A Review On Heath And Production Management Of Sheepin Ethiopia

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Abstract: Sheep are among the most efficient of all the domestic animals and have been for thousands of years. There were around 1.1 billion sheep in the world producing approximately 13 million tons of sheep meat. Ethiopia has around 25 million sheep and they may be grouped into about 14 traditional sheep populations. Sheep production is considered to be advantageous compared to other class of livestock production, due to their high fertility, short generation interval, adaptation in harsh environment and their ability to produce in limited feed resource they are considered as investment and insurance. Sheep have multipurpose functions providing meat, manure and as source of income. In the subsistence sector farmers and pastoralists depend on sheep and goats for much of their livelihood. Strategies for genetic improvement of livestock mainly involve the decision on the use of the variation between breeds (cross-breeding) and within a breed (pure breeding). Sheep crossbreeding program has been started with the aim to increase productivity (meat, wool, and milk) of medium sized indigenous by crossing to exotic breeds. Classified sheep breeds of different region based on agro-ecology and morphological characteristics include Farta, Tikur, Menz, Wollo, Shewa/Legegora, Sekota/Abergele sheep; Afar sheep; Agew/Dangla sheep, Wegera sheep, Semien sheep; Gumuz/Shankila sheep, Bonga, Adilo, Arsi, Horro, and black head somali sheep. Good reproductive performance is a prerequisite for any successful genetic improvement and it determines production efficiency. In Ethiopia the traditional smallholder management system the majority of people in the highlands keep small flocks and practice mixed crop-livestock agriculture which provide cash income, meat, manure, skins, whereas those in the sub moist, cold, very high altitude areas and in arid lowlands keep large flocks in pastoral production system. A number of constraints which obstacle for sheep production and genetic improvement programme are Disease, limited market access and information, feed shortage/frequent drought and water shortage are among the main sheep production constraints in the country.

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1. Introduction

Sheep are among the most efficient of all the domestic animals and have been for thousands of years.

According to FAOSTAT (2007), there were around 1.1 billion sheep in the world producing approximately 13 million tons of sheep meat. Ethiopia has around 25 million sheep (CSA, 2012) and they may be grouped into about 14 traditional sheep populations (Gizaw *et al.*2007). They are also found widely distributed across the different agro-ecological zones of the country (EARO, 2000). Moreover, sheep production in Ethiopia is based on Indigenous breeds except Awassi- Menz cross-bred that contribute less than1% of the population. De-spite low level of productivity due to several technical (genotype, feeding and animal health), institutional, environmental and infrastructural constraints (Tibbo, 2006), indigenous sheep breeds have great potential to contributing more to the livelihoods of the people in low-input, smallholder farmers and Pastoralists under traditional and extensive production systems (Kosgey and Okeyo, 2007).

According to Gatenby (2002), sheep production is considered to be advantageous compared to other class of livestock production, due to their high fertility, short generation interval, adaptation in harsh environment and their ability to produce in limited feed resource they are considered as investment and insurance (Tsedeke, 2007). Sheep have multipurpose functions providing meat, manure and as source of income (Shigdaf *et al.,* 2013). Moreover, they have special features, such as their being small in size, which implies low initial investment in starting and expanding sheep production as a business, efficient utilization of marginal and small plot of land, in connection to this are also sources of foreign currency (Berhanu *et al.,* 2006).

Comparing the presence of large and diverse sheep genetic resources similar to other tropical countries, the productivity of indigenous sheep is very low mainly due to low genetic potential for functional traits as compared to improved tropical and temperate breeds. For example among indigenous sheep breed of Ethiopia the Hararghe Highland sheep had lower growth performance and carcass values as compared to the indigenous Black head Ogaden sheep (Tsegaye *et al.,* 2013).

Due to these reasons tropical countries have been implementing crossbreed of indigenous animals with improved exotic genotypes to improve the genetic potential of indigenous animals. Within the aim of improving indigenous sheep productivity, in Ethiopia crossbreeding has been undertaken employing several exotic breed such as Merino breed from Italy has been crossed with the indigenous Arsi sheep in the Agarfa ranch (BOA, 2000), Bleu du Maine from France, Rambouillet from Spain, Romney and Corriedale from Kenya, and Hampshire from UK (Tibbo, 2006) were mainly crossbred with the indigenous Menz at Debre Berhan ranch. Consequently, due to assumed phenotypic similarity to the local sheep the Awassi breed was imported from Israel, and was crossed with the indigenous Menz (Rummel *et al*., 2005) and Dorper from South Africa (Solomon *et al*., 2007).

However, efforts made so far did not bring significant change in developing countries in the tropics mainly because of sustainability problems (poor performance of imported breeds from the temperate developed world into tropical countries has created a negative image for genetic improvement programmes) (Rewe *et al*., 2002; Ayalew *et al*., 2003). In addition to this, less involvement of producers in the program due to genetic improvement programmes have mostly been implemented without taking into consideration all the needs of the farmer (Rewe *et al*., 2002; Wollny *et al*., 2002).

Therefore, applying on other exotic sheep breed of solution looking improvement programs (crossbreeding with the aim of combining the desirable attributes in the two breeds) are necessary to increase and sustain the productivity of sheep in the areas so as to meet the demands of the human population on them and a breeding programme was set up that was supported with a good recording scheme (Rewe *et al.,* 2002).

Development of genetic improvement programmes for sheep will only be successful when accompanied by a good understanding of the different farming systems and when simultaneously addressing several constraints – e.g., feeding, health control, management, and cost and availability of credit and marketing infrastructure (Baker and Gray, 2004). This requires that genetic improvement efforts be geared towards improvement of growth, reproduction and adaptability traits under the prevailing circumstances. One of the initial steps in setting up such improvement strategies for the sheep is performance evaluation based on available performance data and applying appropriate evaluation procedures (Kosgey *et al.,* 2003; Kosgey, 2004; Gicheha *et al*., 2006).

