PHENOTYPIC CHARACTERIZATION OF INDIGENOUS SHEEP, PRODUCTION SYSTEM AND FARMERS BREEDING PRACTICES IN JIMMA ZONE, OROMIA, ETHIOPIA

M.Sc. THESIS

BY

YAREGAL DERBIE

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Yaregal Derbie

Submitted to the School of Graduate Studies, College of Agriculture and Veterinary Medicine, Jimma University, in Partial Fulfillment of Requirements for the award of Degree of Master of Science in Animal Breeding and Genetics

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September, 2018

Jimma, Ethiopia

DEDICATION

I dedicate this piece of work tomy mother Lengere Leyew for her unreserved love, encouragement and partnership in the success of my life.

STATEMENT OF AUTHOR

The thesis entitled "Phenotypic characterization of indigenous sheep and their breeding practices in Jimma zone, Oromia, Ethiopia", isthe outcome of my own work and all sources of materials used for this thesis have been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirements for M.Sc. degree in Animal Breeding and Geneticsat Jimma University and is deposited at the University Library to be available to borrowers under rules of the library. I truly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma or certificate. I concede copyright of the thesis in favor of the Jimma University, Collage of Agriculture and Veterinary Medicine.

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BIOGRAPHICAL SKETCH

The author Yaregal Derbie was born on April 5, 1992G.C. inLige Ambera kebele, West Gojjam Zone, Amhara Region. He attended his elementary education at Abeskene School and he started his junior secondary education at Abbey Minch senior secondary School . Then he joined DebreTabor University in 2013 and graduated with BSC in Animal Science on 19th June, 2016 G.C. Soon after his graduation, he was employed as Graduate assistance by the Ministry of Education. Then in October 2016, he immediately joined the School of Graduate Studies at Jimma University for a Master of Science study in Animal Breeding and Genetics.

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LIST OF ABBREVIATION

AnGR	Animal Genetic Resources
ARARI	Amhara Regional Agricultural Research Institute
BHS	Black Head Somali sheep
BL	Body Length
BoA	Bureau of Agriculture, Ethiopia
Bop	Bureau of Planning and Economic Development
BW	Body Weight
CGIAR	Consultative Group on International Agricultural Research
CSA	Central Statistic Authority
DAD	Domestic Animal Diversity
DAGRIS	Domestic Animal Genetic Resource Information System
EARO	Ethiopian Agricultural Research Organization
EIAR	Ethiopian Institute of Agricultural Research
EL	Ear Length
ESAP	Ethiopian Society of Animal Production
ESGPIP	Ethiopia Sheep and Goat Productivity Improvement Program
FAO	Food and Agriculture Organization of the United Nation
GDP	Gross Domestic Product
GLM	General Linear Model
HG	Heart Girth
HW	Height at Wither
ILCA	International Livestock Center for Africa
ILRI	International Livestock Research Institute
IPMS	Improving Productivity and Market Success of Ethiopian Farmers
NRC	National Research Council
PAs	Peasant Associations
PW	Pelvic Width
SAS	Statistical Analysis System
SC	Scrotum Circumference
SPSS	Statistical Package for Social Science

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PHENOTYPIC CHARACTERIZATION OF INDIGENOUS SHEEP, PRODUCTION SYSTEM AND FARMERS BREEDING PRACTICES IN JIMMA ZONE, OROMIA, ETHIOPIA

ABSTRACT

The study was conducted in Seka, Dedo and Omonada Districts of Jimma Zone,Oromia Regional State. The objectives of the study were to undertake phenotypic characterization of sheep,farmers breeding practices, selection criteria and to characterize their production environment. The study was performed based on household survey and field measurements. For household survey, 180 households (60 from each district) were involved whereas body measurements and qualitative traits were taken from 570 sheep (190 sheep from each district). Data collected through questionnaire (survey) and observations on qualitative traits were collected and analyzed for sheep traits using frequency procedure of SPSS. Whereas, quantitative traits were analyzed using the SAS versions 9.3, (2014).The result showed that crop and livestock productions were major sources of household heads income in the study area. Among the livestock species, the average sheep flock size were7.80±3.07 in Seka, 8.74 ±3.09 in Dedoand 8.12±4.84 in Omonada. In the study area the average mature ewes had high proportion (4.72±3.19) across all the districts. The primary purpose of keeping sheep was for cash income and breeding ranking in first and second across the three districts, respectively. The major feed resources for sheep during the wet and dry seasons were private natural pasture and commonal natural grazing land in all the three districts respectively. Rivers and spring water were the main water source for sheep in both dry and wet season in the study area. Most the respondents (73.3%, 93.3% and 83.3 for Seka, Dedo and Omonada districts) castrate their rams for primarily to improve fattening.The majority (72.8%) of respondentswere practice uncontrolled mating system.The main sources of breeding rams in the study area were own born from their flock (64.7%) and 35.3% of respondents obtained the source of breeding rams by purchased from market. Body size/appearance and color was the major selection criteria of rams and ewes in the study area. The average age at first mating of male sheep in Seka, Dedo and Omonada was 6.75, 6.76 and 6.58 months whereasfor female 7.56, 6.26 and 7.02 months respectively. Diarrhea, Sheep pox and parasite were the most frequently diseases that affect productive and reproductive performance of sheep in all study districts. Disease, feed shortage, water shortage, predator, Poor veterinary service and capital problem were the major constraints and challenging of sheep production in the study districts. The most frequent coat color patterns observed in the study area were 81.1% plain, 16.4% patchy and sheep with spotted pattern (2.5%) were rarely observed. The dominant coat color types were brown (43.5%), fawn (17.5%), and red (13.0%) were the most frequently observed color type in the study area. The majority (91.1%) of sheep in the study area were polled whereas (8.9%) of the sheep were horned. The size of sheep increased as the age increased from youngest (1PPI) to the oldest (4PPI). The effect of district on body weight and most of the linear body measurements were significant ($p<0.05$) except head length, canon bone length, ear length and tail length. Chest girth selected first, which explain more variation than any other linear body measurements in both ewes (94%) and rams (93%). The prediction of body weight could be based on regression equation $y = -21.82 + 0.68x$ for female sample sheep population and $y = -49.90 + 1.08x$ for male sample sheep population; where y and x are body weight and chest girth, respectively.The result indicated that phenotypic characterization, body weight and linear body measurement description could help as an input for efficient utilization, conservation and designing improvement strategy for this genetic resource for the community.

Keywords: Phenotype, Characterization, Breeding, Practices.

1. INTRODUCTION

In developing countries, livestock production is mostly subsistence oriented and fulfills multiple functions that contribute more for food security (Duguma *et al.,* 2010). In Ethiopia, the agricultural sector is a corner stone of the economic and social life of the people and the country is endowed with huge livestock resources of varied and diversified genetic pools with specific adaptations to a wide range of agro-ecologies (Tassew et al., 2014). The livestock sector in Ethiopia contributes 12% and 33% of the total and agricultural Gross Domestic Product (GDP), respectively, and provides livelihood for 65% of the population (FAOSTAT, 2013). The sector also accounts for 12-15% of the total export earnings (Tewodros *et al.,* 2015).These livestock genetic resources are very important to the development of the economic ,social and environmental of the one country (*ESAP,2004*).

Sheep production is among the most important agricultural activities in the highlands of Ethiopia where crop production is unreliable (Kocho, 2007). Approximately 75% of the sheep are kept in small scale mixed farms in the highland regions, which cover regions of over 1500 m.a.s.l. altitude and receive over 700 mm of annual rainfall, while the remaining 25% are found in the lowlands (Tibbo, 2006). Sheep are traditionally kept in smallholdings and are associated with the small-scale resource poor livestock keepers. Thus, Ethiopia is one of the largest African countries for sheep resources who have long genetic diversity for the livelihoods of rural poor's (Abegaze, 2007). According to Gizaw et al., (2007), sheep are the second most important livestock species next to cattle with nine diverse breeds in Ethiopia. They have adapted to a range of environments from the cool alpine climate of the mountains to the hot and arid pastoral areas of the lowlands (Mirkana, 2010).Currently the total sheep population in Ethiopia has been estimated to be about 30,697,942 million, out of which 72.14 percent are females, and 27.86 percent are males but 99% sheep belongs to indigenous breeds (CSA, 2016/ 2017).

Sheep are the living banks for their owners and source of immediate cash and insurance against crop failure (Tibbo, 2006). Thus 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 (Duguma *et al.* 2010). They are relatively drought tolerant, small in size, easily manageable, and saleable resources.

However, their performance is poor, so there is a need to improve their productivity through selection and breeding (Wollny, 2003).Genetic improvement of the local livestock through appropriate techniques or selection and breeding program is the need of the day (Yakubu, 2010). The environmental pressure also maintains a wide range of genotypes adapted to a specific set of circumstances (Getachew *et al.,* 2010). According to Solomon (2008) genetically there are nine known sheep breeds in Ethiopia however; there is no clear phenotypic or genetic evidence to show their names rather they were represented by their geographical locations. Most often those locations are believed to be home tract to those breeds or ecotypes (Mirkena *et al.,* 2010). In order to make best use from sheep keeping operation, it is important and a prerequisite to have a comprehensive understanding of the whole situation through assessing the production environment (climate, feed availability, and disease prevalence); the production system (production practice, preferences, socio-economic circumstances and level of input use); and productive and adaptive characteristics of the sheep breeds (Sisay, 2009). Because characterizing of production system is a first step to designing any genetic improvement programs (FAO, 2012).

Phenotypic characterization used to describe and classify breeds of farm animal species (Traore *et al.,* 2008). Phenotypic characterization includes information on population size, flock size, composition, information on the production environment, husbandry conditions, which are known to play vital roles in trait expression (Mesfin, 2015). The first phase of characterization is surveying to identify populations based on morphological, geographical distribution, uses, and husbandry and production environments (Traore *et al.,* 2008). The usefulness of breed characterization of the indigenous livestock particularly in sheep is never doubt, because characterization used to inventory and monitoring of animal genetic resources and essential to their sustainable management, effective planning of how and where they can be used and developed (FAO, 2015). Due to this different studies have been carried on characterization of indigenous sheep breeds (types) in Ethiopia like Abegaze (2002), Solomon, (2008), Markos (2006), Mengiste (2008); Shigdaf (2011), Gizaw *et al.,*(2008),Tesfaye(2008) and other researcher has been done on phenotypic characterization of indigenous sheep in different part of Ethiopia. Since utilizing the animal genetic resources efficiently and optimally is Crucial for both food security and sustainable development of the country (Gebretsadik and Anal, 2013).

Even though different authors were able to characterize the existing sheep in overall the country including Horro and Bonga sheep breed in western part of the country, but after these many factors occurred which change sheep phenotypic characterization and their environment. That meanssheep production at any time which is influenced by the combined effects of a number of factors such as management practices of farmers, socio economic and institutional factors like access to animals' health services, credit utilization distance from kebele center and extension contact (Tesfaye *et al., 2017*. According to this, phenotypic information is a pre-requestto identify the potential opportunities and good understanding of the environment. Thefinding of available sheep resources is important to making appropriate decisions for necessary improvement interventions program.Even thoughthe sheep population in the study area is high and suitable for sheep production system (JZLF, 2009), phenotypic characterization of indigenous sheep in the study areahas not been done and also information on breeding practices of indigenous sheep is limited.Hence, it is needed appropriate improvement strategies have to be introduced to improve sheep production and participation of smallholder farmers. So to fill this gap phenotype characterization of indigenous sheep and their breeding practices was carried out. Therefore, the current study aimed with the following objectives.

Objectives:

(a) General objective:

- To undertake phenotypic characterization of indigenous sheep and farmers breeding practices in Jimma zone.

(b) Specific objectives:

- To characterize production environment.
- To assess the breeding objectives and selection criteria of indigenous sheep.
- To characterize the indigenous sheep on the basis of qualitative and quantitative traits.

2. LITERATURE REVIEW

2.1. Diversification of Sheep Breeds

Ethiopia is one of the major gateways for domestic sheep migration from Asia to Africa (Devendra and McLeroy, 1982). The diversification of sheep breeds has been driven by the selection of human being for different criteria such as color, appearance, size and wool production (Kosgey, 2007). Environmental changes under the conditions of domestication would have permitted genetic variation to become more evident and thus more readily influenced by selection and the altered mating system (Traore *et al*., 2008). The process of domestication brought about a number of morphological and physiological modifications in sheep (Michael, 2013). The diversity created among each breed have a genetic basis and can be exploited in a structured cross breeding system designed for a specific production-marketing situation (Leymaster, 2002).

2.2. Sheep Breeds in Ethiopia and their Geographic Distribution

Ethiopia is a home of most populous and diversified indigenous sheep breeds. Ethiopian sheep breeds have been traditionally classified into four broad categories based on tail type and fiber type: the hairy thin tailed, fat tailed and fat rumped (MoA, 1975). Accordingly, attempts have been made to group some of the indigenous sheep types in to these different categories.

Even though the recent molecular study of the Ethiopian sheep population by Solomon *et al*., (2007) classified into14 sheep population and six breed groups and nine breeds in Table 1.Ethiopia has a large sheep population in Africa, which is estimated at 25.5 million sheep (Workeneh, 2004; CSA, 2011).Different sheep breed types are widely distributed across different agro ecological zones of the country. About 75% of the sheep population inhabits the highland part of the country and the remaining 25% are distributed in the lowlands (Tibbo, 2006). Generally, based on phenotypic attribute there are six recognized indigenous sheep breed types in the country, which are further classified in to three sheep types: the fat-tailed hair type (3 breeds), the fat-tailed coarse wool sheep (2 breeds) and the fat-rumped hair sheep.

The DAD-IS (2006) database also mentions three other breed types; namely Akale Guzai, Barka and Bonga. Further, Solomon (2008) grouped Ethiopian sheep breeds into 14 traditional populations (Simien, Sekota, Farta, Tikur, Wollo, Menz, Gumz, Washera, Horro, Adilo, Arsi, Bonga, Afar and Black head Somali) in 9 breeds within 6 major breed groups (Short-fat-tailed, Washera, Thin-tailed, Long-fat tailed, Bonga and Fat-rumped following morphological and molecular characterization (FAO, 2007; Solomon, 2007). A number of indigenous Sheep breed types in Ethiopia are reared and named after specific ethnic community groups e.g. (Afar) or geographical locations (e.g. Horro, Menz) (Gizaw *etal.*, 2007). The indigenous sheep genetic resources have developed specific adaptations to survive and produce under adverse local environmental conditions (climatic stresses, poor quality feed, seasonal feed and water shortage, endemic disease and parasite challenge) that make them suitable for use in the traditional, low-input production system (IBC, 2004).

Table 1: Six Major Sheep Breed Types in Ethiopia

Breed group	Breed	Population	Tail type/shape	Fiber type
Short-fat-tailed	**Simien**	**Simien**	**Fatty and short**	**Fleece**
	Short-fat-tailed	**Sekota, Farta, Tikur, Wollo, Menz**	**Fatty and short**	**Fleece**
Washera	Washera	Washera	Fatty and short	Hair
Thin-tailed	Gumz	Gumz	Thin and long	Hair
long-fat-Tailed	Horro	Horro	Fatty and long	Hair
	Arsi	Arsi-Bale, Adilo	Fatty and long	Hair
Bonga	Bonga	Bonga	Fatty and long	Hair
Fat-rump Sheep	Afar	Afar	Fat rump/fat tail hair	Hair
	BHS	BHS		Hair

Source: Solomon, (2008)

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 major sheep production systems in Ethiopia include the traditional management system and the government ranches which is characterized by different production goals, priorities, management practices and constraints (Tibbo, 2006). 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 (Tibbo, 2006). These government ranches include: Horro Guguduru ranch, which was closed due to high sheep mortality, the Debre Berhan and Amed Guya ranch involved in the production and distribution of crossbred rams to the farmers.

In Ethiopia, sheep are reared in extensive systems with no or minimal inputs; they are kept virtually as scavengers, particularly in mixed crop–livestock systems (Solomon *et al.,* 2013). Solomon (2008) reported that sheep are produced in two main types of systems: sheep-barley systems in sub-alpine areas and pastoral systems in arid lowlands. The majority of people in the highlands keep small flocks and practice mixed crop-livestock agriculture, whereas those in the sub-moist, cold, very high altitude areas and in arid lowlands keep large flocks in pastoral production system. When closely examined, three different production systems have been identified.

2.3.1. Highland Sheep-Barely System

According to Markos (2006), this system is found in the highlands above 3000 meter above sea level (*m.a.s.l.*) where sheep are the main source of cash income, meat, manure, skins and coarse wool for traditional cottage industry to produce blankets, rugs and mattresses by the local handcrafts. In extreme altitudes, precipitous terrain, recurrent droughts, cold temperature and windy climate limit crop production to sheep-barley production system. Sheep breeds of this system (for example, the Menz breed) are perceived to be the hardiest sheep types evolved under stressful environments. The main feed resource includes waste land grazing and sometimes straw. Cropping intensity in this area is generally low. Sheep are the dominant livestock species and flock sizes range from 30 to several hundred head (Solomon *et al.*, 2008). Likewise, Markos (2006) sheep flocks are larger, typically comprising 10-30 animals with fewer small flocks, and fewer larger flocks of above thirty.

2.3.2. Mixed Crop-Livestock System

Mixed crop-livestock system, which covers areas in altitudes between 1500 and 3000 m.a.s.l. in which sheep are kept in small flocks as a source of cash income, meat, manure, skins and in some areas for coarse wool (Markos, 2006). Mixed farming system is predominantly found in highland agro-ecological zones where the climatic factors are conducive for farming of crops and raising livestock. In this system, livestock and crops are maintained as complementary enterprises (IBC, 2004). The sheep flocks are kept along with other livestock species (cattle, goats and equines) in rather reduced communal grazing areas, unsuitable for cropping, or fallows, waterlogged land and steep slopes (Markos,2006). According to Mesfin (2015) the majority of people in the highlands keep small flocks and practice mixed crop-livestock agriculture. These systems are based on cropping associated with livestock husbandry. In mixed farming system of the highland parts 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 (Markos, 2006).

2.3.3. Pastoral and Agro-Pastoral Production System

According to Markos (2006) and Solomon (2008) pastoral production system is located in the arid and semi-arid lowland areas below 1500 *m.a.s.l.* in which livestock rearing is the mainstay of people. Livestock and livestock products provide subsistence, either directly as milk, milk products, meat and blood, or indirectly in the form of purchased cereals through sales of animals. Sheep are raised mainly for cash income (mainly through export) and meat, except in isolated areas where they also keep them for milk (for example, in Afar and parts of Tigray regions). Other important species in this system include cattle, goats and camels. Constant or partial herd mobility is a strategy to achieve feed and water. Similarly, Mesfin (2015) 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. According to the one study pastoralists have no permanent home and, hence move with their herds within their traditional territory (Mengiste, 2010).

2.4. Socio-Economic Importance of Sheep

Indigenous sheep breeds have great potential to contributing more to the livelihoods of the people in low-input, small-holder crop livestock and pastoral production systems (Kosgey and Okeyo, 2007).They considered as a living bank against the various environmental calamities (crop failure, drought and flooding) and have socio-cultural values for diverse traditional communities (Edea *et al.*, 2010). Moreover indigenous sheep in Ethiopia have a multipurpose role for smallholder farmers as sources of income, meat, skin, manure and coarse wool or long hairy fleece. Thus, increasing the current level of productivity of sheep is essential to meet the ever-increasing demands of human population.

Sheep have a great importance as major sources of livelihood (Kosgey, 2004) and contribute to the sustenance of landless, smallholder and marginal farmers especially to the poor in the rural areas throughout the developing countries. They are sold to meet compelling family financial obligations or slaughtered for consumption at home or festivals and the small size of the animal, their high reproductive efficiency, low initial investment makes them suitable for rearing in the small holder farmer (Ademosum, 1994).

Sheep have social and economic importance to the producers. The sheep enterprise in the Ethiopian highland crop/livestock mixed farming system is the most important form of investment as well as cash income and provides social security in bad crop years (Getachew, 1988). According to Ibrahim, (1998) farmers keep sheep for many reason: (a) they are highly adaptable to a broad range of environments, (b) they have short generation cycles and high reproductive rates, (c) certain breeds of sheep (e.g. Red Maasai sheep) are disease tolerant such as helminthosis, (d) they are small enough to be consumed by an average rural family in a day or two hence no refrigeration facilities are needed and (e) they are prolific and need only short periods to increase flock sizes.

2.5. Feeds and Feeding Systems

The main feed resources for sheep production are natural pasture, improved forage and crop residue showing varied availability in different seasons. Natural pasture or indigenous grass was the main feed resource during the rainy season whereas crop residue and improved forage, in dry season (Feleke *et al.*, 2015). The same results have been reported by Getahun (2008) that the main feed source is communal grazing land, crop residues. Communal grazing land, roadside grazing, private grazing, riverside grazing and indigenous browser are the major types of grazing for sheep although there is difference in utilization across months of the years, communal grazing lands are utilized throughout the year (Fikru and Gebeyew, 2015).

Similarly (Tsedeke, 2007; Tesfaye, 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. As a result, for animal that is not supplemented the gains made in the wet season (Alemayehu, 2003). A survey result by Alemayehu (2005) generalized that from the overall feed intake of animals in Ethiopia, natural pastures and crop residues contributed 80-90 and 10-15 percent, respectively.

