PRODUCTION AND REPRODUCTION PERFORMANCES, PRODUCERS' TRAIT PREFERENCES AND MARKETING SYSTEM OF SMALL RUMINANTS IN ADA BARGA AND EJERE DISTRICTS OF WEST SHOA ZONE, ETHIOPIA

M.Sc. THESIS

YADETA NEME BERGAGA

February, 2016

Jimma University

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YADETA NEME BERGAGA

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JIMMA UNIVERSITY

COLLEGE OF AGRICULTURE AND VETERINARY MEDICINE

MSc THESIS APPROVAL SHEET

We, the undersigned, member of the Board of Examiners of the final open defense by **Yadeta Name Bergage** have read and evaluated his/her thesis entitled **"Production and Reproduction Performances, Producers Traits Preferences and Marketing System of Small Ruminants in Ada Barga and Ejere Districts of West Shoa Zone, Ethiopia"** and examined the candidate. This is therefore to certify that the thesis has been accepted in partial fulfillment of the requirements for the degree Master of Science in **Animal Breeding and Genetics.**

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DEDICATION

This thesis is dedicated to my beloved mother Demitu Chawaka who passed away and I deeply wish that God might give her peaceful rest forever.

STATEMENT OF AUTHOR

I the undersigned, hereby declare that the thesis:- Production and Reproduction Performances, Producers Traits Preferences and Marketing System of Small Ruminants in Ada Barga and Ejere districts of West Shoa Zone, Ethiopia is the outcome of my own work and all sources of materials used for this thesis have been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirements for M. Sc degree at Jimma University and is deposited at the University Library to be available to borrowers under rules of the library. I truly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma or certificate. I concede copyright of the thesis in favor of the Jimma University, Collage of Agriculture and Veterinary Medicine.

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BIOGRAPHICAL SKETCH

The author Yadeta Neme Bergaga was born on September 1, 1991 G.C. in Oda Gudaya kebele, Bako Tibe West Shoa Zone, Oromia Region. He attended his elementary education at Bosha School in 1996 -2003 G.C. and he started his junior secondary education at Gedo senior secondary School in 2004-2007 G.C. Then he joined Ambo University in 2008 and graduated with BSC in Animal production on 19th June, 2010 G.C. After graduation he was employed by the Meta Robi district of livestock development and health care agency until he joined Jimma University, school of graduate studies for the degree master of science in Animal Breeding and Genetics in 2014 G.C.

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LIST OF ABBREVIATIONS AND ACRONOMY

AEZ	Agro-ecological zones
AFK	Age at first kidding
AFL	Age at first lambing
ASMM	Age at sexual maturity of male
AFP	Age at first parturition
ANOVA	Analysis of variance
CSA	Central statically agency
FGD	Focus group discussion
GDP	Growth development product
HL	Highland
HH	House holds
LI	Lambing interval
KI	Kidding interval
LL	Lowland
LS	Litter size
ML	Midland
PRA	Participatory rural appraisal
SD	Standard deviation
SE	Standard error
SPSS	Software product for social science
M. A.S.L.	Meters above sea level

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PRODUCTION AND REPRODUCTION PERFORMANCES, PRODUCERS TRAITS PREFERENCES AND MARKETING SYSTEM OF SMALL RUMINANTS IN ADA BARGA AND EJERE DISTRICTS OF WEST SHOA ZONE, ETHIOPIA

ABSTRACT

Small Ruminants production, producer's traits preferences and marketing system in agro- ecologies (AEZs) of Ada Barga and Ejere districts were under taken to characterize production system, reproduction performance, traits preferred for breeding as well as marketing and to document constraints of central highland sheep and goat in its environment. These two districts were selected based on potential for small ruminant production. Two districts stratified into highland (HL), midland (ML) and lowland (LL) agro ecologies and 180 households 69 from HL, 74 from ML and 37 from LL were purposively selected for this study. Detailed structured questionnaires, respondent interviews and FGD were employed as sampling technique. Results revealed that the overall mean family size, cultivated land, grass land per households in mean (SD) were 7.1(2.4), 2.4(1.7) and 0.7(0.6) respectively. Both sheep and goat were significantly affected by AEZs. The average mean of sheep and goat size per household were 10.2, 4.3, 1.3 and 0.5, 5.5, 7.5 in HL, ML and LL, respectively. The overall objective of both sheep and goat rearing across all AEZs were source of income was ranked first. The major availability of feed was natural pasture ranked first with total index 0.96 and 0.49 in wet and dry season, respectively. The overall proportions of respondents were grazing sheep with other livestock (32.8%). Only 20.6% and 30.6 of the respondents practiced separation of new born kids and lambs, respectively from their dams or other flocks. The overall of age at first lambing (AFL) / age at first kidding (AFK), weaning age, slaughter age, age at sexual maturity of male (ASMM), reproductive life span of both sheep and goat were significantly affected by AEZs. The overall mean of slaughter age and ASMM of sheep was 6.43, 8.91 *and* 6.27, 8.39 for goat, *respectively. High intensive kidding and lambing months was April to June. The effective population size (Ne) and level of inbreeding coefficient (ΔF) in HL (103.77 and 0.005 for sheep whereas 3.85 and 0.129 for goat, respectively) during mixed Feed scarcity was ranked first for reasons of culling sheep and goats in HL (14.4%) and ML (10.6%). Own grazing and community grazing land were utilized by higher percent of respondents in LL AEZ compared to HL and ML AEZs. Body conformation and color were ranked first and second with an overall average index (0.51, 0.19) and (0.48, 0.33) for ram and buck selection respectively. Majority of respondents sell small ruminants aged 06 months – 01 year and adult (> 01 year) in both sexes (male and female) across all three AEZs. Low start up cost (25.0%) and multi species grazing (20.6%) were found to be suitable for sheep and goat breeding opportunities. Diseases, feed shortage and water shortage were major constraints ranked first, second and third with an overall index of 0.40, 0.20 and 0.16 for sheep and 0.35, 0.31 and 0.13 for goat, respectively. Addressed constraint should be addressed to increase productive and reproductive of small ruminants.*

Keys words: Goat, sheep, production, reproductive performance, traits preferences, marketing, west Shoa, Ethiopia

1. INTRODUCTION

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).

Small ruminant production contributes significantly to the national and household economy in many countries. Based on annual off take rates of 31.11% for sheep and 35.37% for goats, the potential production is estimated at 8.7 million sheep skins and 8.1 million goat skins in 2011/2012 (FAO ,2011). There are about 35 million (Negassa *et al*., 2011) and 24 million (CSA, 2013) head of sheep and goats in the Ethiopia respectively. In Ethiopia, small ruminants, contribute substantial amounts to income, food (meat and milk), and non-food products like manure, skins and wool. They also serve as means of risk mitigation during crop failures, property security, monetary saving and investment in addition to many other socioeconomic and cultural functions (Solomon *et al.*, 2010). Landless youth and farmers, retired people and other members of society can be engaged in fattening activities that could benefit as result of high market demand and higher prices for meat and live animal.

Ethiopian small ruminant production systems are broadly classified into “modern” and “traditional” (Getahun, 2008). The “modern” system is practiced only in few places such as government ranches and in small scale urban production systems. Most of small ruminant production in the country is categorized under traditional extensive system of production and involves crop-livestock mixed system and the system mainly found in pastoral and arid areas of eastern and north-eastern Ethiopia (Getahun *et al*., 2008; Solomon *et al*., 2010).

Performance of indigenous goat breeds of Ethiopia is highly variable between different management systems. However, there is much potential for a high reproductive efficiency in Ethiopian indigenous goats with improved management systems (Dereje *et al*., 2015).

High mutton / chevon demand, multi species grazing of the small ruminants in the local market as a result of population increase, urbanization and increase in income can be

considered as an opportunity for the small ruminant producers (Belete, 2010 and Solomon, 2010). Identification of breeding objective traits pertinent to specific production environments with the involvement of target beneficiaries is crucial to the success of a breed improvement program (Gemeda *et al*, 2011). Marketing includes all activities from the farm gate to the final consumer (Kotler and Armstrong, 2003).

1.1.Research Gap

Despite their large numbers, small ruminant productivity of the country is constrained by shortage of feed, high prevalence of diseases, poor infrastructure and paucity of information resulting in inadequate utilization of the indigenous genetic resources (Assen and Aklilu, 2012; Solomon, 2014). The earlier studies have indicated that small ruminant production in Ethiopia needs to be addressed systematically by describing the genetic resource bases, production and marketing systems (Tesfaye *et al*., 2010, 2011; Zewudu *et al.*, 2012). Other workers also suggested that breeding systems or genetic improvement efforts need to consider traits preferences of producers in designing breeding programs (Gemeda *et al*., 2010; Tadele, 2010; SPS-LMM, 2010). Moreover, further characterization and identification works are needed to know small ruminant populations in some parts of our country such as the central highlands where small ruminants are generally called central highland sheep and central highland goats (FARM Africa, 1996 and ESGPIP, 2008).

Therefore, assessing the existing production systems, indigenous management knowledge practices, major breeding goal traits, productivity levels of available small ruminant populations / breeds in their habitat and existing small ruminant marketing systems with active participation of producers and buyers are prerequisites to set up genetic improvement program at smallholder level. Though Ada Barga and Ejere districts of west Shoa zone have huge potential for small ruminant production, currently there is not much scientific information on characterization of available breeds/genotypes, production systems, producers' trait preferences and marketing systems. Therefore, the present research was initiated with the following objectives.

i) To assess major small ruminant production and marketing systems in Ada Barga and Ejere districts of West Shoa zone

ii) To assess productive and reproductive performances of small ruminants in the districts

iii) To identify traits preferences of small ruminant producers in the districts

iv) To identify constraints and opportunities for small ruminant production and marketing in these districts

2. LITERATURE REVIEW

2.1. Genetic diversity and distribution of small ruminant in Ethiopia

Ethiopia is home for diverse indigenous sheep and goat populations. The indigenous sheep and goat genetic resources might have developed specific adaptations to survive and produce under adverse local environmental conditions and to perform better under low input system. As a result, they are suitable to be used in the traditional, low-external-input production system (Markos, 2006). Sheep and goats, maintained virtually under the traditional subsistence oriented management systems, constitute an important livestock component in all ecological zones and agricultural systems in the country. Sheep and goat types in Ethiopia are highly affiliated to specific ethnic communities. Several traditional breeds are reared by and named after specific communities (e.g. Menz sheep, Horro sheep, Weyito Guji goat, etc.). Some communities attach special cultural values to their sheep and exclude use of breeding stock from other populations, resulting in cultural barrier to gene flow (Solomon *et al.,* 2010).

2.2. Breeding objective of small ruminant in livelihoods of small holder farmers in Ethiopia

Traditional methodologies for deriving breeding objectives involve the use of profit functions which calculate the impact on farm profit of changes in each trait. However, it is also important that breeding objectives reflect the farming philosophies of the breeders and commercial farmers for whom they are designed. The primary objective for keeping sheep in eastern Ethiopia was income generation followed by milk and meat production (Helen *et al*., 2013; Arse *et al*., 2013; Alubel, 2015, Hundie and Geleta, 2015). Social and cultural functions were also ranked as other important aspects of sheep production (Mengistie *et al.,* 2010; Assen and Aklilu, 2012; Fsahatsion *et al*.; 2013 and Solomon, 2014). Breeding objectives are affected by many factors and have to consider the needs and priorities of the animal owners or producers, the consumers of animal products, the food industry, and increasingly also the general public.

Therefore, there is an increasing recognition of the need to incorporate the perceptions of industry stakeholders in breeding objectives. Also the breeding objective and the selection criteria (traits), on which the livestock keepers wish to improve and base their selection should be identified through the full participation of pastoralist and smallholder farmers. Lack of participation of farmers in defining the breeding objective was the main reason for failure of many livestock improvement programs in the tropics (Wurzinger *et al*., 2011).

2.3. Small ruminant production systems in Ethiopia

Livestock production system and the relative importance and potential for increased production by livestock species in varied areas differed markedly due to differences in production environment (availability of resources, particularly land, water and climate), population, diseases incidence, level of economic development, research support and government economic government support (inputs and services) policies (Solomon *et al.*, 2010). There are various factors that should be considered to categorize small ruminant production systems in Ethiopia. In mixed crop-livestock production system mainly seen in central highland of the country, small ruminant production is characterized by low productivity due to nutritional stress and internal and external parasites. On the other hand, the pastoral and agro-pastoral systems found in the lowlands are characterized by extensive production based largely on the rangeland (Solomon *et al*., 2008).

Getahun (2008) also reported four small ruminant production systems; small ruminant in annual crop-based systems (northern, north-western and central Ethiopia), small ruminant in perennial crop-based systems (mainly southern and south-western highlands), small ruminant in cattle-based systems (agro-pastoral and arid areas), and small ruminant dominated systems (pastoral and arid eastern and northeastern areas). Mode of livestock production in Ethiopia is broadly classified into pastoral, agro pastoral and mixed crop–livestock, per-urban and urban production systems. In pastoral systems, extensive livestock production is mostly the sole source of livelihood with little or no cropping. In the sub moist/moist lowlands, agro pastoralism is the main mode of production. Crop and livestock production are both important activities. The system is either transhumant or sedentary. The pastoral production system in some areas has been evolving into agro pastoral system. Livestock production is a secondary

enterprise in the highland mixed crop–livestock systems, although livestock assumes a major importance in areas (e.g. subalpine areas) where crop production is unreliable. The less dominant and underdeveloped systems include urban/per-urban dairying and sheep/goat fattening and large-scale commercial livestock production (Solomon *et al*., 2010). Gemeda *et al.* (2011) also reported the sheep-barley production system in Menz areas of Amhara region.

2.3.1. Small ruminant management system

According to assessment undertaken in Anambra State, Nigeria about 63% of the respondents kept their livestock in cement block houses, while 25.0, 5.0 and 3.3% kept their goats and sheep in mud, bamboo and wooden houses, respectively and 3.3% did not provide any form of house for their animals (Chah *et al*., 2013). The study of Alubel (2015) in Ziquala districts of Tigray region reported majority of farmers (83.8%) confine their goats without roof and minority of farmer confine their goats in family house (18.18%). Majority (91.6%) of sheep was housed separately from other livestock; whereas, 8.4% of the farmers housed sheep with cattle and/or goat within the same roof by making partition among/between them (Tsedeke, 2007 and Tesfaye, 2008). Most of the farmers used traditional medication practices such as herbs, bleeding, burn animals with hot iron and combination of different traditional practices to treat sick animals (Dereje *et al*., 2013**).**

The study of Dereje *et al*. (2013) in Daro-Labu district of west Hararghe, Eastern Ethiopia reported that, Productivity problems, disease, persistent poor body condition and synergetic effects of all these factors were the common top four reasons for destocking goat flock with proportions of 46.1%, 20.6%, 17.2% and 16.1%, respectively. Farmers also castrate male sheep for fattening purpose. They employ either modern or traditional methods of castration (Tsedeke, 2007). According to Abebe *et al*. (2000), farmers mostly use traditional methods of castration in the central highlands of Ethiopia. Male sheep between the ages of 4 to 12 months are mostly castrated for fattening purpose. Farmers castrate male sheep during September, October, or November. Farmers mostly sell, slaughter or castrate on average breeding males sheep at the age of 6.8 months (Yenesew, 2013).

Knowledge about ways of acquisition of breeding stock and mode of exit/disposal is important in assessing the breeding practices of sheep owners. According to earlier authors

reported Helen *et al.(* 2013) at mixed crop livestock production system in eastern Ethiopia and Yisehak *et al*. (2013) in south western Ethiopia ranked home born, purchase and gift as first, second and third acquisition of animals respectively in Manna district.

Small ruminants depend mainly on natural pasture and crop residue. Farmers usually supplement local beer residue (*Atella*), maize grain, food leftover and salt to their sheep. Noug seed cake supplementation was commonly practiced for sheep fattening (Yenesew, 2013). Communal grazing and private pasture grazing is the main feed resources (Funte *et al.*, 2010; and Fsahatsion *et al*., 2013). In general, buying agro-industrial by-products for sheep production is not common. Farmers generally depend on the naturally available feed resources for sheep production (Yenesew, 2010) in Burie woreda Amhara National Regional State, Ethiopia.

Rivers, springs, tap water and dam (specifically in Afar area) were the main sources of water during the dry season in both Menz and Afar area. Whereas, during the rainy season pond and dams filled by the rainy water were the main sources of water and some farmers and pastoralists reported that they also use tap water during the rainy season. It can be noted that there is a wide variation in time spent to get to water sources. In Menz area smallholder farmers get water at a distance of less than 1 km. About 92.5% sheep owners in Menz and 33.6% in Afar area watered lamb with adults. Majority (75%) of the farmers in Menz area watered their sheep once in two days followed by once a day (22.5%) and some sheep flocks (2.5%) had access to water freely(Tesfaye, 2008).

The study of Tesfaye (2009) in Metema woreda, Amhara region, of Ethiopia reported that 98% of the respondents retained bucks for breeding purposes and 72% of the farmers keep their own breeding bucks whereas the remaining (28 %) use neighbor's bucks. Armistrong, 2006; Tesfaye *et al*., 2011 and Fsahatsion *et al*., 2013 reported on farm level majority of farmers reared their own ram and high degree of inbreeding expected in dega and weyna dega. Helen *et al*. (2013) in eastern Ethiopia reported the level of inbreeding might be high in mixed crop-livestock system where communal grazing is becoming less and less important. Also Tesfaye (2008) reported level of inbreeding 0.20 for Afar and 0.07 for Menz sheep when

flocks are not mixed. Bucks were usually used for service the first time at about 12 months although bucks in exceptionally good body condition were used at younger ages.

2.4. Productive and reproductive performance of small ruminants in Ethiopia.

2.4.1. Reproductive performance of small ruminants in Ethiopia

Reproductive performance is a prerequisite for any successful livestock production program. Where farm resources are severely limited, as it is often the case in SSA (sub - Sahara Africa), reproduction failure is the first sign of decreased productivity. Poor reproductive performances of Ethiopian sheep and goats can be associated with genetic factors, poor management, seasonal fluctuations in feed resources and diseases (Mukasa-Mugerwa *et al*., 2002). Reproductive rate can be influenced by conception rate, litter size, young mortality and interval between parturitions.

2.4.1.1. Age at first parturition (AFP)

Age at first parturition (AFP) can be recorded easily in farmers stock. In small ruminants, AFP is an economically important trait because it determines rate of genetic progress and population turnover rate. Many factors affecting pubertal development would also affect AFP. Galmessa *et al.* (2003a; 2003b) reported the influence of nutrition on age at puberty and parturition both on male and female Horro sheep lambs. FAO (2002) reported age at first lambing ranges between 16.2 and 16.9 months in mixed farming systems of sub-Sahara African countries.

Under most traditional systems, where breeding males are available in the flocks, age at first parturition is a good indicator of early sexual maturity in does and ewes. Tsedeke (2007) reported 12.7 months for lambing and 12.1 months for kidding in Alaba southern Ethiopia. Assen and Aklilu (2012) reported that, the average age at first kidding (AFK) 15.01 months in different agro-ecological zones (high, mid and lowland) in Tigray, Ethiopia. Fsahatsion *et al*. (2013) reported an average age at first lambing (AFL) of 12.4 months in Gamo gofa Zone, Southern Ethiopia. Mesfin *et al*. (2014) reported average AFL of 18.10 months at eastern Amhara region and Yisehak *et al*., 2013 reported AFL of 15.90, 15.85 and 15.63 and AFK 2.09, 2.07 and 2.16 years in Seka, Mana and Dedo districts of Southwestern Ethiopia

respectively. The average age of sexual maturity 7.1 months reported by Tesfaye (2008) for Afar rams. Assen and Aklilu (2012) reported age at sexual maturity 8.42 and 8.8 months for ram and 9.44 and 9.22 for buck in HL and ML of Tigray region, respectively. Age at puberty of male and female 7.5 and 7.1 month for Bonga sheep 9.3 and 7.8 month for Horro sheep reported by Zewudu *et al*., 2012.

2.4.1.2. Lambing/kidding interval

Lambing or kidding interval is the interval between two parturitions that determines reproductive efficiency in small ruminant production. At least three times kidding or lambing is expected per two years under normal circumstances (Girma, 2008). To attain this lambing or kidding interval should not exceed 8 months (245 days). There are reports on the possibility of attaining three parturitions from indigenous small ruminants in two years (Getahun, 2008); 9.16 month for washera sheep (Mengistie 2008); 8.04months (Belete, 2009) and 7.34 month (Fsahastion *et al*., 2013).

2.4.1.3. Liter size

Litter size (LS) is largely determined by ovulation rate but is also modified by fertilization rate and embryonic and fetal losses (Gatenby, 1986; Gautsch, 1987). Other influencing factors are breed, level of nutrition, season and age of ewes. Litter size varies between 1.08 and 1.75 with the average of 1.38 for tropical breeds (Girma, 2008). Liter size of Ethiopian sheep breeds like Menz and Afar sheep breeds is low (Tadele, 2010) which is almost close to one lamb per lambing. The LS reported for Horro ewes ranged from 1.29 – 1.57 and 1.13 for Bonga sheep. Solomon *et al*. (2010) also reported that Washera sheep breed is large in body size and also prolific. The authors reported a litter size of about 1.11 for the breed.

