JIMMA UNIVERSITY

COLLEGE OF AGRICULTURE AND VETERINARY MEDICINE

THE EFFECT OF SUPPLEMENTING *BOTHRIOCLINE SCHIMPERI*, *ERYTHINA BRUCEI* AND *BRUGMANSIA SUAVEOLENS BERCHT* AS REPLACEMENT FOR CONCENTRATE ON WEIGHT GAIN, TESTICULAR PARAMETERS AND SEMEN CHARACTERISTICS OF BONGA SHEEP

Thesis Submitted to Department of Animal Science in Partial Fulfillment of the Requirement for Degree of Master of Science in Animal Production

by

Tilahun Gebre

Advisor: Professor Taye Tolemariam (PhD, Professor)

Co-advisor: Jane Wamatu (PhD)

Co-advisor: Muluken Zeleke (PhD)

Jimma, Ethiopia

December 2021

Jimma University College of Agriculture and Veterinary Medicine

Thesis proposal submission form

Name of student**: Tilahun Gebre** **ID = RM0615/13**

Title: The Effect of Supplementing *Bothriocline schimperi, Erythina brucie* and Brugmansia suaveolens bercht as Replacement for Concentrate on Weight Gain, Testicular Parameters and Semen Characteristics of Bonga Sheep

I declare that the research work has not been done anywhere else before or is not part of ongoing work.

Name of student: **Tilahun Gebre** Signature ________________

We have agreed to supervise the proposed research work. We have evaluated the contents of the proposal and found it to be satisfactory, complete according to the standards and formats of the university. We have also verified that the work has not been done anywhere else before.

Name of Major Advisor: **Prof. Taye Tolemariam** Signature________________

Date________________________________

Name of Co-advisor: **Jane Wamatu (PhD)** Signature____________

Date________________________________

Name of Co- advisor: **Muluken Zeleke (MSc)** Signature__________

Date ________________________________

Decision /suggestion of department Graduate council ___________________________________

Chairperson of DGC ________________________ Signature________________

Date ________________________________

Chairperson of DGC_________________________ Signature________________

Date ________________________________

DEDICATION

I dedicate this Dissertation to my wife, Ayinalem Getaun and other beloved families and best friends who wished me all the best and success in my study.

STATEMENT OF THE AUTHOR

I affirm that this Dissertation is my original work, and that I have properly recognized all sources of materials utilized in this Dissertation. This Dissertation was submitted in partial fulfillment of the requirements for the M.sc degree at Jimma University, and it has been placed at the University library, where it will be available to readers according to the library's rules. I solemnly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

Brief quotations from this thesis are allowable without special permission provided that accurate acknowledgement of source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the Head of Department of Animal Sciences or the Dean of the School of Graduate Studies when in his or her judgment the proposed use of the material is in the interest of scholarship. In all other instances, however, permission must be obtained from the author.

Name: Tilahun Gebre Signature: ________________

Place: Jimma University, Jimma.

Date of submission: __________________

BIOGRAPHICAL SKETCH

The author, Tilahun Gebre was born on Thursday October 27, 1983 in South west Ethiopian people District, Kaffa Zone, Decha woreda Dubiyo kebele. He attended his elementary education in Gebera Primary Schools. And he continued his high school studies at Decha woreda Awurada Senior Secondary School and completed at Bonga Bishaw wolideyohanes Senior Secondary School. After passing Ethiopian High School Certificate Examination successfully, he joined the Alage Agricultural Technical Vocational Educational Training (AATVET) in 2001 academic year and graduated with Diploma in Animal Science in September 2004. Soon after his graduation, he was employed by the South Nation National and people Regional State, Kafa Zone Gimbo woreda Office of Agriculture and natural resources as Animal science expert. Then after six year work experience he has get chance to upgrade diploma to degree. He joined Mizan Tepi University Mizan campus since 2010 and graduated with Degree in Animal Science in September 2014. After degree graduation he joined Kaffa zone livestock and Fishery Department and assigned as animal forage development and utilization team leader in 2014. Finally he joined Jimma University College of Agriculture and Veterinary Medicine, Department of Animal Sciences in December 2020 to pursue his M.sc in Animal Production. At present the author is married and has a son.

ACKNOWLEDGEMENT

First and foremost, the author wishes to express his gratitude to the Almighty God for providing him with health, intelligence, inner strength, and ability in his work, as well as for his faultless protection and guidance throughout his life.

Author would like to express his sincere thanks to his major advisors Professor Taye Tolemariam and Co-advisor Mr Muluken Zelke for their guidance and encouragement from the inception of the proposal up to the final dissertation and paper preparation. Author would like to express his sincere thanks to Kafa zone livestock and fishery department who gave him sponsor sheep letter to join Jimma University. The author would like to acknowledge the International Center for Agricultural Research in the Dry Areas (ICARDA), for its financial assistance.

The author's special appreciation goes to Mr Zelalem Abate and Dr Nahom Belay from Bonga Agricultural research center who check me semen characteristic by using different instrument, Hasabu Abebe and all other recorders from study area, beside to semen collection during data collection for their contribution in house hold with ram selection, follow up that feeding program with me in each day and they were with me in each data collection time.

The author's appreciation goes to Mr Akililu Mamo and Mr Abriham Atumo Who was car driver from Bonga Agricultural research center and they were supporting me in every data collection time from starting to finish.

Special thanks go to Mr Akililu Amade, Mr Adugna Ado Mr Abera Abate, Mr Bereket Kochito, Mekonen Mechalo and all Kaffa zone livestock and Fishery department members for their encouragement throughout the study period. The author's special appreciation goes to his all classmates for their good friendship.

List of Abbreviations

ADG	The Average Daily Gain
AV	Artificial Vagina
ANOVA	Analysis of Variance
BHO	Black Head Ogaden
BW	Body Weight
CSA	Central Statistical Agency
DM	Dry Matter
EARO	Ethiopian Agricultural Research Organization
ESGPIP	Ethiopian Sheep and Goat Productivity Improvement Program
FAO	Food Agriculture Organization
FSH	Follicle-Stimulating Hormone
GDP	Gross Domestic Product
GnRH	Gonadotropin Releasing Hormone
ILCA	International Livestock Center for Africa
KZDLF	Kafa Zone Department of Livestock and Fisher Resources
LSD	Least Significant Difference
LH	Luteinizing Hormone
PUFA	Poly Unsaturated Fatty Acids
RDCR	Respiratory Disease Complex
RCBD	Randomized Completely Blocks Design
SNNPRS	Southern Nations, Nationalities, and Peoples' Regional State
SAS	Statistical Analysis System
SUDCA	Sustainable Development Consulting Association

Table of Contents

LIST OF TABLES

ABSTRACT

This study was conducted to evaluate the effect of flushing Bonga rams with selected indigeneous forages of Ethiopia; Botheriocline schimperi, Erythina Brucei and Brugmansia Suaveolensbercht. The effects on average daily gain and semen quality were measured. The study was conducted on-farm for a period of 90 days + 21 adaptation at Adiyo District, Southwest Kaffa **z***one, Southwest Ethiopia between May 2021 and November 2021. Rams (n=50) with body weight of 40-70kg and ages of 1.5-2 years were used in a factorial design of two flushing levels and five treatments. Experimental animals were allocated based on initial body weight measured at the beginning of the adaptation period and were randomly assigned to one of treatment diets including the control group. Rams had ad libitum access to desho grass as a basal diet and water. Dried leaves of Botheriocline schimperi, Erythina Brucei and Brugmansia Suaveolens berch leaves were supplemented as follows: T1- desho grass ad libitum (control); T2-desho grass ad libitum + 1kg Erythina Brucie (Korch); T3- desho grass ad libitum + 1kg Botheriocline schimperi, T 4- desho grass ad libitum + 1kg of Brugmansia Suaveolensberch; T5- grass ad libitum + 500g concentrate. Flushing was done either 14 days or 21 days before semen collection. Semen was collected weekly over a period of 90 days using artificial vagina. Scrotal circumference and semen quality traits were measured. Quality traits included colour, volume, mass motility and sperm concentration. 14-days flushing had higher (P<0.05) ADG compared to 21-days flushing but had no effect on scrotal circumference nor sperm quality parameters. Supplemented groups had higher (P<0.05) ADG compared to the control. T2 had ADG comparable to T5. Supplementation had no effect on scrotal circumference but tended to increase (P>0.05) sperm quality parameters. Erythina brucei can replace concentrates for growth and flushing of rams.*

Key words: *Nutritional flushing, rams, indigenous forages, sperm quality.*

1. INTRODUCTION

1.1 Background and Justification

Ethiopia has diverse agro-ecological zones suitable for livestock production. Agricultural scenario in Ethiopia is characterized by the pastoralism in low land area, and mixed farming systems in mid and highland areas. Livestock have traditionally been an important component of the agricultural industry in country (Alemayehu, 2002). Ethiopia is a country in East Africa where agriculture is the mainstay of the economy. More than 85% of the Ethiopian population depends on agriculture for their livelihoods. The subsector contributes about 16.5% of the national Gross Domestic Product (GDP) and 35.6% of the agricultural GDP (Metaferia *et al*., 2011). It also contributes 15% of export earnings and 30% of agricultural employment (Behnke, 2010). The livestock population of Ethiopia is estimated at 59.5 million cattle, 30.7 million sheep and 30.2 million goats (CSA, 2017) and they are distributed throughout a range of the wide ecology of the country. Similar to other species of livestock, sheep are also very important sources of food, hair (wool) and manure.

As an integral component of the overall farming system, livestock serve as a source of draught power for crop production, transport, minimize risk during times of crop failure, supply farm families with milk, meat, manure, serve as source of cash income, and plays significant role in the social and cultural values of the society (Azage *et al* 2010). Sheep production is a major component of the livestock sector in Ethiopia owing to the large population of 25.5 million head (CSA, 2011) and the diverse genetic resources (Gizaw, 2008). At the smallholder level, sheep are the major source of food security serving a diverse function including cash income, savings, fertilizer, socio-cultural functions and fibre. Sheep are particularly important for the pastoralist/agropastoralist and for farmers in the subalpine highlands where crop production is unreliable. Sheep are also important foreign currency earners accounting for 34% of the live animal exports.

Among the livestock species, sheep are widely reared in a crop-livestock farming systems and are distributed across different agro-ecological zones of Ethiopia. They provide their owners with a vast range of products and services such as immediate cash income, meat, milk, skin, manure, risk spreading and social functions (Adane and Girma, 2008) Sheep are also an important component of the livestock subsector, contributes close to 30% of the total ruminant livestock meat output and 14% of the total domestic meat production, with live animal and chilled meat export surpluses (Workneh *et al*., 2004). Around 25% of the domestic meat consumption of Ethiopia is provided from sheep (FAO, 2004). Sheep have a great role in the economy of the subsistence farming system and pastoral communities inhabiting diverse production systems. They are important sources of protein in the diets of the poor and manure, also help to provide extra income and support survival for many resource poor producers. They do also serve various social and cultural functions that vary among different cultures, socio-economies, agro-ecologies, and locations (Kosgey, 2004).

Ethiopia is one of the African countries with the largest small ruminant population in the continent (Abebe *et al.,* 2013), recent estimate indicates that there are about 30.7 million heads of sheep in the country, out of which 72.2 percent are females, and the rest are males (CSA, 2017). There are about 14 traditionally recognized sheep populations in Ethiopia, furthermore, the sheep populations are classified into 9 genetically distinct breeds and 6 breed groups among them **Bonga sheep** are one of the Ethiopian recognized breed types found in humid and mid-highland (1200–2500 meters) ecological zones and are geographically distributed in Keffa, Sheka, and Bench zones of Southern Nations, Nationalities, and Peoples' Regional State (SNNPRS) region. That may be grouped into about 14 traditional sheep populations (Gizaw *et al*., 2007; 2008). Most of the sheep population of the country is kept by smallholder farmers and sheep production in the country is traditional (EARO, 2001). Sheep are found widely distributed across the different agro-ecological zones of the country (Gizaw *et al*., 2007). Moreover, sheep production in Ethiopia has great potential to contributing more to the livelihoods of the people in low-input, smallholder farmers and pastoralists under traditional and extensive production systems (Kosgey and Okeyo, 2007).

Sheep production in Ethiopia is characterized by low productivity in terms of growth rate, meat production and reproductive performance (Adugna *et al.,* 2000). CSA (2010) indicated that the average daily growth rate of indigenous meat sheep is 50 g per animal. However, in spite of the huge sheep population, the contribution to the agricultural sector in the country is very low. Their productivity is constrained due to various factors involving biological and environmental aspects as well as socioeconomic factors. Among those reasons this failure, also due to lack of inadequate year-round feed supply both in terms of quantity and quality, and poor nutrition is the main challenges (Solomon, 2001). To achieve the desired benefit of these animals, proper feeding is crucial. There is a need to improve sheep productivity through supplementing to meet the nutrient requirements values considered necessary for maintenance, production and reproduction (Gatenby, 2002).