Performance (reproductive and production) recording is an important tool to suggest the breeding policy for a given area. Reproductive (age at first lambing, lambing interval, lamb mortality and litter size) and productive (birth weight, weaning weight, pre and post weaning weight) performances are important early indicators of adaptability and management adequacy (Abegaz *et al*., 2002; Getahun, 2008).

However, recording in general is hardly practiced in any livestock species in the country, to identify the performance and management gaps (Awigichew, 2000; Tibbo, 2006). On-farm monitoring involves monitoring the productive and reproductive performance of a breed on selected representative households based on improved exotic sheep breeds. Periodic monitoring of the population dynamics and flock structures of a breed is also suggested for the purpose of assessing the risk status of a breed (FAO, 2007). On-farm performance assessment concerned with the whole farm environment provides information in location specific production conditions that could lead to breed improvement options that are appropriate to the system (Getahun, 2008).

However, unlike on station experiments, on-farm study is influenced by many factors which could not be controlled. Tropical developing countries typically rely on non-specialized multipurpose breeds and extensive production systems and control over breeding animals is often poor. Existing breeds are adapted to the existing environmental situation which is characterized by feed scarcity and disease challenge (Baker et al., 2002; Haile et al., 2002; Gizaw et al., 2008a). However, there is a belief that local breeds are less productive and unlikely to continue sustaining the fast growing demand for food that is created by rapid human population growth, urbanization and income growth. Crossbreeding is considered as one of the options and it is a potentially attractive breed improvement method due to its quick benefits as the result of breed complementarity and heterosis effects (Leymaster, 2002; Hayes et al., 2009).

FAO (2007) documented that the transfer of genetic material has been increased dramatically in the recent decades. Sheep are among the most widely distributed livestock species. Consequently, based on a review of Shrestha (2005), the widely practiced breed combination resulted in about 443 composite sheep populations worldwide in 68 countries. Some

remarkable results have been achieved in well-designed selective and crossbreeding schemes. One example is the improvement of local Awassi using within-breed selection, crossbreeding and gene introgression resulting in a highly productive and prolific genotype in Israel (Gootwine and Pollott, 2000; Pollott and Gootwine, 2004).

Another example is the development of Dorper sheep by crossing Dorset Horn rams with fat-rumped Black Head Persian ewes (de Waaland Combrinck, 2000). Such programs have been favored by resourceful environments and well developed infrastructure and markets (Sölkner et al., 1998).

The proportion of exotic and crossbred sheep populations in Ethiopia remains low, only 0.2% (CSA,2013), indicating that research and development efforts of sheep crossbreeding in Ethiopia did not deliver the anticipated benefit to smallholder farmers so far. However, there is still a growing interest of the government and of farmers in sheep cross breeding. There is no comprehensive study showing the performance of crossbreeding, both biological and economical, to substantiate the argument on the benefit of sheep crossbreeding for smallholder farmers.

2. Origin Of Sheep

Sheep belong to the family *Bovidae* and sub-family *Caprinae*. The genus *Ovis* include all Sheep, while domesticated sheep belong to the species *Ovis Aries*. There is more confusion and disagreement about the ancestry of sheep than any other animals. This difficulty arises from the bewildering number of breeds and the marked changes produced by domestication. Sheep are extremely versatile and since domestication they have spread throughout the world (Traore *et al*., 2008) and currently there are more than 850 distinct breeds of sheep scattered throughout the world (FAO, 2000).

The wild ancestor of domestic sheep lived in the mountains and upland steeps of western Asia where the moderate climate and short grass rangelands relatively free of bush and trees, provided an ideal habitat. The outer coat of wild sheep is stiff and hairy and covers a short wooly undercoat, while in domestic sheep the hairy undercoat is absent (Ensiminger, 2002). Domestic sheep are thought to descend mainly from the *Muflon*, *Ovis musimon* and *Ovisorientalis*. The Asiatic Urial *(Ovis vignei)* may possibly be an ancestor of domestic sheep, but the difference in chromosome number makes any direct ancestry questionable. Perhaps some modern breeds trace back to other wild stocks, but differ in chromosome number and geography may limit ancestry.

The considerable differences in appearance between domestic sheep and their wild ancestors occurred very early in the domestication process. Although differing widely in body form and wool character, domestic sheep of all breeds are universally timid and defenseless, least intelligent and least teachable of all the domestic four-toed animals. It is certain that sheep came from the wild sheep of Europe and Asia (Traore *et al*., 2008).

3. Diversification Of Sheep Breeds

Following domestication, further diversification among breeds has stemmed from selection by man for numerous characteristics such as appearance, color, size and wool production (Kosgey and Okeyo, 2007). The modification which domestication brought about resulted from alteration in the mating system whereby inbreeding, out breeding and assortment mating became the predominant mating system as opposed to random mating. The process of domestication brought about a number of morphological and physiological modifications in sheep. Consequently, breeds of sheep differ markedly in adaptability to different environments and in performance for traits that influence efficiency of production and product quality. Environmental changes under conditions of domestication would have permitted genetic variation to become more evident and thus more readily influenced by selection and the altered mating system (Traore *et al*., 2008).

The diversity created among each breed have a genetic basis and can therefore be exploited in a structured cross breeding system designed for a specific production-marketing situation (Leymaster, 2002). The value of breed diversity is that producers can identify and use a breed or breeds that perform at a level consistent with marketing goals and with production resources such as feed availability, labor, facilities and managerial skill. A breed that excels for daily gain and carcass traits may be less adaptable to a harsh environment or a breed that is parasite tolerant and has extended breeding seasonality may not produce a lean carcass at typical market weight (Leymaster, 2002).

Almost all specialized breeds have their origins in developed countries where breeding has been towards specific goals for hundreds of years. Specialized breeds are more genetically uniform than non-specialized breeds. The genetic diversity within non-specialized breeds of livestock in tropical developing countries is still relatively large, although declining. These populations may be carrying unidentified genes which could be critical for increasing production or special adaptation in the future (Rege, 1999).