2.4.2. Production performance

The demand from both domestic and export markets for small ruminant products especially mutton, is increasing in Ethiopia (SPS-LMM, 2010). The productivity of indigenous sheep is currently too low to meet this demand. Ethiopian indigenous sheep are characterized by slow growth, late maturity and low production performances. Appearance of rams, which most of the owners associated with high carcass output and premium price across all the production

systems, includes wide chest, conformation and long body size (Helen *et al*., 2013). Solomon *et al.* (2010) has shown that the overall appearance of sheep is an important economic trait that influences value, particularly in the traditional markets of Ethiopia. While coat color was an important selection criterion, its index varied with satisfaction of producers in the production system.

2.4.2.1. Age at weaning

Tsedeke (2007) reported weaning age 4 and 4.6 months, respectively for kids and lambs in Alaba, Southern Ethiopia. Endeshaw (2007) in his finding stated that weaning age of goats in three agro ecologies in Dale district was 6.27, 5.09 and 4.73 in moist dega, weyina dega and kola months, respectively. Zewudu *et al.* (2012) in western and south-western Ethiopia reported that the overall average weaning ages for both sexes and breeds of indigenous sheep was 4.80 months, within a range of 1 to 9 months. Assen and Aklilu (2012) reported 4.4 and 4.7 for lambs and kids in high and midland of Tigray zone respectively.

2.4.2.2. Disposal of sheep and market age

Disposal of sheep and goat depends on production system and nature of growth potential of breeds. For instance, in mixed crop-livestock system of Horro and Bonga areas male lambs are sold as early as three to four months (Gemeda, 2010). Whereas in Menz areas producers sold male sheep at an average age of about 2 years (Tadele, 2010). In the mixed crop-livestock system of Horro and Bonga areas, the available sheep breeds are Horro sheep and Bonga sheep, respectively. Both Horro and Bonga breeds attain about 38.2 and 31.2kg at yearling under farmers' management. Thus, both production system or production environments and breeds can influence marketing of small ruminants. According to Yenesew *et al*. (2013), the age at which most of the sheep sold on market ranged from 6 to 12 months, in Burie district, North Western Ethiopia. Afar ram attains sexual maturity with average age of 7.1 months (Tesfaye, 2008) and also Assen and Aklilu (2012) reported 8.42 and 8.8 months in high and midland of Tigray region. Usually fast growing males are sold early in life while females are retained for breeding. Such early disposal of young animals culminates into unintentional negative selection because the fast growing animals with good genetic potential for growth are continuously eliminated before they pass their good genes to the subsequent

generations, while the genetically inferior ones remain in the flocks and thus contribute the relatively less desirable genes to the next generation (Gemeda *et al*., 2011). Solomon *et al*. (2010) also reported that unintentional negative selection is practiced as ram lambs with good body conformation are sold at an early age of 3– 6 months for immediate cash needs and inferior ones are maintained for breeding. Culling is practiced for a pressing need of cash, unsatisfactory production, and health reasons or to avoid anticipated losses due to prevailing diseases. Other reasons included feed scarcity, overpopulation, drought and prevention of inbreeding, conformation, color and condition of the animal.

2.5. Seasonality in breeding

Season had significant effect on most reproductive traits including fertility, lambing rate and weaning rate. Local breeds of sheep and goats in tropical conditions are either non-seasonal breeders or exhibit only a weak seasonality of reproduction (Girma, 2008). The higher percentages of lambing/kidding during the rainy seasons were also reported by Mukasa *et al.,* 2002 in Ethiopian highlands. Mehlet (2008) reported the highest kidding in May. Most conceptions take place in June and July, which is the beginning of the major rainy season and most lambs/kids are born in November and December (Solomon, 2014). The high lambing/kidding rate recorded during September to October and April to June might be attributed to availability of adequate feed (Dhaba *et al*., 2013). Belete (2009) also reported an intensive lambing/kidding during April to October and lowest lambing/kidding rate during November to January in Gomma district of Jimma zone. Nutrition was also reported as a key factor for increased conception and subsequent lambing and kidding recorded. Rosa *et al.* (2002) also suggested that it is feed rather than photoperiod dictating breeding activity in the tropics and subtropics.

2.6. Flock structure and ownership patterns

The flock structure or flock composition refers to the age and sex profile of the flock i.e., the relative numbers of sheep with respect to age and sex. There were higher numbers of ewes (88.7%) than rams (11.3%). The flock structure of lamb and ewe was higher in the dega than weyna dega. This might be attributed to the prevalent practice of keeping ewe for breeding purpose which accounted the greater portion of the newly born animals but rams are either

castrated or sold when they reach market age (Mengistie *et al.*, 2010 and Fsahastion *et al*., 2013). Proportionally fewer younger males than females (< 1 year of age) of the same age were found in all flocks. Such disparities may arise from early disposal of male lambs.

Breeding rams (1 to 5 year old) were only about 1.3%, 0.28%, 0.68% and 4.3% of the respective total flocks in Afar, Bonga, Horro and Menz, respectively. This clearly indicates that there is critical shortage of breeding rams in Bonga and Horro flocks (Gemeda, 2010). Similarly Zewudu (2008) also reported that there is critical shortage of breeding rams in both Bonga and Horro flocks. The absence of enough number of breeding rams in the flocks may negatively influence reproductive performances of breeding ewes. It can also be observed from the proportions of ewe lambs (those younger than 1 year) and those of between 1 and 2 year of age, that a relatively high off-take rates are practiced for those younger than 1 year of age (i.e. only a small proportion of ewe lambs are retained for replacement and most of them are disposed before they reach breeding age) (Gemeda, 2010). Women own sheep and goats but they are often not allowed to sell the animals in the absence of their husbands, who generally work as migrant laborers. The versatile role of women in livestock related activities was also reported (Tsedeke, 2007). Women and children had higher responsibility in managing small stocks. Usually owners keep different mix of species like cattle, sheep, goats, and equines.

2.7. Common Phenotypic Trait Preferences

2.7.1. Criteria used by small ruminant breeders /buyers to select animals of their choice

Farmers have their own criteria for selection of breeding sheep. The selection criteria used for male sheep and goat is different. For males, tail type, color and height are given the most emphasis for selection. Tesfaye (2008) in Menz and Afar area reported, appearance is a primary ram selection criteria in both crop-livestock and pastoral production system. Zewudu *et al.* (2012) in Adiyo Kaka district of Kaffa zone of Southern Nations, Nationalities of Ethiopia reported ram selection based on body size. For breeding males, black colored, poor conditioned and small sized sheep are not preferred and culled at a young age or sold or slaughtered at home. Furthermore, farmers in different production systems may have different trait preferences (Roessler *et al*., 2008) and they may also follow as diverse strategies as the

agro-environments within which they perform (Solomon *et al.,* 2010 and Tadele, 2010). Understanding farmers' trait preferences provides insights into which traits are particularly important in their agro-ecosystem and how these can be incorporated in the design of sustainable breeding programs.

Farmers also have different criteria in selection of female sheep and goats. Helen *et al*. (2013) reported in ewe selection appearance, coat color and lamb survival in eastern Ethiopia. Gemeda *et al*. (2011) reported as liter size and lamb growth were more important selection criteria in pastoral and agro-pastoral systems than in the mixed crop-livestock system which were considered highly associated with mothering ability. For breeding females, black colored, old aged, poor conditioned and those ewes which have long lambing interval are culled (Zewudu *et al*., 2012 and Yenesew *et al*., 2013).

2.8. Small ruminant marketing system in Ethiopia

In terms of marketing channels, there were primary markets, secondary markets, tertiary markets and terminal markets. The primary markets were mainly at the grass roots while the terminal markets were mainly in the major urban centers (Katiku *et al*., 2013). It was observed that there were no clearly designated primary market yards where farmers could sell their livestock. Berhanu *et al*. (2015) reported most of small ruminant sold at district market. The traders would buy the animals directly from the farm. Tsedeke (2007) in southern Ethiopia reported that most of producers market their animals based on eye-ball estimation and few of them (2.0%) sale live on weigh basis.

According to Yenesew (2010) in Burie woreda, west Gojjam reported that one household sold on average 1.1 heads of sheep per year. The buyers on the market places are mainly farmers (56%), hotel and other food catering owners (21%), civil servants (13%), sheep traders (3%) and others (7%). Berhanu *et al.* (2015) in highland of Ethiopia reported 62% of farmers buy small ruminants for reproduction purpose, 14.4% for household consumption and 13.8% for trading.

Farmers usually sell their sheep and goat during Easter, New Year and Christmas. During this period the demand for sheep increases thereby resulting in steep rise in market prices of

sheep. The male animals are either sold or slaughtered at home during festivals. The study of Yenesew *et al*. (2013) in Burie district, north western Ethiopia indicated that, both young ram and ewe lambs aged 6 month to 1 year mostly sold. Similarly trends were reported by Alubel (2015) for Abergelle and central highland goat. Rams not required for breeding would be sold or castrated before puberty (Taye *et al.,* 2009); usually taken out of service for castration or for sale at the eruption of the second pair of permanent incisors.

The studies have shown that sheep and goat were the only readily available assets to be sold to meet immediate house expenditure by marginal and landless farmers. Farmers sold their animals when they needed cash for home consumption, to pay loan/children's school fees, at time of crop failure or drought and because of difficulty in management (Belete, 2009 and Ramesh *et al*., 2012).

2.9. Small Ruminant Production Constraints and Opportunities

2.9.1. Small ruminant production constraints

In mixed crop-livestock systems, relatively high inbreeding coefficient because of uncontrolled mating and absence of sharing communal land for communal herding might potentially increase the risk unless appropriate measure is taken (Zewudu *et al.*, 2012).

The study of Deribe and Taye (2014) in southern Ethiopia indicated that, non-genetic factors influence reproductive traits and pre-weaning mortality of kids and lambs. Flock management in groups due to resource endowment, parity, litter size, and season (due to seasonal fluctuations in both quantity and quality of feed) were important factors that need to be considered in the improvement plan of sheep and goats.

2.9.1.1. Feed shortage

Lack of adequate feed resources as the main constraint to animal production was more pronounced in the mixed crop-livestock systems, where most of the cultivated areas and high human population are located (Yenesew *et al*., 2013). Many authors described the seasonal feed shortages, both in quality and quantity, and the associated reduction in livestock productivity in different parts of the country (Getahun, 2008 and Yeshitila, 2007). Feed

shortage problem was similar throughout the country, being serious in high human population areas where land size is diminishing due to intensive crop cultivation and soil degradation. Study of Mesay *et al.* (2013) in Lemu-Bilibilo district in Arsi zone reported that, shortage of feed at the end of dry season when all crop residues have been consumed and pasture growth is poor, was the major constraint for livestock production in the area. The feed shortage also appears even in the rainy seasons since more of the lands are occupied by crops.

2.9.1.2. Health constraints

Dereje *et al.* (2013**)** in Daro Labu district of west Hararghe reported that, 21.7% farmers in lowland and 6.7% farmers in midland area traveled more than 10 km distance to reach government clinics. In general, 46.7% of the respondents travelled more than 1 km of distance in order to obtain veterinary services for treatment of diseases and inadequate nutrition (in terms of quality or quantity) constitute serious constraints to small ruminant production in Africa (Tadesse, 2012). Another serious constraint for small ruminant production in Ethiopia has been the high prevalence of diseases and parasites. This causes high mortality amongst kids and lambs, diminishing the benefits of their high reproductive performance (Markos, 2006). Sharif *et al.* (2005) and Girma *et al*. (2013) reported that kids were at higher risk of dying if they were not being separated from adult animals; this risk factor increases the accident and the contamination of the environment of neonates. Here animals with good adaptive potential are needed in these stressful environments to sustain the livelihoods of the communities (Solomon *et al*., 2010; Tadele, 2010; Zewudu *et al.,* 2012 and Helen *et al*., 2013).

2.9.1.3 .Water shortage

Water shortage is a limiting factor in most lowland areas and to a limited extent in mid altitudes. In eastern, north-eastern and 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). Tsedeke

(2007) reported that problem of water shortage in mixed flock and goat dominating areas of Alaba Woreda.

2.9.1.4. Marketing constraints

The study of Yenesew (2010) in Burie woreda, west Gojjam, reported that sheep sellers get market price information mainly from traders or their neighbors. There is no public market information source in the area for the producers, traders or consumers in general. This reduces the marketing system transparency and efficiency. In the sheep markets there is no weighing or grading of animals at the time of sale. Buyers and sellers judge the sheep they buy/ sell through physical observation only (Juma *et al.,* 2010 and Ramesh *et al*., 2012). This is a disadvantage especially for sellers. There is no precise method to know the quantity (in kg) as well as the quality (fat or lean meat) of produce sold or bought. This will affect the production of quality sheep and sheep productivity in the smallholder system. The implication of long transportation is a major issue in the marketing of shoats in Kenya (Juma *et al.,* 2010).

The major problems in traditional management system were that the system is not market oriented, underdeveloped marketing and infrastructure system, and poor financial facility, etc. (Azage *et al.,* 2006 and Berhanu *et al*., 2006). The role of brokers in marketing small ruminants has two views; one group describes them favorably as they facilitate transaction between buyers and sellers while others see them as problems in marketing as they are the ones who mainly decide the price (Endeshaw, 2007; Tsedeke, 2007 and Ramesh *et al.*, 2012).

2.9.1.5. Housing constraints

All farmers kept suckling goats in the house during the first 24-72 hours after which the mother joins the flock for grazing. Farmers also tended to keep kids inside for periods of up to two months during the rainy and drought periods (Tesfaye, 2009). Lack of separation of new born kids from their dams and rest of flocks significantly affected pre-weaning kid. This may be associated with a high risk of miss mothering, injury, predators and insufficient ingestion of colostrums. The death of kids before weaning was perhaps the biggest cause of economic loss to goat farmers and may be reduced by improvements in the management and feeding of the kidding flock (Snyman, 2010; Girma *et al*., 2013).

2.9.2. Small ruminant production opportunities

High demand of the small ruminants in the local market as a result of population increase, urbanization and also all household member involvement in their management can be considered as an opportunity for the small ruminant production (Tsedeke, 2009).

The study of Okpebholo (2007) showed that low start-up cost as an important factor in providing opportunity for the development of a small ruminant production system by a small-scale farmer with limited resources. Similarly, incensement of mutton /chevon demand, as found in present study, was in agreement with finding reported by Solomon *et al*. (2010) indicating that sheep and goat breeds in the lowlands of the country were in good demand in the middle east markets. Tsedeke (2007) and Zawudu *et al*. (2012) in western and south-western reported, gender participation is another sheep and goat production opportunities.

3. MATERIALS AND METHODS

3.1. Description of Study Area

Based on agro ecology and potential for small ruminant production, the districts of Ada Barga and Ejere of west Shoa zone of Oromia Regional State were selected for the present study. The geographical area of these two districts is shown as shaded area in figure 1.

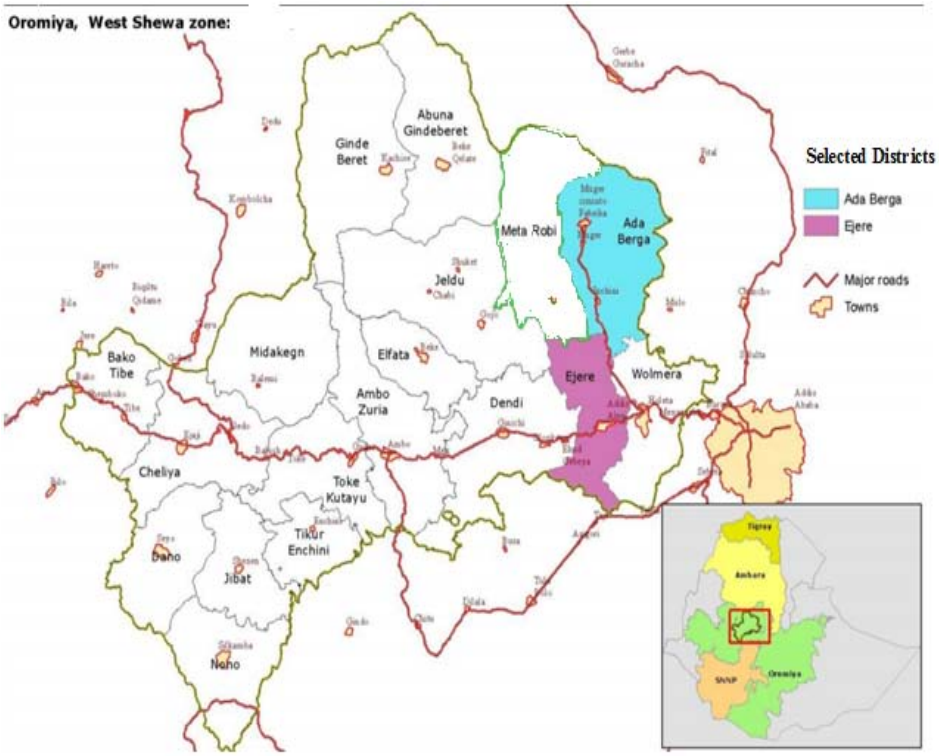

Figure 1: Map of the study area

3.1.1. Ada Barga district

a. Geographical location

Ada Barga is one of the 18 districts in West Shoa zone located at a distance of 60km, West of Addis Ababa, capital city of Ethiopia. The major town is Inchini. This district was selected due to its potential for small ruminant production.

b. Natural resource base

i. Climate

The Ada Barga district receives an average annual rainfall ranging from about 887 to 1,194mm. The minimum, medium and maximum daily temperatures of the area are 10, 15 and 25^{o}C respectively.

ii. Vegetation

The district has relatively high forest cover that serves as a source of livestock feed habitat for different wild life and potential area for small ruminant, dairy, apiculture and irrigated agriculture. Acacia species are major forest tree species in the area. The forest area holds wild animals like leopard, hyena, monkey, fox which are a potential treat for small ruminant production. Major vegetable crops produced in the district are onion, potato, cabbage, and garlic to a smaller extent. Garlic is produced only in small plots although it is a high priced vegetable.

iii. Soil types

The major soils of the Ada Barga district are: platy 44%, red 39% and brown (mixture) 17%.

iv. Agro-ecology

The district is classified as 29% highland, 34% midland and 37% lowland (Zonal Basic Data, 2000) and is situated at an altitude ranging from 1400 to 3,270 meters above sea level (m.a.s.l).

c. Farming system

The livestock commodities of the woreda include cattle, sheep, poultry, equines and goats. The small ruminants consist of 57,511 sheep and 43,574 goats (Fanos, 2012). The district has high potential for both sheep and goat production. The major crops grown in the district were: wheat, barley, pea, sorghum and minor crop like teff and maize. In addition to these, irrigated vegetables like potato, white onion, red onions and cabbage was also produced in the area.

d. Demographic structure

There are 36 rural kebeles and 3 urban kebeles in Ada Barga with an estimated area of 131.12 square kilometers. This district has an estimated total population of 120,654 of whom 60,288 were females and 60,366 were males (Fanos, 2012)

3.1.2. Ejere district

a. Geographical location

Ejere is one of the 18 districts in West Shoa zone and located at a distance of 40 km, West of Addis Ababa, capital city of Ethiopia. The major town is Addis Alem. This district was selected due to potential for small ruminant production.

b. Natural resource base

i. Climate

Ejere district receives an average annual rainfall ranging from about 900mm to 1,200mm. The minimum and maximum daily temperatures of the area are 22 and 28^{o}C, respectively.

ii. Vegetation

The district has relatively high forest cover that serves as a source of livestock feed habitat for different wild life also potential area for small ruminant, dairy, apiculture and irrigated agriculture. Major vegetable crops produced in the district were onion, potato, cabbage, and garlic to a smaller extent.

iii. Soil types

The major soils of the Ejere district are: red soil 58%, black soil 32% and loam soil 10%.

iv. Agro-ecology

The district has been classified into two agro-ecological zones, viz: highland and midland (Zonal Basic Data, 2000). In all 12 and 18 kebele of this district fall in highland and midland

agro-ecological zone respectively. The district is situated at an altitude ranging from 2060 to 3,185 meters above sea level (m.a.s.l).

c. Farming system

The livestock commodities of the Woreda include cattle, sheep, poultry, equines and goats. The small ruminant production consists of 41,368 sheep and 10,197 goats and the district has high potential for both sheep and goat production (Fanos, 2012). The major crops grown in the district were: wheat, barley, pea, teff, sorghum and minor crop like maize and vetch. In addition to these vegetable crops, viz: potato, white onions, cabbages and red onions were also produced in the area.

d. Demographic structure

There are 27 rural kebeles and 3 urban kebeles in Ejere district with an estimated area of 192.78 square kilometers. This district has an estimated total population of 86,934 of whom 42,712were females and 44,222 were males (Fanos, 2012).