According to Gatenby (2002), sheep production is considered to be advantageous compared to other class of livestock production, due to their high fertility, short generation interval, adaptation in harsh environment and their ability to produce in limited feed resource they are considered as investment and insurance (Tsedeke, 2007). Sheep have multipurpose functions like other livestock species, plays vital roles in generating income to farmers, creating job opportunities, ensuring food security, providing services, contributing to asset, social, cultural and environmental values, and sustain livelihoods (Edea *et al.,* 2017), (Metaferia *et al.,* 2011). Moreover, they have special features, such as their being small in size, which implies low initial investment in starting and expanding sheep production as a business, efficient utilization of marginal and small plot of land, in connection to this are also sources of foreign currency (Berhanu *et al.,* 2006).

The most important function of Ethiopian sheep is meat production. Washera, Bonga, Horro, Arsi-Bale (AB) and Adilo are among Ethiopian sheep breeds that are good mutton producers in good environmental conditions while Black Head Ogaden (BHO) are good mutton producers even in a constrained availability of feed and water (Gizaw *et al* 2008). The current high demand for sheep and goat meat has increased their importance in lowland pastoral, agro-pastoral and mixed farming areas as a source of cash income, food security, household milk consumption, live animal savings and manure supply (Tibbo, 2006; Hassen and 156 Tesfaye, 2014). On the other hand, the ever-increasing human population in Ethiopia is forcing conversion of many grazing areas into croplands. As a result, raising large ruminants is becoming increasingly difficult in the highland areas due to lack of grazing areas. In such situations, the importance of sheep in fulfilling the role once played by cattle is being increasingly recognized (Yohannes *et al.,* 2017).

As reported by FAO (2013) sheep meat consumption trends in Ethiopia grow from 36000 ton in 2000 to 86000 ton in 2012. Sheep accounted 34% of the live animal exports (Gizaw *et al*., 2013). Moreover, sheep together with goats contributed 86% of the total value of meat exports (Legese and Fadiga, 2014). Even though the sheep population provided considerable roles to both smallholder farmers and the country’s economy but their present contribution is far below their potential. This is because productivity of sheep is hampered by many factors. However, Yami (2008) indicated that the nutrition of sheep and goats is the most important factor affecting their performance. Similarly, Gizaw *et al*. (2010) and Tesfay *et al*. (2012) noted that small ruminants usually suffer from feed shortage and poor nutrition. The common feeds in Ethiopia such as crop residues and matured natural pasture are inherently low in crude protein (CP), minerals and digestibility (Tolera, 2008; Gizaw *et al.*, 2010).

1.2 Statement of the problem

In Ethiopia including Kaffa zone, the small ruminant production system is not much effective as its potential due to different factors. Such as shortage of feed both in quality and quantity, Environmental factors, Disease, management practice etc. Among these factors nutritional gap takes the largest portion, but on the other hand there are many locally available and abundant forage feeds in the area associated with dense forest availability. That feed also have high nutritive values and preferable by sheep and goats. While still they are not studied about the significance on reproduction functions associated with semen characteristics and growth rate. Based on this gap my study will investigate the relationship between scrotal circumference with semen characteristics and body growth on the ram by feeding that selected feed trials.

1.3 Significance of the study

While my research focused on the above parameters, the Bonga sheep breed has its own distinct characteristics when compared to other Ethiopian indigenous sheep breeds, such as a large litter size, a high growth rate or weight gain, and good edible quality and palatability of meat under extensive management, even with poor feeding or natural pasture grazing. Because of this, the Bonga agricultural research center created two community-based breeding projects in the area: natural matting and artificial insemination (A.I). My research also sought to determine which local feeds can improve semen properties such as volume, motility, and concentration, in order to select the optimal forages for semen collection and artificial insemination.

To overcome the aforementioned obstacles and reap the intended benefits from these sheep, there must be a need to boost sheep production through the application of various technologies and the development of effective management and feeding programs in the area. Even though diverse feeds are available in the area and are consumed by the sheep, their impact on semen characteristics, weight gain and scrotal circumference success, particularly on farm conditions, has not been fully investigated. So that their effects on that parameters under traditional management condition can be evaluated. As a result, the following objectives will be settled in this research proposal:

1.4 Objectives

General Objective

The general objective of this study will be to evaluate the effect of supplementing locally available indigenous forage on weight gain, testicular parameters and semen characteristics of Bonga sheep.

Specific Objectives

- To evaluate the semen quality characteristics of the rams with supplementing different feed.
- To evaluate the testicular characteristic of Bonga sheep by supplying locally available indigenous forage.

2. LITERATURE REVIEW

2.1. Genetic Diversity, Population and Distribution of Sheep Breeds in Ethiopia

The history of the domesticated sheep goes back to between 11,000 and 9,000 BC, with the domestication of the wild mouflon in ancient Mesopotamia. A minority of historians once posited a contentious African theory of origin for Ovis Aries (Blench *et al.*, 1999). These sheep were primarily raised for meat, milk, and skins. However, the exact line of descent between domestic sheep and their wild ancestors is unclear (Hiendleder *et al.*, 2002). In several Sub-Saharan African countries similar to those in many other developing countries mixed crop/livestock production in subsistence manner is the predominant mode of agricultural production system (Tesfaye *et al*., 2004). In Ethiopia, the small ruminant production system in different agro-ecological zones is not studied fully and farmers" needs and production constraints have not been identified. Improvement in small ruminant productivity which is low in Ethiopia can be achieved through identification of production constraints and introduction of new technologies or by refining existing practices in the system (EARO, 2001).

2.2. Sheep Breed of Ethiopia

Ethiopia is believed to be one of the major gateways for domestic sheep migration from Asia to Africa (Edea, 2008) and has a large farm animal genetic diversity. The existence of this diversity is largely due to its geographical location near the historical entry point of many livestock populations from Asia, its diverse topographic and climatic conditions; the huge livestock population's size and wide range in production systems (Workneh *et al*., 2004; Assefa, 2010). Ethiopia has a large sheep population in Africa, which is estimated at 30.7 million sheep CSA, 2011). Different sheep are widely distributed across different agro ecological zones of the country. Generally, traditionally recognized indigenous sheep types of Ethiopia are classified in to fourteen based on their ecology, geographic distribution, distinguishing physical features and population sizes. These are Bonga, Siemen, Sekota, Farta, Tikur, Wollo, Menz, Gumuz, Washera, Horo, Adilo, Arsi, Afar and Blackhead Somali. Based on their ecological distribution, tail types, tail form/shape and fiber type, they can broadly be categorized into four groups (sub-alpine short-fat-tailed, highland long-fat-tailed, lowland fat-ramped and lowland thin-tailed). Among the diverse sheep populations of the country, based on above ecological distribution Bonga sheep is group as long-fat tailed, fatty long tail type /shape and short hair fiber type (Solomon *et al.*, 2008; ESGPIP, 2009).

Table 1 Indigenous sheep breeds in Ethiopia

Breed group	Breed	Population
Short-fat-tailed	Simien	Simien
	Short fat –tailed	Sekota, Farta, Tikur, Wollo, Menz
Washera	Washera	Washera
Thin-tailed sheep	Gumuz	Gumuz
Long-fat-tailed	Horro	Horro
	Arsi	Arsi- Bale, Adilo
Bonga	Bonga	Bonga
Fat-rumped sheep	Afar	Afar
	Black Head Somali	Black Head Somali

Source: Solomon *et al*., (2007)

2.3. Socio-economic Importance of Sheep Production in Ethiopia

Production of Sheep can contribute to the economy and environmental sustainability of the farm under operation and add value to the farm's biological diversity and may fit economic and biological niches that would otherwise stay unfilled even in the future (Wells *et al*., 2000). Sheep play an immense role in the livelihoods of rural farms and serve as a living bank for many farmers, and closely linked to the social and cultural life of resource poor farmers (Ayalew, 2000), particularly youths and women headed households. There is a linkage through manure since the manure of small ruminants is commonly used to fertilize home gardens and crop lands (Legesse *et al*., 2008). Sheep are the major suppliers of meat for rural communities, especially during periods of public festivals (Tsedeke, 2007); Sebsibe (2008) reported an estimated sheep skin output of 8.3 million in the year 2000 and contribute 77 thousand metric tons from mutton production. Low capital requirements for starting or expanding small ruminant production means that risks are low and the enterprise is well suited to low-input systems (Tibbo, 2006). Increasing human population, urbanization and incomes, coupled with changing consumer preferences are creating more demand for these animals and their products (Kosgay *et. al*., 2008).

The main reasons household sale sheep are to generate cash for purchasing food and farm inputs, school and medical expenses, pay credit, purchase livestock and build assets. During drought, the risk of crop failures and food shortage sheep are the preferred one for sale and to satisfy the farmers need. In addition to the live animals, skins are important marketable (Gemiyu, 2009). Even if skins are used for various household purposes, about 60% of total produced skins are marketed. However, one-third of the total household sale skins to illegal traders (Kocho *et al*., 2011) and about 90% meat, 92% skin and hide export trade value from sheep and goat production in the country (FAO, 2004).

Generally in Ethiopia, together with goat they provide about 12% of the value of livestock products consumed and 48% of the cash income generated at farm level, 46% of the value of national meat production, 25% of the domestic meat consumption with production surplus, 58% of the value of hide and skin production, 40% of fresh skins and hides production and 92% of the value of semi-processed skins and hides (Alemayehu *et al.*,, 1993). The annual national mutton and goat meat production is 78 and 62 thousand MT, respectively, largely because of the high average off take rates estimated at about 35% for sheep and 38% for goats (Workneh, 2006). Sheep and goats, respectively, contribute some 20.9% and 16.8% of the total ruminant livestock meat output or about 13.9% and 11.2% of the total domestic meat production, with a live animal and chilled meat export surpluses. Per capita consumption of sheep and goat meat (kg/person per year) in Ethiopia is 2.1 kg (EARO, 2000). The share of small ruminants to the total milk output is estimated at 16.7% with the major production coming from goats (ILCA, 1991).

2.4. Major Sheep Production Systems in Ethiopia

Ethiopia is one of the countries that have predominantly traditional sheep production system. The major sheep production systems in Ethiopia include the traditional sheep production system, which consists mixed crop- livestock systems, and pastoral and agro-pastoral system and the government ranches for breeding and multiplication centers, characterized by different production goals and priorities, management strategies and practices, and constraints (Markos, 2006). The sheep production systems of Ethiopia are classified into five based on degree of integration with crop production and contribution to livelihood, level of input and intensity of production, agro-ecology, length of growing period and relation to land and type of commodity to be produced. These include Highland sheep-barley system, mixed crop-livestock production system, Pastoral and agro-pastoral systems, Ranching system and Urban and peri-urban production systems respectively (Solomon *et al*., 2008).

2.5. Productive performance of Sheep in Ethiopia

Growth performance is a key production indicator as it has implication on the reproductive efficiency of sheep (Momoh *et al*., 2013). Fast growth performance allows sheep to breed early and contribute more numbers of lifetime lamb crop. Faster rate of growth enables attaining an early marketable weight (Berhanu and Aynalem, 2009). It is an important trait especially for mutton type breeds. An optimum level of growth determines the overall productivity of the flock and the economic return from the small ruminants. Growth performance of lambs is determined by their body weight at various stages and daily body weight gain. Growth rate of lambs particularly during the early stages of life, is significantly influenced by breed (genotype), nursing ability of the ewe, the environment under which the animals are maintained including the availability of adequate feed supply in terms of both quantity and quality 12 (Kassahun, 2000; (Taye, 2008). Parity, pre-mating weight of the dam, type of birth, sex and season of birth also affect the growth. Studies indicated that variation exits between indigenous sheep breeds for body weight traits (Kassahun; 2000; Sisay; 2002; Tibbo, 2006; Solomon; 2007). Among the indigenous sheep breeds Horro and Bonga sheep breeds are large sized breeds and are superior in their body weight compared to most of the local sheep breeds Gizaw *et al* (2007)

The birth weight (3.24 kg) of the crossbred Local rift valley sheep with Dorper Sirinka agricultural research center, BED site in eastern Amhara region was heavier than the birth weight (2.36 kg) of the indigenous sheep breeds in the area (Lakew *et al*, 2014) and birth weight (2.25 kg) of Dorper sheep lamb crosses in Wolayita and Siltie zones, southern Ethiopia (Ermias, 2014) but, lower than indigenous Bonga sheep breed reported 3.42 kg and 3.6 kg by Haile *et al* (2014) and Metsafe (2015) respectively. Which is also, greater than Dorper sheep cross of 2.25 kg in for zones of southern region (Belete, 2014) as shown in table 5? However, non-genetic factors (sex, birth season, environment and birth type) have effect on growth performance of sheep.

