size of6.10 reported by Deriba (2009) in Alaba Southern Ethiopia. However, the current finding was higher than3.6 reported by Belete (2009) in Goma District of Jimma Zone,4.8 reported by Dhaba *et.al* (2012) in Illu Abba Bora Zone of Oromia Region and 5.33 reported by Selamawit and Matiwos (2015) in Gedio Zone of southern Ethiopia. The average goat flock size was higher than 2.1 reported by Belete (2009) in Goma district of Jimma Zone, 4.5 reported by Deriba (2009) in Alaba Southern Ethiopia, 3.99 reported by *Dhabaet.al*(2012)in Illu Abba Bora Zone of Oromia Region and 3.46 reported by Selamawit and Matiwos (2015) in Gedio Zone of Southern Ethiopia.

Equines were a used for threshing and transporting agricultural inputs and products, drinking water for animals and human beings, wood, crop residues and charcoal (Lemma, 2002).The average number equine was 1.18±0.204, 0.71±0.107 and 1.14±0.115 in the HL, ML and LL agro ecologies, respectively, with overall average numberof 0.92±0.076. The average number of equines was significantly ($p<0.01$) lowerin ML (0.71±0.107) than HL (1.18±0.204) and LL (1.14±0.115) in the studydistrict.

The average number of chicken was10.95±0.50 which was significantly ($p<0.01$) higher in LL (16.95±0.774) than HL (7.68±1.056) and ML (8.26±0.38) agro-ecologies of the study area.But the average number of chicken in HL and ML agro ecology was statistically similar.

Table 9.The mean (stand error) of livestock holdings and composition in the study area.

Category	Agro ecology				
	HL (n=22)	ML (n=72)	LL (n=44)	Overall (N=138)	P value
Cattle	7.9^{b}±0.647	5.95^{a}±0.336	9.855^{c}±0.640	7.51±0.323	0.001
Sheep	7.27^{c}±0.551	6.60^{b}±0.225	4.64^{a}±0.216	6.08±0.183	0.001
Goat	2.90^{a}±0.293	4.90^{b}±0.257	8.38^{c}±0.278	5.69±0.236	0.001
Equine	1.18^{b}±0.204	0.71^{a}±0.107	1.14^{b}±0.115	0.92±0.076	0.014
Chickens	7.68^{a}±1.056	8.26^{a}±0.38	16.95^{b}±0.774	10.95±0.50	0.001

Different subscripts indicates significant differences at ($p<0.05$) between means with in rows; M=mean; SE=standard error.

Table 10.The mean (stand error) of different age category of sheep and goat flock

Sheep and goat flock category	Agro ecology				
	HL (n=22)	ML (n=72)	LL (n=44)	Overall (N=138)	P value
Lambs (<3 months)	0.55±0.225	0.39±0.075	0.0.43±0.114	0.43±0.064	.697
Male lambs (3-6 months)	1.41^{b}±0.225	1.14^{b}±0.116	0.59^{a}±0.127	1.01±0.084	.001
Female lambs (6-12 month)	1.09^{b}±0.245	1.21^{b}±0.134	0.34^{a}±0.092	0.91±0.091	.001
Ewes	3.55^{b}±0.252	3.08^{b}±0.076	1.68^{a}±0.092	2.7±0.089	.001
Rams (intact) (>6months)	0.50^{a}±0.127	0.56^{a}±0.071	1.05^{b}±0.092	0.70±0.055	.001
Ram Castrates/fattening	0.18^{a}±0.084	0.22^{a}±0.049	0.57^{b}±0.076	0.33±0.040	.001
Mean holding/HH of sheep	7.27^{b}±0.551	6.60^{b}±0.225	4.64^{b}±0.216	6.08±0.183	.001
Kids (<3 months)	0.18^{a}±0.084	0.19^{a}±0.073	0.59^{b}±0.109	0.32±0.055	.003
Male Kids (3-6 months)	0.50^{a}±0.143	1.19^{b}±0.109	1.68^{b}±0.139	1.24±0.082	.001
Female Kids (6-12 month)	0.55^{a}±0.143	0.89^{a}±0.102	1.95^{b}±0.121	1.17±0.084	.001
Does	1.32^{a}±0.021	2.28^{b}±0.101	2.98^{c}±0.147	2.35±0.086	.001
Bucks (intact) (>6months)	0.36^{a}±0.124	0.24^{a}±0.054	0.82^{b}±0.059	0.44±0.045	.001
Bucks Castrates/fattening	0.09^{a}±0.063	0.11^{a}±0.037	0.41^{b}±0.075	0.20±0.034	.001
Mean holding/HH of goat	2.90^{a}±0.293	4.90^{b}±0.257	8.38^{c}±0.278	5.69±0.236	.001

Different subscripts indicates significant differences at ($p<0.05$) between means with in rows; SE=standard error, n=sample population per agro ecology N=total sample

4.4.Sheep and Goat Production System

4.4.1. Purpose of keeping sheep andgoat in the study area

Purpose of keeping/rearing sheep and goat in thestudy area were shown in Table11. Respondents revealed that the primary purpose of keeping sheep and goat were sources of cash income followed by insurance purpose (sources of cash income without plan or in emergency case) and ranked as cash income (1st), insurance (2nd), meatproduction for home consumption (3rd)manure (4th) and wealth (5th) inthe study district.This implies that the primary reason for keepingsheep and goat to generate cash income for the households through the sale of live sheep and goat. Sheep and goats are considered as assets that can be converted readily into cash to meet immediate household financialobligations such as to buy schoolmaterial for the student,fertilizers for improvement of crop production, improved breeds of chickens,medicine tototal livestock species, and to pay land rent(taxes). This current finding was in line with Markos (2006), Sisay (2006), Endeshaw(2007),Tsedeke(2007), Getahun (2008), IPMS (2010), Semakula*et al*. (2010), Dhaba*et al*, (2012), Arse*et al*, (2013), Hailemariam *et al*(2013)and Byaruhanga*etal*.(2015) who reported that sheep and goat are reared primarily for income generation.

Table 11.Purpose of keeping sheep and goat in the study area

Altitude	purpose	Rank(n)							
		1st	2nd	3rd	4th	5th	FValue sum	Index	Rank
HL	Meat	1	3	17	1	-	70	0.22	3rd
	Cash income	19	3	-	-	-	107	0.34	1st
	Manure	-	1	1	17	3	44	0.14	4th
	Wealth	-	-	-	1	4	6	0.02	5th
	Insurance	3	15	4	-	-	87	0.28	2nd
ML	Meat	-	2	52	8	4	132	0.14	4th
	Cash income	62	10	-	-	-	350	0.37	1st
	Manure	-	-	12	54	-	140	0.14	3rd
	Wealth	-	-	-	4	38	46	0.04	5th
	Insurance	10	60	2	-	-	296	0.31	2nd
LL	Meat	-	2	12	2	28	76	0.12	5th
	Cash income	10	18	6	-	-	140	0.23	2nd
	Manure	-	-	-	40	2	82	0.14	4th
	Wealth	-	6	24	2	12	112	0.19	3rd
	Insurance	20	22	2	-	-	194	0.32	1st
Overall	Meat	1	7	81	11	32	330	0.166	3rd
	Cash income	101	31	6	-	-	647	0.325	1st
	Manure	-	1	13	111	5	270	0.136	4th
	Wealth	-	6	24	7	54	164	0.083	5th
	Insurance	33	97	8	-	-	577	0.29	2nd

Index=the sum of (5 times First order +4times second order + 3times third order + 2 times fourth order + 1 times fifth order) for individual variables divided by the sum of (5 times First order +4 times second order + 3 times third order + 2 times fourth order + 1 times fifth order) for all variables.

4.4.2. Farming system of the study area

Esera district was known to be a mixed crop-livestock production system dominant farming system. Livestock production is subsistence-oriented and an important component of the mixed farming system and well integrated with crop production shown in Table12.Land use is dominated by mixed smallholder rain fed agriculture producing cereals, pulses and livestock.

Crop production and livestock husbandry were commonly integrated with mixed farming system in different agro-ecological zones ofthe study area.

In the study area, large land size were covered by annual grain or cereal crops mainly wheat, barley, teff, maize and pulse crops like as beans (*Phaseolus vulgare*), peas (*Pisum sativum*). Perennial crops like *Enset (Ensete Ventricosum)* were cultivated vastly in the highland and midland and represent the major root and tuber crops of the study area), banana (*Musa paradisiaca*), coffee (*CoffeeArabica*), sugar cane (*Saccharum officinarum*), avocado (*Persea americana*),mango (*Mangifera indica*), papaya (pawpaw) (*Carica papaya*), different agro-forestry tree species and eucalyptus plantations and root crop (potatoes (*Solanum tuberosum*), sweet potatoes (*Ipomoea batatas*), cassava (*Manihot cassave*), yam (*Dioscorea*) and taro (*Colocasia esculenta*)) are also grown in considerable amounts. This was in line with the report of Asrat*et al.* (2013) in *Boditti*, *Wolaita* zone of southern Ethiopia. Cash crops, which grown by many farmers at back yardwere pumpkins (*Cucurbita spp.*), Geeshoo (*Rhamnus prinoides*) for preparation of local alcoholic drinks, garlic (*Allium sativum*), onions (*Allium cepa*), ginger (*Zingibere officinale Rosc.*) and pepper (*Piper nigrum*).

Two types of sheep and goat production system namely extensive (69.1%) and semi-intensive (30.9%) were commonly practiced in the study area as shown inTable12.On averageabout 36.4, 70.8 and 100% of extensive production system were found in HL, ML, LL and 63.6 and 29.2% of semi-intensive production system were found inHL and MLagro-ecologiesof the study district respectively.Although, the extensive production system was the most dominant in sheep and goat production systems under smallholder farmers, there were also significant numbers of farmers practicing semi-intensive system. Semi-intensive system was mostly practiced in HL and ML agro-ecology of the study district. This difference might be due was shortage of grazing land and shortage of browsing or grazing areas. The complete absence of semi intensive production systemin the lowland area might be due to limited access to extension service and lack of awareness of farmers in the area in addition to the relatively better access to grazing land.

Table 12.Sheep and goat production system

variables	Agro- ecology			
Production system (%)	HL	ML	LL	Overall

	n=22	n=72	n=44	N=138
Mixed crop live stock	100	100	100	100
Extensive	36.4	70.8	100	69.1
Semi-intensive	63.6	29.2	-	30.9
Total	100	100	100	100

4.4.3. Sourcesof sheepand goat

According to the respondents the source of ewe/doe were home born and purchase from market (100%) without having any difference across all agro ecologies of the study district.Respondents maintainhome born ewe lambs or doe kids or they purchase from market for their replacement stock.

While the source of breeding ram/bucks for household were (10.6%) home born only, (10.1%) purchase from market only, (34.5%) neighboring ram/buck only, (11%) home born and purchase from market,(9.3%)home born and neighboring ram/buck, (21.5%) purchase from market and neighboring ram/ buck and (3 %)of sheep and goat owners use home born, purchase from market and neighboring ram/buck for the purpose of breeding in the study district.

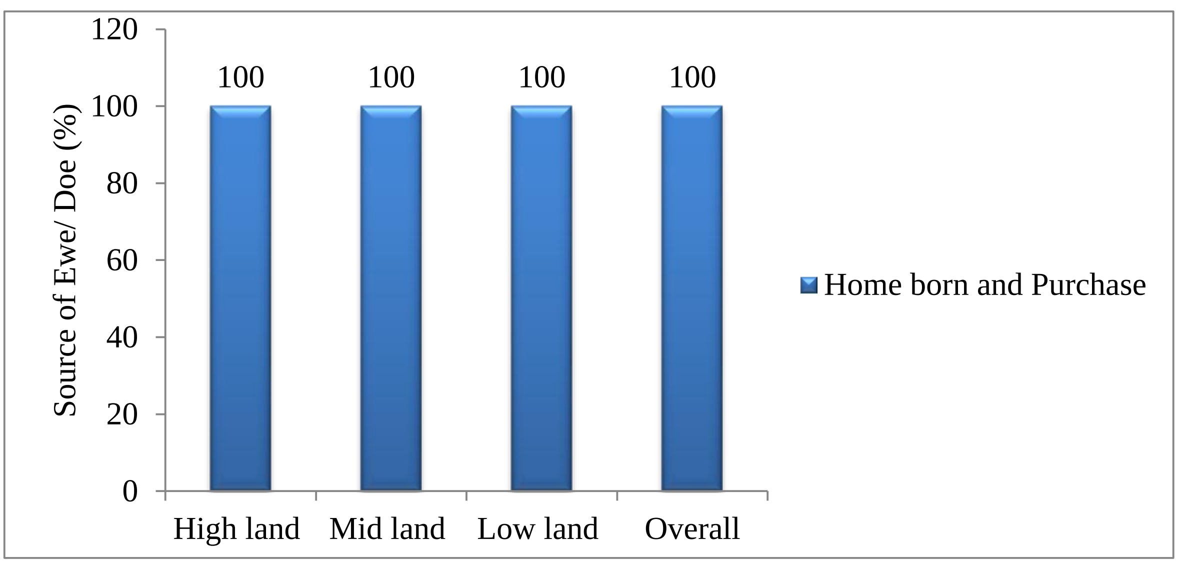

Figure 2. Source of Ewe/Doe for production and breeding

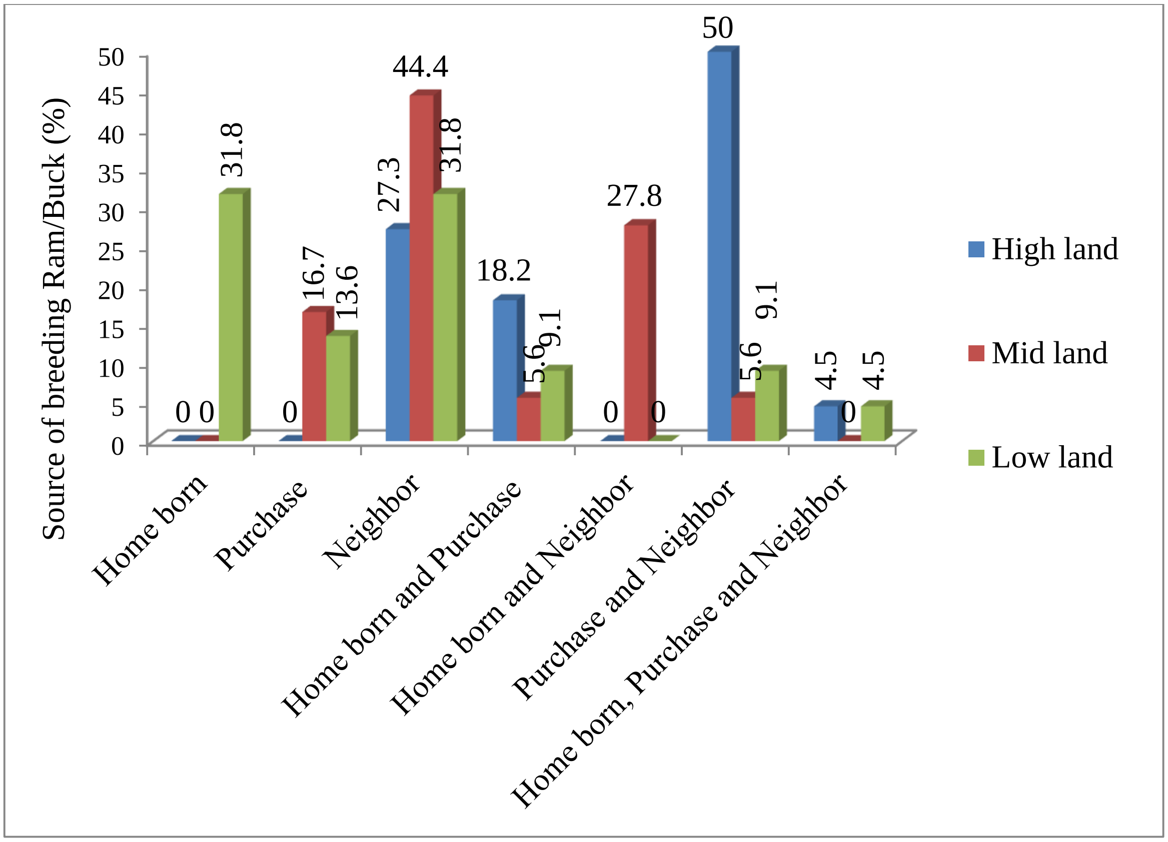

Figure 3.Source of breeding ram/buck

4.5.Sheep and Goat Husbandry Practices

4.5.1. Feeds and feeding practice of sheep and goat in study area

4.5.1.1.Source of feed for sheep and goat

Source of sheep and goatfeeds were summarized in Table 13. The feed resources for sheep and goat were natural pasture, river and road side grazing, crop after math, hay, local brewery product called *Atela*, crop residue and improved or cultivated forages ranked as 1^{st} , 2^{nd} , 3^{rd} , 4^{th}, 5^{th} , $6^{th}$and 7^{th}, respectively.