3.2. Research Design, Sampling and Data Collection.

3.2.1. Data sampling procedure and sample size.

Secondary data were used to achieve the objectives of the study. The secondary data pertaining to livestock population, farming practices, demography, etc were collected from Zonal Agricultural Department Office and Livestock Development Agency. The kebeles in the two districts were stratified into three agro-ecological zones (AEZs), viz: low lands (<1500 masl), midlands (1500-2300masl) and high lands (>2300masl) according to Ministry of Agriculture (MOA) (2000) and Dereje (2011). The discussions with district livestock head and experts showed that in Ejere district 12 and 18 kebeles fall in highland and midland agro-ecological zone, respectively. Out of these one kebele (Damotu) and two kebeles (Chiri and Kimoye) falling in highlands and midlands, respectively, were purposively selected on the basis of sheep and goat production potential. Similarly Ada Barga district has been stratified in three agro ecological zone, viz: highland (11 kebeles), midland (13 kebeles) and lowland (15 kebeles). One kebele from each of three agro-ecological zones, viz: ulagora (highland),

laku karsa (midland) and wogidi (lowland) were selected based on potential for small ruminant production. Thus a total of six kebeles were selected from two districts for present study.

A total of 180 households were purposively selected owning four or more sheep / goat from the total number of house-holds (1833 rearing small ruminant) in the six kebeles for the present study (Table1).

Table 1: Number of households selected per six kebeles.

Agro ecological zone (AEZs)	selected kebeles	Total number of household possessing small ruminants	Proportionate number of households selected/kebele
Highland	Damotu	413	41
	Ulagora	290	28
Midland	Kimoye	178	17
	Chiri	249	24
	Laku karsa	331	33
Lowland	wogidi	372	37
Total	6	1833	180

The numbers of household (69, 74 and 37 in HL, ML and LL, respectively) from each selected kebeles were determined according to proportionate sampling technique as under:

$$W = [A/B] \times N_o$$

Where:

W= Number of household to be calculated from singe selected kebele

A=Total number of households per kebele

B= Total number of households all six kebeles

N_o = the calculated sample size.

The sample size 180 house hold was determined according to the Arsham (2002) as under:

$N=0.25/SE,^2$

Where:

N= Sample size,

SE= Standard error (0.0373) with 95% confidence level

However during this study farmers having an average flock size of ≥4 sheep or goats were interviewed for this study. The sheep and goat rearing farmers were interviewed separately. However, during this some of the farmers rearing both sheep and goats were interviewed two times and this resulted in the total sum of interviews exceeding sample size of 180 household and total percentages above 100%.

The data for this investigation was collected by engaging three enumerators for each study area. The enumerators engaged were adequately trained for collection of the information and/or data in the study area. The pre tested questionnaire was translated to local language of the respondent. Then, the primary data was collected from sample respondents through structured questionnaire (Appendix B) from February-August, 2015.

3.3. Data Sources and Collection Method.

The data for the present study were collected from individual respondents' and focus group discussion.

3.3.1. Survey of sheep and goat production system

Household data on socio-economic characteristics (sex, age, family size, education level, marital status, land size and livestock holding), small ruminant production system, viz: flock structure (age, sex, number of male and female), purpose of keeping small ruminant, marketing of small ruminants (reason of buying/selling, age and sex of animals to be sold, marketing channels, season of marketing, participants and mode of price setting) were collected from selected sheep / goat rears in the study area. The data on reproduction traits (age at first parturition, lambing/kidding interval, liter size); mortality (at different ages), reason of culling, Farmer's indigenous knowledge (IK) with respect to mating system,

watering system, castration, housing system, health management, grazing management, Producer's trait preference (for selection of breeding males and females of small ruminant), adaptive traits (preferred for purchasing and/or marketing or consumption) were collected through the questionnaires (Appendix B) in order to characterize the small ruminant production system in the study area. Besides the major constraint and opportunities of small ruminant production data was investigated using pre-tested and structured questionnaires (Appendix B).

3.3.2. Focused group discussion (FGD)

Focused group discussions were undertaken using checklists to collect information on sheep and goat production and marketing system, productivity, trait preferences, challenge and opportunity. Group composed of 6-9 members of key informants was formed for gathering information. Key informants such as elders, community leaders, women representative, animal health technician and development agents were targeted for the FGD.

FGD were mainly concerned with the characteristics of sheep and goat in the study area, productive and reproductive performance, rank of traits perception by producers, major marketing age of sheep and goats, major entry and exit, constraints and opportunities for small ruminant production, availability of communal land and its utilization, indigenous knowledge on management of breeding was collected using a prepared check list (Appendix C).

3.3. Methods of Data Analysis

3.3.1. Ranking for traits and indices

There are parameters that requiring ranking. Therefore, indices were calculated to provide ranking of breeding objective of sheep and goat, major available feed in both wet and dry season, trait preferences (for both male and female sheep and goats), adaptive feature for sheep and goats, major small ruminant production constraints, way of entry and exit of small ruminants. The indices were calculated as stated here under:

Index = sum of [(3 x number of household rank first) + (2 x number of household rank second) + (1 x number of household rank third)] for a particular cause divided by sum of [(3 x number of household rank first) + (2 x number of household rank second) + (1 x number of household rank third)] for all causes in an agro ecology.

3.3.2. Descriptive statistics

The data on family size, landholding, livestock holding, flock structure, traits studied like: age at first parturition, weaning age, marketing age, lambing/kidding interval, liter size, reproductive life span of sheep and goat was organized, summarized and analyzed by SPSS statistical package (SPSS ver.20, 2011).

3.3.3. Inferential statistics

Comparison of means by one way ANOVA was done using the SPSS statistical software. The General Leaner Model (GLM) of SPSS ver. 20 was used to compare production system parameters across the agro-ecologies and their significance difference was tested. All studdied data on reproduction & production performance of sheep and goat population is generalized by inferential statics.

Model on various performances parameters of sheep and goat, Wherever ANOVA test were employed, the following single factor ANOVA model was used.

$Yij = \mu + AEZ_i + eij$

$Yij = Y^{th}$ observation in i^{th} class

μ = Overall mean

AE_i = effect of agro ecologies, where i =1, 2, 3, j= AEZs

eij = Random error

3.3.4. Estimation of inbreeding:

Rate of change in inbreeding per generation were calculated using the data for effective number of breeding animals (male and females) for household flock is closed (individual grazing) and mixed grazing. Estimates of average change in percentage inbreeding per generation was made and expressed as:

$$\Delta F = 1 / (2\,Ne)$$ (Falconer and Mackay, 1996)

Where: ΔF = Rate of change in inbreeding per generation

Ne = the effective population size

$$Ne = 4\,Nm \times Nf / Nm + Nf$$

Where: Nm = number of breed-able male, Nf = number of breed-able female

4. RESULTS AND DISCUSSIONS

4.1. Socio-Economic Characteristics of Households

4.1.1. General socio economic characteristics

The results of general socio economic characteristics, across three AEZs, have been presented in table 2. Perusal of table showed that majority of households covered in the current study were male headed in the three agro-ecologies. The male and female headed households were 80.6% and 19.4% (pooled), respectively. The majority of house hold heads were in the age group of 21-50 years in both sexes (47.8 and 13.3% in male headed and female headed households, respectively). This is in agreement with the findings of Alubel (2015), who reported similar trends in Ziquala district and Lay Armachiho districts of Amhara Regional State. The study of the educational level of house hold heads showed that 40.0, 54.4, 8.3 and 3.3 % of households' heads were illiterate, could read and write, read up to primary and secondary, respectively. The marital status of household head revealed that 93.3 % were married in the study area. The majority of the households heads professed orthodox (90.5%), followed by protestant (7.2%), waqefata (1.7 %) and seventh day Adventist (0.6 %).

4.1.2. Family size, land and livestock holding.

The results on family size, land and livestock holding have been presented in table 3. There was no significant difference (>0.05) among male, female members of the families and total family size across the three AEZs (Table 3). The total family size in highland, midland and lowland were 7.6, 6.8 and 7.1, respectively in the present study. These values were higher than the average family size of 5.5 reported from Oromia Regional State in 2013 (CSA, 2013).

The average total cultivated land showed significant ($p < 0.05$) difference among the three AEZs. The highest (2.9 hect.) and lowest (1.9 hect.) average cultivated land was found in midland and lowland AEZs, respectively. The pair-wise comparison showed that difference in the mean cultivated land between highland and lowland was significant ($p < 0.05$) whereas differences in remaining mean pairs were not significant.

Table 2: Gender, educational level, marital status and religious belief of house-hold heads

Descriptor	Agro-ecology							
	Highlands		Midlands		Lowlands		Pooled	
	N	%	N	%	N	%	N	%
No. of households	69	38.3	74	41.1	37	20.5	180	100.0
Gender of HH heads								
Male headed	53	29.4	63	35.0	29	16.1	145	80.6
Female headed	16	8.9	11	6.1	8	4.4	35	19.4
Male headed age								
21-50 years	16	8.9	46	25.6	24	13.0	86	47.8
51 and above years	37	20.6	17	9.4	5	2.3	59	32.8
Female headed age								
21-50 years	10	5.6	8	4.4	6	3.3	24	13.3
51 and above years	6	3.3	3	1.7	2	1.1	11	6.1
Education level of HH heads								
Illiterate	24	13.3	23	12.8	14	7.8	61	40.0
Read and write	37	20.6	39	21.7	22	12.1	98	54.4
Primary	6	3.3	8	4.4	1	0.6	15	8.3
Secondary	2	1.1	4	2.2	-	-	6	3.3
Marital status of HH heads								
Single	0	0	1	0.6	0	0	1	0.6
Married	66	36.7	67	37.2	35	19.4	168	93.3
Divorced	0	0	4	2.2	1	0.6	5	2.8
Widow	3	1.7	2	1.1	1	0.6	6	3.3
Religion								
Orthodox	61	33.9	71	39.4	31	17.2	163	90.5
Seventh day adventist	1	0.6	0	0	0	0	1	0.6
Protestant	5	2.8	2	1.1	6	3.3	13	7.2
Waqefata	2	1.1	1	0.6	0	0	3	1.7

N= Number of respondents, HH=household

The total grassland also showed significant ($p < 0.05$) difference among three AEZs. The highest (0.9 hect.) and lowest (0.5 hect.) average grass land was found in lowland and

highland AEZs, respectively. Pair-wise comparison revealed significant differences among all pairs. The highland areas encountered scarcity of grassland whereas lowland areas were faced with shortage of cultivated land in the study areas. The current results were comparable with earlier reports of Fsahatsion (2013) for Gamo gofa Zone (SNNP regional state). The possible reasons could be human population growth rate, land degradation and soil erosion resulting in declining of landholding per household across the three agro-ecologies of the districts.

The average TLU holding of cattle, goat, sheep and horse (Table 3) are significantly ($p < 0.05$) influenced by the AEZs. The three AEZs showed different trends in the TLU of animals per house-hold with respect to three species, viz: cattle, goat, and sheep. The observed trends in highland was sheep greater than cattle and goat, in midland cattle greater than goat and sheep and in lowland goat was greater than cattle and sheep

The cattle per household (TLU) was highest (6.37) in HL and lowest (3.64) in lowland areas (Table 3). The difference in the average cattle / household between highland and lowland was significant. The present findings with respect to cattle were higher than the results of 3.78 reported by Tsedeke (2011) in the highland of Wolaita and Dawuro districts (SNNP Regional State) and the 3.01 reported by Assen and Aklilu (2012) in high land of Dgua Tembien, Laelay Mychew and Mereb Lehe districts (Tigray Regional State). The possible reason for higher number of cattle / household in the highlands of Ada Barga and Ejere districts (present study areas) may be their suitability for cattle rearing together with availability of good milk marketing opportunity (by being nearer to Addis Ababa).

The sheep per household in TLU (Table 3) were highest (1.02) and lowest (0.13) in highland and lowland areas, respectively whereas the average numbers of goats / household were highest (0.75) and lowest (0.05) in lowland and highland AEZs, respectively. These results showed that there was a contrasting trend in sheep and goat numbers / household in the present study. The differences in the average sheep and goat per household among all pairs of comparison were significant ($p < 0.05$). The present results with respect to numbers of goat / household were higher than the earlier finding of 0.02, 0.04 and 0.09 in the highland, midland and lowland of Wolaita and

Table 3: Family size, Land holding and Livestock holding per household in three AEZs

Descriptors	High land (N=69)	Midland (N=74)	Lowland (N=37)	Overall (N = 180)	P-value
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	
Family size (numbers)					
Male	3.9 (1.7)	3.5 (1.6)	3.8 (2.6)	3.7 (1.6)	0.296
Female	3.6 (1.6)	3.3 (1.4)	3.3 (2.2)	3.4 (1.5)	0.527
Total	7.6 (2.6)	6.8 (2.2)	7.1 (2.4)	7.1 (2.4)	0.224
Land (hectors)					
Total cultivated land	2.1 (1.5)^{a}	2.9 (2.0)^{ab}	1.9 (1.3)^{b}	2.4 (1.7)	0.004
Total grass land	0.5 (0.4)$^{\mathbf{a}}$	0.6 (0.5)^{b}	0.9 (0.8)^{c}	0.7(0.6)	0.038
Livestock (TLU)					
Cattle	6.37 (7.2) $^{\mathbf{a}}$	5.04 (4.2) ^{ac}	3.64 (3.1) ^{c}	5.02 (5.5)	0.002
Goat	0.05 (1.7) $^{\mathbf{a}}$	0.55 (5.3) ^{b}	0.75 (5.0) ^{c}	0.45 (5.0)	0.000
Sheep	1.02 (8.0) $^{\mathbf{a}}$	0.43 (4.5) ^{b}	0.13 (2.4) ^{c}	0.53 (6.8)	0.000
Donkey	0.40 (1.0)	0.60 (1.1)	0.55 (1.3)	0.52 (1.1)	0.218
Horse	0.64 (1.5) $^{\mathbf{a}}$	0.24 (0.5) ^{b}	0.08 (0.4) ^{bc}	0.32 (1.0)	0.000
Mule	0.0 (0.2)	0.07 (0.6)	0.0 (0.2)	0.02 (0.4)	0.686
Chicken	0.05 (4.9)	0.05 (4.9)	0.06 (3.4)	0.50 (4.6)	0.352
Bee hives	0.8 (3.2)	0.7 (1.6)	1.5 (2.6)	0.9(2.5)	0.325

N= number of respondent, SD= standard deviation, Same superscript indicate non-significant differences, Different superscript indicate significant differences

Dawuro districts (SNNP Regional State) by Tsedeke (2011). The present results were lower than the reports of Assen and Aklilu (2012), who reported a higher number of goats / household (0.514 and 0.86 in highland and lowland, respectively) in Tigray zone. However the trend in the number of goats / household, in lowland higher than the two AEZs, observed in the present study was in conformity with the trend reported by both these authors. The contrast in the trend of number of sheep (highest in highland but lowest in lowland) and goat (highest in lowland and lowest in highland) per household, observed in the present study, may

possibly be due to the differences in adoptive behavior of these two species to climatic conditions in high and lowland agro-ecologies.

The numbers of horses / house hold (Table 3) were 0.64, 0.24 and 0.08 in high, mid and low-land areas, respectively. The differences among highland - midland and highland – lowland were found to be significant.

4.2. Small Ruminant Production System

The results of farming activities in the study area are presented in table 4. Perusal of this table showed that all respondents across AEZs of the study area (Ada Barga and Ejere districts of west Shoa Zone) were following mixed crop-livestock farming system. The current results were in conformity with respect to highland and lowland AEZs with the earlier report of Solomon (2014), who found that mixed crop-livestock farming system was followed in the altitude between 1500 to 3000 masl in Metema and Abergelle districts of the Amhara National Regional State of Ethiopia.

Table 3: Farming activities in the study area

Particulars	HL (N=69)	ML (N=74)	LL (N=37)	Total
(A) Farming activities (%):				
Livestock production alone	0	0	0	0
Crop production alone	0	0	0	0
Mixed livestock crop production	69(38.3)	74(41.1)	37(20.6)	180(100.0)
(A) Most crops cultivated /produced (%):				
Wheat	41(22.8)	25(13.9)	3(1.7)	69(38.3)
Barley	16(8.9)	23(12.8)	-	39(21.7)
Maize	-	3 (1.7)	15(8.3)	18(10.0)
Sorghum	-	8 (4.4)	10(5.6)	18(10.0)
Teff	8(4.4)	8(4.4)	5(2.8)	21(11.7)
pea	4(2.2)	7(3.9)	4(2.2)	15(8.3)

HL=highland, ML=midland, LL=lowland, N=number of respondents

4.2.1 Flock structure and production objectives

4.2.1.1. Flock structure

The flock structure by age and sex of both goat and sheep in the three AEZs are presented in table 5. Perusal of table 5 showed that all age groups in the two sexes of both species were significantly affected by AEZs except male and female 6 months to 1 year in goat and male 6 months to 1 year, castrate groups in sheep. The pair-wise comparison of means in goats showed significant differences among HL-ML, HL-LL AEZs in male / female kids aged < 6 months; HL-LL, ML-LL AEZs in male goat groups > 1 year and HL-ML, HL-LL AEZs in females goat aged > 1 year. Similarly the pair-wise comparison of means in sheep revealed significant differences among all three pairs of AEZs in male lambs aged < 6 months; HL-ML, HL-LL in female lambs aged < 6 months, female lambs aged 6 months to 1 year and female sheep aged > 1 year and between HL-LL in male sheep aged > 1 year. The trends in the flock structure (Table 5) were in accordance with trends observed in number of both sheep and goat in the study area as reflected in table 2 above. The results were in agreement with the finding of Yaekob (2014) with respect to goat in the three AEZs.

The overall mean of goat per household were lower in female aged 6 months to 1 year (0.08), male aged 6 months to 1 year (0.15) and male > 1 year (0.36) compared to other groups. Similarly overall mean number of sheep / household were lower in male aged 6 months to 1 year (0.21), female aged 6 months to 1 year (0.23) and male > 1 year (0.28) compared to other groups. The possible reason for lower mean numbers of these groups may be sale of these animals. The overall means number of goat and sheep per household were highest in adult females aged > 1 year. The current results were lower than the reports of Solomon (2014) who reported 4.2 (2.32), 3.1 (2.58), 0.6 (0.92) and 25.9 (36.29), 9.5(14.29), 2.8(2.94) for breeding does, kids and breeding buck in lowland Metema district and highland Abergelle goat of the Amhara National Regional State of Ethiopia respectively.

Table4: Flock structure over sexes and ages.

Particulars	HL Mean (SD)	ML Mean (SD)	LL Mean (SD)	Overall mean	p-value
(A) Goat flock structure by age and sexes					
Male kids < 6months	0.04(0.03) [a]	1.04(0.18) [b]	1.05(0.22) [b]	0.66(0.09)	0.000
Female kids <6 months	0.04(0.03) [a]	0.96(0.18) [b]	1.08(0.23) [b]	0.63(0.09)	0.000
Male 6 months to 1 year	0.03(0.02)	0.18(0.05)	0.32(0.17)	0.15(0.04)	0.053
Female 6 months to 1 year	0.01(0.01)	0.1(0.04)	0.14(0.07)	0.08(0.02)	0.162
Male > 1 year	0.03(0.02) [a]	0.35(0.08) [a]	1.00(0.24) [b]	0.36(0.06)	0.000
Female > 1 year	0.39(0.15) [a]	2.62(0.29) [b]	3.65(0.48) [b]	1.98(0.19)	0.000
Castrate	-	0.23(0.07)	0.27(0.16)	0.15(0.04)	0.042
(B) Sheep flock structure by age and sexes					
Male lambs < 6months	1.75(0.20) [a]	0.70(0.12) [b]	0.08(0.04) [c]	0.98(0.10)	0.000
Female lambs <6 months	1.72(0.25) [a]	0.55(0.12) [b]	0.14(0.06) [b]	0.92(0.12)	0.000
Male 6 months to 1 year	0.32(0.09)	0.20(0.08)	-	0.21(0.04)	0.058
Female 6 months to 1 year	0.45(0.11) [a]	0.12(0.05) [b]	0.05(0.03) [b]	0.23(0.05)	0.004
Male > 1 year	0.42(0.10) [a]	0.26(0.05) [ab]	0.08(0.04) [b]	0.28(0.04)	0.028
Female > 1 year	5.41(0.50) [a]	2.39(0.27) [b]	1.00(0.32) [b]	3.12(0.26)	0.000
Castrate	0.12(0.04)	0.12(0.05)	-	0.09(0.02)	0.204

SD= standard deviation, Same superscript indicate non-significant differences, Different superscript indicate significant differences at P<0.05 level

4.2.1.2. Breeding objectives of small ruminants

The rankings of sheep and goat production objectives in the three AEZs were presented in table 6. The first reason for sheep and goat rearing in all three agro ecologies was reported to be as a source of income generations through sale of live animals with an index value of 0.41, 0.47 and 0.48 (for sheep) and 0.6, 0.42 and 0.47 (for goat) in high, mid and low lowland AEZs, respectively. The FGD revealed that sale of live animal generates cash income to the farmer which may be used to buy clothing and food items, pay taxes, purchase fertilizers and other household goods. These findings were in agreement with reports of earlier workers (Solomon *et al*., 2010; Mekuriaw *et al*., 2012; Arse *et al*., 2013 and Hundie and Geleta, 2015).