Growth performance of the indigenous sheep breed of Bonga male sheep had 48 kg body weight (Tibbo and Ginbar, 2004), So Bonga sheep can be mentioned as large sized breed and superior in its body weight. Bonga sheep breed is one of known sheep breeds with high growth rate or high weight gain and high eating quality (palatability) of meat under poor management specially poor feeding (grazing on natural pasture (Edea *et al*., 2012). The indigenous sheep average reproductive life span of Bonga ewes were 7.4 year and lambing interval was around 8.9 months for Bonga ewes. The average age at first lambing of 447 days and 399 days were reported for Bonga sheep. According to a twining rate of 36 % or litter size of 1.36 were obtained for Bonga sheep breed and the breeds showed relatively better multiple births under the existing feed shortages (Zewdu, 2008).

Table 2 Birth weight, three months' weight, six months' weight, pre-& post-ADG

Breed	Birth weight	3- month weight	PreADG	6-month weight	PostADG	Referenc e
Menz	2.3±0.04	9.3±0.6	80±7	13.7±0.3	40±3	Haile et al (2015)
Bonga	3.6±0.01	15.5±0.08	129.1±1.16	22.2±0.21	69.3±1.4	Metsafe (2014)
Horro	3.12±0.13	11.7±0.5	90±6	17.3±0.8	60±9	Haile et al (2014)
Tumelie (Local)	2.36±0.05	8.5±0.14	67.78±1.60	11.92±0.2	37.9±1.2	Lakew et al. (2014)
Tumelie (Local) X dorpe	3.24±0.04	14.9±0.21	129.9±2.23	20.43±0.3	64.6±1.7	Lakew et al. (2014)
Local	2.72	8.367	NA	NA	NA	Belete (2014)
Local X Dorper	2.25±1.7	17.3±0.9	NA	NA	NA	Belete (2014)

2.6. Reproductive Performances of sheep in Ethiopia

Good reproductive performance is a prerequisite for any successful genetic improvement and it determines production efficiency (Edea, 2008). Study suggests that differences exist in reproductive performance between indigenous sheep breeds and their variation allow for the 6 selection of suitable breeds for a given environment (Mukasa-Mugerwa and Lahlou-Kassi, 1995). Age at first parturition is a good indicator of early sexual maturity in ewes. It is an economically important trait as greater population turnover and more rapid genetic progress can be obtained when sheep produce their first progenies at an earlier rather than later age. Early maturing females are also known to have a relatively long and fruitful reproductive life (MukasaMugerwa and Lahlou-Kassi, 1995). Reproductive performance depends on various factors including age at first lambing, litter size, lambing interval and the life time productivity of the ewe, the last one being related to longevity (Sulieman *et al.,* 1990; cited by Amelmal, 2011).

Age at first service

Results revealed that age at first mating for both sexes is not fixed and sheep are left to nature to reproduce. According to Edea (2008) age at first service for Bonga breeds were 7.51 ± 2.14 and 9.3 ± 2.2 months for males and females, respectively and for Horro breeds were 7.1 ± 3 and 7.8 ± 2.4 months for males and females, respectively. The age at first service of 10 months reported by Edea (2008) seem to be lower than that reported in traditional systems for Menz sheep (Mukasa-Mugerwa and Lahlou-Kassi 1995). According to the Amelmal (2011) Age at sexual maturity (puberty) was 11.05±1.6, 10.88±1.7 and 9.5±1.4 months for males and 11.13±2.7, 10.8±1.9 and 9.5±1.4 months for females in Tocha, Mareka and Konta, respectively. The sexual maturity (puberty) in local sheep in Illu Abba Bora and Gumuz female sheep was reported to be 5-8 and 7.21 ± 1.75 months, respectively (Dhaba, 2013 and Solomon, 2007). The result of Tsedeke (2007) for age at puberty of local Alaba sheep were 6.7 and 6.9 months for male and female respectively. These were in close agreement with Edea (2008) and Dhaba (2013) but not with Amelmal (2011)

Age at first lambing

Total lifetime production (life time lamb crop) can be increased by encouraging first lambing at an early age (Amelmal, 2011). Age at first lambing is affected by breed, husbandry and management practices and has wide variation among African sheep. In most traditional systems, first lambing occurs at 450-540 days (15 – 18 months) when ewe weights are 80-85 percent of 7 mature size (Wilson, 1986) and Poor nutrition, disease or parasitic burdens and genotype limit early growth and which may delay early sexual maturity resulting in late age at first lambing. Year and season of birth in which the ewe lamb was born influence age at first lambing through their effect on feed supply and quality during different season (Mukasa-Mugerwa and LahlouKassi, 1995). The difference was attributed to the variation in availability and quality of feed resource across the difference seasons. Wilson and Murayi (1988) investigated those lambs born for twins had longer age at first lambing than their counterpart singles born lambs. The age at first lambing for some of indigenous sheep breeds / types has been summarized in table 3

Table 3 Age at first lambing of Ethiopian indigenous sheep breeds/types

Breed type	AFL (Month)	Source
Gumuz	13.67	Solomon (2007)
Menz	16.5	Gautsch (1987)
Menz	15.22	Abebe (1999)
Menz	17.06	Niftalem, 1990
Thin-tailed sheep	13.7	Mukasa-Mugerwa et al. (1986)
Washera	15.46	Mengiste, 2008
Blackhead Ogaden	23.56 ± 3.63	Fikrte, 2008
Bonga	14.9 ± 3.1	Edea, 2008
Horro	13.3 ± 1.7	Edea, 2008
Arsi-bale	12.7	Tsedeke, 2007
Adilo	14.6	Getahun, 2008
Local sheep in Adaa Liban	17.07	Samuel, 2005
Local sheep in Alaba	12.7	Tsedeke, 2007
Local sheep in Tocha	12.88±1.7	Amelmal, 2011
Local sheep in Mareka	14.75±1.8	Amelmal, 2011
Local sheep in Konta	14.77±1.8	Amelmal, 2011
Local sheep in Illu Abba Bora	10 – 13	Dhaba , 2013
Local sheep in Gamogofa Zone	12.4±0.28	Fsahatsion, 2013
Local sheep in Ada Barga and Ejere	14.29±0.08	Yadeta, 2015

Lambing interval

The interval between two successive parturitions is called lambing interval and one of the main components of reproductive performance which is affected by the breed (Wilson and Murayi, 1988), season (Abebe, 1999), year of lambing (Niftalem, 1990), season (Mengiste, 2008) parity of ewes, post-partum body weight and management practice (Gautsch, 1987), type of 8 management, nutrition, type of mating (Mukasa-Mugerwa and Lahlou-Kassi, 1995; Gbangboche et al., 2006). Management practices and restrictions on breeding also prolong the interval between lambing (Suleiman et al., 1990). In condition of good management adequate nutrition lambing interval of 8 months can be achieved facilitating three lambing from indigenous sheep in two years (Sani and Tiwari, 1974). According to Gizaw et al (2007) in association with the above thought Gumuz breed had an average lambing interval of 6.64 ±1.13 months and thus this breed can produce three lambing in two years even under the traditional management system but the work of (Belete, 2009) and Edea (2008) indicates that lambing interval of Bonga and Horro ewes were around 8 and 7.8 ± 2.4 month respectively. Among other breeds of sheep in Ethiopia that had short lambing interval were Menz (8 and half month) and Afar sheep (9 month) Tesfaye (2008). Genetic and environmental differences led to wide variation of LI among different sheep breeds. The lambing Interval for some of indigenous sheep breeds/types are summarized in Table 4.

Table 4 Lambing Interval of Ethiopian indigenous sheep breeds/types

Breed/Type	**LI (months)**	**Source**
Gumuz	6.64 ±1.13	Solomon (2007)
Menz	8.5	Tesfaye (2008)
Menz	12.7-13.6	Niftalem, 1990
Menz	7.6-9.1	Abebe (1999)
Local sheep around Dire Dawa	11.2-11.3	Aden (2003)
Afar sheep	9	Tesfaye (2008)
Washera	9.16	Mengiste, 2008
Blackhead Ogaden	10.46	Fikrte, 2008
Bonga	8	Belete, 2009
Bonga	8.9 ± 2.1	Edea, 2008
Horro	7.8 ± 2.4	Edea, 2008
Arsi-bale	12.7	Tsedeke, 2007
Local sheep in Gamogofa Zone	7.34±0.13	Fsahatsion, 2013
Local sheep in Gomma district	7.87-8.04	Belete, 2009
Local sheep in Alaba	9.19±0.08	Deribe, 2009
Local sheep in Tocha	11.62±3.8	Amelmal, 2011

Local sheep in Mareka	10.33±4	Amelmal, 2011
Local sheep in Konta	11.02±3.8	Amelmal, 2011
Local sheep in Illu Abba Bora	12-Sep	Dhaba , 2013
Local sheep in Ada Barga and Ejere	8.83±0.44	Yadeta, 2015

Litter size

Litter size is largely determined by ovulation rate but is also modified by fertilization rate and embryonic and fetal losses (Gatenby, 1986) and ovulation rate can be dependent on breed, level of nutrition, season and age (Haresign, 1985). Significantly age of the dam can have effect on number of lambs per lambing. Until the age of five years or fourth parity liter size increases then it decreased slightly above this age (Wilson *et al*., 1984). Some studies have shown that there is increased litter size with an increase in parity and higher litter size at fifth parity (Berhanu and Aynalem, 2009); peak prolificacy is generally achieved between 4 and 8 years of age (Notter, 2000).

Level of nutrition has effect on litter size in that, poor nutrition during service period lead to reduced ovulation rates and increase embryonic mortality and consequently decrease litter size (Gautsch, 1987). The percentage of ewes having twins in tropical sheep breeds, generally range between 0 and 50% (Gatenby, 1986) and while under traditional management conditions the percentage tends to fall below 10%. According to Edea (2008) a twining rate of 39.9 % or litter size of 1.40 and 36 % or litter size of 1.36 were obtained for Bonga and Horro sheep breeds, respectively, whereas low twining rate was reported for both Menz1.13 (Mukasa-Mugerwa *et al.* 2002) and Afar sheep 1.03 (Wilson, 1982). Litter size is influenced by genotype, parity, season, and ewe body weight at mating (Mukasa-Mugarwa and Lahlou-Kassi, 1995) and management system is also a major source of variation in litter size as reported by Mekuriaw *et al.* (2013). Some representative litter size of indigenous sheep of Ethiopia Has been summarized in Table 5

Table 5 Litter size of Ethiopian indigenous sheep breeds/types

Breed/Type	**Litter size**	**Source**
Gumuz	1.17	Solomon (2007)
Menz	1.08	Gautsch (1987)

Menz	1.14	Agyemang et al. (1985)
Menz	1.13	Mukasa-Mugerwa et al. (2002)
Menz	1.02	Niftalem (1990)
Thin tailed	1.3	Mukasa-Mugerwa and Teklye-1988
Afar sheep	1.03	Wilson (1982)
Washera	1.11	Mengiste, 2008
Blackhead Somali	1.04	Galal (1983)
Bonga	1.4	Edea, 2008
Horro	1.36	Edea, 2008
Horro	1.34	Abegaz et al. (2002) &Solomon and Gemeda (2000)
Adilo sheep	1.42	Getahun (2008)
Local sheep in Gamogofa zone	1.3±0.04	Fsahatsion, 2013
Local sheep in Alaba 1.	51+0.04	Deribe, 2009
Local sheep in Ada Barga and Ejere	1.19±0.42	Yadeta, 2015

2.7. Major Constraints of Sheep Production

Identification of constraints which can put obstacle for sheep production and genetic improvement program should be the prior step before trying for its implementation (Baker and Gray, 2004). Disease, limited market access and information, feed shortage/frequent drought/ and water shortage are among the main sheep production constraints in the country. Among these constraints Disease, feed shortage, predators and labor shortage will be the most pertinent constraints for sheep production in Horro and Adiyo Kaka (on Bonga sheep) and had significant influence on sheep productivity (Zewdu, 2008).

Feed shortage

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. Feed shortage problem is similar throughout the country, being serious in high human population areas where land size is diminishing due to intensive crop cultivation and soil degradation. The better use of available feeds and the use of non-conventional feeds for supplementation are growing (Belete, 2009) to alleviate the problem. Seasonal feed shortages, both in quality and quantity, and the associated reduction in livestock productivity in different parts of the country (Tessema *et al.*, 2003). Water shortages is a common problem for both human and livestock consumption in most rift valley parts of the country. It has been reported to be a limiting factor for animal productivity in most mid and lowland areas of Southern region.