3.1. Sheep Breed Classification in Ethiopia

In the developed world breed classification is based on several different parameters such as

suitability for meat or wool production (meat or wool type) or based on their breeding use as specialized ram breed, a specialized dam breed or a dual purpose breed. Wool type breeds may be further classified according to the type of wool produced, hence fine-wool type, medium wool type, long-wool type, coarse-wool type, carpet wool type and fur type (Ensiminger, 2002).

Classification based on their importance is not common in Africa; rather sheep breeds are classified based on their tail form and hair type. In Ethiopia, according to the review work of Workneh *et al.* (2004) at least six sheep breeds are available in the country. These falls into three breed groups: the fat-tailed hair sheep, the fat-tailed coarse wool sheep and the Fat-rump hair sheep. The review work of Workneh *et al.* (2004), the characterization study of Sisay (2002), and Solomon (2007), indicate the presence of long-thin tailed sheep breeds in North West and western part of the country on the border area with Sudan.

Sisay (2009) classified sheep breeds of the Amhara region into four groups based on agro-ecology and morphological characteristics. 1) The central highland sheep: include Farta, Tikur, Menz, Wollo, Shewa/Legegora, Sekota/Abergele sheep; 2) Rift valley: include Afar sheep; 3) North western highland: include Agew/Dangla sheep, Wegera sheep, Semien sheep; and 4) North western lowland sheep: include Gumuz/Shankila sheep. Solomon (2008) conducted morphological and molecular characterization of Ethiopian sheep breeds by targeting those sheep populations traditionally recognized by ethnic and/or geographic nomenclatures. Based on his finding, the Ethiopian sheep breeds are classified into 14 traditional populations in 9 breeds within 6 major breed groups as indicated in Table 1.

Table 1 Ethiopian sheep breeds are classified into 14 traditional populations in 9 breeds within 6 major breed groups

Breed group	Breed	Population	Tail type/shape	Fiber type
I. Short-fat-tailed	Simien	Simien Sekota, Farta,	Fatty and short	Fleece
	Short-fattailed	Tikur, Wollo, Menz	Fatty and short	Fleece
II. Washera	Washera	Washera	Fatty and short	Hair
III. Thin-tailed	Gumz	Gumz	Thin and long	Hair
IV. Long-fat-Tailed	Horro	Horro	Fatty and long	Hair
	Arsi	Arsi-Bale, Adilo	Fatty and long	Hair
V. Bonga	Bonga	Bonga	Fatty and long	Hair
VI. Fat-rump	Afar	Afar	Fat rump/fat tail hair	Hair
Sheep	BHS	BHS	Fat rump/tiny tail	Hair

BHS = Blackhead Somali; Source: Solomon (2008)

Workneh *et al.,* (2004) in their review stated that the Afar sheep manifest a tail attribute somewhat intermediate between the true fat-tailed and fat-rump types of sheep, which may be the result of interbreeding between these sheep populations.

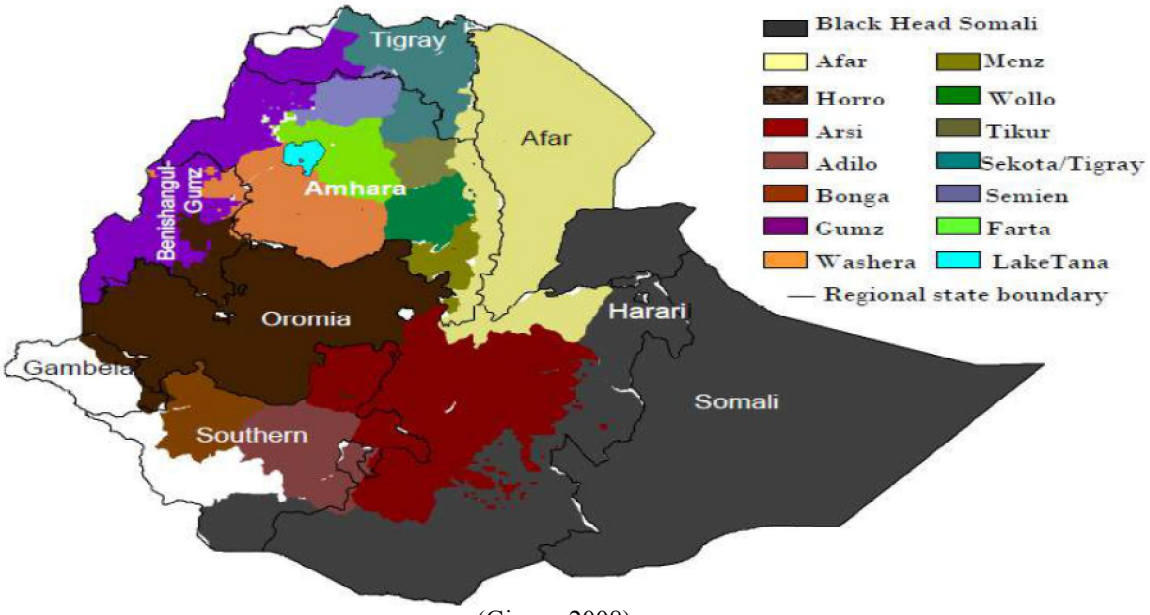
3.1.1. Within breed improvement

Within breed selection involves measuring and selecting on productivity such as growth, survival and litter size. In the tropics small flock sizes, single-sire flocks, lack of animal identification, lack of performance and pedigree recording, low level of literacy and organizational shortcomings (Kosgey et al., 2006) and flock mobility have been major problems. The situation is not exceptional in Ethiopia. Components of within breed improvement include defining the overall development objectives, characterizing the production system, identifying breeds to be used and improved by selection, identifying a list of breeding goal traits and deriving goal values for each of the breeding goal traits. Breeding goal traits must have: (i) reasonably large genetic variability; (ii) easily and cheaply measurable; (iii) if not easily and cheaply measurable then, must have a high genetic correlation with a trait (indicator trait) that is easily measurable, has a higher heritability or can be measured earlier in life than the goal trait it represents; and (iv) desirable economic value, either as a marketable commodity or as a means of reducing production costs.