Table 5: Ranking of sheep and goat production objectives by agro ecologies

Particulars	High land				Midland				Lowland				Over-all
	R1	R2	R3	I	R1	R2	R3	I	R1	R2	R3	I	I
(I) Production objective of sheep:													
Income generation	37	26	3	0.41	33	9	1	0.47	8	1	0	0.48	0.45
Meat	13	14	12	0.18	0	13	3	0.12	1	1	1	0.11	0.14
Manure (fertilizer)	7	5	30	0.15	1	2	23	0.11	0	0	3	0.06	0.11
Social (cultural function)	1	1	0	0.01	0	3	0	0.02	0	3	0	0.11	0.05
Saving (insurance)	6	14	11	0.14	3	13	8	0.17	0	2	5	0.17	0.17
Risk/benefit distribution with other animals	3	7	11	0.08	5	1	6	0.07	0	2	0	0.07	0.08
(II)Production objective of goat:													
Income generation	7	0	0	0.6	35	7	1	0.42	21	8	0	0.47	0.50
Meat	0	3	0	0.21	7	22	2	0.24	6	7	2	0.20	0.21
Manure (fertilizer)	0	0	2	0.07	1	4	10	0.07	1	2	10	0.11	0.08
Social (cultural function)	0	1	0	0.06	1	3	3	0.04	0	3	1	0.04	0.05
Saving (insurance)	0	1	2	0.14	2	5	24	0.15	0	6	3	0.08	0.12
Risk/benefit distribution with other animals	0	0	0	0	3	6	3	0.08	2	2	6	0.09	0.05
Milk	0	0	0	0	0	0	0	0	0	0	1	0.01	0.003

R1= first rank, R2=second rank, R3= third rank, I= index

The second main reason (Table 6) for sheep and goat rearing in all the three agro ecologies was reported to be as a source of meat (personal consumption) except for sheep in midland and lowland areas where the second reason was found to be as saving (insurance) against any unforeseen calamity. The index value were 0.18 in high and 0.17 in (midland and lowland), respectively, for sheep whereas these were 0.21, 0.24 and 0.20 in high, mid and lowland,

respectively, for goat. The present finding (ranking of meat as second objective) was in agreement with earlier reports (Belete, 2009; Mengistie *et al.*, 2010 and Alubel, 2015).

The third reason (Table 6) of sheep rearing was manure (0.15) in highland, meat (0.12) in mid land and saving/social function (0.11) in lowland. Similarly third reason of goat rearing was saving (0.14 and 0.15 in high and midland, respectively) and manure (0.11) in lowland areas.

The overall objectives (Table 6) for sheep rearing (across all AEZs) ranked in the order of income (0.45), saving (0.17) and meat (0.14). However the overall objectives for goat rearing (across all AEZs) ranked as income (0.50), followed by meat (0.21) and saving (0.12).

4.2.3. Feed an feeding system

4.2.3.1. Major feeds available

Major grazing areas (lands) in the three agro ecologies have been presented in table 7. Grazing of small ruminants was common feeding practice in the study area. The grazing is carried on three types of grass land, viz: Land owned by the sheep/ goat rearer themselves, land taken on rent and community grazing land. The interviews with respondent (Table 7) showed that 10.6, 14.4 and 15.6% of households possessed their own grazing land; 26.7, 24.4 and 1.7 % utilized rented grazing land; and 1.1, 2.2 and 3.3%, respectively, made use of community grazing land in HL.ML and LL AEZs. The present findings indicated that own grazing land and community grazing land were utilized by higher % of respondents in LL AEZ compared to HL and ML AEZs. The proportion of respondents using community grazing land in the present study with respect to HL and Ml were very low than the earlier report of Fsahatsion *et al.* (2013) who reported 41.3 and 46.7% of respondents utilizing community grazing land in high and midland respectively at Gamo gofa zone, Southern Ethiopia. However the trend of higher proportion of respondents in ML followed by HL was similar to the trend found by current investigator. In the same study (Fsahatsion *et al.*, 2013) found that the proportion of respondents using own/private grazing land was 25.0% in high and 22.8% in midland. The present result was lower than these reports.

Table7: Most common grazing land of sheep and goat.

Most common grazing land	HL	LL	ML	Overall mean
On the own land	10.6	14.4	15.6	13.53
On the rented land	26.7	24.4	1.7	17.6
On the communal land	1.1	2.2	3.3	2.2

The Index values of major sheep and goat feed sources in three agro ecologies during dry and wet season is presented in table 8. Natural pasture was the major source of small ruminant feed both in dry and wet seasons in all the three agro-ecologies. The current finding was in agreement with Grum (2010) in Metema district, around Amhara region; Amelmal (2011) in Dawuro Zone, Konta Special Woreda of SNNPR; Biruh (2013) in Low Land areas of South Omo Zone and Alubel (2015) around Amhara and Tigray National Regional States. The natural pasture was ranked as first feed source for small ruminants in both wet (with index value of 0.98, 0.96 and 0.95) and dry season (with index value of 0.49, 0.48 and 0.49) in three AEZs (HL, ML, LL, respectively) in the current study. Table 8 revealed that natural pasture was the only feed source of small ruminants during wet season. However, during dry season apart from natural pasture, the other major feed sources were crop residues (ranked second), crop aftermath (ranked third) and hay (grass only, ranked fourth) in that order in all the three AEZs with an overall index values of 0.30, 0.15 and 0.04, respectively.

Table 8: Ranking of major sheep and goat feed sources in agro-ecologies of districts in wet and dry seasons.

Most available feed sources for sheep and goat	High land				Midland				Lowland				Total
	R1	R2	R3	I	R1	R2	R3	I	R1	R2	R3	I	I
Wet season													
Natural pasture	69	59	0	0.98	74	60	0	0.96	37	35	0	0.95	0.96
Non conventional	0	2	5	0.02	0	5	3	0.04	0	2	7	0.05	0.04
Total	69	61	5	1.00	74	65	3	1.00	37	37	7	1.00	1.00
Dry season													
Natural pasture	58	3	3	0.49	57	7	5	0.48	30	3	2	0.49	0.49
Hay (Grass only)	1	6	2	0.05	2	4	4	0.04	0	3	1	0.04	0.04
Crop aftermath	3	17	11	0.15	5	14	15	0.15	2	10	4	0.15	0.15
Non conventional	0	2	8	0.03	0	0	4	0.01	0	0	6	0.03	0.02
Crop residues	7	41	0	0.28	10	49	1	0.32	5	21	1	0.29	0.30
Total	69	69	24	1.00	74	74	29	1.00	37	37	14	1.00	1.00

4.2.3.2. Grazing management of sheep and goats

Perusal of result in (Table 9) revealed that small ruminants were grazed in six different ways in the three AEZs. These six ways were (i) sheep alone, (ii) goat alone (iii) mixed sheep and goat, (iv) sheep with other livestock but not goat, (v) goat with other livestock but not sheep and (vi) sheep and goat mixed with all other livestock. The overall proportion of respondents following these 6 grazing ways were 32.8, 20.6, 18.9, 13.9, 8.9 and 5.0 % for sheep with other livestock but not goat, sheep alone, goat with other livestock but not sheep, goat alone, sheep and goat mixed with all other livestock and mixed sheep & goat, respectively. However, FGD showed that farmers prefer feeding goats alone instead of gazing/browsing them with sheep. This may be due to the fact that goats have the ability to browsing many plant species within short period and less time is required to fill their gut than sheep.

The grazing / browsing practices in dry season (Table 9**)** showed that majority of respondents (23.4 and 27.8 in HL and ML, respectively) followed free grazing of sheep and goat. However free grazing was practiced by a very small proportion (1.7 %) of respondents in LL area in which 12.2 % of respondents (majority) followed herded grazing practice. The possible reason for this may be high population of predators in LL AEZ due to presence of high forest cover. During wet season the small ruminants were herded during grazing by majority of

respondents in all the three AEZs (21.7, 27.8 and 13.9 % in HL, ML and LL, respectively). The possible reason may be that the farmers protect standing crops from any damage due to free grazing of small ruminants and also availability of good grass cover during wet season. These results, for both dry and wet season, were not in agreement with the earlier report of Belete (2009) for sheep dominant, goat dominant, and mixed livestock systems in western Ethiopia.

Table 9: Grazing management of sheep and goat (percentage)

Particulars	Highland (N = 69)	Midland (N =74)	Lowland (N = 37)	Total
Grazing ways				
Sheep alone	11.7	8.3	0.6	20.6
Goat alone	-	5.0	8.9	13.9
Mixed Sheep and goat	0.6	4.4	-	5.0
Sheep with other livestock but not goat	22.8	6.1	3.9	32.8
Goat with other livestock but not sheep	1.1	11.7	6.1	18.9
Sheep and goats with other livestock	2.2	5.6	1.1	8.9
Grazing / browsing Practices in dry season				
Free grazing	23.4	27.8	1.7	53.9
Tethered grazing	0.6	0.6	1.7	2.8
Herded	3.3	2.8	12.2	17.2
Roaming and tethered grazing	9.4	8.9	2.2	20.6
Herded and tethered	0.6	1.1	3.9	5.6
Grazing / browsing practices in wet season				
Tethered grazing	8.9	8.3	1.1	16.1
Herded	21.7	27.8	13.9	63.3
Herded and tethered	7.8	5.0	5.6	20.6

4.2.3.3. Water source and utilization

The results of source of water and frequency of watering are presented in table 10. The rain water followed by river water was the main source of water for sheep and goat during rainy season in all AEZS. However during dry season river water followed by spring water were the main sources for watering small ruminants in the three AEZs.

Table10: Source and frequency of watering sheep and goats in dry and wet seasons.

Description	HL		ML		LL		Overall	
	Rainy season	Dry season	Rainy season	Dry season	Rainy season	Dry season	Rainy season	Dry season
Source of water for sheep and goat								
River	8.9	31.7	10.6	33.3	2.2	14.4	21.7	79.4
Spring	1.7	6.1	5.6	7.8	1.1	6.1	8.3	20.0
Ground water	-	0.6	0.6	-	-	-	0.6	0.6
Rain water	27.8	-	24.4	-	17.2	-	69.4	-
Frequency of watering sheep and goat								
Freely available	33.9	3.9	35.0	2.2	16.1	-	85.0	6.1
Once a day	4.4	32.2	6.1	36.7	4.4	14.4	15.0	83.3
Once in 2 days	-	2.2	-	2.2	-	6.1	-	10.6

The current study result is in agreement with the report of Alubel (2015) who reported that rivers were an important source of water during dry and wet seasons in crop livestock system households. The frequency of watering during rainy season (Table 10) showed that small ruminants had free access to the water. This may be due to abundant availability of water during rainy season. During dry season small ruminants were either watered once in a day (32.2, 36.7 and 14.4 % of respondents) or once in two days (2.2, 2.2, 6.1 % of respondents) in HL.ML and LL areas, respectively. The possible reason is shortage of surface water during dry season. This was corroborated by FGD which revealed that during dry season springs and some rivers get dried and as a result not only sheep and goat but also human beings spent their time to search water.

4.2.3.4. Small ruminant management and husbandry

4.2.3.4.1. Housing

Housing is one of the major sheep / goat husbandry activities which protect them from extreme temperature, rain, wind, predators and theft. The findings in the present study are presented in table 11. Majority of household in midland (16.1%) and lowland (13.9%) of districts were confining their sheep and goats in family house. However in HL the majority

(18.9 %) of respondents housed sheep in separate house. Verandah was used for housing both sheep / goat in next order by 10.0, 15.6 and 5.6 % of respondents in HL, ML and LL areas, respectively. The current study was in agreement with Tsedeke (2007) in Alaba of SNNPR reported about 98.6% and Tesfaye (2008) in Menz and Afar areas who reported that 53.3% (majority) of sheep owner are sheltered in main house with a family. The present study was also in consonance with earlier reports with respect to housing of flocks in the main house (FARM-Africa, 1996 and Markos, 2000). However it is in disagreement with reports of Alubel (2015) who found that majority (83.82%) of Ziquala districts confine their goats without roof and small proportion (18.18%) of farmer confine their goats in family house.

The majority of respondents in highland and midland (28.9%, 14.4% in HL & ML, respectively) reported that sheep and goat were confined separately in the house. However in lowland area both these species (sheep / goat) were confined with other livestock (10.0 %). The present finding in LL area was in agreement with Alubel (2015) who reported 61.02% of respondents in Lay Armachiho district housed their goat together with other animals.

In the study areas different housing materials were used in roofs (Table 11). The wood was used by 21.1 and 15.6 % of respondents in HL and LL areas whereas corrugated iron sheets were used by 21.7 % of respondents in ML area. The wood was the main construction material of sheep and goat houses in all AEZs (35.6, 38.3 and 13.9 % in HL, Ml and LL, respectively). The possible reason may be availability of wood as the area is endowed with good number of Eucalyptus trees. Earth / soil are used by majority of respondents for flooring. This may be favored as it is more economical.

Table 11: Types of sheep and goat houses and housing materials in three AEZs.

Types of house and housing materials	HL	ML	LL	Total
	N (%)	N (%)	N (%)	N (%)
Housing sheep and goat				
In family house	17(9.4)	29(16.1)	25(13.9)	71(39.4)
Separate house	34(18.9)	17(9.4)	2(1.1)	53(29.4)
Veranda (extend of building)	18(10.0)	28(15.6)	10(5.6)	56(31.2)
Confining system				
Sheep alone	52(28.9)	26(14.4)	5(2.8)	83(46.1)
Goat alone	2(1.1)	24(13.3)	13(7.2)	39(21.7)
Sheep and goats alone	6(3.3)	14(7.8)	1(0.6)	21(11.7)
With all other animals	9(5.0)	10(5.6)	18(10.0)	37(20.6)
Housing materials in roofs of sheep and goat houses				
iron sheet	31(17.2)	39(21.7)	9(5.0)	79(43.9)
Wood	38(21.1)	35(19.4)	28(15.6)	101(56.1)
Materials used for construction of walls of sheep and goat houses				
Iron sheet	3(1.7)	2 (1.1)	-	5(2.8)
Wood	64(35.6)	69(38.3)	25(13.9)	158(87.8)
Stone	2(1.1)	3(1.7)	12(6.7)	17(9.4)
Materials used for flooring				
Wood	2(1.1)	3(1.7)	5(2.8)	10(5.6)
Stone	6(3.3)	13(7.2)	12(6.7)	31(17.2)
Earth/soil	61(33.9)	58(32.2)	20(11.1)	139(77.2)

4.2.3.4.2. Culling sheep and goat

The different reasons for culling sheep and goat are presented in table 12. The farmers cull their animals for a number of reasons. Feed scarcity (14.4%, 13.9 %), sickness (10.6%, 12.8 %), productivity problems (6.1%, 6.1 %) were first, second and third reasons for culling sheep and goats in HL and ML areas in the present study. In LL the first, second and third reason for

culling was sickness (5.6 %), productivity problem and/or predators (3.9, 3.9 %) and feed scarcity (3.3 %). The current result was not in agreement with Dereje *et al*. (2013) who found that productivity problems (46.1%) and disease (20.6%) were the first two reasons for culling flock in Daro-Labu district of west Hararghe. The current result in respect to low land area was in agreement with Tsedeke (2007) around Alaba Special Woreda (SNNPRS) and Belete (2009) reported in western Ethiopia. The overall figures for reasons for culling of sheep /goat were feed scarcity (31.7 %), sickness (28.9 %) and productivity problem (16.1 %). However, FGDs stated that sickness, feed scarcity and productivity problem were the first three reason for culling sheep and goat in the three AEZs.

A small proportion of respondents (1.7, 2.2 and 2.2%) in HL, Ml and low land areas cull their sheep / goat for undesirable phenotypic characteristics (black coat color, abnormal legs and hoofs). Similar findings were reported by Tsedeke (2007) in Alaba.

Table 12: Reason of culling sheep and goats in agro ecologies of study area (%)

Reason of culling sheep and goat (%)	HL(N=69)	ML(N=74)	LL(N=37	Overall (N=180)
Old age	5	5.0	1.7	11.7
Sickness	10.6	12.8	5.6	28.9
Productivity problem	6.1	6.1	3.9	16.1
Physical defect	1.7	2.2	2.2	6.1
Predator	0.6	1.1	3.9	5.6
Feed scarcity	14.4	13.9	3.3	31.7

4.2.3.4.3. Castration practice of sheep and goats

Castration of sheep and goats is an important activity for successful production and management system. In all the three AEZs (Table 13) the majority of respondents reported that they do not practice castration in both species. The overall figures for absence of castration were 58.3 and 39.4 % in sheep and goat, respectively.

Table 63: Castration practiced in three AEZs of the study areas in percentages.

Particulars	HL	ML	LL	Overall
Castration practice of male sheep				
Yes	3.9	3.3	-	7.2
No	33.4	20.0	5.0	58.3
Castration practice of male goat				
Yes	-	5.6	2.8	8.3
No	3.9	21.7	13.9	39.4
Age at castration of rams				
12 months	3.3	1.7	-	5.0
18 months	0.6	1.6	-	2.2
Age at castration of bucks				
12 months	-	5.5	2.8	8.3
Castration methods				
Traditional	2.8	3.3	1.1	7.2
Modern	0.6	1.7	0.6	2.8
Both	0.5	3.9	1.1	5.5
Reason of castration				
To fetch more price	2.2	5.0	2.2	9.4
To avoid mating	1.7	2.8	0.6	5.0
To reduce aggressiveness	-	1.1	-	1.1
Castration month of sheep and goats				
February-December	2.2	6.6	2.2	11.1
November- January	1.1	1.7	0.6	3.3
March	0.6	0.6	-	1.1

AEZs= Agro-ecologies zones

However a small proportion of respondents castrate male of both species (Table 13**)** and the overall figures were 7.2 and 8.3% of respondents for sheep and goat, respectively. The majority of respondents carried castration at the age of 12 months in both species. The castration method followed was traditional (by crushing either with stone or iron hammer) by majority of respondents in all AEZs. Similar findings were reported by Tsedeke (2007) in Alaba. The reasons for castration enumerated by the respondents (overall) were (a) to fetch more prices (9.4 %), (b) to avoid mating (5.0 %) and (c) to reduce aggressiveness (1.1 %).

The majority of respondents in highland (2.2%), midland (6.6%) and lowland (2.2%) castrate their animals from February-December (Table 13).

4.2.3.4.4. Entry and exit of small ruminant flock of households

Knowledge about ways of acquisition of breeding stock and mode of exit/disposal is important in assessing the breeding practices of small ruminant. The ranking, according to the indices estimated (**Table 14**), of acquisition of sheep in HL was home-born with an index of (0.55), purchase (0.33), and gift (0.08). This finding was in agreement with Yisehak *et al*. (2013) who reported similar order of ranking in south western Ethiopia. However, the rankings of acquisition of sheep in ML were home-born followed by purchase followed by share-arrangement and differed from HL in respect of third rank only. The corresponding indices estimated were 0.65, 0.33, and 0.02, respectively. In LL areas, based on the indices estimated, the ranking was home-born followed by share arrangement followed by purchase with the value of indices as 0.75, 0.19 and 0.06, respectively.

The rankings of goat acquisition were similar in the three AEZs in the present study. The rankings were home-born, purchase and share arrangement with indices of 0.62, 0.29, 0.09 in HL; 0.76, 0.19, 0.03 in ML and 0.53, 0.33, 0.06 in LL.

The farmers followed different methods for reduced the numbers in both species (Table 14). The first two ways of reducing numbers in sheep were same in all AEZs and these were sale followed by death. The indices estimated were 0.65, 0.19 for Hl. 0.58, 0.23 for ML and 0.64, 0.24 for LL areas. However there was difference in the ranking of third and fourth reason of reducing numbers in the three AEZS.

In goat there was no similarity in the ranking of reasons for reducing numbers (Table 14). In HL the ranking was sale followed by slaughter and death / predators with index values of 0.34, 0.30 and 0.18, respectively. In ML the rankings was death followed by sale and share out with index values of 0.44, 0.42 and 0.07, respectively. In LL the rankings estimated were sale followed by death and by predators with index values of 0.53, 0.22 and 0.18, respectively.

