BAHIR DAR UNIVERSITY
COLLEGE OF AGRICULTURE AND ENVIRONMENTAL SCIENCES

GRADUATE PROGRAM

PHENOTYPIC CHARACTERIZATION OF INDIGENOUS SHEEP AND FARMERS' BREEDING OBJECTIVES IN THREE SELECTED DISTRICTS OF SOUTH WOLLO ZONE, ETHIOPIA

M.Sc. Thesis

By

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Department: Animal Production and Technology,

Program: MSc. in Animal Genetics and Breeding

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Co-advisor: Solomon Gizaw (PhD)

June, 2016
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SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE (M.Sc.) IN ANIMAL GENETICS AND BREEDING

June, 2016

Bahir Dar University

THESIS APPROVAL SHEET

As member of the Board of Examiners of the Master of Sciences (M.Sc.) thesis open defense examination, we have read and evaluated this thesis prepared by Moges Takele Teshale entitled **'phenotypic characterization of indigenous sheep and farmers' breeding objectives in three selected districts of south Wollo Zone, Ethiopia'**. We hereby certify that, the thesis is accepted for fulfilling the requirements for the award of the degree of Master of Sciences (M.Sc.) in Animal Genetics and Breeding.

Board of Examiners

Name of External Examiner	Signature	Date
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Name of Internal Examiner	Signature	Date
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Name of chair person	Signature	Date
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DECLARATION

This is to certify that this thesis entitled **phenotypic characterization of indigenous sheep and farmers' breeding objectives in three selected districts of south Wollo Zone, Ethiopia**, submitted in partial fulfillment of the requirements for the award of the degree of M.Sc. in Animal Genetics and Breeding to the School of Graduate Studies, Bahir Dar University, through the Department of Animal production and Technology done by Moges Takele Teshale ID. No. BDU0602044PR is an authentic work carried out by him under my guidance. The matter embodied in this project work has not been submitted earlier for award of any degree or diploma to the best of my knowledge and belief. However, works of other researchers and authors that served as source of information were duly acknowledged.

Name of the Student

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1) Yeshambel Mekuriaw (PhD (Major avisor)
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ACKNOLWEDGMEMNT

First and for most "Thanks to God for enabling it all".

I would like to express my special and heartfelt gratitude to my major advisors, Dr. Yeshambel Mekuriaw and my co-advisor, Dr. Solomon Gizaw, for their unlimited and unreserved support to make this thesis work successful. Their inspiration and brotherly encouragement was critical for this thesis result. Their willingness to share knowledge and materials and their way of advice to produce competent citizen will never be forgotten.

Similarly I would like to thank International livestock Research institute (ILRI) for funding this research work and education fee and Bahir Dar University College of agriculture and environmental science (CAES) and Animal production and Technology Department for unlimited support of equipment, advising from learning up to the success of this thesis.

My thanks must also extended to the staffs of south wollo zone, Dessie zuria, Tehuledre and Kalu districts agricultural and Rural Development Department for their active involvement and facilitation of the data collection activities and staff deserve appreciation for providing relevant secondary information and taking part in this study.

I am extremely thankful to all my family for their encouragement and financial support during my stay in the campus. Finally, nothing will be done, no success without blessing of God**.**

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ABBREVATION

AFL	Age at First Lambing
ANGR	Animal Genetics Resource
ANOVA	Analysis Of Variance
ANRS	Amharic National Regional State
ASS	Agriculture Sample Survey
M A.S.L	Meter Above Sea Level
BL	Body Length
BW	Body Weight
CAES	College of Environmental Science
CSA	Central Statistics Agency
CV	Coefficient of Variation
EARO	Ethiopian Agricultural Research Organization
EL	Ear Length
ESGPIP	Ethiopian Sheep &Goat Productivity Improvement Program
FAO	Food and Agricultural Organization
FARM AFRICA	Food and Agricultural Rehabilitation Management in Africa
FDRE	Federal Democratic Republic of Ethiopia
FMD	Foot and Mouth Disease
GDP	Gross Domestic Product
GLM	General Linear Model
HH	House Holds
HG	Heart Girth
HL	Head Length
HW	Height at Wither
IBC	Institute of Biodiversity Conservation
ILRI	International Livestock Research Institute
IPMS	Improving Productivity & Market Success of Ethiopian Smallholder Farmers
LBM	Linear Body Measurement
MFED	Ministry of Finance and Economic Development
MOA	Ministry of Agriculture
PPI	Pairs of Permanent Incisors

R	Correlation Coefficient
RH	Rump Height
RL	Rump Length
RW	Rump Width
SAS	Statistical Analysis System
SE	Standard Error
SPCB	Standard Phenotypic Characterization of Breeds
SPS- LMM	Sanitary & Phytosanitary Standards & Livestock Meat Marketing
SPSS	Statistical Package For Social Science
TL	Tail Length
X^2	Chi Square

PHENOTYPIC CHARACTERIZATION OF INDIGENOUS SHEEP AND FARMERS' BREEDING OBJECTIVES IN THREE SELECTED DISTRICTS OF SOUTH WOLLO ZONE, ETHIOPIA

Moges Takele[1], Yeshambel Mekuriaw [2], Solomon Gizaw[3]

ABSTRACT

This study was aimed to get information on production system, breeding objective and physical characteristics of native sheep types in kalu Tehuledre and Dessie Zuria districts of South Wollo Zone under smallholders' management conditions. Survey was undertaken on 180 HHs selected randomly. Body measurements were *taken from 276 sheep, male (81) and female (195) sheep. Dentition was used to estimate the age of the sheep. Data were gathered through semi-structured questionnaire, focus group discussions and field observations. Survey data were analyzed using (SPSS 20.0, 2011) and phenotypic characterization and body measurement data were analyzed using (SAS 9.2 2010). Source of cash income, saving value, meat for home consumption, skin, manure and wealth status were the major purpose of keeping sheep. The average sheep flock size owned per household of Dessie zurea was (9.7±0.6) and significantly (P<0.05) higher than Teuledre (7.5±0.6) and Kalu (6.2±0.3). Body conformation and growth rate were used for male selection while lambing interval, twinning ability, body conformation was the preferred traits for breeding ewe in all districts. The overall average age at first mating in males were (7.29±0.05) and female (8.42±0.14) months. Age at first lambing 13.1±0.09, Lambing interval, reproductive life span of ewe and liter size were 8.04 ±0.07 months, 10.5 ± 0.3 lambs and 1.22 ± 0.06 lambs, respectively. Major production constraints were disease, feed and water shortage in order of importance. The overall body hair coat colour pattern was recorded (68.8%, 19.2% and 12%) for Plain, patchy and spotted respectively. White (26.1%), red dominant (29.7%), black (9.4%), red with white (12.3%), white with black (1.8%) red brown (7.6 %)), creamy white (13%), were the common coat colour observed. District had affected live body weight and linear body measurement. Body weight of Teuledere sheep significantly (p<0.05) heavier than Kalu and Kalu heavier than Dessie zuria. Sex had also significant effect (p<0.05) and revealed an important source of variation on body weight, body length, ear length and heart girth and*

all body linear measurements, were not significant (p>0.05) .In most traits, males were heavier and longer than females (p<0.05). Age had significant effect (p<0.05) on body weight and linear body measurement. Body weight were highly significant (p<0.05) at all ages .Body weight was significantly (P<0.05) correlated with all continuous traits observed in this study. Based on the result it could be concluded that, the fixed effect, age, sex, districts and age with sex interaction were the most limiting factor and significant (p<0.001) effect on live body weight and linear body measurement and revealed an important source of variation . To recommend that, the reproductive performance of sheep in south wollo has been observed that have good reproductive potential. So we should exploit and use this reproductive potential properly with modern management system.

Key words: Characterization, breeding objectives, indigenous sheep, South Wollo

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CHAPTER ONE

INTRODUCTION

1.1. Background and Justification

The world total numbers of goats and sheep were 861.9 and 1078.2 million, respectively, i.e. there is about one goat to approximately 1.25 sheep in the world, FAOSTAT (2008). There are tremendous variations among the different parts of the world regarding the number of goats, its ratio to sheep and their percentages. Characterization of sheep resources is a prerequisite for their rational utilization. In developing regions, there exist types of farm animal species which own their distinct identity to a combination of traditional 'breeding objectives' and geographical and/or cultural separation by communities which own them (Rege, 2003). Knowledge of traditional animal breeding practices and breeding objectives is important to develop sustainable genetic improvement schemes under smallholder situations. Lack of such knowledge leads to the setting up of unrealistic breeding goals in the design of livestock genetic improvement programs and the consequence of which can put in danger the conservation of indigenous animal genetic resources (Zewdu Wuletaw *et al*., 2006).The current level of productivity of sheep is essential to meet the demands of the ever-increasing human population. On the other hand, by improving the productivity of sheep, export earnings as well as the income of the household will be improved. There are, however, a number of constraints that affect the productivity of sheep such as mortality, feed scarcity and inadequate indigenous breed utilizations to production.

Ethiopia is home for 6 breed group, at least 9 breeds and 14 traditional sheep populations and has a large number of sheep estimated at 29.33 million, out of which about 72.77 percent are females, and about 27.23 percent are males from total number of sheep 99.78% are indigenous breeds (CSA, 2015). In Ethiopia sheep are the second largest number of livestock species after cattle. (CSA, 2012/13) also reported that the majority (99.8%) of sheep breeds in Ethiopia are indigenous. (Solomon Gizaw *et al*., 2007) reported, these sheep population are found and distributed in different agro-ecological zones with different production systems of the country .Sheep production has great contribution for the country at large and for smallholder farmers in terms of fetching foreign currency, income, job opportunity, human nutrition, risk aversion, ecological

roles, rural banking and social values. Sheep have a unique niche in smallholder agriculture from the fact that they require small investments; have shorter production cycles, faster growth rates and greater environmental adaptability as compared to large ruminants. They are important protein sources in the diets of the poor and help to provide extra income and support survival for many farmers in the tropics and sub-tropics (Markos Tibbo *et al* 2006; Notter 2012). Sheep play an important economic role and make a significant contribution to both domestic and export markets through provision of food (meat and milk) and non-food (manure, skin and wool) products .They also play a major role in the food security and social well-being of rural populations living under conditions of extreme poverty which is particularly the case for eastern parts of Ethiopia (Alvarez *et al* 2009; Gemeda Duguma *et al* 2010).

The demand from both domestic and export markets for product from small ruminants, especially mutton, is increasing in Ethiopia (SPS-LMM, 2010). However, the productivity of indigenous sheep is currently too low to meet this demand (Ameha Sebsibe 2008). Attempts have been made to improve productivity of indigenous sheep through crossing with exotic breeds such as Corriedeale, Hampshire, Romney, Awassi and Dorper (Solomon Gizaw and Getachew Terefe, 2009). However, these programs have not been successful, probably because of a lack of understanding of the indigenous sheep, preferred breeding objectives of the farmers and absence of involvement of all stakeholders in the designing of breeding strategies (Markos Tibbo *et al*. 2006,Gemeda Duguma *et al* 2010). While previous studies in Ethiopia have characterized indigenous sheep breeds both phenotypically and genotypically with their breeding objectives and farmers' breeding practices, diversity of production systems and genetic resources is still not well-represented and it is demanding (Workneh Ayalew *et al*., 2004, Mengiste Taye, 2009, Shigdaf Mekuriaw, Getachew Terefe *et al* 2010; Getachew Terefe *et al* 2011; Zewdu Edea *et al* 2012). In particular, there is limited information on phenotypic characteristics, farmers' breeding practices, trait preferences, and selection criteria of breeding stock used by owners of sheep in eastern parts of the country where indigenous breeds have special merit in Middle Eastern export markets (SPS-LMM, 2010).

Various scholars from different corners of the world have been advising that the performance of indigenous sheep could be improved through management and there is also potential for genetic improvement through selection (Zewdu Wuletaw *et al*., 2006).

Selection of a particular sheep breed for further improvement requires information about phenotypic characteristics and desired traits for the objectives of sheep production by smallholder farmers.

1.2 statement of the problem

The current status of knowledge on characterization of farm animal genetic resources in Ethiopia shows that there is inadequate information on breed level characterization (both phenotypic and genotypic), farmers' breeding practices, and breeding objectives (Rege, 2003, Workneh Ayalew *et al*., 2004).

South Wollo Zone has high potential of sheep population. However, the indigenous sheep breed available in the Zone is recently not phenotypicaly characterized; farmers' breeding practices are yet reported as to the level of my knowledge. Furthermore, breeding objective of indigenous sheep in the proposed study area is not reported/ documented. These information, however, are highly required for policy makers, sheep breeders and development practitioners working on sheep production improvement program in the area as a prerequisite for designing sustainable sheep genetic improvement programs and strategies for the future development of indigenous breeds. More specific the aim of the improvement schemes is to increase production, product quality, cost efficiency, maintain genetic diversity and support the conservation and use of specific breeds. Hence, this study is designed with the following objectives.

1.3. General objective

The overall objective of this research is to describe indigenous sheep breed existing in South Wollo Zone of Amhara region in terms of morphology, farmers' breeding objectives

1.3.1. Specific objectives

- ✓ To describe the phenotypic characteristics of indigenous sheep available in the selected districts of South Wollo Zone.
- ✓ To identify the breeding objectives of farmers on indigenous sheep type available in selected districts of south wollo zone.

CHAPTER TWO

LITERATURE REVIEW

2.1. Origin and Distribution of Sheep

Records of domestication of sheep date back to as early as 7000 in near east. The home of wild sheep is the mountain ranges of central Asia, from where sheep spread westwards into Europe and eastwards into North America during the Pleistocene period (Ryder, 1983). Domesticated sheep belong to the species *Ovis aries*. Sheep are believed to have been among the first animals to be domesticated, preceded by the dog and goat. The domestication of both sheep and goats probably dates back to the pre-settled agricultural period. It is also believed that most domestication took place in western Asia where the majority of the present day small ruminant breeds likely originated. Sheep are extremely versatile and since domestication they have spread throughout the world (Devendra and McLeroy, 1982) and currently there are more than 850 distinct breeds of sheep scattered throughout the world (FAO, 2000; Rege, 2003).

Ethiopia has a large number of sheep estimated (CSA 2010). Sheep types in Ethiopia are highly affiliated to specific ethnic communities. A number of traditional breeds are reared by and named after specific communities. As could be noted, the indigenous sheep breeds are usually named after specific ethnic groups (e.g. Afar,) or geographical locations (e.g. the Horro, Menz, farta). Similarly, the classification of these major types is largely based on morphological or physical characteristics. Most of the investigations done up to now have been carried out on research stations, on-farm performance studies are very few. This in turn affects the understanding of the factors which influence sheep production at the farm level and also the introduction of specific interventions by development organizations.

2.2 Sheep Population and Distribution in Ethiopia

Table 2.1. Sheep types and their ecology, geographic distribution, physical features, performance levels and population sizes

Sheep types	Other names	Geographic distribution	Important physical features* and performance levels	Population (000)
Subalpine group	short-fat-tailed	9.1 –14.5ºN and36.3–39.8ºE	Litter size range: 1.0 ± 0.01 to 1.09 ± 0.05	
Menz	Legegora, Shoa, Abyssinian, Ethiopian highland sheep	North Shoa zone of Amhara state	Short fat tail turned-up at end; small body size; short legged; long fleece with coarse wool; commonly black with white patches, white, brown, white with brown patches; straight-faced; horned males; short semi-pendulous ears with 12% rudimentary ears in the population. Kept by Amhara community	971.4
Sekota	Tigray highland, Abergelle	Wag Himra zone of Amhara State and Tigray	Short fat tail turned-up at end and fused with main part; medium sized; predominantly brown or white coat, few black with brown belly; white animals have finer hair or woolly undercoat; semi-pendulous or rudimentary ears in Wag Himra and Tigray, predominantly rudimentary in Tekeze valley. Reared by Agew, Tigray and Amhara communities	732.3
		North Gondar zone of Amhara state (Debark, Dabat, Janamora, Wegera)	Short fat tail; well developed woolly undercoat; plain brown, plain white, brown/white with white/brown patches, plain black and black with brown belly; unique long laterally spiral horn in males and short horns in most females; largest of the highland woolen sheep. Reared by Amhara community	347.6

Table 2.1 (continued…)

Tikur		North Wollo zone of Amhara state	Short fat tail; woolly undercoat; predominantly black (60%) coat; small body size; majority short semi-pendulous ears, 24% rudimentary ears. Reared by Amhara communities	525.3
Wollo		South Wollo zone of Amhara state	Short-fat-tail with short twisted/coiled end, occasionally turned up at end; Small size; well developed woolly undercoat; predominantly black, white or brown, either plain or with patches of white, black or brown; long hair with woolly undercoat; horned males. Reared by Amhara communities	
Farta		South Gondar zone; Gondar zuria, Belesa, Dembia districts	Short fat tail; medium size; woolly undercoat; commonly white (37.5%), brown (27.5%) and black with brown belly (15%), white/brown with brown/white patches; males are horned. Reared by Amhara communities	555.6
Washera	Agew, Dangilla	West and East Gojam and Agew Awi zones of Amhara state; Dangur, Madura and Alefa Takusa districts	Short fat tail; large body size; short-haired; predominantly brown; both males and females are polled. Reared by Amhara and Agew communities	1227.7
Highland long-fat-tailed group		10.4–5.8ºN and34.5–40.3ºE	Litter size range 1.29 ± 0.06 to 1.55 ± 0.12	
Adilo	Wolaita	North Omo, Derashie, Gedio and Amaro zones of Southern state; some northern Borana districts (1300–2400 m.a.s.l)	Long fat tail reaching the hocks, broad at the base and upper third with long tapering end; large size; shorthaired; males are short-horned and 18.4% of ewes are horned; predominantly brown (43%), brown with white patches (32%), black (16%), and black with brown patch (9%). Reared by Southern nationalities	407.7

Source, (Solomon Gizaw *et al*., 2013).