In the current finding all respondents confirmed that the primary and major feed resources of sheep and goat was natural pasture either private or communal pasture land followed by river and road side grazing and browsing in the study district. Sheep and goat production was heavily dependent on grazing and browsing from natural grazing pasture which include grass species, shrubs, browse species and legume tree species. But these feed resources are generally poor in quality and their productivity and supply is seasonal and low particularly during the critical time of the dry season.This finding was in agreement with Adugna (2008);Abera *et al*(2014)and Samuel (2014), who reported that natural pasture, crop residues, aftermath grazing, hay, agro-industrial by-products, commercial concentrate and non-conventional feeds were the most important feed resources used in different parts of Ethiopia.

And also this result was in consistency with Hailemariam *et al*(2013), who reported the primary source of feed for small ruminant was natural pasture in Gamogofa Zone Southern Ethiopia. Also Shewangzaw and Adis, (2016) who reported that the main sources of small ruminant feed were natural pasture and crop residuein North Gondar Zone of Amara Region, Ethiopia.

In current study, respondentsreported that crop residue was the sixth ranked available feed resources used for sheep and goat in study area. Crop residues were the source of feed during the dry season when pastures grazing area were not able to provide reasonable quantity of feed in the study districts. The major crop residues used as source of sheep and goat feed in the study area are teff straw, barley straw, wheat straw, pulse straw, maize stover in HL and ML agro ecology and teff straw and maizestover in LL agro ecology.

Crop aftermath grazing of cereal crops occurred after harvest from mid-September to December in LL and November to January in ML and HL in study area. Aftermath grazing is reserved and grazed privately for some period and then after it became accessible to the community in the locality. This is probably to exploit the potential of crop aftermath at individual level since land available for stubble grazing is private resource. Moreover, small ruminants have to be herded closely to protect from crop damage until harvesting of food crops over in season of the year in study district.

According to respondents reports the main improved forage species widely distributed were elephant grass, desho grass, sesbania and leucaena in the study area. Elephant grass and desho grass was the dominant improved forage species cultivated in study district. However, growing of improved forage was not a common practice in the study area;this might be due to lack of awareness of farmers on improved forage species, shortage of land for cultivation and lack of improved forge seed supply and adoption of farmers to cultivate improved forages.

This result is in line with Samuel (2014) in Southern Ethiopia and Abate *et.al (*1993) who indicated that no special effort is made to grow feed for farm animals in subsistence-oriented smallholder production system in the highlands of Ethiopia.

Table 13.Source of sheep and goat feeds and ranked by the respondents

Altitude	Sources of feed	Rank(n)									
		1st	2nd	3rd	4th	5th	6th	7t	F Value sum	Index	Rank
HL	Natural pasture	22	-	-	-	-	-	-	154	0.26	1st
	Crop aftermath	-	12	10	6	-	-	-	146	0.24	2nd
	River and road side grazing	-	7	9	3	1	-	-	102	0.17	3rd
	Hay	-	-	3	11	5	-	-	74	0.12	4th
	Crop residue	-	2	4	6	3	-	-	65	0.10	5th
	Atela	-	1	-	4	10	-	-	52	0.09	6th
	Cultivated forages	-	-	-	-	-	2	1	16	0.02	7th
ML	Natural pasture	72	-	-	-	-	-	-	504	0.27	1st
	River and road side grazing	-	50	18	18	-	4	-	462	0.24	2nd
	Crop aftermath	-	22	44	6	-	-	-	376	0.19	3rd
	Hay	-	-	6	38	18	4	-	240	0.12	4th
	Atela	-	-	-	16	30	6	-	166	0.08	5th
	Cultivated forages	-	-	-	-	8	40	6	110	0.05	6th
	Crop residue	-	-	-	10	20	-	-	100	0.05	7th
LL	Natural pasture	44	-	-	-	-	-	-	308	0.28	1st
	River and road side grazing	-	42	2	-	-	-	-	262	0.24	2nd
	Crop aftermath	-	-	42	2	-	-	-	218	0.20	3rd
	Atela	-	2	-	34	8	-	-	172	0.15	4th
	Hay	-	-	-	8	26	4	-	118	0.10	5th
	Cultivated forages	-	-	-	-	-	14	-	28	0.03	6th
	Crop residue	-	-	-	-	-	2	-	8	0.008	7th
Overall	Natural pasture	138	-	-	-	-	-	-	966	0.26	1st
	River and road side grazing		99	-	21	1	4	-	840	0.23	2nd
	Crop aftermath		34	96	14	-	-	-	740	0.20	3rd
	Hay		-	9	57	49	8	-	432	0.12	4th
	Atela		3	-	54	48	13	-	390	0.10	5th
	Crop residue		2	4	16	23	2	-	173	0.05	6th
	Cultivated forages		-	-	-	8	56	1	154	0.04	7th

Index=the sum of (7 times First order +6times second order + 5 times third order + 4 times fourth order + 3 times fifth order + 2 times six order + 1 times seventh order) for individual variables divided by the sum of (7times First order +6 times second order + 5 times third order +4 times fourth order + 3 times fifth order+ 2 times six order + 1 times seventh order) for all variables.

4.5.1.2.Feed Shortage in the Study Area

Feed shortage due to seasonal availability and poor quality of feeds major limiting factor in small ruminant productivity. About 77.3, 97.3 and 86.4% of the respondents in HL, ML and LLrespectively, reported as there is feed shortage problemwith overall 87% of respondents suffered feed shortage for their sheep and goat. According to key informants discussion and respondents, feed shortage problem was found in both dry and wet season.

Major reason of feed shortage reported was expansion of crop cultivation, shortage and decline in production grazing land, weather condition, and increment in number of animal and human population. The months of feed shortage in study area were during dry season (December-January). In these seasons the main reason of feed shortage are due to weather condition and shortage and lack of rain fall and the other feed shortage was happenin wet season (June – August) the main reason for feed shortage was expansion of crop cultivation in the study area

Allrespondents described that the main reason of feed shortage was due to combination of different reason in study area. About 51 % of respondents reported that the main reason of feed shortage were expanding crop cultivation, shortage of grazing land, climatic condition, and increase animal and human population and 28.4%of them explained that expanding crop cultivation, shortage of grazing land, decline in productivity of grazing land, climatic condition, increase animal and human population. This current finding was in line with Tsedeke (2007) who reported that the major reason of feed shortage for livestock was expansion of crop cultivation followed by declining yield and carrying capacity of the grazing lands in Alaba southern Ethiopia. Dhaba*et al*. (2012), also reported that the main reason for shortage of feed were expanding crop cultivation, shortage of grazing land, decline in productivity of grazing land, increase animal and human population in Ilu Abba Bora Zone of Oromia Regional State, Ethiopia. Belete (2009) reported that the intensity of annual and perennial crop cultivation and shrinkage of grazing land are main reason of feed shortage in Goma district of Jimma Zone, Western,Ethiopia.

Table 14. Reasons for feed shortage in the study area

Reason for feed shortage		Agro ecology			
		HL (n=22)	ML (n=72)	LL (n=44)	Overall (N=138)
Do you have shortage of feed (%)	Yes	77.3	97.3	86.4	87.0
	No	22.7	2.7	13.6	13.0
Reason for feed shortage (%)					
Expanding crop cultivation and increase human population		-	-	4.5	1.5
Expanding crop cultivation, increase human and animal population		9.1	-	-	3.0
Decline in productivity grazing land and shortage of grazing land		-	-	4.5	1.5
Expanding crop cultivation, shortage of grazing land , weather condition, increase in animal and human population		27.3	66.7	59.1	51
Decline in productivity of grazing land and increase human population		-	-	4.5	1.5
Expanding crop cultivation, decline in productivity and shortage of grazing land , climatic condition, increase animal and human population		40.9	30.6	13.6	28.4
Total		77.3	97.3	86.4	87

4.5.1.3.Feeding Practice of sheep and goat in Study Area

According to respondents feeding system of sheep and goat were 72.7, 94.4 and 27.3%tethered grazing and browsingwhile 27.3, 5.6 and 72.7% were free grazing and browsing in HL, ML and LLagro-ecologies, respectively. In HL and ML agro ecology tethered feeding system was common and dominant,which might be due to shortage of private grazing land, unavailability of communal grazing land and protection of cropdamage bysheep and goat. On other hand, free grazing and browsing tendency was high inLL agro ecologywhich might be due to the presence of high amount of natural private and communal grazing land which consists of enough amount of grazing and browsing grass, shrubs, legumes and plant species.

This result was in line with Endeshaw (2007); Tsedeke (2007); Getahun (2008); Belete (2009), Tesfaye (2009) and also Dhaba *et al*. (2012), who reported that the feeding system of small ruminants was free grazing and browsing in dry season, tethered grazing and browsing at wet season and cut and carry system in Illu Abba Bora Zone of the Oromia regional state. On the same way, Zawudu *et al*. (2012) also reported that the herding, tethering and free grazing of small ruminant feeding system were practiced in Western and South western Ethiopia and Selamawit and Matiwos (2015) who reported that the feeding system for small ruminant practiced were free grazing and browsing, partly tethered grazing or browsing, fully tethered grazing or browsing and confined grazing in GedioZone Southern Ethiopia). On other hand, the current finding was disagreeing with the report of Hagos *et.al* (2017) who reported that were the feeding system of small ruminants practicedwere only free grazing system in Western Tigray, North Ethiopia.

From the interviewed households, 5.5% herd sheep alone, 5.5 % goat alone, 30.9% sheep and goats together and 58.1% keep sheep and goat withother livestock while grazing and browsing.According to group discussion with participants and respondents, majority of farmers prefer herding small ruminant with other livestock due to shortage grazing land and presence a single private grazing land in the studydistrict.This result was disagreeing with the report of Hailemariam *et.al* (2013) who reported that the majority of respondents kept sheep alone (63%) while (28.3%) sheep and goat and 8.7% of kept sheep, goat and cattle during grazing and browsing in Gamogofa Zone Southern, Ethiopia and Yadeta,(2016) also reported that farmers rears (20.6%) sheep alone, (13.9%) goat alone,(5%) sheep and goat and (8.9%) sheep and goat with other livestock during grazing and browsing in Ada Barga and Ejere districts of West Shoa Zone, Ethiopia

Table 15.Feeding practice of sheep and goat

Variables	Agro ecology			
	HL (n=22)	ML (n=72)	LL (n=44)	Overall (N=138)
Grazing system (%)				
Tethered grazing and browsing	72.7	94.4	27.3	64.8
Free grazing and browsing	27.3	5.6	72.7	35.2
Total	100	100	100	100
Herding system (%)				
Sheep alone	9.1	2.8	4.5	5.5
Goat alone	9.1	2.8	4.5	5.5
Sheep and goat	22.7	15.3	54.5	30.9
Sheep and goat with other livestock species	59.1	79.2	36.5	58.1
Total	100	100	100	100

4.5.1.4.Feed Supplementation of sheep and goat

Natural pasture and crop residues do not fulfill the nutritional requirements of animals particularly in the dry season due to poor management and poor quality (Malede and Takele,(2014). Thus, provision of supplementary feeds toincrease theproductivity of livestock isessential.

According to the respondents, about 92.7% of respondentspractice supplementing feeds for their sheep and goat. About 21% of the respondents supplement their sheep and goat during dry season only and 71% supplement in both dry and wet season of the year in study area. This finding was in line with Getahun (2008) in highland parts of Ethiopia and Belete (2009) in Goma district of Jimma Zone, Western Ethiopia. The proportions of households who supplement their sheep and goat once a day and twice a day were 62.5 and 30.2% respectively in study district.

The major feed source used for supplementation of sheep and goat was *Atela*, home refusal, salt/local mineral and maize grain after and before grazing or browsing in study area.

About100 % of respondents in HL agro-ecology confirmed that the major feed that they supplement their sheep and goat were *atela*, home refusal, salt/local mineral, tree legumes and maize grain, in ML 91.7% of household use the major feed as home refusal, salt/local mineral and maize grain, while in LL about 86.4% of respondent use the major feed for supplementation of their sheep and goat was home refusal, *atela*, salt/localmineral and maize grain in the study area.

Table 16.Supplementation of sheep and goat in addition to browsing or grazing in study area

Variables		Agro ecology			
		HL (n=22	ML (n=72)	LL (n=44	Overall (N=138
Supplementation of feed (%)					
Do you supplement sheep and goat	Yes	100	91.7	86.4	92.7
	No	-	8.3	13.6	7.3
	Total	100	100	100	100
Season of supplementation					
Dry season only		31.8	22.2	9.1	21
Wet season		-	-	2.3	0.76
Both dry and wet season		68.2	69.5	75	71
Total		100	91.7	86.4	92.7
Frequency of supplementation	Once a day	45.5	55.6	86.4	62.5
	Twice a day	54.5	36.1	-	30.2
	total	100	91.7	86.4	92.7
Types of feed supplemented					
Home refusal		100	91.7	86.4	92.7
Atela		100	70.8	86.4	85.7
Salt/local mineral		100	91.7	86.4	92.7
Tree legume		100	68.1	77.5	81.8
Maize grain		100	91.7	86.4	92.7

n=sample population peragro–ecology=total sample, HL=highland, ML=midland,LL=lowland

4.5.2. WaterSource and Utilization

Water is very crucial nutrient required by livestock in large amount to transport nutrient around the body, regulation of body temperature, formation and maintenance of body tissue. The common source of water in the study area were river water, tape water, spring water and rain fall water in both dry and wet season of the year(Table.17).

From these water sources respondents, reported that the common sources of water during dry season were river water and spring water (31.6%) and river water, tap water and springwater (68.4%). During the wet season it was rain wateronly (11.4%), rain and river water (42.3%), tap and rain water (33.2%) and river, tap and rain water (13.1%) across all agro-ecologies that madethe source of water in the study area. One hundred percent of the respondents in study area provide waterfor theirsheep and goat both in dry and wet season of the year either by harvesting water from different water source or going long distance to the river with their livestock. According to the respondents, farmers travel 1.439±.09 km distance from homestead to the water source in the study district. There was no significant difference ($p>0.05$) between the three agro ecologies in distance of watering points from home-stead. About 79% of respondent reported that there was shortage of water for sheep and goat in dry season. Farmers in the study area, alleviate water shortage by harvesting water from river to homestead by using draft animal and family labour and travel long distance to the river with their flock to water their livestock in general and sheep and goat in particular in the study district. This current finding was in consistency with Abule, (2003);pastoralist area reported water is main limiting factor in livestock production.

According to respondents proportion of households that water their sheep and goatonce ina day and twice a day are 2.8and 97.2% in dry season respectivelywhile 100% of respondents water oncein a day in wet season in study district.Watering frequencies were higher in dry season which is related with less moisture content of the feed and hotness in atmospheric temperature during dry season. This study was higher than Belete *et.al*(2015) who reported that the watering frequency during wet season 46.7% watered freely and 29.7% and in dry season 29.7% and 26.9% of small ruminants watered freely, once in two days, once in two days and once in three days, respectively.