Water shortage

Water scarcity is a growing problem in arid and semi-arid regions with global warming and changing patterns of rainfall, which limit water resources and affect feed quality and quantity in addition to increasing heat stress. This challenging situation causes a wide array of physiological responses in sheep with a negative impact on production, immunity and welfare (Barbour *et a.*, 2005; Jaber *et al*., 2011). In south-eastern part of the country there is also critical shortage of water; however, there are breeds adapted to lowland agro ecologies through their physiological adaptation mechanisms (Belete, 2009). Restrictions of water may result in poor nutrition and digestion, because there is a relationship that exists between water intake and consumption of roughages, particularly during dry season. Long distance travel of small and large ruminants in searching of water was another problem (Mesay *et al.*, 2013).

Physiological change in response to water stress

Feed Intake and Body Weight

Feed consumption is highly related to water intake (Silanikove, 1992). An adequate level of water intake is necessary for proper digestive function (Hadjigeorgiou *et al.,* 2000). In contrast, Kay (1997) states that drinking water is not needed for swallowing and moistening feed, since water can be circulated from the blood to maintain high salivation; it is, however, needed to replace the inevitable water loss by excretion and evaporation. When Awassi sheep experienced a 3- to 4-d intermittent watering regimen voluntary feed intake was reduced to approximately 60% of controls (Jaber *et al*., 2004; Hamadeh *et al*., 2006). The effect of this reduction in feed intake caused by dehydration is dependent on the type of feed that is available for the animals. Therefore, the negative effect of water restriction is more pronounced when sheep are kept on low- versus high-quality forage (Morand-Fehr 2005). Because of this relationship, it is often difficult to differentiate the effects of water r scarcity, per se, from those due to low feed intake. The direct consequence of water scarcity and the associated decrease in dietary intake is a reduction in body weight. Part of the reduction in weight is due to body water loss, while the other part is caused by the consequent mobilization of fat (and possibly muscle) used for energy metabolism to compensate the decrease in dietary intake (Jaber *et al*., 2004) and rumen fill is also reduced due to the decrease in feed intake. Furthermore, it was observed that water scarcity leads to more weight loss than feed scarcity alone (Ahmed Muna and El Shafei Ammar 2001; Chedid 2009; Karnib 2009).

Disease problem

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, mis-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 Gumez sheep in North Western Lowland of Amhara Region. Diseases and parasites are the major constraints to improved small ruminant production and productivity in most production systems/agro-ecological zones. Hence, health problems cause high mortality and reduced reproductive and growth performances resulting in reduced output per animal and flock off-take rates (Solomon *et al.*, 2010). The high prevalence of diseases and parasites causes high mortality amongst kids and lambs, diminishing the benefits of their high reproductive performance (Girma *et al.* 2013).

Market access and information

Ethiopia's huge livestock population, proximity to the export markets and other conducive conditions gave the country a comparative advantage in livestock trade (Belachew and Jemberu, 2003). There are several livestock trading constraints in Ethiopia. They also reported that inadequate market infrastructure, absence of market information system, absence of market oriented livestock production system, inadequate number of exporting firms with low level of capacities, inadequate knowledge of international trade, low level of quarantine facilities and procedures, prevalence of various diseases, repeated bans, excessive cross-border illegal trade and stiff competition are the major challenges that hinder the smooth livestock trade in Ethiopia.

Due to lack of market information, the available livestock markets in the country are loosely integrated. Lack of market information may also increase the marketing cost. The highland areas in the country are livestock deficit due to higher population density (Belachew and Jemberu, 2003). The Ethiopian cattle, sheep and goat are the preferred livestock types in the Middle East Countries. This is due to the meat produced from these animals is organic in nature and the meat is of good taste (Belachew and Jemberu, 2003). The major problems in traditional management system is that the system is not market oriented, underdeveloped marketing and infrastructure system, and poor financial facility (Azage *et al*., 2006, Berhanu *et al*., 2006). Long market chain is an important barrier for producers and inhibits them from direct benefiting through sell of their animals without involvement of brokers (Endrias and Tsedeke, 2006).

Poor marketing information and problems of credit facilities (Berhanu *et al*., 2006; Endrias and Tsedeke, 2006) reduced the benefit gained by the smallholders. Inadequate infrastructure like road accessibility and marketing facilities are also contributing for the reduced benefit made from the sale of animals by the producers (Tibbo, 2006). Reports indicate that because of lack of standardized marketing systems with transparent market price information farmers cannot receive their sufficient return from sheep production as they gain according to trader prices and also lack of access to domestic and export 12 markets hold back them from obtaining incentive benefits. As the result of poor quality skins farmers received low prices from skin marketing. The extension system provides little or no technical support to farmers regarding production, preservation and marketing of skin (Tsedeke *et al.*, 2011). To boost the enormous contribution of the livestock sector to the national economy, improving animal productivity and establishing standardized marketing systems are very important.

2.8. Major Feed Resources for Sheep in Ethiopia

Major feed resources in Ethiopia include natural pasture, crop residues, collected fodders, agro-industrial byproducts, multipurpose trees and shrubs, stubble grazing, cultivated forage and conserved forages (Berhanu *et al*., 2009; Adugna *et al*., 2012; Dawit *et al*., 6 2013; Geleti *et al*., 2014; Derbe, 2015). The contribution of these resources varies depending on agro ecology, season and farming system. Accordingly, the contribution of major feed resources is indicated as grazing (56.23%), crop residue (30.6%), hay (7.44%), agro-industrial by products (1.21%), concentrate/other feeds (4.76%), and improved fodder/pasture (0.3%) (CSA, 2015). The fibrous agricultural residues contributes a major part of livestock feed especially in densely populated areas where land is prioritized for crop cultivation. The same authors reported that crop residues contribute about 30.6%), of the total feed supply in Ethiopia. Similarly, the naturally occurring grasses, legumes, herbs, shrubs and tree foliage are used as animal feed (Adugna, 2008). The availability of feed resources in the highlands of Ethiopia depends on the mode and intensity of crop production as well as population Pressure (Seyoum *et al.*, 2001).

Crop residue include cereal and legume residue like wheat straw, barley straw, teff straw Faba bean straw, field pea straw, and maize Stover. Currently, conversion of grazing land to crop land is increasing from time to time resulting in more biomass of crop residues which contribute about 50% (that grow up to 80%) of ruminant feeds during the dry season of the year and are becoming the most important feed resource covering significant amount of livestock feed in the highland of Ethiopia especially during dry season (Adugna, 2007). But, quality and digestibility is very low with less than 50% digestibility, high fiber content more than 70% NDF and low crude protein < 5% CP (Gizachew and Smit, 2005).Crop residues represent a large proportion of feed resources in mixed crop-livestock systems (Birhan and Adugna, 2014). Reliance on crop residues for animal feed is increasing from time to time as more land is cropped to feed the fast growing human population. Feed is the single largest cost associated with raising small ruminants, typically accounting for 60-65% of the total production cost of sheep (Lemus and Brown, 2008). In most production system of Ethiopia, extensive free grazing in communal lands and stubble grazing are the most common practices of sheep feeding (Solomon *et al.*, 2010), whereas limited grazing areas and cultivation of pasture lands causes loss of palatable forage species due to high grazing pressure.

For that matter one way of improving the poor quality of the feed resources is by supplementation with other high quality feeds. Concentrate feeds (agro-industrial by products) have a good potential of supplementation value but in most developing countries like Ethiopia concentrates are expensive, that are in short supply and may not be easily accessible to smallholder farmers (Tolera *et al.,* 2000). Hence, there is a need to search for supplement sources that could be applied at smallholder farmer levels with affordable costs. The use of leaves' of some trees and shrubs as substitution to concentrate supplementation may be one of the alternative solutions to improve the nutritional problems. (Benavides, 2000; Doran *et al.*, 2007) Descriptions of some of the most common feed resources are listed below

Table 6. Coverage in proportion of animal feed resources in Ethiopia.

S/N	**Type of feed resources**	**Coverage in percent**
1	Natural grazing	56.23
2	Crop Residue	30.6
3	Hay	7.44
4	Agro-industrial by products	1.21
5	Other feeds (concentrates)	4.76
6	Improved forage	0.3

(Source: CSA, 2015)

Natural Pasture

Natural pastures are naturally occurring grasses, legumes, herbs, trees and shrubs that are used as animal feed (Alemayehu; 2005). They comprise the largest feed resources, but estimates of the contribution of feed resource vary greatly. The 75- 80% of the estimated livestock feed in Ethiopia is obtained from natural pasture. Grazing land occurs on permanent grazing areas follow land and on farm land following harvest, both follow land and crop stable provide. The total area grazing and browsing in the country is 62,280 million hectares. Out of this 12% is in the farming area and the rest is around pastoral area. Hay is the most commonly stored fodder on the farmer and is one oldest system used to level out the feed supply through out of the year. It is generally the most covenant process of forage. The aim of making hay is to conserve the maximum of dry matter and nutrient at the lowest cost. Hay should be made at the optimum data to maximize yield and still have the percentage of digestible dry matter necessary to meet the nutrient need of sheep (Behnke, and Scoones, 1993).

Improved Forage as Sheep Feed

Over the past three decades a number of introduced forages are tested on-station in different agro-ecological zones, and considerable efforts were made to test the adaptability of different species of pasture and forage crops under varying agro-ecological situation (Alemayehu, 1997). As a result, quite a number of useful forages have been select for different zones. Improved pasture and forages have been cultivate and used in government ranches, state farms, farmer's demonstration plots and dairy and fattening areas. Forage crops are commonly grown for feeding animals with oats and vetch mixtures, fodder beet, elephant grass mixed with dismodium species. More recently, about 32 government and non-governmental organizations in the Ethiopian highlands are involved in promoting multipurpose fodder trees in an integrated rural development program (Mengstu, 2008). These fodder tree species were extensively distributed in most parts of the country because of their adaptation for a wide range of soils, moisture regimens and ease for establishment and rapid growth rate. There are a number of improved forage varieties of both grass and legume species appropriate for various agro ecologies (ESGPIP, 2008). Among these, desho grass, oat and vetch forage species are widely known and distributed.

Agro-Industrial By-Products

Agro-industrial by-products are the by-products of the primary processing of crops, including bran and related by-products of flourmills, oilseed cakes from small and large-scale oil processing plants and by-products of the sugar factory such as molasses. Agro-industrial byproducts such as oilseed cakes, wheat bran and molasses are important sources of relatively high quality feeds mostly used in urban and peri-urban livestock production (Gizaw *et al.*, 2017). Agro-industrial by-products are also other potential feed resources that can be used as supplements to crop residues and poor quality natural pasture based diets. Supplementation with agro-industrial by-products has been used in many developed Countries for improving locally available nutrients of feed resources. Since feed cost accounts more to total cost in any livestock production, it is of paramount importance to incorporate locally available byproducts and raw materials into the feed of ruminant animals. The agro-industrial byproducts contain more phosphorus than calcium, a condition that is very likely to cause calcium deficiency (Tolera, 2008). Concentrate mix is formulated to supplement a basal diet and thus it is not a balanced feed (Lukuyu *et al*., 2012).

These by-products such as oilseed cakes, wheat bran and molasses are important components of the concentrate feeds. Most tropical forages are low in nutrient content and cannot supply enough nutrients for optimum animal performance. Agro-industrial by-product along with grazing and scavenge are important source of feed ingredients for sheep production and they can be grouped according to their nutrient contents namely: energy rich supplements (< 18% CF), and miscellaneous by-products mostly supply minerals as well as energy and protein such as by-products from brewery, fruit and vegetable industries (Ranjhan, 2001). Agro-industrial byproducts such as noug seed cake, linseed cake, barley and wheat bran are important source of protein and energy for supplementing basal diet (Getahun, 1993).

Crop Residues

Crop residues are the fibrous by-products obtained from the cultivation of cereals, pulses, oil plants, roots and tubers; and can be used as an important feed resource for ruminant production particularly in subsistent type of farming. Crop residues also represent the largest agricultural harvest and incorporate more than half of the world's agricultural biomass (Lopez *et al.*, 2005). The most commonly used crop residues for animal feeding in Ethiopia are obtained after grain harvest of barley, teff, wheat, maize, sorghum, lentil, faba bean, field pea, chickpea, haricot bean, etc (Endale, 2015).