2.3. Sheep Production Systems in Ethiopia

According to (FAO, 2000), a production environment encompasses all input-output relationships, over time, at a particular location. The relationships will include biological, climatic, economic, social, cultural, and political factors, which combine to determine the productive potential of a particular livestock enterprise. Animal uses, genetic variance, and abundance of genetic diversity change across production systems. As different production systems evolve varying pressures are place dup on the existing breeds, (FAO, 2004). Marked differences between production systems, such as product needs and prices, disease occurrence, spread and control methods and climatic differences will often require, for each environment, the use of quite different genetic resources to realize sustained production of food and agriculture, (FAO, 2000).

Sheep production in Ethiopia is generally of subsistence in nature. Sheep are reared in extensive systems with no or minimal inputs; they are kept virtually as scavengers, particularly in mixed crop–livestock systems (Solomon Gizaw *et al.,* 2013). Extensive systems of production share common characteristics, such as small flock sizes, communally shared grazing, uncontrolled mating, absence of recording, low productivity per animal, relatively limited use of improved technology, and use of on-farm by-products rather than purchased inputs. Market-oriented or commercial production is almost non-existent.

The major sheep production systems in Ethiopia include the traditional management system (the pastoral and agro-pastoral and mixed crop- livestock systems) and the government ranches, characterized by different production goals and priorities, management strategies and practices, and constraints, (Markos Tibbo, 2006). Generally, the mixed crop-livestock systems are the most densely populated and hold the largest number of ruminant livestock. In the mixed farming system of the highlands of Ethiopia sheep depend mostly on grazing fallow lands, waterlogged lands, natural pasture and crop residues usually with no extra-supplement and receive minimum health care.

In the lowland part of the country small ruminant production is associated with the purely livestock based nomadic and transhumance pastoral production systems based largely on range, primarily using natural vegetation. The pastoral systems are found mainly in the

medium-to-low potential areas where crop production is difficult due to low and erratic rainfall. In this system though there are cultivations in some areas, livestock production forms an integral part of the socio-cultural life for the vast and diverse human populations. Most of the livelihoods of the inhabitants depend on livestock products and live animals sales or exchange, (Coppock, 1994). Risk avoidance is an important integral part of the breeding objectives in those areas. People moves periodically with their livestock in search of feed and water for their animals. In the lowlands of Ethiopia, livestock is comprised of large sheep flocks, where only surplus are sold at local markets or trekked to major consumption centers. Extensive livestock keeping is the backbone of the economies of the lowlands, (EARO, 2000). The government ranch is accounted for very small proportion of sheep production system in Ethiopia. It was found in government sheep breeding, and multiplication centers, (Markos Tibbo, 2006). This include government owned ranches such as Horro Guguduru ranch, which was closed due to high sheep mortality, the Debre Berhane and Amed Guya ranch involved in the production and distribution of crossbred rams to the farmers**.**

2.4. Socio-Economic Importance of Sheep

Regardless of the harsh environmental conditions, small ruminants are important in feeding the rapidly expanding population of the developing world (Markos Tibbo *et al*., 2006). In addition to their adaptation to the harsh environment, they require low initial capital and maintenance costs, are able to use marginal land and crop residues, produce milk and meat in readily usable quantities, and are easily cared by most family members. Small ruminants play an important role for sustainable rural livelihoods and the utilization of marginal ecological areas (Köhler-Rollefson, 2001; Thornton and Herrero, 2001). Small ruminants provide meat and milk to the smallholders and are considered as insurance mainly against cop failure, as saving, socio-cultural and ceremonial purpose (Kosgey *et al*., 2004; Markos Tibbo, 2006; Habtemariam *et al*., 2012).

Hence, small ruminants are important to the livelihood of smallholder farmers and to the economy of the country. About 31%-38% and 21%-33% of the Ethiopian smallholder farmers own sheep and goat (Asfaw Negassa and Jabbar, 2008), The livestock sector contributes 30% to 35% of the Ethiopian agriculture GDP, 19% of the total GDP and more

than 85% of farm cash income (Benin *et al*., 2002). Small ruminants account for about 40% of the cash income earned by farm households, 19% of the total value of subsistence food derived from all livestock production, and 25% of total domestic meat consumption (Adane Hirpa and Girma Abebe, 2008).

Sheep contributes close to 30% of the total ruminant livestock meat output and 14% of the total domestic meat production, with live animal and chilled meat export surpluses (Workneh Ayalew *et al*., 2004). The sheep enterprise in the Ethiopian highland where crop and livestock production are integrated, is the most important form of investment and cash income and provides social security in bad crop years. Despite the economic importance of small ruminants to the farming household and overall economic development of a country, efforts to improve the productivity and production systems of small ruminants are lacking (MFED, 2010).

2.5 .Constraints of Sheep Production

Sheep production and productivity in Ethiopia is constrained by many factors such as scarcity of feed, lack of infrastructure, high mortality rates, inadequate veterinary coverage, poor quality products and low average reproductive rates **(**Ehui, 1999, Tsedeke Kocho; 2010**).** However, high reproductive wastage is the major constraint of sheep productivity, which also greatly reduces selection possibilities; thus, improving the frequency of lambing and reducing mortality should be the emphasized schemes of sheep production. Sheep have higher survival rates under unfavoured conditions and are widely adapted to different agro-climates. They are kept by all ethnic groups and production systems. Importantly, because of their small body sizes, small ruminants have lower feed requirements that allow integration of them into different enterprises. Moreover, in addition to requiring a small initial investment, flock numbers can be restored more rapidly because of their fast reproductive rates, and they are also suitable for meeting subsistence needs (meat and milk) of the smallholders (FAO,1991) .

Lack of adequate feed resources as the main constraint to animal production is more pronounced in the mixed crop-livestock systems, where most of the cultivated areas and high

human population are located (Sisay Amare, 2006). The problem of good quality and quantity feeds observed in lowlands where pastureland seems relatively abundant. There is a great seasonal variation of quality and quantity of feed resources in most part of the country.

According to (Alemayahu Mengistu, 1998), there is excessive supply of feed during the rainy season which is usually followed by a deficit in grazing in the following dry season. On the other hand, the allocation of more land for crop production resulted in availability of crop residues as alternative feed, particularly in the smallholder livestock production system.

Although there is difference in utilization across months of the years, communal grazing lands are utilized throughout the year. Similarly many reports (Abule Ebro; 2003; Tsedeke Kocho, 2007; Tesfaye Kebede, 2008) indicated that natural pasture is the main feed resource for small ruminants and cattle. The availability and quality of forages are not favorable and uniform in nutrient quality all year round

In southern part of the country, although the degree of shortage varies within farming systems/agro-ecologies feed shortage is reported as a major constraint for small ruminant production, (Endeshaw Assefa,2007; Tsedeke Kocho,2007; Getahun Legesse,2008). Another serious constraint for small ruminant production in Ethiopia has been the high prevalence of diseases and parasites. This causes high mortality of lambs, diminishing the benefits of their high reproductive performance (Solomon Gizaw *et al*., 1995; Yohannes Gojjam *et al*., 1995; Solomon Abegaz and Gemeda Dugema , 2000; Markos Tibbo, 2006).

Water shortage is also reported as limiting factor in most lowland areas to a limited extent in mid altitudes. 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 adaptation mechanisms.

2.6. Reproductive Performance of sheep

Any successful livestock production program is a result of good reproductive performance of sheep. To obtain meat, milk and fiber the existence of birth and survival is necessity, (Tesfaye Getachew, 2008). The productivity of sheep mostly based on the reproductive performance of sheep. And reproductive performance depends on various factors

including age at first lambing, litter size, lambing interval and the life time productivity of the ewe, the last one being related to longevity (Sulieman *et al*., 1990).

2.6.1. Age at first lambing

In most traditional systems, first lambing occurs at 450-540 days when ewe weights are 80-85 percent of mature size (Wilson, 1986) and different report deals the age of ewes for first lambing is in between this range (450-540 days). The average (Mean±SD) age at first lambing of 447±93 days and 399 ± 51 days were reported for Bonga and Horro sheep, respectively Zewdu,Edea (2008). And also the average age at first lambing of Gumuz sheep was 410.1 ± 72 days, (Solomon Abegaz, 2007). Poor nutrition, disease or parasitic burdens and genotype limit early growth and it can put obstacle for early maturity for giving first birth.

Table 2.2. Age at first lambing of Ethiopian sheep breeds under different management

Spp	Breed	Management type	Age(Day)	Source/Reference
Sheep	Arsi-Bale	Traditional(Kofele	354	Getahun Legesse, 2008
	Arsi-Bale	Traditional (Adilo)	438	Getahun,Legesse 2008
	Arsi-Bale	Traditional	510	Samuel Menbre, 2005
	Arsi-Bale	Traditional	381	Tsedeke Kocho , 2007
	menz	Traditional	390-540	Mukesa Mugerewa *et al* 1986
	menz	Traditional	485	Agyemang *et al* 1985
	Menz	Traditional	477-547	Niftalem Dibessa
	Menz	Station	459	Demeke *et al*,1995
	Menz	Traditional	443	Niftalem Dibissa, 2000
	Menz	On Station	523 month	Mukasa-Mugerwa,Lahalou 1995

2.6.2 Lambing interval

Lambing interval is the interval between two successive parturitions that determines reproductive efficiency in sheep production. The ewe with long lambing interval has lower reproductive efficiency, Ibrahim (1998). Extended lambing intervals commonly

arise from long post-partum anoestrus intervals, repeated cycles of service intervals without conception, embryo death or abortion (Gatenby, 1986; Ibrahim, 1998).

In good management condition, adequate nutrition lambing interval can be possible to attain three lambing from indigenous sheep in two years (Sani and Tiwari, 1974). According to (Solomon Abegaz, 2007) in association with the above thought Gumuz breed had an average lambing interval of 6.64 ±1.13 months so the breed can produce three lambing in two years even under the traditional management system but the work of (Zewdu Edea, 2008) indicates that lambing interval of around 8.9 ± 2.1 month for Bonga ewes and 7.8 ± 2.4 month for Horro ewes. Among other breeds of sheep in Ethiopia that had short lambing interval are Menz (8 and half month) and Afar sheep (9 month) (Tesfaye Getachew ,2008).

Table 2 .3. Lambing interval of Ethiopian sheep under different management

Spp	Breed	Management type	Lambing interval	Source/Reference
	Arsi-bale	Traditional	7.8	Tsedek Kocho, 2007
	Bonga	Traditional	8	Belete Shenkute, 2009
	Menz	Traditional	7-10	Niftalem Dibissa, 2000
	Menz	On Station	8.4	Mukasa ,Lahalou 1995
	Washara	Traditional	9+0.5	Mengistie Taye,2008

2.6. 3. Prolificacy /Litter size/

Litter size is a combination of ovulation rate and embryo survival number of lambs born per parturition. There is a positive relationship between litter size and age and litter size and parity (Getahun Legesse, 2008; Girma Abebe, 2008). According to (Zewdu Edea ,2008) a twining rate of 39.9 % or litter size of 1.40 and 36 % or litter size of 1.36 were obtained for Horro and Bonga sheep breeds, respectively and the two breeds showed relatively better multiple births under the existing feed shortages. Under traditional management conditions the percentage of twining rate or number of lambs per lambing in some breeds tends to fall below10 percent. The report of (Tesfaye Getachew, 2008) where low twining rate of both Menz and Afar sheep breeds was recorded support this scenario.

Table 2.4: Litter size of Ethiopian sheep under different management condition

Spp	Breed	Management type	Liter size	Source/Reference
Sheep	Menz	Station	1.12	Mukasa and Lahalou, 1995
	Washara	Traditional	1.11	Mengite Taye *et al*.,2009
	Horro	Station	1.34	Solomon Abegaz *et al*.,2000
	Menz	Traditional	1.11	Niftalem Dibessa, 2000
	Arsi-bale	Traditional(Kofele)	1.24	Getahun Legesse, 2008
	Arsi-bale	Traditional(Alaba)	1.70	Tsedeke Kocho, 2007
	Bonga	Traditiona	1.4	Belete Shenkute,2009
	Adilo	Traditional	1.42	Getahun Legesse, 2008

2.6.4 Reproductive life span

Long reproductive life span in tropical (unfavorable) condition is one of the adaptation traits of tropical livestock. The average reproductive life span of Horro and Bonga ewes were 7.9 ± 3.1 years and 7.4 ± 2.7 years, respectively. Long term reproductive performance (long living, high fertility, ability to produce more offspring) of dams should be given more importance in selection programs, (Zewdu Edea, 2008). According to (Solomon Abegaz, 2007) in a circumstance that there is lack of comparative figures for Ethiopian breeds, quite long reproductive life span of Gumuz breed (8.5 years for ewes) and (3.67 years for rams) was reported.

2.7. Breeding objectives and Trait Preferences of farmers on indigenous sheep

The concept and structure of conventional livestock breeding objective was initially formalized by (Hazel, 1943) and it defines the traits of importance and the direction of genetic improvement; (Borg, 2004). Breeding objective is defined as the traits to be improved, the cost of production and the revenue from product sales related to a genetic change in each trait.

Sustainable animal breeding strategies require a broad definition of breeding objectives that emphasize maintaining adaptation and biodiversity in addition to Profitability (Olesen *et al*.,2000;Neilsen *et al*.,2005,2006).Sölkner *et al*.(1998) and Kosgey *et al*. (2004) argued that when defining animal breeding objectives, particularly for subsistence farmers in marginal situations, the needs and interests of the target group should be incorporated .This involves incorporating both tangible and intangible benefits of livestock keeping

According to (Solomon Gizaw *et al* 2007) in Ethiopia, the livelihood of smallholder households depends to a great extent on livestock and sheep contribute substantial amounts to income, food (meat and milk), and non-food products like manure, skins and wool. They also serve as a means of risk mitigation during crop failures, property security, monetary saving and investment in addition to many other socioeconomic and cultural functions, (Markos Tibbo, 2006). However, sheep productivity is constrained by lack of technical capacity, scarce feed, diseases, insufficient infrastructure and market information resulting in inadequate utilization of the indigenous genetic resources.

According to (Zewdu Edea, Abebe Haile, Markos Tibbo ,2012) keeping of bonga and horro sheep is for tangible benefits (such as regular source of income, meat, and manure). Most farmers in both sites keep sheep primarily as source of income. Functions like ceremony received relatively low ranking among the reasons for keeping sheep in both production systems. Similar multi- purpose functions of sheep rearing were reported for sheep keepers in the central highlands of Ethiopia (Abebe Mekoya 1999). (Getachew Terefe *et al*, 2010) also reported that milk production from sheep was the primary objective of pastoralists in north-east Ethiopia (Afar). However, (Dhaba Urgessa *et al*, 2012) and (Zewdu Edea *et al*, 2012) reported that production and consumption of milk from sheep is not common in mixed crop-livestock system where income generation is considered as the primary objective of keeping sheep.

Although the primary purposes differed between production systems, the use of indigenous sheep as multipurpose animals was common to all production systems. Multi-purpose sheep rearing is common in Ethiopia, (Getachew Terefe *et al* 2010; Solomon Gizaw *et al* 2010; Zewdu Edea *et al* 2012) and linked to the need to maximize output from an animal that can survive on a low input of resources (Jimmy *et al* 2010). Multiple functions are particularly

important in low- to medium-input production environments, Zewdu Edea *et al* (2012). Given the breadth of purposes that farmers and pastoralists have for keeping sheep, much care is required in the choice of breeding objectives and breeding strategies as the function of the animals is closely linked to the traits desired by the producers (Jimmy *et al* 2010). Knowledge of reasons for keeping animals is a prerequisite for deriving operational breeding goals (Jaitner *et al* 2001). Milk production of sheep should always be considered in designing a breeding strategy for pastoral and agro-pastoral systems where sheep milk consumption is common and acceptable.

Lack of proper recognition of the purpose of keeping animals by their owners has been a major reason in the failure of past genetic improvement programs (Sölkner *et al* 1998).

2.8. Sheep Marketing System

Farmers sell their sheep to anyone who pays an acceptable price and the buyers are mainly other farmers, traders and final consumers. Yearlings of both sexes are sold to market when farmers are in need of cash, Solomon Gizaw *et al,* (2012).

Farmers market sheep and goats at farm gates or the nearest local/primary markets. Farmers use all markets found in their localities regardless of political boundaries and ethnic and cultural differences.Farmers sell their sheep mainly to traders, consumers and to a lesser extent to other farmers. Even though farmers sell their animals when financial problems force them to sell, they do prefer to sell their sheep during holidays and festive occasions(Tsedeke Kocho,2007). As indicated by farmers, sheep price is affected by season - holidays and festivals. It was reported that better price is fetched during Ethiopian New Year, Christmas, and Easter. Information on market price, supply, grades, and standards are not available to farmers. Formation of farmers' cooperatives and development of marketing facilities would enable farmers to get better prices for their animals

According to (Ayele Solomon *et al*. 2003), the current knowledge on livestock market structure, performance and prices is poor and inadequate for designing policies and institutions to overcome perceived problems in the marketing systems of Ethiopia. Moreover, (Gede *et al*., 2005) from Indonesia reported that farmers possess minimal marketing information and usually complain about the prices they receive for their merchandise.