The overall breeding goal for sheep production in Ethiopia would be improving growth to achieve a yearling weight of 30 kg, and survival of 90% at yearling. Since the stated yearling weight is demanded by importers from Ethiopia (Aklilu et al., 2005), stakeholders which include exporters of sheep as live or mutton, should be involved at all phases.

If a lamb could attain a high weight at 12 months of age, subsequent fattening for 3 months after castrating could fetch high market prices even in domestic markets. Measuring breeding goal traits with components of production and reproduction (e.g. number and weight of offspring per year) in smallholder farms, however, is not easy. The difficulty to measure and value the intangible benefits (Kosgey et al., 2006) derived from sheep presents more complications. Therefore, systems of utilizing

government ranches and research flocks as nucleus breeding units, where proper livestock recording could be anticipated, should be looked for.



(Gizaw, 2008)

Figure 1: Geographic distribution of sheep in Ethiopia

3.1.2. Crossbreeding efforts based on exotic and indigenous sires

Introduction of Romney, Corriedale, Hampshire, and Rambouillet was targeted to cross them with local sheep breeds aiming to supply wool for the Debre Berhan blanket factory established in 1967. From the year 1969 to 1974, a total of 99 crossbred ewe lambs and ram lambs were distributed to farmers. The breeds were performed well in growth performance under station and farmer situation except Romney breed (DBHBMC, 2007); nevertheless, they were not preferred by farmers due to their physical characteristics (face covered with hair, absence of horn in males and thin tail), fatty nature of wool making it difficult to spin wool in the traditional way, and the suspected poor skin quality. Thus, during the monarchy time, crossbreeding was mainly limited to on station to supply fattened sheep for the king palaces and occasions. Following the downfall of the monarchy (1974), the crossbreeding efforts were directed to produce and disseminate crossbred rams to smallholder farmers. DBSBMC and AMSBMC distributed more than 4000 crossbred rams of different breeds (Awassi, Corriedale, and Hampshire) to smallholder farmers at subsidized prices between the year 1974 and 2001 (DBHBMC, 2007).

Hampshire and Corriedale breeds were initially used while these breeds were gradually replaced by Awassi following the introduction of Awassi in 1980. Awassi breed has been well accepted by Ethiopian farmers due to its similar physical appearance to that of local breeds. In the first four years of Awassi ram distribution, individual smallholder farmers were targeted. Later, from 1979 to 1989, the focus was shifted to farmers organized in cooperatives. However, no performance evaluation was performed in the cooperatives, and animals were looted during the government change in 1991. Consequently, the cooperatives were abolished and dismantled (Emana,2009) so that the focus was again changed to disseminate rams to individual smallholder farmers. The target has been on disseminating rams with 75% Awassi inheritance to farmers for crossbreeding with their localewes aimed at replacing the local sheep breed through repeated backcrosses (DBSBMC, 2007).

On-station research results on growth, reproductive performance and carcass performances from CADU farm (Osslon and Beyene, 1990) and Sheno (now Debre Berhan) Agricultural Research Center (Demeke et al., 1995) were reported. A survey by DBARC in the year 1997 to evaluate the on-farm performance of crossbred in North Shewa and South Wollo districts of the Amhara Region exposed the total failure of ram dissemination (Gizaw and Getachew, 2009). It was difficult to find either

crossbred rams or offspring from disseminated rams in the surveyed areas. Following that an on-farm evaluation of the performance of Awassi × local crossbred sheep under farmers' management was commenced by DBARC in three villages in the highlands of Ethiopia in 1997. Details of the breeding program followed by DBARC are indicated (Gizaw and Getachew, 2009; Getachew et al.,2013).

Similarly, the Awassi × Tikur sheep crossbreeding started in two villages of North Wollo by Sirinka Agricultural Research Center in 2007. The ESGPIP project was implemented in collaboration with local universities and research centers at 2 nucleuses and 10 Breeding, Evaluation and Distribution (BED) sites, established in different parts of the country since 2007. Their nucleus sites were used to multiply the imported purebred Dorper sheep and provide a continuous supply of pure Dorper sheep to the BED sites, private commercial or cooperative farms and to those individuals who wished to establish their own pure breed producing farms. At BED sites, purebred sires were crossed with indigenous dams to obtain F1 sires for dissemination to farmers. The funding of ESGPIP terminated in 2011 and the activities were handed over to local universities and research centers for further implementation of the crossbreeding program. Crossbreeding among indigenous breeds has also been practiced at DBARC as an alternative to the use of exotic genotypes for crossbreeding. Indigenous Washera rams were distributed in the highlands of North Shewa, South Wollo, North Wollo, and Gondar areas (ANRSBoARD,2004).

In 2005, a village-based Farta × Washera sheep crossbreeding program has been started (Mekuriaw et al., 2013) with the aim to increase productivity of medium sized indigenous Farta (Gizaw et al., 2008a) by crossing or introducing male and females of indigenous Washera sheep.

3.2. Sheep Breeding and Genetic Improvement in Ethiopia

Genetic improvement of livestock is often viewed as a complex set of tasks requiring a high level of organization and technical sophistication. In Europe, animal breeding has been traditionally supported by the state and implemented by large national breeding programs (Haile et al., 2011). Data recording, channeling of the recorded data towards a data processing center, estimation of „breeding values" with complex statistical methods and central decisions about the use of male breeding animals are ingredients of such breeding programs. In developing countries, the required supportive infrastructure is largely unavailable, so attempts to replicate developed-country approaches have met with little success (Haile et al., 2011).