Non-Conventional Feed Resources

Non-conventional feed resources generally refer to all those feeds that have not been traditionally used for feeding livestock and are not commercially used in the production of livestock feeds (Amata, 2014). Nonconventional feeds such as vegetable refusals, sugar cane leaves, Enset leaves used as animal feed (Endale, 2015). As reported by Teklu *et al*. (2011), non-conventional feeds like left over of Enjera and Porridge were supplemented to livestock. Non-conventional feeds could partly fill the gap in the livestock feed supply, decrease competition for food between humans and animals, reduce feed cost and contribute to self-sufficiency in nutrients from locally available feed sources (Nitis, 1999). Non-conventional feeds one vary according to feed practice of animals reared by the society and others, e.g. such as vegetable refusals are non-conventional. Related to this anything used as livestock feed in the area additionally were added into the production of the feed resources to estimate its dry matter production (Alemayehu, 2003). The non-conventional feed resources generally refer to all those feeds that have not been traditionally used in animal feeding and or are not normally used in commercially produced rations for livestock feeds that includes, oil palm by-products, single- cell proteins, feed materials of plant and animal origin (e.g. poultry excreta), and poor quality cellulosic roughages from farm residues such as stubbles, haulms and vines (Devndra ; 1988).

Browse Forage Species as Sheep Feed

The vital need of the farmers for high quality feed for ruminants in developing countries can be achievable through intensive utilization of multipurpose trees and shrubs as they have better nutritional quality nearly equal to that of grain-based concentrates (FAO, 2002). Browse tree and shrub fruits from successfully constructed enclosures could be used as important dry season protein supplements thereby increasing the economic benefits of enclosures (Yayneshet *et al.*, 2008). Recognition of the potential of tree foliage to produce considerable amounts of high protein biomass has led to the development of animal farming system that integrate the use of tree foliages with local bulky feed resources (Leng, 1997). Moreover, browse species provide fodder for ruminants in many parts of the globe because most of them maintain their greenness and nutritive value throughout the dry season when grasses dry up and deteriorate both in quality as well in quantity (Bruh, 2008).

The role of fodder trees in ruminant diets can be seen as a source of post ruminant protein for digestion, nitrogen and mineral supplement to improve fermentative digestion and microbial growth effectiveness in the rumen on poor quality forage and a total feed supplying almost all the biomass and other needed nutrients to support high levels of animal products. Foliages of browse species are generally rich in CP and minerals and they are used as a dry season supplement to poor quality pasture and fibrous crop residue. In general, legumes are higher in Ca, K, Mg, Cu, Zn, Fe and Co than grass. It is also indicated that at least 75% of the shrubs and trees of Africa serve as browse plants and many of them are leguminous (Zelealem, 2004).

2.9. Nutrient Requirement of Sheep

The nutrient need of sheep may be classified as energy, protein, minerals, vitamins and water. The nutrient requirements are the values considered necessary for maintenance, production reproduction and prevention of any signs of nutritional deficiency (Assefa, 2007 and Gatenby, 2002). The CP requirements of growing and fattening sheep with 20kg body weight are 85 and 127 g/day, respectively (Ranjhan, 1997), (Cheeke ,1999) indicated that early-weaned lambs with 10 and 20 kg body weight have CP requirements of 127 g/day and 167 g/day with 26.2% and 16.7% CP on DM basis, respectively. On the other side, the sheep with live weight of 20 and 30kg and average daily gain of 50 g/day requires protein and energy requirement of 30 to 40 and 45 to 55 CP g / day and metabolizable energy ranging from 4.1 to 5.1 MJ/day and 5.6 to7 MJ/day respectively (ARC, 1980).

The energy need of sheep is largely met through the consumption and digestion of roughage-pasture and hay. The energy requirement of sheep is affected by BW and extent of growth (gain) and protein content of the ration (Poppi, 1995). Growing sheep need protein, as do other classes of animals, for maintenance and growth. Additionally, sheep need protein for the production of wool (a protein product). The protein requirement of growing sheep is affected by growth, weight for age, body condition, rate of gain and protein to energy ratio (Enisminger, 2002). A protein deficiency is characterized by reduced appetite, lower feed intake, and poor feed efficiency. In turn, this makes for poor growth, poor muscular development, loss of weight, reduced reproductive efficiency and reduced wool production. Under extreme conditions, there are digestive disturbances, nutritional anemia and edema. Minerals are divided into two groups, macro-minerals, those required at 0.1% or more in the diet, and micro-minerals, those required at very small amounts part per million levels. There are seven major minerals Calcium (Ca,), phosphorus (P), magnesium (Mg), potassium (K), sodium (Na), and sulfur (S). Each of these minerals has been found to be deficient for grazing livestock under specific conditions, with the exception of Cl (McDonald *et al*., 2011).

Table 7 Energy and protein requirement of growing male sheep

Sheep class	nutrients	Daily weight gain (g/day				DM
		0	50	100	150	
Female	ME (MJ)	3.4	4.5	5.8	6.5	0.56
	MP (g)	21	45	58	71	
Castrated Male	ME (MJ)	3.4	4.5	5.7	6.2	0.56
	Mp (g)	21	47	61	76	
Growing Male sheep	ME (MJ)	3.9	4.8	5.8	6.4	0.56
	Mp (g)	21	47	61	76	

Source: McDonald, 2010).

2.10. Supplementation

Low quality forages when supplemented with good quality grasses, legumes or concentrate feeds significantly improve feed intake and performance. During the dry season where forages are scarce and low quality, supplementation of the basal diet with good quality forage or concentrates helps to reduce the problem of low palatability and intake. Different studies have reported high production when poor quality forages are fed with different levels of concentrates and or supplemented with multipurpose trees. Generally, supplement is a semi-concentrated source of one or more nutrients used to improve the nutritional value of a basal feed, e.g., protein supplement, mineral supplement. In order to improve production levels, energy inputs such as concentrate feeds have to be considered essential for any sheep enterprise, even for those based on dual purpose systems, since reduced intake of energy by animals consuming low quality forages is the principal cause of low production (Getu, 2008). In generally concentrate supplementation to improve the intakes of low quality forages as well as improving yield (Bwire and Wiktorsson, 2003).

Effect of Supplementation on Growth Performance

Small ruminants will adapt their growth to the feed supply. Under unfavorable conditions of drought and scant feed resources small and stunted sheep and goats are better adapted than larger ones and have a survival advantage as the low body mass is important to minimize feed and water requirements (Silanikove, 2000). Over time, some researchers believe that this result is under natural selection for the small sized animal's common in desert and tropical environments (Wiegand, 1994). Similarly, it has been reported from South Africa that average daily intake of dry matter is 1.14 kg, 0.93 kg and 1.27 per 100 kg live weight for sheep of the Merino, black head Persian and Dropper breeds, respectively. It would appear from this data that feed consumption on the tropical breeds is somewhat lower than that of temperate type of sheep. However, the investigation of (Demiruren *et al.*, 1971) suggested that Iranian sheep would respond quit well to improved nutritional levels.

The crudest, but the most common measure of growth in farm animals is change in body weight. It is crude because change in body weight includes change in weight of intestinal contents, which in ruminants may often account for 20% of body weight gain (McDonald *et al.,* 2002). A slow growth rate has been limiting profitability of indigenous sheep breeds (Muksa *et al.*, 1995). There is paucity of information on genetic variability for growth in indigenous sheep breeds of Ethiopia, but in agreement with the findings by (Shapiro *et al*., 1994), who also studied Ethiopian highland sheep, supplementation improves growth performance and profitability. In general, it is not profitable to allow animals to deposit more fat than is needed for obtaining desired meat quality. To attain this, it would be important to have a good knowledge of the total quantities of protein and energy produced, so that diets can be fed which suit the requirements of the animal (Hadjipanyiotou, 1991).

Effect of Supplementation on Feed Intake and Digestibility

Feed intake of sheep can be affected by many factors. For instance, as ruminants of a given species grow, their feed intake will be approximately proportional to their metabolic body weight (W 0.75) (Rook, 1983). Gut volume was also found to be the most important factor in limiting the voluntary consumption or intake of roughage diets by ruminants. Moreover, the main dietary factor that control voluntary intake of feeds accounts for 50-75% of the variation in ruminant performance

(Waldo and Jorgensen, 1981). The most limiting factor for intake that can be observed in roughage is the total cell content and this account for the rumen fill which highly correlate with both the rumination and chewing time among a wide range of forages. Intake is more closely related to the rate of digestion in the rumen of ruminants than to the total digestibility of roughages (Meissner *et al.,* 1999). Rate of digestion is slower for less digestible feeds. As a rule of thumb, the daily DM intake of sheep feed on a coarse diet varies from about 1.5% of body weight for poor-quality feed to about 3% for good-quality feed (Gatenby, 1991). Thus; the amount of nutrient that sheep obtain from different feeds varies accordingly. However, (Van Soest, 1994) reported that DM intake is negatively correlated with rumen retention time and positively correlated with rumen volume and feed digestibility. Digestibility is much reduced when a ration has too little CP in proportion to the amounts of soluble carbohydrates and during the dry season pasture protein levels fall below 6-7% (Silanikove, 2002). Feed that is low in protein and high in fiber content results in low digestibility and voluntary feed intake (Tolera *et al.,* 2000).

Feeding effect on biochemical and seminal parameters of ram.

Nutrition plays a vital role in the reproductive performance of sheep, since it affects the hypothalamic-pituitary-gonadal axis. There is a forceful link between nutrition and reproduction in male animals, in which underfeeding negatively affects hormonal status and reproductive function because of the severe negative energy balance. This in turn results in delayed puberty, low testicular development, and reduced semen production as a response to disorders in gonadotropin releasing hormone (GnRH), luteinizing hormone (LH), and follicle-stimulating hormone (FSH) synthesis (Zabuli *et al*., 2009). However, male reproductive performance and sperm quality are basically sustained by the proper functioning of the endocrine system, which leads and stimulates androgen biosynthesis from cholesterol, whose concentration in blood may establish testosterone secretion modulated by steroid genic acute regulatory protein and trans locator protein. Within the cells, this protein transfers cholesterol from the outer to the inner mitochondrial membrane, being the main step for testosterone biosynthesis. Disorders in StAR function are related to testicular dysfunction and underfeeding condition (Awad *et al*., 2015).

Cholesterol is synthetized as response to the energy metabolism in the liver, using glucose and amino acids as key precursors. Nutritional status and composition of dietary fatty acids seems to be a key condition to the levels of cholesterol in the blood. Moreover, dietary polyunsaturated fatty acids (PUFA) enhance energy density and optimize reproductive parameters in male sheep. However, high levels of cholesterol in animals and higher accumulation in Sertoli cells may thereby reduce normal and physiological testicular function, decrease sperm concentration, impair sperm motility, and undervalue the male fertility (Fair *et al*., 2014; Morgan *et al*., 2014).

The source of fatty acids suggested is the byproduct from agro-industrial processing, in which palm kernel cake stands out due the contents of fatty acids such as lauric, meristic, oleic, palmitic, stearic, and linoleic (Oliveira *et al*., 2015b) and their inclusion in the diet may increase GnRH pulses, resulting in reproductive performance. The n-3 and n-6 fatty acids are the main polyunsatured fatty acids acting on reproductive axis to promote testicular development and production of hormones Moreover, supplemental feed can be a major cost incurred to maintain husbandry. Then, alternative feeds may provide nutrients needed by animals to enhance their reproduction at a lower cost than traditional feeds. Therefore, the objective of this study was to assess the effects of palm kernel cake on biochemical and semen parameters of sheep (Sartoni and Guardieiro, 2010).

It is important to assess the potential fertility of ram before it is intended to use for semen production and artificial insemination (AI). This is usually performed by evaluating the semen quality. Evaluation of semen such as semen volume, sperm concentration, sperm motility and morphology, allows the detection and elimination of clear cut cases of male infertility or subfertility (Verstegen *et al.,* 2002; Madhuri *et al*., 2012). Semen volume and color are the indicators of sperm concentrations. Color can be an evidence of injury or infections in the tract. Sperm motility, viability and plasma membrane integrity are the strong indicator of sperm function (Pena *et al*., 2005).

3. MATERIALS AND METHODS

3.1. Geographical Description of the Study Area

The study was conducted in Boka Kebele Adiyo (Menjiwo) woreda Kaffa Zone.which is one of the 14 zones of the Southern nation nationality and people’s regional government. It is located in south western part of Ethiopia and it has 12 rural districts (woreda) and five city administration which are /Bonga, Wacha, Awurada, Deka and Shishinda/. It is 473 k/m away from Addis Ababa

Ethiopia and 724 k/m from SNNPR center Hawasa. Kaffa is a place of great diverse potential tourist attraction site. These can be expressed through ancient churches mosques and natural forests, different unique wild life, and others, which is 500-3500 above sea level. Kaffa is drained towards Omo-Gibe and Baro- Akobo basin. Inhabitants: 1.1million. Geographical location: 06024-8003'N of latitude and 35048-36078'E of longitude. Total land area: 10602.7sq/k/m. Annual average Temperature**:** 14 to 17^{o}C. Annual average rain fall: 1600-2200mm. Altitude variation: stretched from 500-3500 meter above sea level. Ethnic Group: three indigenous ethnic groups of people live in kaffa. Those are Kaffecho, Chara and Na'o. Other nation's nationalities also co-exist in peace with indigenous ethnic groups. **Language**: native spoken language in Kaffa is Kafi noonoo, Naa'o and Chara. However, most of the people speak Amharic, to some extent English is spoken & understood.