Table 74: Flock acquisition and exit way of sheep and goat in three AEZs

	High land				Midland				Lowland				Over all
	R1	**R2**	**R3**	**I**	**R1**	**R2**	**R3**	**I**	**R1**	**R2**	**R3**	**I**	**I**
(I) Sheep													
Acquisition method													
Home born	42	10	0	0.55	32	0	0	0.65	8	0	0	0.75	0.65
purchase	17	19	0	0.33	10	9	0	0.33	0	1	0	0.06	0.24
Receive share arrangement	1	0	5	0.03	0	1	0	0.02	1	1	1	0.19	0.08
Gift	7	1	1	0.08	0	0	1	0.01	0	0	0	0.00	0.03
Exit way													
Sale	57	0	0	0.65	31	4	0	0.58	7	0	0	0.64	0.62
Death	8	13	0	0.19	7	9	1	0.23	2	1	0	0.24	0.22
slaughter	1	6	1	0.06	1	2	6	0.07	0	0	0	0.00	0.04
predators	1	6	2	0.07	0	1	0	0.02	0	1	2	0.18	0.09
Theft	0	0	2	0.01	1	0	0	0.02	0	0	0	0.00	0.01
Share out	0	1	2	0.02	2	5	0	0.09	0	0	0	0.00	0.03
(II) Goats:													
Acquisition method													
Home born	7	0	0	0.62	44	0	0	0.76	20	0	0	0.53	0.64
purchase	0	5	0	0.29	4	11	0	0.19	10	4	0	0.33	0.27
Receive share arrangement	0	0	3	0.09	1	1	0	0.03	0	2	3	0.06	0.06
Gift	0	0	0	0.00	0	1	0	0.01	0	1	0	0.02	0.02
Exit way													
Sale	5	0	0	0.34	29	1	0	0.42	22	1	1	0.53	0.43
Death	1	2	1	0.18	16	22	0	0.44	2	12	0	0.22	0.28
slaughter	0	4	5	0.30	1	2	0	0.03	1	1	1	0.05	0.13
Theft	0	0	0	0.00	1	0	0	0.01	0	0	0	0.00	0.00
Share out	0	0	0	0.00	0	7	0	0.07	0	1	0	0.02	0.03
predators	1	0	5	0.18	2	0	0	0.03	5	0	9	0.18	0.13

4.2.3.4.5. Newborn's separation practices

The results (Table 15) showed that almost half of the respondent of the study areas do not separate new born lambs and kids. Among sheep and goat producers, the overall figures showed that around 35 and 27.2% of the respondents did not separate newly born lambs and kids from their dams respectively. The overall proportion, who separate lambs / kids, was 30.6 and 20.6% of the respondents. The separation of lambs / kids was either during day or night or both. However among these three times, the majority of respondents separated their lambs / kids during day in all AEZs (Table 15). Similar finding is reported by Girma *et al*. (2013) in Adami Tulu Jido kombolcha district of east Shoa Zone, Ethiopia.

The FGD showed that almost all of farmers those practiced separation of new born lambs / kids at day time. Some farmers stated that if newborn lambs / kids were separated from their dam at night, they bleat / make bleating noise and disturb all other flock and even owners as reasonable number of animals confine in family houses.

Table 85: Newborn's separation practices in the three AEZs (%).

Particularly		HL	ML	LL	Total
(A) New born lamb					
Separation practiced					
	Yes	16.1	11.1	3.3	30.6
	No	21.1	12.2	1.7	35.0
Separation time					
	Day	8.9	5.6	2.8	17.2
	Night	0.6	1.7	0.0	2.3
	Both	6.7	3.9	0.6	11.1
(B) New born kid					
Separation practiced					
	Yes	0.6	14.4	5.6	20.6
	No	3.3	12.8	11.1	27.2
Separation time					
	Day	0.6	6.7	2.2	9.4
	Night	0.0	2.8	1.1	3.9
	Both	0.0	5.0	2.2	7.2

4.2.3.4.5. Health management practices.

4.2.3.4.5.1. Treatment of sick animals

Treating sick sheep / goat (Table 16) using modern drugs is common in all the three AEZs. The proportion of respondents using modern treatment ranged from 11.1% (LL) to 35.6% (HL) with an overall proportion of 80.0 %. In lowland percentage of respondents treating their sick sheep and goats were lower than the two AEZs due to clinics far apart from their homestead. The results showed (Table 16) that government veterinary clinics one of the main sources of modern treatment of sick sheep and goat in all AEZs. This is might be due to majority of households consult governmental veterinarians to treat sick animals in order to get drugs with minimum price. The present results were in agreement with Dereje *et al.* (2013) in Daro-Labu district of west Hararghe, eastern Oromia. The earlier report of Yenesew (2010) that treating animals using modern drugs is common at Burie woreda, west Gojjam is in agreement with present findings.

Table 96: Health management practice of sheep and goat (percentage) in three AEZs

Particulars	HL	ML	LL	Overall
Treatment of sick animal				
Traditional treatment	2.8	7.8	9.4	20.0
Modern	35.6	33.3	11.1	80.0
Source of Veterinary service				
Government	32.2	23.9	13.9	70.0
Private institutions	6.1	17.2	6.7	30.0
Traditional treatment practices through				
Bleeding under the tongue	1.7	3.3	2.8	7.8
Firing /branding under the neck by hot iron metal	0.6	2.8	4.4	7.8
Drenching of chopped white oil mixed with cooked pepper	0.6	1.7	2.2	4.4

The traditional forms of treatment, wherever followed, comprised of three methods, viz: bleeding under the tongue, firing /branding under the neck by hot iron metal and drenching of chopped white oil mixed with cooked pepper. The HL and ML showed same order of traditional treatment, i.e. bleeding under the tongue followed by firing /branding under the

neck by hot iron metal followed by drenching of chopped white oil mixed with cooked pepper. However in LL the order was firing /branding under the neck by hot iron metal followed by bleeding under the tongue and drenching of chopped white oil mixed with cooked pepper.

Hence, government clinics were the core sources of modern animal treatment center. Thus results were in disagreement with Yenesew (2010) who reported that treating animals using modern drugs is common in the lowland and private vet clinic is mainly drug source at Burie woreda, west Gojjam. However similar finding prescribed by Dereje *et al.* (2013) in Daro-Labu district of west Hararghe, eastern Ethiopia.

4.3. Productive and Reproductive Performances of Small Ruminants

The results on productive and reproductive performance, viz: AFL, weaning age, slaughter age, age at sexual maturity of male, LI, LS, reproductive life span, for both sheep and goat are presented in table 17.

4.3.1. Age at first lambing (AFL) / kidding (AFK)

The differences in both AFL and AFK were found to be statistically significant (Table 17) across the three AEZs. The pair-wise comparison showed that HL-LL and ML-LL differences were significant for AFL whereas HL-Ml and HL-LL were significant for AFK.

The age at fist lambing (AFL) and age at first kidding (AFK) is an indication of the overall flock productivity. The AFL of current results was 14.12, 14.36 and 15.22 months for sheep and AFK was 15.33, 13.82 and 13.60 months for goats in high, mid and lowland respectively (Table 17). The present results in respect of both species were lower than the reports of FAO (2002) wherein age at first lambing ranged between 16.2 and 16.9 months in mixed farming systems of sub-Sahara African countries; Mesfin *et al*. (2014) who reported average AFL of 18.10 at eastern Amhara region and Yisehak *et al*. (2013) who reported AFL of 15.90, 15.85 and 15.63 months and AFK of 2.09, 2.07 and 2.16 years in Seka, Mana and Dedo districts of Southwestern Ethiopia. Both AFL and AFK in the current study was an indicator of early sexual maturity in ewes and does.

Table 107: Average of reproductive performance of sheep and goats in three AEZs

Parameters (in months)	High land (N=69)	Midland (N=74)	Lowland (N=37)	Overall mean	P-value
	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE	
Sheep					
Age at first lambing (months)	14.12±0.11[a]	14.36±0.10[a]	15.22±0.32[b]	14.29±0.08	0.001
Weaning age (months)	3.84±0.44[a]	3.93±0.40[a]	4.44±0.52[c]	3.92±0.46	0.001
Slaughter age (months)	6.34±0.50[a]	6.37±0.53[a]	7.33±0.70[c]	6.43±0.59	0.000
Age at sexual maturity of male (months)	8.79±0.05[a]	8.93±0.04[a]	9.67±0.16[b]	8.91±0.04	0.000
Lambing interval (months)	8.73±0.55[a]	8.83±0.58[a]	9.56±0.17[c]	8.83±0.44	0.000
Liter size(in number)	1.21±0.49	1.18±0.45	1.16±0.43	1.19±0.42	0.458
Reproductive life span of female (months)	129.49±14.55[a]	124.57±16.54[a]	112.00±14.69[c]	126.41±15.89	0.005
Goats					
Age at first kidding (months)	15.33±0.42[a]	13.82±0.15[b]	13.60±0.19[b]	13.85±0.12	0.002
Weaning age (months)	4.67±0.51[a]	3.82±0.39[b]	3.52±0.50[c]	3.77±0.52	0.000
Slaughter age (months)	6.50±0.54	6.39±0.53	6.03±0.49	6.27±0.54	0.011
Age at sexual maturity of male (months)	9.67±0.21[a]	8.38±0.06[b]	8.16±0.07[b]	8.39±0.06	0.000
Kidding interval (months)	9.33±0.21[a]	8.22±0.59[b]	8.10±0.54[b]	8.25±0.52	0.000
Liter size(in number)	1.25±0.41	1.32±0.33	1.21±0.31	1.28±0.33	0.151
Reproductive life span of female (months)	98.00±9.03[a]	100.65±17.46[a]	120.41±13.78[c]	107.29±18.37	0.000

N=Number of respondents, SD= standard deviation, same superscript indicate non-significant differences, Different superscript indicate significant differences at P<0.05 level

The current result for AFK (Table 17) in highland 15.33 area were similar with the finding of Assen and Aklilu (2012) who reported average age at first kidding of 15.01 months in different agro-ecological zones (high, mid and lowland) in Tigray, Ethiopia.

However, the current results were higher than the findings of Tsedeke (2007) who reported 12.7 months for AFL and 12.1 months for AFK in Alaba southern Ethiopia and Fsahatsion *et al*. (2013) who reported an average AFL of 12.4 months in Gamo gofa Zone, Southern Ethiopia.

4.3.2. Weaning age

The differences in weaning age in both species were found to be significant (Table 17) across the three AEZs. The pair-wise comparison showed that HL-LL and ML-LL differences were significant in sheep and goats.

The weaning age of lambs was 3.84, 3.93 and 4.44 months in high, mid and lowland of agro-ecologies, respectively, in the present study. The result obtained in all the three agro ecologies for weaning age of lambs were lower than Tsedeke (2007) and Zewudu *et al.* (2012) in western and south-western Ethiopia who reported that the overall average weaning ages for both sexes and breeds of indigenous sheep was 4.80 months.

The weaning age of kids was 4.67, 3.82 and 3.52 months in high, mid and lowland, respectively (Tabele17). These findings were lower than that of Endeshaw (2007) who reported weaning ages of 6.27, 5.09 and 4.73 for goats in moist dega, weyina dega and kola respectively, in Dale district and report of Tsedeke (2007) in respect of goats in Alaba, southern Ethiopia

However, weaning age of lambs (4.44) and kids 4.67 in low and highland of the current study were in agreement with finding of Assen and Aklilu (2012) who reported 4.4 and 4.7 for lambs and kids in high and midland of Tigray zone, respectively.

The possible reasons for lower weaning age in both species in the current study may possibly be (a) ewes / does suckle their lams/kids for short period of time, (b) early weaning allows ewes / does to express estrous cycle earlier resulting in improved reproductive efficiency and

(c) farmers preference for more lamb / kid crop / unit time to earn more income. The latter two reasons impose stress on both lambs and kids affecting their weaning weight. Thus special management is required at this stage for early weaned lambs / kids so that's early weaning stress are overcome.

4.3.3. Slaughter age /market age and age at sexual maturity of male (ASMM)

The slaughter age for both sexes was significantly influenced by AEZs in sheep (Table 17) but the same influence in goat was non-significant. In sheep the differences between HL-LL and ML-LL were significant. The average slaughter ages were 6.34, 6.37, 7.33 in sheep and 6.5, 6.39, 6.03 months in goats in high, mid and lowland areas, respectively. The results with respect to sheep showed that sheep in HL grow faster than the other two AEZs. Perusal of results showed that in both species young stock were slaughtered at an early age before attaining sexual maturity. Gemeda (2010) also reported that male lambs were sold as early as three to four months in mixed crop-livestock system of Horro and Bonga areas.

The age at sexual maturity of males (ASMM) (Table 17) in both species showed highly significant differences among the three AEZs. The differences between HL-LL and ML-LL were significant in sheep whereas HL-LL and HL-ML differences were significant in goat. The ASMM were 8.79, 8.93 and 9.67 months in rams and 9.67, 8.38 and 8.16 months in bucks in HL, ML and LL, respectively. The current findings with respect to ram were higher than the results reported by Assen and Aklilu (2012) who reported ASMM of 8.42 and 8.8 months in HL and ML of Tigray region respectively. The present results with respect to ram are also higher than the average age of 7.1 months reported by Tesfaye (2008) for Afar rams. The age at first sexual maturity may be affected by weaning season and post weaning nutrition and thus through good management age at first sexual maturity could be substantially improved. Galmessa *et al*. (2003) reported that well fed / supplemented ram lambs of Horro breed reached at first sexual maturity at the age of 6-7 months at Bako agricultural research center.

A comparison of slaughter age and ASMM of the current results is presented in figure 2.

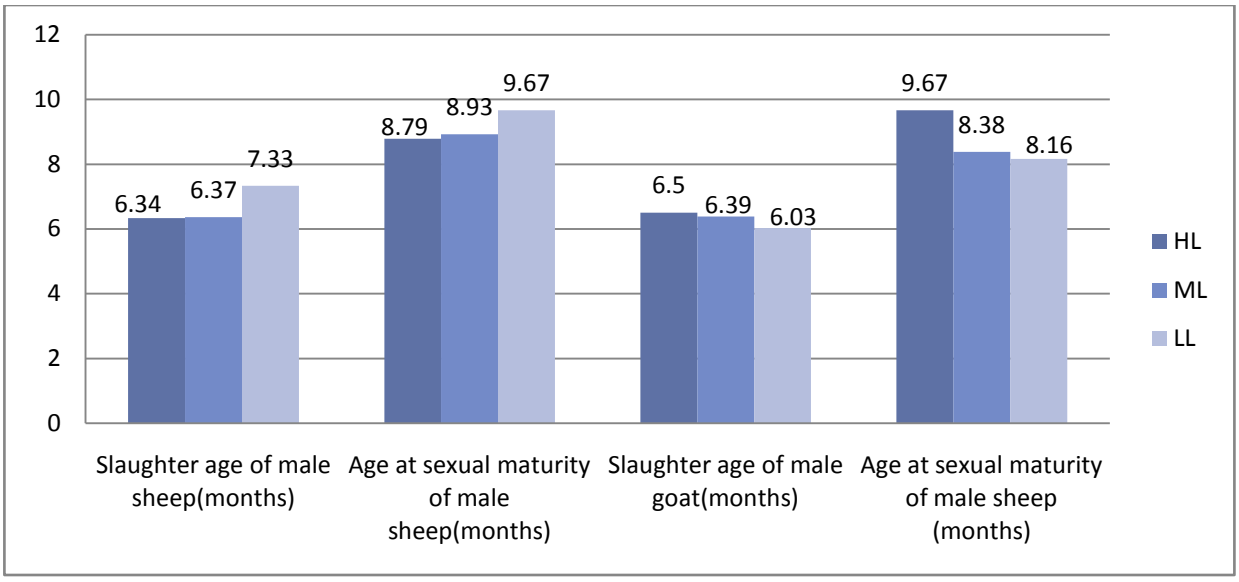

Figure 2: slaughter and market age of male sheep and goat in three AEZs

Perusal of this figure (Figure2) showed that males of both species were slaughtered before they attain sexual maturity. This indicated that a good number of males were eliminated from the flocks at an earlier age and thus narrowing the selection base of males. This reduction in selection base of males will be a limiting factor in the improvement of both these species. Similar trends were reported by earlier workers (Gemeda *et al*., 2010; Solomon *et al*., 2010; Tesfaye, 2010 and Yenesew *et al*., 2013). In order to stop this practice the farmers need counseling / guidance so that male animals were retained after they attain sexual maturity and pass on their genes, if found good, to the next generation. This was important for sustainable utilization of available resources and to improve overall productivity.

4.3.4. Lambing / kidding interval

Lambing or kidding interval is the interval between two consecutive parturitions that determines reproductive efficiency in small ruminant production. The AEZs had highly significant ($P<0.01$) influence on both lambing and kidding interval in the present study. The differences in the lambing interval between HL-LL and ML-LL were significant (Table 17). Similarly differences in the kidding interval between HL-ML and HL-LL were significant.

The lambing interval in the study area was reported to be 8.73, 8.83, 9.56 months and kidding interval was 9.33, 8.22 and 8.10 months in high, mid and lowland, respectively. The lambing

/kidding interval in the present study were higher than the earlier reports in small ruminants (Getahun, 2008, Belete, 2009 and Fsahastion *et al*., 2013).

4.3.5. Litter size

The litter size in both species involved in the current study was not influenced significantly by AEZs (Table 17). The liter size in sheep was reported to be 1.21, 1.18 and 1.16 in high, mid and lowland, respectively, of study area. The current results were within the range (1.08 - 1.75) reported by Girma (2008) for tropical breeds. The current litter size were higher than those reported by Tadele (2010) for Menz and Afar sheep breeds (close to one lamb per lambing), Bonga sheep (1.13) and Washera sheep (1.11) reported by Solomon *et al*. (2010). However present results were lower than the range of 1.29 – 1.57 observed in Horro ewes by the same author.

The litter size in goats was 1.25, 1.32 and 1.21 in HL, ML and LL areas, respectively. These results were within the range (1 -- 1.7) reported by Solomon *et al.* (2014) from on station, on farm monitoring and breeds survey studies for different Ethiopian goat breeds.

4.3.6. Reproductive life span of female sheep / goat (months)

The variations in the reproductive life span of females in both species were significant due to AEZs (Table 17). The pair-wise comparison showed significant differences between HL- LL and ML – LL areas in both species. The reproductive life spans were 129, 125 and 112 months in sheep and 98, 101 and 120 months in goat in HL, ML and LL AEZs, respectively.

4.3.7. Intensive months of lambing and kidding

The survey carried showed that both lambing and kidding were recorded throughout the year. Based on group discussion and interview of individual respondents it was found that higher parturitions occur from April to June in both species. Survey results (Figure 3**)** showed that apparent peaks of intensive kidding and lambing were in April and May, respectively. The FGDs confirmed that high intensive kidding and lambing months ranged from April to June and lowest lambing/kidding was November, February and August. This observation (FGD) was in agreement with Dhaba *et al*. (2013) who reported high lambing/kidding rate was recorded during April to June.

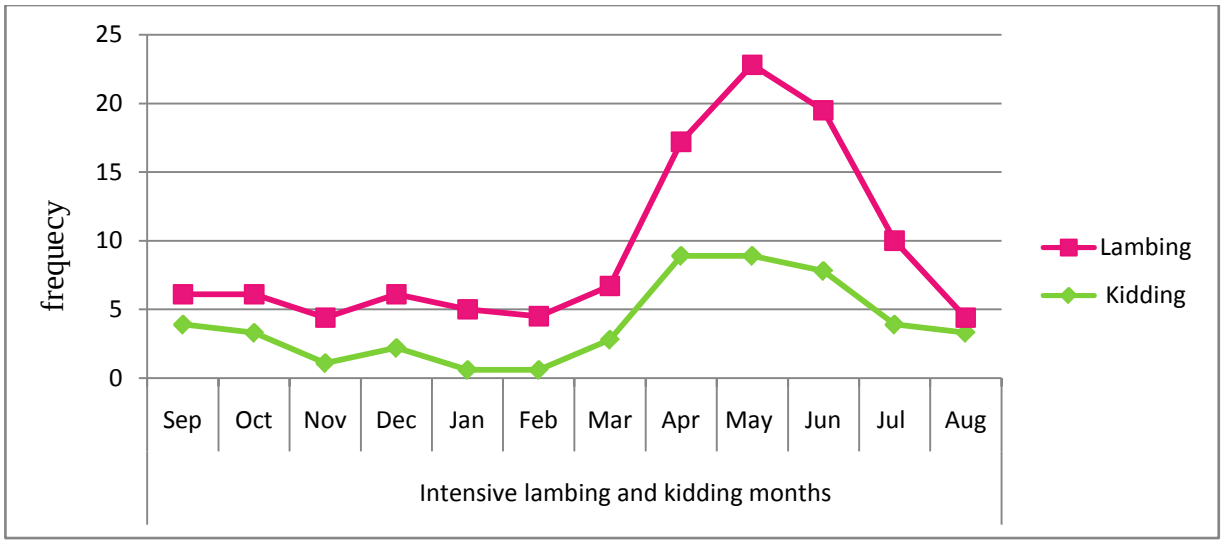

Figure3: Intensive lambing and kidding month of sheep and goat in study area.

The perusal of results in figure 4 revealed that the maximum conception of sheep and goat occurs during the months January and December, respectively. This may be due to availability of sufficient forage in natural pasture and crop residues / crop aftermaths in the fields which results in good flushing of both sheep and goat females. The current finding with respect to goat was in agreement with Mehlet (2008) who reported the highest kidding in May.