Table 17.Common Source and frequency of watering, means of alleviating water shortage (%) and distance (km) to water source

Variables			Agro ecology			
			HL (n=22)	ML (n=72)	LL (n=44)	Overall (N=138)
Common Source of water (%)						
River, Rain and spring water			27.3	8.3	59.1	31.6
River, Rain, Tap water and spring water			72.7	91.7	40.9	68.4
Total			100	100	100	100
During dry season (%)	River and spring water		27.3	8.3	59.1	31.6
	River , Tap and spring water		72.7	91.7	40.9	68.4
	Total		100	100	100	100
During wet season (%)	Rain water		9.1	25	-	11.4
	River and rain water		27.3	36.1	63.6	42.3
	Tap and rain water		40.9	22.2	36.4	33.2
	River ,tap and rain water		22.7	16.7	-	13.1
	Total		100	100	100	100
Availability of Water constraint during dry season		Yes	63.6	91.7	81.8	79.0
		No	36.4	8.3	18.2	21.0
		Total	100	100	100	100
Means of over-coming water shortage	Travel long distance to the river with their livestock		63.6	91.7	81.8	79
	Harvesting water from different sources		63.6	91.7	81.8	79.0
Distance to water sources from home (km)			1.3 ±.2	1.6 ±.11	1.3 ±.14	1.4 ±.09
Frequency of watering per day	Dry season	Once a day	-	2.8	5.5	2.8
		Twice a day	100	97.2	94.5	97.2
	Wet season	Once a day	100	100	100	100

4.5.3. Sheep and goat Housing System

Housing system of sheep and goat was summarized inTable 18. Hundred percent of respondents were experienced on sheep and goat housing system in study area.Farmers in the study area use different types of sheep and goat houses. Sheltering sheep and goat with other livestock in the houses constructed attached to the main house is predominant in the area (57.2%) followed by sheltering sheep and goat in the main house with other livestock and family members (23.5%) and 19.3 percent of the respondents shelter their sheep and goat in separate house alone in the study district.Sheltering sheep, goat and other livestock with family members may create different health problem to members of family due to problem zoonotic disease, west and bad odor of the excreta. This result was comparable with Tsedeke (2007), who reported that 98.6% of the respondents confine their sheep and goat flock in the main house with family members while 0.7% of the respondents confine their sheep and goat in separate house in in Alaba, Southern Ethiopia. the current result disagreed with report of Alubel (2015) who reported that the majority (83.82%) offarmers confine their goats without roof while small proportion (18.18%) of farmer confine their goats in family house Ziquala district. Hundie and Geleta, (2015)also reported that majority (83.33%) offarmers shelters their sheep in separate house while small amount (16.67%) producers shelter their sheep in family house in Horro Guduru and East Wollega zones, West Ethiopia. on other hand, the current finding werelower than the report of Yadeta (2016) who reported that 39.4% of farmer confine sheep and goat in family house while 29.4% of farmers confine their sheep and goat in separate house in Ada Barga and Ejere districts of West Shoa Zone, Ethiopia

Hundred percent of the respondents confirmed that the main reason for housing sheep and goatwere to provide night shelter, protect from cold weather, hot weather, predator and theft in study area(Table.18). This result was comparable with Belete *et al,* (2015) who reported that housing is required to protect animals from extreme temperature, disease,predator, theft and to make management easier and to provide opportunity for intensive feeding and controlled breeding in Bale zone , Oromia , Ethiopia. Also Belete (2009) and Sisay and Kefeyalewu, (2015) who reported that Housing is required to protect sheep and goat from predators, adverse climatic condition and to provide supplement in the evening in Gome district, Jimma Zone Oromia , Ethiopia and in Degahabur zone, Eastern Ethiopia, respectively.Also Hundie and Geleta (2015) reported thatthe respondents shelter their sheep during night time throughout the year to protect them from cold, rain ,predators and theft in Horro Guduru and Eastern Wollega Zones west Ethiopia

Lambs and kids are kept around the homestead until two orthree weeks with their dam to avoid walking long distances in search of feed and water and to minimize exposure to predators. Cleaning of sheep and goat houses was common practice in the study area. The frequency of cleaning house was 82.3% of the respondents once in day while 17.7% of respondents twice in a day in district. This current result was comparable with Yenesewu *et.al*(2013) who reported that the majority (78%) of respondents clean their sheep house once in a dayin Burie district, NorthWestern Ethiopia.

Table 18.Housing, reason of housing, cleaning and cleaning frequency of house of small ruminant

variables		Agro ecology			
		HL (n=22)	ML (n=72)	LL (n=44)	Overall (N=138)
Experience of housing	Yes	100	100	100	100
	No	-	-	-	-
	total	100	100	100	100
Do you have separate House	Yes	27.3	30.6	-	19.3
	No	72.7	69.4	100	80.7
	total	100	100	100	100
Reason of housing small ruminants (%)					
Provide night shelter		100	100	100	100
Protect from cold weather		100	100	100	100
Protect from hot weather		100	100	100	100
Prevent from predator		100	100	100	100
Prevent from theft		100	100	100	100
Total		100	100	100	100
Types of house (%)					
House attached to main house		54.5	30.9	86.4	57.2
Family house or main house		18.2	38.9	13.6	23.5
Separate house		27.3	30.6	-	19.3
total		100	100	100	100
Experience of cleaning house	Yes	100	100	100	100
	No	-	-	-	-
	Total	100	100	100	100
Cleaning frequency per day	Once	79.8	80.6	86.4	82.3
	twice	20.2	19.4	13.6	17.7
	total	100	100	100	100

HL=highland, ML=midland, LL=lowland, n=sample population, N=total population

Figure 4. Main or family house Figure 5. House attached to main or family house

4.5.4. Breeding and selection of sheep and goat inthestudy area

4.5.4.1.Breeds and Breeding system of Sheep and Goat

Hundred percent of the respondents owned indigenous breeds of sheep and goat in the study area. 100% of the respondents were practiced natural breeding system with no significant difference between all agro ecologies of the study area. 5.7% of respondent practiced selection of ram and buck for breeding who mate their ewe and doe by selecting better performing rams and bucksand 94.3% of the respondents use simply uncontrolled mating system of ewe and doe either in private or communal grazing area. But when the estrus sign of ewe and doe were seen by owners before when females and males are allowed to run together with free movement on pasture(uncontrolled mating),98.5% of respondents of sheep and goat owners practiced selection criteria of rams or bucks for breeding who mate their ewe and doe by selecting superior rams and bucks to mate their ewe and doe and 1.5%of sheep and goat owners was not practiced selection of rams or bucks for breeding, they simply use uncontrolled mating system in communal or private grazing land during the time when females and males are allowed to run together with free movement on pasture.

One hundred percent of the respondents were experienced on selection of sheep and Goat for production based on trait preferences. On average 100, 98.5, 92.4 and 74.16% of the respondents select their sheep and goat for production based body conformation, coat color, meat production potentialand behavior respectively in the study area. Majority of respondents were select sheep and goat for production based oncoat color, body conformation and meat production potential and small amount of respondents select based on behavior in study area.

Table 19.Breeding system and Selection criteria for Sheep and Goat production in study area

Variables		Agro- ecology			
		HL (n=22)	ML (n=74)	LL (n=44)	Overall(n=138)
Breeding system (%)					
Natural breeding		100	100	100	100
Selection of ram or buck for mating					
Estrus sign of ewe or doe were not seen before release into communal or private grazing area	yes	7.25	6.75	3.125	5.7
	no	92.75	93.25	96.875	94.3
	total	100	100	100	100
Estrus sign of ewe or doe were seen before release into communal or private grazing area	yes	100	100	95.5	98.5
	no	-	-	4.5	1.5
	total	100	100	100	100
Experience of selection (%)	yes	100	100	100	100
Parameters of selection of sheep and goat for breeding and production purpose (%)					
Coat color		100	100	95.5	98.5
Body conformation		100	100	100	100
Meat production potential		100	100	77.3	92.4
Behavior(temperament)		95.5	86.1	40.9	74.16

HL=highland, ML=midland, LL=lowland, n=sample population, N=total population

4.5.5. Weaning, Castration and Culling of Sheep and Goat

4.5.5.1.Weaningand Castration of sheep and goat

Weaning and castration practice in Esera district shown in Table20. About 88 % of respondents practiced weaning of lambs or kids while 12 % of respondents were not practiced weaning of lambs and kids before marketing age or before puberty in study area. The overall average age of weaning of lambs and kids was 3.55±0.088 months in study area. The average age of weaning of lams and kids was significantly (P<0.01) lower in ML (2.72±0.18 months) than HL (3.68±0.351) and LL(3.55±0.088). This difference might be due to the difference in management activity and objective of weaning for sheepand goat owner inthe study area.

According to focus group discussion and respondents the main reasons for castration of rams and bucks were to fatten and to avoid mating of the same flock. About 40.9, 25and 4.5% of households from HL, ML and LL areas castrate their rams and bucks before market in order to fetch higher prices after fattening, respectively.About 59.1, 75and 95.5%of households from HL, ML and LLareas castrate their rams and bucks before marketing in order to fetch higher prices after fattening and to avoid mating of the same flock respectively in study district. About 51.4% of the respondent perform castration in veterinary clinics by using burdizo, 14% perform castration only by local methods by using stone and stick while 34.6% of the respondent use both local method and burdizo for castration of their ram or buck in study district. In this finding the usageof Burdizo was lower and the usage of local method was higher than Dhaba*et.al*(2012) who reported 91.1 % and 8.9% of respondent performed castration at veterinary clinics by using Burdizo and local method respectively in Illu Abba Bora Zone of Oromia region.

The overall average age of castration of rams and bucks were 7.2101±0.084 months and 7.2319±0.084 months, respectively. The average age of castration of ram and bucks was significantly higher ($p<0.01$) in HL aged (8.04 ±0.25 and 8.18 ±0.23) months than ML (7.08±0.10 and 7.08 ±0.10) and LL (7.0 ±0.13 and 7.0±0.13) months,respectively, But the average age of castration of both rams and bucks in ML and LL agro ecology were similar in study area. This finding was lower than Tsedeke(2007) who reported the average age of castration for ram and bucks were 1.1 year and 1.6 year respectively in Alaba Southern Ethiopia,Belete (2009), also reported that the average age castration was 12.2±0.3 for ram and 12.8±0.4 months for bucks in Goma district of Jimma zone, western Ethiopia and Dhaba*et al*.(2012), who reported the average castration age of both ram and bucks were 13 % of respondent (6-12 months), 69% of respondent (12-18 months) and 18 of respondent (>24 months) in Illu Abba Bora Zone of Oromia region.

Table 20.Castration and weaning practice of sheep and goat in the study area

variables		Agro ecology				
		HL (n=22)	ML (n=72)	LL (n=44)	Overall (N=138)	p-value
Do you practice weaning of lambs or kids	Yes	86.4	77.8	100	88.0	
	No	13.6	22.2	-	12.0	
Average age of weaning in Months (M+SE)						
Lamb		3.68±0.351	2.72±0.18	3.55±0.088	3.15±0.119	0.001
Kid		3.68±0.351	2.72±0.18	3.55±0.088	3.15±0.119	0.001
Do you practice castration of Rams Or Bucks (%)						
Yes		100	100	100	100	
Method of castration (%)						
Local method		13.6	12.5	15.9	14.0	
Burdizo		59.1	54.2	40.9	51.4	
Local method and burdiz		27.3	33.3	43.5	34.6	
Total		100	100	100	100	
Average age of castration in months(M+SE)						
Ram		8.04^{b} ±0.258	7.08^{a}±0.10	7.0^{a} ±0.134	7.21±0.084	0.001
Buck		8.18^{b} ±0.233	7.08^{a} ±0.10	7.0^{a} ±0.134	7.23±0.084	0.001
Reason of castration (%)						
For fattening purpose		40.9	25	4.5	23.5	
For fattening and avoid mating of their flock		59.1	75	95.5	76.5	
Selection criteria for castration and fattening						
Body conformation		100	100	100	100	
Physical characteristics		100	100	100	100	
Age		100	100	100	100	
total		100	100	100	100	

HL=highland, ML=midland, LL=lowland, n=sample population, N=total population

Selection of rams or bucks for castration and fattening were shown in Table 21. All of respondents select rams and bucks for castration and fattening based on combination of conformation, physical characteristic and age of rams and bucks in study district. The primary criteria used for selection of rams and bucks for castration and fattening were body conformation followed age which determine market demand and tenderness of meat respectively in study district respectively. This finding was in line with Takele *et.al*, (2006);

Belete, 2009) in Goma district of Jimma zone, western Ethiopia and Selamawit and Matiwos,(2015) in Gedio Zone, southern Ethiopia.

Table 21.Selection of Rams and bucks for castration and fattening ranked by respondents in study area

Agro ecology	Criteria of selection	Rank(n)					
		1st	2nd	3rd	F value sum	index	Rank
HL	Body conformation	11	9	6	57	0.43	1st
	Physical characteristics	-	6	9	21	0.16	3rd
	Age	11	7	7	54	0.41	2nd
ML	Body conformation	32	32	14	174	0.42	2nd
	Physical characteristics	3	21	6	57	0.14	3rd
	Age	41	23	6	175	0.44	1st
LL	Body conformation	34	12	6	132	0.5	1st
	Physical characteristics	2	12	18	48	0.18	3rd
	Age	8	20	22	86	0.32	2nd
Overall	Body conformation	77	53	26	363	0.45	1st
	Physical characteristics	5	39	33	126	0.16	3rd
	Age	60	50	35	315	0.39	2nd

Index=the sum of (3 times First order +2times second order + 1times third order) for individual variables divided by the sum of (3 times First order +2times second order + 1 times third order) for all variables.

4.5.5.2.Culling of sheep and goat for Production

Culling was used to improve the overall productivity of the flock and also the reasons for culling could be different for differentproduction system and agro-ecologies. Different reasons for culling sheep and goat are presented in Table 22.The primary and secondary reason of culling sheep and goat from the flock was due to age followed by low production potential, age followed by sickness and sickness followed by age in HL, ML and LL agro ecology of the study area respectively. In overall the primary reason of cullingsheep and goat from the flock was due to age followed by sickness or disease problem. The overallfour mainreasons for culling sheep and goat from the flock was due to age (1^{st}), sickness or disease problem (2^{nd}), Low production (3^{rd}) and lambing and kidding problem(4^{th}). However, smallnumbers of respondents culltheir sheep and goat from flock due tophysical defects and unwanted physical characteristics (black coat color in relation to market demand)in study district.This result was in line with Belete*et al*(2015) who reported that the main reason for culling sheep and goat from the flock was due to old agein Bale zone of Oromia regional state.

Table 22.Culling of sheep and goat for Production and Ranked by Respondents

Altitude	Reason of culling	Rank(n)								
		1st	2nd	3rd	4th	5th	6th	F value-sum	Index	rank
HL	Old age	11	10	1	-	-	-	120	0.26	1st
	sickness	2	2	17	1	-	-	98	0.21	3rd
	Lambing and kidding problem	1	2	1	15	2	1	74	0.16	4th
	Physical defects	-	-	-	1	4	17	28	0.06	6th
	Unwanted physical characteristics	-	-	-	3	16	3	38	0.08	5th
	Low production	8	8	3	1	-	2	105	0.23	2nd
ML	Old age	38	30	4	-	-	-	394	0.27	1st
	sickness	22	10	28	12	-	-	330	0.22	2nd
	Lambing and kidding problem	-	10	20	42	-	-	214	0.15	4th
	Physical defects	-	-	-	2	10	56	82	0.05	6th
	Unwanted physical characteristics	-	-	-	6	52	10	132	0.09	5th
	Low production	12	24	20	12	4	-	316	0.22	3rd
LL	Old age	14	12	2	14	2	-	198	0.21	2nd
	sickness	22	10	8	2	2	-	224	0.24	1st
	Lambing and kidding problem	4	16	10	14	-	-	186	0.20	3rd
	Physical defects	2	-	14	2	2	24	102	0.11	5th
	Unwanted physical characteristics	-	2	2	26	12	2	122	0.13	4th
	Low production	2	4	8	-	14	16	100	0.11	6th
Overall	Old age	63	52	7	14	2	-	712	0.25	1st
	sickness	46	22	53	14	2	-	652	0.23	2nd
	Lambing and kidding problem	5	28	31	71	2	1	474	0.17	4th
	Physical defects	2	-	14	5	16	97	212	0.07	6th
	Unwanted physical characteristics	-	2	2	35	80	15	292	0.10	5th
	Low production	22	31	31	13	18	28	521	0.18	3rd

Index=the sum of (6 times First order +5times second order + 4times third order + 3 times fourth order + 2 times fifth order+ 1 times sixth order) for individual variables divided by the sum of (6 times First order +5 times second order + 4 times third order + 3 times fourth order + 2 times fifth order+ 1times sixth order) for all variables.

4.6.Reproductive Performance of Sheep and Goat in the Study Area

The reproductive performances of sheep and goat were shown in Table 23 and 24, respectively. The overall average age at puberty for male and female sheep and goat was (6.652 and 7.290 months) and (6.638 and 6.899 months), respectively, inthe study area. This current finding was in line with the finding of Tsedeke (2007) who reportedthat the average age at puberty of sheep (6.7 months for male and 6.9 months for female) and 7 month for female goat and 6.6 month for male goat in Alaba Southern Ethiopia and the current result was lower than Markos (2000) who reported 300 days for male sheep and 12 months male goat in Awassa zuria woreda. On other hand the current finding was higher than Combellas (1980) who reported 231 days for female tropical sheep breeds and Payne and Wilson, (1999) reported tropical male goats reach sexual maturity at 132 days.