According to Feleke *et al.,* (2015) in Kembata Tambaro Zone**,** on months August and February, serious feed scarcity was prominent and utilize different feeds: agro industrial by-products, tubers and other feed supplements whereas sell their sheep specially lambs to reduce feed requirement of sheep on dearth period. During November, December, June and May, there were excess feed supplies that encourage farmers to fatten their sheep by buying additional sheep from the market. A marked seasonal variation in the quantity and quality of feed supply and the acute problem of feed supply during dry season (IRLI, 2000). Shrinkage and decline yield of grazing lands driven by increase livestock population and drought was reported to be the leading reasons for feed shortage across all the study sites. Increases of human population and Decline carrying capacity of grazing land are also mentioned to cause feed shortage (Gebeyew, 2015).

2.6. Sheep Housing

Housing is one of the major sheep husbandry activities which protect them from extreme temperature, rain, wind, predators and theft(Yadeta,2016).A report in Doyogena Woreda by Feleke et al. (2015), Keeping sheep in the main house together with the family is very common (100%) which is in agreement with (Tsedeke,2007). In contrast to this study, Yenesew*et al.,* (2013)reported that 9% of the households provided separate housing. Zelalem et al., (2013) in Northern Ethiopia reported that farmers put their sheep in separate housing (pen) constructed in the homestead or around the homestead. Traditionally, the pens are constructed in two different ways. The first and most commonly used pen constructed is open ended without roof which is usually used to confine sheep during dry season at night. Except few respondents almost all households keep their flock separately from large ruminants. The second one is mostly used to confine sheep during rainy season to protect them from rain and cold. It is three or two- side wall constructed from local materials such as stone or wood and partially roofed. Farmers with this sort of housing keep all types of animals.

According to Fikru and Gebeyaw (2015) sheltering their sheep for reasons to protecting from bad weather, predators, and to provide supplement in the evening. Small ruminants are sheltered for protection in most rural communities such as, in central rift valley (Samuel, 2007) however; places of sheltering and type of house were varying. Almost above 50% households shelter their animals in separately constructed house, and others are using main house and grazing area (Feleke *et al*, 2015). Housing of flocks in the main house is more common than other reports in the country (Berhanu, 1998).

2.7. Diseases

Diseases and parasites are also contributing for higher production losses, particularly in young Stocks. Respiratory Disease Complex (RDC) is among the most important diseases and associated complexes in small ruminants' husbandry and management (Deribe,2009). Early mortalities (as high as 50% in lambs) are among the most important losses associated to managements like cold stress, starvation, miss-mothering, etc. (Tibbo, 2006). Also Tesfaye (2008) has mentioned that the major constraint of sheep production in Menz and Afar areas are feed Shortage/frequent drought and disease each with varying intensity. Similarly Solomon (2007) also identified disease problem was the first and the most important production constraint of Gumuz sheep in North Western Lowland of Amhara Region.

According to Fsahatsion *et al.*, (2013) reported that mortality rates attributable to diseases and parasites are 25.3% (sheep) in Alaba, and 14.6% (sheep) in Gomma. Primary reasons for the prevailing high rate of mortality can be attributed to diseases and parasitic infestations Tsedeke (2007) in Alaba and Woliyta and Dawro zone, respectively. As reported by Tajebe et al (2011) economic losses due to disease and parasites have quadruplet their effect further when factors such as feed shortage, poor management practices and environmental factors are prevalent. Moreover, according to the report of Yohannes (2007) parasite and infectious disease were the major cause of sheep mortality in Alamata woreda of Southern Tigray.

Yenesew (2010) who reported considerable mortality of sheep caused by feed deficiency under traditional management system.

Shortage of feed and inadequate supplementary feeding were reported to be a major cause of livestock mortality and poor performances in highland agro-ecologies of southern and central Ethiopia (Hassen *et al.*, 2010. Solomon *et al.*, (2010) Peste des petits ruminants (PPR), foot and mouth disease, pasteurellosis and anthrax are the most important diseases prevalent in Ethiopia, besides the same incidences of teniasis (tape worm) helminthes problems and ect-oparasitic load (tick and mites) too prevalent. Feleke *et al.*, (2015) reported in southern Ethiopia major common diseases encountered in various flocks in order of significance were pasteurellosis, Pneumonia and internal parasites which hinder Performance of sheep.

2.8. Production Constraints of Sheep

Sheep production in Ethiopia is based on indigenous breeds except for less than 1% exotic sheep group of mainly Awassi-Menz crossbreds (Tibbo, 2006). Identification of constraints which can put obstacle for sheep production and genetic improvement program me should be carried on priority before trying for its implementation (Baker and Gray, 2004). According to Tsedeke (2010) sheep production and productivity in Ethiopia is con-strained 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. However, high re-productive 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 un-favored conditions and are widely adapted to different agro-climates. They can found in all ethnic groups and production systems.

Tsedeke (2010) reported farmers rearing sheep confess a range of interlinked technical,socioeconomic and institutional bottlenecks. The most serious constraint hindering sheep production in Kembata Tambaro zone is lack of capital. Another most devastating phenomenon that curtails sheep productivity is land shortage. In addition feed scarcity, water shortage, disease like parasite, market problem, inbreeding, poor management and awareness problem were the major constraints followed to capital. Moreover, Abebe *et al.*, (2000)reported that feed shortage in the dry and rainy season: diseases, inadequate veterinary service and lack of capital are the main sheep production constraints in Lallo-mamma Mider District, North Shoa.

A study conducted in Degehabur Zone shows that diseases and parasites are overriding problems in sheepproduction. In addition drought, feed and water shortage were another limiting constraint in small ruminantproduction. Feed shortage in both seasons (dry and wet) limits productivity of small ruminants and it was further worsened due to the absence of awareness and practice of feed conservation techniques. Problems of input supply,credit services and appropriate extension services the major constraints of sheep production (Gebeyew, 2015).Disease, feed shortage, predators and labor shortage were the most pertinent constraints for sheep production in Horro and Adiyo Kaka (Bonga) had significant influence on sheep productivity (Zewdu, 2008).

2.9. Phenotypic Characterization

Phenotypic characterization of AnGR is the process of identifying distinct breed populations and describing their external and production characteristics in a given environment and under given management taking into account the social and economic factors that affect them (FAO, 2012). The information provided by characterization studies is essential for planning the management of AnGR at local, national, regional and global levels. A good understanding of breed characteristics is necessary to guide decision-making in livestock development and breeding program. The classical description of breeds using the phenotype is based upon characters such as coat color, horn, tail type, tail shape, body measurements and other specific visible traits.

Phenotypic relationships, based up on the comparison of morphological characters, are used to estimate variations within breeds and distances between breeds, and are used to describe them in terms of the frequency of the most typical characteristics. Morphological or phenotypic characterization has been suggested and used to describe and classify breeds of farm animal species (Traore *et al.*, 2008). According to Sisay (2009) morphological data are cheap and easy to obtain, in comparison to molecular data. The advantages of morphological data are that it is relatively easily obtained; requiring relatively inexpensive instrumentation in comparison to Molecular instruments.

Characterization of livestock breeds includes information on population size, flock size and composition, production estimates and information on the production environment and husbandry conditions, which are known to play vital roles in trait expression (Mesfin, 2015).The first phase of characterization is surveying to identify populations based on morphological descriptors and describe their geographical distribution, uses, and husbandry and production environments (Traore *et al.*, 2008).

The phenotypes are an expression of genetic characteristics which is modified by environmental conditions and genetics variance (Yakubu, 2010).Characterization of animal genetic resources includes all activities associated with the description of animal genetic resources aimed at better knowledge of these resources and their state (FAO, 2000).The traditional description of sheep breed is based upon morphological characters such as coat color, horn, tails, body measurements and other specific visible traits. Even though in Ethiopia, only few breeds have been described for their physical appearance (Workneh*et al.*, 2004) recent studies indicated that the current population/genetic structure in Ethiopian sheep is strongly associated with historical patterns of sheep migration, geographic isolation and interbreeding(Gizaw *et al*., 2007).

In Ethiopia phenotypic characterization has been started by FARM-Africa (1996) to describe and classify breeds of farm animal species due to this different authors write about characterization. The phenotypic characterization and performance of Menz sheep and its crosses with the imported Awassi has been characterized at Debre Berhan Agricultural Research Center (DBARC) by (Tesfaye, 2008). The International Livestock Research Institute (ILRI) also evaluated Menz and Horro sheep breeds at Debre Berhan Research Station (Markos *et al.,* 2006).

On-farm characterization of Menz sheep in Lallo-Mama woreda around Debre Berhan was conducted (Agyemang et al., 1985) similarly on-farm evaluation of Washera sheep breed in Western Highland of the Amhara region(Mengiste,2008). Characterization of Blackhead Somali sheep (Fekerte, 2008) characterization of thin-tailed Gumuz sheep (Solomon, 2007), Characterization of Horro sheep breed has been done at Bako Research Center (Solomon, 2002) were conducted and might be useful to start sheep breed improvement programs. However, until know the current state of knowledge on characterization of farm animal genetic resources in Ethiopia shows that there is lack of information about potential level of productivity, production characters of local breeds managed in their native production system and the genetic make-up of the indigenous breeds (Workneh *et al*., 2004). So characterizing the existing sheep production systems and analyzing their production constraints are important tools to diagnose the status and trends of the system to identify areas for future interventions (Getahun, 2008).

2.9.1. Qualitative Traits of Indigenous Sheep

Qualitative traits of indigenous sheep population were summarized in Table 2. There is an increasing interest in the characterization of African small ruminant populations because of their major role in the maintenance of genetic resources as the basis of future improvement at both the production and the genetic levels (Nsoso *et al*., 2004). The classical description of breeds using the phenotype is based upon morphological characters such as coat color, horn, tail type, tail shape, body measurements and other specific visible traits. Phenotypic relationships, based up on the comparison of morphological characters, are used to estimate variations within breeds and distances between breeds, and used to describe them in terms of the frequency of the most typical characteristics. Morphological characterization has been suggested and used to describe and classify breeds of farm animal species (Traore *et al.,* 2008).

According to Sisay (2009) morphological data are cheap and easy to obtain information, in comparison to molecular data. The advantages of morphological data are that it is relatively easily obtained; requiring relatively in expensive instrumentation in comparison to molecular instruments.According to the report of Solomon there are high morphological, ecological, ethnic and production systems diversity of indigenous sheep distributions in Ethiopia (Solomon, 2008). The result of Yakubu A and Akinyemi MO (2010) points out those phenotypes are an expression of genetic characteristics, modified by environmental conditions and that variance in both genetics and environment may affect phenotypic variance.

According to Wossenie (2012) reported that Harerghe Highland sheep had coat color pattern were (52.2%) plain and (47.8%) patchy with the most frequently observed predominant coat color type being light brown (35.3%), light brown with white patch (29.1%) and white (23.9%) was reordered similarly Michael (2013) also reported that 57.42% were plain, 38.71% patchy and 3.8% had spotted coat pattern in east Gojjam.

Table 2: Descriptions of qualitative traits of indigenous sheep

Sheep type	Location	(i) Coat Type Pattern (%)			Reference
		Plain	**Spotted**	**Patchy**	
Horro	Wollega	87.5	10.6	1.9	Zewdu, 2008
Bonga	Bonga	63.8	32.2	3.6	Zewdu,2008
Washera	West Gojjam	57.14	28.73	8.25	Michael,2013
Menz	North Shewa	69.32	28.0	2.8	Tesfaye ,2008
Afar	Afar	58.1	40.6	1.3	Tesfaye ,2008
Dawuro Sheep	Dawuro zone	58.3	36.55	5.15	Amelmal, 2011
Dawuro Sheep	Bensa district, SNNR	47.43	51.90	0.68	Hizkel , 2017
Bale sheep	Bale zone	12	20.1	67.8	Belete , 2017

Sheep type	Location	(ii) Coat Colour Type (%)						Reference
		White	**Brown**	**Red**	**Black**	**Red + White**	**Black+ White**	
Horro	Wollega	24.5	56.2	-	4.4	-	-	Zewdu, 2008
Bonga	Bonga	14.1	46.9	21.1	2.4	9.9	2.1	Zewdu,2008
Washera	West Gojjam	20.6	11.15	20.48	4.29	19.21	-	Michael,2013
Menz	North Shewa	21.5	-	29.3	15.8	16.4	6.3	Tesfaye,2008
Afar	Afar	47.2	-	7	1.2		41.9	Tesfaye ,2008
Dawuro Sheep	Dawuro zone	15.6	18.15		4.0		-	Amelmal, 2011
Dawuro Sheep	Bensa district, SNNR	7.98	1.00	22.46	-		13.05	Hizkel, 2017
Bale Sheep	Bale zone	3.7	5.7	21.1	-	21.7	41.1	Belete, 2017

Table 2: Cont…

Sheep type	Location	(iii) Head Profile (%)		(iv) Hair Type (%)		(v) Horn (%)		Reference
		Straight	Convex	Smooth	Rough	Present	Absent	
Horro	Wollega	92.7	7.3	-	-	-	-	Zewdu, 2008
Bonga	Bonga	68.9	31.1	-	-	-	-	Zewdu,2008
Washera	West Gojjam	52.54	47.46	50.79	27.78	20.48	78.73	Michael,2013
Menz	North Shewa	97.3	2.7	0.9	99.1			Tesfaye,2008
Afar	Afar	99.3	0.7			0	100	Tesfaye,2008
Dawuro Sheep	Dawuro zone	91.2	8.8			-	-	Amelmal, 2011
Dawuro Sheep	Bensa district, SNNR	-	-			56.3	43.7	Hizkel, 2017
Bale Sheep	Bale zone	88	12			51	49	Belete, 2017

Sheep type	Location	(vi) Ear form (%)		(vii) Tail form (%)		(viii) Wattle (%)		Reference
		Lateral	Rudimentary	Straight tip downward	Straight twisted up	Present	Absent	
Horro	Wollega	-	-	69.6	30.4	5.9	94.1	Zewdu, 2008
Bonga	Bonga	-	-	67	33	5.1	94.9	Zewdu,2008
Washera	West Gojjam	96.3	3.7	-	-	-	-	Michael,2013
Menz	North Shewa	84.6	15.4	0.5	99.5	5.7	94.3	Tesfaye,2008
Afar	Afar	80.3	19.7	0.5	99.5	2.2	97.8	Tesfaye,2008

2.9.2. Body Weight and Linear Measurement of Sheep

The body weight and body measurements of indigenous sheep have been summarized in Table 3.Body measurements are considered as quantitative growth indicators which reflect the conformational changes occurring during the life span of animals. Live weight is the most common measure of animal performance because knowing the body weight of a sheep is important to provide reliable and informative measure for selection, feeding requirements, health management and decision on selling price (Thiruvenkanden, 2005) and also live body weight is an important growth and economic trait.

However, it is not always possible to measure it due to mainly the lack of weighing scales, particularly in rural areas (Zewdu*et al.*, 2009). For this reason, live weight parameter, which is an important selection criterion, cannot be effectively used at an adequate level. Where weighing scale is not available, especially in the rural communities of Ethiopia, the best method is regress live weight on certain body characteristics which can be easily measured (Tesfaye *et al.,* 2009). This is possible because there is a balanced relationship between body measurements and live weight in animals. The importance of linear body measurements in estimation of body weight of small ruminants have been addressed for studying the breed standards (Riva *et al.,* 2004).

Measurements taken on the live animals have been used extensively for a variety of reasons both in experimental work and in the practice (Tassew, 2012). Possible reasons overtime for this may include: management decision such as how much to feed, when to breed, determination of dosages of various medications and vaccines and most important is when to market either as weaned, growers or for slaughter. These measurements provide important evidences for the growth of the breed and the properties that change with environmental effects and feeding factors (Riva, 2004).

Studies indicated that variation exists in indigenous sheep breeds for body weight traits were reported by (Sisay; 2002; Markos, 2006; Solomon; 2007). Among the indigenous sheep breeds Horro and Bonga sheep breeds are large sized breeds and are superior in their body weight Solomon *et al.,* (2007). Information on live body weight and linear measurements of the existing breed types has vital role in the selection program (Bosenu, 2012). Therefore, it is beyond doubt that live body weight and linear body measurement is playing crucial role in genetic improvement and selection of specific breed (Tesfaye, 2008).

Table 3: Body Weight and Linear Body Measurements of Some Sheep Breeds in Ethiopia

Breed	Quantitative traits				Source
	BW	BL	HG	WH	
Bonga	31.87	69.16	72.92	68.12	Zewdu, (2008)
Horro	27.65	67.40	73.81	69.43	
	26.60	61.75	62.60	63.60	Markos *et al.*, (2004)
CHS	27.00	59.75	72.70	63.20	Sisay ,(2002)
Washera	29.0	63.1	78.2	70.43	Michael,(2013)
	30.45	65.15	75.10	68.85	Sisay ,(2002)
	32.8	66.7	74.10	69.4	Solomon ,(2008)
Holla Sheep in south Wollo	22.09	52.40	69.95	58.43	Adina *et al.*,(2017)
Native sheep North Wollo zone	25.51	57.46	69.93	59.36	Tassew*et al*.**,(**2025)
Indigenous Sheep Types in Bale Zone	26	48.75	71.4	62.1	Belete *et al*.,(2017)
Afar	26.10	56.40	72.35	60.55	Sisay, (2002)
	29.2	54.6	75.7	64.1	
Black head Somali	31.	53.3	74.1	64.1	Helen,(2015)
Harerghe highland	32.7	54.5	76.9	61.3	
Sheep types in Selale area	27.75	62.59	75.34	65.43	Bosenu, **(**2014)
Menz	24.50	61.90	66.90	63.90	Markoset al., (2004)
Gumuz	33.30	67.15	77.00	65.45	Solomon ,(2007)
Sheep In Wolaita zone	26.7	65.13	71.21	65.17	Mesfin et al.,(2016)
Sekota/Tigray Sheep	27.52	56.69	77.64	61.81	Mulata et al.,(2014)
In Central Tigray	22.0	54.5	71.4	59.4	Tesfaye et al.,(2016)
Sheep in southern regional state	29.2	63.0	74.1	64.0	Abera ,(2013)

BW = Body weight; BL = Body Length; CG = Heart Girth; WH = Wither height; CW = Chest width

2.10. Flock Structure and Ownership Patterns

A study carried in north western lowland of Amhara region indicated that out of the total sampled Gumuz sheep under farmers management condition, about 42.58% were adult females, while the proportion of rams in a flock was only 5.8 % (Solomon, 2007). In Menz sheep flock breeding ewes take a major portion (46.8%) followed by lambs (19.2%) and ewe lambs (14.3%) and low proportion (5.65%) of breeding rams and castrates (3.92%). Similarly, in Afar pastoral system breeding ewes were dominant (49.2%) followed by lambs (23.6%) and ewe lambs (18.1%) as well as 2.83% breeding rams and 0.8% castrates(Tesfaye, 2008).

Higher average sheep flock size of 24 sheep per head has been reported by Abebe (1999) for Menz sheep in Lalo-Mama woreda. Generally in most of the traditional systems both breeding ram and ewe graze together throughout the year with all age class of sheep and in most cases with other species of livestock (Aden, 2003).Report for male to female ratio of different studies range from 1: 6.7 to 1: 29 (Solomon, 2007).

2.11. Reproductive Performance of Indigenous Sheep

Good reproductive performance is a prerequisite for any successful genetic improvement and it determines production efficiency (Zewdu, 2008). Many Studies suggests that differences exist in reproductive performance between indigenous sheep breeds and their variation allow for the selection of suitable breeds for a given environment. Reproductive performance depends on various factors including age at first lambing, litter size, lambing interval and the life time productivity of the ewe (Suleiman *et al.,* 1990).

2.11.1. Age at First Lambing (AFL)

The AFL of some of the indigenous sheep breeds has been summarized in table 4. The age at first lambing marks the beginning of a female productive life and influences both the productive and reproductive life of the female. According to Zewdu (2008) the Average age at first lambing for Bonga and Horro sheep was 14.9 ± 3.1 months and 13.3 ± 1.7 months, respectively. Amelmal (2011) and Zewdu (2008) showed that average age at first lambing of Dawuro and Bonga sheep were 14.09±1.8, 14.9 ± 3.1 months respectively. The average age at first lambing (AFL) of Gamo Goffa ewes was, also, 12.4 months (Fsahatsion et al, 2013). In most traditional systems, first lambing occurs at 15-18 months when ewe weights are 80-85 percent of mature size (Wilson, 1982).The average age at first lambing of Bonga and Horro sheep was 14±3.1 and 13.3±1.7 months, respectively (Zewdu, 2008). And also the average age at first lambing of Gumuz sheep was 13.67 ±2.4 months (Solomon, 2007). Poor nutrition, disease or parasitic burdens are obstacle for age at first lambing (Mukasa-Mugerwa and Lahlou-Kassi, 2002).

Table 4: Age at First Lambing of Ethiopian Indigenous Sheep Breeds/Types

Breed/type	AFL(months)	Source
Sheep in Ada Barga &Ejere, North show	14.29±0.08	Yadeta, 2016
Gumuz	13.67	Solomon, 2007
Menz	17.06	Niftalem, 1990
Washera	15.46	Mengiste, 2008
Blackhead Somalia	23.56 ± 3.63	Fikrte, 2008
Bonga	14.9 ± 3.1	Zewdu, 2008
Horro	13.3 ± 1.7	Zewdu, 2008
Arsi-bale	12.7	Tsedeke, 2007
Adilo	14.6	Getahun, 2008

2.11.2. Lambing Interval

The interval between two successive parturitions is called lambing interval and it can be affected by season of lambing number of parity of ewes and management practice, nutritional accessibility and breed (Wilson and Murayi, 1984). According to Solomon (2007) 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 (2008) indicated 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 (2008).