4.4. Perception of Traits By Small Ruminant Producers

4.4.1. Source of rams and bucks and their preferred traits for breeding

The results of sources of rams and bucks are presented in **table 18.** Perusal of results showed that there were only two sources for rams and bucks, viz: owned ram / buck and neighbor's ram / buck, in the three AEZs. The majority of respondents were using neighbors ram for mating and the values were 24.4, 13.9 and 3.3 % in HL, ML and LL, respectively. Similarly majority of respondents used neighbors buck in HL and ML (2.2 and 17.2 %, respectively) whereas in LL majority (9.4 %) used their own buck for mating. The current results were in disagreement with that of Tesfaye *et al*., 2010, 2011 and Fsahatsion *et al*. (2013) who reported majority of farmers reared their own ram in on-farm studies. The FGD showed that there were no cross or pure exotic sheep and goat breeds in the study areas.

Table 118: Source of breeding ram and buck (in percentage) in three AEZs

Particulars	HL N (%)	ML N (%)	LL N (%)	Total
Source of breeding ram				
Own	23 (12.8)	17 (9.4)	3 (1.7)	43 (23.9)
Neighbors	44 (24.4)	25 (13.9)	6 (3.3)	75 (41.7)
Total	67 (37.2)	42 (23.3)	9 (5.0)	118 (65.6)
Source of breeding buck				
Own	3 (1.7)	18 (10.0)	17 (9.4)	38 (21.1)
Neighbors	4 (2.2)	31 (17.2)	13 (7.2)	48 (26.7)
Total	7 (3.9)	49 (27.2)	30 (16.6)	86 (47.8)

The criteria pertaining to selection of breeding rams and bucks are presented in table 19. The respondents ranked body conformation (size) as number one for selecting a breeding ram in all the three AEZs (0.51, 0.53 and 0.48 in HL, ML and LL, respectively). However second and third rank for selecting breeding ram differed in the three AEZs. The second rank was tail with index of 0.27 in HL; color with an indices of 0.25, 0.29 in ML and LL, respectively) and third rank was age at first maturity with index of 0.13 in HL; tail with indices of 0.10 and 0.11 in ML and LL, respectively.

This finding is in consonance with the results of Tesfaye (2008) who reported that body size is a primary ram selection criteria in both crop-livestock (0.29) and pastoral (0.35) production systems in Menz and Afar areas; Solomon *et al*., 2010; Zewudu *et al.* (2012) in Adiyo Kaka district of Kaffa zone of Southern Nations, Nationalities of Ethiopia reported ram selection based on body size with an index (0.34) , color (0.28) and tail formation (0.27) ; Fsahatsion (2013) in Gamo gofa zone report body size as primary criteria in ram selection in weyna-dega.

The perusal of results (Table 19) showed that respondents ranked bucks on the basis of body conformation (size), color and age at first maturity as rank first, second and third in all three AEZs in the present investigation. The indices estimated were 0.43, 0.51, 0.52 for body conformation; 0.34, 0.27, 0.40 for color and 0.20, 0.17, 0.05 for age at first maturity in HL,

ML and LL, respectively. The current finding was in agreement with Solomon (2014) who reported body conformation (size) followed by coat color were found as the most important selection criteria of breeding bucks with the index values of 0.33 and 0.22 for Western Lowland goat keepers and 0 .31 and 0.25 for Abergelle, respectively.

Table 129: Rank of desirable traits for selecting breeding rams and bucks for mating in three AEZs.

Trait for	High land				Midland				Lowland				Over-all
	R1	R2	R3	I	R1	R2	R3	I	R1	R2	R3	I	I
(A) Rams													
Body conformation (size)	32.2	4.4	0	0.51	20.6	2.8	0	0.53	4.4	0.6	0	0.48	0.51
Age at first maturity	0	0	27.2	0.13	1.1	1.1	5	0.08	0.6	0	0	0.06	0.09
color	2.2	1.1	0	0.04	0	15	1.1	0.25	0	4.4	0	0.29	0.19
Libido	2.8	0	0	0.04	0.6	0	0	0.01	0	0	1.1	0.04	0.03
Adaptability	0	0	1.1	0.01	1.1	0	0	0.03	0	0	0.6	0.02	0.02
Tail	0	27.8	0	0.27	0	4.4	3.3	0.10	0	0	3.3	0.11	0.16
(B) Bucks													
Body conformation (size)	2.8	0	0	0.43	25.6	1.7	0	0.51	12.8	3.9	0	0.52	0.48
Color	0	3.3	0	0.34	1.7	18.9	0	0.27	3.3	12.8	0	0.40	0.33
Age at first maturity	1.1	0	1.1	0.20	0	6.7	12.8	0.17	0.6	0	2.2	0.05	0.14
Libido	0	0	0.6	0.03	0	0	6.7	0.04	0	0	1.7	0.02	0.03
Adaptability	0	0	1.1	0.05	0	0	2.2	0.01	0	0	1.1	0.01	0.02

The results revealed that in all the three agro-ecologies body size was the primary selection criteria for both ram and buck selection as parent of next generation. The possible reason may be that body size was an important economic trait that influenced market price, particularly in the traditional markets of Ethiopia. The body size of rams and bucks, which most of the owners associated with high carcass output and premium price across all the production systems, included wide chest, conformation and long body size.

According to FGD listed that, coat color was also one of the three selection criteria and it was observed that red, white or mixed colors were more preferred in the study areas in both

species. However black coat color was not preferred possibly due to less market value across all the production systems. The less preference for black color observed in present study was in agreement with earlier workers (Ferew, 2008; Gemeda *et al*., 2011; Zewudu *et al*., 2012 and Yenesew *et al*., 2013) who also noted that black coat color is generally less preferred color in most parts of Ethiopia.

4.4.2. Traits preferred for breeding ewes and does

The criteria pertaining to selection of breeding ewes and does are presented in table 20. In selecting a breeding ewes body size and coat color were ranked first and second across all AEZs with indices of 0.45, 0.44, 0.44 for body size and 0.28, 0.31, 0.39 for coat color in HL, ML and LL areas respectively. The lamb survival which is attributed to mothering ability was ranked third with index of 0.10, 0.17 and 0.17 in HL, ML and LL AEZs. The present results were in agreement with Helen *et al.* (2013) who reported body size (0.46), coat color (0.17) and lamb survival (0.15) were the three criteria in ewe selection in eastern Ethiopia. Hence coat color is for their satisfaction and market price in local market.

The criteria of doe selection showed minor variation in the ranking across three AEZs in present study (Table 20). In HL coat color followed by body size and kidding interval were ranked first, second and third (0.36, 0.28 and 0.18, respectively) by the respondents. In ML body size, coat color and kidding interval were ranked first, second and third with index of 0.47, 0.26 and 0.11, respectively. However in LL body size, coat color and kidding survival with index values of 0.47, 0.30 and 0.08 ranked first, second and third, respectively.

The current study indicated that overall attention was focused on observable traits, like body size, coat color and twining ability / lamb survival (sheep) and body size, coat color, kidding interval / kidding survival (goat), compared to production and reproduction traits in selecting breeding ewes and does. The possible reason for this may be due to lack of weight balances during buying / selling they use observable traits. However absence of animal recording in Ethiopia seems to be an important impediment in improving small ruminant productivity. Accordingly an efficient but economical animal recording system needs to be designed for Ethiopian farming conditions.

Table20: Rank of desirable characteristics for selecting ewes and does for breeding

Traits for	High land				Midland				Lowland				Over all
	R1	R2	R3	I	R1	R2	R3	I	R1	R2	R3	I	I
Ewes													
Body size	32.2	0	0	0.45	20.6	0	0	0.44	4.4	0	0	0.44	0.44
Color	0	30	0	0.28	1.1	20	0	0.31	0.6	5	0	0.39	0.32
Twining ability	2.2	2.8	6.7	0.09	0	1.1	0	0.03	0	0	0	0.00	0.04
Age at first lambing	2.8	0.6	0.6	0.05	0.6	1.7	0	0.04	0	0	0	0.00	0.03
Lamb survival	0	0	21.1	0.1	1.1	0	21.1	0.17	0	0	5	0.17	0.16
Lambing interval	0	3.3	1.7	0.03	0	0	0	0.00	0	0	0	0.00	0.01
Adaptability	0	0	0.6	0.00	0	0	0.6	0.00	0	0	0	0.00	0.00
Tail	0	0	0.6	0.00	0	0.6	1.7	0.01	0	0	0	0.00	0.00
Does													
Body size	1.7	0.6	0	0.28	22.2	4.4	0	0.47	12.2	4.4	0	0.47	0.41
Color	1.1	2.2	0	0.36	2.2	17.2	0	0.26	2.8	10	0.6	0.30	0.31
Twining ability	1.1	0	0	0.15	1.1	2.2	0	0.05	0	0	3.3	0.03	0.06
Age at first kidding	0	0	0.6	0.03	0	1.1	3.3	0.03	0	0.6	0.6	0.02	0.04
kids survival	0	0	0	0.00	1.7	1.1	1.1	0.05	1.7	0.6	1.7	0.08	0.04
kidding interval	0	0.6	2.8	0.18	0	0	17.8	0.11	0	0	7.2	0.07	0.13
Adaptability	0	0	0	0.00	0	1.1	1.1	0.02	0	1.1	0	0.02	0.01

4.4.3. Effective population size and level of inbreeding

The effective population size (Ne) is influenced by actual number of breeding male and female in the flock at a given time and thus subject to change due to variation in the flock size, type of rearing practice (mixed flock grazing or individual flocks). The rate of inbreeding coefficient per generation changes with any change in the effective population

size. The results presented in table 21 **(**see also appendix 1**)** showed that the total number of breeding rams were 28, 13, 2 and total number of breeding ewes were 353, 119, 19 in mixed flocks (mixed during grazing) in high, mid and lowland agro ecologies, respectively. The corresponding figures for individual sheep flocks were 1, 6, 1 for total number of rams and 20, 58, 18 for total number of ewes, in HL, ML and LL, respectively. The effective population size (Ne) estimated in high, mid and lowland areas were 103.77, 46.88, 7.24 whereas the rate of inbreeding per generation (ΔF) was 0.005, 0.011 and 0.069, respectively, in mixed flocks grazing. Similarly effective population size (Ne) estimated in high, mid and lowland areas were 3.80, 21.75 and 3.79 whereas the rate of inbreeding per generation (ΔF) was 0.131, 0.023 and 0.132, respectively, in individual flocks during grazing.

Table 21: Effective population size (Ne) and level of inbreeding of sheep in different agro-ecologies in average (mean)

Agro ecologies	Mixed sheep population during grazing				Individual sheep flocks (not mixed) during grazing			
	Nm	Nf	Ne	ΔF	Nm	Nf	Ne	ΔF
HL	28	353	103.77	0.005	1	20	3.80	0.131
ML	13	119	46.88	0.011	6	58	21.75	0.023
LL	2	19	7.24	0.069	1	18	3.79	0.132
Overall mean	14.33	163.67	52.63	0.028	2.67	32	9.78	0.095

Ne = *effective population size;* ΔF = *coefficient of inbreeding,* Nm = *total number of male,* Nf = *total number of female.*

The Ne in mixed flocks was higher in HL compared to other two AEZs (ML and LL) with concomitant low ΔF in HL compared to the other two. The perusal of estimated Nm showed (Table 21) that there were very few (less) breeding rams compared to Nf in all three AEZs. This bias in Nm may have reduced the Ne in present study. However in ML and LL, the Nf estimated too was less than the HL areas. This low effective population size on both male and female side seems to be the main reason for high ΔF in ML and LL compared to HL. This is further corroborated by the average sheep population per selected respondent figures presented in table 3 (1.02 for HL vs 0.43 & 0.13 for ML and LL, respectively) and early slaughter age ranging from 6.34 – 7.33 (Table 17) (months) prevalent in the study areas. The overall effect of this was higher ΔF in ML and LL compared to HL AEZ.

The level of inbreeding / generation in HL and ML of mixed sheep during grazing in the present study were lower than estimates of 0.06 reported by Armstrong (2006) and estimates of 0.02, 0.03 and 0.16 reported by Helen *et al*. (2013) in pastoral, agro-pastoral and mixed crop-livestock systems, respectively. Whereas ΔF estimated in LL in mixed sheep during grazing is higher than these workers reported. This may be due to small effective population size of sheep per household in the LL areas.

The results on estimation of Ne and ΔF for goat are presented in table 22**.** These results (Table 22**)** together read with appendix 2 showed that the total number of breeding bucks were 1, 22, 29 and total number of breeding does were 26, 150, 96 in mixed flocks (mixed during grazing) in high, mid and lowland agro ecologies, respectively. The corresponding figures for individual goat flocks were 1, 5, 7 for total number of bucks and 11, 51, 33 for total number of does, in HL, ML and LL, respectively.

Table 132: Effective population size and level of inbreeding of goats in different agro ecologies in average (mean).

Agro ecologies	Mixed goats population during grazing				Individual goat flocks during grazing			
	Nm	Nf	Ne	ΔF	Nm	Nf	Ne	ΔF
HL	1	26	3.85	0.129	1	11	3.67	0.136
ML	22	150	76.74	0.007	5	51	18.21	0.027
LL	29	96	89.09	0.006	7	33	23.10	0.022
Overall mean	17.33	90.67	56.56	0.047	4.33	31.67	14.99	0.061

The Ne estimates in the current study were 3.85, 76.74, 89.09 (Mixed goat flocks) and 3.67, 18.21, 23.10 (individual goat flocks) in the three AEZs (HL, ML and LL, respectively). The ΔF estimated were 0.129, 0.007 and 0.006 (Mixed goat flock) and 0.136, 0.027 and 0.022 (Individual goat flocks) in high, mid and lowland areas, respectively.

The Ne in both types of flocks (Mixed flocks; individual flocks) was higher in LL compared to the other two AEZs (HL and ML) with concomitant low ΔF in LL compared to the other two. The perusal of estimated Nm showed (Table 21) that there were very few (less) breeding rams compared to Nf in all three AEZs. This bias in Nm may have reduced the Ne in present study. However in HL and ML, the Nf estimated too was less than the LL areas. This low

effective population size on both male and female side seems to be the main reason for high ΔF in HL and ML compared to LL. This is further corroborated by the average goat population per selected respondent figures presented in table 3 (0.75 for LL **vs** 0.05 & 0.55 for HL and ML, respectively) and early slaughter age ranging from 6.03 – 6.50 months (Table 17) prevalent in the study areas. The overall effect of this was higher ΔF in HL and ML compared to LL AEZ.

4.4.4. Adaptive traits

The ranking of some adaptive features of sheep and goat in the three AEZs is presented in table 23. Perusal of these results showed that sheep in all the three AEZs were uniformly reported to be more adaptive to cold, water shortage and heat in descending order as respondents ranked these as first (0.49, 0.47, 0.52), second (0.28, 0.20, 0.25) and third (0.14, 0.15, 0.22) in HL, ML and LL areas, respectively. The results with respect to goat (Table 23) showed that these were more adapted to feed shortage, water shortage and cold, in descending order, in HL AEZ with index values of 0.26, 0.24 and 0.21. However in ML and LL the goats were uniformly reported to be more adaptive to heat, water shortage and feed shortage in decreasing order with index values of 0.46, 0.42 for heat (ML and LL), 0.27, 0.36 for water shortage (ML and LL) and 0.14, 0.10 for feed shortage (ML and LL). These results also showed that respondents reported that both species of animals possessed less adaptation to diseases, ecto and endo-parasites in all AEZs. Thus this study has shown that in both sheep and goat the parasitic load needed to be assessed periodically followed by designing appropriate dosing schedule so that loss due to both ecto- and endo-parasites is reduced. Besides a vaccination schedule also needs to be designed for these areas.

Table 143: Ranking some adaptive features of sheep and goat in three AEZs

Adaptive features	High land				Midland				Lowland				Over all
	R1	R2	R3	I	R1	R2	R3	I	R1	R2	R3	I	I
Sheep													
Diseases tolerance	1.1	0.6	0	0.02	0	0	0.6	0.01	0	0	0	0.00	0.01
Endo (internal) parasite	1.1	0	0	0.02	0	0	1.1	0.01	0	0	0	0.00	0.01
Ecto (external) parasite	0.6	3.3	1.7	0.04	0	4.4	6.7	0.12	0	0	0	0.00	0.05
Feed shortage	0	0	1.1	0.01	2.2	0	1.1	0.06	0.6	0	0	0.01	0.03
water shortage	1.7	28.3	0	0.28	1.7	10	0	0.20	1.1	1.7	0	0.25	0.24
Cold	32.8	3.9	0	0.49	15.6	6.7	0	0.47	2.2	2.2	0	0.52	0.49
Heat	0	1.1	27.8	0.14	3.8	2.2	1.1	0.15	1.1	1.1	0	0.22	0.17
Goats													
Diseases	0	0	0	0.00	0.6	0	0.6	0.01	0	0	1.1	0.01	0.01
Endo (internal) parasite	0	0	0	0.00	0	0	2.2	0.01	0	0	1.1	0.01	0.01
Ecto (external) parasite	1.1	0	0	0.15	0.6	0.6	1.1	0.03	0	0.6	0	0.01	0.06
Feed shortage	1.7	0	0.6	0.26	2.2	1.1	13.9	0.14	0	0.6	8.9	0.10	0.17
water shortage	0.6	1.1	1.1	0.24	2.8	17.8	0	0.27	4.4	10.6	0	0.36	0.29
Cold	0	1.7	1.1	0.21	0.6	2.8	5.6	0.08	0	2.8	2.8	0.09	0.12
Heat	0.6	0.6	0	0.14	21.1	5	0	0.46	12.2	2.2	0	0.42	0.34

The present results of ranking in sheep were in agreement with the reports of earlier workers (Solomon *et al*., 2010; Tadele, 2010; Zewudu *et al*., 2012 and Helen *et al.*, 2013).

4.5. Small Ruminant Marketing Systems

4.5.1. Reason of selling, buying and marketing place in sheep and goats

The reasons for selling, buying and marketing place of sheep and goat in the study areas is presented in table 24. Perusal of results showed that reasons for sale were need of cash,

difficulty in management, sale for old age / defects and crop failure in HL and ML areas. However, in LL first reason for sale was crop failure followed by need for cash followed by difficulty in management and / or sale due to old age or defect. These results indicated that both species have an important role in meeting the income needs of the farmers and thus serve as a buffer from hardship. The current results were in agreement with Belete (2009) who reported that farmers in western Ethiopia sold their animals for cash need.

Table154: Reason of selling, buying and marketing place of sheep and goat in three AEZs

Particulars	HL		ML		LL		Total	
	(%)	Rank	(%)	Rank	(%)	Rank	(%)	Rank
Reason of selling sheep and goat								
Need of cash income	(15.6)	1	(14.4)	1	(6.7)	2	(36.7)	1
Difficulty in management	(11.7)	2	(9.4)	2	(3.3)	3	(24.4)	2
Sale due to old age / defect	(6.1)	3	(8.9)	3	(3.3)	3	(18.3)	4
Crop failure	(5.0)	4	(8.3)	4	(7.2)	1	(20.6)	3
Reason of buying sheep and goat								
Replacement	(33.9)	1	(33.9)	1	(16.2)	1	(83.9)	1
Household consumption	(2.2)	2	(3.9)	2	(2.2)	2	(8.3)	2
Trading	(2.2)	2	(3.3)	3	(2.2)	2	(7.8)	3
Marketing place of sheep and goats								
Farm gate	(11.1)	2	(7.8)	3	(3.3)	3	(22.2)	3
District market	(18.9)	1	(17.2)	1	(11.7)	1	(47.8)	1
Both	(8.3)	3	(16.1)	2	(5.6)	2	(30.0)	2

The farmers in the study areas reported three reasons, viz: replacement, house-hold consumption and trading for buying both sheep and goat (Table 24). The replacement was the main reason, ranked number one, for purchase in all AEZs. The house-hold consumption and trading were ranked number two (both reasons) for purchase in HL and LL whereas these were ranked as second and third reasons of purchase in ML. The trend of current study result was in agreement with Berhanu *et al.* (2015) who reported that in highland of Ethiopia 62% of farmers buy small ruminants for replacement purpose, 14.4% for house-hold consumption and

13.8% for trading. Most of the small ruminants that are bought for replacement purposes are ewes and does.

The results of marketing place (Table 24) showed that district markets were the main marketing place for these two species in all AEZs. The farm gate was ranked second place by HL respondents whereas it was ranked third by ML and LL respondents. The current study was in agreement with Terfa *et al*. (2012) reported that most of sheep producers (66%) sold their sheep in the nearest market whereas, 7% sold within the village and 7% in distant market. Also Berhanu *et al*. (2015) who reported that most of small ruminant sold at district market (38.2%).

4.5.2. Sale of small ruminants by sex and age groups

The results of preference of respondents for sale of small ruminants (sheep and goat) by sex and age groups in the present study are presented in table 25. Perusal of results showed that majority of respondents sell small ruminants aged 06 months – 01 year and adult (> 01 year) in both sexes (male and female) across all three AEZs. The respondents ranked these two age groups as first (06 months –01 year) and second (adult, greater than 01year) in all AEZs. The FGD also showed similar trends in the sale of these two age groups. Similar finding (06 months – 01 year and adult > 01 year of male sheep) frequent sell was reported by Yenesew *et al*. (2013) in Burie district, north western Ethiopia.