The average age at puberty of male lambs in LL was significantly ($p<0.01$) lower (6.409±0.07) than HL (6.682±0.12) and ML (6.792±0.06) months. This difference might be due to difference in management (feeding, housing, watering ;)and multiple birthsbut the average age at puberty of male lambs in HL and ML agro ecology was similar. The average age at puberty of female lambs in HL was significantly ($p<0.01$) higher (7.727±0.16month) than ML (7.278±0.06months) and LL (7.091±0.04 months) but the average age at puberty of female lambs in ML and LL agro ecology was similar.

The average age at puberty of male and female goat was significantly different ($p<0.01$) in HL (5.136±0.1 and 5.591±0.16 months), ML (4.389±0.49 and 4.444±0.05 months) and LL (3.5±0.66 and 3.5±0.66 months) respectively in the study area.

The overall average marketing age of male and female lambs and kids was 4.125±0.06, 4.228±0.81 months and 4.28±0.08, 4.326±0.07 months respectively. The average marketing age of male and female lams and kids was significantly different ($p<0.01$) in HL (5.0±0.17, 5.636±0.21, 5.136±0.16 and 5.591±0.16), ML (4.306±0.05, 4.389±0.05, 4.389±0.49 and 4.444±0.05 months) and LL (3.455±0.08, 3.455±0.08, 3.5±0.66 and 3.5±0.10 months) respectively in study district. This difference might be due to the difference in management practice (feeding, watering,housing, Health care) and prolific nature of the ewe or doe.

The overall average age at first lambing for ewe and kidding doe was 12.312±0.05 months and 12.783±0.05 months respectively. This finding was comparable with Tsedeke (2007) who reported 12.7 months for lambing and 12.1 months for kidding in Alaba Southern Ethiopia, Belete (2009)also reported 12.5±0.3 months for age at first kidding and 13±0.3 months for age at first lambing in Goma district of Jimma zone,Hailemariam *etal*, (2013) whoreported age at first lambing of indigenous sheep was12.4±0.28 months in Gamogofa Zone southern Ethiopia. The current finding was lower than FAO (2002) who reported age at first lambing ranges between 16.2 and 16.9 months and age at first kidding from 13.5 to 17.5 months in mixed farming systems of sub-Sahara African countries. Mamabolo and Webb, (2002), reported that the average age at first kidding 16 months, Selamawit and Matiwos (2015), who reported average age at first lambing of 13 month and kidding of 12.9 month in Gedio zone Southern Ethiopia.On the other hand, the current finding was higher than age at first lambing (8.4 months) of Menz sheep in Ethiopian highlands (Mukasa-Mugerwa and Kassi, 1995)

The average age at first lambingof sheep and kidding of goat in HL was significantly ($p<0.01$) higher (12.727±0.16 and 13.045±0.16) than ML (12.319±0.07 and 12.958±0.06) and LL (12.091±0.04 and 12.364±0.07) months, respectively. This difference might be due to difference in management, lengthen estruscycle and prolificacy of ewe or doe but the average age at first lambing of sheep and kidding of goat in ML and LL agro ecology was not significantly different respectively.

The overall average lambing interval of ewe and kidding interval of doe was 7.710±0.05 and 8.217±0.036 months, respectively. This finding was in line with Tsedeke (2007) who reported that the average lambing interval of 7.8 months for ewes in Alaba Southern Ethiopia, Belete(2009) who reported the average lambing and kidding interval of 8.04 months and 7.84 months for sheep and goat respectively in Goma district of Jimma zone of Oromia region, Hailemariam *et.al* (2013) who reported that the average lambing interval 7.34± 0.13 months in Gamogofa Zone southern Ethiopia, Belete*et.al*(2015) who reported average kidding interval 8.0±0.12 months for goat in Bale zone Oromia Ethiopia, Selamawit and Matiwos(2015), who reported that the average lambing and kidding interval of 8.01±0.22 month for sheep and 8.3±1.6 months for goat in Gedio Zone of Southern Ethiopia. The current finding was lower than Deribe (2009) who reported that the average lambing and kidding interval of 9.19±0.08 months for sheep and 9.05±0.08 for goat in Alaba southern Ethiopia. The average lambing interval of sheep was significantly longer ($p<0.01$) in HL than in the ML andLL. The average kidding interval of goat in HL was significantly ($p<0.01$) higher(8.5±0.127month) than ML (8.236±0.05months) and LL (8.045±0.318months) but the average kidding interval of goat in ML and LL agro ecology was not significantly different.

The overall average litter size of ewe and doe was 1.64±0.041 and 1.62±0.042, respectively, observed in the study area. This study was lower than Tsedeke (2007) who reported thatthe average liter size 1.7 and 1.75 sheep and goat respectively in Alaba southern Ethiopia, Selamawit and Matiwos (2015) who reported the average liter size 1.78±0.5and 1.7±0.63 for sheep and goat in Gedio Zone of southern Ethiopia, Endeshaw, (2007) who reported the average liter size 2.07 for goat in dale district southern Ethiopia. In contrary the current result was higher than Mukasa Mugrewa *et al*. (2002) whoreported that the litter size (1.14) for Horro sheep in western Ethiopia, Getahun (2008) reported litter size of 1.42 and 1.24 for Adilo sheep and goats, respectively, Deribe (2009)who reported litter size of 1.51±0.04 for sheep and 1.47±0.04 for goat in Alaba southern Ethiopia and Hailemariam et *al*. (2013) reported litter size (1.3±0.04) for sheep in Gamogofa Zone southern Ethiopia.

The average litter size of ewe and doe in LL was significantly ($p<0.01$) higher (1.89±0.048 months and 1.82±0.05 months) than HL (1.55±0.109 months and 1.55±0.10 months) and ML (1.51±0.503 months and 1.51±0.059 months) but the average litter size of ewe and doe in HL and ML agro ecology was similar.This difference in reproductive performance of sheep and goat might be due to difference in management (like nutrition,health care, watering)condition of study district.

Table 23.Reproductive Performance of Sheep in Study district

variables		Agro ecology				
		HL (n=22)	ML (n=72)	LL (n=44)	Overall (N=138)	P value
AFL		12.727^{b}±0.16	12.319^{a}±0.07	12.091^{a}±0.04	12.312±0.05	.001
LI		8.455^{c}±0.17	7.722^{b}±0.05	7.318^{a}±0.07	7.710±0.05	.001
MA	Male	5.0^{c}±0.17	4.306^{b}±0.05	3.455^{a}±0.08	4.125±0.06	.001
	Female	5.636^{c}±0.21	4.389^{b}±0.05	3.455^{a}±0.08	4.28±0.0811	.001
AAP	Male	6.682^{b}±0.12	6.792^{b}±0.06	6.409^{a}±0.07	6.652±0.04	.001
	Female	7.727^{b}±0.16	7.278^{a}±0.06	7.091^{a}±0.04	7.290±0.04	.001
ALS		1.55^{a}±0.109	1.51^{a}±0.503	1.89^{b}±0.048	1.64±0.041	.001

AFL=Age at first lambing, LI=lambing interval, MA=Marketing age, AAP=Age at puberty,ALS=Average litter size.HL=highland, ML=midland, LL=lowland, n=sample population, N=total population

Table 24.Reproductive Performance of Goat in Study district

variables		Agro ecology				
		Highland (n=22)	Midland (n=72)	Lowland (n=44)	Overall (N=138)	P Value
AFK		13.045^{b}±0.16	12.958^{b}±0.06	12.364^{a}±0.07	12.783±0.05	.001
KI		8.5^{b}±0.127	8.236^{a}±0.05	8.045^{a}±0.318	8.217±0.036	
MA	Male	5.136^{c}±0.16	4.389^{b}±0.49	3.5^{a}±0.66	4.228±0.81	.001
	Female	5.591^{c}±0.16	4.444^{b}±0.05	3.5^{a}±0.10	4.326±0.07	.001
AAP	Male	7.045^{c}±0.10	6.722^{b}±0.06	6.295^{a}±0.06	6.638±0.04	.001
	Female	7.409^{c}±0.10	6.986^{b}±0.06	6.50^{a}±0.07	6.899±0.05	.001
ALS		1.55^{a}±0.10	1.51^{b}±0.059	1.82^{b}±0.05	1.62±0.042	.001

AFK=Age at first kidding, KI=kidding interval, MA=Marketing age, AAP=Age at puberty, ALS=Average litter size, HL=highland, ML=midland, LL=lowland, n=sample population, N=total population

4.7.Sheep and Goat Disease Occurrence

Diseases are a major constraint to the improvement of livestock industry in the tropics as they decrease production and increase the morbidity and mortality (Mwacharo and Drucker,2005). The most commonly prevailing diseases and parasite which hinder sheep and goat production in the study area were presented in Table 25.All respondents' reported that there were the occurrence of sheep and goat disease in the study area. In current study, the major sheep and goat diseases and parasites were the occurrence of internal parasite, external parasite,Pasteurellosis, mastitis, ORF (sour mouth) and food and mouth disease with index of 0.28, 0.25, 0.22, 0.10, 0.09 and 0.06, respectively in study area.According to the economic importance the result of this study revealed that internal parasite, external parasite and Pasteurellosis disease were major problem which affect sheep and goat production. According to the current finding, about 47.1% of respondents prevent and treat disease and parasite by improving management practice, Hygiene, vaccination and treatment, 8% by improving management practice and Hygiene and 44.9 % by improving management practice, Hygiene and vaccination in the district.

Table 25.Sheep and goat Disease and parasite Ranked by Respondents in Study Area

Altitude	purpose	Rank(n)								
		1st	2nd	3rd	4th	5t	6th	F value sum	Index	rank
HL	Internal parasite	14	3	2	2	-	2	115	0.27	1st
	External parasite	6	14	1	-	-	1	111	0.26	2nd
	Pasteurellosis	2	1	7	5	3	2	68	0.16	3rd
	Mastitis	-	-	6	9	3	-	57	0.14	4th
	ORF	-	3	2	3	3	-	38	0.09	5th
	FMD	-	1	4	3	3	1	37	0.08	6th
ML	Internal parasite	52	16	2	2	-	-	406	0.30	1st
	External parasite	10	48	14	-	-	-	356	0.25	2nd
	Pasteurellosis	8	8	28	10	14	-	258	0.18	3rd
	mastitis	-	-	18	26	10	-	170	0.12	4th
	ORF	2	-	10	6	18	-	106	0.08	5th
	FMD	-	-	-	26	10	-	98	0.07	6th
LL	Internal parasite	14	26	4	-	-	-	230	0.28	1st
	Pasteurellosis	38	-	4	-	-	-	244	0.30	2nd
	External parasite	-	16	28	-	-	1	181	0.23	3rd
	ORF	-	-	2	28	-	2	94	0.12	4th
	Mastitis	-	-	-	12	2	2	42	0.05	5th
	FMD	-	-	-	-	8	2	18	0.02	6th
Overall	Internal parasite	80	45	8	3	-	2	751	0.28	1st
	External parasite	16	78	43	-	-	1	648	0.25	2nd
	Pasteurellosis	48	1	39	15	17	2	570	0.22	3rd
	Mastitis	-	-	24	47	15	2	269	0.10	4th
	ORF	2	3	14	37	21	2	238	0.09	5th
	FMD	-	1	4	29	21	3	153	0.06	6th

Index=the sum of (6 times First order +5times second order + 4times third order + 3 times fourth order + 2 times fifth order+ 1 times sixth order) for individual variables divided by the sum of (6 times First order +5 times second order + 4 times third order + 3 times fourth order + 2 times fifth order+ 1times sixth order) for all variables. HL=highland, ML=midland, LL=lowland

4.8.Constraints and Opportunities of sheep and goat production

4.8.1. Constraints of sheep and goat Production

Sheep and goat production in the study area was constrained by interlinked technical, socioeconomic and institutional constraints including lack of regular supervision of animal science expert and veterinarians.Constraints hindering performances of smallholder sheep and goat are presented in Table26.According to the respondents, about 76.9% of them reported sheep and goat constraints were disease and parasite, feed shortage and grazing land shortage, water shortage, drought and predators,8.2% disease and parasite, water shortage, drought and predators, 6.4% were disease and parasite, feed shortage and grazing land shortage, drought and predators and 8.5% were disease and parasite, drought and predators in study area. This result was similar with the findings from Alaba district of Southern Ethiopia, Ilu Abba Bora zone of Oromia Regional State, Gamogofa Zone of southern Ethiopia, Bale Zone Ethiopia and North Western Lowlands of Amhara Region, Ethiopia (Tsedeke, 2007; Tesfaye, 2009; Solomon, 2010; Dhaba, 2012; Hailemariam *et.al*, 2013; Tsegaye *et.al*, 2013; Belete et. al, 2015 and Yohannes*et.al*, 2017).

Table 26.Constraints of sheep and goat Production

Variables	Agro ecology			
	HL (n=22)	ML (n=72)	LL (n=44)	Overall (N=138)
Constraints of sheep and goat production (%)				
Disease and parasite, drought and predator	18.2	2.8	4.5	8.5
Disease and parasite, water shortage, drought and predator	4.5	11.1	9.1	8.2
Disease and parasite, feed and grazing land shortage, drought and predator	4.5	5.6	9.1	6.4
Disease and parasite, feed and grazing land shortage, Water shortage, drought and predator	72.7	80.6	77.3	76.9
Total	100	100	100	100

4.8.2. Opportunity of sheep and goat production

Despite constrains of sheep and goat production there are lots of opportunities which make the sheep and goat owner to expand sheep and goat production at large in Dawurozone generally and study district particularly. According to respondents and focus group discussion with key informants all respondents reported to expand sheep and goat production by considering opportunity of small production compared with other livestock production as well as crop production in study area. The major opportunity of sheep and goat production identified and prioritized were high market demand, requiring small space and initial capital for investment, short generation interval and multiple birth, low labour requirement and adaptation of harsh environment in study area. Respondents prioritized the major and primary opportunity of sheep and goat production was short generation interval followed by high market demand with index value of 0.26 and 0.24 respectively in study area. Short generation interval of sheep and goat were the primary opportunityconsidered by the respondents which might be due to quick turn over which was related with twinning rate of sheep and goat are advantages to enhancing household incomes which has led to diversification of agricultural activities and high market demand of sheep and goatwere the second opportunities of their production which might be due toincrease in population, urbanization and increase in household income.This current finding was in line withBelete (2009) who reported the main opportunity of small ruminant production was high turnover, low labour and small space requirement and high market demand in Goma district Jimma zone Western Ethiopia and Okpebholo and Kahan, (2007) who reported the main opportunity of goat production was high market demand, low startup cost, low labour requirement and short generation interval or prolific nature. Also Hailemariam*etal*., (2013) reported that the main opportunity of sheep production was high market demand, easy to manage and keep immediatereturn and appropriate for slaughter in Gamogofa zone southern Ethiopia.

Table 27.Opportunities of sheep and goat Production

Altitude	purpose	Rank(n)							
		1st	2nd	3rd	4th	5th	F value sum	Index	Rank
High land	HMD	4	6	4	8	-	72	0.22	4th
	RSSIC	7	2	9	4	-	78	0.23	2nd
	SGI	5	11	6	-	-	87	0.26	1st
	RLL	6	4	3	9	-	73	0.22	3rd
	AHEC	-	-	-	-	22	22	0.07	5th
Midland	HMD	36	8	12	16	-	280	0.26	2nd
	RSSIC	8	22	26	16	-	238	0.22	3rd
	SGI	18	30	22	2	-	280	0.27	1st
	RLL	10	12	12	38	-	210	0.19	4th
	AHEC	-	-	-	-	72	72	0.06	5th
Lowland	HMD	16	-	20	2	6	150	0.23	3rd
	RSSIC	18	12	6	8	-	172	0.26	2nd
	SGI	10	24	8	2	-	174	0.27	1st
	RLL	-	8	10	26	-	114	0.17	4th
	AHEC	-	-	-	-	43	43	0.07	5th
Overall	HMD	56	14	36	26	6	502	0.24	2nd
	RSSIC	33	36	41	28	-	488	0.23	3rd
	SGI	33	65	36	4	-	541	0.26	1st
	RLL	16	24	25	73	-	397	0.20	4th
	AHEC	-	-	-	-	137	137	0.07	5th

HMD=high market demand, RSSIC=require small space and initial capital, SGI=short generation interval, RLL=require low labour and AHEC=adapt harsh environmental condition.