2.11.3. Litter Size

The litter size of some of the indigenous sheep breeds has been summarized in table 5. According to Zewdu (2008) a twining rate of 39.9 % or litter size of 1.40 for Horro breed and 36 % or litter size of 1.36 for Bonga sheep breed suggested that the two breeds showed relatively better multiple births under the existing feed shortages. The report of Tesfaye (2008) showed low twining rate in both Menz and Afar sheep breeds which is 1% and 5% respectively. The management system is also a major source of variation in litter size as reported by Mekuriaw et al. (1995) showed that Horro sheep breed is the most prolific breed among the Ethiopian breeds with a litter size of up to 1.53 followed by Washera and Menz.

2.11.4. Reproductive Life Span

According to Zewdu, (2008) long reproductive life span in tropical condition is one of the adaptation traits of tropical livestock. Long term reproductive performance (long living, high fertility, ability to produce more offspring) of dams should be given more importance in selection programs. According to Solomon (2007) quite long reproductive life span of Gumuz sheep breed, Horro and Bonga ewes were reported 8.5, 7.9 ± 3.1 and 7.4 ± 2.7 years, respectively.

Table 5:Lambing Interval and Litters Size of Some Sheep Breeds of Ethiopia

Breed/type	LI (days)	Litter size	Source
Sheep inAda Barga&Ejere west show	8.83±0.44	1.19±0.42	Yadeta,2016
Local in sheep in Tigray	8.41	-	Assen and Aklilu,2012
Local in sheep in Begayt	8.55	-	Ashebir et.,al,2016
Local in sheep in Arsi bale	12.27	1.75	Tsedeke,2007
Local in sheep in Sidama	9.6	-	Marufa et.,al,2017
Local in sheep in gamogofa zone	7.34	1.3	Fsahatsion etal.,2013
Gumuz	6.64±1.13		Solomon,(2007)
Menz	8.5	-	Tesfaye ,(2008)
Blackhead Somali	315.97	-	DAGRIS, (2004)
Menz	-	1.13	Mukasa et al.(2002)
Horro	-	1.14	Mukasa et al.(2002)
Local sheep around Dire Dawa	11.2-11.3	1.01	Aden, (2003)
Washera	253	1.16	DBARC ,(2006)
Horro	-	1.53	Solomon, (1996)
Local sheep in Gamogofa zone	7.34±0.13	1.3±0.04	Fsahatsion,2013
Local sheep in Alaba	7.87-8.04	1.51+0.04	Derbie, 2014
Local sheep in Ada Barga and Ejere	9.19±0.08	1.19±0.42	Yadeta, 2015
Local sheep in Tocha	11.62±3.8	24.75±7.9	Amelmal, 2011
Local sheep in Mareka	10.33±4	37.8±12.9	Amelmal, 2011

2.12. Breeding Strategies and Genetic Improvement

Breeding strategies implemented in developing countries in the past has been concentrated on the importation of higher-producing exotic temperate breeds that were developed for high-input, production environments. The sheep breeding strategies adopted in Ethiopia over the last several decades were largely focused on importing exotic breeds for cross-breeding. Several efforts have been made to this end since the early 1960s (Tibbo, 2006).

However, such genetic improvement programs failed due to poor planning and due to the fact that they were implemented without considering all the needs of sheep owners and stakeholders in decision making and the program had no regard for the potential of indigenous breeds (Hassen *et al.*, 2002; Kosgey, 2004). According to these authors, Ethiopian indigenous sheep breeds can be as productive if not more productive than exotic sheep breeds if proper strategies are designated to improve their genetic makeup and the environment. Besides lacking sustainability, the conventional approach further contributed to the erosion of local breeds adapted to the lower input mixed farming and pastoral production systems found throughout the developing world (ILRI, 1999).

2.13. Breeding Practices of Indigenous Sheep in Ethiopia

2.13.1. Mating System and Sources of Breeding Rams

Mating is predominantly uncontrolled in most of the production systems. According to Nigussie *et al.*,*(*2013) in Jijiga and Shinile and in Eastern Harerghe zone in each production system, 98%, 89% and 71% in the pastoral, agro pastoral and mixed crop-livestock systems, respectively, kept their own indigenous breeding rams. Similarly, Tesfaye (2008) reported in Menz and Afar sheep, breeding is generally uncontrolled, except only to some extent in Afar area. Majority of the smallholder farmers and pastoralists were not aware about the disadvantage of inbreeding. Some farmers and pastoralists reported that they heard the negative effect of inbreeding but no one tried to avoid except few of smallholder farmer and of pastoralist who revealed that they did not allow close inbreeding.

According to Zewdu *et al*., (2012) in western and south western Mating was predominantly uncontrolled. Majorty ofAdiyo Kaka and some of Horro farmers kept their own breeding rams. Likewise, Hailemariam*et al.* (2013) who reported in Gamogofa district area the breeding was uncontrolled mating. Similarly, Amare *et al*., (2012) in western zone Tigray reported mating was predominantly uncontrolled except in Setit Humera where rams are isolated during the day time. Controlled breeding requires strong extension services to ensure that rams are used efficiently to maximize the benefit (Zewdu *et al.*, 2012).

Fekerte (2008) states that on-farm characterization of blackhead Somali sheep in shinile zone at the Northwestern of the Somali Region, Ethiopia, 78 percent of the respondents practiced partial controlled mating system and the ram run with ewes only during breeding season and the remaining 22 percent used uncontrolled mating system. The primary reason for uncontrolled mating is the use of communal grazing area where by animals from various households graze together.

2.13.2. Selection criteria

Selection of parents of the next generation in both the rams and ewes is based on the performance and preference of farmers.In Ethio- Somali Region, Selection of breeding animals was focused on selection of breeding males but selection of breeding females is not common (Fekerte ,2008). According to Tesfaye(2008) in Menz and Afar district the importance of selection has been recognized and they practiced to some extent their own selection criteria. Similarly, Zewdu *et al.,* (2012) Adiyo Kaka and Horro district reported Selection of parents of the next generation in both the rams and ewes was very common in farmers. Likewise Tassew *et al*.(2014) North Wollo district farmers in Habru and Gubalafto areas are well experienced in selection of future breeding ewes and rams from own flock of sheep.

According to Nigussie *et al.,* (2013) in eastern Ethiopia selecting a breeding ram based on the appearance, coat color and fast growth in eastern Harerghe zone and appearance, age and fast growth were the selection criteria in Jijiga and Shinile. Similarly, Taye *et al*., (2016) in Doyogena area select their breeding rams and ewes based on body size, appearance/conformation and color of the sheep. In addition, Tesfaye *et al.* (2008) conformation, fast growth, coat color, tail size and shape and mating ability of the ram were the selection criteria of breeding rams in both Menz and Afar district area.

In western Tigray zone breeding rams were selected based on their growth, tail length, appearance/conformation and color of sheep (Amare *et al.*, 2012). Likewise, Hailemariam *et al.,* (2013) in Gamogofa district body conformation was the primary selection criteria. Large body size, red or brown coat color, tail with long, broad and twisted at the end are the most preferred traits by most of the farmers in Adiyo Kaka and Horro area. However, in contrast to Adiyo Kaka, farmers of Horro preferred male with broad and straight pointed tail (Zewdu *et al.*, 2012).

According to Tesfaye (2008) the selection criateria of Menz sheep of breeding ewe were lambing interval, mothering ability, ability to give multiple birth (twining) and coat colour of ewe. Afar sheep breeders consider milk yield, mothering ability, appearance and/or size of ewe and lambing interval as the four more important traits of section. In the Afar pastoral system milk had has a significant role for home consumption. Both farmers and pastoralist gave more attention for the coat colour and conformation of their animals. Likewise, Hailemariam *et al.*, (2013) reported body condition, performance history, tail, coat color, ear and horn shape were selection criteria in Gamogofa district. The traits of body size, age at first maturity, lamb growth, tail length and coat color were the selection criteria in Humera, west Tigray zone (Amare *et al.*, 2012).

2.14. Breeding objective of sheep in Ethiopia

The main breeding objective of farmers in the subalpine sheep–barley system for Menz sheep was to improve their market value through increased meat production by improving growth rates and conformation (Tesfaye, 2008). In consistent with this, Tadele (2010) reported farmers in the mixed-livestock production system improve their market value through increasing meat production by body size, mothering ability and twinning for the Bonga and Horro breed. Likewise, Nigussie *et al.*, (2013) in East Harerghe zone asserted the primary objective was increasing meat production for income generation. The primary objective of the farmers in Western Tigray was meat production, income generation and consumption (Amare *et al.*, 2012).

According to Nigussie *et al.*, (2013) milk production was the primary objective in agro-pastoral and pastoral production systems of Jijiga and Shinile area and the purpose of keeping rams (70.6%) was for mating purpose, for fattening (13.8%) and for both fattening and mating purpose was (15.6%) (Fekerte, 2008) but Tesfaye *et al.* (2010) also reported that milk production from sheep was the primary objective of pastoralists in Afar north-east Ethiopia. However, Zewdu *et al.*, (2009) reported that production and consumption of milk from sheep was not common in mixed crop-livestock system where meat production for income generation was considered as the primary objectives in Bonga and Horro district.

The sheep breeding objective of some area mainly pastoralists were adaptation to drought arid and semi-arid areas and are used for milk and meat. Bonga and Horro breed are kept for mutton production. The Menz breed is fat-tailed and is raised for its meat and coarse wool (Tadele, 2010).According to Abebe, (1999) there is a multi-purpose function of sheep rearing for sheep keepers in the central highlands of Ethiopia. Multiple functions are particularly important in low and medium input production environments. Different studies addressed the importance of multiple values of indigenous livestock breeds in developing countries in low input system (Kosgey, 2006). According to Fsahatsion Hailemariam, *et al.*,*(*2013) the primary reason of sheep keeping by the farmers is for source of income generations through the sale of live animals and the cash obtained might be used to buy clothing and food items, pay taxes, additional fertilizers to manures, household supplies (children schools) and the second main reason of sheep keeping is for meat production, for manure, social and cultural functions.

2.15. Herding practices

Herding practice have an implication for designing genetic improvement programs and introducing improved sheep management such as strategic health interventions at village level (Gizaw *etal.*, 2013). The flock herding practices of the smallholder and large scale farmers reflects the breeding managements and has an impact on the flock size. According to Yohannes *et al.*,(2017) in lowlands of north western Ethiopia, Amhara Region, in Metema and Quara districts herding practice is free grazing and about 51%, 31.7% and 17.2% of the small holder farmers herd sheep together with goat, separate and either separate or sometimes with goat depending on the availability of hired labor, respectively. Because of their feeding habit, farmers prefer to manage sheep separately, but the majority of the smallholder farmers keep sheep with other livestock because of the shortage of labor. Gizachew *etal.,* (2010) reported that sheep and goat are herded together in Afar pastoral and agro-pastoral system. According to Mekoya *et al.,* (2000) sheep in the central highlands of Ethiopia are herded separately for grazing all year round using family members.

2.16. Correlation between body weight and other linear body measurements

Many researchers gave an attention to the body size of livestock animal as the object being observed (Handiwirawan *et al.,* 2011). Several studies reported a strong correlation between some linear body sizes with some production traits, i.e. linear body size can be used to estimate the body weight of sheep and also it can be used to estimate some properties of lamb carcass trait (Jimmy *et al.*, 2010).

The correlation between body weight and other liner measurements for the breed could be analyzed for both sexes and all age groups of the animals. In most of the studied animals, a girth circumference is positively, strongly and significantly correlated to body weight (Tassew*et al.,*2015).High correlation coefficient of body weight and body measurements suggested that either of this variable or their combinations could provide a good estimation for predicting live weight of sheep (Tajebe *et al.*, 2011).

According to (Amelmal, 2011) a negative relation could be seen between body weight and some independent variables in a particular age group this could due to small number of observations in that particular age group. Positive and highly significant correlations were observed between body weight and most of the body measurements of Tocha, Mereka and Konta sheep in southern nation nationalities and people regional state of Ethiopia. Correlation coefficients between live weight and other measurements estimated for male Afar sheep found in the intermediate age group were non-significant while r value was large (Tesfaye*et al*., 2009).

The high correlation of different measurements with body weight would imply these measurements can be used as indirect selection criteria to improve live weight (Solomon*et al.*, 2008) or could be used to predict body weight. The high correlation coefficients between body weight and body measurements for all age groups suggest that either of these variables or their combination could provide a good estimate for predicting live weight of sheep from body measurements (Mesfin *et al.,* 2016).

2.17. Prediction of body weight from other body measurements

It is not unsure that the importance of body weight and different body measurements in breed improving strategies and selection toward estimate traits which are important to boost the sheep productivity (Amelmal, 2011). he precision of functions used to forecast live weight or growth characteristics from live animal measurements is of enormous financial contribution to livestock production enterprises. Multiple linear regression equations were developed for predicting body weight (BW) from other linear body measurements like Body length (BL), Wither height (WH), Chest girth (CG) and Scrotum circumference(SC) (Tesfaye*et al*., 2009).

Increasing the genetic potential for meat production of a sheep breed requires selection for increased size and live-weight. Proper size and weight measurements are often difficult in villages due to lack of weighing scales. Linear measures like heart girth are useful under these situations. Mathematical equations can be developed based on large number of actual weight linear measurement data. The equations can be used to change linear measurements into weight estimates. Individual equations can be derived based on condition, sex and age of the animal. More than one linear measurement may be used in an equation to improve predictive ability (Tajebe *et al*., 2011).

3. MATERIALS AND METHODS

3.1. Description of the Study Area

The study was carried out in three districts of Jimma zone selected based on the sheep production potential. The selected districts were Seka, Dedo and Omo nada. Geographically, Jimma zone is situated between the coordinates of 7°41'N 36°50'E latitude and longitude with altitude ranging from 1740 to 2660 (m.a.s.l) meter above sea level. Rainfall pattern of the zone is bimodal type with small rainfall during the months of February to April followed by the main rainy season from July to September. Jimma zone consists of 20 districtswith total area coverage of 1800 km^2 according to Jimma zone livestock and fishery Bureau (JZLF, 2009).

Jimma area is characterized by cash crop, cereal and livestock integrated farming systems. The area is predominantly rich in coffee and chat cash crops. It has a diverse agro-ecology classified as high lands (*Dega*), mid lands (*Woina-dega*) and semi-dry low lands (*Kolla*) covering 15%, 67% and 18%, respectively (Dechassa, 2000). The zone receives mean annual rainfall ranging from 1,200 to 2,800 mm and the mean monthly maximum and minimum temperatures of the zone are 11.3 ^{0}C and 26.2 ^{0}C, respectively. The farming system of the zone is characterized as mixed crop and livestock farming. The zone endowed with different livestock resources such as cattle, small ruminants, equines, poultry and honeybee. The livestock also plays a key role in income generation and food security. Sheep are the components of the livestock production system. The zone had a total sheep population 760,133 (CSA, 2016/17).

3.1.1. Seka

The Seka district, situated at 7° 35′ 0″ N, latitude and 36° 33′ 0″ E longitude is one of the nearest in the Jimma zone and located about 375 km South-west of Addis Ababa and 19 km from Jimma city. It situated at an altitude ranging from 1580 to 2560 meters above sea level. The district receives rainfall, ranging from 1,200 – 2,800 mm per annual. The average minimum and maximum daily temperatures of the area are 12.6^{0}C and 29.1^{0}C, respectively (Meaza, 2015).

The farming system of Seka district was mixed farming, compromising both cropping and livestock. Enset is staple crop in the district. Other main crops grown in the district are maize, barley, wheat, teff, sorghum, sweet potatoes, etc. In the mixed farming system, livestock are important for draught power. They are main source of cash income to cover household's expense and supplemental diet. The district also known by its cash crop mainly coffee and chat (Meaza, 2015). Seka district has a total population of 208,096, of whom 104,758 were men and 103,338 were women; 7,029 or 3.38% of its population were urban dwellers. According to the district Office of Livestock and Fishery Bureau when the livestock comprise of cattle, 199046, sheep,97 908,goat,34 624,horse, 7019,mule,9135, donkey, 9098 and chicken,78924 respectively.

3.1.2. Dedo

Dedo district whose administrative town is Sheki, located in southern of Jimma zone at a distance of 377 km from Addis Abeba and 20 km from Jimma city. It is situated between 7^0 29 ′ 53 ″ N and $36^0$53 ′ 29 ″ E at an altitude ranging from 2500 to 3360 meters above sea level. The area receives an average annual rainfall ranging from 1600-2600mm and average minimum and maximum daily temperatures of 20ºc and 28oc, respectively (Meaza, 2015).The 2007 national census reported a total population for this district of 288,457, of whom 143,935 were men and 144,522 were women. The livestock composition of the district which are: cattle,337,469, sheep,460,380, goat,34,964, horse, 35,905,mule,19,561, donkey, 17,410 and chicken,197,380 (JZLFO, 2009).

3.1.3. Omo Nada

Omo Nada, is located 72 km in the eastern part of the Jimma town, between 7°17'and 7°49'N and 37°00' and 37°28'E, longitude the altitude of the district is 1000 -3340 m.a.s.l. and its agro-ecologically 23%,62%and 15% covered by high land ,mid land and law land respectively. Approximately it is 285 km southwest of the capital Addis Ababa in Oromia Regional State, Ethiopia. The mean annual temperature ranges between 25°C and 33°C. The estimated population is 289,506 of whom 144,988 are male and 144,518 are women; 14,258 of its population are urban dwellers (CSA, 2007). According to the district Office of Livestock and Fishery Bureau,(2015) indicated that the livestock composition in this district, cattle, 252,811, goat 117,114, sheep, 111,714, chicken, 189,196, horse 5,194, donkey, 26, 519 and mule 3971 respectively.The geographical features of the three districts were given in Table 6.

Table 6: Geographical Variables and Sheep Populations of the Study Locations Summarized

District	Altitude (masl)	Latitude (°N)	Longitude (°E)	Annual avg. max. T^0	Annul avg. min. T^0	Annual Rainfall(mm)	Total sheep popn the area
Seka	1580 -2560	7° 35′ 0″N	36° 33′ 0″E	29.1^{0}C	12.6^{0}C	200 – 2,800	97,908
Dedo	2500 -3360	7^0 29 ′ 53″ N	36˚ 53 ′ 29 *″E*	28°c	20°c	1600-2600	460,380
Omonada	1000 -3340	7°17’-7°49’N	37°00 - 37°28’E	33 °C	25 °C	1300 -1800	111,714

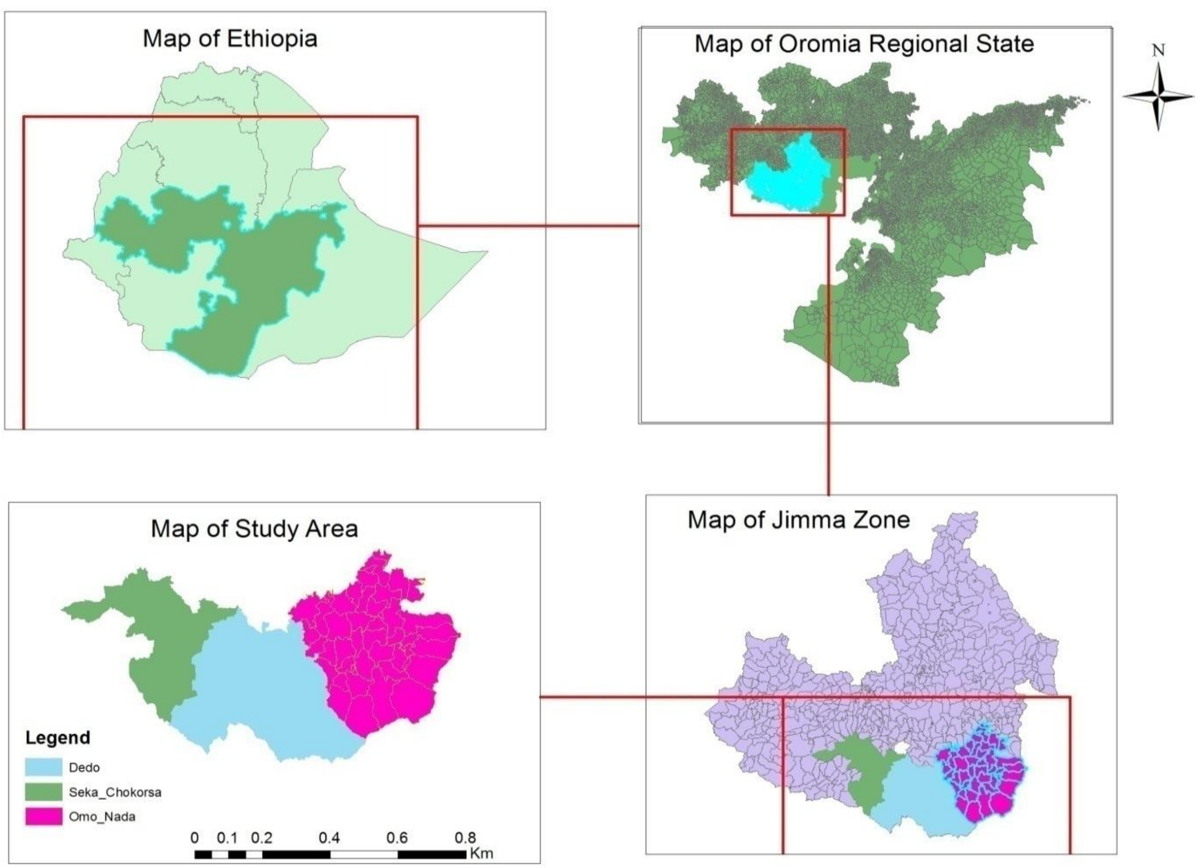

Figure 1:Location of the Study Area

3.2. Sampling Technique and Sample Size Determination

Purposive sampling technique was employed for the selection of districts and peasant associations for the study based on (Workneh, 2004). The selection of both districts and peasant association were selected purposively. This means in the first stage, districts known for sheep populations were identified followed by identification of potential peasant association. Potentials of sheep production area were used as criteria for selecting the study sites. Thus, three districts were purposively selected. From each districts two peasant associations (PA) were selected purposively based on the same criteria.