2.8.1. Marketing routes

According to (Ayele Solomon *et al*., 2003), the domestic livestock marketing structure of Ethiopia follows a four tier system. The main actors of the 1st tier are local farmers and rural traders/rural assemblers who transact at farm level. Those small traders from different corners bring their animals to the local market (2nd tier). Traders/wholesalers purchase a fairly large number of small animals for selling to the secondary markets. In the secondary market (3rd tier), both smaller and larger traders operate and traders (wholesalers or retailers) and butchers from terminal markets come to buy animals. In the terminal markets (4th tier), big traders and butcher (wholesalers or retailers) transact larger number of mainly slaughter type animals.

Ethiopia also exports chilled goat meat to five countries and mutton to the Gulf States of Saudi Arabia and United Arab Emirates which are the largest recipients (Solomon Gizaw *et al*., 2005). Similar author reported that high annual volumes in recent years are especially apparent for mutton and lamb (2003) and goat meat (2003-4), confirming that export market options for Ethiopia have recently expanded.

2.8.2 Marketing constraints

Improving marketing success of livestock producers that improve livestock productivity, which in turn improves marketing success, Access to local market, is the most important economic determinant to adopt technologies, (Zelalem Tamerat, 2007) and choice of production enterprises. Market locations in primary and secondary markets are usually not fenced; there are no permanent animal routes and no feed and watering infrastructures. Yet, buyers and sellers are subjected to various service charges by the local authorities as well as other bodies, Ayele (Solomon *et al*., 2003). Nearly in all parts of the country, there is no regular market information on prices and supplies, nor formalized grades and standards of sheep and goats and other livestock (Kebede Andargachew and Ray 1992; Ayele Solomon *et al*. 2003). As a result, there is excess supply of animals beyond demands in some seasons.

The more mobile trader is better informed on market prices which combined with excess supply places the trader in a better position during price negotiation. Illegal market in

Metema area is identified as a constraint to producers and traders, (Tesfaye Tetsegaye, 2009).Traders and exporters are also faced with marketing problems. A survey in IPMS, Berhanu Gebremedhin *et al*., 2007) identified lack of adequate supply of good condition animals, inadequate market places, lack of holding (concentration) places, feed supply, lack of market information, poor marketing infrastructure and multiple taxation at checkpoints (especially when animals are trekked or trucked through towns) and lack of efficient vaccination services for export animals as the major problems.

2.9. Body weight and linear body measurements

For breeding (selection), feeding and health care and for market age determination knowing the body weight of a sheep is important. However, this fundamental knowledge is often unavailable for sheep in the small scale farming sector, due to unavailability of scales, (Zewdu Edea, 2008). According to Sisay Lemma (2002) variation exists between indigenous sheep breeds for body weight traits.There are number of reports on body weight and linear body measurements among them recently, (Mengiste Taye, 2008) reported 28.3 ± 0.3kg, 69.1± 0.20cm, 59.5 ± 0.2cm and 77.1 ± 0.3cm for body weight, wither height, body length and chest girth, respectively for Washera female sheep. Similarly the same author reported 32.3 ± 2.8 kg, 70.0 ± 1.90 cm, 61.5 ± 1.8 cm and 82.3± 2 cm for body weight, wither height, body length and chest girth, respectively for Washera male sheep. Among the indigenous sheep breeds Bonga male sheep had 48 kg, 73 cm, 69 cm and 85 cm body weight, wither height, body length and chest girth, respectively ,Markos Tibbo (2004), so Bonga sheep can be mentioned as large sized breed and superior in its body weight.

According to Mengsite Taye *et al* (2011) Farta sheep is short fat tailed. 67% of males and 10% of females were horned. The overall mean body weight, wither height, heart girth, body length and pelvic width obtained were 25.8±0.26 kg, 63.6±0.31 cm, 70.4±0.38 cm, 55.4±0.30 cm and 12.7±0.11 cm, respectively. Fixed effects age and sex had affected all the traits considered. Male and older age sheep were consistently larger for all the traits over female and younger sheep respectively. Generally, it is possible to conclude that Farta sheep is relatively of smaller body size as compared to other breeds of the country. Efforts to improve the performances of Farta sheep should consider the harsh

environmental condition to which the breed is maintained.Solomon Abegaz *et al* (2011) reported Gumuz sheep is a thin tailed short haired sheep. The mean mature body weight (kg) obtained was 31.4 and 34.6 for females and males, respectively. The average body length (cm) obtained were 67.0 and 68.3, height at wither (cm) were 63.6 and 67.3and chest girth (cm) were 76.1 and 78.0 for mature females and males, respectively. The average birth weight, one month weight and adjusted weaning weight were 2.79±0.03 kg, 6.57±0.18 kg and 12.5±0.23 kg, respectively.

2.10. Animal genetic resources characterization

Populations of livestock species in developing regions are traditionally recognized as distinct types by ethnic group or geographical locations, from where they often derive their names. Preliminary identification of breeds or populations involves phenotypic characterization of distinct populations using a combination of stratified and purposive sampling strategies. Qualitative and quantitative descriptions, including morphometric measurements of animals, are collected through farm level surveys to identify and describe the representative samples of animals from the targeted populations or breeds or breed groups. For this purpose, a comprehensive list of animal descriptors was developed by FAO (1986) and Workneh Ayalew and Rowlands (2004).

Characterization is a vital tool in animal selection and breeding. However, lack of information on the genetic potential and diversity of sheep discourages attempt towards their exploitation and conservation for increased productivity, Buvanendran *et al* (1980). The term "phenotypic characterization of AnGR" is used to refer to the process of identifying distinct breed populations and describing their characteristics and those of their production environments, FAO (2010b).

Characterization of indigenous breeds is a base for any breed or productivity improvement programs. Characterization should include physical description, reproduction and adaptations, uses, prevalent breeding system, population trends, predominant production system, description of environments in which it is predominantly found and an indication of performance levels (Workneh Ayalew *et al.,* 2004). Standard phenotypic characterization of breeds/ SPCB/ is carried out based on morphological characters such as coat colour, horn, tails, body measurements and other specific and visible traits.

According to Workneh Ayalew *et al.,* (2004), Ethiopia sheep are classified in to at least six breed types and three breed groups (the fat-tailed hair sheep, the fat-tailed coarse wool sheep and the fat rumped hair sheep.) Solomon Gizaw (2008) also classified Ethiopian sheep breeds in to 14 traditional populations, 9 breeds and 6 major breed groups (Short-fat-tailed, Washera, Thin-tailed, Long-fat tailed, Bonga and Fat-rumped).

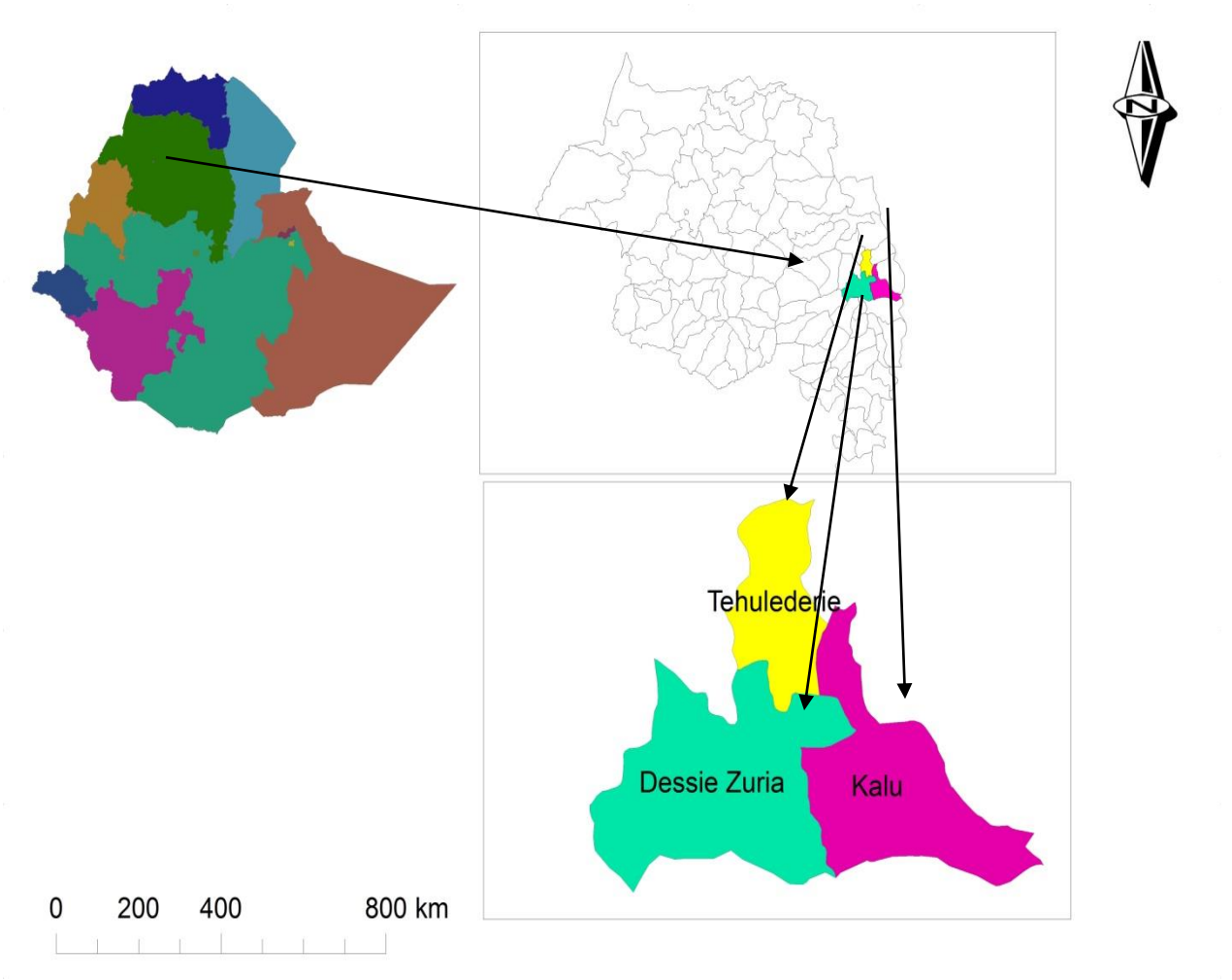
2.9.1. Phenotypic characterization

Qualitative and quantitative variables to be observed and recorded include: Phenotype: qualitative variables such as coat color, fiber type, face profile, presence of horn, and tail type, and quantitative characters to be measured are body weight, withers height, body length, and heart girth. Phenotypic performance characteristics, such as body weights of adult males, daily milk yield at onset or peak lactation, and lactation length. Flock/herd-level reproductive performance data (e.g. ewe fertility, lambing rates, prolificacy, and pre-weaning survival rates).Means for each quantitative measurement is calculated to describe each population sampled.

CHAPTER THREE

MATERIALS AND METHODS

Fig 1 Map of the study area



3.1. Description of the Study Areas

The study was conducted in South Wollo Zone of three districts (Dessie Zuria, Kalu and Tehuledere) of Amhara National Regional State (ANRS). South Wollo Zone is home for 1,487,920 head of cattle, 2,098,256 sheep, 760,497 goats, 377,141 equines, 1,471,914 poultry and 93,295 beehives. The Zone has the second highest livestock population in Amhara National Regional State. It ranks first in sheep population and third in cattle population compared to other zones. Wheat, sorghum and teff are the main crops. South Wollo is 398.

Based on the 2007 Census conducted by the Central statistics agency of Ethiopia (CSA), this Zone has a total population of 2,518,862, an increase of 18.60% over the 1994 census, of whom 1,248,698 are men and 1,270,164 women; with an area of 17,067.45 square kilometers.

Dessie Zuria: is one of the Woredas in South Wollo Zone, which is a moisture deficit Woreda. The major agro-ecologies are moist low and highlands (52%) and sub moist low and highlands (47%). The Woreda has rugged topography with highly degraded soils which are not generally suitable for cropping and land holding per household is small. The livestock population of the district is comprised of 109570 cattle, 164371 sheep, 58493 goats, 31,058 equines and 115102 poultry. Dessie Zuria is situated at an altitude ranging 1700-3800 meters above sea level with area of 937.32 km^2. Dessie Zuria districts receive an average annual 1150 mm rainfall and the mean annual temperature is 10.5^oC. Because of the high altitude less annual temperature recorded.(District office, unpublished, Dessie zuria agricultural and rural development office, 2004,). Based on Central Statistical Agency of Ethiopia (CSA), 2007) the total human population of Dessie Zuria was estimated to be 157,679 of whom 77,626 are men and 80,053 women people.

Tehuledere: Tehuledere is bordered on the south by Dessie Zuria, on the southwest by Kutaber, on the northwest and the north by the Mille River, on the northeast by Were Babu, and on the southeast by Kalu**.** Tehuledere is situated at an altitude ranging from 1100 to 2300 m.a.s.l. with area of 405.37 km^2. The average annual rainfall ranges from 1000 to 1100 mm per year and annual average temperature values is (19 ^oC) in the low lying areas of Tehuledere, especially those areas close to the Afar region.(District office, unpublished). Based on the 2007 national census conducted by the Central Statistical Agency of Ethiopia (CSA), this woreda has a total population of 117,877, a decrease of 1.14% from the 1994 census, of whom 59,300 are men and 58,577 women; 14,745 or 12.51% are urban inhabitants and 103,132 or (87.49%) are rural inhabitants. The livestock population of the district is comprised of 98,277 cattle, 57,960 sheep, 55,468 and goats (CSA 2013/14).

Kalu: Also known as (Harbu) and one of the woredas in South wollo zone. Kalu is bordered on the west by Dessie Zuria, on the north by Were Babu, on the south and east by the Oromia Zone, on the southeast by Argobba special woreda, and on the southwest by

Abuko. Kalu lies within an altitude range of 500-1750 m. a.s.l. The district receives an average annual rainfall of 200 to 800 mm per year and annual average temperature values is (17.75 ^{o}C) in the low lying areas of Kalu and especially those areas close to the Afar region (District office, unpublished). Based on the (2007) national census conducted by the Central Statistics Agency of Ethiopia (CSA) this woreda has a total population of 186,181.From this, 94,187 are men and 91,994 women; 89.36% of the population rural and 10.64% are urban inhabitants. Crops like Teff, barley wheat Maize and sorghum can grow. The district has about 88983 heads of cattle, 8110 heads of equines, 66885 heads of shoats, and 3256 heads of camels (CSA, 2013/14).

3.2. Sampling Procedures, sample size and Methods of Data Collection

Study sites were selected purposively based on the distribution of sheep population, Agro ecology and accessibility of sites and prior to sampling of the study Kebeles, valuable information was collected from the three districts of agriculture office. Discus about the objective of the work were held with districts livestock and veterinary experts, coordinators and head office. A rapid field visits were held to select the study Kebele. Based on this approach, three districts (Dessie zuria, Tehuledre and Kalu) were indentified.

Table 3.5 Summary of total Sample Size (HH and sheep) across study area

District	kebele	LBM of sheep		No. of HH interviewed	Discussion group
		Female	Male		
Dessie Zuria	Borumeda	22	10	20	1
	Tita	22	10	20	1
	Kurkur	22	9	20	1
Teuldre	Hara	22	9	20	1
	Kutir 05	21	8	20	1
	Kutir 09	22	8	20	1
Kalu	Kutir 01	21	9	20	1
	Kutir 05	21	9	20	1
	Kutir 34	22	9	20	1
Total	9	195	81	180	9

LBM =Linear body measurement

3.2.1. Survey

The survey data were collected from randomly sampled household who have sheep and Semi-structured questionnaires were used to collect all the relevant information in a single visit-multiple-subject formal survey method. The questionnaire was modified and prepared based on drafted guideline of FAO (2012). Socio-economic characteristics of household, flock composition, flock structure, trait preference, breeding practices, reproductive performances (age at first mating, age at first lambing, lambing interval, life time ewe and productive life), feed resources and feeding strategy, healthcare and common diseases, marketing system and production constraint were the major variables collected by the questionnaire.

In addition, focus group discussion and key informant and village elder's interviews were used to validate the data collected through household survey and to gain a greater insight into the topics covered. The group discussions was composed of village leaders, elder farmers, women and socially esteemed individuals. This is because these individuals are known to have better knowledge on the overall present and past status of sheep production and breeding in the study areas. The key informant interviews were held with livestock development agents and districts livestock development experts. The questionnaire was translated to Amharic language for data enumerators and interviewed farmers

3.2.2. Morphological and linear body measurements

For morphological characters (qualitative) and body measurements (quantitative), 276 animals, female (195) and male (81) were randomly sampled. Spring balance was used for measuring of body weight and meter was used to linier body measurement. Sheep sample were taken based on the minimum standard set by FAO (2012) to undertake characterization. Pregnant animals were excluded from the measurement to avoid bias. Flocks were measured early in the morning before grazing. Age groups of sheep were estimated and classified into five age groups based on their dentition (FAO, 2012) and the lambs and the young were differentiated by asking the age of animals from the owners.