History of exotic breed introduction in to Ethiopia (Targeting blanket factory established in 1967 Wool and meat)

In 1947 In 1967 Corriedale, Hampshire, Romney _Kenya Merino from Italy (NGO)

Figure: 2; Introduction of exotic breed to Ethiopia for wool and meat

Strategies for genetic improvement of livestock mainly involve the decision on the use of the variation between breeds (cross-breeding) and within a breed (pure breeding). The strategy adopted in livestock genetic improvement in developing regions is mainly crossbreeding of the local breeds with exotic sires. Country reports on the state of farm animal genetic resources (FAO, 2007) and review of Kosgey et al. (2006) show that there are very few structured sheep pure-breeding programs in developing regions,

particularly in Africa. Cross-breeding programs in developing regions have been criticized as incompatible with conservation of indigenous adapted breeds. However, still only 26% of African countries favor development of local breeds according to country reports on the state of the world's animal genetic resources (FAO, 2007).

In 1980….recently 2011 Menz sheep
Awassi_Israel
Figure: 3; introduction of exotic breed to Ethiopia for wool and meat

Dorpersheep were introduced into the Jijigaarea (Somali Region) in the late 1980s

Figure: 4; Dorpersheep introduced in Somali region

In Ethiopia, attempts have been made to improve productivity of indigenous sheep through crossing with exotic breeds such as Corriedeale, Hampshire, Romney, Awassi and Dorper (IBC, 2004; Solomon and Tesfaye, 2009). However, these programs have not been successful, probably because of lack of understanding of the preferred breeding objectives of the farmers and absence of involvement of all stakeholders in the designing of breeding strategies (Markos et al., 2006; Gemeda et al., 2005).

Sustainable animal breeding strategies require a broad definition of breeding objectives that emphasize maintaining adaptation and biodiversity in addition to profitability. Sölkner et al. (1998) argued that when defining animal breeding objectives, particularly for subsistence farmers in marginal situations, the needs and interests of the target group should be incorporated. This involves incorporating both tangible and intangible benefits of livestock keeping. Defining breeding objectives involves identifying breeding-objective traits, deriving their relative importance, and constructing the aggregate genotype that can subsequently be translated into a selection index (Kosgey et al., 2006)

Recently, community-based sheep breeding strategy has been initiated in the country (Gemeda, 2005) which needs the clear understanding of production system, breeding objectives and farmers/ sheep owner‟s trait preferences and full participation of the sheep owners. However, production systems and production objectives are determined by agro-ecology and commonly differ in terms of stress factors, such as water shortages, disease and parasites as well as temperature extremes.

3.3. Characterization of Sheep Breeds

Characterization is defined as the distillation of all knowledge, which contribute to the reliable prediction of genetic performances of an animal genetic resource in a defined environment and provides basis for distinguishing between different animal genetic resources and for assessing available diversity. Characterization includes clear definition of genetic attributes of an animal genetic resource and the environments to which it is adapted. It should include physical description, reproduction and adaptations, uses, prevalent breeding system, population trends, predominant production system, description of environments in which it is predominantly found and an indication of performance levels (Workneh *et al.,* 2004).

Most of the sheep characterization works undertaken in Ethiopia focused on-station management. Characterization of the thin-tailed Gumuz sheep and its production system (Solomon, 2007), on-farm evaluation of Washera sheep breed in Western Highland of the Amhara National Regional State (Mengiste, 2008), characterization of Blackhead Somalisheep (Fekerte, 2008) and production system and marketing of sheep in Southern Ethiopia (Tsedeke, 2007) were conducted and might be useful to start sheep breed improvement programs. Characterization of the performance of east Gojam sheep types is limited, no one yet tried to characterize under farmers condition. Characterization of Horro sheep breed has been done at Bako Research Center (Solomon, 2002).

Generally, the current state of knowledge on characterization of farm animal genetic resources in Ethiopia shows that there is lack of information about potential level of productivity, production characters of local breeds managed in their native production system and the genetic make-up of the indigenous breeds (Workneh *et al.,* 2004), although the country is widely known to possess a large population of livestock with enormous diversity.

Most commonly identified indigenous sheep breed types reared by Amhara community are Simian, Short fat tailed, and Washera. Other sheep types reared in the region include simian, Sekota, Farta, Tikur, Wollo, Menz and Washera (also called Agew, Dangilla). These sheep types are identified by fatty and short tail, and their fiber type -wool/fleece. Washera, however, is characterized by short hair type (Solomon, 2008). Washera sheep is the predominant breed in West and east Gojam Zones of the Amhara Region extending to the South of Lake Tana. Washera sheep weigh about 2.8, 13.8 and 22.7 kg at birth, weaning andsix months of age, respectively and it is known for having high twinning rates (Kassahun and Solomon, 2006).

According to Solomon (2008), the short fat-tailed sheep breeds of the region are highlyadapted to the local environment, are the only sheep in Ethiopia producing course fleece andlowest in productive and reproductive performance (with the exception of Washera breed showing better productive and reproductive performance).

4. The Status And Sheep Production Systems In Ethiopia

In Ethiopia there are two main categories of sheep production systems. The first and the most common system is the traditional smallholder management system, in which sheep are kept as an adjunct to other agricultural activities along with other livestock species. The second, which is limited in scope and area coverage, is the private commercial production system (Markos, 2006).

In the traditional smallholder management system the majority of people in the highlands keep small flocks and practice mixed crop-livestock agriculture, whereas those in the sub moist, cold, very

high altitude areas and in arid lowlands keep large flocks in pastoral production system. In the mixed crop-livestock production system, sheep provide cash income, meat, manure, skins and in some areas coarse wool for the smallholder farmers (Markos, 2006).

The average adult body weights of some of Ethiopian indigenous sheep breeds as obtained by Solomon *et al*. (2007) was 26.9 for Simien, 25.4 for short-fat-tailed, 32.8 for Washera, 31.0 for Gumz, 35.4 for Horro, 28.6 for Arsi, 34.2 for Bonga, 31.0 for Afar and 27.9 for Black Head Somali. Though sheep production is an integral part of the traditional subsistence mixed crop livestock production system and the room for improved productivity of indigenous breeds, research and development done towards this goal is very low (Kassahun and Solomon,2006).