Respondents were selected randomly who own at least two sheep. The actual survey was taken to a sampling site during which qualitative and quantitative measurements were made on mature sheep. Both primary and secondary data were used in this part of the study. General information of the area, topography, climatic data and sheep population size was obtained from secondary data, from Zonal and district agricultural office.

Thesample size of household's formula described by (Cochran, 1977)

$$\mathbf{n = \frac{Z^2 * (p)(q)}{e^2}}$$ Were,

n = number of respondents

Z^2 = standard normal deviation (1.96 for 95% confidencelevel)

e= level of precision (0.05)

p = 0.13(estimation population variability proportion, 13%)

q = 1-p i.e. (q=0.86).

Therefore based on the formula,

$n = \frac{Z^2 * (p)(q)}{e^2} = \frac{3.8416 * (0.136)(0.864)}{0.0025}$ =180 households were selected.Based on this 180sheep owner households were interviewed.

While for body measurements and qualitative trait descriptions, dentition was used to determine the age of sheep which had one and above pair of permanent incisor (1ppi) was used for body measurements and qualitative trait description based on:

$$\mathbf{n} = \frac{\mathbf{Z}^2 * (\mathbf{p})(\mathbf{q})}{\mathbf{e}^2}\mathbf{;}\ \text{Where,}$$

n= sample size for infinite population

Z= standard normal deviation (1.96 for 95 percent confidence level)

e = level of precision (0.05)

p =the estimated value for the variability proportion of the population, 14.5%conservative population variability

q = 1-p

$$\text{n} = \frac{\text{Z}^2 * (\text{p})(\text{q})}{\text{e}^2} = \frac{\mathbf{(1.96)2*0.145*0.855}}{\mathbf{0.05*0.05}} \mathbf{=190}$$

This is for one district, but for three districts 3*190=570. Therefore totally 570 indigenous sheep used for collecting data of qualitative and quantitative traits descriptions.The details are given in Table 7.

Table 7: Summaryof the Sampling Procedure

District	Kebeles/ Peasant Associations(PA)	No. of respondents	Sample animals			Group Discuss-ions
			Female	Male	Total	
Seka	Shashe Manae	30	85	10	95	1
	Ola okay	30	85	10	95	1
Dedo	Ilala	30	85	10	95	1
	Sito	30	85	10	95	1
Omonada	Nada Chaila	30	85	10	95	1
	Beso Genbo	30	85	10	95	1
		180	510	60	570	

3.3. Data Typeand Method ofData Collection

3.3.1. Production system description

Questionnaires were designed and administered to address the description of the socio-economic practice of the community, description of the production , sheep, information on socio-economic condition of each household family size and their major sources of income were collected. Sheep flock composition, breeding practices and their objectives, selection criteria, culling practice, castration practices, and the major diseases of sheep in the area were collected from each selected household. Information were collected from the sheep owner through designing questionnaire and group discussion with DA's, village leaders, sheep owners, elders of the society who have a better knowledge on the present and past social and economic status of the area to strength the reliability of survey questionnaires.

3.3.2. Morphometric Data Collection

Visual observations of morphological features were made based on breed morphological characteristics descriptor list of FAO (2012) for phenotypic characterization of sheep. Each individual sheep were identified by its sex, dentition and sampling site and dentition record were used to estimate the approximate age of an animal. Adult sheep were classified into four age groups as one pair of permanent incisors (1PPI), two pairs of permanent incisors (2PPI), three pairs of permanent incisors (3PPI) and four pairs of permanent incisors following the description of African sheep (Wilson and Durkin, 1984). The qualitative traits such as coat color pattern, coat color type, back profile, head profile, ear orientation, horn present/absent, horn orientation, tail type and hair type were observed.

The quantitative trait were recorded such as body weight , body length, height at withers, heart girth, pelvic width, tail length, tail circumference, canon bone length, canon bone-circumference, ear length and scrotal circumference were measured according toFAO (2012). Measurements were made using flexible measuring tape while body weight were measured using suspended spring balance having 50kg capacity. Each experimental animal were identified by sex, districts and age group. Linear body measurements were taken by holding the animals in a stable condition.

3.4. Data Management and Analysis

Data was collected through questionnaire and recorded, coded and entered on Microsoft excel and analyzed by using SPSS version, 20 while the quantitative traits were analyzed by SAS version 9.3(2014). This indicated that different type of statistical analysis was used depending on the nature of the data. Data generated from questioners and observations were described and summarized by using descriptive statistics. Chi- square(x^2) test was carried out to assess the statistical significance among categorical variable using district effect.

An index formula was calculated to provide overall ranking of the reasons of keeping sheep, feed resource, disease, selection criteria and constraints of sheep.

Index = Σ of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] given for particular purpose of keeping sheep divided by Σ of [3 for rank 1 + 2 for rank 2 + 1 for rank 3]

Similar indices were used for ranking trait preferences, selection criteria, importance of major farming activities to the family food and income and major constraints of sheep production.

The rate of inbreeding from effective population size for a randomly mated population was calculated according to Falconer and Mackay, (1996) as:

$$Ne = \frac{4(Nm\ NF)}{(Nm + NF)};$$

Where: Ne = effective population size,

Nm = number of breeding males

NF = number of breeding females.

The rate of inbreeding coefficient (F) was calculated from Ne as:

$$F = \frac{1}{2}Ne.$$

The General Linear Model (GLM) procedure of SAS was used to analyze the linear body measurements. The Sex of animal, the district and age group were fitted as fixed effects while the linear body measurements were fitted as dependent variables.

(a) Model employed for analyses of adult (mature) body weight and other liner measurements except scrotum circumference were:

$$Yijkl = \mu + Ai + Bj + Sk + (AS)\, ik + eijkl$$

Where:

Yijkl = the l^{th} observation in the ith age group, jth location group and kth sex;

μ = overall mean

Ai = effect of i^{th} age group (i = 1, 2, 3, 4)

Bj=the effect of jth districts (j = 1, 2, 3)

S_k = effect of kth sex (k=1, 2)

(AS) ik= the effect of interaction of i of age group with k of sex

Eijkl= random residual error

Pearson's correlation coefficients were calculated among body weight and linear body measurements and between linear body measurements for females and males using (SAS, 2014). Body weight were regressed on body linear measurements (height at whither (HW), body length (BL), chest girth (CG), pelvic width(PW), head length (HL),cannon bone length (CBL), cannon bone circumference (CBC), ear length (EL), tail length (TL) and tail circumference (TC). Stepwise multiple regression procedure of (SAS, 2014) to determine the best fitted regression equations for the prediction of body weight from linear body measurements for adult animals.

The following models were used for the estimation of body weight from LBM.

For male:

$y=\beta o+\beta 1x1+\beta 2x2+\ldots+ \beta 13x13+ ej$ where:

y=the response variable (body weight)

Bo= the intercept

X1… x13 were body measurement (variables) such as body length, height at Withers, canon bone length, canon bone circumference, etc. including scrotum circumference

β1… β13 were regression coefficients of thevariablesx1… x13

ej= random error

For female:

$y=\beta o+\beta 1x1+\beta 2x2+ \ldots + \beta 12x12+ej$ where:

y=the dependent variable body weight

Bo= the intercept

X1... x12 were measurements (variables) like body length, height at withers, canon Bonelength, canon bone circumference, etc. except scrotum circumference

β1… β12 were regression coefficients of the variable x1… x12

ej= random error

4. RESULT AND DISCUSSION

4.1. General household information

The result of general socio-economic and household characteristics of the sampled households was presented in Table 8. A total of one hundred eighty households were considered for the household survey in the current study. The majority proportion of male headed household for each districts was 91.7%, 93.3% and 85% in Seka, Dedo and Omonada districts respectively. The overall 90 % of the interviewed households in the study area were male headed whereas about 10 % of the interviewed households were female. The proportion of less percentage of female households in the study areas might be due to work load inside the house. The current result was comparable with Amelmal(2011) who reported that in Tocha, Mareka and Konta 96.7%, 88.3% and 83.3% of respondents respectively were headed by males.The consequence of high participation of female headed in the current study, withthis background male headed household have better probability of mobility, participate in different meetings and have more exposure to information about better production participation than female; SimilarlyUrgessa(2015) women headed household less likely control over economic resources and the nature of their economic activity". Then, it was hypothesized that male headed households have more chance to participate in improved sheep production and it influence positively and significantly

Actually age of the respondents affect the participation on improved sheep production positively and significantly. Assan (2014) who reported that when farmers' age increase their maturity also increases and they will be eager to apply new technology and those household heads having matured age due to a good farm experience have much better association with more productivity. However, in the current study theoverall average age structure of respondent HH showed that majority (42.2%) of the respondent's age structure fell under range of 31-40, which is the active age group and they are the main source of farm labor.The age structure of respondent HH in the three districts, followed the pattern shown in overall figures, where the highest proportion fell in age group of 31-40 years (41.7, 40.0 and 45.0 inSeka, Dedo and Omonada districts, respectively).

The overall marital status of respondents across the districts about 88.3%, 6.7% and 5% of the interviewed households were married, divorced and windowed respectively.

According to Mathebula (2015), high level of educations was expected to have more exposure to the external environment and accumulate knowledge of farm practicing.Actually when the education levels of farmers' increase, they have a better ability to identify the problem of their farm income as well as they can calculate its costs and benefits. Similarly in the current study the respondent of households in the study area have different educational backgrounds. The overall educational status of the respondents in the present study was 42.2%, 29.4%, 22.2% and 6.1% for read and write, primary school, illiterate, and secondary high school respectively. So most of the sampled households were literate and this might be a good opportunity in adoption of modern husbandry practices, new technology, breed improvement interventions and community based breeding program in the study area. The current result was in agreement with Hizkel (2017) who reported that Bensa district of SNNR, the educational status of the respondentswere33.6, 25.75, 22.7, and 18.2% for primary attendants, illiterate, read and write and secondary attendants, respectively.

The total average family size in Seka, Dedo and Omonada were 8.0, 7.6, and 7.51 respectively in the present study these values were higher than the average family size of 5.5 reported from Oromia Regional State in 2013 (CSA, 2013) however the average family size of the households was 7.70 which is lower to 8.5 reported by Yoseph *et al.*, (2015). Thus, the higher family size in the current studymight be due to the existence of polygamous marriages and lack of awareness on family planning in the area.

Table 8: General Socio- Economic and Household Information in the Study Districts

Variables	District								X^2 value
	Seka		Dedo		Omonada		Overall		
	N	%	N	%	N	%	N	%	
Sex structure									
Male	55	91.7	56	93.3	51	85.0	162	90.0	
Female	5	8.3	4	6.7	9	15.0	18	10.0	**2.593^{Ns}**
Age structure									
20-30	7	11.7	9	15.0	6	10.0	22	12.2	
31-40	25	41.7	24	40.0	27	45.0	76	42.2	
41-50	17	28.2	14	23.3	15	25.0	46	25.6	
51-60	7	11.7	10	16.7	10	16.7	27	15.0	
>60	4	6.7	3	5.0	2	3.3	9	5.0	**2.458^{Ns}**
Marital status									
Married	55	91.7	51	85.0	53	88.3	159	88.3	
Divorced	3	5.0	5	8.3	4	6.7	12	6.7	
Widowed	2	3.3	4	6.7	3	5.0	9	5.0	**1.318Ns**
Educationalstatus									
Illiterate	11	18.3	12	20.0	17	28.3	40	22.2	
Read and write	27	45.1	24	40.0	25	41.7	76	42.3	
Primary	20	33.3	18	30.0	15	25.0	53	29.4	
Secondary high school	2	3.3	6	10.0	3	5.0	11	6.1	4.815Ns
Family size	8.00±1.86		7.60±2.06		7.51±2.23		7.70±2.06		

N=Number of households;*significant difference at p < 0.05, NS=non-significant (p>0.05)

4.2. Farming activity and source of income of households

The farming activity and thesource of income of households of the study area were presented in Table 9. The major farming activities in the study area were mixed farming, since the area is suitable for both rearing of livestock and cultivating crop coupled with conducive climate for agriculture. Crop production was the main source of household income while the contribution of livestock is less as compared to crop production. This might be due to the prevalent crop-livestock mixed farming system, where farmers focus mainly on crop production than livestock production, and could be due to shortage of livestock feed resource. The present study showed that cash crop production was major income generating farming activity followed by crop, livestock and vegetable production, in decreasing order. In general both crop and livestock productions were the major sources of income forthe respondent of household in the study area.

Table 9: Farming activity and source of income of households in the study area

Income source	Seka				Dedo				Omonada			
	R1	**R2**	**R3**	**I**	**R1**	**R2**	**R3**	**I**	**R1**	**R2**	**R3**	**I**
Cereal crop production	21	23	13	0.34	17	16	22	0.30	20	22	14	0.33
Cash crop production	27	28	12	0.36	24	23	6	0.34	30	22	8	0.39
Vegetable production	2	2	6	0.04	4	5	11	0.09	1	4	6	0.05
Livestock production	10	7	29	0.26	15	17	20	0.27	9	12	32	0.23

4.3. Sheep management practice by family members

The household's activities in the study districts are summarized in the Table 10. The sheep purchasing and selling activity in the study district is carried out by men 78.3%, 70% and 65% in Seka, Dedo and Omo/nada respectively. However the children participation accounts for 8.3%, 11.7% and 10% which had a little role in sheep purchasing and selling activity while women accounts for 13.3%, 18.3% and 25% and were intermediate between men and children in purchasing and selling activity. Children play significant role in managing sheep herding practice that accounts 70%, 66.7% and 60% and men had second position in managing of herding sheep (26.7%, 23.3% and 26.7%) whereas women 3.3%, 10% and 13.3% were involved in herding and have a little role in managing of herding sheep respectively in the study districts. The current study similar with Workneh (2004) reported that selling of sheep activity is undertaken by fathers (90%) followed by mothers (5.56%) and children (4.44%).

The cleaning of sheep barn is carried by 81.7%, 80% and 85% women in Seka, Dedo and Omonada districts, respectively. While in sheep barn cleaning in all districts the burden of the activity was left for mothers that articulated 81.7%, 80% and 85% in seka, Dedo and Omonada districts respectively. The children of the respondent HH were involved but men had no role in this activity. This activity was mostly left for women and girls this might be the thinking attitude and lack of awareness of the society members who classify the different working activity for men and women and that may be consequences of lack of awareness about gender equality.

Table 10: Sheep Management Activities by Family Members in the Study Area

Activities	Seka			Dedo			Omonada		
	Men	Women	Children	Men	Women	Children	Men	Women	Children
	N %	N %	N %	N %	N %	N %	N %	N %	N %
Purchasing+ Selling	47(78.3)	8(13.3)	5(8.3)	42(70.0)	11(18.3)	7(11.7)	39(65.0)	15(25.0)	6(10.0)
Herding	16(26.7)	2(3.3)	42(70.0)	14(23.3)	6(10.0)	40(66.7)	16(26.7)	8(13.3)	36(60.0)
Feeding+ Watering	13(21.7)	13(21.7)	34(56.7)	14(23.3)	18(30.0)	28(46.7)	16(26.7)	13(21.7)	31(51.7)
Sheep barn cleaning	0.00	49(81.7)	11(18.3	0.00	48(80.0)	12(20.0)	0.00	51(85)	9(15.0)

4.4. Composition of livestock species in the study area

The average livestock composition and sheep flock size for Seka, Dedo and Omonada districts showed in Table 11. In the study site respondents had different livestock compositions. Among the major livestock species in the study area cattle, sheep, goats, chicken and donkey. However the dominant livestock species in the study area were sheep. The possible reasons might be that the management of sheep are easy from other livestock's and also this could be due to the fact that the area had suitable environmental condition for sheep production. The average flock size of sheep among the study districts Dedo had the largest (8.74) sheep flock size, followed by Omonada (8.12) and Seka (7.80) but that of Dedo and Omonada districts the average flock size of sheep per household almost similar.

The overall average sheep flock size in the current study was 8.22 which is comparable with Zewdu (2008) for Horro sheep (8.2) average sheep flock size observed butless than the report of Tesfaye (2008) for Menz (31.45) and Afar (23.0). This could be due to the fact the current study area is well known for cropproduction implying that farmers give high attention for crop production than livestockproduction.However relatively the current flock size was higher compared to the report of Tassew (2012) 7.02 for Habru districts in North Wollo zone, Amhara National regional State.

However, there was significant difference (P< 0.05) in Seka districtfrom bothDedoand Omonada districts in cattle population. According to focal group discussion of the respondents, the community around that area provide more attention for cattle due to the availability of better feed source when comber to the rest of the two districts. Omonada district significant difference from both in Seka and Dedo in goat population while in terms of sheep population there is no significantly differ across all districts. According to the respondents in all district chicken had not significantly different among the districts while the number of donkey in seka district significantly differ from the rest of the two districts.

Table 11:Average Livestock Holdings per Household in the Study Area.

	Seka	**Dedo**	**Omo/nada**	**Overall**
Livestock	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**
Cattle	7.45±43a	5.65±2.46ab	6.06±2.77b	6.39±3.35
Goat	3.18±2.04b	3.02±1.93b	6.13±2.56a	4.11±2.61
Sheep	7.80±3.07	8.74 ±3.09	8.12±4.84	8.22±3.76
Chicken	6.18 ±3.36	5.05±4.20	5.70±3.94	5.64±3.35
Donkey	0.20±40b	0.87±.77a	0.42±.56a	0.49±.66

[a,b] : means on the same row with different superscripts are significantly different (P<0.05)

4.4.1. Sheep flock structure

The average sheep flock size per household and structure in each districts of the study area presented in Table 12 and Figure 2 (a, b, c).The flock owner determines the flock composition on the basis of economic and management considerations. The average mature female sheep flockstructure observed in the current study was (4.72). This resultwas far lower comparable with 5.7 reported for Haraghe highland sheep in Metta, 5.2 in Gorogutu and 6.2 in Deder (Wossenie, 2012). Breeding mature female represents the largest proportion among the flock structure while the castrated rams represent the lowest proportion of flock structure in all districts. In Dedo district, ewes accounted for the largest number (4.95±2.03) followed by lambs less than 6 months (1.68±1.02), Lambs 6-12month (1.65±0.81), Mature male >1 year (0.43±0.56) and Castrated rams (0.05±0.22).

Similarly in Seka district breeding mature ewes also accounted the largest number from the flock (4.58±2.87),allowed by lambs less than 6 months (1.35±0.78), lambs 6-12month (1.33±0.64) and mature male >1 year (0.51±0.56) finally castrate rams the lowest and accounts 0.03±0.18 . In Omonada district breeding mature ewes was the largest number of sheep category in a flock which is (4.63±4.29), while the remaining flock structure followed as lambs (6-12) month (1.55±0.93), ram lambs less than 6 months old (1.23±0.88), Mature male >1 year (0.63±0.60) and the last one is castrates (0.08±0.28).

As a whole the overall mean sheep flock structure observed in the present study 1.42±0.99,1.50±0.88, 0.52±0.58, 4.72±3.19 and 0.06±0.23 by Lambs less than 6 month, Lambs 6-12 month , Mature male >1 year, Mature female>1 year and castrates respectively. The larger proportion of breeding mature females in the observed flock structure is highest however; the number of breeding rams in a flock was generally small. The possible reason might be that mature breeding males are commonly castrated at early age for fattening and to easily manage finally they are sold at early age than females in the current study. The current finding was similar with Michael (2013) who reported that very small number of breeding rams was observed in east Gojjam due to early castration of rams for fattening purpose and selling of rams for income generation.Lambs less than 6 months there was a significant difference in Seka, Dedo and Omonada while others Lambs 6-12month, Castrated rams, mature male >1 year and Mature female>1 year were non-significant across all districts.

Table 12: Average Sheep Flock Size Household and Structure in Each Districts of the Study Area

Flocks	Seka	Dedo	Omonada	Overall
	Mean ± SD	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**
Lambs less than 6 month	1.35±0.78ab	1.68±1.02a	1.23±0.88b	1.42±0.99
Lambs 6-12month	1.33±0.64	1.63±1.02	1.55±0.93	1.50±0.88
Mature male >1 year	0.51±0.56	0.43±0.56	0.63±0.60	0.52±0.58
Mature female>1 year	4.58±2.87	4.95±2.03	4.63±4.29	4.72±3.19
Castrated rams	0.03±0.18	0.05±0.22	0.08±0.28	0.06±0.23

SD= standard deviation

		
Figure 2**a**: Sheep flock structure in Dedo	Figure 3**b**: Sheep flock structure in Omonada	Figure 4**c**: Sheep flock structure in Seka

4.5. Purpose of keeping sheep

When increase in productivity of agriculture enable to get huge money and enhancing improved breed purchasing power. According to Rasch *et al*. (2016), the rural households with better farm income have better possibility to be participating in improved sheep production.The purpose of keeping sheep in the study area presented in Table 13. Knowledge of reasons for keeping animals is a prerequisite for breeding goals (Jointer et al., 2001). According to the respondents in Table 13 the primary objective of keeping sheep was for income generation, breeding, saving, manure and meat consumption purpose and they ranked first, second, third, fourth and fifth respectively in all districts. As a whole in the study area sheep are mainly kept for income generation and reared for reproduction/breeding purposewhich was in agreement with the earlier reports ofBelete et al.,(2010) and Tesfaye et al., (2011) who reported that sheep were reared mainly for income generation. Similarly, the multipurpose functions of sheep rearing were reported for sheep keepers in other part of Ethiopia (Zewdu et al., 2009).