The age group (06 months -01 year) preferred as number one for sale (Table 25) in both sexes indicated that growing male hoggets and female hoggets, with good genetic potential, were regularly / purposely eliminated from the population through sale. Alubel (2015) has also arrived at this possibility. This trend greatly affected future improvement and thus narrowed the genetic base of flocks resulting in high coefficient of inbreeding as Ne is getting decreased in both sexes.

Table 165: Preference of households for sale of small ruminants by sex and age groups

Sex	Age group	HL (N 69)		ML (N 74)		LL (N 37)		Overall (N 180)	
		%	Rank	%	Rank	%	Rank	%	Rank
Male	< 06 months	5.6	3	4.4	4	3.3	3	13.3	4
	06 months – 01 year	20.0	1	18.3	1	8.3	1	46.7	1
	Adult (> 01 year)	10.0	2	12.2	2	7.2	2	29.4	2
	Castrated	2.8	4	6.1	3	1.7	4	10.6	3
Female	< 06 months	5.0	3	3.3	3	3.3	3	11.7	3
	06 months – 01 year	14.4	1	19.4	1	10.6	1	44.4	1
	Adult (> 01 year)	18.9	2	18.3	2	6.7	2	43.9	2

4.5.3. Season of marketing sheep and goats

The results of season of marketing sheep and goats in the present study are presented in table 26. Perusal of results showed that sale of small ruminants was related to the seasonal holiday markets in all study areas. The present results showed that majority of respondents sold their small ruminants at the time of Easter, Christmas, Ethiopian New Year, Epiphany and Meskel festivals in descending order in all AEZs except LL where number 2 and 3 were New Year and Christmas festivals. These results indicated that during major cultural and religious holidays, especially after long fasting by orthodox Christian believers (during this fasting period consumption of animal products is strictly banned), there is a sharp increase in demand for meat. Thus farmers take advantage of this opportunity as they get more returns.

The present results were in agreement with earlier findings by Ehui (2000) who reported that in Addis Ababa households are more likely to buy live sheep during the quarters in which the Ethiopian new year and Easter; Tsedeke (2007) in Alaba southern Ethiopia; Belete (2009) in western Ethiopia who reported that marketing and consumption of sheep and goats was targeted to holidays of the year rounds and Gemeda *et al*. (2012) also reported that there was little/no evidence of strategic production of sheep for marketing except sales targeted to traditional Ethiopian festivals.

Table 176: Season of marketing sheep and goats (%)

Time of selling	HL	ML	LL	Overall
Epiphany	5.0	5.6	2.2	12.8
Easter	13.9	10.6	8.9	33.3
Ethiopian new year	7.2	8.9	4.4	20.6
Christmas	10.0	12.8	3.3	26.1
Meskel	2.2	3.3	1.7	7.2

4.5.4. Market channels

The major marketing channels linking producers with end users were identified (Figure 4) in the present study. These different channels represent the full range of available outlets through which sheep and goats move from the different collection points in major production areas to terminal markets to meet end-users needs.

Channel 1 Producer → small trader → hotels

Channel 2 Producer → small trader → general consumer

Channel 3 Producer → general consumer

Channel 4 Producer → large trader → general consumer

Channel 5 Producer → small trader → large trader

Channel 6 Producer → small trader → large trader → general consumer

Figure 4: Marketing channels of small ruminants

4.5.5. Marketing participants and mode of price setting

The results of marketing participants and mode of price setting is presented in table 27. Perusal of results showed that the respondents sold their small ruminants to farmers (42.80 %), small traders (22.2 %), large traders (13.90 %), hotels (11.1 %) and general consumer (10.0). The results indicated that hotels and general consumers fell at the last steps of the marketing participants. This conversely showed that small traders, who in fact were middleman, were important marketing participants. This finding is in agreement with Tsedeke (2007) in southern Ethiopia and Yenesew (2010) in Burie woreda of Amhara National

Regional State, Ethiopia, who reported that general consumers (12.2%) and hotels (16.7%) showed less marketing participating for sheep and goat buying.

The results of mode of price setting (Table 27) showed that majority (97.2%) of the respondents market their animals based on "eye-ball" estimation (visual appraisal) whereas only few (2.8%) farmers preferred to sell their animals based on live weight.

Table 187: Marketing participants and mode of price setting in sheep and goat buying

Particular	N	%
(I) Participants		
Farmers	77	42.80
Small traders	40	22.20
Hotels	20	11.10
General consumer	18	10.00
Large traders	25	13.90
(II) Mode of price setting		
Eye ball estimation	175	97.2
Weight base	5	2.8
(III) Average number of animals sold	**Mean**	**SD**
Average number of sheep sold/household per year	4.4	3.7
Average number of goats sold/household per year	2.2	2.4

This finding is in agreement with Tsedeke (2007) in southern Ethiopia who reported that most of producers market their animals based on eye-ball estimation and few of them (2.0%) sell on live weigh basis. Animals were reported to be marketed on individual basis and agreement to prices reached after a long one-to-one bargaining between buyers and sellers and sometimes brokers. They visually inspected the animals, and negotiated and haggled over the prices until consensus was arrived at.

The average number of sheep and goat sold / household / year (Table 27) was 4.4 (3.7) and 2.2 (2.4), respectively, in the present study. The result of the current study was higher than

Yenesew (2010) in Burie woreda, west Gojjam, who reported that one household sold on average 1.1 heads of sheep per year.

4.6. Constraints and Opportunities of Small Ruminant Production and Marketing

4.6.1. Constraints in small ruminant production

The identification of major constraints for a given farm animal production system in a given area is a prerequisite to plan appropriate intervention strategies for improving productivity. Accordingly major constraints faced by small ruminant production system, based on interview of respondents, in the study areas were identified and are presented in table 28.

Perusal of these results showed that disease was ranked as first constraint for both species in all the three agro ecologies with index values of 0.42, 0.48 and 0.31 in HL, ML and LL, respectively for sheep and 0.40, 0.42, 0.23 in HL, ML and LL, respectively for goat. Solomon *et al*. (2013) also identified diseases as first constraint in sheep production under perennial crop-livestock and cereal livestock production systems. Lack of improved breeds as a constraint was identified by respondents as number two in case of goats in HL area. Feed shortage, water shortage, long dry season were ranked either second, third or vice versa for both species in the three AEZs. The present findings were in agreement with Yenesew *et al.* (2013) who reported that in Bure district of North western Ethiopia feed shortage was very severe especially in the highland kebeles and Mesay *et al.* (2013) in Lemu-Bilibilo district in Arsi zone also reported that, shortage of feed at the end of dry season when all crop residues have been consumed and pasture growth is poor, was the major constraint for livestock production in the area.

The age-wise and season-wise mortality pattern in small ruminants during the period of the last 12 months (2014) is presented in table 29. Perusal of these results showed that respondents reported that mortality among young stock (0-6 months of age) was higher in all AEZs for both species. The overall percent of respondent reporting this were 10.4 (less than 03 months), 5.6 (3-6 months) for sheep and 9.4 (less than 03 months) and 7.2 (3-6 months) for goat in the present study.

Table 28: Rank of major constraints by sheep and goats rears.

Major constraints	High land (N=69)				Midland (N=74)				Lowland (N=37)				Over-all
	R1	R2	R3	I	R1	R2	R3	I	R1	R2	R3	I	I
Sheep													
Shortage of feed	12	26	17	0.27	1	25	10	0.25	0	0	3	0.06	0.20
Shortage of water	6	22	15	0.20	1	1	21	0.10	2	2	0	0.19	0.16
Diseases	44	15	3	0.42	37	5	0	0.48	4	2	1	0.31	0.40
Predators	0	0	0	0.00	1	0	1	0.02	1	2	0	0.13	0.05
Lack of improved breed	3	1	1	0.03	0	0	1	0.00	0	0	2	0.04	0.02
Long dry season	0	1	16	0.05	2	10	1	0.11	1	3	2	0.20	0.12
Shortage of capitals	2	2	6	0.04	0	1	8	0.04	1	0	1	0.07	0.05
Goats													
Shortage of feed	3	4	0	0.40	15	18	8	0.30	8	8	0	0.23	0.31
Shortage of water	0	1	1	0.06	7	1	31	0.18	5	0	10	0.14	0.13
Diseases	4	1	1	0.40	23	27	0	0.42	9	1	12	0.23	0.35
Predators	0	0	0	0.00	2	0	2	0.02	4	1	0	0.08	0.03
Lack of improved breed	0	0	5	0.11	0	0	0	0.00	2	0	0	0.03	0.05
Long dry season	0	0	0	0.00	0	3	7	0.04	0	17	0	0.19	0.08
Shortage of capitals	0	1	0	0.04	2	0	0	0.01	2	3	5	0.10	0.05

Index = sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for particular constraints divided by sum of [3 for rank 1 + 2 for rank 2 + 1 for rank 3] for all constraints.

Table 199: Age-wise and season-wise mortality pattern in small ruminants during the period of the last 12 months (2014) (in %)

	HL	ML	LL	Overall
(I) Sheep:				
(a) Age groups:				
Lambs (less than 3 months)	3.9	5.4	1.1	10.4
Lambs (3 to 6 months)	3.3	1.7	0.6	5.6
Adult Ewes (> 1 year)	1.7	1.1	0.0	2.8
Adult Rams (> 1 year)	1.7	0.6	0.0	2.2
Castrates	1.1	0.6	0.0	1.7
(b) Season:				
Winter (Dec. – Feb.)	4.4	3.3	1.1	8.9
Summer (June - August)	3.3	1.7	0.0	5.0
Autumn (September – Nov.)	2.2	2.2	0.0	4.4
Spring (March - May)	1.7	2.2	0.6	4.3
(II) Goat:				
(a) Age groups:				
Kids (less than 3 months)	0.0	6.1	3.3	9.4
Kids (3 to 6 months)	1.1	3.9	2.2	7.2
Adult Does (> 1 year)	0.0	5.0	0.6	5.6
Adult Bucks (> 1 year)	0.6	3.3	1.1	5.0
Castrates	0.6	1.7	0.6	2.8
(b) Season:				
Winter (Dec. – Feb.)	1.1	3.8	2.8	7.7
Summer (June - August)	1.1	11.7	3.3	16.1
Autumn (September – Nov.)	0.0	1.7	1.1	2.8
Spring (March - May)	0.0	2.8	0.6	3.4

This result was in agreement with Sharif *et al.* (2005) and Girma *et al*. (2013) who reported that kids were at higher risk of dying. The present results showed that young stock was exposed to high mortality and possible reasons may be paucity of energy in neonates (this result and their weak immunological status, which exposes them to infections. Thus management intervention in terms of protection from cold / windy climate, incessant rains and feeding needed to be developed for both species. Gemeda *et al*. (2002) indicated that prepartum supplementation of breeding ewes, preferential treatment of maiden ewes and providing preferential treatment of ewes lambing may partially solve lamb mortality problem. Perusal of table 28 further showed that respondents reported that higher mortality occurred during winter (Dec. – Feb.) in sheep for all AEZs and goat in HL area only. However, summer (June - August) season was reported to be period of higher mortality in goats in ML and LL AEZs. The later finding was in disagreement with Sharif *et al*. (2005) and Girma *et al*. (2013) who reported pre weaning kids frequently died in winter season. However, FGD responded that there were massive attacks of fox on young stock and hyena / other wild animals on adult flock. This finding is in agreement with Tsedeke (2007) in Alaba southern Ethiopia; Assen and Aklilu (2012) in different agro-ecological zones in Tigray and Solomon *et al*. (2014) in Amhara National Regional State of Ethiopia.

The results in table 28 above showed that shortage of water was ranked as third constraint followed by long dry season as a fourth constraint for sheep and goat production. Accordingly distance covered during dry season in search of water, as reported by respondents, is presented in table 30. Perusal of table 30 showed that good proportion (8.9, 9.4 and 10.0 % in HL, ML and LL, respectively) of respondents reported that a distance of 3-5 km was covered in search of water during dry season. The other distances covered in search of water were either < 1 km (14.4, 13.3 and 2.2 % in HL, ML and LL, respectively) or 1-2 km (13.3, 15.0 and 4.4 % in HL, ML and LL, respectively). The current study agreed with earlier workers **(**Tsedeke, 2007 and Mesay *et al*., 2013). The FGD revealed that during dry season water in some of the rivers dries up and thus not only animals but even human beings spent their time to search water, especially in LL areas.

Table 30: Distance covered during search of water in dry season in three AEZs

Distance	HL (%)	ML (%)	LL (%)
Watered at home	1.7	3.3	3.9
<1km	14.4	13.3	2.2
1-2km	13.3	15.0	4.4
3-5km	8.9	9.4	10.0
Total	38.3	41.1	20.6

4.6.2. Opportunities

4.6.2.1. Major opportunities in small ruminant rearing

The opportunities of small ruminant rearing in the three AEZs**,** based on respondent interview, are presented in table 31. The respondents listed four main reasons for small ruminant rearing and these were, viz: low start up cost, multispecies grazing, increase in mutton / chevon demand and minimal labor requirements. The order of their importance in HL and LL was low start up cost, multispecies grazing, increase in mutton / chevon demand and minimal labor requirements whereas it was multispecies grazing, low start up cost, increase in mutton / chevon demand and minimal labor requirements in ML AEZ. The study of Okpebholo (2007) showed that low start-up cost as an important factor in providing opportunity for the development of a small ruminant production system by a small-scale farmer with limited resources. Thus these findings agreed with present results.

Table 20: Opportunities of sheep and goat breeding (in %) in three AEZs.

Particulars	HL ((N=69)	ML (N= 74)	LL (N=37)	Overall (%)
Low start up cost	13.9	15.0	9.0	38.3
Multispecies grazing	12.2	16.1	5.0	33.3
Meat demand increase	7.2	6.1	3.3	16.7
Minimal labor requirements	5.0	3.9	2.8	11.7

The multispecies grazing, as found in present study, agreed with the reports of Arse *et al*. (2013) in Adami Tulu, Arsi Negelle and Fantale districts of Oromia Regional State, Ethiopia. Similar, increase mutton /chevon demand, as found in present study, was in agreement with finding reported by Solomon *et al*. (2010) indicating that sheep and goat breeds in the lowlands of the country were in good demand in the middle east markets.

4.6.2.2. Gender-wise labor allocation (percentage) in small ruminant rearing

The gender-wise labour allocation in small ruminant rearing, as reported by respondents, is presented in table 32. The hired labour (Table 32) was engaged by small proportion (< 12 %) of respondents and thus labour provided by family members was mainly responsible for small ruminant rearing. Among family members, according to respondent interviews, all members including men, women, boys and girls, participated in various management activities in varying proportions. The men were involved in buying (68.9 %), selling (66.6 %) and attending sick animals (58.3 %). The women were involved in cleaning flock barn (35.6 %), attending sick animal (23.9 %) and buying / selling (20.6 %). Similarly boys and girls participated in flock herding (65.6, 19.4 % for boys and girls, respectively), cleaning flock barn (9.4 and 51.7 %, for boys and girls, respectively) and feeding / watering (60.0 & 19.4 % for boys and girls, respectively). The present results were in agreement with Tsedeke (2007) and Zawudu *et al*. (2012) in western and south-western Ethiopia.

Table 21: Gender-wise labour allocation in small ruminant rearing (%)

Tasks	Home labour				Hired labor	Total
	Men	Women	Boys	Girls		
Flock herding	3.3	0.6	65.6	19.4	11.11	100.0
Buying	68.9	20.6	6.7	3.3	0.6	100.0
Selling	66.6	20.6	7.2	3.9	0.0	100.0
Attending sick animals	58.3	23.9	11.1	4.4	2.2	100.0
Cleaning flock barn	2.2	35.6	9.4	51.7	1.1	100.0
Feeding and watering	3.3	6.2	60.0	19.4	11.1	100.0

5. SUMMARY, CONCLUSION AND RECOMMNEDATION

5.1. Summary and Conclusion

This study was conducted in Ada Barga and Ejere districts of west Shoa Zone of Oromia Regional State to characterize central highland sheep and goat production and marketing system in their production environment based on agro ecology (high, mid and lowland) of the areas. The survey study was implemented by interviewing selected individual small ruminant producer and focus group discussion. Ada Barga and Ejere, districts of the west Shoa zone were selected for this study based on potential for small ruminant production.

The overall objectives for sheep rearing (across all AEZs) ranked in the order of income (0.45), saving (0.17) and meat (0.14). However the overall objectives for goat rearing (across all AEZs) ranked as income (0.50), followed by meat (0.21) and saving (0.12). The results showed that 10.6, 14.4 and 15.6% of households possessed their own grazing land; 26.7, 24.4 and 1.7 % utilized rented grazing land; and 1.1, 2.2 and 3.3%, respectively, made use of community grazing land in HL.ML and LL AEZs. During dry season apart from natural pasture, the other major feed sources were crop residues (ranked second), crop aftermath (ranked third) and hay (grass only, ranked fourth) in that order in all the three AEZs.

The overall proportion of respondents following sheep with other livestock but not goat, sheep alone, goat with other livestock but not sheep, goat alone, sheep and goat mixed with all other livestock and Mixed Sheep & Goat grazing ways were 32.8, 20.6, 18.9, 13.9, 8.9 and 5.0 % , respectively. The rain water followed by river water was the main source of water for sheep and goat during rainy season in all AEZS. However during dry season river water followed by spring water were main source for watering small ruminants in the three AEZs. Majority of house hold in midland (16.1%) and lowland (13.9%) of districts were confining their sheep and goats in family house. However in HL the majority (18.9 %) of respondents housed sheep in separate house. Verandah was used for housing both sheep / goat in next order by 10.0, 15.6 and 5.6 % of respondents in HL, ML and LL areas, respectively.

Both age at first lambing (AFL) and age at first kidding (AFK) were found to be significantly affected by AEZs. The AFL were 14.12, 14.36 and 15.22 months for sheep and AFK was

15.33, 13.82 and 13.60 months for goats in high, mid and lowland respectively. The differences in weaning age in both species were found to be significant across the three AEZs. The weaning age of lambs was 3.84, 3.93 and 4.44 months in high, mid and lowland of agro-ecology, respectively, whereas weaning age of kids was 4.67, 3.82 and 3.52 months in high, mid and lowland, respectively. The slaughter age for both species was significantly influenced by AEZs. The average slaughter ages were 6.34, 6.37, 7.33 in sheep in high, mid and lowland areas, respectively. The age at sexual maturity of males (ASMM) in both species showed highly significant differences among the three AEZs. Accordingly, the ASMM were 8.79, 8.93 and 9.67 months in rams and 9.67, 8.38 and 8.16 months in bucks in HL, ML and LL, respectively. The AEZs had highly significant influence on both lambing and kidding interval in the present study. The lambing interval in the study area was reported to be 8.79, 8.83, 9.56 months and kidding interval was 9.33, 8.22 and 8.10 months in high, mid and lowland, respectively. The litter size in both species was not influenced by AEZs. The variations in the reproductive life span of females in both species were significant due to AEZs. The reproductive life spans were 129, 125 and 112 months in sheep and 98, 101 and 120 months in goat in Hl, Ml and LL AEZs, respectively. The survey results showed that apparent peaks of intensive kidding and lambing were in April and May, respectively.

The respondents ranked body conformation (size) as number one for selecting a breeding ram in all three AEZs. However second and third rank for selecting breeding ram differed in the three AEZs. The second rank was tail; color in ML and LL, respectively and third rank was age at first maturity in HL; tail in ML and LL, respectively. The results showed that respondents ranked bucks on the basis of body conformation (size), color and age at first maturity as rank first, second and third in all three AEZs in the present investigation. In selecting a breeding ewes body size and coat color were ranked first and second across all AEZs. The twining ability was ranked third in HL whereas lamb survival was ranked as third criterion of selection of breeding female in ML and LL areas. For does in HL coat color followed by body size followed by kidding interval were ranked first, second and third whereas in ML body size, coat color and kidding interval were ranked first, second and third. However in LL body size, coat color and kidding survival were ranked first, second and third, respectively.

The effective population size (Ne) estimated in high, mid and lowland areas were 103.77, 46.88, 7.24 whereas the rate of inbreeding per generation (ΔF) was 0.005, 0.011 and 0.069, respectively, in mixed sheep grazing. Similarly effective population size (Ne) estimated in high, mid and lowland areas were 3.80, 21.75 and 3.79 whereas the rate of inbreeding per generation (ΔF) was 0.131, 0.023 and 0.132, respectively, in individual sheep during grazing.

The results showed that majority of respondents sell small ruminants aged 06 months – 01 year and adult (> 01 year) in both sexes (Male and female) across all the three AEZs. The respondents sold their small ruminants to farmers (42.80 %), small traders (22.2 %), large traders (13.90 %), hotels (11.1 %) and general consumer (10.0).

The study showed that disease was ranked as first constraint for both species in all three agro ecologies. Feed shortage, water shortage, long dry season were ranked either second, third or vice versa for both species in the three AEZs. However lack of improved breeds as a constraint was identified by respondents as number two in case of goats in HL area. The opportunities were listed as low start up cost, multispecies grazing, increase in mutton / chevon demand and minimal labor requirements in decreasing order of their importance in HL and LL whereas it was multispecies grazing, low start up cost, increase in mutton / chevon demand and minimal labor requirements in ML AEZ.