Table 3.6. Age of sheep by its dentition classes and number of sample

Pair of permanent incisor teeth(PPI)	Age range	No of sheep Sampled		
		Female=195	Male=81	Total=276
0 PPI	< 1 years	36	20	56
1 PPI	pair 1-1½ years	52	19	71
2 PPI	pairs 1½-2years	38	18	56
3 PPI	2½-3years	39	11	50
4 PPI	More than three years	30	13	43

Source: FAO (2012), ESGPIP technical bulletin no.23 (2009)

The qualitative characteristics of 12 traits (sex, dentition, body hair coat colour pattern, body hair coat colour, hair type, horn presence, horn shape, horn orientation, ear orientation, facial (head) profile, wattles, ruff) FAO (2012) were observed and judged. The quantitative characteristics of 10 traits (body weight (BW), body length (BL), heart girth (HG), Tail length (TL)height wither (WH), ear length (EL), head length (HL), rump length (RL), rump width (RW) and rump height (RH) were recorded and measured by using the standard format adapted from the FAO (2012) breed descriptor list (Appendix). Body weight (kg) was estimated from heart girth measurement and other body measurements were taken using a flexible metal tape after restraining and holding the animals in natural position. The researcher and his assistants did the morphological and linear body measurements.

3.3. Statistical Analysis

3.3.1. Survey data

Data collected through questionnaire were coded and entered into Statistical Package for Social Sciences (SPSS for windows, release 20.0, 2011). For data involving frequencies, descriptive statistics were in use and Chi-square or t-test was employed when required to test independence of categories or to assess the statistical significance of household head's Characteristics, sheep flock size and structure.

Indices were calculated for ranked variables purposes of keeping sheep in the study areas, class of sheep selling when cash is needed in study areas, feed resources in the study areas,

criteria for trait preferences of sheep. In reference to its formula; Index = sum of (7 for rank 1 + 6 for rank 2 + 5 for rank 3+4 for rank 4 + 3 for rank 5 + 2for rank 6+1 for rank 7) given for an individual attribute divided by the sum of (7 for rank 1 + 6 for rank 2 + 5 for rank 3+4 for rank 4 + 3 for rank 5 + 2 for rank 6+1 for rank 7) for overall attributes (reasons).

3.3.2. Qualitative and linear body measurements

Data from the body weight, linear measurements and morphological observations for the phenotypic characterization was analyzed using statistical analysis system (SAS Version 9.2, 2010). Qualitative data from the observations were analyzed separately for both sexes for both agro ecologies/districts using frequency procedures. Chi-square test was employed to test for independence between the categorical variables.

General Linear Model (GLM) was used to determine the effect of agro- ecology; sex ,age and the interaction effect of age with sex on quantitative trait measurements using (SAS, Version 9.2, 2010) .Correlation (Pearson's Correlation coefficient) between body weight and the linear body measurements were computed.

Model used to analyze body weight and other linear body measurements was:

$$Y_{ijk} = \mu + S_i + A_j + D_k + (SA)_{ij} + e_{ijk}$$

Where:

Y_{ijk} = The Observed body weight and linear body measurements;

μ= Overall mean;

S_i= The fixed effect of sex (i=Male and Female);

A_j = The fixed effect ofage (j = 0PPI, 1PPI, 2PPI, 3PPI and 4PPI)

$D_{k=}$ The fixed effect districts (k=Dessie zuria, Tehuledre and Kalu)

$(AS)_{ij}$= The interaction effect of age with sex

e_{ijk} = Residual error

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1. General Household Characteristics

A total of one hundred eighty households (60 from each district and 20 from each kebeles were considered for the household survey in the current study. The value of sex, age, family size, and educational level of information of household headed respondents across the study areas is presented in Table (4.7). The average family size of Dessie zuria was higher than to the Tehuledre and Kalu and Tehuledre was higher than to Kalu. The average family size of the households in the study area was 6.5±0.23, 6.2±0.2 and 5.72±0.26 for Dessie zuria , Tehuledre and Kalu respectively. In this study, male headed household accounted for the largest proportion of the studied samples (respondents) throughout the study areas. Thus, the proportion of male headed household in Dessie zuria,Tehuledre and Kalu were 81.7%, 83.3% and 88.3%, respectively. The mean age of respondents was 46.1±0.9 years (ranged from 30 to 65) Dessie zuria, 48.4±1.5 years (27 to 75) Tehuledre, and 42.6.0±0.97 years (27 to 60) Kalu. Marital status of the respondents in Dessie zuria only (75%, 18.3% and 6.7%) of the respondents was married, divorced and widowed respectively whereas in Tehuledre was 83.3% married, 16.7% divorced and in Kalu, 85% married, 11.7% divorced and 3.3% widowed. Regarding education status of the respondents only (68.3 %, 60 % & 56.7%) read and writes (15%, 25%, and 30%) of the respondents Illiterate and (16.7%, 15% & 13.3%) was above grade four for Dessie zuria , Tehuledre and Kalu respectively.

Table (4.7) Household characteristics in different categories in the study areas

	Agro-ecologies							
	Highland		Midland		Lowland		Overall	
Descriptor	N	%	N	%	N	%	N	%
Owner's position in HH								
Female headed	11	18.3	10	16.7	7	11.7	28	15.6
male headed	49	81.7	50	83.3	53	88.3	152	84.4
Family size 1-2	3	5	11	18.3	2	3.3	16	8.9
3-5	34	56.7	38	63.4	47	78.3	119	66.1
>5	23	38.3	11	18.3	11	18.4	45	25
Average family size (Mean ± SE)	6.5±0.23		6.2±0.2		5.72±0.26		6.14±0.23	
Marital status* Married	45	75	50	83.3	51	85	146	81.1
Divorced	11	18.3	10	16.7	7	11.7	28	15.6
widowed	4	6.7	0	0	2	3.3	6	3.3
Educational level								
Illiterate	9	15	15	25	18	30	42	23.3
Write and Read	41	68.3	36	60	34	56.7	111	61.7
Grade4-6	10	16.7	9	15	8	13.3	27	15

4.2 Livestock holding

Livestock holding of the study area is summarized in next table, (4.8). Overall average, a household owned 4.37 cattle, 7.8 sheep, 4.5 goat, and 4.14 chickens, 0.73 donkeys, 0.4 mules, 0.41 camels and 0.3 horses (table 4.8).There was significant ($P<0.05$) difference in the livestock density between districts except mule holding. Higher Sheep holding per house hold in Dessie zuria than the Tehuledre and Kalu and cattle and goat holding in Dessie zuria was too less than to Tehuledre and Kalu. Rearing of camel is practiced only in Kalu.The advantage of sheep over cattle was because of more productive (more prolific, less gestation interval), easily produced on a small plot of land, contribute to more flexible short-term form of investment and also easily marketable compared to cattle's. This finding is in line with those of (Sahana *et al* 2004, Dixit *et al*, 2005 and Fikrete Firew, 2008)

Table (4.8) Livestock holding of the study area

Livestock holding	Agro-ecologies					
	Highland (Mean±SE)	Midland (Mean±SE)	Lowland (Mean±SE)	Overall (Mean±SE	X^2	P value
Cattle	3.3± 0.2	4.72±0.3	5.1 ±.03	4.37±0.16	50.2	<0.001
Sheep	9.7±0.6	7.5±0.43	6.2±0.3	7.8±0.28	14.1	0.008
Goat	1.29±0.16	4.6 ±0.21	6.6±0.5	4.5±0.25	2.21	<0.001
Chicken	4.12±0.3	4.5±0.3	3.8±0.23	4.14±0.16	26.2	0.000
Donkeys	1.1±0.09	0.6±0.07	0.46±0.07	0.73±0.05	35.9	<0.001
Mules	0	0.35±0.07	0.55±0.08	0.4±0.05	3.8	0.15(ns)
Camels	0	0	1.1±0.10	0.41±0.04	112.6	0.000
Horse	0.75±0.09	0	0	0.37±0.06	54.2	0.000

X^2 = Pearson Chi-square; SE = Standard Error

4.3. Sheep Flock Size and Structure

Flock structure of sheep is presented in Table (4.8) .The mean sheep flock size in Dessie zuria was higher and significant ($p<0.05$) than in Tehuledre and Kalu as showed in table (4.8). In Dessie zuria, breeding ewes accounted for the largest number (2.85± 0.18) followed by lambs less than 6 months old (2.57±0.1), female 6 month to 1 year (1.63±0.14), male 6 month to 1 year (1.13±0.12), breeding ram (0.87±0.12) and castrates (0.57±0.1). In Tehuledre as well, ram lambs less than 6 months old accounted for the largest number (2.2±0.16) followed by breeding ewes (1.92±0.11), female 6 month to 1 year (1.17±0.1), male 6 month to 1 year (1.03±0.01), breeding ram (0.63±0.1) and castrates (0.52±0.08). According to the survey result breeding ewes accounted for the largest number (2.27±0.1), in the Kalu followed by lambs less than 6 months old (1.82±0.13) male 6 month to 1 year old (0.75±0.1), female 6 month to 1 year (0.71±0.1), breeding ram (0.4±0.07) and castrates (0.28±0.06). There were sheep flock structure difference ($p< 0.05$) in breeding ewes, lambs less than 6 months , male 6 month to 1 year old ,female 6 month to 1 year , and no significance difference($p>0.05$) in castrates and breeding ram among districts.

The flock structure of breeding ewe and lamb was higher in all districts of the study area as compared to other age classes. This might be attributed to the prevalent practice of keeping ewe for breeding purpose which accounted the greater portion of the newly born animals while rams are either castrated or sold when they reach market age. The higher proportion of breeding ewe in the flock followed by suckling age group for both species was in agreement with those of Zewdu Edea *et al* (2008) and Mengistie Taye *et al* (2010)

Table (4.9) Sheep Flock Size and Structure of across the study area

	Districts				
Sheep age	Dessie zuria Mean±SE	Tehuledre Mean±SE	Kalu Mean±SE	Overall Mean±SE	P value
Lambs <6 month	2.57±0.1	1.92±0.11	1.82 ±0.13	2.1±0.1	0.03
Male 6 month to 1 year	1.13±0.12	1.03±0.01	0.75±0.1	0.97±0.06	0.007
Male>1 year(breeding ram)	0.87±0.12	0.63 ± 0.1	0.4±0.07	0.63±0.06	$0.082^{(ns)}$
Female 6 month to 1 year	1.63±0.14	1.17±0.1	0.71±0.1	1.17±0.07	<0.001
Female>1 year(breeding ewe)	2.85±0.18	2.2±0.16	2.27±0.1	2.44±0.06	0.003
castrated	0.57±0.1	0.52±0.08	0.28±0.06	0.46±0.05	0.12(ns)
Over all mean	9.7±0.6	7.5±0.43	6.2±0.3	7.8±0.28	0.008

SE = Standard Error; NS=Non Significant

4.4. Major farming activity

Mixed crop and livestock production system is the dominant farming system across the study areas. Livestock production is an important component and well integrated with crop production. Livestock species kept by the farmers comprise cattle, sheep, goats, equines and chicken; while camel was common in lowland. The major farming activities in the Dessie zuria and Tehuledre study area were 100% follow mixed crop-livestock production system. Whereas the Kalu farmers practiced dominantly (93.3%) mixed crop and livestock farming followed by livestock rearing (6.7%).

The major crops grown were cereals followed by pulses, vegetables, oilseeds and fruit crops. Main crop grown in the Dessie zuria were barley (55%), followed by wheat (22), maize(8%) field pea (9%) and linseed (6%) whereas wheat (40%), sorghum (32.5%) , maize (17.5%),

and teff (10%) were the main crop grown in Tehuledre were sorghum (70%),wheat (15%) , teff (9%) and maize (6%) were mainly grown in the lowland. Farmers in the Kalu study area; nearly Borkena River practiced different irrigated crop farming for cash income such vegetable crops (sugarcane, tomato, onions, and potatoes) and cabbages were also reported to be used as additional source of income next to the sale of crop and livestock

4.5. Purpose of keeping Sheep and Marketing

4.5.1. Purpose of keeping

Table (4.10), shows the ranks of the sheep production objectives by smallholder farmers. The reasons for keeping sheep are related to the farmers' needs in the long or short term. The results of this survey showed that sheep play multi-functional roles in all production systems with almost similar production objectives. The results indicated the relative importance of tangible benefits of sheep keeping were (such as income generation, saving, meat consumption, skin, Wealth and manure).The primary reason for keeping sheep in the study area was income generation with the index of (0.28, 0.26 and 0.26) for Dessie zuria , Tehuledre and Kalu respectively through the sale of live animals .The cash obtained might be used to buy clothing and food items, pay taxes, additional fertilizers to manures and household supplies (children schools).Other reasons mentioned by farmers and their respective indices were meat consumption (0.26,0.19,0.17), Saving (0.2,,0.18,0.15), skin (0.16,0.2,0.19),Wealth (0,0.08,0.09) and sheep as means of manure (0.1,0.11,0.13) for Dessie zuria , Tehuledre and Kalu respectively. This result is in line with those of Gatenby (2002), Chipman (2003), Adugna Tolera and Aster Abebe (2007), Belete Shenkute (2009) and Mengistie Taye *et al* (2010). All the average nearly, ninety nine percent (99%) of the interviewed households showed, the future interest to continue and expand sheep production. Among the reason of sheep production expansions, immediate return, twinning ability, high fertility rate and high market demand are the most appreciated issues currently.

Table (4.10). The mean weighted index of the sheep production objectives in the study area

Agro-ecologies/	Rank of sheep keeping objectives						
Dessie zuria	R1	R2	R3	R4	R5	R 6	index
Meat for home con	16	28	13	3	0	0	0.26
Income	35	16	9	0	0	0	0.28
Wealth status	0	0	0	0	0	0	0
Manure	0	0	0	18	25	17	0.1
Skin	0	3	17	24	16	0	0.16
Savings	9	13	21	15	2	0	0.2
Tehuledre							
Meat for home con	11	13	17	14	5	0	0.19
Income	31	23	6	0	0	0	0.26
Wealth status	0	0	0	5	25	30	0.08
Manure	0	0	15	7	18	20	0.11
Skin	11	13	7	16	9	4	0.2
Savings	7	11	15	18	3	6	0.18
Kalu							
Meat for home consumption	6	13	13	12	15	1	0.17
Income	33	22	5	0	0	0	0.26
Wealth status	0	0	5	9	15	31	0.09
Manure	2	5	10	10	21	12	0.13
Skin	10	15	17	12	6	0	0.19
Savings	9	5	10	17	3	16	0.15

R1= Rank 1, R2=Rank2, R3 Rank Rank3, R4= Rank4, R5= Rank5, R6= Rank6

4.5.2. Marketing of Sheep

The survey result revealed that the nearby traditional (local and woreda) market is available around the farmers throughout the year. Farmers mainly sold their sheep to traders, butchers, and consumers and to farmers. Most of sheep keepers across the study areas were sold their sheep when they got financial problems to cover different expenses (school fee for their

children, closing, medical, agricultural inputs and other household expenses and when droughts happen and as regular income generation). However, respondents across the study areas reported that they usually sell their sheep classes by making priority unless they are forced to sell due to urgent money demand in the household. In Dessie zuria, mostly farmers practice fattening. Castrated in the first, old ram and old ewe second and third with the index of (0.33, 0.29, and 0.23) and old ram was the first rank in Tehuledre and Kalu study area for immediate sale. Average market age of male and female sheep in the Dessie zuria was 8.9±0.08 and 9.4±0.07 months respectively. Whereas (8.2±0.03 and 8.8 ±0.01) months for male and female in Tehuledre and 7.9±0.08 male and 8.2±0.2 month female in the Kalu study area. Respondents sold every age category (lambs up to old ewe/rams and castrated rams) of sheep whenever they want cash income. However, it indicates herders maintain their breeding flock by retaining outstanding males in the ewe/rams rather than selling breeding female from the flock.

Table (4.11). The mean weighted index of class of sheep selling when cash is needed flock and sell the undesirable ones and old

	Dessie zuria							Teuledre							Kalu						
Category of sheep	R1	R2	R3	R4	R5	R6	index	R1	R2	R3	R4	R5	R6	Index	R1	R2	R3	R4	R5	R6	index
lambs	0	0	0	14	43	3	0.06	0	0	0	14	43	3	0.05	0	0	0	14	43	3	0.06
Breeding ewe	0	0	0	19	17	24	0.04	0	0	0	19	17	24	0.09	0	0	0	19	17	24	0.04
Breeding rams	0	4	1	22	0	33	0.07	0	4	1	22	0	33	0.05	0	4	1	22	0	33	0.07
Castrated	32	26	2	0	0	0	0.33	32	26	2	0	0	0	0.27	32	26	2	0	0	0	0.33
Old ewe	13	10	32	5	0	0	0.23	13	10	32	5	0	0	0.21	13	10	32	5	0	0	0.21
Old rams	15	20	25	0	0	0	0.29	15	20	25	0	0	0	0.33	15	20	25	0	0	0	0.29

R = Rank, Index= sum of (3 for rank 1+ 2 for rank 2 + 1 for rank 3) given for an individual reason (attribute) divided by the sum of (3 for rank 1 + 2 for rank 2 + 1 for rank 3) for overall reasons.

The meat demand grows much higher during major holidays/festivals. Thus, the density of producers who sale their sheep targeting the particular holidays/festivals was higher. This was to reap maximum benefit from sales. In Dessie zuria (55% and 45%) farmers were sell their sheep in the farm and woreda market respectively and Tehuledre farmers (34%, 40%, and 26%) sale their sheep at the farm/home, local and woreda market respectively whereas respondents in Kalu study area, sale their sheep at the farm/home (26.4%), local market (55%), and woreda market (26.4%).(36.7%,28.3% and 35%) of farmers in Dessie zuria sale their sheep for trader, butcher and farmer respectively .Similarly in Tehuledre d and Kalu farmers sale their sheep for trader (40%, 33.3), butcher (31.7% 31.7) and for farmer (28.3% 35%) respectively. This result was similar with the reports of Tsedeke Kocho (2007), Belete Shenkute (2009) and Tesfaye Getachew (2009) in Southern, Western and Northern part of Ethiopia

4.6. Husbandry Practices Indigenous sheep in South Wollo

4.6.1. Feed resources and feeding system

Available feed resources for sheep commonly used by farmers in the study area in different seasons are presented in Table (4.12). The quantity and quality of feed resources available for animals primarily depends upon the climatic and seasonal factors, (Zewdu Edea, , 2008).The different feed resources reported in all across the studied areas were natural pasture, crop residue, hay, improved pasture and concentrate for both dry and wet season.
The importance of natural pasture as major feed resource for sheep was also reported by (Solomon Abegaz, 2007). According to the respondents in the study area, natural pasture from the communal rangeland and grazing on fallow land ranked first in wet season were the main feed source for sheep in all agro-ecologies whereas crop residue was the first and main feed source of sheep for highland and lowland whereas hay was the first feed source in midland in dry season.