4.1. The Importance of Sheep Production for the Small holder Farmers

Small ruminants are an integral part of mixed-farming systems throughout Ethiopia (Getahun*et al*., 2008; Abebe, 1999). Sheep have social and economic importance to the producers. Indigenous sheep breeds are kept for meat and hair production, and income generation (IBC, 2004). The sheep enterprise in the Ethiopian highland crop/livestock mixed farming system is the most important form of investment as well as cash income and provides social security in bad crop years (Getachew, 1988).

Very often, there are no banking facilities in rural areas and an easy way to store cash for future needs is through the purchase of sheep and goats. In fact, in some areas, small ruminants have been described as the 'village bank'. It has to be noted that this is beyond the cash value of the animal. Livestock, being a living bank for the small producer, are indicators of wealth of a family and are used for wealth ranking (Hadera, 2002).

Furthermore, as urbanization, population and incomes increase, the demand for food of animal origin will rise and create markets for animal products and encourage commercialization of agriculture (Ehui *et al*., 2000). Ease of management, low investment capital, and feed requirements of sheep compared with large ruminants are factors putting sheep production as a viable alternative animal (Dinksew and Girma, 2000). Farmers keep small ruminants for many reasons, the major ones being that they are a source of food (milk and meat), fiber (wool and skins), cash and a form of savings (Ibrahim, 1998).

Other special attributes of sheep include: 1) they are highly adaptable to a broad range of environments, 2) they have short generation cycles and high reproductive rates, which lead to high production efficiency, 3) certain breeds of sheep (e.g. Red Maasai sheep) are disease tolerant such as helminthosis, 4) they are small enough to be consumed by an average rural family in a day or two hence no refrigeration facilities are needed (Ibrahim, 1998), and 5) they are prolific and need only short periods to increase flock sizes after catastrophes or following periods of high prices (Winrock International, 1983).

4.2. The economic Role of Sheep for Smallholders and pastoral system in Ethiopia

Production of Sheep can contribute to the economy and environmental sustainability of the farm under operation and add value to the farm's biological diversity and may fit economic and biological niches that would otherwise stay unfilled even in the future (Ann *et al*., 2000). Sheep play an immense role in the livelihoods of rural farms and serve as a living bank for many farmers, and closely linked to the social and cultural life of resource poor farmers (Workeneh, 2000), particularly youths and women headed households. There is a linkage through manure since the manure of small ruminants is commonly used to fertilize home gardens and crop lands (Legesse *et al.,* 2008).

Sheep are the major suppliers of meat for rural communities, especially during periods of public festivals (Tsedeke, 2007); Ameha (2008) reported an estimated sheep skin output of 8.3 million in the year 2000 and contribute 77 thousand metric tons from mutton production. Low capital requirements for starting or expanding small ruminant production means that risks are low and the enterprise is well suited to low-input systems (Tibbo, 2006). Increasing human population, urbanization and incomes, coupled with changing consumer preferences are creating more demand for these animals and their products (Kosgay *et. al.,* 2008).

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

5. Reproductive Performance

5.1. Growth performance

The growth performance and survival of sheep is an important character for meat production, which determines the overall productivity of the flock and the economic return from sheep production enterprises (Mengistie, 2008). In a sheep production system where

the main objective is lamb meat production, post weaning growth rate of lambs is just as important as the pre-weaning growth rate (Kassahun, 2000). For same reason, EARO (2000), indicated that growth rate in indigenous sheep and goats is low and drops.

5.2. Age at puberty

Good reproductive performance is a prerequisite for any successful genetic improvement and it determines production efficiency. Horro ewe lambs could attain puberty at seven months of age weighing 21 kg and produce viable lambs (Solomon *et al.*, 2007) without any adverse effect on their subsequent growth and reproductive performance while Menz sheep in Ethiopian highlands can attain puberty (first estrus) at 10 months of age and 16.9 kg mean weight or 56 percent of their mature body weight.

5.3. Lambing interval

Lambing interval is defined as the interval between two consecutive parturitions. It has three phases: the gestation period, the postpartum anestrus period and the service interval. Lambing interval is one of the main components of reproductive performance which is affected by season (Abebe, 1999; Mengiste, 2008), year of lambing (Niftalem, 1990), parity of ewes, post-partum body weight and management practice), type of management, nutrition, type of mating (Mukasa-Mugerwa and Lahlou-Kassi, 1995).

5.4. Litter size

Prolificacy or litter size is defined as the number of progenies born per parturition. Average litter size can be calculated on a yearly basis to be consistent with the annual rate of fertility. Litter size is largely influenced by ovulation rate and ovulation rate is substantially controlled by genotype and improvement could be achieved by selection. Litter size of Ethiopian sheep breeds like Menz and Afar sheep breeds is low (Abebe, 1999) which is almost close to one lamb per lambing while breeds like Horro and Washera are more prolific with litter size of 1.35 and 1.2, respectively (FAO, 1991); (Mengiste, 2008), (Niftalem, 1990; Abebe, 1999; Tesfaye, 2008) reported low twining rate of both Menz and Afar sheep breeds.

5.5. Reproductive life span

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

Workneh *et al.,* (2004) in their review stated that the Afar sheep manifest a tail attribute somewhat intermediate between the true fat-tailed and fat-rump types of sheep, which may be the result of interbreeding between these sheep populations.