Index=the sum of (5 times First order +4times second order + 3times third order + 2 times fourth order + 1 times fifth order) for individual variables divided by the sum of (5 times First order +4 times second order + 3 times third order + 2 times fourth order + 1 times fifth order) for all variables.

4.9.Chemical composition of majorSheep and GoatFeed Resources

The chemical composition of major natural grass species of the study area were shown in Table28.The dry matter content of *Penisetum clandustinum*indigenous grass species were 90.84±1.5, 85.01±1.5 and 81±3.7 in HL, ML and LL agro-ecology respectively with overall average dry matter content of 85.61±1.9 in the study area. This result was lower than Kasahun*et.al*, (2017) who reported that the dry matter content of natural grass species 95.129 in Dessie and Kombolcha towns of Ethiopia. Gashu *et.al*,(2017)also reported that the dry matter content of natural pasture grass species was 90.75 in Chire district Southern Ethiopia. The NDF content of *Penisetum clandustinum* indigenous natural grass were

68.10±2.3, 66.74±4.6 and 66.51±3.7 in HL, ML and LL respectively with overall average content of 67.12±1.8 in the study district.According to Van Soest (1985), NDF content above 55% was reported to limit DM intake and hence, NDF content of the *Penisetum clandustinum* in the study area could affect feed intake, which directly limits productivity of small ruminant. According Holechek(1984) grasses have lower crude protein, phosphorus, and lignin concentrations and higher total fiber and cellulose concentrations than do forbs and shrubs. The CP and ash content of *Penisetum clandustinum indigenous* grass species was (8.61±.29, 6.32±1.2 and 5.83) and (9.0±.29, 7.0±.57 and 7.33±1.33) in HL, ML and LL agro ecology respectively in the study area. This result was comparable with,Gashu *et.al*, (2017) who reported the CP and NDF content of natural pasture grass species 6.875 and 68.5 respectively in Chire district southern Ethiopia and lower than Deribe *et.al* (2013) who reported the CP and ash content of natural pasture grass 8.38 and 9.46 respectively in mixed farming system of Southern Ethiopia, Gashaw and Defar, (2017) who reported the NDF, CP and ash content of grazing land grass species were 74.537, 8.10 and 9.89 respectively in Gasera and Ginnir Districts, Bale Zone, Ethiopia.,

The CF and ADF content of *Penisetum clandustinum* indigenous grass species was 47.7±.33, 46.55±1.4 and 41.63±1.7 and 55.89±2.9, 47.26±1.7 and 46.92±1.8 in HL, ML and LL agro ecology, respectively.

The result indicated that the CF contents of*Penisetum clandustinum* indigenous grass species was significantly ($p<0.05$) higher in highland (47.7±.33) than lowland (41.63±1.7) but the CF content was not significant when midland (46.55±1.4) was comparedwith both HL and LL agro ecology in the study area. The difference in CF content might be due fertility of the soil, method of harvesting and during transportation.

Table 28.Chemical composition of natural grass species (*Penisetum clandustinum)*

Feed(S.N)	Altitude	Chemical composition							
		DM	Ash	CP	EE	CF	NDF	ADF	NFE
Penisetum	HL	90.84±1.5	9.0±.29	8.61±.29	2.46±.57	47.7[a]±.33	68.10±2.3	55.89±2.9	23.02±1.1
clandustinum	ML	85.01±1.5	7.0±.57	6.32±1.2	2.02±.47	46.55[ab]±1.4	66.74±4.6	47.26±1.7	23.10±3.0
	LL	81±3.7	7.33±1.33	5.83±.42	1.47±.09	41.63[b]±1.7	66.51±3.7	46.92±1.8	24.73±3.4
M±SE		85.61±1.9	7.77±0.54	6.9±1.7	1.98±.26	45.31±1.1	67.12±1.8	50.02±1.8	23.62±1.3
P-value		0.084	0.315	0.084	0.34	0.039	0.948	0.050	0.88

Means with the same letter within the same row are not significantly different at ($p<0.05$); DM=Dry matter, CF=Crud fiber, CP=Crud protein, EE=Ether extract, NDF=Neutral detergent fiber, ADF=Acid detergent fiber AND NFE=Nitrogen free extract, HL= highland, ML=midland, LL=lowland, ns=not significant, *=significant, M±SE= mean and standard error

The chemical composition of indigenous browse and legume treespecies wereshown in Table29.The DM content of *Aspilia massambicensis*, *Plectranthus sp*.,*Abutilon hirtum* and *Vernonia Urticifolia*were (83.05±1.8, 88.32±1.1 and 92.51±2.0), (92.64±.57, 89.00±1.1 and 88.00±1.1), (92.18±.71, 85.68±.89 and 88.93±1.1) and (92.02±.88, 91.43±1.7 and 91.57±1.1) in HL, ML and LL agro ecology, respectively. The DM content of *Plectranthus sp*. and *Abutilon hirtum*was significantly (P<0.05) higher in HL than ML and LL agro ecology but the dry matter content of *Aspilia massambicensis* was significantly (p<0.01) higher in LL agro ecology than that of HL and ML ago ecology in the study area.

The CP content of *Aspilia massambicensis* was significantly (p<0.01) different in HL, ML and LL agro ecology. The CP content of *Plectranthus sp.* was significantly (p<0.01) higher in LL than HL and ML but the CP content of *Plectranthus sp.* in HL and ML agro ecology was not significantly different in the study district. And also the CP content of *Vernonia Urticifolia* was (p<0.05) significantlyhigher in HL than ML agro ecology.The ash content of *Aspilia massambicensis* was significantly (p<0.01) higher in LL than HL agro ecologies of the study area.

The average nutritional content ofEE, CF, NDF, ADF and NFE content of *Aspilia massambicensis*, *Plectranthus sp*., *Abutilon hirtum* and *Vernonia Urticifolia* was (2.79±0.53, 2.30±0.31, 1.75±0.22 and 2.88±0.37), (40.09±0.93, 39.29±0.56, 42.8±1.09 and 40.45±1.06), (41.31±0.95, 44.76±1.3, 40.38±1.0 and 39.0±0.17), (55.62±1.3, 58.27±1.6, 54.27±1.1 and 58±1.68) and (16.59±1.0, 20.94±1.5, 19.54±1.20 and 23.39±1.68) respectively in study district.

The EE content of *Vernonia Urticifolia* was significantly (p<0.05) higher in HL (4.10±.57) than LL (2.09±.33) but EE content of *Vernonia Urticifolia* was similar in ML compared with HL and LL. Inversely, NFE content of *Vernonia Urticifolia* was significantly (p<0.01) higher in LL (26.73±1.33) than HL (17.58±1.44), but NFE content *Vernonia Urticifolia*was similar in ML compared with HL and LL ago -ecologiesof the study district.

The NDF content of *Aspilia massambicensis* was significantly (p<0.01) higher in LL (43.77±.84) than HL (38.16±.88) but similar in ML compared with both HL and LL agro ecology of the study district. The ADF content of *Plectranthus sp.* was significantly (p<0.01) lower in HL (52.27±0.88) than ML (61.48±0.57) and LL (61.06±1.7). The ADF content of

Plectranthus sp. in LL and ML was not significantly different and the NFE content of *Plectranthus sp.* was higher in HL than LL but not different in ML compared with both HL and LL agro ecology. The CF content of *Abutilon hirtum*was significantly (P<0.01) Higher in HL (46.33±1.2) than LL (39.71±1.0) but similar in ML compared with both HL and LL agro ecologies of the study district.

The overall average DM, ash, CP, EE, CF, NDF, ADF and AFE content of indigenous browse and legume tree species was 89.53±.56, 9.04±.36, 17.26±.40, 2.43±.19, 40.66±.50, 41.36±0.67, 56.54±.75 and 20.11±.78 respectively.The current finding was lower in DM and ash content and higher in CP, NDF and ADF content than Deribe *et.al*, (2013) who reported that the DM, ash, CP,NDF and ADF content of indigenous browse species 94.55±0.33, 9.68±0.77, 16.40±0.79, 33.40±1.1 and 28.87±0.80 in mixed farming system of Southern Ethiopia, respectively.

Table 29.Chemicalcomposition indigenous Browseand legume tree species

Feed(S.N)	Altitude	Chemical composition							
		DM	Ash	CP	EE	CF	NDF	ADF	NFE
Vernonia	HL	92.02±.88	6.99±.57	19.0^{a}±.92	4.10^{a}±.57	43.35±.2.6	42.04±.57	60±1.05	17.58^{b}±1.4
Urticifolia	ML	91.43±1.7	7.08±.05	17.0^{ab}±.74	2.47^{ab}±.33	39.15±.57	39.0±1.25	57. 0±4.0	25.7^{ab}±2.1
	LL	91.57±1.1	8.72±.88	15.0^{b}±.78	2.09^{b}±.33	38.87±.57	36±2.76	57.0±3.73	26.73^{a}±1.3
M±SE		91.34±.65	7.6±.41	17.0±.70	2.88±.37	40.45±1.06	39.0±1.37	58.0±1.68	23.39±1.6
P-value		0.954	0.156	0.038	0.035	0.159	0.213	0.759	0.015
significance		ns	ns	*	*	ns	Ns	ns	**
Aspilia	HL	83.05^{b}±1.8	8.89^{b}±.33	14.26^{c}±.49	4.14±1.2	39.49±1.4	38.16^{b}±.88	55.80±2.8	16.25±2.2
massambic	ML	88.32^{ab}±1.1	10.9^{ab}±.54	17.47^{b}±.61	2.32±.57	39.72±1.52	42.00^{ab}±1.1	55.84±2.4	17.88±2.2
ensis	LL	92.51^{a}±2.0	13.3^{a}±.57	20.56^{a}±.57	1.93±.28	41.05±2.03	43.77^{a}±.84	55.24±2.5	15.65±.5
M±SE		87.96±1.1	11.0±.68	17.43±.95	2.79±.53	40.09±.93	41.31±.95	55.62±1.3	16.59±1.0
P-value		0.02	0.002	0.001	0.210	0.813	0.017	0.985	0.707
significance		**	***	***	ns	ns	**	ns	ns
Plectranthu	HL	92.64^{a}±.57	11.56±1.1	15.38^{b}±.57	2.02±.40	37.62±.65	45.53±2.7	52.27^{b}±.88	26.06^{a}±1.6
s	ML	89.00^{ab}±1.1	8.66±.88	17.43^{b}±.57	2.21±.33	40.63±.57	44.16±3.1	61.48^{a}±.57	20.05^{ab}±.3
	LL	88.00^{b}±1.1	7.61±.63	21.36^{a}±1.3	2.68±.88	39.63±.88	44.58±1.8	61.06^{a}±1.7	16.70^{b}±2.0
M±SE		89.88±.86	9.2±.74	18.05±.98	2.30±.31	39.29±.56	44.76±1.3	58.27±1.6	20.94±1.5
P-value		0.037	0.053	0.009	0.73	0.062	0.933	0.002	0.013
significance		*	ns	***	ns	ns	Ns	***	**
Abutilon	HL	92.18^{a}±.71	8.59±.57	17.22±1.4	2.11±.57	46.33^{a}±1.2	42.95±2.1	56.02±2.0	17.92^{ab} ±0.91
hirtum	ML	85.68^{b}±.89	8.0±1.2	16.44±1.0	1.6±.30	42.43^{ab}±.88	40.13±1.7	52.88±1.5	17.19^{b}±1.23
	LL	88.93^{ab}±1.1	8.12±.88	16.04±.66	1.53±.29	39.71^{b}±1.0	38.08±.57	53.9±2.6	23.51^{a}±1.8
M±SE		88.93±1.1	8.24±.46	16.57±.57	1.75±.22	42.82±1.09	40.38±1.0	54.27±1.1	19.54±1.20
P-value		0.008	0.896	0.749	0.591	0.01	0.194	0.593	0.03
significance		**	ns	ns	ns	**	Ns	ns	*
Overall Mean ± SE		89.53±.56	9.04±.36	17.26±.40	2.43±.19	40.66±.50	41.36±0.67	56.54±.75	20.11±.78

Means with the same letter within the same row are not significantly different at (p<0.05); DM=Dry matter, CF=Crud fiber, CP=Crud protein, EE=Ether extract, NDF=Neutral detergent fiber, ADF=Acid detergent fiber AND NFE=Nitrogen free extract, HL= highland, ML=midland, LL=lowland, ns=not significant, *=significant, ***=highly significant M±SE= mean and standard error.

5. CONCLUSION AND RECOMMENDATION

5.1.Summary and Conclusion

This study was assessed sheep and goat management practices(housing, feeding, watering, health care, breeding, culling, weaning, castration;), reproduction performance, feed resources and feeding system, constraints and opportunities for sheep and goat production. The result of this study demonstrated that, sheep and goat production system and chemical composition of different feed resources were affected by agro ecology in study district. The result showed that average flock size per household of sheep and goat were6.08±0.183 and 5.69±0.236, respectively.

Livestock production system in the study area in general and small ruminant production system in particular was more of extensive production system and natural mating was a common breed practice and less breed and breeding system to improve the production and productivity. The major feed resources used to feed sheep and goat species were natural pasture, river and road side, and crop aftermath, but the higher proportion of feed was derived from natural pasture both in dry and wet season of the year. There were shortage of feed resource both in dry season and wet season of the year by either decreasing the productivity of grazing land and expansion of crop cultivation on different grazing area. Indigenous Browse and legume tree species are good in nutritive content in addition to their locally availability and their cheapness. The main water source for sheep and goat was river, tap, rain water and water harvested from river and spring water in the study area.Reproductive performance like Age at first lambing/kidding, lambing/kidding interval andlitter size of female sheep and goat and marketing age and age at puberty of both female and male sheep and goat determines production potential and productivity and prerequisite for any successful livestock production.

In the study area, sheep and goat plays a significant role for small holderfarmers through income generation, insurance, source of manure, meat production for home consumption and wealth, however sheep and goat production was constrained by disease and parasite, shortage of feed and grazing land, water shortage, drought and predatorwhile merited by having short generation interval, high market demand, require small space and investment capital, require less labour and adapt harsh environmental condition.

5.2.Recommendation

Government should provide strong extension services and training on sheep and goat production system, husbandry practices and potentials of existing breed for sheep and goat production is necessary in order to improve the production capacity and productivity of sheep and goat and to enhance income of smallholder society.

The sheep and goat breeds in the study area were not known, therefore, phenotypic characterization of existing breeds to ascertain the different traits that will give better performance which will help in developing future intervention areas.

Farmers should collect available feed resourcesand enriched their feed bunk before the feed scarcity with strong extension service and should have to use indigenous browse and legume tree species widely as feed resources and supplementary feed Source to improve the level of production

Farmers should be encouraged to cultivate improved forages through provision of planting materials and forage seeds to alleviate shortage of feed problem

Farmers should separate the house of theirlivestock from family house to reduce the problem of occurrence of zoonotic disease and to provide favorable condition for family members.

6. REFERENCES

Abate, T. Mohamed-S, M.A. Tekalign, M. Alemu, T. and Miressa, D. 1993. Grain, Fodder and Residue Management. In Improved management of Vertisols for sustainable crop - livestock production in the Ethiopian highlands: Synthesis report 1986-92. Technical Committee of the Joint Vertisols Project, Addis Ababa, Ethiopia, pp. 103-137.

Abebe, M. Oosting, J. Fernandez-Rivera, S. Van der Zijpp, J. 2008. Multipurpose fodder trees in the Ethiopian highlands: Farmers' preference and relationship of indigenous knowledge of feed value with laboratory indicators. Agri. Syst. 96: 184- 194.

Abera, M. Tolera, A. and Assefa, G. 2014. Feed resource assessment and utilization in Baresa watershed, Ethiopia. *Int. J. Sci. Res*, *3*(2), pp.66-72

Abule G.E., 2003. *Rangeland evaluation in relation to pastoralist's perceptions in the middle Awash valley of Ethiopia* (Doctoral dissertation, University of the Free State).

Abule, E.1998. Role and decision making power of women in livestock production around Adami Tulu. In6th ESAP Proceedings, Addis Ababa, Ethiopia, August 14-15, 1998. **Pp.** 95-102

Adane, K. and Birhan, T.2005. Effect of harvesting frequency and nutrient levels on natural pasture in the central highlands of Ethiopia.*Tropical science*, *45*(2), pp.77-82.