According to FGD revealed that the possible reason of keeping sheep were in the study area, as needed for cash to enable them to cover the expenditure on account of cost of agricultural inputs, children schooling, family health care and even food items.Thus farmers keep sheep for immediate cash needs to solve above financial problems in this study. This findings were in agreement with reports of earlier workers (Solomon et al., 2010)sale of live animal generates cash income to the farmer which may be used to buy clothing and food items, pay taxes, purchase fertilizers and other household goods.

Table 13: Purpose of Keeping Sheep in the Study Area

Purpose of keeping	Seka				Dedo				Omonada			
	R1	**R2**	**R3**	**I**	**R1**	**R2**	**R3**	**I**	**R1**	**R2**	**R3**	**I**
Meat	0	6	21	0.09	0	5	22	0.09	0	7	18	0.09
Breeding	13	36	5	0.32	10	27	11	0.26	18	27	11	0.33
Income	47	13	0	0.46	50	10	0	0.47	42	18	0	0.45
Saving	0	5	28	0.10	0	18	17	0.15	0	8	24	0.11
Manure	0	0	6	0.02	0	0	10	0.03	0	0	7	0.02

4.6. Feed source and grazing management

Feeds are a major input for sheep production systems. The quantity and quality of feed resources available for animals primarily depends upon the climatic and seasonal factors (Zewdu, 2008). Generally the major source of feed in dry and wet season in the study area expressed in Table 14.The different feed resources in dry season ranked in the study areawere communal natural pasture, private natural grazing land, crop residue and crop aftermath for Seka; 0.34; 0.42, 0.18 and 0.06; for Dedo; 0.19, 0.54, 0.12 and 0.14 and for Omo/nada 0.40; 0.42; 0.10 and 0.08 respectively.When all the crops were harvested, a few respondents roam sheep freely across the villages during the dry season but a little it is obvious there is feed scarcity during dry season in all over Ethiopia there was feed scarcity facing smallholder sheep feeders occur during dry seasons this result was in linewith Takele (2003). According to the Focal Group Discussion feed conservation practices and crop residue utilization for small ruminants were meagerly practiced in all districts. However, the use of communal grazing lands was comparable with the findings of (Teshome, 2006, Tsedeke, 2007 and Tesfaye, 2008) who indicated that communal natural pasture is one of the feed resources for small ruminant in Ethiopia.

Table 14: Major Feed Sources during the Dry and Wet Seasons In the Study Area

Feed source	Seka				Dedo				Omonada			
	R1	**R2**	**R3**	**I**	**R1**	**R2**	**R3**	**I**	**R1**	**R2**	**R3**	**I**
Dry Season												
Communal natural pasture	15	35	9	0.34	5	12	30	0.19	28	29	3	0.40
Private natural pasture	43	10	6	0.42	55	15	0	0.54	32	26	2	0.42
Crop residue	2	15	27	0.18	0	17	10	0.12	0	4	30	0.10
Crop aftermath	0	0	18	0.06	0	16	20	0.14	0	1	25	0.08
Wet Season												
Communal natural pasture	10	25	25	0.29	6	20	44	0.28	37	12	25	0.44
Private natural pasture	50	10	0	0.47	54	6	0	0.48	17	41	0	0.37
Fallow land	0	25	35	0.24	0	34	16	0.23	6	7	35	0.19

DS= Dry Season, WS= Wet Season

Grazing aftermath is an important source of sheep feed from the start of the dry season to the start of the short rainy season in this area. In the study districts there was a wide spread utilization of nonconventional feed resources such as chat left over, home left-over, fruit left over, banana parts and weeds. According to interviewed households, they fed their animals with chat and home left-over after being utilized by family members. The respondent farmers reported that similarly communal natural pasture, private natural pasture and fallow land were the main sources of feed during wet season in the study districts. This result is similar with Yadeta(2016) natural pasture was the major source of small ruminant feed for both in dry and wet seasons in all the three agro-ecologies zone west Shewa.

Natural pasture private grazing lands was the predominant source of feed for sheep during the main rainy season. Sheep are tethered around homestead to reduce risks of crop damage and to protect from predators.when in wet seasons; the major feed resource is private grazing land that the household use herded grazing system so that sheep do not go into crop fields as herders are closely following. These results, for both dry and wet season, were not in agreement with the earlier report of Belete (2010) for sheep dominant and mixed livestock systems in western Ethiopia. In wet season the common feed sources are communal natural pasture, private natural pasture and fallow land ranked as seka 0.29, 0.47, 0.24, Dedo 0.28,0.48, 0.23, and Omo/nada 0.44,0.37and 0.19 respectively.

4.6.1. Grazing management practice

The overall grazing method in dry and wet season across all the districts presented as percentage in Table 15. However the grazing management system in the study area characterized as village management condition. In fact, the different types of grazing methods depend on season.The grazing methods practiced in the three districts during dry and wet seasons were herding, tethering and herding + tethering but the proportion of respondent farmers practicing these methods showed variation across both districts and seasons. The tethering and herding + tethering methods of grazing was followed by farmers (Respondent HH) in Seka (23.3, 51.7%, respectively, in DS and 46.7, 41.7 %, respectively in WS); in Dedo (51.7, 31.7%, respectively, in DS and 51.7, 43.3%, respectively in WS); and in Omonada (21.7, 36%, respectively, in DS and 23.3, 38.3 %, respectively in WS) districts.

The remaining respondent HH practiced herding as method of grazing. The possible reasons for tethering and/ or herding + tethering as method of grazing might be to avoid any damage of the standing crops. In the study area tethering and tethering +herding were the main activity in wet season this result in agreement with (Hizkel, 2017).According to the focus group discussants, the main reasons for tethering was in order to keep sheep apart from preventing crop damage, for optimal usage of family labor and to protect from predators

Table 15:Grazing Management Practiced by Owners with Respect toSeason

Grazing Method	**Seka**		**Dedo**		**Omonada**		**Over all**	
	DS %	**WS %**	**DS %**	**WS %**	**DS %**	**WS %**	**DS %**	**WS %**
Herding	25.0 (15)	11.7(7)	16.7(10)	5.0(3)	41.7(25)	38.3(23)	27.0(50)	18.3(33)
Tethering only	23.3(14)	46.7(28)	51.7(31)	51.7(31)	21.7(13)	23.3(14)	32.2(58)	40.6(73)
Herding+ tethering	51.7(31)	41.7(25)	31.7(19)	43.3(26)	36.0(22)	38.3(23)	40.0(72)	41.1(74)
X^2 value							**20.836***	**27.320***

DS= Dry Season, WS= Wet Season

4.6.2. Herding Practices of Households in the Study Area

A good understanding of the community's herding practices is crucial to bring sustainable improvement in the smallholders flock through community based strategies (Sölkner-Rollefson, 2003).In the study area the herding practices presented in Table 16. The major type of sheep flock herding practice in the day time in the study area about 18.9%, 53.3% and 27.8% of respondents lambs were herded separately, herded all class of sheep together and herded together with other animals respectively except new born lambs were managed separately for some days near to the house. The sheep flock herded activity during the day time in seka and Omo/nada districts the highest percentage were all class of sheep herded together accounts 56.7% and 70%, respectively.

Because of the management feeding habit of farmer'spreference to manage sheep separately is different and the possible reason for this herding practice may be high population of predators in Omo/nada district due to presence of high forest cover. While sheep flock herded during the day time in seka ,Dedo and Omo/nada herding lambs separated and herded together with other animals accounts 16.7%; 26.7%; 13.3% and 26.7%, 40% and 16.7% respectively with districts.

In the study area the way of herding of the sheep respondents were accounted as 88.3%, 93.7%, 75.0% of the Sheep of HHs herded separately in Seka, Dedo, and Omo/nada districts respectively while11.7%, 6.7% and 25.0% of the respondents were herded together with other animals respectively for the districts. The overall way of herding (85.6%) sheep of a HH herded separately while only14.4% of the sheep owner herded together within neighboringlivestock. According to the focal group discussion of the respondents in study area the main objective of herding was to prevent sheep from damaging crops, theft and predators.

Table 16: Summarized of Herding Practices Reported by Households in the Study Area

Way of herding Practice	Seka		Dedo		Omonada		Overall	
	N	%	N	%	N	%	N	%
Sheep flock herded during the day time								
Lambs are separated	10	16.7	16	26.7	8	13.3	34	18.9
All class of sheep herded together	34	56.7	20	33.3	42	70.0	96	53.3
Herded together with other animals	16	26.7	24	40.0	10	16.7	50	27.8
X^{2-}value								**16.729****
Way of herding								
Sheep of a HH herded separately	53	88.3	56	93.7	46	75.0	155	85.6
Sheep >1 HH herded together	7	11.7	4	6.7	14	25.0	25	14.4
X^{2-}value								**8.721***

Figure 5: A flock of sheep herded grazing in Omo/nada area

4.7. Water sources and watering frequency

The sources of water and frequency of watering in the study area were presented in Table 17. Perusal of Table 17 showed that river was the main source of water in dry and wet season across all the study districts. In dry season river water was reported to be the major water source (55.6%) for sheep in the study area and other water sources include ponds, spring and pipe water in dry season consists 6.1%, 31.1%, and 7.2%, respectively while in wet season river, spring and rain water were the major source of water for sheep and they accounts 48.9%, 41.1% and10% respectively. In other ways the river was followed by spring, pipe water and pond as second, third and fourth source of water, in descending order, in all districts. Similarly during wet season river, spring and rain water were the three sources of water, in descending order, across all study districts. The current finding was comparable with report of (Solomo,2007) who found that river was the major water source of Gumuz sheep in north western lowland of Amhara region.

Table 17: Source of Water for Sheep in the Study Area Ranked by Farmers

Source of water	Seka		Dedo		Omonada		Overall	
	N	%	N	%	N	%	N	%
Dry Season								
Pond	4	6.7	2	3.3	5	8.3	*11*	6.1
River	29	48.0	35	58.3	36	60.0	100	55.6
Spring	21	35.0	20	33.0	15	25.0	56	31.1
Pipe water	6	10.0	3	5.0	4	6.7	13	7.2
X^2-value								**4.317^{Ns}**
Wet Season				Cc				
River	29	48.3	27	45.0	32	53.3	88	48.9
Spring	24	40.0	28	46.0	22	36.7	74	41.1
Rain water	7	11.7	5	8.3	6	10.0	18	10.0
X^2-value								**1.522^{Ns}**

Watering frequency and distance of water during dry and wet season in the study area presented in Table 18. Even if water availability is not the major problem in the study area, the distances of watering points had variation during the dry and wet seasons. Majority (60.0%) of the respondent in dry season watered their sheep once a day while in wet season majority (67.8%) of the respondents water their sheep at freely available in a day. About 27.8% for dry and 11.7% for wet season of the respondents watered their sheep twice a day.According to the report of the respondents,72.2% watered their sheep by moving less than 1 km during the dry season while, during the wet season, 96.1% of the farmers watered their sheep by moving less than 1 km. The remaining 10.0% in dry season and 3.9% during wet season of the respondents watered their sheep at distance of 1-5

Km.Whichindicated that, there is sufficient water availability in the study area in both dry and wet season. The frequency of watering during rainy season (Table 18) showed that sheep had free access to wateringbecause of due to the abundant availability of water during this season. Dedo district had significant difference of watering frequency from Seka and Omo nada districts in dry season because of in Dedo district in dry season the respondents use highly tethering management al practice where comparing to the rest of the two districts.

Table 18: Seasonal Watering Frequency and Watering Point in the Study Area

Variables	**Seka**		**Dedo**		**Omonada**		**Overall**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
(I)Frequency of watering in Dry Season								
Freely available	6	10.0	4	6.7	12	20.0	22	12.2
Once a day	39	65.0	32	53.3	37	61.7	108	60.0
Twice a day	15	25.0	24	40.0	11	18.3	50	27.8
X^2-value								**10.769***
(II)Frequency of watering in Wet Season								
Freely available	47	78.3	35	58.3	40	66.7	122	67.8
Once a day	8	13.3	15	25.0	14	23.3	37	20.6
Twice a day	5	8.3	10	16.7	6	10.0	21	11.7
X^2-value								**3.809^{Ns}**
(III)Distance of Water Point in Dry season								
Less than 1 km.	47	78.7	43	71.7	40	66.7	130	72.2
1km to 5 km	4	6.7	5.0	8.3	9	`15.0	18	10.0
Watered at home	9	15.0	12	20.0	11	18.3	32	17.8
X^2-value								**3.340^{Ns}**
(IV)Distance of Water Point in Wet season								
<1km	57	95.0	60	100.0	56	93.3	173	96.1
1km-5km	3	5.0	00	0%	4	6.7	7	3.9
X^2-value								**3.865^{Ns}**
(V) Quality of Water in Dry season								
Muddy	7	11.7	9	15.0	6	10.0	22	12.2
Clean	49	81.7	46	76.3	44	73.3	139	77.2
Smelly	4	6.7	5	8.3	10	16.7	19	10.6
X^2-value								**4.173^{Ns}**
(VI) Quality of Water in Wet season								
Muddy	41	68.3	51	85.0	43	71.7	135	75.0
Clean	19	31.7	9	15.0	17	28.3	45	25.0
X^2-value								**3.809^{Ns}**

N=Number of households;*significant difference at $p < 0.05$, NS= ($p>0.05$)

4.8. Housing

In the study districts there were three types of housing practices showed in Table 19. Good housing can affect productivity by reducing stress, disease, hazards and providing comfort. Farmers in the study area were use different types of sheep houses. In the current finding respondents housed their sheep at night throughout the year to protect them from cold, rain, predators and theft. This result agrees with the report of Belete et al., (2010) who states that all small ruminants are housed for protection from adverse weather conditions and predators in western highlands of Ethiopian. In the study area almost all sheep flock structure housed altogether but not with other livestock in adjacent or separately house in and around the family house while this is disagree with Judith (2006) who reported that the highland sheep in Amhara region were housed in the family house.

Adjacent housing sheep that are attached with the main house and it is the predominant in the study area (52.2%) followed by separately constructed sheep houses which accounted as (33.3%) and 14.4% of the main sheep house constructed within family house found in the area. In Seka, Dedo and Omo/nada 48.9%, 50% and 58.3% housing practice were adjacent house from the family house whereas 41.7%,30% and 28.3% of housing practices in the districts were separately constructed house in these districts respectively and 10%, 20% and 13.3% farmers housed their sheep within family house, respectively.According to the respondents in the study district 92.8% of lambs were housed with adult's sheep means females, males and young animals are kept in the same house. In contrast to this (Fikrte, 2008) reported that the males of black head Somali sheep are kept separately from the female to control breeding. As a whole the housing practice of sheep in the study showed non-significance difference ($p<0.05$) among the three districts which showed that the housing practice of households across all districts are the same.

Table 19 : Housing Practices of Households

Variables	Districts							
	Seka		Dedo		Omo/nada		Overall	
	N	%	N	%	N	%	N	%
(I)Type of Housing:								
Housed within family	6	10.0	12	20.0	8	13.3	26	14.4
Separate house	25	41.7	18	30.0	17	28.3	60	33.3
Adjacent house with family house	29	48.9	30	50.0	35	58.3	94	52.2
X^2-value								**3.889^{Ns}**
(II) Lambs Housed with other Sheep:								
Yes	57	95.0	51	85.0	59	98.0	167	92.8
No	3	5.0	9	15.0	1	1.7	13	7.2

(A) Adjacent house

(B) Separate house

Figure 6: Type of house in the study area

4.9. Castration practice of male sheep

The results of extent of castration and castration practices are presented in Table 20. In the present study castration was primarily practiced to avoid unnecessary mating, to improve the fattening potential, to have a sheep with better temperament and to acquire better price by selling the fattened sheep. Castration is a widely used practice for the fattening of rams. In the study area 73.3%, 93.3% and 83.3 in Seka, Dedo and Omonada respondents castrate their rams for the purpose of fattening practice. This current result indicates there was a significance difference among the districts which shows that castration highly practice in Dedo district.This might be due to the area is most suitable and conducive environment for sheep rearingthan the rest of the two and the respondents depend on livestock including sheep for income source. However castration was primarily practiced to improve the fattening potential in all districts. Castration is becoming common because of their great potential for fattening and rewarding prices during sale. Likewise, Tesfaye *et al.*, (2009) reported that farmers are more interested to fatten and sell rams at higher price for pressing cash need instead of maintaining for breeding around Menz area.

Table 20:Castration practice of male sheep in the study area

Parameters	Seka		Dedo		Omonada		Overall	
	N	%	N	%	N	%	N	%
Do you castrate male sheep?								
Yes	44	73.3	56	93.3	50	83.3	150	83.3
No	16	26.7	4	6.7	10	16.7	30	16.7
X^2 value								**8.640***
Castration method								
Modern	14	31.8	32	57.1	26	52.0	72	48.0
Traditional	30	68.2	24	42.9	24	48.0	78	52.0
X^2 value								**6.812***
Castration reason								
Control breeding	9	20.5	7	12.5	4	8.0	20	13.3
Better price	33	75.0	44	78.6	46	92.0	123	82.0
Better temperament	2	4.5	5	8.9	00.0	00.0	7	4.7
X^2 value								**8.237***
Age of castration								
6-12 month	14	31.8	16	28.6	10	16.7	40	26.7
1-2 years	27	61.4	34	60.7	35	70	96	64.0
>2 years	3	6.8	6	10.7	5	10	14	9.3
X^2 value								**2.207^Ns^**
Type of supplementation feed for castrated rams								
Cereals	14	31.8	20	35.7	10	20.0	44	29.3
Food left over	24	54.5	31	55.4	37	74.0	92	61.3
Concentrate	6	13.6	5	8.9	3	6.0	14	9.3
X^2 value								**5.797^Ns^**
For how long do you supply								
2-3 month	18	40.9	22	39.3	19	38.0	59	39.3
3-4month	6	13.6	3	5.4	2	4.0	11	7.3
Until get fattening	20	45.5	31	55.4	29	58.0	80	53.3
X^2 value								**5.02^Ns^**

The overall average castration practices in all districts were 83.3%. The possible reason in the study area the aim of castration was to sell at higher price and gaining much profit form fattened sheep. In seka (75%), Dedo (78.6%) and Omonada (92%) farmers gave more attention for better price while 20.5% of seka and 12.5% of Dedo and Omo/nada 8% farmers castrate their sheep to avoid unnecessary mating. In some rare cases also, farmers in Seka (4.5%) and Dedo (8.9%) castrate rams to improve ram temperament so as to avoid ram run from the flock. The majority (68.2, 42.9 and 48.0 %,) of respondent farmers use traditional method of castration in Seka, Dedo and Omo/nada districts, respectively. This was in conformity with the study of Tsedeke (2007) who reported that major method accustomed in Alaba was traditional method.

Majority of the respondents in Seka (31.4%%), Dedo (28.6 %) and Omonada (16.7%) rams were castrated from 6 month to 12 month of age. The reason of this lower percentage number in the study area indicated that farmers believed that castration at early age affect the growth of the rams while 64.0% of respondents castrate between the ages of 1-2 year. This work slightly similar with Shigdaf et al., (2009) who report that the average age of castration was two years.The majority (68.2, 42.9 and 48.0%,) of respondents use traditional method of castration in Seka, Dedo and Omo/nada districts, respectively. This was in conformity with the study of Tsedeke (2007) who reported that major method accustomed in Alaba was traditional method.

The study showed that castration was primarily practiced (a) to realize better price (75.0, 78.6 and 92.0% in Seka, Dedo and Omo/nada districts, respectively); (b) to control breeding (20.5, 12.5 and 8.0% in Seka, Dedo and Omo/nada districts, respectively), and (c) to get better temperament (4.5, 8.9 and 0 % in Seka, Dedo and Omo/nada districts, respectively). The realization of higher price due to castration as the primary purpose in the present study was in agreement with report of Tesfaye et al., (2009) who found that farmers are more interested to fatten and sell rams at higher price for pressing cash need instead of maintaining for breeding around Menz area. The majority of the respondents in Seka (61.4 %) Dedo (60.7 %) and Omo/nada (70 %) castrated rams from 1-2 years of age. The present finding was slightly similar with Shigdaf *et al.*, (2009) who reported that the average age of castration was two years. This may possibly due to fact that farmers believed that castration lambs at early age affected their growth.

4.10. Mating system and breeding practice

In the study districts un-controlled mating was a common method used to breed indigenous sheep and all farmers reported that female animals were served randomly by any intact male in the flock. Perusal of results Table 21 showed that majority (66.7, 78.3 and 71.7% in Seka, Dedo and Omonada districts, respectively) of respondent practiced un-controlled mating. Which is in line with the earlier studies in the country have reported that natural mating (un-controlled mating) was a common method to breed different livestock species and almost all farmers practiced this system (Samuel, 2005). While 33.3, 21.7and 28.3% of the respondents use controlled breeding practicethis small proportion of farmers practicing controlled breeding in the present study was comparable with reports of Bosenu *et al.*,(2014) in werena district (13.33%) and Angolelatera (10%).The overall results showed that the reason of un-controlled mating in all the study area was communal grazing (10%), lack of awareness (60.2%) and lack of sufficient number of rams (29.8%) this result is in line with Tesfaye (2008) he stated that the reason for uncontrolled mating in Menz and Afar areas was communal grazing area.