Generally with the index of natural pasture (0.3), hay (0.25), concentrate (0.19), crop residue (0.12), improved pasture (0.11) were the main feed resource in wet season in highland whereas crop residue (0.31), hay (0.27), natural pasture (0.17), were the main feed resource in dry season. However, the major feed resource commonly used in midland were with the index of natural pasture (0.34, 0.24), hay (0.29, 0.33), crop residue (0.18, 0.25), concentrate

(0.19, 0.18) in both wet and dry season .Similarly farmers in lowland used feeds for their sheep were natural pasture (0.3, 0.2), hay (0.27, 0.31), concentrate (0.15, 0.16), crop residue (0.15, 0.33), improved pasture (0.13, 0) in wet and dry season with the respectvily index .

Table (4:12) Feed resources of sheep across the study area

Feed resource	Distiricts																	
	Dessie zuria						Tehuledre						Kalu					
Wet season	R1	R2	R3	R4	R5	I	R1	R2	R3	R4	R5	I	R1	R2	R3	R4	R5	I
Natural pasture	32	19	9	0	0	0.3	42	18	0	0	0	0.34	46	14		0	0	0.3
Improved pasture	0	6	2	18	34	0.11	0	0	0	0	0	0	0	0	1	28	31	0.13
Hay	26	25	9	0	0	0.29	17	30	13	0	0	0.29	14	33	12	1	0	0.27
Crop Residue	0	0	7	31	22	0.12	1	6	17	36	0	0.18	0	7	20	21	12	0.15
Concentrate	2	10	33	11	4	0.19	0	6	30	24		0.19	0	6	27	10	17	0.15
Dry Season																		
Natural pasture	11	23	18	8	0	0.25	11	17	23	9	0	0.24	0	6	30	24	0	0.2
Hay	12	20	11	17	0	0.27	36	19	5	0	0	0.33	19	40	1	0	0	0.31
Crop Residue	37	17	2	4	0	0.31	13	24	23	0	0	0.25	41	14	5	0	0	0.33
Concentrate	0	0	29	31	0	0.17	0	0	9	51	0	0.18	0	0	24	36	0	0.16

I=Index, R1=Rank1, R2=Rank2, R3=Rank3, R4=Rank4, R5=Rank5

4.6.2 Grazing Management and ways of herding

Grazing management and way of herding sheep in the study area is presented in (Table 4.12). None of respondents practice free grazing in all study area in dry and wet season. (78.3%, 65%, and 11.7%) in Dessie zuria, Tehuledre and Kalu respondents practice sheep graze with other livestock respectively and (0%, 20%, 41.7%), with goat, (21.7%, 15%, 4 6.6%) sheep graze alone. In Dessie zuria, farmer grazes their sheep by herding (76.6%, 50%) tethering (0%; 18.3%) and cut carry system (23.4. %; 31.7%) in dry and wet season and in Tehuledre herding (86.6%, 56.7%) tethering (0%; 25%) and cut carry system (13.4. %; 18.3%) in dry

and wet season whereas Kalu were practice herding (73.3%, 36.7%) tethering (0%; 41.7%) and cut carry system (26.7 %; 21.4%) in dry and wet season respectively.

Male family members mostly practiced herding and there was no labour shortage across the study areas. However, in Dessie zuria there are higher number of sheep population reared, owners employ animal keeper with payment of money and with living as a family member. While if the keeper was from family or relative member, by gave one or more female sheep from the flock as a gift to rear as his own animal

Table (4.13) Grazing management practices of sheep in the study area

	Distiricts							
Grazing management practices	Dessie zuria		Tehuledre		Kalu		Overall	
Ways of grazing	N	%	N	%	N	%	N	%
Sheep alone	13	21.7	9	15	28	46.6	50	27.8
Sheep with goat	0	0	12	20	25	41.7	37	20.6
Sheep with other livestock	47	78.3	39	65	7	11.7	93	51.6
Grazing in dry season								
Herded	46	76.6	52	86.6	44	73.3	108	60
Cut and carry	14	23.4	8	13.4	16	26.7	38	21.1
Grazing in wet season								
Herded	30	50	34	56.7	22	36.7	86	47.8
Tethered	11	18.3	15	25	25	41.7	51	28.3
Cut and carry	19	31.7	11	18.3	13	21.4	43	23.9

N=Number of household (respondents)

4.6.3. Water sources and watering

According to the respondent, Table (4.13), river was the major water source (78.3%, 26.7%) in dry and wet season respectively for Kalu. In dry season , Dessie zuria farmers get water for their animals from, spring (23.3%), and hole/water well (76.7) whereas in wet , water well (55%),spring (25%) and from pond (20%) in a distance of 1-5 Km. Solomon Abegaz (2007) also reported that river was the major water source in Gumuz sheep in north western lowland of Amhara region. During the dry season, Tehuledre farmers got water for their

sheep from water well (40), pond (18.3 %),river (35%), and spring (6.7%) and farmers allowed their flock to take freely available (43.3%), twice a day (38.3%) and once a day (18.4%) in 1-5 km circumstance .On the other hand, during wet season majority of the farmers in Kalu (40%) spring (31.7%) pond and (26.7%) in 100% freely watered in 1-5 km distance.

Table (4.14) .Water resource, frequency of watering, and distance to water of the study area

	Districts					
Dry season	Dessie zuria		Tehuledre		Kalu	
source of water	N=60	%	N=60	%	N-60	%
hole/water well	46	76.7	24	40	2	3.3
Dam/pond	0	0	11	18.3	0	0
River	0	0	21	35	47	78.3
Spring	14	23.3	4	6.7	11	18.3
Distance to water						
<1 Km	3	5	51	85	57	95
1-5 1 Km	57	95	9	15	3	5
Frequency of watering						
Freely available	19	31.7	26	43.3	31	51.7
Twice a day	38	63.3	23	38.3	17	28.3
Once a day	3	5	11	18.4	12	20
Wet season						
Hole/water well	33	55	16	26.7	1	1.7
Dam/pond	12	20	21	35	19	31.7
River	0	0	13	21.7	16	26.7
Spring	15	25	10	16.7	24	40
Distance to water						
<1 Km	0	0	0	0	0	0
1-5 Km	60	100	60	100	60	100
Frequency of watering						
Freely available	23	38.3	60	100	60	100
Twice a day	0	0	0	0	0	0

Once a day	37	61.7	0	0	0	0

4.6.4. Housing of sheep

Farmers all in the study area housed their sheep throughout the year to protect them from cold and rain, predators and theft. Dessie zuria and Tehuledre respondent are housed usually their sheep in separated and in the adjoined house whereas Kalu respondents housed their sheep in family house which is separated by wood addition to the separated and in the adjoined house.

Some farmers in the Kalu with small flock size tie their sheep to a peg. According to the information of the members of the focus group, there is a difference in the productivity of sheep between those tied and housed freely, i.e., tied animals were healthier and productive than those housed freely. Farmers explained this as sheep housed freely lay one over each other because of their social behaviour and also in need of the warmth from huddling. Pregnant animals, young lambs and weak animals are the most vulnerable groups. In addition, animals may not get enough rest at night.

Newborn lambs in the first week of birth are separated from their dam and cared for at home during the day when sheep are taken to grazing and before they get into their house upon their return in the afternoon. This is a common practice in other parts of the country (Abebe Mekoya, 1999; Mengistie Taye, 2008; Tesfaye Getachew, 2008). In all the study area, farmers use large baskets to keep newborn lambs and allow lambs to be kept dry, clean and warm. Suckling occurs in the morning before the dam leaves for grazing and when the flocks are back from grazing in the afternoon.

Table (4.15) Housing system of sheep in the study areas

	Agro-ecologies					
	Highland		Midland		Lowland	
House type	N	%	N	%	N	%
Separated House	43	71.7	27	45	23	38.3
Adjoin house	17	28.3	33	55	32	53.3
In family house	0	0	0	0	5	8.4

N= Number of respondent

4 .6.5 Common types of diseases and parasites

It is well documented that disease control is very basic for genetic improvement of livestock, Solomon Gizaw (2007). Healthy sheep with normal physiological function and structure that enable the sheep to attain highest production is vital. According to respondents, the expansion of governmental and privet veterinary services in all agro ecologies mentioned that sheep loss have been partially minimized. However, respondents of the study areas were able to identify the types of diseases affecting their animals by recognizing the common symptoms through experience. In this study internal and external parasite, Diarrhea, Anthrax, FMD, Pasturelloesis, were the most frequently reported diseases. Internal and external parasites (13.3%), Pasturelloesis (51.7%), Anthrax (23.3%), Diarrhea(11.7%), common disease of Dessiee zuria and (55% & 45%) respondent got veterinary access from government and private veterinary in a distance of <1 km (18.3%),1-5km (71.7%) and greater than 5 km (10%) circumstance. Whereas in Tehuledre, Internal and external parasites (18.3%), Pasturelloesis (31.7%), Anthrax (10%), Diarrhea (15%), FMD (25%). Tehuledre respondent got veterinary access from government and private veterinary in a distance of 1-5 km (35) and greater than 5km (65%) and treat their sheep from government veterinary (65%), private veterinary (15%) and from shop or open market (20%) whereas in Kalu common disease are Internal and external parasites (25%), Pasturelloesis (16.7%),Anthrax (5%), Diarrhea (35%) ,FMD (18.3%) and treat their sheep from the government veterinary service.(80%), private veterinary (6.7%), shop or open market (13.3%) in a distance of <1km (11.7%), 1-5km (60%) and >5km (28.3%) .

4.7. Breeding Management

4.7.1. Criteria of trait preferences

Respondents across the study areas practiced selection for both breeding males and females. Selection within the indigenous population is necessary to understand their potential & to use and to cull less desirable male and female animals. Farmers in all across the study areas were well experienced in selection of future breeding ewes and rams. Almost all farmers in all agro ecological areas, appearance, growth rate, color, age and libido were the primary source of criteria for selecting breeding ram and twinning ability, age at first maturity, lambing interval, body conformation, Color, docile were the main preferred traits in selection of future breeding ewes. The mean weighted index of the owners' selection criteria for breeding ewe and ram across the study areas is presented in table (4.16). Dessie zuria respondents were more emphasized for body conformation with the index (0.23), growth rate (0.22) and colour (0.21) for male selection criteria and also twinning ability (0.26) Lambing interval (0.26) and body conformation (0.19) for breeding ewe selection criteria as respective index whereas in Kalu (index=0.25, 0.22, 0.21) twinning ability, lambing interval and appearance are more emphasized selection of breeding ewe while the male selection criteria of this agro-ecology area was, body conformation with the of index (0.25) growth rate (0.23) colour (0.19) and age (0.17). Selection criteria for breeding ewe for Tehuledre were, twinning ability (0.26), lambing interval (0.25) and body conformation (0.19) while the male selection criteria was, body conformation (0.25) growth rate (0.24) colour (0.2) and age (index=0.14) with respective index.

Table (4.16) The mean weighted index of trait preferences for the selection of breeding sheep in the study area

Traits	Districts																			
	Dessie zuria							Teuledre							Kalu					
Ram	1	2	3	4	5	6	index	1	2	3	4	5	6	index	1	2	3	4	5	6	index
Body conformation	20	23	17	0	0	0	0.23	26	20	12	2	0	0	0.25	19	29	12	0	0	0	0.25
Color	15	18	12	8	7	0	0.21	8	20	11	17	4	0	0.2	21	0	6	15	18	0	0.19
Docile	0	0	6	7	17	30	0.09	0	0	0	5	22	33	0.07	0	0	3	6	20	31	0.08
Growth rate	25	13	15	1	0	6	0.22	26	18	16	0	0	0	0.24	18	20	14	5	0	3	0.23
Age	0	6	10	32	12	0	0.15	0	2	12	33	8	5	0.14	2	11	25	20	2	0	0.17
Libido	0	0	0	12	24	24	0.09	0	0	9	3	26	22	0.09	0	0	0	14	20	26	0.09
Ewe																					
Twinning ability	30	25	5	0	0	0	0.26	26	31	3	0	0	0	0.26	28	21	11	0	0	0	0.25
Body conformation	2	7	37	14	0	0	0.19	11	5	22	17	5	0	0.19	9	22	19	10	0	0	0.21
Color	0	5	9	26	15	5	0.14	0	5	23	25	7	0	0.16	0	6	13	30	11	0	0.15
Docile	0	0	0	1	26	33	0.07	0	0	0	0	23	37	0.07	0	0	0	2	30	28	0.1
AFM	0	0	0	19	19	22	0.09	0	0	0	12	25	23	0.08	0	0	0	9	19	32	0.08
lambing interval	28	23	9	0	0	0	0.25	23	19	12	6	0	0	0.24	23	11	17	9	0	0	0.22

AFM= age at first maturity

4.7.2. Breeding Practices

Breeding/mating was 100% in Kalu uncontrolled .Only in Dessie zuria and Tehuledre (21.7%, 26.7%) practiced controlling breeding to avoid dry season lambing and to prevent the born of undesirable lambs and by culling/ castration and isolation, of unwanted ram and selecting desirable male and female to mate. Reason of uncontrolled mating in the Dessie zuria area, due to having common grazing area (68.3%) and lack of awareness (31.7%) reported by respondents. whereas respondents reported in Tehuledre for uncontrolled mating, common grazing area (66.7%) lack of awareness (25%) and due to insufficient ram in the flock (8.7%). In Dessie zuria (60%), Tehuledre (76.3%) and (58.7%) respondents in Kalu , that they were able to identify the sire of the lamb by relating lamb with the color (75%,63.3%,78.3%) and appearance (25%, 31.7%, 21.7%) respectively in Dessie zuria, Tehuledre and Kalu.

In all the studying area, 100% respondents reported allow their ram to mate his mother, daughter and sister .The ram use pattern and source were (36.7%, 31.7%, 21.7%) Neighbors and (63.3%, 68.3%, 78.3%) of the rams are own flock for Dessie zuria, Tehuledre and Kalu respectively. The results are indicator to the fact that a fair degree of inbreeding can be expected in the flock as a single ram may be siring a number of offspring's in a year and from neighboring households .The obtained result is in agreement with that of (Tesfaye Getachew *et al* 2010, 2011)

Table (4.17) Breeding management and way of mating system of the study areas

Descriptor	Districts						Overall	
	Dessie zuria		Teuledre		Kalu			
Mating system	N	%	N	%	N	%	N	%
Controlled	13	21.7	16	26.7	0	0	29	16.1
Uncontrolled	47	78.3	44	73.3	60	100	151	83.9
Reason of uncontrolled mating								
Common grazing area	41	68.3	40	66.7	32	53.3	113	62.8
Lack of awareness	19	31.7	15	25	21	35	55	30.6
Insufficient ram	0	0	5	8.7	7	11.7	12	6.6
Do you identify the sire of lamb:Yes	42	60	46	76.7	35	58.3	123	68.3
No	18	40	14	23.3	25	41.7	57	31.7
Criteria to identify sire								
body conformation	15	25	19	31.6	13	21.7	47	26.1
Color	45	75	38	63.3	47	78.3	130	72.2
Source of breeding ram; Own flock	38	63.3	41	68.3	47	78.3	110	61.1
Neighbors	22	36.7	19	31.7	13	21.7	70	38.9
Do you allow a ram to mate his mother								
Yes	100	100	100	100	100	100	100	100
No	0	0	0	0	0	0	0	0
Do you allow a ram to mate his daughter	100	100	100	100	100	100	100	100
Yes	0	0	0	0	0	0	0	0
No	100	100	100	100	100	100	100	100
Do you allow a ram to mate his sister								
Yes	100	100	100	100	100	100	100	100
No	0	0	0	0	0	0	0	0

4.8. Reproductive Performance

4.8.1 Age at first lambing (AFL)

The average reproductive performance of sheep in the study is presented in Table (4.18). The average age at first lambing (AFL) was assessed to be (13.22±0.03, 13.4±0.13 and 13.1±0.09) months in Dessie zuria, Tehuledre and Kalu respectively. Age at first lambing (AFL) results as assessed in the study significantly ($P<0.05$) differed across the three districts. This result tell us to the fact that the ewes attain maturity later in the Tehuledre areas when compared to those reared in the Dessie zuria and Kalu districts .Which may be a fallout of both genetic and non genetic factors affecting of the trait. The average age at first lambing (taking all the agro-ecologies into account) is agreed with the observations of Tsedeke Kocho (2007) in Alaba area of SNNPRs. However, the mean values are lower than those reported by Fikerte Firew (2008),Getahun Legesse (2008), Mengestie Taye *et al* (2011) and Zewdu Edea (2008).