Adane, Y. and Girma, A. 2008).Economic significance of sheep and goats. In Sheep and Goat, Production Handbook for Ethiopia. ESGPIP, Addis Ababa, Ethiopia. Pp**.** 2-4

Ademosun, A.A. Bosman, H.G. and Jansen, H.J. 1988. Nutritional studies with West African Dwarf Goats in the humid tropics. Proc. Goat production in the Humid Tropics- (Eds. Smith, O.B. and Bosman H. G.)PudocWageningen, pp: 51-61.

Adesogan, T. Sollenberger, E. Newman, C. and Vendramini, B. 2012.Factors Affecting Forage Quality.

Adugna, T. 2007. Feed resources for producing export quality meat and livestock in Ethiopia (Examples from selected Weredas in Oromia and SNNP regional states

Adugna, T. 2008. Feed resources and feeding management: a manual for feed- lot operators and development workers. Ethiopian Sanitary &Phytosanitary Standards and Livestock & Meat marketing Program (SPS-LMM) Texa Agricultural Experiment Station (TAES)/Texas A&M University System, Addis Ababa

Alemayehu, M. 2002. Forage Production in Ethiopia: A case study with implications for livestock production, Ethiopian Society of Animal Production (ESAP), Addis Ababa, Ethiopia, p106.

Alemayehu, M. 2004. Rangelands Biodiversity: Concepts, Approaches, and the Way Forward. Addis Ababa, Ethiopia

Alemayehu M (2006). Country Pasture/Forage Resource Profiles: Ethiopia.

Alemu, Y. Zinash, S. and Seyoum, B. 1991. The Potential of Crop Residues and Agro-Industrial By-Products as Animal feed. In: proceedings of ESAP, 3rd National Improvement Conference. 24-26 May 1989. IAR, Addis Ababa, Ethiopia.Pp: 57-63.

Alubel, A. 2015. On-farm Phenotypic Characterization and Performance Evaluation of Abergelle and Central highland goat breeds as an input for designing community-based breeding program. Accept for award of M.Sc (Animal Genetic and breeding), Haramaya University, Haramaya, Ethiopia, 2014 pp 147,

Ameha, S. 2011. Export requirements for meat and live small ruminants. AlemuYami, R.C. Merkel and T. A.Gipson **(**eds). In 47th technical bulletin. March, Addis Ababa, Ethiopia. Pp. 2-3

Ameha, S. 2011. Export requirements for meat and live small ruminants: How can development agents assist producers to improve small ruminant export? Techn.*Bull*, (47).

Andualem, T. Berhan, T. Gebeyehu, G. and Ermias, B. 2015. Characterization of cattle husbandry practices in Essera *Woreda*, Dawuro Zone, and Southern Ethiopia. College of Veterinary Medicine and Agriculture, Addis Ababa University, Ethiopia.

Arse, G. Feyisa, H. Gurmessa, U. Merga, M. and Girma, D. 2013. Assessment on Challenges and Opportunities of Goat Farming System in Adami Tulu, ArsiNegelle and Fantale Districts of Oromia Regional State, Ethiopia. African Journal of Agricultural Research , 8, 26-31.

Asfaw, N. and Jabbar, M. 2008. Livestock ownership, commercial off-take rates and their determinants in Ethiopia.Research Report 9. International Livestock Research Institute (ILRI), Nairobi, Kenya.

Asrat, A. Zelalem,Y. and Ajebu,, N.,2013. Characterization of milk production systems in and around Boditti, South Ethiopia."*Development* 25 (2013): 10

Assen, E. and Aklilu, H. 2012. Sheep and goat production and utilization in different agro-ecological zones in Tigray, Ethiopia.Livestock Research for Rural Development. Volume24,Article#16. http://www.lrrd.org/lrrd24/1/asse24016.htm

Azage, T. Berhanu, G. Dirk, H. Berhanu, B. and Yoseph, M. 2013. Smallholder dairy production and marketing systems in Ethiopia: IPMS experiences and opportunities for market-oriented development, Improving Productivity and Market Success of Ethiopian Farmers Project (IPMS) International Livestock Research Institute (ILRI), Addis Ababa, Ethiopia Pp: 14-15, 17 and 22.

Banerjee, A.K. Animut, G. and Ermias, E. 2000.Selection and breeding strategies for increased productivity of goats in Ethiopia. In: Merkel, R.C., Abebe, G. and Goetsch, A.L. (Eds.), The opportunities and challenges of enhancing goat production in East Africa, pp. 70-79. Debub University, Awassa, Ethiopia, 10-12 November, 2000.

Behnke, R.H. 2010. The contribution of livestock to the economies of IGAD member states: study findings, application of the methodology in Ethiopia and recommendations for further work.

Belachew, H. and Jemberu, E. 2003.Challenges and opportunities of livestock marketing in Ethiopia.YilmaJobre and GetachewGebru (eds). In 10thproceeding of ESAP, August 22-24, Addis Ababa, Ethiopia.**Pp.** 4-6

Belay, B. and Aynalem, H. 2009. Reproductive performance of traditionally managed sheep in the south western part of Ethiopia.*Livestock Research for Rural Development.Volume 21, Article #154.*

Belay, D. Azage, T. and Hegde, B. P. 2012. Smallholder Livestock Production System in Dandi District, Oromia Regional State, Central Ethiopia. Global Veterinarian 8(5):472-479, 2012 ISSN 1992-6197. IDOSI Publications, 2012

Belete, A. Kefelegn, K. and Kefene, E. 2015. Assessment of production and reproduction system of indigenous goat types in Bale Zone, Oromia, Ethiopia. *Academia Journal of Agricultural Research*, *3*(12), pp.348-360

Belete, S. 2009: Production and marketing systems of small ruminants in Goma district of Jimma zone, western Ethiopia. MSc. Thesis.Hawassa University, April, Awassa, Ethiopia. Pp. 38-54.

Berhanu, G. Hoekstra, D. and Azage, T.2006. Improving the Competitiveness of Agricultural input Markets in Ethiopia: International Association of Agricultural Economics (IAAE), August 12 – 18, 2006, Gold Coast, Australia

Byaruhanga, C. Oluka, J. and Olinga, S. 2015. Socio-Economic Aspects of Goat Production in a Rural Agro-Pastoral System of Uganda. Universal Journal of Agricultural Research, 3, 203-210. https://doi.org/10.13189/ujar.2015.030604

Central Statistical Agency (CSA, 2010). Agricultural Sample Survey, 2009/10 (2002EC), Report on Crop and Livestock Product Utilization, Statistical Bulletin 468.FDRE: Addis Ababa

Central Statistics Agency (CSA, 2017). Agricultural sample survey. Livestock and livestock characteristic report (Private Peasant Holdings**)**. April, Addis Ababa, Ethiopia.

Cochran, W.G.1977. *Sampling techniques, 3rd Edition*. John Wiley &Sons, New York.

Combellas, J.D. 1980.Production and reproduction parameters of tropical sheep breeds in improved production systems.*Tropical Animal Production*, *5*(3), pp.266-272

CTA. 2007. The ACP-EU Technical Centre for Agricultural and Rural Cooperation CTA Practical Guide Series, No. 1. Wageningen.Netherlands,pp: 1873-8206

Dawit, A. and Ajebu, N. 2013. Assessment of feed resource availability and livestock production constraints in selected Kebeles of Adami TulluJiddo Kombolcha District, Ethiopia. *African Journal of Agricultural Research*, *8*(29), pp.4067-4073

Deribe, G. 2009. *On-farm performance evaluation of indigenous sheep and goats in Alaba, southern Ethiopia* (Doctoral dissertation, Hawassa University)

Deribe, G. Abubeker, H. Tsedeke, K. Tekleyohannes, B. Zekarias, .and Addisu. 2013. Chemical composition and digestibility of major feed resources in mixed farming system of southern Ethiopia. World Applied Sciences Journal, 26(2), pp.267-275.

Devendra, C. 1986. Feeding systems and nutrition of goats and sheep in the tropics.In Improvement of small ruminants in Eastern and Southern Africa.(Eds. Adeniji K.O. and Kategile J.A.) OAU/STRC/IBAR, NAa.rnbi Kenya, pp: 91-109.

Dhaba, U.Belay, D. Solomon, D. and Taye, T. 2012. Sheep and goat production systems in Ilu Abba Bora zone of Oromia Regional State, Ethiopia: Feeding and management strategies. *Global Veterinaria*, *9*(4), pp.421-429.

Dirsha, M. W. Ashenaf, M. W. and Gebeyehu, G. N. 2018. Feed resources assessment, laboratory evaluation of chemical composition of feeds and livestock feed balance in enset (Ensete ventricosum)-based mixed production systems of Gurage zone, southern Ethiopia. International Journal of Livestock Production, 9(6), 112-130.

Duressa, D. Kenea, D. Keba, W. Desta, Z. Berki, G. Leta, G. and Tolera, A. 2014. Assessment of livestock production system and feed resources availability in three villages of Diga district Ethiopia. ILRI: Addis Ababa, Ethiopia.

Emana, M. Ashenafi, M. and Getahun, A. 2017.Nutritional Characterization of Selected Fodder Species in Abol and Lare Districts of Gambella Region, Ethiopia.*J Nutr Food Sci*, *7*(581), p.2.

Endalew, B. and Ayalew, Z. 2016. Assessment of the Role of Livestock in Ethiopia: A Review. Am. Eur. J. Sci. Res. 11(5):405-410.

Endeshaw, A. 2007.Assessment on production system and marketing of goats at Dale district (Sidama Zone). MSc Thesis ,Hawassa University, Awassa, Ethiopia.

Ermias, B. 2014. On- farm performance evaluation of dorper sheep breed crosses in Wolaita and Siltie zones, southern Ethiopia

Ethiopian Agricultural Research Institutes (EARO), (2000): National Small Ruminants Research Strategy Document. EARO, Addis Ababa, Ethiopia.

EWFEDO (Esera woreda finance and economic development office). 2018. Official document and annual report of finance and economic development Unpublished. Balle, SNNPR, Ethiopia.

EWLFDO (Esera Woreda livestock and fishery development Office). 2018.Official Document on Livestock and fishery resource Unpublished. Balle, SNNPR, Ethiopia

FAO (Food and Agriculture Organization of the United Nations). 2002. *Cattle and Small Ruminant Production Systems in sub-Saharan Africa - A Systematic Review*. Otte, M.J. and Chilonda, P. (eds). Livestock Information Sector Analysis and Policy Branch. FAO,Rome, Italy

FAO, 2012.Phenotypic Characterization of Animal Genetic Resources.FAO Animal Production and Health Guidelines No. 11, Rome.

FAO. 2004. Livestock sector brief: Ethiopia. Food and Agricultural Organization of the United Nations.Livestock Information, sector Analysis and Policy Branch. FAO, Rome.

Fekede, F. 2013. Evaluation of feed resources and assessment of feeding management practices and productivity of dairy cattle in the central highlands of Ethiopia. PhD. Dissertations, National dairy research institute, karnal-132001 (Haryana), India.

Gashaw, M. and Defar, G. 2017. *Livestock feed resources, nutritional value and their implication on animal productivity in mixed farming system in Gasera and Ginnir Districts, Bale Zone, Ethiopia. International Journal of Livestock Production, 8(2), pp.12-23*

Gashe, A. Zewdu, T. and Kassa, A,. 2017. Feed Resources in Gozamen District, East Gojjam Zone, Amhara Region. J Environ Anal Toxicol 7: 437. doi: 10.4172/2161-0525.10004

Gashu, G. Tegene, N. and Aster, A. 2017. Assessment of Availability and Nutritive Values of Feed Resources and their Contribution to Livestock Nutrient Requirements in Chire District, Southern Ethiopia

Gelayenew, B. A. 2012. Assessment of livestock feed resources, seasonal chemical composition and in sacco dry matter degradability of major forage species in Abobo woreda, Gambella Regional State, Ethiopia. MSc Thesis, Hawassa University, Ethiopia

Getachewu, A. and Jane, W. 2014. Prospects to improve the productivity of sheep fattening in Ethiopia: Status, challenges and opportunities

Getahun, L. 2008. Productive and Economic performance of Small Ruminant production in production system of the Highlands of Ethiopia.Ph.D. dissertation.University of Hohenheim, Stuttgart-Hoheinheim, Germany.

Giridhar, K. and Samireddypalle, A. 2015.Impact of climate change on forage availability for livestock. In: Climate change Impact on livestock: adaptation and mitigation. Sejian, V,Gaughan, J., Baumgard, L., Prasad, C. S. (Eds), Springer-VerlagGMbH Publisher, New Delhi, India, pp 97-112

Girma, A. 2008.Reproduction in sheep and goats. Alemu Yami and R.C. Merkel(eds.). IN: Sheep and goat Production Hand Book for Ethiopia. Ethiopia Sheep And Goats Productivity Improvement Program (ESGPIP), Addis Ababa, Ethiopia. pp. 57-72.

Girma, A. Merkel, R. C. and Sahlu, T. 2000. Enhancing food security and income generation potential of families in Southern Ethiopia through improved goat production and extension. In proceeding of a conference.Langston Univ. da la Garza Inst. for Goat Research; Debub Univ. Awassa, Ethiopia.November 10-12, Awassa, Ethiopia.

Girma, M. Animut, G. and Assefa, G. 2015. Chemical composition and in vitro organic matter digestibility of major indigenous fodder trees and shrubs in Northeastern drylands of Ethiopia. Livestock Research for Rural Development, 27(2), p.26

Gurmesa, U. Misgana, D. Feyisa, H.andMerga, M. 2011. Participatory analysis of problems limiting goat production at selected districts of East Showa zone, Ethiopia.*African Journal of Agricultural Research*, *6*(26), pp.5701-5714.

Hagos, A. Solomon, G. and Mengistie, U. 2017. Begait goat production systems and breeding practices in Western Tigray, North Ethiopia.*Open Journal of Animal Sciences*, *7*(02), p.198

Hagos, H.Banerjee, A.K. and Mummed, Y.Y. 2018. Indigenous breeding practices and selection criteria of sheep breed in central zone of Tigray, Northern Ethiopia. *International Journal of Livestock Production*, *9*(6), pp.151-159.

Hailemariam, F. Melesse, A. and Banerjee, S. 2013. Traditional sheep production and breeding practice in Gamogofa Zone, Southern Ethiopia. *Int. J. Livestock. Prod*, *1*(3), pp.26-43.

Hailu, D. Gemeda, D. Berhanu, S. Takela, F. Mesfin, T. Tatek, W. and Tesfaye, A.T 2008. Non-genetic factors influencing post weaning growth and reproductive performance of Arsi-Bale goats. Livest.Res. Rural Dev. 20(7).

Helen, N. Yoseph, M. Solomon, A., Kefelegn, K. and sanjoy, S.K. 2015. Indigenous Sheep Production System in Eastern Ethiopia: Implications for Genetic Improvement and Sustainable Use. *American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS)*, *11*(1), pp.136-152.

Holechek, J.L. 1984. Comparative contribution of grasses, forbs, and shrubs to the nutrition of range ungulates. Rangelands, 6(6),

Hundie, D. and Gelata, G. 2015. Assessment on production situation and breeding practices of ‘Horro sheep’under traditional management in Horro Guduru and East Wollega Zones, West Ethiopia.*Global Journal of Animal Breeding and Genetics*, *3*(3), pp.146-

Hussen, M. Kechero, Y. and Molla, M. 2015. Productive and reproductive performances of ruminant livestock in Jimma Zone, Southwest Ethiopia. Journal of Reproduction and Infertility, 6 (2): 27-34.

Ibrahim, M. N. andSchiere, J. B. 1989. Feeding of urea-ammonia treated rice straw. A compilation of miscellaneous reports produced by the straw utilization project (Sir Lanka).PudocWageningen. pp. 1- 28.

Improving Productivity and Market Success (IPMS) of Ethiopian Farmers Project, 2010

Kasahun, D. 2011. Identification and nutritional value assessment of the major browse species utilized by livestock in Chilega Woreda, North Gondar.

Kassahun, A. S. Berhan, T. and Ashenafi, M. 2017.Identification of Feed Resources for Cattle Fattening and Chemical Composition Determination in Dessie and Kombolcha Towns, Ethiopia. European Scientific Journal, ESJ, 13(9).