In the study area, majority of the households did not have their own breeding male. As a result (62.2%) of the respondents reported that they mixed their sheep flock with neighbor farmer’s flock rather only 37.8% of the interviewed households had their own breeding rams. According to the respondents, the limited attention for breeding males is attributed for castrated to add market value.The main sources of breeding rams in the study area were own born from their flock (64.7%) and 35.3% of respondents obtained the source of breeding rams by purchased from market. This report is similar with the report of Bosenu *et al.,* (2014). On enquiry from respondent farmers regarding owning of breeding ram, it was revealed that majority of farmers (63.3, 55.0 and 68.3% in Seka, Dedo and Omonada districts, respectively) did not own their breeding rams. While 36.7, 45.0 and 31.7% of the respondents had their own breeding rams in Seka, Dedo and Omonada respectively. According to interviewed farmers, two breeding ram sources were available in the study area. The proportion of own flock and market flock being used as a source of breeding ram was 68.2% and 31.8% for Seka, 63% and 37% for Dedo and 63.2% and 36.8% for Omonada districts respectively. This result not comparable with Kosgey (2004) who reported that use communal herding that allows breeding female mix with different flocks of sheep including male ram and rotational use of breeding males used for minimized inbreeding.

The Purpose of keeping ram in the study area were 32.3% for breeding ,26.5% for fattening and the rest 41.2% for both breeding/mating and fattening purpose. The objective of keeping rams across the district showed that there is no significance difference which means the objective of keeping ram is relatively similar in all districts. The overall purpose of keeping ram were 32.3% for breeding, 26.5% for fattening and the rest (41.2%) for both breeding/mating purpose in the study area but the purposes of keeping rams were non-significant differences in all districts.

Table 21: Mating System and Breeding Practices of Farmers in the Study Area

Breeding practice	Seka		Dedo		Omonada		Overall	
	N	%	N	%	N	%	N	%
(I) Type of mating:								
Partially Controlled mating	20	33.3	13	21.7	17	28.3	50	27.8
Un-controlled mating	40	66.7	47	78.3	43	71.7	130	72.2
X^2 value								**2.049^{Ns}**
(II) Reasons for Un-controlled Mating:								
Mixed grazing of Sheep in Communal Pasture	2	5.0	4	8.5	7	16.3	13	10.0
Lack of Awareness	22	55.0	30	63.8	27	62.8	79	60.8
Insufficient number of rams	16	40.0	13	27.7	9	20.9	38	29.2
X^2 value								**5.760^{Ns}**
(III) Do You have a Breeding Ram?								
Yes	22	36.7	27	45.0	19	31.7	68	37.8
No	38	63.3	33	55.0	41	68.3	112	62.2
X^2 value								**2.316^{Ns}**
(V) Source of breeding ram:								
Own Farm Born	15	68.2	17	63.0	12	63.2	44	64.7
Purchased	7	31.8	10	37.0	7	36.8	24	35.3
(VI) Purpose of keeping ram:								
Mating	6	27.3	9	33.3	7	36.8	71	32.3
Fattening	7	31.8	7	25.9	4	21.1	23	26.5
Mating +Fattening	9	40.9	11	40.7	8	42.1	86	41.2
X^2 value								**0.759^{Ns}**

4.11. Selection criteria of breeding ram

Selection criteria are the characteristics that allow the farmers to achieve the breeding objectives and select replacement animals (Holst,1999). It is expected that farmers select replacement stocks by considering its own morphological and production characteristics. In general as stated by Tabbaa(2009) livestock producers place more weight on morphological selection criteria (subjective selection) than production selection criteria (objective selection).The ranking of selection criteria of breeding ram by respondent farmers presented in Table 22. Selection of parents for the next generation in both rams and ewes were based on the performance and preference of farmers is important. In the study area selecting a breeding ram in seka district body size (appearance/size) was ranked first whereas color was ranked first in Dedo and Omonada with an index of 0.43, 0.39 and 0.39 respectively. Body size in Dedo and Omonada were ranked second with indices value of 0.37 and 0.35 respectively. Libido, family history and fast growth were ranked, third, fourth and fifth in seka districts with indices value of 0.08, 0.07 and 0.04respectively. This result was comparable with Yadeta,(2016)in west Shewa, Bosenu *et al.*,(2014) reported in Selale area and Wossenie *et al.,(*2014) in East Harerghe showed that traits like appearance and color were the most considered characters for selection of rams. In the present study area, the characteristics used in selecting breeding ram were based on body confirmation/appearance and color type (given higher priority) might be due to its phenotypic expression in offspring and its economic importance. Another possible reason for preferring good appearance and color traits may be that farmer’s belief that good appearance and color traits have economic value during selling and buying price at the market level. Therefore, priority is given to such type of traits in the study area.

Table 22: Selection Criteria for Selecting Breeding Ram in the Study Area

Selection Criteria	Seka				Dedo				Omonada			
	R1	**R2**	**R3**	**I**	**R1**	**R2**	**R3**	**I**	**R1**	**R2**	**R3**	**I**
Color	24	30	3	0.38	32	22	3	0.39	28	26	4	0.39
Body size	33	27	0	0.43	25	29	3	0.37	23	24	10	0.35
Fast growth	0	1	16	0.04	1	4	17	0.08	5	2	18	0.10
Family history	1	1	19	0.07	2	5	23	0.10	4	6	21	0.13
Libido	2	1	22	0.08	0	0	14	0.06	0	2	7	0.03

4.12. Selection criteria of breeding ewe

The ranking of selection criteria of breeding ewe by respondent farmers presented in Table 23. According to the rank of the respondents, the selection criteria of ewes was based on color, ranked as criteria one, with the index values of 0.43, 0.39 and 0.40 for Seka, Dedo and Omo/nada, respectively, whereas appearance was ranked, as second criteria, with index values 0.35 (seka),0.37 (Dedo) and 0.38 (Omo/nada) districts. This implies that farmers are highly interested in the color type and the appearance to select their ewe because they believe that well color type and well conformed animal gives well color type and well conformed offspring that increase the market price of the stock and result in higher monetary return to the owners. The present observations were similar to those reported by Yadeta(2016), Tesfaye (2008) and Zewdu (2008) who indicated that the body size and color were the highly selected traits for selecting breeding females in Bonga and Horro breeds. However, In Ethio- Somali Region, selection of breeding animals was focused on selection of breeding males but selection of breeding females is not common (Fekerte ,2008).

Table 23: Selection Criteria of Breeding Ewe Ranked by Respondents

Selection criteria	Seka				Dedo				Omonada			
	R1	**R2**	**R3**	**I**	**R1**	**R2**	**R3**	**I**	**R1**	**R2**	**R3**	**I**
Color	37	22	0	0.43	27	27	5	0.39	32	25	1	0.40
Appearance	22	21	17	0.35	25	28	4	0.37	25	28	6	0.38
Fast growth	0	12	11	0.09	1	2	12	0.05	1	2	10	0.05
Family history	1	5	13	0.07	5	2	12	0.09	0	2	16	0.06
Age at first lambing	0	0	7	0.03	1	0	11	0.04	1	1	8	0.04
Lambing interval	0	0	8	0.02	1	1	7	0.03	0	2	10	0.04
Litter size	0	0	4	0.01	0	0	9	0.03	1	0	9	0.03

4.13. Reproductive performance

The reproductive performances of sheep in the study area are presented in Table 24. Good reproductive performance is a prerequisite for any successful sheep production Program. In the other way reproduction performance is the best mechanism for evaluation of live animal. Evaluations of the reproductive performance of economically important traits of the livestock are very useful inputs for planning a breeding program(Solomon, 2014). In the present study there is a better reproductive performance were observed. The possible reason may be the suitability of the study area for sheep production or the sheep breed type performance may be good.In fact, in the current finding there is no significance difference across the districts in terms of reproductive performance(age at first mating, age at first lambing, lambing interval and litter size).

4.13.1. Age at First Mating of Ram and Ewes

The average age at first mating of male sheep in Seka, Dedo and Omonada was 6.75±0.16, 6.76±0.16 and 6.58±0.16 months, respectively. While the age at first mating of female sheep in Seka,Dedo and Omonada was 7.56±0.17, 6.92±0.22 and 7.02±0.19 months, respectively. The current result was comparable with Hizkel (2017) who reported in Bensa district local male sheep showed an average age at sexual maturity of 7 ± 0.12 months whereas in highland female sheep showed average age at sexual maturity of 7.68 months. In the current study area age at first mating result indicated that female sheep reach at early age as compare to male in sexual maturity which is in agreement with Tesfaye (2008) who reported that an average age of maturity of Afar sheep was 7.1months.

4.13.2. Age at First Lambing

Age at first lambing in the study area presented in (Table 24). The lambing interval of sheep across the district were 12.63, 12.36 and 12.48 months in seka,Dedo and Omonada district respectively. The overall age at first lambing of the study area was 12.49 months this current finding comparable with Yadeta (2016) who reported that the age at first lambing was 12.84±0.24 months in west Shewa zone.Similarly the current result was lower than the earlier report of Amelmal (2011) who reported that the average age at first lambing of Tocha, Mareka and Konta sheep was 12.88±1.7, 14.75±1.8 and 14.77±1.8 months, respectively.

4.13.3. Lambing Interval

The lambing interval of ewe was 7.85±0.09, 7.68±0.12and 7.60±0.13 months for Seka, Dedo and Omonada districts, respectively. This result is greater than the result that of Wossenie (2012) who reported for Haraghe high land sheep (6.5±0.7) but comparable with the lambing interval for Horro sheep (7 . 8) months (Zewdu, 2008).This result was slightly longer than the average lambing interval by Mesfin (2015) who reported the average lambing interval of sheep in Wolaita zone was 7.48 ± 1.88 months. However, there is no significance difference ($p<0.05$) among the three districts in terms of lamping intervalof sheep in the current study.

4.13.4. Litter Size

According to the respondents in the study area the average number of lambs per lambing was 1.12±0.02 (overall) whereas in Seka, Dedo and Omo/nada districts the number of lambs per lambing (Litter size) was 1.12±0.04, 1.1±0.39 and 1.13±0.04, respectively.

Table 24: The reproductive performance sheep in the study area

Reproductive Traits	Seka	Dedo	Omonada	Overall
	Means ±SE	Means ±SE	Means ±SE	Means ±SE
Age at first mating of males (months)	6.75±0.16	6.76±0.16	6.58±0.16	6.7±0.093
Age at first mating of females (months)	7.56±0.17	6.92±0.22	7.02±0.19	7.28±0.11
Age at first lambing (months)	12.63±0.17	12.36±0.23	12.48±0.25	12.49±0.13
Lambing interval (months)	7.85±0.09	7.68±0.12	7.60±0.13	7.71±0.07
No lambs per lambing	1.12±0.04	1.1±0.39	1.13±0.04	1.12±0.02
life span of ewe in year	6.98±0.13a	6.87±0.05a	5.92±0.09b	6.58±0.06

4.14. Disease

Diseases have numerous negative impacts on productivity of herds i.e. death of animals, loss of weight, slow down growth, poor fertility performance, decrease in physical power etc. (CSA, 2012). The maximum productivity in a given system of production is obtained when disease control is optimal as a result healthy sheep with normal physiological function and structure that enable the sheep to attain highest production.

Farmers in the study area do not exactly know the type of disease scientifically which causes mortality but they were able to describe the symptoms. In the study area the major disease associated with sheep production ranked by respondents presented in Table 25. It is well documented that disease control is very basic for genetic improvement of livestock (Solomon, 2007). However in the study area Diarrhea, Sheep pox and parasite were the most frequently ranked diseases that affect productive and reproductive performance of sheep across all the studied districts. According to the respondents in the study site disease and parasite were the most important constraints that hindering sheep production.

Table 25: Common Diseases in the Study Area as Reported by Farmers

Disease	Seka				Dedo				Omonada				Description of the symptoms
	R1	**R2**	**R3**	**I**	**R1**	**R2**	**R3**	**I**	**R1**	**R2**	**R3**	**I**	
Sheep pox	7	4	14	0.12	3	7	10	0.09	6	19	25	0.22	Coughing
FMD	12	12	5	0.18	9	15	10	0.19	11	9	5	0.16	Vesicles on the foot and mouth
Dihearia	9	18	16	0.21	18	17	14	0.28	10	10	3	0.15	Diarrhea
Pasturol oesis	2	10	11	0.10	9	12	8	0.16	11	7	16	0.18	Fever, nasal discharge and grunting
Anthrax	9	12	5	0.16	7	3	10	0.10	6	6	4	0.09	Acute death of sheep
Parasite	21	4	9	0.23	14	6	8	0.18	16	9	7	0.20	Emaciation, loss of appetite and Diarrhea

4.15. Availability of Veterinary Services

Access to health service is very critical variable that can affect the motivation of farmers to participate on improved sheep production. When sheep health care access is improved, productivity will increase as well as farmers will be encouraged participating improved sheep production. According to Robinson *et al.* (2017), unless a farmer having access to health services, she/he cannot decide to participate in improved sheep production. Almost all farmers in the current studied had access to veterinary services (Table 26) and use modern drugs to treat their sheep in order to against the disease, however some farmers use drugs from private or market. The overall respondents in the current study 77.8% and

22.2% use government and private veterinary service respectively. However there is no significance difference among the districts which indicates that government veterinary services are uniformly distributed in all districts. The distance of veterinary services were little numerical difference among the districts but not significantly difference. In the current study interims of distance 58.3% ofthe household respondents were far from 1-5kmwhile 21.1% and 20.6% respondents were far away less than 1km and 5-10km respectively. The importance ofdetermining distance from the *kebele* center farmers who living closer to kebele centers likely to get update information and adopt improved sheep breed than those who are living at far but unfortunately in the current study there is no the distance problem between the kebele center and the respondents. Similarly idea by Deress *et al*. (2014), when farmers come from far,probability of improving agricultural technology adoption decrease.According to focus group discussion, most of the respondents in the study area were use modern veterinary drugs to treat sick animals from the government while there was some of the respondents use from private veterinary service.

Table 26: Veterinary Accesses and Distance to the Nearest Veterinary Services as Reported by Respondents.

	Seka		**Dedo**		**Omonada**		**Overall**	
Veterinary access	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Government veterinary clinic	51	85.0	43	71.7	46	76.7	140	77.8
private veterinary clinic	9	15.0	17	28.3	14	23.3	40	22.2
X^2-value								**3.150^{Ns}**
Distance of veterinary service								
<1 km	17	28.3	10	16.7	11	18.3	38	21.1
1-5 km	35	58.3	33	55.0	37	61.7	105	58.3
5-10 km	8	13.3	17	28.3	12	20.0	37	20.6
X^2-value								**5.789^{Ns}**

4.16. Culling practice of sheep in the study area

Culling is an important management practice for livestock production. The reasonof culling in the study areas presented in Table 27. It is obvious that most farmers used to cull unproductive animals when during the prevalence`` 1q23 of disease andthe occurrence of feed shortage. In the current study the respondents reported that sheep were culled based on black color, physical defect, reproductive problem, sickness and old age. This study comparable with Verbeek *et al.*,(2007)who reported that the main reasons for culling of goats and sheep for smallholder farmers were old age of the animals and fertility problems.

The results showed that in Seka district the reason of culling in descending order were Sickness (53.3%), Physical Defect (16.7%), Old age (15.0%) and reproductive problems (13.3%) whereas in Dedo district these were Sickness (48.3%), Physical Defect (21.7%), reproductive problems (20.0%) and Old age (6.7%), However in Omonada district the culling reason, in decreasing order, were Physical Defect (43.3%), Sickness (33.3%), Reproductive Problem (11.7%) and Black Color (6.7%).Culling ofunproductive sheep in the study area were no significance difference even if physical defect and sickness were the major reason of culling practice. The overall reason of culling practice across the districts were sick, physical defect, reproductive problem, old age and black color in ranked descending order.

Table 27: Culling Practice of Sheep in the Study Area

Culling practice	Seka		Dedo		Omonada		Over all	
	N	%	N	%	N	%	N	%
Black color	1	1.7	2	3.3	4	6.7	7	3.9
Physical defect	10	16.7	13	21.7	26	43.3	49	27.2
Reproductive problem	8	13.3	12	20.0	7	11.7	27	15.0
Sick	32	53.3	29	48.3	20	33.3	81	45.0
Old age	9	15.0	4	6.7	3	5.0	16	8.9
x^{-2}value								**20.978***

4.17. Effective population size and level of inbreeding

Utilization of breeding rams born within the flock, uncontrolled matingand lack of awareness about inbreeding and small flock size maybe leads to the accumulation of inbreeding and decreased genetic diversity (Jaitner *et al.,* 2001). The effective population size (Ne) is influenced by actual number of breeding male and female in the flock at a given time and thus subject to change due to variation in the flock size, type of rearing practice (mixed flock grazing or individual flocks). The rate of inbreeding coefficient per generation changes with any change in the effective population size.

Table 28: Effective Population Size and Level of Inbreeding in the Study Area

Districts	Nm	Nf	Ne	ΔF
(I) Flocks not Mixed				
Seka	0.43	3.15	1.52	0.33
Dedo	0.39	3.53	1.41	0.35
Omo/nada	0.45	2.39	1.53	0.32
Overall	1.16	15	4.30	0.11
(II) Flocks Mixed during Communal grazing				
Seka	1.14	15.42	4.25	0.12
Dedo	1.00	24.75	3.84	0.13
Omo/nada	1.21	12.00	4.41	0.11
Overall	0.42	3.06	1.49	0.33

Ne = effective population size; Nm = Number of male; NF = Number of Female
F = coefficient of inbreeding

The effective population size (Ne) and the rate of inbreeding (ΔF) calculated for sheep flocks in the study area presented in Table 29. The effective population size ranged from 0.39 to 0.45 and 2.39 to 3.53 for male and female sheep, respectively, when flocks were not mixed (Separate herding) in the present study indicating an acute problem on male side (Ne less than 1 ram). The inbreeding coefficient was computed as 0.33, 0.35 and 0.32 for Seka, Dedo and Omonada districts respectively. Similarly effective population size ranged from 1.0 to 1.21 and 12.0 to 24.75 for male and female sheep, respectively, when flocks were mixed (Mixed herding) in the present study. The inbreeding coefficient was computed as 0.12, 0.13 and 0.11 for Seka, Dedo and Omonada districts respectively, in mixed flocks in the present study area.

Perusal of results showed that inbreeding coefficients were higher in flocks not mixed compared to when flocks were mixed. The possible reason for higher inbreeding coefficient was (a) very low effective population sizes in both sexes in general but males in particular, (b) higher chances of mating of closely related male and female sheep in flocks not mixed, and (c) lack of awareness about inbreeding effects on future productivity among farmers in all three districts. In order to overcome this problem (Low effective population size and high inbreeding) the farmers need to be educated on all aspects of breeding management including retention good rams in flocks and also introduction/exchange of good rams among different village herds on regular scale.The low effective population size of males may be due to castration of higher proportion of male sheep in the age group of 1-2 years as corroborated by the results presented in table 20 in the present study. Therefore, mixing sheep flocks also might be recommended in this study area to decrease the rate of inbreeding by increasing the effective population size.

4.18. Constraints of sheep production

Participatory identification and prioritization of the major constraints of livestock production is the first step to design and implement based on the need of interventions development options. In other ways identifying the constraints of sheep production is a base to solve the problems and to improve sheep productivity. Thus, the major constraints of challenging sheep production reported by respondent in the study area presented in Table 29. This study observed that disease, predator and feed shortage have been reported by the respondents as major constraint in sheep production and these were ranked first, second and third reasons across all the three districts in the present study. The index values of diseases were 0.39, 0.40, 0.44; predator were 0.34, 0.25, 0.27; and feed shortage were 0.13, 0.23, 0.15 in Seka, Dedo and Omo/nada districts respectively. Poor veterinary service and capital problem were among the minor reported problems limiting sheep farming across the study areas.

These constraints identified by respondents were in agreement with the reported by Belete *et al.,* (2010) in Western Highland part of Ethiopian. Similarly feed shortage ranked as third constraints was in agreement with Yenesew et al., (2013) who reported that in Bure district of North western Ethiopia feed shortage was very severe especially in the highland kebeles.Mesa et al., (2013) also in Lemu-Bilibilo district in Arsi zone reported that, shortage of feed at the end of dry season when all crop residues have been consumed and pasture growth is poor, was the major constraint for livestock production in the area. According to FGD of the respondents, the causes of feed scarcity in the study area were due to the shortage of grazing land and expansion of arable farming at the expense of grazing land. The present study indicated that, ranking of sheep rearing constraints by the producer's reflect their priority needs for intervention since most respondents ranked diseases problem as the first constraint. It is suggested that animal health strategy needs to be formulated in the study area to reduce mortality and/or morbidity rates as both affect productivity. In general, for effective breeding strategy sheep producers should be encouraged to adopt proper and cost effective disease control measures, and the limited animal health services need to be strengthened.