Table 2. Reproductive performance of indigenous sheep breeds

Breed	LS	AFL	LI	Management	Source
Menz	1.09	-	-	On-station	FAO (1991)
Menz	1.02	598	279	On-station	DBARC (2006)
Menz	1.02	512	395	On-farm	Niftalem (1990)
Menz	1.03	-	286	On-farm	Abebe (1999)
Menz	1.12	450	252	On-station	Mukasa-Mugerwa and Lahlou Kassi (1995)
Local sheep around					
Dire Dawa	1.01	-	336	On-farm	Aden (2003)
Afar	1.03	-	-	On-station	Yebrah (2008)
Afar	1.14	-	-	On-farm	FAO (1991)
Washera	1.11	464	271	On-farm	Mengistie (2008)
Horro	1.35	-	-	On-station	FAO (1991)
Horro	1.34	-	-		Solomon (2002)
BHS	1.00	-	-	On-station	Yebrah (2008)
BHS	-	540	192	On-farm	Wossenie (2012)
Gumuz	-	410	200	On-farm	Solomon (2007)
Sardi (Morocco)	1.07	-	-	On-station	Boujenane et al. (1997)
Yankasa (Nigeria)	1.10	533	-	On-station	Osuhor et al. (1996)
Djallonke	1.40	622	243	On-station	Gbangboche et al. (2006)

LS = Litter size, AFL = Age at first lambing, LI = Lambing interval. BHS = Blackhead Somali

6. Factors Influencing Performance Of Sheep

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

6.1. Feed and water shortage

Tesfaye (2008) has mentioned that the major constraint of sheep production in Menz and Afar areas are feed shortage/frequent drought and disease each with varying intensity. Feed shortage problem is similar throughout the country, being serious in high human population areas where land size is diminishing due to intensive crop cultivation and soil degradation. The better use of available feeds and the use of non-conventional feeds for supplementation are growing (Belete, 2009) to alleviate the problem. Seasonal feed shortages, both in quality and quantity, and the associated reduction in livestock productivity in different parts of the country (Tessema *et al.,* 2003). Water shortages is a common problem for both human and livestock consumption in most rift valley parts of the country. It has been reported to be a limiting factor for animal productivity in most mid and lowland areas of Southern region. In south-eastern part of the country there is also critical shortage of water; however, there are breeds adapted to lowland agro ecologies through their physiological adaptation mechanisms (Belete, 2009).

6.2. Disease

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

6.3. Market access and information

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

The Ethiopian cattle, sheep and goat are the preferred livestock types in the Middle East Countries. This is due to the meat produced from this animals is organic in nature and the meat is of good taste (Belachew and Jemberu, 2003). The major problems in traditional management system is that the system is not market oriented, underdeveloped marketing and infrastructure system, and poor financial facility (Berhanu *et al*., 2006). Long market chain is an important barrier for producers and inhibits them from direct benefiting through sell of their animals without involvement of brokers (Endrias and Tsedeke, 2006).

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

6.4. Flock Structure and Ownership Patterns

Flock structure is defined as the proportion (in terms of head) of the flock of sheep, which is formed by

different age and sex classes of animals. Flock composition in terms of age and sex classes has been taken as an indicator of the management objectives for the owner and the production (reproductive, mortality and off-take rate) of the flock (Ayalew *et al.,* 2002).

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

According to CSA (20013), about 73.4 percent of the entire sheep population was females, and 26.4 percent were males. Sheep ownership varies depending on the wealth status and the overall farm production objectives (Deribe, 2009). In the highlands, sheep are kept in small flocks of about 5 sheep per household by nearly 40 % of all smallholders. However, at higher altitudes (2800-3000 m) one can find flocks with 30 to more than 100 sheep (Awigichew, 2000; Samuel, 2005). An average flock size of sheep of Alaba is 5.0 (Tsedeke, 2007). High percentage of single ownership was reported from traditional sector of Ethiopian highlands (Amelmal, 2011), which gives guarantee for testing technological innovations. The owner and care taker relationship was also reported.

7. Sheep Production And Husbandry System In Ethiopia

In several Sub-Saharan African countries similar to those in many other developing countries mixed crop/livestock production in subsistence manner is the predominant mode of agricultural production system (Tesfaye *et al*., 2004). In Ethiopia, the small ruminant production system in different agro-ecological zones is not studied fully and farmers' needs and production constraints have not been identified. Improvement in small ruminant productivity which is low in Ethiopia can be achieved through identification of production constraints and introduction of new technologies or by refining existing practices in the system (EARO, 2001).

According to Tibbo (2006), there are two sheep production systems in the country based on input-output flow. These are the traditional smallholder management system and the private commercial and pastoral production system. The traditional subsistence smallholder management system is the most common one in the country and sheep are kept as an adjunct to other agricultural activities along with other livestock species. But the parastatal and commercial production system represents a minor portion of the sheep production system in the country. When closely examined, these two broad categories could be further classified as three major different production systems; highland sheep-barely, mixed crop-livestock and pastoral and agro-pastoral production systems (Tibbo, 2006; Solomon *et al*., 2008) characterized by different production goals and priorities, management strategies and practices, and constraints (Deribe, 2009).

Getahun (2008) also reported four production system categories based on the prevalent agricultural activity; 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). Zeleke (2009) reported enset-coffee-cereal-livestock production system from the central Southern region, though some studies describe this system simply 'enset-coffee' system. Sheep are reared in mixed crop-livestock and pastoral systems of southern region of the country (Deribe, 2009). However, the production system referring specifically for small ruminants was not reported. Damot Gale and Damot sore woredas of Wolaita zone (Melese *et al*., 2013), Adilo Woreda of Kambata Tambaro zone, Badawacho Woreda of Hadiya zone and Mirab Azernet woreda of Silte Zone are sharing similar farming system and are generally categorized under the mixed crop-livestock production system of the central mid and highlands of southern region (Getahun, 2008, Melese *et al*., 2013).

There are still micro-level differences under the broad categories of each farming system. On-farm recording aids to consider those differences in the production system. Farmers are practicing animal husbandry in different production systems and agro ecologies. In a mixed farming systems, small ruminants are confined and tethered in a wooden hut during the night and are only allowed grazing and browsing during the day under the supervision of a herdsman, particularly young men or women (Deribe, 2009).

The enclosure of livestock in huts or kraals is done mainly to protect them from theft and predation (Webb and Mamabolo, 2004; Tsedeke, 2007). Until crops harvested, flocks are usually tethered and maintained under nutritional stress. During dry season almost all owners release their animals to roam around

while during the rainy season animals are herded or tethered; tethering being more frequent for goats than for sheep (Jaitner *et al.,* 2001). Tethering in dry season and herding in wet season is reported for Goma Woreda of Oromia region (Belete, 2009).