Kenfo, H., Mekasha, Y. and Tadesse, Y., 2018. A study on sheep farming practices in relation to future production strategies in Bensa district of Southern Ethiopia. *Tropical animal health and production, 50*(4), pp.865-874.

Ketema, T.G. and Debre, Z. 2015. Seasonal dynamics in botanical composition, nutritive value of vegetation and soil nutrient status of Gambella rangelands, southwestern Ethiopia

Kosgey, I.S. 2004.*Breeding objectives and breeding strategies for small ruminants in the tropics*.

Kosgey, I.S.G.J. Rowlands , J.A.M. van Arendonk , R.L. Baker. 2008. Small ruminant production in smallholder and pastoral/extensive farming systems in Kenya. Small Ruminant Research 77:11–24, Nairobi Kenya.

Malede, B. and Takele, A. 2014. Livestock feed resources assessment, constraints and improvement strategies in Ethiopia. Middle-East Journal of Scientific Research, 21(4), pp.616-622.

Markos , T. 2006. Productivity and health of indigenous sheep breeds and crossbreds in the central Ethiopian highlands. Doctoral Thesis, Swedish University of Agricultural Sciences. Uppsala, Sweden

Markos, T. 2000. Livestock production constraints in a M2-2 sub-agro ecological zone with special reference to goat production. In: The opportunities and challenges of enhancing goat production in East Africa. Proceeding of a conference. Markel, R.C., Abebe, G. and Goetsch, A.L. (eds.) 113-117. Langston Univ., OK (USA). E (Kika) dala Garza Inst. for Goat Research; Debub Univ. Awassa (Ethiopia).College of Agriculture, 10-12 Nov. 2000, Awassa, Ethiopia.

Mengistie, T. Belay, D. and Mussie, H.M. 2013. Reproductive performance of central highland goats under traditional management in Sekota District, Ethiopia.*Asian J. Biol. Sci*, *6*(6), pp.271-276.

Mengistu, A. 2006.Country Pasture/Forage Resource Profiles.*Ethiopia View Article PubMed/NCBI Google Schola*

Merkel, R.C. and Alemu,Y.,2008. *Sheep and Goat Production Handbook for Ethiopia*

Metaferia, F. Cherenet, T. Gelan, A. Abnet, F. Tesfay, A. Ali, J.A. and Gulilat, W. 2011. A Review to Improve Estimation of Livestock Contribution to the National GDP.Ministry of Finance and Economic Development and Ministry of Agriculture. Ethiopia: Addia Ababa;

Mukasa-Mugerwa, E. and Lahlou-Kassi, A. 1995.Reproductive performance and productivity of Menz sheep in the Ethiopian highlands.*Small Ruminant Research*, *17*(2), pp.167-177.

Mukasa-Mugerwa, E. Anindo, D. Sovani, S.Lahlou-Kassi, A. Tembely, S.Rege, J.E.O. and Baker, R.L. 2002.Reproductive performance and productivity of Menz and Horro sheep lambing in the wet and dry seasons in the highlands of Ethiopia.*Small Ruminant Research*, *45*(3), pp.261-271.

Mulugeta A (2005). Characterization of Dairy Production Systems of Yerer watershed in Ada LibenWoreda,Oromia Region, Ethiopia. An MSc,Thesis Presented to the School of Graduate Studies of AlemayaUniversity, Alemaya University. 140 p.

Mwacharo, J.M. and Drucker, A.G. 2005. Production Objectives and Management Strategies of Livestock-Keepers in South-East Kenya: Implications for a Breeding Programme.TropicalAnimalHealthandProduction,37,635652.http://www.ncbi.nlm.nih.gov/pubmed/16619880 https://doi.org/10.1007/s11250-005-4253-8

Okpebholo, F. and Kahan, T. 2007.Opportunities and Challenges for Developing Small Ruminant Production Systems. Cooperative Extension Program, College of Engineering Sciences, Technology and Agriculture, Florida A&M University, Tallahassee, Florida.*The Caprine Chronicle*,22: 1-4.open access environments of Sub-Saharan Africa.

Samuel, M.A. 2014. Livestock feeds and feeding system in enset (Ensete ventricosum) dominated mixed farming system of southern Ethiopia. *Online Journal of Animal and Feed Research*, *4*(6), pp.150-158

Seid, G. and Berhan, T. 2014. Assessment of Cattle Husbandry Practices in Burji Woreda, Segen Zuria Zone of SNNPRS, Ethiopia.*Int. J. Technol. Enh. Emer. Eng. Res*, *2*(4), pp.11-26

Selamawit, D. and Matiwos, H. 2015. Sheep and goat production practice in agroforestry systems of Gedio Zone, Ethiopia. *International Journal of Environment*, *4*(2), pp.296-307.

Semakula, J. Mutetikka, D. Kugonza, R.D. and Mpairwe, D. 2010. Smallholder Goat Breeding Systems in Humid, Sub Humid and Semi Arid Agro-EcologicalZones in Uganda. Global Veterinaria , 4, 283-291

Sepulveda,W. S. Maza, M. T. and Pardos, L. 2011. Aspects of quality related to the consumption and production of lamb meat. Consumers versus producers. Meat Science, 87, 366–372.

Shewangzaw, A. and Adis, K. 2016. Sheep Production and Marketing System in North Gondar Zone of Amhara Region, Ethiopia University of Gondar, Faculty of Veterinary Medicine, P.O.Box, 196, Ethiopia.

Siegmund-Schultze, M. Legesse, G. Abebe, G.andZárate, A.V. 2009. Bottleneck analysis of sheep production systems in southern Ethiopia: Comparison of reproductive and growth parameters. *Options Méditerranéennes*, *91*, pp.67-69.

Sileshi, Z. and Desalegn, L. 2008. Sheep and Goat flock health. In Sheep and Goat Production Handbook for Ethiopia.ESGPIP.**Pp** 213-272.

Sisay, F and Kefyalew, G. 2015. Sheep and goat production systems in Degehabur Zone, Eastern Ethiopia: challenge and opportunities. *Advances in Dairy Research*, pp.1-9.

Sisay, T. Pravee, V. Pornsri, C. and Suwapong, S. 2006. Assessment of Small Ruminant Management Practices in Jijiga and Shinille Zones of Somali Regional State, Ethiopia.*Kasetsart J.(Nat. Sci.)*, *40*, pp.98-999

Solomon, A. and Alemu, Y. 2009. Shelters and housing for sheep and goats. R.C. Merkel (eds). In 32th technical bulletin. August, Addis Ababa, Ethiopia. Pp: 1-2.

Solomon, B. 2004.Assessment of livestock production systems and feed resource base in SinanaDinsho District of Bale Highlands, Southeast Oromia.

Solomon, G. Komen, H. Hanotte, O. and van Arendonk J. 2008. Indigenous sheep resources of Ethiopia: Types, production systems and farmers preferences. Animal Genetic ResourcesInformation 43:25–40.

Solomon, G. 2010. *Sheep and goat production and marketing systems in Ethiopia: Characteristics and strategies for improvement* (Vol. 23). ILRI (aka ILCA and ILRAD).

Solomon, G. Azage, T. Berhanu, G. and Dirk, H. 2010. Sheep and goat production and marketing systems in Ethiopia: Characteristics and strategies for improvement. IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project Working Paper 23. ILRI (International Livestock Research Institute), Nairobi, Kenya. pp. 58

SPSS (2013).Statistical package software for social science (2013) version 20.00. SPSS in.c.1989-2013 USA

Takele, K. Gemeda, D. Fikru, T. Ulfina, G. and Yohannes, G.2006. Study on sexual and fattening performance of partially castrated Horro rams. *Ethiopian Journal of Animal production*, p.29.

Taye, M. Yilma, M. Mengistu, S. Abiso, T. Bassa, Z. Wolde, S. Rischkowsky, B. Dessie, T. Okeyo, M. and Haile, A. 2016. Characterization of production system and breeding practices of sheep producers in Doyogena district, Southern Ethiopia.*African Journal of Agricultural Research*, *11*(52), pp.5192-5201.

Tegene, N. Dinku, G. and Mohammed, B. 2015. Assessment of potential of natural pasture and other feed resources in sweet potato production system of Shebedino District, Sidama Zone, SNNPRS, Ethiopia. *International Journal of Livestock Production*, *6*(8), pp.91-98.

Teka, H.Madakadze I.C. Angassa, A. and Hassen, A.2012. Effect of Seasonal Variation on the Nutritional Quality of Key Herbaceous Species in Semi-arid Areas of Borana, Ethiopia.*Indian Journal of Animal Nutrition*, **29** (4): 324-332.

Tesfaye, D. 2008. *Assessment of feed resources and rangeland condition in Metema district of north Gondar zone, Ethiopia* (Doctoral dissertation, Haramaya University)

Tesfaye, K. Madsen J.O. and Azage T., 2004. Manure Production, Handling and Use around Holetta Agricultural Research Center. In Proceedings of the 13th annual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia.

Tesfaye, T. 2009. *Characterization of goat production systems and on-farm evaluation of the growth performance of grazing goats supplemented with different protein sources in Metema Woreda, Amhara Region, Ethiopia* (Doctoral dissertation, Haramaya University).

Tsedeke, K. 2007. Production and marketing system of sheep and goats in Alaba, Southern Ethiopia.MS.c. Thesis, Hawassa University, Awassa, Ethiopia

Tsegaye, D. Berhanu, B. and Aynalem, H. 2013. Herd husbandry and breeding practices of goat in different agro ecologies of Western Hararghe, Ethiopia. *Ethiopian journal of animal production*, p.139

Webb, E.C. and Mamabolo, M.J. 2004. Production and reproduction characteristics of South African indigenous goats in communal farming systems.Department of Animal & Wildlife Sciences, Faculty of Natural & Agricultural Sciences, University of Pretoria, Pretoria 0002, South Africa. Peer-reviewed paper: 8th International Conference on Goats Williamson, G. and W.J.A. Payne, 1974. An Introduction to Animal Husbandry in the Tropics.Tropic Agricultural Series, Longman Group Ltd. pp. 447.

Wilson, R.T. 1989. Reproductive performance of African indigenous small ruminantsundervarious management systems: a review. Animal Reproduction Science. 20: 265-286.

Wilson, R.T. and Durkin, J.W. 1988. Small ruminant production in central Mali: reproductive performance in traditionally managed goats and sheep. Livestock Prod. Sci. 19; 523–529.

Yadeta, N.B. 2016.*Production and reproduction performances, producers' trait preferences and marketing system of small ruminants in Ada Barga and Ejere Districts of west Shoa Zone, Ethiopia* (Doctoral dissertation, Jimma University)

Yayneshet, T. 2010. Feed resources availability in Tigray region, northern Ethiopia, for production of export quality meat and livestock. *Ethiopia Sanitary &Phytosanitary Standards and Livestock & Meat Marketing Program (SPS-LMM) Report. 77pp*

Yenesewu, A.Solomon, M. Azage, T. and Firewu, T. 2013.Assessment of sheep production system in Burie District, north western Ethiopia.*Global Journal of Agricultural Research*, *1*(2), pp.29-47

Yohannes, D. Mengistu, U. Yosef, T. and Solomen, G. 2017. Sheep Production and Breeding Systems in North Western Lowlands of Amhara Region, Ethiopia: Implication for Conservation and Improvement of Gumz Sheep Breed. *Journal of Animal Sciences*, *7*, pp.179-197

Zewudu,E. Haile, A. Tibbo, M. Sharma, A.K. Sölkner, J. and Wurzinger, M. 2012. Sheep production systems and breeding practices of smallholders in western and south-western Ethiopia: Implications for designing community-based breeding strategies. *Livestock Research for Rural Development*, *24*(7).

Zinash, S. and Seyoum, B. 1991.Utilization of feed resources and feeding systems in the central zone of Ethiopia.Proceedings of the Third National livestock improvement Conference, Addis Ababa, Ethiopia. Pp:129-132

Zinash, S. Aschalew, T. Alemu, Y. and Azage, T. 2001. Status of Livestock Research and Development in the Highlands of Ethiopia. P.C.Wall (ed.). In Proceedings of Two Stockholders Workshop

7. APPENDICES

7.1.Scientific name and list of grasses, legumes and browse tree species identified as sheep and goat feeds for chemical analysis in Esera district.

Table.1. Scientific name of sheep and goat feed

Number	Vernacular Name(Dawurogna)	Scientific name	Types of forbs
1	Dogginya	Penisetum clandustinum	Grass species
2	Zammuwa	Vernonia Urticifolia	Browse &legumes
3	Kishshuwaa	Aspilia massambicensis	Browse &legumes
4	Shuyik'k'aa	Plectranthus	Browse &legumes
5	C'ayshiyaa	Ablution hirtum	Browse &legumes

7.2.Summary of Anova table

Appendix table 1. Anova table of Dry matter content of *Vernonia Urticifolia*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	0.49202222	0.24601111	0.05	0.9536
Error	6	30.85180000	5.14196667		
Corrected Total	8	31.34382222			

Appendix table 2. ANOVA table of ash content of *Vernonia Urticifolia*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	5.72526667	2.86263333	2.57	0.1563
Error	6	6.68473333	1.11412222		
Corrected Total	8	12.41000000			

Appendix table 3. Anova table of CP content of *Vernonia Urticifolia*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	24.00000000	12.00000000	5.90	0.0383
Error	6	12.20700000	2.03450000		
Corrected Total	8	36.20700000			

Appendix table 4. Anova table of CF content of *Vernonia Urticifolia*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	37.78880000	18.89440000	2.54	0.1588
Error	6	44.64000000	7.44000000		
Corrected Total	8	82.42880000			

Appendix table 5. Anova table of EE content of *Vernonia Urticifolia*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	6.81715556	3.40857778	6.14	0.0354
Error	6	3.33333333	0.55555556		
Corrected Total	8	10.15048889			

Appendix table 6. Anova table of NDF content of *Vernonia Urticifolia*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	54.7232000	27.3616000	2.02	0.2135
Error	6	81.2832000	13.5472000		
Corrected Total	8	136.0064000			

Appendix table 7. Anova table of ADF content of *Vernonia Urticifolia*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	18.0000000	9.0000000	0.29	0.7586
Error	6	186.6352000	31.1058667		
Corrected Total	8	204.6352000			

Appendix table 8. Anova table of Dry matter content *Abutilon hirtum*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	63.37502222	31.68751111	11.99	0.0080
Error	6	15.85333333	2.64222222		
Corrected Total	8	79.22835556			

Appendix table 9. Anova table of Ash content *Abutilon hirtum*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	0.56935556	0.28467778	0.11	0.8964
Error	6	15.33333333	2.55555556		
Corrected Total	8	15.90268889			

Appendix table 10. Anova table of CP content *Abutilon hirtum*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	2.15286667	1.07643333	0.30	0.7494
Error	6	21.33333333	3.55555556		
Corrected Total	8	23.48620000			

Appendix table 11. Anova table of CF content *Abutilon hirtum*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	66.55742222	33.27871111	10.33	0.0114
Error	6	19.33333333	3.22222222		
Corrected Total	8	85.89075556			

Appendix table 12. Anova table of EE content *Abutilon hirtum*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	0.58695556	0.29347778	0.58	0.5906
Error	6	3.05893333	0.50982222		
Corrected Total	8	3.64588889			

Appendix table 13. Anova table of NDF content *Abutilon hirtum*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	35.91795556	17.95897778	2.18	0.1938
Error	6	49.33333333	8.22222222		
Corrected Total	8	85.25128889			

Appendix table 14. Anova table of ADF content *Abutilon hirtum*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	15.44995556	7.72497778	0.57	0.5935
Error	6	81.33333333	13.55555556		
Corrected Total	8	96.78328889			

Appendix table 15.Anova table of DM *content Plectranthus*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	35.77920000	17.88960000	5.96	0.0375
Error	6	18.00000000	3.00000000		
Corrected Total	8	53.77920000			

Appendix table 16. Anova table of Ash content of *Plectranthus*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	25.05706667	12.52853333	4.98	0.0531
Error	6	15.09333333	2.51555556		
Corrected Total	8	40.15040000			

Appendix table 17. Anova table of CP content of *Plectranthus*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	55.54002222	27.77001111	11.36	0.0091
Error	6	14.66666667	2.44444444		
Corrected Total	8	70.20668889			

Appendix table 18. Anova table of CF content of *Plectranthus*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	14.10695556	7.05347778	4.58	0.0620
Error	6	9.24326667	1.54054444		
Corrected Total	8	23.35022222			