Table29: Major Constraints of Sheep Production in the Study Area Ranked by Respondents

Constraint	Seka				Dedo				Omonada			
	R1	**R2**	**R3**	**I**	**R1**	**R2**	**R3**	**I**	**R1**	**R2**	**R3**	**I**
Disease	29	23	6	0.39	34	19	6	0.40	41	16	2	0.44
Feed shortage	5	8	17	0.13	14	15	12	0.23	6	12	13	0.15
Water shortage	0	4	9	0.05	0	1	11	0.04	0	2	10	0.04
Predator	23	22	11	0.34	12	20	14	0.25	13	24	11	0.27
Poor Veterinary Service	1	1	7	0.03	0	2	7	0.03	0	4	9	0.05
Capital problem	2	2	10	0.06	0	3	10	0.04	0	2	15	0.05

4.19. Phenotypic Characterization of Indigenous sheep population

4.19.1. Qualitative Traits of the Sample Population

Qualitative traits of indigenous sheep population in the study area are presented in Table 30.There is an increasing interest in the characterization of African small ruminant populations because there is a major role in the maintenance of genetic resources as the basis of future improvement at both the production and the genetic levels (Nsoso *et al.,* 2004). Similarly Tassew (2010) states that knowing the potential of local sheep population and trait preferences are useful to make better informed decisions in developing interventions to improve the contribution of sheep to livelihoods of their keepers.

Qualitative traits in the study area there was a significant ($p<0.05$) difference between indigenous sheep population in coat color type, head profile, horn presence, horn orientation, toggle presence, hair type and ear orientation.Whereas non-significant difference is observed in coat color pattern, tail form, back profile and horn shape of the sample sheep population. The most frequent coat color patterns observed in the study area was 81.1% plain, 16.4% patchy and sheep with spotted pattern (2.5%) were rarely observed. The dominant coat color types were brown (43.5%), fawn (17.5%), red (13.0%), red and white (9.7%) and other type of color type that contributed small proportion were pure white, brown with white, black with white, and pure black also observed in varied proportion. This finding is in agreement with (Zewdu, 2008) who reported that brown coat color type was the dominant colors of Bonga sheep. The proportion of black is very small in the current study. According to FGD in the study area strongly supported coat color type were depending by the preference of farmers such as brown, white and red colors but they against the black color for which the farmers are exercising some kind of selection for the preferred ones.

The most dominant hair type of the sampled sheep populations were short smooth hair type that accounted as (88.8%) this type of traits help to fatten easily as it makes the sheep free from external parasite and the feed required for hair production could be used for meat production. The remaining (11.2%) of coarse long hair type were also rarely observed but it will be causes external parasites that will affect their health and productivity of sheep.

The majority (91.1%) of sheep in the study area were polled whereas (8.9%) of the sheep were horned.These findings are contrary to the results of Solomon (2008), who reported that above 50% of Arsi Bale female sheep were horned. However out of the horned sampled sheep population, 6.1% had curved horn shape, the remaining 1.7% had spiral and 1.1% had straight horn shape. In terms of horn-orientation in the current study from the total sampled sheep population 6.5% of the sheep had backward horn oriented, 1.8 lateral, 0.5% forward, and 0.2% upward horn orientation.

In the study area about 51.6% of the sampled sheep had semi-pendulous ear orientation out of total sampled sheep and the remaining (48.4%) of the population had carried horizontally ear orientation. This result is slightly agree with the report of Zewdu (2008) who reported that majority of Bonga sheep had semi-pendulous ear orientation.Most the majority of the sampled sheep population had straight (94.2%) head profile whereas the remaining (5.8%) was slightly convex profile. With regard to back profile about (69.8%) of the sampled sheep population had straight back profile and (30.2%) had concave profile.

The majority of the sampled sheep population had straight and downward end (79.3%) tail type while (20.7%) had straight and twisted end up tail type. In the study area majority (74.9%) of sampled sheep had no toggle and the remaining (25.1%) had toggle.

In terms of qualitative traits the dimensions of the identified sheep populations from the three districts they share some common characteristics. The possible reason might be due to the geographic proximity of the three districts.

Table 30: Qualitative Trait of Sample Sheep Population in the Study Area

Traits and Level	Seka				Dedo				Omonada				Over all	
	Female		Male		Female		Male		Female		Male			
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Coat color pattern														
Plain	138	80.7	15	78.9	145	84.8	14	73.7	133	77.2	17	89.5	462	81.1
Patch	30	17.5	3	15	21	12.3	4	21.1	34	19.5	2	10.5	94	16.4
Spotted	3	1.8	1	5.3	5	2.9	1	5.3	4	2.3	0	0	14	2.5
X^2value													**2.908Ns**	
Coat color type														
Brown	69	40.4	10	52.6	71	41.5	5	26.3	80	46.8	13	68.4	248	43.5
Black +white	4	2.3	0	0	4	2.3	1	5.3	2	1.2	0	0	11	1.9
Pure Black	1	0.6	0	0	5	2.9	1	5.3	4	2.3	0	0	11	1.9
Pure White	7	4.1	0	0	14	8.2	2	10.5	4	2.3	2	10.5	29	5.1
Red	21	12.3	1	5.3	33	19.3	3	15.8	14	8.2	2	10.5	74	13.0
Red +white	15	8.8	3	15.8	9	5.3	1	5.3	26	15.2	1	5.3	55	9.7
Red+ Black	4	2.3	1	5.3	5	2.9	0	0	3	1.8	0	0	13	2.3
Brown +white	10	5.8	0	0	8	4.7	3	15.8	7	4.1	1	5.3	29	5.1
Fawn	40	23.4	4	21.1	22	12.9	3	15.8	31	18.1	0	0	100	17.5
X^2 value													**36.18***	
Head profile														
Straight	164	95.9	17	89.5	156	91.2	15	78.9	167	97.7	18	94.7	537	94.2
Slightly convex	7	4.1	2	10.5	15	8.8	4	21.1	4	2.3	1	5.3	33	5.8
X^2 value													**10.03***	
Back profile														
Straight	122	71.3	10	52.6	127	74.3	15	78.9	106	62	18	94.7	398	69.8
Concave	49	28.7	9	47.7	44	25.7	4	21.1	65	38	1	5.3	172	30.2
X^2Value													**4.063Ns**	
Horns														
Present	10	5.88	9	42.1	14	8.2	10	52.6	4	2.3	3	15.8	50	8.9
Absent (Polled)	160	94.1	11	57.9	157	91.8	9	47.4	167	97.7	16	84.2	520	91.1
X^2 value													**10.041^***	

Table 30 continued

Horn shape														
Polled	160	93.5	11	57.8	157	91.7	9	47.4	167	97.7	16	84.2	520	91.1
Straight	0	0	0		3	1.8	1	5.3	1	0.6	0	0	5	1.1
Curved	8	4.7	7	36.8	9	5.3	6	31.6	3	1.8	2	10.5	35	6.1
Spiral	3	1.8	1	5.3	2	1.2	3	15.8	0	0	1	5.3	10	1.7
X^2 value													**12.228 [Ns]**	
Horn orientation														
Upward	1	9.0	8	42.1	0	0	7	36.8	0	0	3	15.8	1	0.2
Back ward	6	54.0	1	5.3	9	5.3	3	15.8	4	2.3	0	0	37	6.5
For ward	3	27.0	0	0	0	0	0	0	0	0	0	0	3	0.5
Lateral	1	9.0	0	0	5	2.9	0	0	0	0	0	0	10	1.7
X^2 value													**22.935***	
Ear orientation														
Semi-pendulous	*95*	55.6	6	31.6	101	59.1	9	47.4	75	43.9	8	42.1	294	51.6
Horizontally	76	44.4	13	68.4	70	40.9	10	52.6	96	56.1	11	57.9	276	48.4
X^2 value													**7.96***	
Hair type														
Smooth/short	155	90.6	16	84.2	144	84.2	15	78.9	158	92.4	18	94.7	506	88.8
Coarse/long	16	9.4	3	15.8	27	15.8	4	21.1	13	7.6	1	5.3	64	11.2
X^2 –value													**8.061***	

Table 30 continued

Toggle														
Present	41	23.9	6	31.6	32	18.7	3	15.8	56	32.7	5	26.3	143	25.1
Absent	130	76.1	13	68.4	139	81.3	16	84.2	115	67.3	14	73.7	427	74.9
X^2 value														**9.484***
Tail form														
Straight and dawn ward end	145	84.8	15	78.9	140	81.8	12	63.2	127	74.3	13	68.4	452	79.3
Straight and twisted end up	26	15.2	4	21.1	31	18.2	7	36.8	44	25.7	6	31.6	118	20.7
X^2 value														**3.211Ns**

Representative adult female sheep in the study area

Representative adult male sheep in the study area

Figure 7: The dominant sample sheep coat color type in the study area

4.19.2. Body Weight and Linear Body Measurements

Information on body weight and physical linear measurements of specific sheep population at constant age has paramount importance in the selection of genetically superior animals for production and reproduction purpose (Yoseph, 2007). The least square means and standard errors of body weight and other body measurements by sex, age, location and sex by age interaction were presented in Table31. The body measurements are considered as qualitative growth indicators which reflect the conformational changes occurring during the life span of animals. Although live body weight is an important growth and economic trait, it is not always possible to measure it due to mainly the lack of weighing scales, particularly in rural areas. Body measurement can also be used routinely in weight estimation and selection programmes based on its utility in determining breed evolution trends (Getahun, 2008).

In the study area, the overall mean of body length, body weight, height at wither, chest girth, ramp height, pelvic width, canon bone length, canon bone circumference, tail length, tail circumference, head length and scrotal circumference were 61.12cm, 27.36kg, 63.28cm, 71.38cm, 64.20cm, 11.37cm, 11.36cm, 8.21cm, 31.63cm, 15.59cm, 14.66cm and23.57cm respectively.The values obtained for body weight (27.36 kg) in this study were lower than those obtained by Zewdu (2008) 30.75kg for Bonga and for Horro 29.66kg and also by Solomon (2007) for Bonga breed which was 35 kg. This much lower values in body weight in the present study (27.36 kg) might be due to the difference nutritional status of the animals or due to the fact that the change of environmental variation or may be the result of breed dilution through mixing of flocks leading to increase in inbreeding. Additional possible reason may be this particular studyof body weight and linear body measurements were taken during the dry seasonwhich is a period of critical feed shortage and this might be the consequence of lower body weight in the current study.

Sex Effect

Sex had significant ($p<0.05$) effect on body weight (BW), body length (BL),chest girth (CG), wither height (WH), rump height(RH), tail length (TL), ear length (EL), canon bone length(CBL),canon bone circumference(CBC) and tail circumference (TC) whereas pelvic width (PW) and head length (HL) ($p<0.05$) were not affected ($p>0.05$) by sex. The sex differences in live weight and most of the LBMs observed in this study showed that these parameters are sex influenced. Male sheep had consistently higher measurement value than females across all the significantly affected variables except some that were not significant ($p<0.05$). This finding could bein agreement with Sowande and Sobola, (2007) who reported that ewes have slower rate of growth and reach maturity at smaller size compared to males due to the effect of estrogen which restricts the growth of the long bones of the body weight.

Age Effect

The linear body measurements and body weight were significantly ($p<0.05$) affected by age except tail length and cannon bone circumference. The size of sheep increased as the age increased from youngest (1PPI) to the oldest (4PPI) which is in agreement with Tesfaye, (2008) the size and shape of the animal increases until the animal reach its maturity and the effect of age on body weight and other body measurements were also observed indifferent sheep breeds of Ethiopia. The average value of body weight for age group was 25.03, 27.48, 30.53 and33.72 kg for 1ppi, 2ppi, 3ppi and 4ppi respectively. This implies that growth patterns of the animal might be explained well by body measurements as the age advances. The current finding was similar with Jamal, (2017) who reported that age had highly significant ($P<0.001$) effect on body weight and all other linear body measurements except head length which was not significant ($P>0.05$).

In general, body weight of indigenous sheep increases with an increase in age of the animal. Thus, body weight of indigenous female sheep population increased by 2.50kg, 2.09kg and 2.41kg as animal grows from 1PPI to 2PPI dentition class, from 2PPI to 3PPI dentition class and from 3PPI to 4PPI dentition class whereas for the male sheep were 2.40kg,4.01kg and 3.95kg, respectively(Table 31). The change in body weight was higher for male between the age class 2PPI and 3PPI, which was approximately 4.01kg which is relatively better but not significantly higher while in the other age groups in both sexes almost constant growth .

District Effect

In the current study, the effect of district on body weight and most of the linear body measurements were also significant ($p<0.05$) except head length, canon bone length, ear length and tail length. This is similar with Michael (2013) who reported that district had significant ($p<0.05$) effect on live body weight and most of the linear body measurements across the studied districts in East Gojjam zone. The present result also was in agreement with the earlier study result that showed district had significant effect on body measurement of indigenous sheep in west Shewa (Yadeta, 2017).There was a variation of body weight in study districts especially in Omo-nada district the body weight and other linear measurements were lower as compared to the other districts. This difference could be the result of the Management; environmental difference or may be the mixing of inbreeding of breed across the study area.

Age by Sex Interaction Effect

Age by sex interaction had significant effect ($p<0.05$) on body weight and other linear body measurements except for head length, tail length and cannon bone circumference. For all age groups males had higher body weight and other linear measurements ($p<0.05$) than females but pelvic width and some of linear measurements were similar for the two sexes at all age group. These differences might be due to function ofsex-related differences between sex differential hormonal effects on growth of sheep (Semakula *et al.,* 2010).

Table 31: Live Body Weight and Linear Body Measurements of Sheep in the Study Area

Effect and levels	N	BL LSM±SE	WH LSM±SE	CG LSM±SE	RH LSM±SE	PW LSM±SE	CBL LSM±SE	CBC LSM±SE
Overall	570	61.12±0.16	63.28±0.17	71.38±0.17	64.20±0.16	11.37±0.03	11.36±0.04	8.21±0.03
CV%		2.77	2.98	2.05	2.82	5.43	8.65	10.17
R^2		0.83	0.79	0.87	0.80	0.49	0.07	0.17
District		*	*	*	*	*	Ns	
Seka	190	63.2±0.21a	65.10±0.23a	72.88±0.18ab	66.00±0.22a	11.34±0.08b	11.73±0.12	8.15±0.10b
Dedo	190	63.19±0.22a	65.19±0.24a	73.49±0.19a	66.04±0.23a	11.58±0.07a	11.52±0.12	8.69±0.01a
Omo/nada	190	62.05±0.21b	64.36±0.24b	72.78±0.18b	65.00±0.23b	11.52±0.08ab	11.55±0.12	7.98±0.01b
Sex		*	*	*	*	Ns	*	Ns
Male	57	64.40±0.23a	66.56±0.26a	74.77±0.20a	67.16±0.24a	11.52±0.08	11.87±0.14a	8.33±0.12
Female	513	61.04±0.07b	63.21±0.08b	71.34±0.24b	64.15±0.08b	11.42±0.02	11.33±0.04b	8.21±0.04
Age		*	*	*	*	*		Ns
1PPI	166	58.58±0.22d	60.64±0.24d	68.200±0.18d	61.61±0.23d	10.57±0.07c	11.13±0.13c	8.02±0.10
2PPI	134	61.37±0.22c	63.40±0.25c	71.52±0.19c	64.37±0.23c	11.16±0.08bc	11.43±0.13bc	8.30±0.10
3PPI	136	64.41±0.25b	66.36±0.29b	74.76±0.22b	67.26±0.28b	11.88±0.09ab	11.74±0.15ab	8.33±0.13
4PPI	134	66.53±0.29a	69.15±0.33a	77.74±0.25a	69.37±0.31a	12.26±0.10a	12.09±0.17a	8.44±0.15
Sex by age interaction		*	*	*	*	*	*	Ns
Male,1PPI	18	61.09±0.40d	63.04±0.45de	70.37±0.35d	63.98±0.44cd	10.58±0.15cd	11.08±0.24bcb	8.07±0.20
Female,1PPI	148	56.06±0.14e	58.23±0.16f	66.03±0.12e	59.24±0.15e	10.57±0.05d	11.18±0.18bc	7.96±0.07
Male,2PPI	18	62.90±0.41c	64.87±0.46c	72.52±0.36c	65.82±0.44b	11.07±0.15bc	11.61±0.24abc	8.46±0.20
Female,2PPI	116	59.83±0.16d	61.94±0.18e	70.52±0.14d	62.93±0.17d	11.24±0.06b	11.26±0.09c	8.15±0.08
Male, 3PPI	12	66.10±0.49ab	67.84±0.55b	76.43±0.43b	68.69±0.53a	11.87±0.18a	12.12±0.29ab	8.40±0.24
Female,3PPI	124	62.72±0.15c	64.87±0.17cd	73.10±0.13c	65.84±0.16bc	11.89±0.06a	11.36±0.08bc	8.26±0.07
Male, 4PPI	9	67.52±0.56a	70.50±0.63a	79.77±0.49a	70.14±0.60a	12.55±0.20a	12.68±0.33a	8.41±0.28
Female, 4PPI	125	65.53±0.15b	67.79±16b	75.72±0.13b	68.60±0.16a	11.96±05a	11.51±0.08bc	8.48±.070

Table 31 continued

Effect and levels	N	HL	EL	TL	TC	SC	BW
	570	**LSM±SE**	**LSM±SE**	**LSM±SE**	**LSM±SE**	**LSM±SE**	**LSM±SE**
Overall		14.66±0.05	10.58±0.03	31.63±0.14	15.59±0.12	23.57±0.12	27.36±0.13
CV%		8.26	8.86	10.82	16.07	3.72	4.95
R^2		0.04	0.05	0.05	0.25	0.60	0.83
Districts		Ns	Ns	*	*	*	*
Seka	190	14.89±0.15a	10.86±0.11	32.33±0.42ab	15.55±0.31b	23.72±0.20b	29.28±0.16a
Dedo	190	14.61±0.15	10.70±0.12	33.05±0.43a	19.18±0.32a	24.23±0.21a	29.62±0.17a
Omonada	190	14.94±0.15	10.66±0.11	31.18±0.43b	16.29±0.31b	23.65±0.20b	28.69±0.16b
Sex		Ns	*	*	*		*
Male	57	14.98±0.17	10.58±0.04a	32.82±0.47a	18.75±0.35a	23.86±0.12	31.19±0.19a
Female	513	14.65±0.05	10.90±0.13b	31.54±0.15b	15.26±0.11b		27.18±0.06b
Age		Ns	*	Ns	Ns	*	*
1PPI	166	14.55±0.15	10.44±0.11b	31.88±0.43	16.76±0.32	22.56±0.21d	25.03±0.17d
2PPI	134	14.95±0.16	10.56±0.12b	31.69±0.44	16.96±0.33	23.18±0.21c	27.48±0.18c
3PPI	136	14.69±0.18	10.79±0.14ab	32.33±0.52	17.09±0.38	24.37±0.26b	30.53±0.20b
4PPI	134	15.06±0.21	11.18±0.16a	32.83±0.59	17.23±0.43	25.34±0.29a	33.72±0.23a
Sex by age interaction		Ns	*	Ns	Ns	*	*
Male,1PPI	18	14.73±0.29	10.37±0.23b	32.92±0.82	18.56±0.60	22.56±0.21d	26.39±0.33e
Female,1PPI	148	14.38±0.09	10.50±0.07b	30.82±0.28	14.95±0.20		23.66±0.11f
Male,2PPI	18	15.18±0.29	10.47±0.23b	32.22±0.82	18.50±0.50	23.18±0.21c	28.79±0.33d
Female,2PPI	116	14.71±0.11	10.64±0.08b	31.16±0.32	15.40±0.23		26.16±0,13e
Male, 3PPI	12	14.79±0.35	10.97±0.27ab	32.64±1.00	19.07±0.73	24.37±0.26b	32.80±0.39b
Female, 3PPI	124	14.58±0.10	10.60±0.08b	32.02±0.30	15.12±0.12		28.25±0.12d
Male, 4PPI	9	15.22±0.40	11.80±0.31a	33.49±1.15	18.87±0.84	25.34±0.29a	36.75±0.45a
Female, 4PPI	125	14.90±0.10	10.55±0.08b	32.17±0.30	15.58±0.22		30.69±0.12c

4.20. Correlation between Body Weight and Linear Body Measurements

The association among body weight and linear body measurements of sheep in the study area is presented in Table 32. Almost all of the linear body measurements had positive and significant ($p<0.05$) correlation with body weight except ear length in females and tail length (TL), canon bone circumference (CBC), tail circumference (TC) and head length (HL) for males. The Positive and highly significant ($P<0.0001$) correlations between body weight and most of the body measurements implies that these measurements can be used as indirect selection criteria to improve live weight (Tesfaye and Solomon, 2008) or could be used to predict live body weight of the sheep. Correlations between the quantitative traits in the sampled sheep population showed low to strong positive significant and non-significant values. In males chest girth ($r = 0.97$), body length ($r= 0.92$), wither height ($r = 0.94$) and rump height ($r = 0.89$) had strong and significant ($P<0.05$) positive associations with body weight. Scrotal circumference ($r = 0.83$) and pelvic width($r = 0.75$) had moderate correlation with body weight, cannon bone length ($r = 0.37$) and head length ($r = 0.46$) had low weak relationship with body weight however ear length ($r = 0.17$), tail length ($r = 0.14$), canon bone circumference ($r = 0.08$), tail circumference ($r = 0.11$) were non-significant values. The high, positive and significant correlation between body weight and chest girth suggest that this variables could provide a good estimate for predicting live weight of sheep. In addition the high correlation coefficients between body weight and body measurements for the sampled sheep populations showed that either of these variables or their combination could provide a good approximation for predicting live weight.