5.2. Recommendation:

1) Comprehensive farmers awareness program needs to be under taken on scientific small ruminant management system emphasizing lamb/kid management, advantages of selection of male / female animals for future breeding, disadvantages of slaughter/marketing of young stock, adult / fertile stock, advantages of pasture management by community , advantages of separate housing and disadvantages of increasing inbreeding;
2) A location / area specific dosing / vaccination schedule be developed to reduce mortality due to diseases and parasitic infestation;
3) Traits preferred by small ruminant farmers in selection, breeding and production of small ruminant farmers should be considered in designing any community based small ruminant improvement program for the study area; and
4) Effective population size of both sheep and goat per house-hold needs to be increased by devising appropriate intervention measures to reduce level of inbreeding,

5.3. Future research:

I. On farm performance evaluation of sheep and goat is required to understand effect of seasons and year on productive and reproductive of small ruminants; and

II. Comprehensive breed characterization of small ruminant genotypes in central high lands may be undertaken in phased way.

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7. APPENDICES

7.1. Appendices A: Tables

Appendix1: Number of breeding male and female of sheep in mixed and not mixed grazing in three AEZs

Agro ecology	Mixed grazing sheep						Not mixed sheep					
	Nm			Nf			Nm			NF		
	N	n	Mean ±SE	N	n	Mean ±SE	N	n	Mean ±SE	N	N	Mean ±SE
HL	22	28	0.41±0.10	61	353	5.12±0.53	1	1	0.01±0.01	6	20	0.29±0.11
ML	11	13	0.18±0.05	29	119	1.61±0.25	6	6	0.08±0.03	13	58	0.78±0.21
LL	2	2	0.05±0.03	5	19	0.51±0.22	1	1	0.03±0.02	4	18	0.49±0.24
Overall	31	39	0.22±0.04	85	432	2.45±0.27	12	12	0.07±0.01	33	146	0.81±0.13

Nm= number of breed able male sheep, Nf= number of breed able female sheep, N= number of respondents, n= total number of sheep, SE= standard error, HL= highland, ML= midland, LL= lowland

Appendix2: Number of breeding male and female of goat in mixed and not mixed grazing in three AEZs

Agro ecology	Mixed grazing goat						Not mixed goat					
	Nm			Nf			Nm			NF		
	N	n	Mean ±SE	N	n	Mean ±SE	N	N	Mean ±SE	N	N	Mean ±SE
HL	1	1	0.01±0.01	6	26	0.38±0.15	1	1	0.01±0.02	4	11	0.03±0.01
ML	13	22	0.28±0.08	34	150	1.93±0.30	5	5	0.07±0.03	9	51	0.69±0.17
LL	14	29	0.81±0.23	21	96	2.78±0.49	3	7	0.19±0.12	8	33	0.89±0.34
Overall	28	52	0.29±0.06	58	262	1.46±0.18	10	14	0.08±0.03	21	95	0.53±0.10

Nm= number of breed able male goat, Nf= number of breed able female goat, N= number of respondents, n= total number of goat, SE= standard error, HL= highland, ML= midland, LL= lowland

Appendix 1: Average number of livestock and their Conversion factors to Tropical Livestock Unit (TLU)

Descriptors	High land (N=69)	Midland (N=74)	Lowland (N=37)	Overall (N = 180)	Conversion factors (TLU)	High land (N=69)	Midland (N=74)	Lowland (N=37)	Overall (N = 180)
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Livestock (TLU)									
Cattle	9.1 (7.2) [a]	7.2 (4.2) [ac]	5.2 (3.1) [c]	7.5(5.5)	0.7	6.37 (7.2) [a]	5.04 (4.2) [ac]	3.64 (3.1) [c]	5.02 (5.5)
Goat	0.5 (1.7) [a]	5.5 (5.3) [b]	7.5 (5.0) [c]	4.0(5.0)	0.1	0.05 (1.7) [a]	0.55 (5.3) [b]	0.75 (5.0) [c]	0.45 (5.0)
Sheep	10.2 (8.0) [a]	4.3 (4.5) [b]	1.3 (2.4) [c]	5.9(6.8)	0.1	1.02 (8.0) [a]	0.43 (4.5) [b]	0.13 (2.4) [c]	0.53 (6.8)
Donkey	0.8 (1.0)	1.2 (1.1)	1.1 (1.3)	1.0(1.1)	0.5	0.40 (1.0)	0.60 (1.1)	0.55 (1.3)	0.52 (1.1)
Horse	0.8 (1.5) [a]	0.3 (0.5) [b]	0.1 (0.4) [bc]	0.4(1.0)	0.8	0.64 (1.5) [a]	0.24 (0.5) [b]	0.08 (0.4) [bc]	0.32 (1.0)
Mule	0.0 (0.2)	0.1 (0.6)	0.0 (0.2)	0.0(0.4)	0.7	0.0 (0.2)	0.07 (0.6)	0.0 (0.2)	0.02 (0.4)
Chicken	4.5 (4.9)	5.4 (4.9)	5.7 (3.4)	5.1(4.6)	0.01	0.05 (4.9)	0.05 (4.9)	0.06 (3.4)	0.50 (4.6)

N= number of respondent, SD= standard deviation, Same superscript indicate non-significant differences, Different superscript indicate significant differences, TLU= tropical livestock unit

Source: Jahnke, 1982 (for Conversion factor (TLU)).

7.2. Appendices B: Questionnaires

1. Enumerator's Name _____

2. Kebele _____3. Gox_____

1: General Socio Economic

1. Name of the interviewee _____

2. Sex of the interviewee 1. Male 2. Female

3. Age group codes **1**=<20 **2**= (20-30) **3**= (30-40) **4**= (40-50) **5**= (50-60) **6**=>60

4. Level of education codes: 1=None 2= primary 3=secondary 4=higher school 5=higher education

5. Marital status codes 1=single 2= married 3 = divorced 4=widow

6. Position in House hold: 1.male head 2.female head 3.relative 4.son

7. Religion: **1**. Catholic **2**.orthodox **3**.Muslim **4**. Seventh Day Adventist **5**.protestant 6.Tradational African religion

8. Family size: Females _____Males _____Total_____

9. What is your farming activity? 1. Livestock production 2.crop production 3.crop livestock production 4.Other specify…….

10. Non farming activities 1.Hand craft 2.Trading 3.daily labor 4. Others (specify)……..

11. Rank your farming and non- farming activities according to the respective codes below table.

Crop production			
Major	Rank	**Minor**	Rank

12. How much is your land allocated for the followings?

A. for crop cultivation (ha) _____ *b*. Irrigation (Ha) _____c. Grazing/pasture land (ha)

d. Fallow land _____Others, specify (ha) _____

13. Type of grazing land and ownership

Type of grazing land	Own	Rent	Communal
1= grassland			

14. Fill the owner and rank their most importance

Livestock		Total number owned by the house hold	Number owned specifically by men	Number owned specifically by women	Number owned by male children	Number owned by female children
Cattle	Indigenous					
	Exotic/cross					
Goat	Indigenous					
	Exotic/cross					
Sheep	Indigenous					
	Exotic/cross					
Donkey	Indigenous					
	Exotic/cross					
Horse	Indigenous					
	Exotic/cross					
Chicken	Indigenous					
	Exotic/cross					
Bees	Indigenous					
	Exotic/cross					

15. Fill the age group of the following sheep and goat owner

Age group of sheep and goat	Goat owner				Sheep owner			
	Number owned specifically by men	Number owned specifically by women	Number owned by male children	Number owned by female children	Number owned specifically by men	Number owned specifically by women	Number owned by male children	Number owned by female children
1=male<6 month								
2=female<6month								
3=male 6month to 1								

year								
4=female 6month to 1year								
5=male>1year								
6=female>1year								
7=castrate								

16. How many breeding ewe you have? _____

17. How many breeding doe you have? _____

18. If you have more than one ewe and /or one doe what is the reason? Use the following codes:

1=for breeding purpose 2= others----------

19. How many breeding ram you have? _____

20. How many breeding buck you have? _____

21. If you have more than one ram and /or one buck what is the reason? Use the following codes:

1=for preservation 2=for service /mating 3=others----------

22. What are Routes of flock entry and Routes of flock exit? Rank them accordingly.

Routes of flock entry	Rank them	Routes of flock exit	Rank them
1= Home Born		1= sale	
2=Purchase		2=death	
3=Share arrangement		3=Slaughter	
4=others		4=Predator	
		5=Theft	
		6= others	

2. Breeding objective of Sheep and Goats (Rank them)

	Purpose	Rank
1	Income source (sale)	

2	Meat	
3	Milk	
4	Manure(fertilizer)	
5	Sacrifice/rituals	
6	Social/cultural function	
7	Saving (Insurance)	
8	Risk/Benefit Distribution with other animals	
9	Other reasons	

3. Small ruminant production systems

1. Have you tether practice of sheep and goat? 1. Yes 2. No.

2. If yes, why? 1=to avoid crop and vegetation damages 2=Save labor 3=Protect from predators 4=Utilize marginal land and hillsides 5= control breeding 6=others, specify

3. How you grazing your sheep in the dry season? 1=Free 2=tethered 3=cut and carry 4=herded5=3and4 6=2, 3&4

4. How you grazing your goats in the dry season? 1=Free 2=tethered 3=cut and carry 4=herded5=3and4 6=2, 3&4

5. How you grazing your sheep in the wet season? 1=Free 2=tethered 3=cut and carry 4=herded5=2and3 6=2, 3&4

6. How you grazing your goats in the wet season? 1=Free 2=tethered 3=cut and carry 4=herded5=2and3 6=2, 3&4

4. Productive and reproductive performance of small ruminants.

1. What is the reason for Poor reproductive performances of your sheep and goats?

1. Poor management 2.Seasonal fluctuation 3.Genetic and environmental factor 4. Other (specify)----------

2. Fill the following Table of productive and Reproductive performance of sheep and goats

SN	Particularly	Sheep		Goat	
		Male	female	male	female
1	Age at first parturition (months)				
2	Parturition interval (months)				
3	Average litter sizes :				
	1=single				
	2=twin				
	3=triplets				
4	Weaning and age at weaning				
5	Average culling/disposal age in month/year)				
6	Slaughter age /marketing age(months)				

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

If yes, why (rank)? 1=old age 2=Sickness 3=Lambing and kidding problems

4=Physical defect 5=Unwanted physical characteristics 6=feed scarcity7=others, specify

4. Average reproductive lifetime of ewe (in years) _____and doe (in years) _____

5. Seasonality in breeding

1. Thick **(**√**)** the season/months of the year you observe intensive lambing, kidding and conception?

SN	Species	Intense breeding and conception months											
		Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1	Lambing												
2	Kidding												
3	conception												

2. What are common sources of breeding males for your flocks?

SN	Sources of breeding males	Ram (in number)	Bucks(in number)
1	Own		
2	Neighbors		

3. If you have breeding buck, what type of it? 1. Crossbred buck 2. Exotic 3. Local bred buck

4. If you have breeding ram, what type of it? 1. Crossbred buck2. Exotic buck 3. Local bred buck

5. If you have exotic and /or crossbred buck, how do you have it?

1=inherited (from mother) 5= obtained from development project as loan

2=purchased from neighboring farm/market 6= as gift from relative/friends

3=purchased from friend 7=as loan from relative/friends/neighbor payment

4=purchased from a development project as gift 8=other (specify)

6. What is type of mating used? 1. controlled 2. Uncontrolled

7. Could you able to identify the sire of a lamb/kid? A. Yes B. No

If yes, specify the criteria used to identify_____

8. Do you allow ram/kids to mate his? **(**√**)** it.

Yes No

Reason_____

a. Mother		
b. Daughter		
c. Sister		

9. Do you allow your ram /buck to serve other than yours?

a. Yes b. No Reasons_____

10. for how many years on the average one buck_____ (in month/year) and one ram _____ (in month/year) serving in your flock?

11. Who manage more your sheep and goats?

Participants	Sheep (rank)	Goat(rank)
1=Male house hold		

2=Female house hold		
3=Male children		
4=Female children		
5=Other(specify)		

12. Is there any special management for breeding buck or ram? 1. Yes 2. No

If yes specify type of management_____

6. Small ruminant Management system

6.1. Housing system

1. Where you confine sheep and goats?

1=Main house 2=Adjoin house (in the house) 3=Separate constructed house

4=Grazing area (open kraals) 5=others, specify _____

2. Housing materials

Type	roof	Wall	Floor
1) Iron sheet			
2) grass/sheet			
3) wood			
4) stone/bricks			
5) concrete			
6) earth/mud			

3. How you confine house of sheep and goats?

1=Sheep alone 2=Goats alone 3=Sheep and goats alone

4=Sheep, goats and all other animals together 5=others, specify _____

4. Are new born kids/lambs housed with adults? 1. Yes 2. No

5. Do you separate new born kids/lambs from their mother? 1. Yes 2. No

If yes for how many days you separate kids_____ and lambs_____ from their mother?

6.2. Health management system

1. What are the common diseases and parasites that affect health and production of sheep and Goats

SN	Name of disease	Affect			Symptoms	Seasons/months
		sheep	Goat	both		
1						
2						
3						

2. What would you do when your sheep and goats sick?

1=Treat with local medicine 2=Sales immediately

3=Slaughters immediately 4=Takes to veterinary center

5= others, specify_____

3. Are you accessible to veterinary services in your locality/near distance? 1=Yes 2=No

If yes how far? A. < 1km b. 1-5km c. 6-10km

4. from where you usually obtain veterinary services?

1=Government 2=DA offices 3=NGOs 4=Private institutions 5=Open markets

5. How you obtain services in these institutions?

1=Free of charge 2=Payment 3=Credit 4=others, specify

6. Did your sheep and goats vaccinated? 1=Yes 2=No

If yes how? 1=after report of disease cases 2=after certain animals died3=others, specify___

7. Did you use traditional treatment when your sheep/ goat got sick? 1. Yes 2. No

If yes what is? And how? _____

8. What are the major health constraints of sheep and goats in your area?

major health constraints of sheep and goats	Rank
1=distance to reach government clinics	

2=high prevalence of diseases and parasites	
3= Lack/shortage of drugs and medicines	
4= others_____	

9. Has there been any death of sheep and goats over the last 12 months?1=yes 2=No

If yes, rank in the following table.

SN	Sheep		Goats	
	Structure	Rank sheep died	Structure	Rank goats died
1	< 3months		< 3months	
2	3-6 months		3-6 months	
3	Ewes		Does	
4	Rams		Bucks	
5	Castrates/fattening		Castrates/fattening	

10. If Majority of death occurs on new born lambs/kids (<3months), what is the reasons?

1=lack of separate lamb/kid from their dams 2=insufficient ingestion of colostrums 3=Running with their mother or other flock before mature 4= others_____

6.3. Castration

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

If yes why? 1=to fetch more price (by fattening) 2=to avoid mate their flock with these males 3=others, specify _____

2. At what age do you castrate bucks? _____Months, Rams? _____ Months

3. Thick **(√)** the most castration months of sheep and goat and among them rank the top 2 months.

SN	Species	Most castration months											
		Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1	sheep												
2	goats												

4. For how long do you keep castrated? Sheep_____ year and goats' _____ year

5. What method you use to castrate your sheep and goat?: a. Modern b. Traditional

If you castrate traditionally, what type of materials used for castration?

6.4. Feeding system

1. Tick **(√)** the most available feed resource in wet and dry season and rank them.

Types of feed sources	Sheep				Goats			
	Wet season	Rank	Dry season	Rank	Wet season	Rank	Dry season	Rank
1=natural pasture								
2=established pasture								
3=hay								
4=crop residues								
5=fallow land								
6=concentrates								

2. is there feed shortage or constraint for your sheep and goats? 1=Yes 2=No

If yes what are the major constraints of feed? 1=low availability of fodder 2=poor incentives to farmers 3= Increase of human population 4= Drought 5=others_____

6.5. Water Resources and Watering

1. What are the common water sources of sheep and goat in this area?

SN	Sources of water	During rainy season	During wet season
1	River		
2	Pond		
3	Rain water		
4	Water harvest		
5	Deep well		
6	Pipe		
7	Any other sources		

2. Distance to watering point

Distance	rainy season	wet season
Watered at home		
<1km		
1-5 km		
6-10 km		
>10km		

3. Are kids and lambs watered with the adults? 1= yes 2= No

If no how they are watered? 1= at home 2=we not watered them

4. Frequency of watering sheep and goats

Frequency	Sheep		Goats	
	rainy season	wet season	rainy season	wet season
Freely available				
Once a day				
Once in 2 days				
Once in 3 days				
Others				

6.6. The most trait preferences

1. Do you select best breed able female goat as parent of the next generation within your goats? 1. Yes 2. No

2. If your answer is yes, which traits you prefer for female goat (does) selection?

Criteria	Tick as mentioned	Rank (Top five)
Size/ appearance		
Color		
A= white		
B= brown		
C= black		
Kid growth		

Kid Survival		
Lambing frequency		
Twining ability		
Mothering ability		
Age at first maturity		
Ear length		

3. Do you select best breed able male goat as parent of the next generation within your goats?
   1. Yes 2. No
2. If your answer is yes, which traits you prefer for male goat (bucks) selection?

Criteria	Tick as mentioned	Rank them
Appearance/conformation		
Color		
A= white		
B= brown		
C= black		
Growth		
Libido		
Age at first maturity		
Pedigree		
Adaptability		

1. Tick **(**√**)** the most traits you prefer for breeding male and female of sheep selection criteria.

Phenotypic traits	Sheep			
	Breeding male	Rank	Breeding female	Rank
1=Appearance/conformation				
2= color(quality):				
A= white				
B= brown				
c= black				

d=Brown and White				
e= Black and White				
3=libido				
4=tail type:				
5=fertility(litter size)				
6= Beard :				
7=hair type:				
8=Ear length:				
9=Growth rate				

2. Rank the adaptability of sheep and goat to the area.

Adaptability traits	Adaptability of sheep at	Adaptability of Goats at
1=disease		
2=internal parasite		
3=external parasite		
4=heat		
5=drought		
6=feed shortage		
7=water shortage		

3. What are the traits you prefer that associated with high carcass output?

1= wide chest 2= long body size 3= fat tail 3=red color 4=white color 5=black color 6=others--

6.7. Small ruminant marketing system

1. When in the year you prefers to sale or purchase sheep and/or goats?

SN	Season of selling	rank sale season of more sheep	rank sale season of more goat
1	During festivals		
2	during Easter		
3	During New Year		
4	During Christmas		

2. What are the Reasons you sell your sheep and goats and rank them?

The Reason	Sheep (rank)	Goat(rank)
1= Cash need		
2= To pay loan		
3= Difficulty in management		
4= time of crop failure or drought		
5= Sell for replacement		

3. On average how many sheep_____ and goats_____ you sell per year?

4. Rank the major market problems in the following table.

Major market problem of sheep and goats	Rank
1=price determine by visual (lack of weighing)	
2=no public market information	
3=long transportation	
4=price determined by brokers	
5=others_____	

5. Who buy your sheep and goats?

participants	Rank
1= farmers	
2=Traders	
3=hotels	
4= civil servants	
5= others	

6. How you sales or purchases your animals? 1= Live weight basis 2= 'Eye ball' Estimation 3=both

7. Did you ever get animal price and market information? 1= Yes 2= No

If yes, from where?

1= DAs 2= Governmental organizations, 3= NGOs 4= others, specify

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

If yes, what?

1= Tax burden 2= Unwanted broker disorder and high commission fees

3= Seasonality of market demand and prices 4= Lack of market road from my areas

5= Lack of market and price information 6= others, specify

9. Rank the following major constraints for sheep and goats breeding?

constraints	For sheep rank	For goats rank
1=lack of feed		
2=lack of water		
3=Diseases		
4=Predators		
5=lack of improved sheep and goats		
6=Long dry season		
7= others----------		

10. List marketing channels of your sheep and goats_____

7.3. Appendices C: FGD interview

District: 1. Ada Barga 2. Ejere, Kebele_____

Part 1: Production system of small ruminant

1. List type of grazing land available in study area…….

2. What are Routes of flock entry and Routes of flock exit? Rank them accordingly……

3. List and rank the breeding objective of sheep and goats ……

4. List grazing way of sheep and goat in both dry and wet season ……

Part 2: Productive and reproductive performance of small ruminants

1. List reason of culling of sheep and goats from flock…….

2. Seasonality of breeding sheep and goats……...

3. What are common sources of breeding males for your flocks? .....

4. List major management undertake for new born kids/lambs ……

5. List and rank majority age classes of sheep and goats died more with respective to season…….……

6. At what age most of farmers castrate their bucks? _____Months, Rams? _____ Months

7. List and rank most available feed resource in wet and dry season …….

Part 3: The most trait preferences

1. List and rank most trait preferred for breeding ram……,Breeding buck……, breeding ewe……and Breeding doe……

2. List and rank adaptive traits for sheep and goats.....

Part 4: Small ruminant marketing and constraints in the kebele

1. When in the year you prefers to sale or purchase sheep and/or goats…….....

2. Rank the major market problems in this kebele……

3. List and rank the major constraints for sheep and goats breeding in this kebele……