Appendix table 19. Anova table of EE content of *Plectranthus*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	0.69646667	0.34823333	0.33	0.7302
Error	6	6.30373333	1.05062222		
Corrected Total	8	7.00020000			

Appendix table 20. Anova table of NDF content of *Plectranthus*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	2.9403556	1.4701778	0.07	0.9331
Error	6	126.0000000	21.0000000		
Corrected Total	8	128.9403556			

Appendix table 21. Anova table of ADF content of *Plectranthus*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	162.2562667	81.1281333	19.21	0.0025
Error	6	25.3333333	4.2222222		
Corrected Total	8	187.5896000			

Appendix table 22. Anova table of DM content of *Penisetum clandustinum*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	146.8704222	73.4352111	3.86	0.0836
Error	6	114.1340667	19.0223444		
Corrected Total	8	261.0044889			

Appendix table 23. Anova table of Ash content of *Penisetum clandustinum*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	6.89780000	3.44890000	1.41	0.3152
Error	6	14.69340000	2.44890000		
Corrected Total	8	21.59120000			

Appendix table 24. Anova table of CP content of *Penisetum clandustinum*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	13.16686667	6.58343333	3.85	0.0840
Error	6	10.25913333	1.70985556		
Corrected Total	8	23.42600000			

Appendix table 25. Anova table of CF content of Penisetum clandustinum

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	63.05306667	31.52653333	5.88	0.0385
Error	6	32.15473333	5.35912222		
Corrected Total	8	95.20780000			

Appendix table 26. Anova table of EE content of *Penisetum clandustinum*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	1.47775556	0.73887778	1.30	0.3401
Error	6	3.41586667	0.56931111		
Corrected Total	8	4.89362222			

Appendix table 27. Anova table of NDF content of *Penisetum clandustinum*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	4.4034667	2.2017333	0.05	0.9484
Error	6	247.3333333	41.2222222		
Corrected Total	8	251.7368000			

Appendix table 28. Anova table of ADF content of *Penisetum clandustinum*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	155.0466667	77.5233333	5.21	0.0488
Error	6	89.3333333	14.8888889		
Corrected Total	8	244.3800000			

Appendix table 29. Anova table of DM content of *Aspilia massambicensis*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	134.9044667	67.4522333	7.59	0.0227
Error	6	53.3333333	8.8888889		
Corrected Total	8	188.2378000			

Appendix table 30. Anova table of DM content of *Aspilia massambicensis*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	29.45786667	14.72893333	19.76	0.0023
Error	6	4.47193333	0.74532222		
Corrected Total	8	33.92980000			

Appendix table 31. Anova table of CP content of *Aspilia massambicensis*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	59.41548889	29.70774444	31.29	0.0007
Error	6	5.69646667	0.94941111		
Corrected Total	8	65.11195556			

Appendix table 32. Anova table of CF content of *Aspilia massambicensis*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	4.25086667	2.12543333	0.21	0.8125
Error	6	59.33333333	9.88888889		
Corrected Total	8	63.58420000			

Appendix table 33. Anova table of EE content of Aspilia massambicensis

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	8.35815556	4.17907778	2.05	0.2101
Error	6	12.25373333	2.04228889		
Corrected Total	8	20.61188889			

Appendix table 34. Anova table of NDF content of Aspilia massambicensis

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	49.27386667	24.63693333	8.73	0.0167
Error	6	16.92373333	2.82062222		
Corrected Total	8	66.19760000			

Appendix table 35. Anova table of ADF content of *Aspilia massambicensis*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	0.6752000	0.3376000	0.02	0.9846
Error	6	130.0000000	21.6666667		
Corrected Total	8	130.6752000			

7.2.Household questionnaire

Household Questionnaire to assess sheep and goat production systems and evaluation of chemical major feed resources in Esera district, Dawuro Zone, Southern Ethiopia.

Questionnaire Number_________________________

Introduction and informed consent

Good morning/ Good afternoon!

My name is _________________________ I came from Jimma University, to conduct MSc thesis on assessment of sheep and goat production systems and chemical evaluation major feed resources in Esera district, Dawuro Zone, Southern Ethiopia. Hence without your participation it is impossible to achieve the goals. You are randomly selected to provide information for this research. The information you provide will help the researcher for identify small ruminant production system, feeds available, opportunities and constraints limiting production. The interview may take between 2 - 3 hours to complete. Any information you provide will be strictly confidential and will not be used for any purpose outside this research. Information provided in this survey will not be attributed directly to you and will be used only for descriptive and analytical purposes in a form that will not reveal your identity or the identity of your organization.

Consent given Yes ____________ No________________

(If the answer is "No" to this question, end the interview now)

Questionnaire for respondents

Region____________Zone________Woreda___________Kebele _________________

Agro-ecology ________________

Name of enumerator _____________ Date of interview __________________

I. Socio-economic characteristics

Name of respondent _________________

1. Sex 1. Male 2.Female

2. Age ____________years

3. Marital status: 1. Single 2.Married 3.Widowed 4.Divorced

4. How many family members do you have (family size)______________

5. Educational status?

1. Illiterate 2. Read and write 3. Primary school 4. Junior Secondary School

5. Secondary School 6. College and above

6. Occupation? 1. Farmer 2. House wife 3.Student 4. Herder 5.Trader 6.Handicraft maker

7. Unemployed 8. Government employed 9. Employed non-government

10. Other (specify) _________

7. What is/are your current farming activities?

1. Livestock production only 2. Livestock rearing and backyard farming

3. Mixed live-crop production 4. Bee keeping 5. Others (specify)

8. Land holding and land use systems

8.1. What is the size of your total land holding? (Exactly as indicated on land size (Certificate) ____ha

8 .2. How much is your land allocated for the followings or land use systems 1. Crop land ______________ha 2. Grazing/pasture land _____ ha

3. Fallow land _________ha 4. Others(specify) ______ha

9. For what purpose do you keep small ruminant? Select one or more, then rank

	Purpose (tick)	Rank
a. Meat	__________	________
b. Milk	__________	________
c. Cash income	__________	________
d. Skin	__________	________
e. Manure	__________	________
f. Wealth	__________	________
g. Insurance	__________	____

10. Livestock herd composition and flock structure

II. Breeding system

s/number	structure	Size owned	Origin or source			
			Family gift	Home born	Purchase	Rib
	Cattle herd					
1	Cows					
2	Bulls					
3	Heifers					
4	Male calves					
5	Female calves					
6	Oxen (draft)					
7	Oxen (fatten)					
	Sheep flock					
1	Lambs (<3 months)					
2	Male lambs (3-6 months)					
3	Female lambs (6-12 months)					
4	Ewes					
5	Rams (intact) (>6months)					
6	Castrates/fattening					
	Goat flock					
1	Kids (<3 months)					
2	Male kids (3-6months)					
3	Female kids (6-12 months)					
4	Does					
5	Bucks (>6months)					
6	Castrates/fattening					
	Equines					
1	Stallion /male horses					
2	Mare/female horses					
3	Female donkey					
4	Male donkey					
5	Mules					
	Chickens					
1	chickens					
total						

1. What is your breeding system? 1. Natural breeding 2. Artificial breeding 3. Both

2. If your breeding system is natural and estrus sign of ewe and doe were seen before mating,

1. We select the best type of ram and we inseminate our sheep and goat

2. We don't have any selection activity; simply we used uncontrolled breeding

3. Others --------------------------------

3. If your breeding system is natural and estrus sign of ewe and doe were not seen before mating(before release into communal or private grazing area)

1. We select the best type of ram and we inseminate our sheep and goat

2. We don't have any selection activity; simply we used uncontrolled breeding

3. Others --------------------------------

4. Do you have an experience of selection the best sheep and goat type for breeding purpose? 1. Yes 2. No

5. If yes what are your parameters used to select the best sheep and goat for breeding purpose? 1. Color coat 2. Behavior 3. Body conformation

4. Meat production potential 5. Others ------------

6. What is the source of your breeding ram or bucks?

1. Born in the flock 2. Purchased from market 3. Gift from family 4. Rent 5. Others

7. For what purpose do you keep breeding ram or buck in the flock?

1. Mating 2. Social value 3. For fattening 4. Others (specify)__________________

8. Do you keep the ram other than breeding? 1. Yes 2.No

If yes for Q7, what purpose? 1. Fattening 2 social value 3 cultural values 4. Others

9. If you do not have your own breeding ram or bucks, where do you mate your ewe or doe? 1. Neighboring ram 2. Communal grazing areas 3.Unknown 4. Others (specify) ------

10. Source of sheep and goat?? 1. Purchase from market 2. Born in the flock 3. Gift from family 4. Rent 5. Othersspcify_____

11. How is the reproductive performance of sheep and goats in your farm?

Number	Performance traits	Sheep		Goat	
		Male	Female	Male	Female
1	Age at first parturition (months)				
2	Parturition interval (months)				
3	Average litter sizes(single, twin, triplets)				
4	Average age at puberty (months)				
5	Slaughter age (months)/marketing age				

12. Weaning, castration and culling management

1. Do you practice weaning lams and kids? 1. Yes 2.No

2. If yes, when? Lambs__________ months Kids ___________ months

3. Do practice castration of sheep and goats? 1. Yes 2.No

4. At what age you castrate? Sheep __________ months Goat ___________ months

5. If yes, why? 1. To fatten 2.To avoid mate their flock with these males 3.Others------

6. How do you select Male sheep and goats for castration and fattening? (Rank)

1. Conformation (height, length and appearance)_____

2. Breed (known local ecotypes)_____

3. Physical characteristics (color, horn, tail length and width, ear etc)_____

4. Age___________ 5. Others, specify _________

7. What is the common ways of castrating your sheep and goats?

1.Local methods (stone, stick, metal,) 2. Burdizo 3.other (specify)_____

10. Do you practice culling of sheep and goats from flock? 1.Yes 2.No

11. If yes, why (rank)? 1.Old age_____ 2.Sickness _____3.Lambing and kidding problems_________________ 4.Physical defect_____________________

5. Unwantedphysical characteristics ___________6.Unproductive____ 7 other____

III. Watering of sheep and goat

1. What is the common source of water for sheep and goat?

Number	Source of water	Dry season	Wet season
1	Pond water		
2	River water		
3	Tap water		
4	Rain water		
5	Water harvest		
6	Spring water		

2. What is the frequency of watering per day?

Number	Small ruminants	Frequency	
		Dry season	Wet season
	sheep		
	goat		

Codes: Frequency: 1 = Once in a day 2 = Twice in a day 3 = Three times in a day

3. How far the water points from your home? ___________ Kms round trip.

4. Do you think availability of water is a major constraint during the dry period?

1. Yes 2. No

5. If the answer is yes, how did you alleviate the problem?

1. By digging the ground water 2. By going long distance to the river with their livestock

3. Harvesting or fetching water from different sources.

IV. Feeds resources and feeding system

1. What are the sources of feed?
   1. Natural pasture 2. Crop residue 3. Crop after math. 4. River and road side sources 5. Brewery product (atela) 6. Hay 7. Improved or cultivated forages

Rankthem1----------2----------3----------4-------5--------6------7---------------

2. Did you come across shortage of sheep and goat feed? 1. Yes 2. No

3. If yes, Can you mention at what months feed shortages exist?

1.____

2.____

3.____

4. If yes, what was your solution to alleviate your problem?

1.____

2.____

3.____

5. What is the main reason of feed shortage for goat and sheep?

1. Expanding of crop cultivation
2. Decline in productivity of grazing land
3. Increasing animal population
4. Shortage of grazing land
5. Increasing human population

6. Do you produce cultivable forages? 1 = Yes 2 = No

7. If yes, what type of forages do you produce?

1. Sesbania 2. Elephant grass 3. Desho grass 4.Lacuna 5. Other (specify)______

8. If no, what was your reason?

1. I did not hear anything about it.

2. Even though I heard, I don’t get the seed.

3. I don’t have any shortage of feeds

4. I don’t have any extra land to cultivate

11. Feeding system of sheep and goat?

1. Tethered grazing 2. Stall feeding (cut and carry system)

3. Partial grazing and browsing 4. Free grazing or browsing

12. How sheep and goat graze or browse?

1. Sheep alone 2.goat alone 3.both sheep and goat 4.Together with other livestock

13. Do you supplement your sheep and goat??? 1. Yes 2. No

14. If yes, what are the feeds that you supplement your sheep and goat after or before grazing or browsing?

1. Homemade brewer's recipes (atela) 2. Home refusals 3. Salt/local mineral sources

4. Crop residue 5. Tree legumes 6.Maize grain 7. Cultivated Fodder leaves

15. When do you usually offer your sheep and goats with supplements?

1. Dry season 2.Wet season 3=both

16. How often do you offer supplements to your sheep and goats?

1. Once a day 2.Twice a day

3. Whenever available 4.others, specify__________

V. Sheep and goat health condition

1. Do you have any sheep and goat health problems? 1. Yes 2.No

2. If yes, what are the major sheep and goat health problems? Please rank in order of importance.

1. Foot and mouth disease 2. Mastitis 3. ORF (sour mouth infection)

4 pasteurellosis 5. External parasite 6.Internal parasite 7. Other specify

Rank: 1 ________ 2 ______ 3 ______ 4 _______ 5 ______ 6 _______

3. How did you overcome the problem? Explain____________________________________

4. What do you do when your sheep and goat are sick?

1. Keep of waiting 2. Culling 3. Consult veterinarian 4. Others (specify)________

5. Do you have access to veterinary services? 1. Yes 2. No

VI. Housing system

1. What is the main reason for housing of sheep and goat?

    1. To protect from hot climate 2. To protect from cold weather

    3. To protect from predator 4. To protect from theft

    5. Night shelter 6. Other, specify-----------------

2. Do you have an experience of housing your sheep and goats? 1. Yes 2. No

3. If yes, what type of housing system?

    1. Simply crashes 2. Open with roof on the top only

    3. I keep the Shoat with the people residence with other animals

4. I tethered at the yard

4. Do you have separate house for your sheep and goat??? 1. Yes 2. No

5. If no indicate type of housing/enclosure for your sheep and goat flock.

    1. in family house with separate barn with other animals

    2. in family house with the same barn with other animals

    3. yard/corral 4. Others (specify)_____________

6. How do you confine house sheep and goats?

1. Sheep alone 2.Goats alone 3.Sheep and goats alone 4.Sheep, goats and all other animals together 5.Others, specify __________

7. Do you clean the sheep and goat Barn??? 1. Yes 2.No

8. If yes how many times per day? 1. Once 2. Twice 3. three times in a day

VII. Constraints of sheep and goat production

1. Disease and parasites 2.Feed and grazing land shortages 3.Water shortage

4. Labor shortage 5.Droughts 6.Predators

2. Do you want to expand sheep and goat flock sizes and production in the future?

1. Yes 2.No

VIII. What are the main opportunity for sheep and goat production? Rank them

1. High market demand____
2. Require small space and initial capital for investment____
3. Short generation interval and multiple birth_____
4. Low labour requirement_____
5. Adapt harsh environmental condition_____

Points for Secondary Data Collection

1. District name-----------------------------

1. Human population:

1.1. In urban 1.2. In rural

a. Male______________________ a. Male______________

b. Female____________________ b. Female____________

2. Livestock population:

a. cattle________________________________ e. mule_________________________

b. goats________________________________ f. horse_________________________

c. sheep________________________________ g. poultry_______________________

d. donkey______________________ bee hives local----------transitional----------modern--------

3. Average land holding per household (in ha)______________

4. Season of the year

a. Main rainy season from ______________________________to_________________

b. Short rain season from _______________________________to_________________

c. Dry season from ____________________________________to _________________

5. Topography of the districts (%):

Plain________________Mountain______________Plateau__________Other_____

6. Climatic data (distribution and amount)

a. Annual average temperature _______Maximum _________Minimum_______

b. Annual average rain fall (mm) ________Max. (mm)_______Min. (mm)_____

c. Humidity (%): annual average __________Min. _____________Max.________

7. Agro-ecological zone of the district (%)

a. Lowland____

b. Intermediate____

c. Highland____

8. Production system/farming system____________________________

9. Vegetation cover____

10. Major soil types: a.____

b.____

c.____

11. Opinion on relative importance of sheep and goat in the farmers' livelihood (income contribution of the activity in percent) ______________________________

12. Major sheep production constraints in the district---
----

13. Major sheep production opportunities in the district---
----

14. Major sheep and goat disease ---
----

15. Major crops cultivated---
----

15. Major sheep and goat feed resources in this area---