In females chest girth ($r = 0.92$), body length ($r= 0.90$), wither height ($r = 0.89$) and rump height ($r = 0.88$) had strong and significant ($P<0.05$) positive associations with body weight, pelvic width ($r = 0.59$) had moderate correlation with body weight whereas ear length, tail length, canon bone circumference, tail circumference, cannon bone length and head length had low weak relationship with body weight. The strong correlation observed between Rump height and Height at wither ($r=0.88$), body length $r=0.90$ in females and in males Height at wither ($r=0.94$), Rump height ($r=0.89$) but Chest girth ($r=0.97$) and ($r = 0.92$) for male and female respectively correlated with body weight that indicated Chest girth have appropriate variable for predicting live weight for both sex in this study than other measurements similarly Michael (2013) chest girth was the recommended variable to estimate the body weight of the sheep at the farmer's level when there is no other instruments like spring balances to measure exact live body weight of sheep.

Table32: Coefficient of Correlations between Body Weight and Linear Body Measurements of Sampled Sheep Population (Above the Diagonal for Females and Below the Diagonal for Males; Female = 513 & Male = 57

	BL	**HW**	**CG**	**RH**	**PW**	**CBL**	**CBC**	**HL**	**EL**	**TL**	**TC**	**BW**
BL		0.98*	0.94*	0.98*	0.59*	0.13*	0.22*	0.09*	-0.002ns	0.13*	0.12*	0.90*
HW	0.96*		0.93*	0.98*	0.58*	0.11*	0.22*	0.08*	0.008ns	0.13*	0.10*	0.89*
CG	0.93*	0.93*		0.93*	0.62*	0.12*	0.22*	0.12*	0.007ns	0.15	0.08*	0.92*
RH	0.95*	0.95*	0.87*		0.59*	0.11*	0.20*	0.08*	0.005ns	0.15ns	0.12*	0.88*
PW	0.68*	0.69*	0.77*	0.64*		0.09*	0.19*	0.13*	0.05*ns	0.01ns	0.08ns	0.59*
CBL	0.30*	0.31*	0.38*	0.27*	0.38*		0.08	-0.05ns	0.09*	-0.08ns	-0.04ns	0.14*
CBC	0.17ns	0.16ns	0.20ns	0.20ns	0.39*	-0.05ns		0.06ns	-0.01ns	0.29*	0.12*	0.26*
HL	0.05ns	0.06ns	0.09ns	0.08ns	0.07ns	0.10ns	-0.15ns		0.02ns	0.10ns	0.07ns	0.14*
EL	0.48*	0.44*	0.48*	0.40*	0.47*	0.26ns	0.28*	-0.02ns		-0.10*	0.01ns	0.003ns
TL	0.14ns	0.16ns	0.14ns	0.19ns	0.01ns	-0.08ns	-0.29*	0.10ns	-0.20ns		0.10*	0.14*
TC	0.10ns	0.09ns	0.10ns	0.14ns	0.19ns	-0.21ns	0.49*	0.002ns	-0.03ns	0.25ns		0.09*
BW	0.92*	0.94*	0.97*	0.89*	0.75*	0.37*	0.08ns	0.46*	0.17ns	0.14ns	0.11ns	
SC	0.75*	0.75*	0.82*	0.73*	0.69*	0.27*	0.28*	0.09ns	0.36*	0.10ns	0.23ns	0.83*

4.21. Prediction of Body Weight from other Body Measurements

Multiple linear regression models for predicting the body weight of sheep from linear body measurements are presented in Table 33.The accuracy of functions used to predict live weight or growth characteristics from live animal measurements of immense financial contribution to livestock production enterprises (Tesfaye,2008).Regression analysis is commonly used in animal research to describe quantitative relationships between a dependent variable and one or more independent variables such as body weight and body measurements (chest girth, body length and height at wither) especially when there is no access to weighing equipment (Cankaya, 2008).

In this study, Chest girth, body length, canon bone circumference, Head length, wither height and Rump height were the best fitted model for female sheep, whereas Chest girth, Rump height, body length, Scrotal circumference, wither height, canon bone circumference and tail circumference were the best fitted model for male sheep. The fitted prediction model was selected with smaller C (p), MSE and higher R^2 values. Chest girth selected first, which explain more variation than any other linear body measurements in both ewes (84%) and rams (94%).

However, the change in R-square of chest girth was not strong strengthening the preceding argument due to inclusion of additional variables in the model that could serve as a best predictor of body weight under field condition. Moreover, thus, body weight prediction from chest girth alone would be a practical option under field conditions. This is in agreement with the results of Hizkel (2017) who reported that chest girth was selected first for prediction of live body weight of sheep however, the change in R-square not strong strengthening due to inclusion of additional variables in the model.

Regression of body weight over independent variables, which have higher correlation with body weight, was done to set adequate model for the prediction of body weight separately for each sex.$y = -21.82 + 0.68x$ for female sample sheep population and $y = -49.90 + 1.08x$ for male sample sheep population; where y and x are body weight and chest girth, respectively.

Table 33:Multiple Regression Analysis of Live Body Weight on Different Body Measurements of Female (N=513) and Male Sheep (N=57) in the Study Area.

Model	Intrcept	B1	B2	B3	B4	B5	B6	B7	R^2	AdjR^2	C(P)	MSE
For Female sheep												
CG	-21.82	0.68							0.84	0.8400	55.40	1.40
CG+BL	-20.46	0.21	0.48						0.85	0.0101	20.76	1.31
CG+BL+CBC	-21.37	0.20	0.48	0.19					0.85	0.0031	11.40	1.29
CG+BL+CBC+HL	-22.47	0.21	0.47	0.20	0.09				0.85	0.0014	8.49	1.28
CG+BL+CBC+HL+CBL	-23.33	0.21	0.47	0.09	0.19	0.09			0.85	0.0008	7.44	1.27
CG+BL+CBC+HL+CBL+HW	-23.38	0.13	0.09	0.46	0.09	0.19	0.09		0.86	0.0006	7.08	1.27
CG+BL+CBC+HL+CBL+HW+RH	-22.59	0.23	0.19	0.46	-0.20	0.08	0.18	0.09	0.86	0.0010	5.55	1.26
For male sheep												
CG	-49.90	1.08							0.94	0.94	22.80	0.89
CG+RH	-53.95	0.89	0.28						0.95	0.009	11.69	0.76
CG+RH+BL	-52.98	-0.39	1.02	0.48					0.95	0.004	7.67	0.69
CG+RH+BL+SC	-53.34	-0.35	0.93	0.46	0.27				0.96	0.002	5.99	0.66
CG+RH+BL+SC+HW	-52.63	-0.44	0.27	0.87	0.34	0.29			0.96	0.002	5.03	0.65
CG+BL+RH+SC+HW+CBC	-53.38	-0.40	0.30	0.85	0.29	0.20	0.24		0.96	0.002	4.32	0.62
CG+BL+RH+SC+HW+CBC+TC	-53.53	-0.40	0.29	0.84	0.30	0.29	-0.04	0.28	0.96	0.002	4.26	0.60

5. SUMMERY, CONCLUSION AND RECOMMONDATION

5.1. Summery and Conclusion

This study was conducted with the objective of phenotypic characterization of indigenous sheep and their breeding practice within their production environment. A total of 180 respondents were selected for characterization of theproduction system and 570 mature Sheep sampled were taken for phenotypic characterization of sheep population (qualitative and quantitative characters). The average number of sheep per household in Seka, Dedo and Omonada was 7.80, 8.74 and 8.12 sheep respectively. Mature Ewes older than 1 year accounted for the largest proportion in Dedo (4.95±2.03), in Seka (4.58±2.87) and in Omonada 4.63±0.60 among sheep flock structure while ram lambs were aged greater than one year in the flock accounted as 0.51±0.56, 0.43±0.56 and 0.63±0.60 in Seka, Dedo and Omonada respectively. Respondents in the study area were keeping both male and female sheep mainly for income generation, breeding and an asset as a saving purpose.

Natural pasture and crop residue were the main feed sources during rainy and dry seasons across all the districts. The main source of water for sheep in the study areas were rivers and spring water, and the majority of farmers reported that they allow their flock to get watered as they needed and when they want.

Mostly, sheep were sheltered in adjacent and separate house in the current study. As well as housed sheep inside with the main house were also reported as in rare case. Castration was practiced by majority sheep keepers. Most of the respondentsallow or permit uncontrolled mating practices this type of common breeding practice in the study area leads to inbreeding and decrease genetic variation. The inbreeding coefficient in the study area was higher this is due to utilization of breeding rams born with in the flock, small flock's size and lack of awareness about inbreeding.

Parasites (Internal and external), Diarrhea and sheep pox were the major diseases reported for sheep in all the study districts. Disease, predator and feed shortage were the major production constraints in the study area.

All farmers in Seka, Dedo and Omonada farmers select breeding rams and ewes based on physical appearance and coat color type. The most dominant coat colour patterns in the sample populations were plain and patchy while fawn, brown, red, red with white spotted were the most frequently observed coat color types. Most of the sheep were characterized by possessing short and smooth hair coat type. The predominant tail type observed in both sexes of sampled sheep populations were long fat tail with straight end up at the tip. The majority of the sample populations had straight head profile with few frequency of concave profile. Horn was absent (polled) in most of the sampled sheep populations and curved horn shape predominates for those horned sheep. The most frequently observed ear orientations were semi-pendulous and horizontal. Toggle was grossly absent in most of sheep in the study area. Sex of animals had significant effect ($P<0.05$) on body weight and most of body measurements.

Dentition classes of animals contributed significant differences to body weight and most of the linear body measurements. Generally most of the body measurements of sheep were affected by sex and dentition class and there was slightly district effect for some the body measurements. Qualitative traits like coat color type and pattern influenced the decision of farmers in choosing animals so determination of economic value for such traits is suggested.

Effective population size of sheep per house-hold needs to be increased by devising appropriate intervention measures to reduce level of inbreeding.Sheep production system in the study area was more of extensive production system. Hence, for enhancing future sheep production in the area, emphasis is to be given on disease management, feed availability, predator, mating or breeding could be improvement.

5.2. Recommendation

The following sets of recommendations were forwarded from the results of the study:

i. Existing livestock and management activities need to be strengthened in the study area especially in areas of disease control, feeding management, breeding management (including increasing effective population size to reduce inbreeding, periodic change of breeding rams, selection of good male to serve as future rams) and other aspects of sheep management;

ii. A system by which breeding rams could be regularly exchanged between farmers should be created and strengthened to minimize the level of inbreeding and enhance efficient utilization of better breeding males;

iii. Strengthening of existing animal health facilities in the study districts to control mortality and/or morbidity of sheep;

iv. Designing location and area specific strategies for sheep improvement incorporating farmers at various decision levels;

v. Efforts should be made to alleviate the main constraints that hindered sheep production in the study area; and

vi. Provision of training on sheep production and flock management.

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APPENDEX

A) Questionnaire number: ________District ________kebele (PA) _____ Date____

1. Respondent's Sex: 1. Male 2.Female
2. Marital status of respondents A. Married B. Widowed C. Divorced
3. Respondent's Age (in years)________
4. Respondent's Educational level A. Illiterate B. Reading and writing   C. Primary (1-8) D. Secondary (9-12)
5. Household family size (number): Male________Femal______ Total____
6. The main households farming income are?   A. Crop production   B. Livestock production C. both
7. Livestock composition per household
8. Do you have sheep breed? If you yes what is your acquisitionmethodssheep breed (Tick one box)

Source	Birth (born)	Purchasing (bought)
Rank		

9. Sheep flock structure by age group in the study area

Sheep	Number
lamb < 6 month	
lamb 6-12month	
Mature male sheep (>1year)	
Mature female sheep (>1year)	
Castrates	
Total	

10. Grazing method

	Wet season	Dry season
Herding		
Tethered		
Herding +tethered		

11. Production system

	Crop livestock(mixed)	Agro pastoralists	Pastoralists
Mark			

12. Gender aspects of work sharing – mark one or more boxes in each row

Work-sharing	Household			Rank
	Women	Men	Children	
Feeding+ Watering				
Herding				
Barn cleaning				
Purchasing+ Selling sheep				

13. Purpose of keeping sheep

Species	Meat	Breeding	Manure	Saving	Income
Sheep					
Rank					

14. Feed sources used for sheep

Type of feed source	Wet season	Rank	Dry season	Rank
Natural gazing land				
Communal natural gazing land				
Crop residues				
Concentrate				

15. Source of water

Source	Wet season	Dry season
Pond water		
River		
Spring		

16. Distance to the nearest watering point?

Distance from home	Dry season	Wet season
Watered at home		
<1km		
1–5 km		

17. Frequency of watering for adult animals

Frequency	Wet season	Dry season
Freely available		
Once a day		
Twice a day		

18. Water quality

Quality	Wet season	Dry season
Muddy		
Clean		

19. Housing practices of the sample population of adult sheep (Tick one box).

1. In home with human		
2. Separate house		
3. Adjacent to human house		

20. Are lambs housed with adult sheep? A. Yes B. No

21. Are sheep housed together with other animals? A. Yes B. No

22. What are the major sheep diseases occur frequently in your area?

No	Disease	Rank
1.		
2.		

23. Do you have access to veterinary services? A. Yes B. No

24. If yes, which type of veterinary service you accessed?

Treatment	Government	Private	NGOs	Other
Mark				

25. Reproductive characteristics of indigenous sheep

Sex	Age at first lambing	Age at first mating	Lambing Interval
Male			
Female			

26. Do you practice selection for breeding male and breeding female? A. Yes B. No

27. If you yes for Selection criteria ewe?

Traits	Color	appearance	Family history	Age at first mating	Lambing interval	Litter size
Rank						

28. Selection criteria for rams

Traits	Color	Body size	Fertility	Pedigree	Libido	Temperament	appearance
Rank							

29. Do you allow other lambs to mate your flock? A. Yes B. No

30. Purpose of keeping lambs

Objective	Mating	Better price	Fattening
Rank			

31. Type of mating? A. Controlled B. Uncontrolled

32. If uncontrolled, what is the reason?

Reason	sheep grathing together	Lack of awareness	Insufficient number of rams
Mark			

33. Do you have a ram? A. yes B. No

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

	Neighboring lambs	Communal grazing areas
Mark		

34. Do you castrate your lambs? A. Yes B. No

If you castrate your lamb, what are your reasons for castration?

	Control breeding	Improve fattening	Better price	Better temperament
Mark				

35. What is the common method you castrate your ram?
A. Traditional B. Modern (Burdizzo)
36. At what age do you castrate rams? A. < 6months B. 6- 12 months C. > 12months
37. Do you practice culling of sheep from flock? A. Yes B. No

If yes, reasons for culling? Reasons for disposal/culling (Tick one box)

Sheep	Black Color	Physical defect	Sick	Reproductive problem	Old age
Mark					

38. How is the sheep flock herded during the day time?
A. Male and female separated B. lambs are separated C. All classes of sheep herded together

39. Herding practices of sheep flock

Sheep herding practice	Rank
Separate herding of sheep common	
Herding sheep with cattle	

40. Way of herding? A. sheep of a household run as a flock B. sheep of more than one household run as a flock

41. What are the main constraints for sheep production? (Rank with significance)

Constraint	Feed shortage	Water shortage	Disease	Predator
Rank				

B) FGD interview

1. List and rank the breeding objective of sheep?
2. List way of grazing sheep in both dry and wet season?
3. What are common sources of breeding males for your flocks?
4. At what age most of farmers castrate their bucks?
5. List and rank most traits preferred for breeding ram and sheep?
6. List and rank the major constraints for sheep breeding practices?

C) Qualitative traits measurement recording format andcodes

NO.	AGE	SEX	CCP	CCT	HP	BP	H	HS	HO	E O	HT	Wp
1												
2												

Traits	**Codes**
Sex	1=Female, 2= Male
Age	1ppI=1, 2ppI=2, 3ppI =3, 4ppI=4
CCP = Coat color pattern	1= plain 2= Patchy 3= Spotted,
CCT = Coat color type	1= Black with white, 2 = Pure black, 3=Pure white, 4= Red 5=red and white 6= brown
HP = Head (facial) profile	1 = Straight, 2 = slightly convex,
H = Horn presence	1= Present 2= absent
HS = Horn shape	1 = polled, 2 = straight 3= curved
HO = Hornorientation	1= lateral 2= upward, 3= back ward, 4=Forward

EO = Ear orientation	1= Rudimentary, 2= horizontally
WP = Wattles	1= Present 2= Absent
BP = Back profile	1= straight, 2= concave
HT =Hair type	1= Smooth/short, 2=Coarse
TF=Tail form	1=twisted end and up 2= straight and downward

D) **Quantitative Traits Measurement Recording Format and Averivation**

-NO.	BL	HW	CG	RH	RW	PL	CBL	CBC	HL	EL	TL	TC	SC	BW
1														
2														

BL = Body Length,	CBC = cannon bone circumference
HW = Height at Withers,	HL = Head Length
HG = Heart Girth,	EL = Ear Length,
RL = Rump height	TL =Tail Length,
RW = Rump Width	TC =tail circumference,
PW = Pelvic Width,	SC = Scrotum Circumference,
CBL =cannon bone length,	BW =Body weight,

F) ANOVA for the effect of age and sex by age.

Appendix Table1: ANOVAfor Body Length of Indigenous Sheep for the Effect of Age and Sex by Age.

Source	**DF**	**Type III SS**	**Mean Square**	**F Value**	**Pr > F**
Sex	1	538.118537	538.118537	187.45	<.0001
Age	3	1707.596907	569.198969	198.28	<.0001
Sex*age	3	58.370293	19.456764	6.78	0.0002
Error	558	1601.875425	2.870744		

Appendix Table2: ANOVA for Height at Wither of Indigenous Sheep for the Effect of Age and Sex by Age

Source	**DF**	**Type III SS**	**Mean Square**	**F Value**	**Pr > F**
Sex	1	533.739017	533.739017	149.71	<.0001
Age	3	1869.443604	623.147868	174.79	<.0001
Sex*age	3	39.294814	13.098271	3.67	0.0121
Error	558	1989.333198	3.565113		

Appendix Table3: ANOVA for Chest Girth of Indigenous Sheep for the Effect of Age and Sex by Age.

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Sex	1	557.745574	557.745574	259.33	<.0001
Age	3	2362.542524	787.514175	366.16	<.0001
Sex*age	3	44.657001	14.885667	6.92	0.0001
Error	558	1200.110164	2.150735		

Appendix Table 4: ANOVA for Ramp Height of Indigenous Sheep for the Effect of Ageand Sex by Age.

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Age	1	429.046686	429.046686	131.22	<.0001
Age	3	1615.957680	538.652560		<.0001
Sex*age	3	63.097343	21.032448	6.43	0.0003
Error	558	1824.473404	3.269666		

Appendix Table5: ANOVAfor Pelvic Width of Indigenous Sheep for the Effect of Age and Sex by Age.

Sources	DF	Type III SS	Mean Square	F Value	Pr > F
Sex	1	0.45191309	0.45191309	1.19	0.2766
Age	3	80.16605033	26.72201678	70.12	<.0001
Sex*age	3	3.18681284	1.06227095	2.79	0.0401
Error	558	212.6483313	0.3810902		

Appendix Table6: ANOVAfor Canon Bon Length of Indigenous Sheep for the Effect of Age and Sex by Age

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Sex	1	14.12536950	14.12536950	14.62	0.0001
Age	3	23.39459886	7.79819962	8.07	<.0001
Sex*age	3	10.25649055	3.41883018	3.54	0.0146
Error	558	538.9621326	0.9658820		

Appendix Table7: ANOVA for Canon Bon Circumference of Indigenous Sheep for the Effect of Age and Sex by Age.

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Sex	1	0.68111012	0.68111012	0.98	0.3237
Age	3	4.94131411	1.64710470	2.36	0.0706
Sex*age	3	0.90948865	0.30316288	0.43	0.7285
Error	558	389.4948739	0.6980195		

Appendix Table8: ANOVA for Head Length of Indigenous Sheep for the Effect of Age and Sex by Age.

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Sex	1	5.38394142	5.38394142	3.67	0.0560
Age	3	7.74333908	2.58111303	1.76	0.1542
Sex*age	3	0.43822321	0.14607440	0.10	0.9603
Error	558	819.3747643	1.4684136		

Appendix Table9: ANOVAfor Ear Length of Indigenous Sheep for the Effect of Age and Sex by Age.

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Sex	1	5.12393614	5.12393614	5.82	0.0162
Age	3	13.67685545	4.55895182	5.18	0.0016
Sex*age	3	13.50613481	4.50204494	5.11	0.0017
Error	558	491.4129160	0.8806683		

Appendix Table10 : ANOVA for Tail Length of Indigenous Sheep for the Effect of Age and Sex by Age.

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Sex	1	77.8668660	77.8668660	6.65	0.0102
Age	3	33.3651934	11.1217311	0.95	0.4164
Sex*age	3	15.6127140	5.2042380	0.44	0.7214
Error	558	6536.355308	11.713898		

Appendix Table11: ANOVA for Tail Circumference of Indigenous Sheep for the Effect of Age and Sex by Age.

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Sex	1	578.3081533	578.3081533	92.07	<.0001
Age	3	5.8338439	1.9446146	0.31	0.8185
Sex*age	3	4.9495734	1.6498578	0.26	0.8523
Error	558	3504.901161	6.281185		

Appendix Table12: ANOVA for Body Wight of Indigenous Sheep for the Effect of Age and Sex by Age.

Source	DF	Type III SS	Mean Square	FValue	Pr > F
Sex	1	758.598995	758.598995	414.25	<.0001
Age	3	1926.725236	642.241745	350.71	<.0001
Sex*age	3	86.407772	28.802591	15.73	<.0001
Error	558	1021.844806	1.831263		