4.8.2. Lambing interval (LI)

Lambing interval (LI), presented in Table 4.18. Lambing interval is one of the most important components affecting the lifetime productivity of the ewe. Results of lambing interval as assessed in the study were significantly ($P<0.05$) differed across the three districts. From the result the time between successive parturition of indigenous sheep in Dessie zuria were shorter than Tehuledre and Kalu. The mean lambing interval (LI) in the study area was assessed to be Dessie zuria (7.8±0.08), Tehuledre, (8.03±0.08) and Kalu (7.87±0.02) month. The result agreed with result of (Mukessa Mugerwa,Lalalou, 1995) in Menz sheep ,less than washera by Mengistie Taye (2008) and greater than Arsi-Bale sheep by Tsedeke Kocho (2007).The result in the study indicates that the ewes are regular breeders and they may be lambing three in two years.

4.8.3. Litter size (LS)

The average litter size or prolificacy as obtained in the present study area is (1.13±0.05, 1.32±0.07, 1.22±0.05) per head for Dessie zuria, Tehuledre and Kalu respectively. No significance difference between districts in liter size. This result is comparable to the observation of Horro sheep breed as reported by Solomon Abegaz *et al* (2000). However, the

average litter size is lower than the average litter size Arsi-Bale sheep reported by Tsedeke kocho (2007) and Bonga by Belete Shenkute (2009) in-mixed crop livestock production in Alaba area of SNNPRs and Goma district of Jimma zone, respectively. However, Mukasa-Mugerwa *et al* (2002) reported 1.13 in Menz and 1.14 in Horro Ethiopian highlands sheep.

Table (4.18) The average reproductive performance of sheep in the study area

	Districts				
	Dessie zuria	Teuledre	Kalu	Overall	
Characters	Mean ±SE	Mean ±SE	Mean ± SE	Mean ± SE	p -valu
Average age at 1st mating of male (months)	7. 5±0.04	7. 23±0.07	7.14.±0.3	7.29 ± 0.05	0.062
Average age at 1st mating of female (months)	8.1±0.12	8.42±0.23	8.73±0.10	8.42±0.14	0.001
Average age at 1st lambing (months)	13.22±0.03	13.4±0.13	13.1±0.1	13.1±0.09	
Av erage lambing interval (months)	7.8±0.08	8.03±0.08	7.87±0.02	8.04±0.07	0.0052
Average litter size	1.13±0.05	1.32±0.07	1.22±0.05	1.22±0.06	0.056ns
In life span of ewe give a crop number	13.9±0.34	9.13±0.19	8.6±0.24	10.5±0.3	0.0011

4.9. Major Sheep Production Constraints

Sheep production in the study areas was significantly benefited the owners or producers, they could be used for meat for home consumption, major source of cash income, for schooling fee, source of input purchase and other festivity activities. It was also used as insurance for crop production. Farmers reported that the major sheep production constraints were disease and severe feed and water shortage, drought and predator across the study areas. The pasture production potential was declining because of shrinkage of pastureland due to increasing of farmland, overstocking and deforestation. In Dessie zuria ditricts, feed shortage was severe following by sever disease and water shortage with the index of (0.33, 0.32 and 0.2) respectively. The feed shortage Problem was increased during dry season, from March to May; whereas in Teuledre disease (0.29), feed shortage (0.26) followed by (0.24) water shortage with the respective index.

Drought occurrence and predator was also the other constraints that affected sheep production. In Kalu with respective index of disease (0.3) feed shortage (0.26), water shortage (0.23) were the major sheep production constraints. According to informants, and village elder, the diminishing in size of grazing land was related with the conversion of areas that used for grazing offered for different organizations, investors and settlers. Occurrence of outbreak disease following the mid ending rainy season was major constraints in the Kalu area.

Table (4.19) The mean weight of major constraints of sheep production in the study areas

	Districts																	
	Dessie zuria						Tehuledre						Kalu					
Major constraints	R1	R2	R3	R4	R5	Index	R1	R2	R3	R4	R5	Index	R1	R2	R3	R4	R5	Index
Disease	24	26	9	1	0	0.32	31	18	11	0	0	0.29	33	19	8	0	0	0.3
Drought	0	2	23	35	0	0.15	0	0	5	27	28	0.11	0	0	3	41	16	0.12
Feed shortage	29	18	13	0	0	0.33	19	22	13	6	0	0.26	18	22	17	3	0	0.26
Water shortage	7	14	15	24	0	0.2	10	20	24	6	0	0.24	9	19	25	5	2	0.23
Predator	0	0	0	0	0	0	0	0	7	21	32	0.1	0	0	7	11	42	0.09

N=Number of respondents

4.10. Phenotypic Characterization of Indigenous sheep in South wollo

4.10.1. Qualitative characteristics

The physical characteristic of 81 male and 195 female indigenous sheep in across the study areas is presented in table (4.20.) In the entire study, plaint coat colour is dominant in all districts. The study discovered out of the total sampled population, the dominant body hair coat colour pattern for male was observed (65.5%, 24.1%, 10.4%) whereas female was observed (62.2%, 24.2% ,13.6) plain coat, patchy and spotted respectively for the Dessie zuria district. (75%) of female sheep in Teuledre study area was plaint coat followed by patchy and spotted coat (17.2%, 7.8%). Although male was (69.2%) plaint, (19.2%) patch and (11.6%) spotted. In Kalu, (48%) male and (36.4%) female sheep have horn. Head profile of sheep in Dessie zuria had straight (17.2%, 34.8%), slight convex (34.5%, 25.8%) and slight concave (48.3%, 39.4%) for male and female respectively whereas straight (46.2%, 45%), slight convex (34.6%, 22%) and slight concave (19.2%, 33%) for male female in Teuledre. The overall horn shape of the study area was polled, (42.4%) scurs (17.8%) curved (22.1%) and 5% spiral horn shape. There were different coat color types in south wollo sheep populations to which red dominant coat color (38.5%, 58%) relatively dominant in Teuledre districts in both sexes respectively whereas in kalu, creamy white coat colour male (6%) and female (43.9%) dominant.

Males in Dessie zuria and Kalu were not having wattles. Dessie zuria (12.1%), Kalu (3%) of female have wattle whereas (7.7%) of males and (9.4%) of females have wattles in Teuledre. Mostly males and females in Dessie zuria have short ear (75.9%, 56%) respectively but in Kalu, the ear formation were rudimentary (16%, 47%), short ear %48%, 31.8%), long ear (36%, 21.2%) for males and females respectively.

Generally black coat colour were the dominant body coat colour in female and males in the Dessie zuria whereas creamy white the dominant body coat colour for lowland in both sexes .

Table (4.20 Qualitative physical body characteristics of the study area sheep)

		Districts													
		Dessie zuria				Teuledre				Kalu				overall	
		M		F		M		F		M		F			
		N	%	N	%	N	%	N	%	N	%	N	%	N	%
Head profile	Straight	5	17.2	23	34.8	12	46.2	29	45	10	40	35	53	114	41.3
	Slight convex	10	34.5	17	25.8	9	34.6	14	22	9	36	20	30.3	79	28.6
	Slight concave	14	48.3	26	39.4	5	19.2	21	33	6	24	11	16.7	84	30.1
Ear form	Erect	5	17.2	3	4.5	0	0	11	17	5	20	31	47	55	19.9
	Horizontal	17	58.6	32	48.5	7	27	33	52	13	52	19	28.8	121	43.8
	S/ pendulous	7	24.1	26	39.4	15	57.7	16	25	7	28	14	21.2	85	30.8
	pendulous	0	0	5	7.6	4	15.3	4	6.3	0	0	2	3	15	5.4
Presence of ruff	Present	18	62.1	0	0	11	42.3	0	0	18	72	0	0	47	17
	Absent	11	37.9	66	100	15	57.7	64	100	7	28	66	100	229	83
Horn shape	Polled	5	17.4	28	42.4	6	23.1	23	36	13	52	42	63.6	117	42.4
	Sucurs	0	0	15	22.7	0	0	9	14	8	32	17	25.8	49	17.8
	Straight	3	10.3	9	13.6	0	0	12	19	4	16	7	0	35	12.7
	Curved	15	51.7	14	21.3	12	46.2	20	31	0	0	0	0	61	22.1
	Spiral	6	20.6	0	0	8	30.7	0	0	0	0	0	0	14	5
Ear formation	Rudimentary	0	0	6	9.1	0	0	9	14	4	16	31	47	50	18.1
	Short ear	22	75.9	37	56	14	53.8	33	52	12	48	21	31.8	139	50.4.
	Long ear	7	24.1	23	34.9	12	46.2	22	34	9	36	14	21.2	87	31.5
Presence of Wattle	Present	0	0	8	12.1	2	7.7	6	9.4	0	0	2	3	18	6.5
	Absent	29	100	58	87.9	24	92.3	58	91	25	100	64	97	258	93.5

Table 4.20 (*continued…*)

		Dessie zuria				Tehuledre				Kalu					
		M		F		M		F		M		F		Overall	
Variable	Trait	N	%	N	%	N	%	N	N	%	N	%	N	%	%
	Polled	5	17.4	28	42.4	6	23.1	23	36	13	52	42	63.6	117	42.4
	Sucurs	0	0	15	22.7	0	0	9	14	8	32	17	25.8	49	17.8
	Straight	3	10.3	9	13.6	0	0	12	19	4	16	7	0	35	12.7
	Curved	15	51.7	14	21.3	12	46.2	20	31	0	0	0	0	61	22.1
Horn shape	Spiral	6	20.6	0	0	8	30.7	0	0	0	0	0	0	14	5
	Plaint coat	19	65.5	41	62.2	18	69.2	48	75	18	72	46	69.7	190	68.8
	patchy	7	24.1	16	24.2	5	19.2	11	17	5	20	9	13.6	53	19.2
Coat pattern	Spotted	3	10.4	9	13.6	3	11.6	5	7.8	2	8	11	16.7	33	12
	Shot hair	9	31	24	36.4	6	23	15	23	15	60	45	68.2	114	41.3
Hair type	Coarse	20	69	42	63.6	20	77	49	77	10	40	21	31.8	162	58.7
	White	9	31	10	15.2	7	26.9	15	23	12	48	19	28.9	72	26.1
	Red dominant	3	10.4	19	28.8	10	38.5	37	58	5	20	8	12.1	82	29.7
	Black	10	34.5	16	24.2	0	0	0	0	0	0	0		26	9.4
	Red + White	0	0	6	9	5	19.2	9	14	4	16	10	15.1	34	12.3
	White + black	0	0	5	7.5	0	0	0	0	0	0	0	0	5	1.8
	Brown	7	24.1	7	10.6	4	15.4	3	4.7	0	0	0	0	21	7.6
coat colour	Creamy White	0	0	3	4.6	0	0	0	0	4	16	29	43.9	36	13

4.10.2. Quantitative characteristics

Least square mean ± SE and pair wise mean comparison of body weight and other linear body measurements of indigenous sheep in South wollo are presented in (Table 4.21). Sex, age, districts and sex with age interaction were used as fixed effect on Live Body Weight and morphological measurements.

Effect of agro ecologies: Districts had an effect on body weight and other linear body measurements significantly ($p<0.05$) as showed in (Table 4.21). In this study, majority traits, except body length, rump length and heart girth showed significance difference between districts. In most traits, the values of the indigenous sheep in the Dessie zuria were significantly ($p<0.05$) higher than the Teuledre and Kalu sheep while by tail length and circumference Kalu were significantly ($p<0.05$ higher than to Dessie zuria and Teuledre. The ear length and body weight of the Teuledre sheep were significantly ($p<0.05$ higher than the sheep found in the Kalu and Dessie zuria.

The overall least squares mean body weight obtained in the present study (24.8±0.18) was lower than values reported by Mengistie Taye *et al* (2011) for farta sheep, the values reported by Solomon Abegaz *et al*. (2007) and Tesfaye *et al*. (2009) for Menz and Afar sheep, the values reported for Washera (Mengistie Taye *et al*., 2010), Horro and Bonga sheep (Zewdu Edea *et al*., 200). The overall least squares mean of traits of the study area was Body weight (24.8±0.18) Kg ,Heart Girth (66.4±0.45),Body length (60±0.3),Tail Length (23.6±0.2), Ear Length (9.8±0.2) Rump Length (20±0.13) Head length (17±0.1), Height at wither (63.6±0.34), Rump width (17.2±0.1) and Rump Height (64.2±0.34) centimeter. The sheep found in Dessie zuria of average body weight were (24.4±0.07) Kg, Heart Girth(67.4±0.75),Body length (60.4±0.5),Tail Length (22.4±0.3), Ear Length (11.5±0.1) Rump Length (20.4±0.22) Head length (17.6±0.08), Height at wither (64.2±0.45), Rump width(17.6±0.12) and Rump Height (64.5±0.51) centimeter whereas in Teuledre sheep of body weight were (25.62±0.1) Kg, Heart Girth (66.4 ±0.76),Body length (60.5±0.56),Tail Length (23.4±0.25), Ear Length (12.3±0.1) Rump Length (19.6±0.22) Head length (17.1±0.01), Height at wither (63.0±0.63), Rump width (16.9±0.1) and Rump Height (63.6±0.64) centimeter and lastly the lowland sheep average body weight were

(26.3±0.42) Kg, Heart Girth (65.3±0.81),Body length (58.6±0.5),Tail Length (25.0±0.25), Ear Length(5.4±0.12) Rump Length(20.1±0.22) Head length (16.5±0.22), Height at wither (63.8±0.66), Rump width(17.1±0.11) and Rump Height (64.3±0.61) centimeter

Table (4.21) The least square means and pair wise mean comparison of quantitative body measurements (cm) for all agro ecologies.

Dependent variables	Districts				
	Dessi zuria (N=95)	Teuledre (N=90)	Kalu (N=91)	Overall (N=276)	p-value
Body weight(Kg)	24.4±0.07	25.62±0.1	24.5±0.05	24.8±0.18	0.0002
Heart Girth	67.4±0.75	66.4±0.76	65.3±0.8	66.40±0.77	0.01
Body length	60.4±0. 5	60.5±0.56	58.60±0.5	60.0±0.52	0.200
Tail Length	22.4±0.29	23.4±0.25	25.0±0.24	23.6±0.26	0.0002
Ear Length	11.5±0.1	12.3±0.1	5.4±0.12	9.80±0.1	0.0072
Rump Length	20.4±0.22	19.6±0.2	20.1±0.23	20.04±0.21	0.77
Head length	17.6±0.7	17.1±0.1	16.5±0.16	17.04±0.32	0.0012
Height at wither	64.2±0.46	63.0±0.63	63.8±0.66	63.60±0.58	0.36
Rump width	17.6±0.12	16.9±0.1	17.1±0.11	17.20±0.11	0.011
Rump Height	64.5±0.5	63.6 ±0.64	64.3 ±0.61	64.2±0.58	0.014

* Significantly (P< 0.05) different.

Effect of sex: Sex had show significant effect ($p<0.05$) between two sexes on body length, ear length, body weight and heart girth and revealed an important source of variation for body weight and other linear measurements. The other parameters were not shown significant difference ($p>0.05$) among two sexes as shown in table (4.22). The values of males were higher ($p<0.05$) than females in a traits of Heart girth (HG), body length (BL), body weight and ear length, and male were not significance difference ($p>0.05$) on a trait ,tail length (TL), height at wither (HW) and rump height (RH) Head length (HL). In this result, male were not found heavier ($p>0.05$) and longer ($p>0.05$) than female in across the study areas. Male sheep and sheep with dentition 4PPI had higher heart girth than female and lower dentition groups, respectively. The result is in agreement with literature (Mengistie *et al*., 2010; Tesfaye *et al*., 2009; Zewdu *et al*., 2009).

The overall mean of male sheep in south wollo were body weight (25.75±0.22) Kg, Heart Girth (66.0±0.8), Body length (57.6±0.54),Tail Length (22.7±0.34), Ear Length(8.1±0.35) Rump Length (20.3±0.06), Head length (16.6±0.22), Height at wither (62.2±0.8), Rump width (17.3±0.2) and Rump Height (63.3±0.54) centimeter whereas female body weight (23.92±0.17) Kg, Heart Girth (65.8±0.6),Body length (56.3±0.46),Tail Length (22.1±0.25), Ear Length(8.5±0.23) Rump Length (17.9±0.1) Head length (16.7±0.12), Height at wither (62.1±0.34), Rump width(16.9±0.1) and Rump Height (61.2±0.32) centimeter

Table (4.22).The least square means and pair wise mean comparison of quantitative body measurements (cm) for both sexes

	Sex		
Dependent variable	Male (N=81)	Female (N=197)	p-value
Body weight(Kg)	25.75±0.22	23.92±0.17	0.0012
Heart Girth	66.0±0.8	65.8±0.6	0.006
Body length	57.6±0.54	56.3±0.46	0.001
Tail Length	22.7±0.34	22.1±0.25	0.99
Ear Length	8.1±0.35	8.5±0.23	0.045
Rump Length	20.3.±0.06	19.7±0.1	0.21
Head length	16.6±0.22	16.7±0.12	0.7
Height at wither	62.2±0.8	62.1±0.34	0.64
Rump width	17.3±0.2	16.9±0.1	0.82
Rump Height	63.3±0.54	61.2±0.32	0.3

Effect of age: Live body weight and other linear parameters of sheep increased with increasing rate until the eruption of the first pairs of incisors (1PPI). After eruption of the first pairs of incisors, increasing of body weight was small between 1PPI to 4PPI and the increase was at decreasing rate. The rate of increase in body weight was minimal as the sheep advances in age and attributed to the attainment of mature weight at later age (3PPI and 4PPI). Literature stated that there is a cyclical change in ewe weight around the breeding cycle and the younger ewes are gaining faster than older one .A sharp increasing decline in body weight and other linear traits. Body weight of sheep in different age group

in the study area were 0PPI (18.7±0.24), 1PPI (25.3±0.34), 2PPI (28.7±0.3), 3PPI (29.8±0.4), and 4PPI (30.7±0.5).