Whereas the specific study area Adiyo (Menjiyo) is bordered on the north by the Gojeb River which separates it from the Oromia Region and on the east by the Konta special woreda. Agro-ecologically Adiyo district consists of 20.45% dega (highland >2300 m.a.s.l), 61.53% Woinadega (intermediate highland 1500-2300 m.a.s.l) and 18.02% (lowland < 1500 m.a.s.l). The area is known for the mixed crop-livestock farming system is the dominant production system in this woreda. Adiyo Kaka (Menjiwo) woreda is located in 36 o 47'E longitude and 7 o 26 'N latitude with altitude ranging from 500 to 3500 meters. For Adiyo Kaka the maximum and minimum annual temperature is 36 ^{o}C and 38^{o}C, respectively (SUDCA, 2007). It has a bimodal pattern of rainfall which are March to May; July to mid-October (Wish-wash Meteorological Station, 2013). The total domestic livestock population in Adiyo (Menjiwo) woreda is estimated to be about 1,519,545 of which cattle estimated 489,218 (32.2%) sheep are estimated about 297,958 (19.6%) Goat estimated about 194,853 (12.82%) Poultry estimated 490,584 (32.28%) and equine 46,926 (3.1%) (KZDLF, 2019).

3.2. Peasant association and farmers selection

From that of district one Kebele was purposively selected based on the availability of feed trial (Botheriocline schimperi, Erythrina Brucie and Brugmansia Suaveolensbercht) and also sufficient of ram population with fifteen both in age and live weight, as well as volunteer farmers and easy to timely follow-up, will be considered. The volunteer participant farmers (purposely selected ram owners) from the selected peasant association will be households of five villages that participated in the selection. The breeding ram will select from the flock based on their body weight and age cluster and allocate to different blocks with an average of 1 ram from individual farmers. The study will be conducted by using 50 individual households and 50 rams. Awareness creation training were given to farmers on the aim and purpose of overall the research protocols.

3.2 Sampling Technique

From that of total 50 Farmers (households) 50 ram will be selected and considered purposively for the household survey in the current study based on data. Sampling frame will be established in a purposive sampling procedure selected based on age (parity) and body weight.

3.3. Experimental Animals and Their Management system will be

In this experiment that of purposively selected 50 rams age was determined by the first birth records. And also, during the period, all ram was tagged for identification purpose during vaccination, experiment and for accurate data collection as well as for proper randomization. Then after ram will be quarantined for 90 days under in each farmer houses. But every feeding and management system will be controlled by researcher. The experimental sheep will be cheeked for health status, sprayed with acaricides (diazzinole) for external parasites and given unthihelmentic tablets (albendazol) and injections of Ivermectin solution for both internal and external parasite. As well as vaccinate against common infectious diseases in the area based on the prescription of the veterinarian to resist for new outbreak occurrence. All sheep were confined in individual pens at farmer houses and identified with neck collar and adapted to treatment feeds for 90 days which will provide feeding and watering trough for each individual.

3.4. Experimental Feeds Preparation and Feeding Management

Experimental feeds identified were composed of Botheriocline schimperi, Erythina Brucie and Brugmansia Suaveolensbercht and purchased concentrate; of that Experimental plant was harvested from both farmers with labor costing by researcher. That plant leaves were harvested manually with leaf picking method and immediately, speeded in thinly on plastic sheet under shed in well-ventilated room for drying with turning of 10 - 12 times/day. Finally, mechanical chopping will do in to pieces size approximately to 2-3cm length for more palatability, acceptability and digestibility by the ram. Then feeding will start with 0 kg as control, 500g of concentrate, 1kg of Erythina Brucie (Korch), 1kg of Botheriocline schimperi, 1kg of Brugmansia Suaveolensbercht will provid for experimental animals according to randomized chance. Experimental feeds for each treatment will offered in two equal portions twice a day at 8:00 AM and 6:00 PM. All groups will access to drinking water twice a day.

3.5. Experimental Design and Treatments

A randomized completely blocks design (RCBD) consisting of one control and four supplemental treatment diets with ten ram within each treatment will be employed. Experimental animals will be blocked into five based on initial body weight measured at the beginning of the adaptation period and will be randomly assigned to one of five treatment diets including control group. The trial will be conducted for 90 days exclusive of 21 days of adaptation period. All the experimental ram will have ad libitum to access grass as basal diet and water. The treatment will consist of T1-grass ad libtum (control); T2-grass ad libtum +1kg dried of Erythina Brucie leaf; T3- grass ad libtum +1kg of (Botheriocline schimperi) leaf ,T4- grass ad libtum +1kg of Brugmansia Suaveolensberch; T5- grass ad libtum +500g concentrate. Generally sheep need protein, as other classes of animals, for maintenance, growth, reproduction and prevention of any signs of nutritional deficiency (Awet, 2007 and Gatenby, 2002). Dietary nutrients, especially energy and protein are the major factors affecting productivity of sheep, the low energy density at which the sheep does not lose weight is between 8 and 10 MJ/kg DM and the minimum protein level required for maintenance is about 8% in the DM (Gatenby, 2002)., Erythina Brucie and

Table 8 Experimental treatment

Treatment	Basal diet grass	Erythina Brucie	Botheriocline schimperi	Brugmansia Suaveolensberch	Concentrate feed	No of animals
T1	ad libtum	0	0	0	0	10
T2	ad libtum	1000	0	0	0	10

T3	ad libtum	0	1000	0	0	10
T4	ad libtum	0	0	1000	0	10
T5	ad libtum	0	0	0	500g	10

3.7 Parameters

Body Weight Measurements

The body weight measurement was taken fortnightly for each ram for the whole experimental period after overnight fasting. The initial body weight of experimental rams were measured at the end of the adaptation period while the final body weight was measured at the end of the feeding trial. The average daily gain (ADG) will be calculated by subtracting the initial body weight from the final body weight and then dividing it by the number of feeding days.

Semen Collection and Characteristics Testing.

In this section semen, collection method was performed by using an Artificial Vagina. The semen collection will be undertaken for 3 months and samples will be taken every week and four times a month. The parameters will assess the quality of the semen per ejaculation volume, color of semen, mass motility of semen, Individual Motility, the concentration of spermatozoa, live spermatozoa, normal and abnormal spermatozoa, PH of the semen, sperm tail, and mid-piece morphology, and Sperm head morphology.

Testicular Parameters.

Testicular Diameter, length, scrotum circumference and width and volume

- Body weight
- Semen Characteristics
- Testicular parameter measurement
- Cost-benefit analysis

3.6. Data analysis

Data **analysis** will be analyzed using ANOVA procedure of SAS 9.3. Data was separated by least significant difference (LSD) .Mean differences will be considered significant when $P \leq 0.05$, whereas $0.05<P<0.10$ was considered to show a statistical tendency for difference. The appropriate model will be used for data analysis as follows:

$$Y_{ij} = \mu + T_i + B_j + e_{ij}$$

Where:

Y_{ij} = response variable

μ = overall mean

T_i = treatment (feed) effect

B_j= block (birth type and body condition score) effect

eij= random error (the residual error)

4. RESULT AND DISCUSSION

4.1 Chemical Composition of experimental feed

The chemical composition of experimental feeds presented in table 2. The CP content of the grass hay used in the present study was very low, below the maintenance requirement of the sheep (Van Soest 1994). This implies that the desho grass hay is of poor-quality revealing necessity of supplementary feeding for animals feeding. Low CP content for grass hay comparable to that noted in this study has been reported previously (Mulu 2005; Bruk 2008).

The nutrient content of the *Erythrina brucei* was within the range of CP (20.7–28.5 % DM) reported for nine ILCA accessions (Larbi et al. 1996) also comparable with CP in concentrate mix which are used as protein supplements in Ethiopia (Bediye et al. 2007). However, the CP content of E. brucei was higher than those reported for Erythrina abyssinica (Larbi et al. 1993; Kaitho et al. 1998) and Erythrina Burana (Kaitho et al. 1998). The variation in CP content of the leaves might be due to the age of the tree, stage of harvest, stage of leaf growth, the season of harvest, soil fertility, species, and variety of Erythrina as reported by Maasdrop et al. (1999) for different forage types.

Table 9 Chemical composition of feed used in the experiments

Feeds	Chemical composition and IVODM (DM%) of experimental feeds							
	DM	OM	CP	NDF	ADF	ADL	ME	IVODM
PGH	92.5	85.0	7.04	69.2	44.9	5.4	5.9	50.7
EB	93.3	87.3	20.5	35.9	28.0	8.0	8.8	66.5
CM	92.6	89.4	22.6	36.2	21.8	3	10.9	78
BSB	92.1	87.4	20.1	41.5	32.0	11.9	8.1	59.9
BS	92.8	83.9	29.5	23.2	24.6	6.8	9.4	72.4

PGH= Pennisetum glaucifolium hay, EB= Erythrina brucei BSB= Bothriocline schimperi, BSB= Brugmansia suaveolens bercht, *CM= concentrate mix; DM = dry matter; CP= crude protein; NDF= neutral detergent fiber; ADF= acid detergent fiber; ADL= acid detergent lignin; OM= organic matter; DOMD = digestible organic matter in dry matter; ME = metabolizable energy, IVODM=invitro digestible matter*

4.2 Semen quality and testicular parameter

The color, volume, mass motility, concentration and scrotal circumference of Bonga sheep nutritionally flushed for short term and long-term during breeding season was presented in table 3 and 4. The color of the semen was not influenced by the feed in 14 days flushing of the rams as was reported also by Salhab et al (2003). The volume of semen significantly varied between treatments (1ml-1.3ml). this is comparable with semen volume of Awassi rams in another report was 1.2ml (Salhab et al 2003). In the current study, ejaculation volume of Bonga rams was 1.ml, which agrees with Malejane et al (2014), using different collection techniques (artificial vagina and electro ejaculator) to evaluate semen quality of Dorper rams. The findings indicated that nutritional flushing is significantly affects the volume of semen of rams

Table 10 Semen quality and scrotal circumference of Bonga sheep in short term flushing (14 days)

Parameter	Semen quality and scrotal circumference					
	T1	T2	T3	T4	T5	P<0.001

Color	Creamy	Creamy	Creamy	Creamy	Creamy	
Volume (ml)	1.0	1.3	1.3	1.17	1.3	0.0001
Mass motility (1-5)	4.0	4.7	4.5	4.5	4.7	0.002
Concentration (×109) /ml	3.4	3.7	3.6	3.5	4.3	0.0002
Scrotal Circumference Cm)	28.2	29.0	28.3	28.9	29.1	0.003

The finding on mass motility of spermatozoa was implies nutritional flushing significantly that the motility of spermatozoa which was similar to previous findings of Moghaddam et al (2012). The reproductive performance and semen characteristics were different among the flushing terms and feeds. High spermatozoa motility is as a liner implication of high semen quality with good fertilizing ability.

Nutritional flushing is significantly influencing the spermatozoa concentration of semen in a Bonga sheep. The current result indicated that the long term flushing was the higher spermatozoa concentration than short and long rain seasons of Ethiopia. There was a significant variation in semen concentration which is in agreement with many findings (Malejane et al 2014).

Table 11 Semen quality and scrotal circumference of Bonga sheep in long term flushing (21 days)

Parameter	Semen quality and scrotal circumference					P<0.001
	T1	T2	T3	T4	T5	
Color	Creamy	Creamy	Creamy	Creamy	Creamy	
Volume (ml)	1.02	1.4	1.3	1.4	1.5	0.0001
Mass motility (1-5)	4.2	4.6	4.4	4.6	4.8	0.003
Concentration (×109) /ml	3.4	3.6	3.8	3.9	4.5	0.0001
Scrotal Circumference Cm)	29.2	30.5	29.2	29	29.2	0.003

4.3 Breeding Rams Body Weight Gain

The supplemented groups achieved higher final body weight than desho grass Hay (control) group, but values for the supplemented treatments did not differ from each other. Bodyweight gain, average daily weight gain, and feed conversion efficiency follow a similar trend and values were in the order of Commercial Concentrate>EB>Hay.

The current finding is similar to who observed a linear increase in BW gain in sheep with increasing levels of feed supplementation to the basal feed of grass hay with better response in sheep.

Table 12 Body weight gain of the Bonga sheep breeding rams nutritionally flushed or short term (14 days)

Parameter	Treatments					$P<0.001$
	T1	T2	T3	T4	T5	
IBW (kg)	44.9	45.6	43.8	44.3	44.1	0.003
FBW (kg)	46.2	48.75	46.2	46.1	46.2	0.0002
BWG (K	1.3	3.15	2.4	1.8	3.1	0.0001
ADG (gm)	92.9	225.0	171.4	128.6	221.4	0.0005

The average daily gain of Bong sheep breeding ram on nutritional flushing of short term is 92.9 gm for control group fed only desho grass hay and 221.4 gm for concentrate mix feeding group. The daily body weight gain of breeding rams for Erythrina brucie (225.0gm) is comparable with the concentrate group.

Table 13 Body weight gain of the Bonga sheep breeding rams nutritionally flushed or long term (21 days)

Parameter	Treatments					$P<0.001$
	T1	T2	T3	T4	T5	
IBW (kg)	45.7	45.5	45.4	45.2	45.0	0.003
FBW (kg)	48.1	49.5	48.8	48.1	49.4	0.0002
BWG (K	2.4	4	3.4	2.9	4.4	0.0001
ADG (gm)	171.4	285.7	242.9	207.1	314.3	0.0005

5. CONCLUSION

Most semen quality traits were influenced (P>0.05) by the feed consumed. The color of semen is the same across the treatments. Semen taken from ram's long-term flushing had higher volume and number of live spermatozoa. Long term flushed rams were superior for semen volume and concentration while compared with short term flushing. The is correlation between flushing and scrotum circumference while body weight change is linear.

6. REFERENCES

Adane Hirpa and Girma Abebe. 2008. Economic Significance of Sheep and Goats. In: Alemu Yami & R. C. Merkel (eds). Ethiopian Sheep and Goat Productivity Improvement Program (ESGPIP), Addis Ababa, Ethiopia.

Adugna T, Assefa G, Geleti D, Gizachew L, and Mengistu A. 2012. Feed Resources Availability and Quality. In: Tolera, A., Yami, A. and Alemu, D. (Eds.). Livestock Feed Resources in Ethiopia: Challenges, Opportunities and the Need for Transformation. Ethiopian Animal Feed Industry Association, Addis Ababa. Pp. 5-36.

Adugna Tolera, (2008) Feed resources and feeding management: A manual for feedlot operators and development workers

Adugna, A., 2007. The role of introduced sorghum and millets in Ethiopian agriculture.

Alemayehu M, Gezahagn K, Fekede F, and Getnet A. 2017. Review on major feed resources in Ethiopia: conditions, challenges and opportunities. Academic Research Journal of Agricultural Science and Research, 5(3):176-185. DOI: 10.14662/ARJASR2017.013. Retrieved in August 2018 fromhttps://www.researchgate.net/publication/321170371.

Alemayehu, Z. and Ian, F., 1993. Small Ruminant Productivity in the Central Ethiopian Mixed Farming Systems. In 4. National Livestock Improvement Conference. Addis Abeba (Ethiopia). 13-15 Nov 1991

Ahmed Muna M. M. and El Shafei Ammar I.Effects of water and feed restriction on body weight change and nitrogen balance in desert goats fed high and low quality foragesSmall Rumin. Res.2001411927

Amata, I.A., 2014. The use of non-conventional feed resources (NCFR) for livestock feeding in the tropics: A review. *Journal of Global Biosciences, 3(2), pp.604-613.*

Assefa, F., Urge, M. and Animut, G., (2007) Weight Gain and Carcass Characteristics of Adilo Sheep Fed Urea Treated Wheat Straw Supplemented with Enset (Ensete Ventricosum), Atella and Their Mixtures.

Awad, N.S., Soliman, M.M., Mohamed, A.A., Sabry, A.M., Shahaby, A.F. and El-Tarras, A.E., 2015. Effect of altitude on some male fertility related traits in Saudi ovine and caprine species. *Annals of animal science*, *15*(3), p.641.

Ayalew, W., 2000. *Do smallholder farmers benefit more from crossbred (Somali× Anglo-Nubian) than from indigenous goats?* (Doctoral dissertation, Georg-August University of Goettingen).

Azage Tegegne, Berhanu Gebremedhin and Hoekstra D. 2010. Livestock input supply and service provision in Ethiopia: Challenges and opportunities for market oriented development. IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project Working Paper 20. ILRI (International Livestock Research Institute), Nairobi, Kenya. 48p.

Barbour E., Rawda N., Banat G., Jaber L., Sleiman F. T., and Hamadeh S.Comparison of immunosuppression in dry and lactating Awassi ewes due to water deprivation stressVet. Res. Commun.2005294760

Behnke, R., 2010. The Contribution of Livestock to the Economies of IGAD Member States: Study Findings, Application of the Methodology in Ethiopia and Recommendations for Further Work, IGAD LPI Working Paper 02-10. Odessa Centre, IGAD Livestock Policy Initiative, Great Wolford, UK

Bela, B. and Haile, A., 2009. Factors affecting growth performance of sheep under village management conditions in the south western part of Ethiopia. *Development*, *21*, p.11.

Belete, S., (2009): Production and marketing systems of small ruminants in goma district of Jimma zone, western Ethiopia. Msc. Thesis. Hawassa University Hawassa, Ethiopia, 38-54.

Benin, S., Ehui, S., Pender, J., 2006. Policies for livestock development in the Ethiopian highlands. In: Pender, J., Place, F., Ehui, S. (eds.), Strategies for sustainable land management in the

East African highlands. Washington D.C.: International Food Policy Research Institute. doi: 10.2499/0896297578 (pp. 141– 164).

Berhanu, G. Hoekstra D. and Azege T., (2006): Improving the Competitiveness of Agricultural Input Markets in Ethiopia: Experiences since 1991. Paper presented at the Symposium on Seed-fertilizer Technology, Cereal productivity and Pro Poor Growth in Africa: time for New Thinking 26th Triennial Conference of the

Birhan, M. and Adugna, T., 2014. Livestock feed resources assessment, constraints and improvement strategies in Ethiopia. *Middle-East Journal of Scientific Research*, *21*(4), pp.616-622.

Bruh, W., 2008. Supplementation with dried foliages of selected Indigenous browses: effects on feed intake, digestibility, body weight gain and carcass characteristics of Abergelle goats offered hay. *An MSc Thesis, Haramaya University, Ethiopia*.

Bwire, J.M.N. and Wiktorsson, H., 2003. Effect of supplementary feeding strategies on the performance of stall fed dual-purpose dairy cows fed grass hay-based diets. *Asian-australasian journal of animal sciences*, *16*(3), pp.359-367.

Cheeke, P.R., 1999. Applied Animal nutrition: feed and feeding 2nd ed. Prince hall. *Inc., New Jersey. 525p*.

Deribe, G., (2009): On-farm performance evaluation of indigenous sheep and goats in Alaba, Southern Ethiopia. Msc. Thesis. Hawassa University, November, 2009, Awassa, Ethiopia.

Chedid, M. 2009. Physiological responses of feed and water restricted dry Awassi ewes to aspirin administration. M.Sc. thesis. American University of Beirut, Beirut, Lebanon. pp. 1–64

CSA (Central Statistical Agency), 2008. Summary and Statistical Report of the 2007 Population and Housing Census, Addis Ababa, Ethiopia. 114pp.

CSA (Central Statistical Agency). 2017. Agricultural Sample Survey, report on livestock and livestock characteristics (Private Peasant Holdings). Federal democratic republic of Ethiopia, Addis Ababa. Statistical Bulletin 585. Vol. 2, April 2017, Ethiopia.

CSA (Central Statistics Authority) (2011): Ethiopian Agricultural Sample Enumeration for the year 2010/2011. Statistical Report on Farm Management Practices, Livestock and Farm Implements. Central Statistical Authority, Addis Ababa, Ethiopia.

Demiruren, A.S., Beheshti, R.D., Salimi, H., Saleh, B.A. and Djaferi, A., 1971. Comparison of the reproductive and productive capacities of sheep of the Kellakui, Kizil, Bakhtiari and Baluchi breeds in Iran. *Animal Husbandry Research Institute*, *1*, p.53.

Devendra, C., 1988. Non-conventional feed resources and fibrous agricultural residues: strategies for expanded utilization; proceedings of a consultation held in Hisar, India, 21-29 Mar. 1988.

EARO (Ethiopian Agricultural Research Organization) (2001): Small ruminant research Strategy. EARO, Addis Ababa, 59.

Edea, Z., 2008. *Characterization of Bonga and Horro indigenous sheep breeds of smallholders for designing community based breeding strategies in Ethiopia* (Doctoral dissertation, Haramaya University).

Edea, Z., Haile, A., Tibbo, M., Sharma, A. K., Sölkner, J. and Wurzinger ,M. 2012. Sheep production systems and breeding practices of smallholders in western and south-western Ethiopia Addis Ababa: ICARDA and ILRI

Endale, A., Erko, B., Weldegebreal, F. and Legesse, M., 2015. Predictors of compliance with community-directed treatment with ivermectin for onchocerciasis control in Kabo area, southwestern Ethiopia. *Parasites & vectors*, *8*(1), pp.1-8.

Enisminger, M.E., 2002. Sheep and Goat Science/Animal Agriculture series/6th.

Fair, S., Doyle, D.N., Diskin, M.G., Hennessy, A.A. and Kenny, D.A., 2014. The effect of dietary n-3 polyunsaturated fatty acids supplementation of rams on semen quality and subsequent quality of liquid stored semen. *Theriogenology*, *81*(2), pp.210-219.

Federal Democratic Republic of Ethiopia Central Statistical Agency (CSA), “Agricultural sample survey 2016/17. Volume II report on livestock and livestock characteristics private peasant holdings,” Statistical bulletin, Federal Democratic Republic of Ethiopia Central Statistical Agency (CSA), Addis Ababa, Ethiopia, 2017.

Food and Agriculture Organization (FAO), (2004). Livestock Sector Brief: Ethiopia, Livestock information, sector analysis and policy branch, FAO, Rome.

Gatenby, R.M., 1991. Sheep: The tropical agriculturalist. *CTA-Macmillan*,.

Gemiyu, D., 2009. *On-farm performance evaluation of indigenous sheep and goats in Alaba, Southern Ethiopia* (Doctoral dissertation, Hawassa University).

Getu, H., Spelt, J.K. and Papini, M., 2008. Cryogenically assisted abrasive jet micromachining of polymers. *Journal of Micromechanics and Microengineering*, *18*(11), p.115010.

Gizaw S, H Komen, O Hanotte, and J Arendonk. 2008. Indigenous sheep resources of Ethiopia: types, production systems and farmers preferences. Animal Genetic Resources 43:25-40. Food and Agriculture Organization of the United Nations (FAO). Retrieved in May 2018 from https://doi.org/10.1017/S1014233900002704.

Gizaw, S., Ebro, A., Tesfaye, Y., Mekuriaw, Z., Mekasha, Y., Hoekstra, D., Gebremedhin, B. and Tegegne, A., 2017. Feed resources in the highlands of Ethiopia: A value chain assessment and intervention options.

Gizaw, S., Komen, H., Windig, J.J., Hanotte, O., Van Arendonk, J.A.M., 2008. Conservation priorities for Ethiopian sheep breeds combining threat status, breed merits and contribution to genetic diversity. Genet. Sel. Evol., 40, 433–447.

Gizaw, S., Van Arendonk, J.A., Komen, H., Windig, J.J. and Hanotte, O., 2007. Population structure, genetic variation and morphological diversity in indigenous sheep of Ethiopia. *Animal Genetics*, *38*(6), pp.621-628.

Gizaw, S., van Arendonk, J.A.M., Komen, H., Windig, J.J. and Hanott, O., (2007): Population structure, genetic variation and morphological diversity in indigenous sheep of Ethiopia. Anim. Genet, 38: 621 - 628.

Hadjigeorgiou, I., Dardamani, K., Goulas, C. and Zervas, G., 2000. The effect of water availability on feed intake and digestion in sheep. Small Ruminant Research, 37(1-2), pp.147-150.

Haile, A., Dessie, T. and Rischkowsky, B.A., 2014. Performance of indigenous sheep breeds managed under community-based breeding programs in the highlands of Ethiopia: Preliminary results.

Hirpa, A., Abebe, G., 2008. Economic significance of sheep and goats. In Yami, A., Merkel, R.C. (eds), Sheep and goat production handbook for Ethiopia. Ethiopian Sheep and Goat Productivity Improvement Program (ESGPIP), pp 1–4.

Hamadeh S. K., Rawda N., Jaber L. S., Habre A., Abi Said M., and Barbour E. K.Physiological responses to water restriction in dry and lactating Awassi ewesLivest. Sci.2006101101109

International Livestock Centre for Africa. Livestock Economics Division, 1991. *A Handbook of African Livestock Statistics* (No. 15). Livestock Economics Division, International Livestock Center for Africa.