Table (4.23) The least square means and pair wise mean comparison of quantitative body measurements of sheep in (cm) for all ages.

Parameter/Traits	Age of sheep					Overall	P-value
	0ppi	1ppi	2ppi	3ppi	4ppi		
Body weight(kg)	18.4±0.4	23.6±0.1	26.8±0.22	27.8±0.7	27.9 ±0.2	26.3±0.4	0.0001
Heart Girth	55.0±0.0.4	64.0±0.5	71.0±0.48	71.8±0.4	72.7±0.5	66.4±0.5	0.001
Body length	53.1±0.37	59.2±0.5	62.2±0.42	62.7±0.4	63.3±0.4	60.0±0.3	0.000
Tail Length	22.0±0.45	22.8±03	24.7±0.3	24.2±0.2	24.9±0.3	23.6±0.2	0.008
Ear Length	9.1±0.44	9.6±0.42	9.8±0.44	10±0.42	10.2±0.4	9.8±0.2	0.003
Rump Length	18.2±0.18	18.9±0.2	20.6±0.22	21.2±0.2	22.1±0.3	20± 0.13	0.002
Head length	16.5±0.19	17.1±0.1	17.2±0.1	17.2±0.2	17.4±0.1	17.0±0.1	0.012
Height at wither	54.7±0.53	63.4±0.3	66.2±0.44	67.6±0.3	67.7±0.4	63.6±0.3	0.001
Rump width	16.6±0.01	17.1±0.1	17.1±0.1	17.3±0.5	18.3±0.2	17.2±0.1	0.01
Rump Height	55.8±0.35	63.0±0.3	66.5±0.5	68.8±0.4	68.6±0.5	64.2±0.3	0.0001

*PPI=Pair permanent incisor

Effect of sex by age group Interaction*:* The interaction effects between sex of animal and age group had an effect on the variation of body weight and linear body measurement and reflect higher differences ($p<0.001$) of all parameter. The result showed that when the age increased the variation of body weight and linear body measurement also increased. In

Majority of traits, males were heavier and higher ($p<0.05$) than females in the same age group of female. Females were higher ($p<0.05$) than males in a trait at age (heart girth (0ppi), tail length (0ppi), ear length and rump width (1ppi, 2ppi, 4ppi) . Body weight of males in age group 0PPI (19.1±0.6 kg), age group 1PPI (23.9 ± 0.4kg), age group 2PPI (28.7 ± 0.6kg), group 3PPI (31±0.9 kg) and group 4PPI (31.5±0.1 kg) in the current study whereas female was group 0PPI (18±0.2 kg), age group 1PPI (24.3 ± 0.1kg), age group 2PPI (28.5±0.4kg), group 3PPI (29±0.42 kg) and group 4PPI (30.3±0.6 kg).

Table 4.24 Least square means and pair wise mean comparison of quantitative body measurements (cm) for sex by age interaction

	Sex by age group										
varia bles	Female 0ppi	Female 1ppi	Female 2ppi	Female 3ppi	Female 4ppi	male 0ppi	male 1ppi	male 2ppi	male 3ppi	male 4ppi	p-value
B W	17.9±0.2	23.6±0.4	25.2±0.4	26.4±0.4	26.4±0.6	19.3±0.6	24.8±0.1	26.9±0.6	28.7±0.9	28.9±0.1	<0.001
H G	54.9±0.6	64±0.5	70.5±0.7	72.5±0.5	71±0.6	53.3±0.4	67.1±1.1	72±0.63	73.7±0.5	73.6±0.6	<0.001
BL	52.8±0.5	58.3±0.5	61±0.42	62±0.5	63.2±0.6	53.6±0.6	61.7±0.8	64.9±0. 6	65.4±0.7	63.6±0.7	<0.001
TL	22±0.6	22.7±0.4	25±0.4	24.2±0.3	24.9±0.4	21.9±0.8	23.1±0.5	24±0.6	24.5±0.3	24.8±0.5	<0.001
EL	9±0.6	10.4±0.5	9.7±0.52	10±0.5	10±0.5	9.3±0.7	9.8±0.9	9.4±0.9	10.5±0.8	9.5±0.9	<0.001
RL	18.2±0.2	19±0.23	20.8±0.3	21.0±0.3	22.6±0.3	18.3±0.4	18.9±0.4	20.1±0.3	21.7±0.7	21±0.5	<00001
HL	16.4±0.2	17±0.12	17.2±0.1	17.2±0.3	17.4±0.2	16.6±0.3	17.2±0.3	17.2±0.2	17.4±0.2	17.4±0.2	<.0001
HW	54.8±0.6	63.3±0.3	66±0.53	67.4±0.4	67.4±0.5	54.5±1.1	63.8±0.6	66.6±0.8	68.2±0.7	68.6±0.8	<0.001
RW	16.5±0.1	17.1±0.2	17±0.15	17.2±0.2	18.4±0	16.7±0.2	17±0.22	17.3±0.2	17.7±0.3	18±0.3	<0.001
RH	56±0.3	62.7±0.4	65.8±0.6	68.7±0.5	68.3±0.7	55.6±0.8	63.7±0.5	67.9±0.9	69.1±0.6	69.2±0.6	<0.001

4.10.2.5. Correlation between Body Weight and other Linear Body Measurements

*Accordingly, correlation coefficients (r) between live body weight and other body measurement traits were found positive with the presence of highly significant (P<0.0001) associations of body weight with heart girth (r= 0.82) and body weight with height at wither (r= 0.8) and body weight with rump height (r=07) in Tehuledre. However, no significant correlation (P >0.05) between ear length, head length and other body measurements except body length with ear length p<0.05).The high correlation coefficients between body weight and linear body measurements suggest that either of these variables or their combination could provide a good estimate for predicting body weight of sheep.

Table (4. 25). Correlation Coefficients (r) and p-values of sample sheep in Tehuledre study area

		Bw	HG	BL	T L	E L	R L	H L	HW	R W
Bw	r									
HG	r	0.82**								
BL	r	0.72**	0.76**							
T L	r	0.44**	0.46**	0.39**						
E L	r	0.14	0.13	0.002	0.11					
R L	r	0.6**	0.6**	0.55**	0.34**	0.01				
H L	r	0.125	0.18	0.21*	0.08	-0.02	0.114			
HW	r	0.8**	0.76**	0.67**	0.36**	0.2	0.46**	0.14		
R W	r	0.46**	0.41**	0.29**	0.11	0.32	0.31**	0.11	0.42**	
R H	r	0.70**	0.72**	0.68**	0.43**	0.18	0.46**	0.228*	0.68**	0.28**

** The Pearson's correlation coefficient among quantitative variables for Kalu sample sheep population is presented in Table (4.26) All body measurements correlate significantly (p<0.05) with body weight. Correlations between the quantitative traits of this district sheep population showed low to strong positive association. Strong and highly significant (P<0.0001) positive associations were observed between body weight with heart girth (r= 0.71), body weight with height at wither (r=0.73), body weight with rump height (r=0.72), heart girth with rump height (r=0.79) and wither height with heart girth(r=0.76). The values of the correlation coefficients varied with different linear body measurement and body weight.

This indicates that there is variation in the different linear body measurement and bodyweight of the sheep.

Table (4.26) Coefficients of correlation between body weight and other body measurements of sheep in Kalu study area

		Bw	HG	BL	T L	E L	RL	HL	HW	R W
Bw	r									
HG	r	0.71**								
BL	r	0.65**	0.68**							
TL	r	0.12	0.15	0.101						
EL	r	0.36**	0.34**	0.31**	0.07					
RL	r	0.45**	0.47**	0.54**	0.03	0.30**				
H L	r	0.46**	0.58**	0.37**	0.15	0.27*	0.26*			
HW	r	0.73**	0.746**	0.671**	0.12	0.23*	0.456**	0.439**		
R W	r	0.24*	0.25*	0.31**	<0.001	0.07	0.22*	0.1	0.14	
R H	r	0.72**	0.76**	0.66**	0.19	0.24*	0.46**	0.42**	0.8**	0.19

*P< 0.05; ** P< 0.0001, BW= Body Weight; HG = Heart Girth; HW = Height at Withers; BL = Body Length; EL=Ear Length; HL= Head Length; RL =Rump length; RH=Rump Height; RW= Rump Width, TL=Tail Length

******* The Pearson's correlation coefficient among quantitative variables for Dessie zuria sample sheep population is presented in Table (4.27) Correlations between the quantitative traits of this district sheep population showed low to strong positive and negative association. Strong and highly significant (P<0.001) positive associations were observed between body weight with heart girth (r= 0.84), rump height with rump width (r=0.86), body weight with rump height (r=0.82), heart girth with rump height (r=0.79) and wither height with heart girth(r=0.76).

Table (4. 27).Correlation Coefficients (r) & p-values of sample sheep in Dessie zuria study area

		Bw	HG	BL	T L	E L	R L	H L	Hw	RW
Bw	(r)									
HG	(r)	0.84**								
BL	(r)	0.6**	0.64**							
T L	(r)	0.63**	0.59**	0.46**						
E L	(r)	0.17*	0.16	0.27**	0.1					
R L	(r)	0. 6**	0.49**	0.29**	0.46**	0.06				
H L	(r)	-0.13	-0.10	-0.20*	-0.2**	-0.1	-0.15			
Hw	(r)	0.73**	0.76**	0.58**	0.54**	0.3**	0.5**	-0.16		
R W	(r)	0.36**	0.27**	0.18*	0.27**	0.2*	0.37**	-0.1	0.35**	
R H	(r)	0.82**	0.79**	0.63**	0.55**	0.22*	0.58**	-0.12	0.86**	0.4**

*P< 0.05; ** P< 0.0001, BW= Body Weight; HG = Heart Girth; HW = Height at Withers; BL = Body Length; EL=Ear Length; HL= Head Length; RL =Rump length; RH=Rump Height; RW= Rump Width, TL=Tail Length

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1. Conclusion

Sheep are the most important animals in the study areas due to broad adaptability to the harsh environment ranging from the altitude of (500-3800) m.a.s.l in south wollo in different Agro-ecologies. From this study it could be concluded that sheep play an important role through their multiple functions in the livelihoods of people in the study area, and they have potential for greater contribution through better management (health and nutrition) and genetic improvement (controlled breeding practice). Most of the sheep in the study area had plain coat pattern. Red dominant, black and creamy white coat color, straight head profile, semi-pendulous ear orientation. Mostly none genetic factor such as agro-ecology, sex, age, and interaction of sex with age had also significant effect ($p<0.05$) and revealed an important source of variation on body weight and body linear measurements. Age group had significant effect ($p<0.05$) in all traits on body weight and other body measurements. Live body weight and other linear parameters of sheep increased with increasing rate until the eruption of the first pairs of incisors (1PPI). Districts had affected live body weight and linear body measurement. In this study, majority traits, except body length, rump length and height at wither, others showed significant difference between districts. In most traits, the values of the Dessie zuria sheep were significantly ($p<0.05$) higher than the Teuledre and Kalu sheep while tail length and circumference were higher ($p<0.05$) for Kalu sheep than Dessie zuria and Teuledre. Due having short ear, long and wide tail and creamy body coat colour kalu sheep near similar to the Afar sheep Correlation coefficients (r) between live body weight and other body measurement were found positive with the presence of highly significant ($P<0.001$) associations of body weight with heart girth ($r= 0.82$) in Teuledre, body weight with heart girth ($r= 0.71$), in kalu, and body weight with heart girth ($r= 0.84$) in Dessie zuria. The values of the correlation coefficients varied with different linear body measurement and body weight. This indicates that there is variation in the different linear body measurement and body weight of the sheep. The presence of morphometric information on sheep could aid future decision on the management, conservation and improvement of the indigenous sheep genetic resources. It is suggested that it is important to undertake well planned on station study to predict further genetic potential of sheep type in the study areas.

5.2. Recommendations

- Most of the highland sheep have black coat color and it have negative market price impact. So selection of desirable colour should be done within those breed and minimize the market price impact.

- Phenotypic characterization of indigenous sheep is one way of knowing the breed potential and it is already characterized. So molecular characterization should be done next to know the breed performance more and conservation.

- There were started community based breeding strategy, mate recording , birth and sire of lamb recording, ear tagging in Dessie zuria to control and minimize inbreeding and to improve productivity, so this best practice should applied to other districts

CHAPTER SIX

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APPENDIX

APPENDIX 1

BIOGRAPHICAL SKETCH OF THE AUTHOR

The author, Moges Takele, was born on January 12, 1978 E.C in Lay Armachiho woreda, North Gondar Zone. He attended his elementary education at Janikaw Elementary School from 1987 to 1991. He pursued his junior secondary education at Limat ber junior secondary school from 1992 to 1993. He attained his secondary high school study at Limat ber Secondary high school from 1994 to 1995. He studied his preparatory school at Fasiledes preparatory and high school from 1996 to 1997. He then joined Haramaya University in 1998 and was awarded a BSc degree in Animal production in 2000. After his graduation, he was employed in North Gonder zone, Gonder Zuria woreda agriculture office and served as animal production expert for five years. In October 2006 he joined the School of Graduate Studies at Bahir Dar University for a Master of Science study in Animal Genetics and Breeding.

APPENDIX. ỊỊ

DESCRIPTIONS OF BODY WEIGHT AND BODY MEASUREMENTS

Parameters taken to measure linear body measurements in south wollo zone of indigenous sheep

Body Weight (kg)	BW	Live weight
Body Length (cm)	BL	The distance from the base of the tail to the base of the neck
Heart Girth (cm)	HG	The circumference of the body immediately behind the shoulder blades in a vertical plane perpendicular to the long axis of the body
Ear Length (cm)	EL	Distance from the base to the tip of the right ear, along the dorsal surface
Rump Length (cm)	RL	Distance from hip to pin
Rump Width (cm)	RW	Maximum distance between left and right hurls
Tail Length (cm)	TL	Distance from the root of the tail to the tip
Head Length (cm)	HL	Distance between the upper limit of the forehead to the tip of the nose
Withers Height (cm)	WH	Height from the top of the withers to the ground
Rump Height (cm)	RH	Height from the top of the rump to the ground

APPENDIX III

QUESTIONNAIRE

Phenotypic characterization and farmers' breeding objectives of indigenous sheep in thee selected distincts of south Wollo Zone, Ethiopia

1. GENERAL INFORMATION AND SOCIO- ECONOMIC ASPECTS

Name of enumerator: _____ Date: _____Kebele/----------

Village: _____Zone: _____ District: _____

1.1. Name of Interviewee_____Sex _____ Age _____

1.2. Owners position in household (Tick one box)

a. Male head b. Female head c. Relative d. Son e. Daughter

Others (specify) _____

1.3. Marital status/ Tick one/ a. Married b. Divorcedc. Widowed

1.4. Education level/ Tick one/ a. Illiterate b. Writing and reading c. Grade _____

1.5. Religion; **1**.Orthodox **2**.Catholic **3.**Muslim 4.Seventh Day Adventist **5**. Protestant 6.Traditional

1.6. Household family size (number) /Tick one/

Children a. Males ≤ 15 yrs _____ b. Females ≤15yrs_____c Males > 15yrs _____

d. Females >15yrs _____

1.7. Land holding /farm size (in ha)

	Own	Rented
a. Crops (including fallow land)		
b. Fallow land		
c. Grazing		

Others (specify)		

1.8. Type of grazing land and ownership .Tick, Rank the top 3 according to their importance;

Type of grazing	Own	Rank	Rent	Rank	Communal	Rank
a. Open grassland						
b. Tree covered grassland						
c. Bush/shrub grassland						
d. Stone covered grassland						
e. Swampy grassland						

1.9. What is your major farming activity? (Tick one box)

a. Livestock production_____ b. Crop production _____ c. Both _____

1.10. On which do you depend more for? a. Food _____ b. Income source _____

1.11. Numbers of livestock kept

Type of livestock	Number	Type of livestock	Number
a. Cattle		f. Donkeys	
b. Sheep		g. Mules	
c. Goats		h. Camels	
d. Chickens		i. Horses	

1.13. Population trend in major livestock species

	Increasing	Decreasing	Stable	Reasons
Sheep				
Cattle				
Goat				
Camel				

1.14. Sheep Number by age group

Age group	Number	Age group	Number
a. Lambs ` less than 6 months		d. Female > 1 year	
b. Male > 1 year (Intact)		e. Female 6 months to 1 year	
c. male 6 months to 1 year		f. Castrated male	

1.15. Major crop grown/Tick /

Crops	Main season	Short rain	Crops	Main season	Short rain
a. Barley			e. Maize		
b. Wheat			f. Bean		
c. Teff			g. Pea		
d. Sorghom			Others		

1.16. List three most important crops

During long rain (‘Meher’)	during short rain (‘Belg’)
1.	
2.	
3.	

2. PRODUCTION AND MANAGEMENT SYSTEM

2.1. General

2.1.1. Production system/Tick one/

a. Crop–livestock system b. Agro-pastoralists c. Pastoralists

Others (specify_____

2.1.2. Mobility

Type of Mobility	Family	Reason	Livestock	Reason
a. Sedentary				
b. Transhumance				
c. Nomadic				
Other reason				

2.1.3. If transhumance, which livestock species and age class are moved?

Livestocks	Species	Age class	Season of Mobility	Length
1.				
2.				
3.				
Others				

2.1.4. Purpose of keeping sheep (Tick and Rank the top 3)

	Tick	Rank	Tick	Rank
a. Meat			f. Manure	
b. Milk			g. Skin	
c. wool			h. Savings	
d. Income			Ceremonies/gift/	
e. Wealth status				
Others (specify)				

Do you intend to expand your sheep flock? A. Yes, ____ B. No, _____

If yes, reason _____

If no, reason _____

2.1.5. Members of household and hired labor responsible for sheep activities; (M = Male, F= Female)

	Family				Hired labor			
	(>15yrs)		(<15yrs)		(>15yrs)		(<15yrs)	
	M	F	M	F	M	F	M	F
a. Purchasing sheep								
b. Selling sheep								
c. Herding								
d. Breeding								
e. Caring for sick animals								
f. Feeding								
g. Milking								
h. Shearing								
i. Making dairy products								
j. Selling dairy products								
Others (specify)								

2.2. **Feeding, grazing and watering**

2.2.1. Feed source (Tick and rank the top 3)

	Wet season	Rank	Dry season	Rank
a. Natural pasture				
b. Established pasture				
c. Hay				
d. Crop residues				

e. Fallow land				
f. Concentrate				
g. Others (Specify)				

2.2.2. Grazing method (Tick and Rank the top 3 according to their importance)

	Wet season	Rank	Dry season	Rank
a. Free grazing				
b. Herded				
c. Paddock				
d. Tethered				
e. Zero-grazing				
Others (specify)				

2.2.3. Length of grazing time during wet season (in hours):

Morning from, _____ to _____ hours. Afternoon from _____to_____ hours.

Or from----------to ----------

2.2.4. Length of grazing time during dry season (in hours):

Morning from, _____ to _____hours. Afternoon from, _____to _____hours

. Or from----------to ----------

2.2.5. Specify the area of your communal grazing land ____ hectares for ____ households

2.2.6. Trend in communal grazing areas?

Grazing areas	Mark/tick	Reason
Increasing		
Decreasing		
Stable		

2.2.7. How is sheep flock herded during the daytime?

a. Male and female are separatec. C All classes' sheep herded together

b. lambs are separated d. Others (specify)_____

2.2.8. Sheep flock is herded

a. Together with cattle b. Together with goat c. sheep herded separately

d. Together with equines e. Together with calves f. All herded together

g. Together with camel Others (Specify)_____

2.2.9. Way of herding

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

2.2.10. If the answer is b, how many household mix their sheep together _____

2.2.11. Crop residues used for sheep. Tick and Rank the top 3 according to their importance

	Wet season	Rank	Dry season	Rank
a. Wheat				
b. Barley				
c. Sorghum				
d. Maize				
e. Bean				
f. Pea				
g. Lentil				
h. Chick pea				
Others (Specify)				

2.2.12. Concentrates used for sheep

Type	Tick	Rank	

a. Homemade grain			
b. Oil seed cakes			
c. Local brewery by-products			
d. Flour by-product			

2.2.13. Is there seasonal fluctuation in feed supply? Yes, _____ No, _____

2.2.14. At which season of the year do you experience feed shortage? _____

2.2.15. What is your copping mechanism? ——

2.2.16. Supplementation regime (Tick the top of 3)

	Dry season	Wet season
a. Roughage		
b. Minerals (salts)/vitamins		
c. Concentrates		
d. None		
Others (specify)		

2.2.18. Do you practice fattening of sheep? Yes, _____ No, _____

2.2.19. If yes, which categories of animals do you fatten? Rank the top 3 in the second column

Type of animals	Rank	Type of animals	Rank
a. Culled young female		e. Castrates	
b. Culled young male		f. Older males	
c. Young females		g. Older female	

d. Young males		Others

2.2.20. At which periods of the year do you commonly fatten sheep? _____

Season	Fattening duration	Reason
1.		
2.		
3.		

2.2.21. Source of water

Sources	Dry season	Wet season	Sources	Dry season	Wet season
a. Bore hole/water well			d. Spring		
b. Dam/pond			e. Tape water		
c. River			f. Rain water		
Others (specify)					

2.22. Distance to nearest watering point

	Dry season	Wet season
a. Watered at home		
b. <1km		
c. 1–5 km		
d. 6–10 km		
e. >10 km		

2.2.23. Are lambs watered with the adults? a. Yes, _____ b. No, _____

2.2.24. If no, describe watering distance and frequency for lambs?

_____

2.2.25. Frequency of watering for adult animals

	Dry season	Wet season
a. Freely available		
b. Twice a day		
c. Once a day		
d. Once in 2 days		
e. Once in 3 days		
Others (specify)		

2.2.26. Water quality

	Dry season	Wet season
a. Clean		
b. Muddy		
c. Salty		
d. Smelly		

2.3. Housing

2.3.1. Housing/enclosure for adult goat (Tick one or more boxes)

With roofhouse	Without roof
a. separate	a. In family house
b. Veranda	b. Yard
Others	Others

2.3.2. Type of housing materials

	Roof	Wall	Floor

a. Iron sheets			
b. Grass/Bushes			
c Wood			
d Stone/bricks			
f. Concrete			
Others (specify)			

2.3.3. Are lambs housed with adults? a. Yes, _____ b. No ,_____

If no, specify _____

2.3.4. Are sheep housed together with cattle? a. Yes,_____ b. No._____

3. BREEDING PRACTICES

3.1 General

3.1.1 Do you have crossbred rams a. Yes, _____ b.No, _____

3.1.1.1 If yes, How many? _____

3.1.1.2. Breed of crossbred rams a. Exotic _____ b. Local _____

3.1.1.3. Source of ram's _____

3.1.2. Do you have local rams? a. Yes ____ b. No ____

3.1.2.1. If yes, how many? _____

3.1.2.2. If more than one, why do you need to keep more than one rams? _____

3.1.2.3. For how many years on the average is the same breeding rams serving in your flock? _____

3.1.3. Is there any special management for breeding rams? a. Yes _____ b. No. _____

3.1.3.1. If yes, specify type of management_____

3.1.4. Purpose of keeping rams

a. Mating b. Socio-cultural c. For fattening

Others (specify

3.1.5. Source of ram (s)

a. Born in the flock b. Purchased, private c. Purchased in partner d. Rent

3.1.6. If you do not have breeding ram, how do you mate your ewe?

a. Neighboring ram _____ b. Unknown_____ c. Others (Specify)_____

3.1.7. What is your main breeding objective?

a. Meat_____ b. Income____ c. Skin and hides ____d. Wool _____ e. Milk ———

Others (specify) _____

3.1.8. Do you practice selection for?

a. Breeding male a. Yes, _____ b. No, _____

b. Breeding female a. Yes, _____ b. No, _____

3.1.9. Age of selection? a. Breeding male ____months b. Breeding female, ___Months

3.1.10. Selection criteria for breeding rams.(Then rank according to the reason)

	Selection criteria for breeding rams	yes	Rank		Selection criteria for breeding ewe	yes	Rank
A	Appearance/conformation			A	Twinning ability		
B	Color			B	Kid survival		
C	Character/docile			C	Appearance/conformation		
D	Growth			D	Color		
E	Age			E	Character/docile		
F	Libido			F	Kid growth		
G	Dairy character			G	Milk yield		

				H	Age at first sexual maturity		
				I	lambing interval		

List the top 3 preferred color and Unwanted colors as rank

preferred color	Unwanted colors
1._____	1. _____
2._____	2._____
3._____	3._____

3.1.12. Breeding/mating system

a. Controlled _____ b. uncontrolled, _____

3.1.13. If uncontrolled, what is the reason?

a. sheep graze together _____c. Insufficient number of ram _____

b. Lack of awareness_____d. Others (specify) _____

3.1.14. Could you able to identify the sire of lambs? a. Yes _____b. No,_____

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

_____

3.1.16. Do you allow a rams to mate his Mother /Daughter or Sister? a. Yes b. No,

Reason if yes? _____

Reason if no? _____

3.1.17. Do you allow your ram to serve ewe other than yours? a. Yes b. No

Reason? _____

3.1.18. Do you allow your ewe to be served by anyone else rams? a. Yes b. No

Reason ? _____

3.2 Castration and culling

3.2.1. Do you castrate rams? a. Yes, _____ b. No, _____

3.2.2. If yes, reasons for castration

a. Control breeding _____ c. Better temperament _____

b. Improve fattening _____ Others (specify) _____

3.2.3. If no, give reason _____

3.2.4. At what age do you castrate? (Tick and write the Reason)

a. < 3 months _____,Reason? _____

b. 3–6 month's _____, Reason?_____

c. >6 months _____, Reason? _____

d. Specify _____, Reason? _____

3.2.4.1 Season of castration._____ Reason?_____

3.2.5. Do you give supplementary feed for castrated sheep a. yes, ____b. No, ____

3.2.6. If yes, type of supplementary feed 1._____

2._____

3._____

3.2.7. For how long do you supplement castrated sheep? _____

3.2.8. Type of castration method_____

4 Marketing of sheep

-Do you have sheep market access? a. Yes, ____ b. No, ____

-If you yes, How many minutes does it take to reach market place? _____minutes

-Do you sell your sheep in the local market? a. Yes, ____ b. No, ____

-If you yes in which season do you mostly sell?

a. Start of wet season b. End of wet season c. Start of dry season d. any time

3.2.9. Reasons for selling a. Cash needed _____b. Disposal/culling_____

3.2.10. Which class of sheep do you sell first in case of cash needed?

	Rank		Rank
a. male lambs less than 6 months		f. Breeding rams	
b. Female kids less than 6 months		g. Castrated	
c. Ram kids between 6 months and one year		h. Old ewe	
d. Ewe kids between 6 months and one year		i. Old rams	
e. Breeding ewe			

3.2.11. Average market age in month Male _____ Female _____

3.2.12. Average culling age due to old age Male _____ Female _____

3.2.13. Is your sheep number increasing in the last 10 years?

a. Increased _____b. Decreased, _____c. Stable._____

3.2.14. What is the trend compared with other livestock?

	Increased	Decreased	stable	Reason
a. Compared with cattle	_____	_____	_____	_____
b. Compared with goat	_____	_____	_____	_____
c. Compared with camel	_____	_____	_____	_____

3.3 Reproduction characteristics

3.3.1. Average age at sexual maturity month_____

3.3.2. Age at first lambing

a. Male ____ Months

b. Female ____ Months

3.3.3. Lambing interval of ewe

a. Average ____ Months

b. Maximum ____ Months

c. Minimum ____ Months

Do your ewe conceive at once service? 1/ Yes 2/No

If no, how many times does she serviced repeatedly _____

3.3.4. Do you fix age at first mating for the females? a. Yes _____b. No_____

3.3.5. Do you fix age at first mating for the males? a. Yes _____b. No_____

3.3.6. Average reproductive lifetime of ewe (in years) _____

3.3.7. Average number of lambing per ewe's lifetime _____

3.3.8. Lambing pattern, occurrence of most births (Tick and then rank top 3)

	Rank	Rank	
January		July	
February		August	
March		September	
April		October	
May		November	
June		December	

3.3.9. Occurrences of multiple births per 100 ewe _____.

3.4 Milking

3.4.1. Is the ewe milked? Yes, _____b, No, _____

3.4.2. Milk production / day / ewe (liter) a. average ____b. minimum ___c. maximum ___

3.4. 3. Lactation length a. average____ b. minimum ____ c. maximum ____

3.4.4. Frequency of milking a. once a day b. twice a day c.three times a day

3.4.5. Total annual milk yield in liter _____

3.4.6. Average weaning age of lambs (Tick one box)

a. < 3 months_____ b. 3–4 months_____

c. 5–6 months _____d. > 6 months_____

3.4.7. Milk feeding up to weaning. a. Unrestricted suckling___ b. Restricted suckling ____

c. Bucket feeding_____ Others (specify) _____

4. HEALTH

4.1 Causes of sheep death

causes	Tick	Rank	causes	Tick	Rank
A. Predators			D. Poisoning plant		
B. Disease			E. Unknown		
C. Accident			F. Others/ /		

4.2. Mortality in the last five years

Number Number

a. Kids less than 6 month _____ d. Male 6 month to 1 year _____

b. Male >1 year (intact) _____ e. Female 6 month to 1 year _____

c. female >1 year) _____ f. Castrated male _____

4.1. List types of diseases, which occur frequently, affect the productivity of sheep in the area, and rank them based on importance

Type of disease	symptom	Season of occurrence	Susceptible age group	rank	treatment	
					Traditional	modern

4.3. Access to veterinary services

a. Government veterinarian b. Private veterinarian c. Shop or market

Others (specify) _____

4.4. Distance to nearest veterinary services

a. <1km b. 1–5 km c. 6–10 km

4.5. Disease, parasite, heat, frost, drought tolerance of sheep compared with other species rank across the column based on tolerance

	sheep	cattle	Goat	Camel	rank
Disease					
Internal parasite					
External parasite					
Heat					
frost					
drought					
Feed shortage					
Water shortage					
Adaptability					

5. Sheep production input delivery and demand

5.1 What type of inputs in sheep production are you gained before?

A/ vet service B/ feed resource development C/ improved breed D/ extension service

5.2 What are the influential factors related to input/ service provision?

1 _____

2_____

3 _____

4_____

5.3 What are the constraints to use inputs/services in sheep production development?

1 _____

2_____

3 _____

4_____

5.4 Delivery and farmers demand of input in sheep production

	Types of input deliver	Quantity	Unit	Beneficiary		Delivered year
				M	F	
1	Improved breed/exotic crosses					
2	feeds					
3	Veterinary service					
3.1	Medicine					
3.2	Vaccination					

FOCUS GROUPS DISCUSSION POINTS

PRA (PARTICIPATORY RAPID APPRAISAL)

Questionnaire number: _____ Name of enumerator: _____

Date: _____Kebele/Village:_____

Zone:_____ Woreda:_____

Part A. Socio-cultural underpinnings of breeding

1.1. History of the breed

1.2. Social laws

- Herding

-Communal land use

-Mobility

1.3. Indigenous knowledge in managing the breed.

- Breed identification

-Special qualities of the breed

-Good and undesirable character of sheep compared with other livestock

1.4. Major loss of livestock specifically sheep in the past, Reason?

1.5. Occurrence and frequency of disease, drought, conflict, flood and other disasters.

1.6. Local perceptions about the physical characteristics of the sheep type

1.7. Is a sheep considered as cultural heritage by your community?

1.8. Do you think farmers will continue to keep the sheep even if it loses its market demand or if in the future they will offer access to high meat producing or early growing exotic sheep breeds?

1.9. Is sheep breeding, as a profession, associated with particular social sub group within your community?

1.10. Major feed resources during different seasons.

1.11. Mobility period, length and reason

1.12. Herding and breeding practices during migration

1.13. Major farming activities

1.14. Income contribution of the activities in percent

1.15. Extinct sheep breeds type or any loss in genetic diversity

1.16. Type of services in sheep husbandry

1.17. Sheept population trend in the last 10 years.

1.18. Extension services in sheep production.

Part B. Environmental resources and production background

2.1. Local calendar systems

2.2. Seasonal availability of grazing land and feeds

2.4. Describe the concentration and distribution of your sheep.

2.5. Do you think the population is decreasing or increasing? What do you think /are the possible reasons?

Part C. Purpose of sheep rearing and Trait Preferences

3.1. Describe the benefits from keeping sheep flocks in the area

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

Part D. Local special attributes of the sheep

4.1. Do members of the community identify individual members of the sheep population among members of other sheep breeds (strains)?

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

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

Part E. Constraints for sheep production and local coping mechanisms

5.1. Main constraints related to sheep production and coping mechanisms locally employed against these.

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

5.3. Is your community interested in potential genetic improvement efforts?

APPENDIX 5

CHECKLIST FOR COLLECTION OF SECONDARY DATA FROM ZONE AND WOREDA

Questionnaire number: _____ Name of enumerator: _____

Date: _____Kebele/Village:_____

Zone:_____ Woreda:_____

1. Human population of the district_____

2. Livestock population in the districts

Type of livestock	Number	Type of livestock	Number
a. Cattle		f. Donkeys	
b. Sheep		g. Mules	
c. Goats		h. Camels	
d. Chickens		i. Horses	

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

4. Seasons of the year 1. Rainy season from _____to _____

2. Dry season from _____to_____

5. Topography of the zone (%):

Plain_____Mountain_____Plateau_____Other_____

6. Climatic data (distribution and amount)

Annual average temperature_____

Maximum_____Minimium_____

Annual average rain fall_____

Maximum_____Minimium_____

Humidity (%) _____

Annual average humidity_____

Maximum_____Minimium_____

7. Agro ecological zone of each district (%)

Lowland (500-1500) _____

Intermediate (1500-2300) _____

Highland (>2300) _____

8. Land use pattern (in hectare or in percent) _____

9. Production system /Farming system in percent_____

10. Vegetation cover_____

11. Major soil types 1._____

2._____

12. Opinion on relative importance of sheep in the farmers' livelihood (Income contribution of the a activity in percent) _____

13. Major sheep production constraints in each district?

Constrains	tick	rank
a. Genotype	_____	_____
b. Feed shortage	_____	_____
c. Water shortage	_____	_____
d. Disease	_____	_____
e. Drought	_____	_____
f. Market	_____	_____
g. Lack of superior genotypes	_____	_____
h. Predator	_____	_____

14. Organization/institutions actively involved in the area and their role in sheep production._____

15. Name of sheep breed, origin, distribution and the status of the breed at present._____

(Increasing, decreasing or stable and reasons for the trend)

16. Major sheep disease, occurrence, mortality, and treatment._____

17. Any efforts on-gonging in areas of sheep market (cooperatives, linking producers with traders, infrastructure development and market routes._____