Jaitner, J., Sowe, J., Secka-Njie, E., Dempfle, L., 2001. Ownership pattern and management practices of small ruminants in The Gambia – Implications for a breeding program. Small Rumin. Res. 40, 101–108.

Jaber L. S., Habre A., Rawda N., AbiSaid M., Barbour E. K., and Hamadeh S. K.The effect of water restriction on certain physiological parameters in Awassi sheepSmall. Rumin. Res.200454115120

Karnib, M. 2009. The effect of vitamin C administration on some physiological parameters in water and feed restricted dry Awassi ewes. M.Sc. thesis, American University of Beirut, Beirut, Lebanon. pp. 1–48

Kassahun, A., 2000. Comparative performance evaluation of Horro and Menz sheep of Ethiopia under grazing and intensive feeding conditions (Doctoral dissertation, Humboldt University of Berlin).

Kay, R.N.B., 1997. Responses of African livestock and wild herbivores to drought. Journal of Arid Environments, 37(4), pp.683-694.

Kocho, T., Abebe, G., Tegegne, A. and Gebremedhin, B., 2011. Marketing value-chain of smallholder sheep and goats in crop-livestock mixed farming system of Alaba, Southern Ethiopia. *Small Ruminant Research*, *96*(2-3), pp.101-105.

Kok, D., Ates, E., Korkutal, I. and Bahar, E., 2007. Forage and nutritive value of the pruning residues (leaves plus summer lateral shoots) of four grapevine (Vitis vinifera L.) cultivars at grape harvest and two post-harvest dates. *Spanish Journal of Agricultural Research*, (4), pp.517-521.

Kosgey, I.S., 2004. Breeding Objectives and Breeding Strategies for Small Ruminants in the tropics. Ph.D. Thesis. Wageningen University, Netherlands, 272 p.

Kosgey, I.S., and Okeyo A.M., (2007): Genetic improvement of small ruminants in low input, smallholder production systems: Technical and infrastructural issues. Small

Kosgey, I.S., Rowlands, G.J., Van Arendonk, J.A.M., Baker, R.L., 2008. Small ruminant production in smallholder and pastoral/extensive farming systems in Kenya. Small Rumin. Res. 77, 11–24.

Lakew, M., Haile-Melekot, M. and Mekuriaw, G., 2014. Evaluation of growth performance of local and Dorper× local crossbred sheep in eastern Amhara region, Ethiopia. *Iranian Journal of Applied Animal Science*, *4*(4), pp.787-794.

Legesse, G., 2008. Productive and economic performance of small ruminants in two production systems of the highlands of Ethiopia. PhD Thesis. Universität Hohenheim, Stuttgart-Hohenheim, Germany.

Legesse, G., Abebe, G., Siegmund-Schultze, M. and Zárate, A.V., 2008. Small ruminant production in two mixed-farming systems of southern Ethiopia: status and prospects for improvement. *Experimental Agriculture*, *44*(3), pp.399-412.

Leng, R.A. and Fujita, T., 1997. *Tree foliage in ruminant nutrition*. FAO.

López, S., Davies, D.R., Giráldez, F.J., Dhanoa, M.S., Dijkstra, J. and France, J., 2005. Assessment of nutritive value of cereal and legume straws based on chemical composition and in vitro digestibility. *Journal of the Science of Food and Agriculture*, *85*(9), pp.1550-1557.

McDonald, P., Edwards, R., Greenhalgh, J., Morgan, C., Sinclair, L. and Wilkinson, R., 2011. Animal Nutrition 7th edition England UK. *Harlow, England: Pearson Education Limited*.

Meissner, R.A. and Facelli, J.M., 1999. Effects of sheep exclusion on the soil seed bank and annual vegetation in chenopod shrublands of South Australia. *Journal of Arid Environments*, *42*(2), pp.117-128.

Mekuanint G and Girma D. 2017. Livestock feed resources, nutritional value and their implication on animal productivity in mixed farming system in Gasera and Ginnir Districts, Bale Zone, Ethiopia. International Journal of Livestock Production, 8(2):12-

23.DOI:10.5897/IJLP2016.0297. Retrieved August 2018 from http://www.academicjournals.org/journal/IJLP/article-full-text-pdf/D096B1E62571.

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

Momoh, O.M., E.A. Rotimi, and N.I. Dim, 2013. Breed effect and non-genetic factors affecting growth performance of sheep in a semi-arid region of Nigeria. Journal of Applied Biosciences 67:5302 – 5307.

Morgan, D.H., Ghribi, O., Hui, L., Geiger, J.D. and Chen, X., 2014. Cholesterol-enriched diet disrupts the blood-testis barrier in rabbits. *American Journal of Physiology-Endocrinology and Metabolism*, *307*(12), pp.E1125-E1130.

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

Nitis, I.M., 1999. Non-Conventional Roughages in *Tropical and Sub-Tropical Asian-Australasian* Countries-Review. *Asian-Australasian Journal of Animal Sciences*, *12*(3), pp.449-459.

Oliveira, R., Faria, M., Silva, R., Bezerra, L., Carvalho, G., Pinheiro, A., Simionato, J. and Leão, A., 2015. Fatty acid profile of milk and cheese from dairy cows supplemented a diet with palm kernel cake. *Molecules*, *20*(8), pp.15434-15448.

Poppi, D.P. and McLennan, S.R., 1995. Protein and energy utilization by ruminants at pasture. *Journal of animal science, 73(1), pp.278-290.*

Ranjhan, S.K., 1993. *Animal nutrition in the tropics (No. Ed. 3). Vikas Publishing House Pvt. Ltd.*.

Ranjhan, S.K., 1997. Nutrient requirements and feeding of sheep for wool and meat production. *Animal Nutrition in Tropics. 4th Edition (revised). Vikas Publishing House, Jangpura, New Delhi, pp. 340ą362*.

Rege, J.E.O., 1994. Indigenous African small ruminants: a case for characterization and improvement. In: Lebbie, S.B.H., Rey, B., Irungu, E.K. (eds.), Small ruminant research and development in Africa, Proceedings of the Second Biennial Conference of the African

Small Ruminant Research Network, AICC, Arusha, Tanzania, 7 – 11 December 1992, pp. 205–211.

Rook, J.A.F. and Thomas, P.C., 1983. Nutritional physiology of farm animals.

S. Gizaw, S. Lemma, J. A. M. Van Arendonk, and H. Komen, "Estimates of genetic parameters and genetic trends for live 8 Journal of Nutrition and Metabolismweight and fleece traits in Menz sheep," Small Ruminant Research, vol. 70, no. 2-3, pp. 145–153, 2007.

S. N. Kumar, M. R. Jayashankar, N. Ramakrishnappa, W. Ruban, and R. M. Sreesujatha, "Carcass and meat quality characteristics of Bandur ram lambs," Indian Journal of Animal Research, vol. 52, no. 5, pp. 774–779, 2017.

Sartori, R. and Guardieiro, M. M. 2010. Fatores nutricionais associados à reprodução da fêmea bovina. Revista Brasileira de Zootecnia 39:422-432.

Sebsibe, A., 2008. Sheep and goat meat characteristics and quality. *Sheep and Goat Production Handbook for Ethiopia. Ethiopian Sheep and Goats Productivity Improvement Program (ESGPIP), Addis Ababa, Ethiopia. pp323-328*.

Shigdaf, M., Zeleke M., Mengistie T., Hailu M., Getnet M. and Aynalem H., (2013): Reproductive performance and survival rate of Washera and Farta sheep breeds under traditional management systems in Farta and Lay Gayint Districts of Amhara Regional state, *Ethiopia. Ethiop. J. Anim. Prod., 13: 65- 82.*

Silanikove, N., 2000. The physiological basis of adaptation in goats to harsh environments. *Small Ruminant Research*, *35*(3), pp.181-193.

Sisay, L., 2002. Phenotypic classification and description of indigenous sheep types in the Amhara national regional state of Ethiopia (Doctoral dissertation, MSc thesis, Department of Genetics, University of Natal, Pietermaritzburg, South Africa).

Solomon, A., 2007. In situ characterization of Gumuz sheep under farmer's management in north western lowland of Amhara region. *Sc Thesis presented to the School of Graduate Studies of Haramaya University of Agriculture, Dire Dawa, Ethiopia. 86p*.

Solomon, A., (2007): In situ characterization of Gumuz sheep under farmers management in north western lowland of Amhara region. An M.Sc Thesis presented to the School of Graduate Studies of Haromaya University, Dire Dawa,

Steen, W.M., 1980. Arc augmented laser processing of materials. *Journal of applied physics*, *51*(11), pp.5636-5641.

Taye, M.T., 2008. On-farm performances of Washera sheep at Yilmanadensa and Quarit districts of the Amhara National Regional State.

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

Tesfaye G., (2008): Characterization of Menze and Afar Indigenous Sheep Breeds of Smallholders and Pastoralist for Desighing Community Based Breeding Strategies in Ethiopia. An M Sc Thesis presented to the School of Graduate Studies of Haramaya University, Dire Dawa, Ethiopia.

Tibbo, M. and Ginbar T., (2004): Phenotypic characterization of the Bonga sheep in Kaffa zone: Field mission Report. Kaffa, Bonga.

Tibbo, M., 2006. Productivity and health of indigenous sheep breeds and crossbreds in the central Ethiopian highlands (Vol. 2006, No. 2006: 51).

Tolera, A., 2008. Feed resources and feeding management: A manual for feedlot operators and development workers. *SPM-LMM program. Addis Ababa, Ethiopia*.

Tolera, A., Merkel, R.C., Goetsch, A.L., Sahlu, T. and Negesse, T., 2000, November. Nutritional constraints and future prospects for goat production in East Africa. In *The opportunities and challenges of enhancing Goat production in east Africa. A conference held at Awassa College of agriculture*, *Debub University* (pp. 10-12).

Tsedeke, K. (2007): Production and marketing of sheep and goats in Alaba, SNNPR. Msc thesis. Hawassa University. Awassa, Ethiopia, 25-54.

Van Soest, P.J., 1994. *Nutritional ecology of the ruminant*. Cornell university press.

Waldo, D.R. and Jorgensen, N.A., 1981. Forages for high animal production: nutritional factors and effects of conservation. *Journal of Dairy Science*, *64*(6), pp.1207-1229.

Wells, A., Gegner, L.E. and Earles, R., 2000. *Sustainable sheep production*. ATTRA.

Wiegand, T. and Wissel, C., 1994. Host-parasitoid models in temporally and spatially varying environment. *Ecological modelling, 75,* pp.161-170.

Wilson, R.T., 1986. Strategies to increase sheep production in East Africa. FAO Animal Production and Health Paper. 58, 118–123.

Workneh A., Ephrem G., Tibbo., M.Yetnayet. and Rege J.E.O. (2004). Current state of knowledge on characterisation of farm animal genetic resources in Ethiopia. In Farm Animal Biodiversity in Ethiopia: Status and Prospects. In: Proceedings of the 11th annual conference of the Ethiopian Society of Animal Production (ESAP) held in August 28-30. Addis Ababa, Ethiopia.

Workneh, A., 2006. Getting incentives right: concerns associated with expansion of cattle export markets in Ethiopia. *Ethiopian Journal of Animal Production*, *6*(2), pp.99-103.

Y. Abebe, S. Melaku, and A. Tegegne, "Assessment of sheep marketing system in burie district, north western Ethiopia," Journal of Agricultural Research, vol. 2, no. 3, pp. 97–102, 2013.

Yadessa, E., 2015. *Assessment of feed resources and determination of mineral status of livestock feed in Meta Robi District, West Shewa Zone, Oromia Regional State, Ethiopia* (Doctoral dissertation, Ambo University).

Yohannes D, Mengistu U, Yosef T, and Solomon G.2017. Sheep production and breeding systems in northwestern lowlands of Amhara region, Ethiopia-implication for conservation and improvement of Gumz sheep breed. Open Journal of Animal Sciences, 7:179-197.DOI: 10.4236/ojas.2017.72015. Retrieved in August 2017 from http://www.scirp.org/journal/PaperInformation.aspx?PaperID=75748&#abstract

Z. Edea, "Characterization of Bonga and Horro indigenous sheep breeds of smallholders for designing community based breeding strategies in Ethiopia," M.S. thesis, Haramaya University, Haramaya, Ethiopia, 2008

Zabuli, J., Tanaka, T., Lu, W., Kuroiwa, T. and Kamomae, H., 2009. Responses of gonadotropin secretion to short-term dietary supplementation in ovariectomized goats with different body weights. *Animal reproduction science*, *116*(3-4), pp.274-281.

Zewdu, E., (2008): Characterization of Bonga and Horro indigenous sheep breeds of smallholders for designing community based breeding strategies in Ethiopia. Msc thesis submitted to the department of animal science, school of graduate studies, Haramaya University, Haramaya.