Sheep fattening is a common practice in different parts of the country, though the degree of fattening and resource base differs markedly. About 39.0 % of the farmers owning small ruminants practice some form of fattening before marketing and majority of the farmers sale their animals early before attaining optimum market weight (Solomon *et al*, 2005; Getahun, 2008). The major management practice used to obtain stability of structure is selling or slaughtering of males not required for other production functions, for home consumption and/or performance of rituals (Webb and Mamabol, 2004) and selling stock, supplementation and maintenance feeding as a strategy of management during drought. In the central highlands of Ethiopia, pregnant ewes were housed separately during the last few weeks of pregnancy until about 2-4 weeks postpartum. Rams not required for breeding would be sold or castrated before puberty (Taye *et al.,* 2009).

7.1. Sheep production systems

In Ethiopia there are two main categories of sheep production systems. The first and the most common system is the traditional smallholder management system. The second, which is limited in scope and area coverage, is the private commercial and parastatal production system. In the *traditional subsistence smallholder management system*, sheep are kept as an adjunct to other agricultural activities along with other livestock species. There is no specialized system with defined breeding objectives. The common trend, however, is that the majority of people in the highlands keep small flocks and practice mixed crop-livestock agriculture, whereas those in the sub-moist, cold, very high altitude areas and in arid lowlands keep large flocks in pastoral production system. When closely examined, three different production systems can be identified:

7.1.1. Sheep-barley or sheep production system

prevails in high altitude areas (above 3000 m.a.s.l.) where sheep are the main source of cash income, meat, manure, skins and coarse wool for traditional cottage industry to produce blankets, rugs and mattresses by the local handcrafts. In extreme altitudes, precipitous terrain, recurrent droughts, cold temperature and windy climate limit crop production to sheep-barley orjust sheep production. Sheep breeds of this system (for example, the Menzbreed) are perceived to be the hardiest sheep types evolved under stressful environments. The sheep breeds thrive well with slow growth rate but considerably high annual reproduction rate under gastro-intestinal parasite infestations, recurrent drought and grazing scarcity (Lemma, 2002).

7.1.2. Mixed crop-livestock system

Which covers areas in altitudes between1500 and 3000 m in which sheep are kept in small flocks as a source of cash income, meat, manure, skins and in some areas for coarse wool. The sheep flocks are kept along with other livestock species (cattle, goats and equines) in rather reduced communal grazing areas, unsuitable for cropping, or fallows, waterlogged land and steep slopes (Mengistu, 2000).

7.1.3. Pastoral production system

Pastoral production system is located in arid and semi-arid lowland areas below 1500 m.a.s.l. in which livestock rearing is the mainstay of people. Livestock and livestock products provide subsistence, either directly as milk, milk products, meat and blood, or indirectly in the form of purchased cereals through sales of animals. Sheep are raised mainly for cash income (mainly through export) and meat, except in isolated areas where they also keep them for milk (for example, in Afar and parts of Tigray regions). Other important species in this system include cattle, goats and camels. Constant or partial herd mobility is a strategy to achieve feed and water. Pastoralists have no permanent home and, hence move with their herds within their traditional territory (Mengistu, 2000).

7.1.4. Parastatal and commercial production system

Represent a very small proportion of sheep production systems in Ethiopia. Sheep in these systems are managed either intensively or semi-intensively. Privately owned ranches, farms or governmental sheep breeding and multiplication centers constitute this type of production system. Privately owned ranches not only breed sheep for market but also purchase grown rams from nearby farmers, and fatten and sell them during festive occasions. Some ranches, however, export sheep to the Middle East either as live animals or as mutton. Established by government (parastatal), two ranches (namely, Debre Berhan and Amed Guya) have been crossbreeding and distributing crossbred rams to farmers on cost-recovery basis until banned in 2001 when maedi-visna disease was confirmed in crossbreds and associated sheep flocks.

7.2. Constraints to sheep production

Sheep production in Ethiopia is based on indigenous breeds except for less than1% exotic sheep group of mainly Awassi-Menz crossbreds. The indigenous sheep are year round breeders and mating is not controlled. However, the current off-take rate is very low. Increasing the current level of productivity is essential to provide meat to the ever-increasing human population, to increase export earnings and household income thereby improving the living

standard of smallholders. There are, however, a number of constraints to sheep production and the major ones are summarized as follows.

7.2.1. Lamb mortality

Lamb mortality is the single most important constraint limiting productivity Studies indicate that up to 50% of the lambs born can die mainly due to diseases and other causes such as adaptation failure, dystocia, cold stress, starvation and mismothering (Hinch *et al*., 1986). Information is required on pattern and causes of mortality to improve survival.

7.2.2. Feed scarcity

Sheep in the tropics primarily graze natural pastures or utilize crop residues and their by-products, whose supply and quality fluctuate seasonally. In the highlands of Ethiopia, the communal grazing land is diminishing due to encroachment by cropping land because of increased food demand due to the human population growth (Dibissa, 2000). The land is degraded (Sundquist, 2003) due to high and increasing human and livestock population worsened by poor land use policy resulting in low productivity of the system. Overgrazing, nutrient depletion due to limited recycling of dung and crop residues in the soil, low use of chemical fertilizers, declining fallow periods, soil and organic matter burning, soil erosion and deforestation are all major concerns (Desta *et al*., 2000).

Inadequate access to feed influences the severity of several infections, particularly in young animals (MacRea, 1993). Isolated efforts to solve this problem may alleviate only part of the problem. Instead, integrated efforts should involve combined efforts of improving land tenure policies to promote natural resource management, livestock productivity through reducing stressors (e.g.diseases) by herd/flock health management, genetic means (e.g. within and between breed selection, crossbreeding), and improving productivity per unit of Input than keeping large number of mediocre animals. Furthermore, efforts should be made in family planning to limit human population growth rate and exercise human mobility through re-settlement alternatives in less degraded and under-utilized but productive areas within the country.

7.2.3. Inadequate utilization of indigenous sheep breeds

Despite the fact that huge sheep genetic diversity does exist in the country, no comprehensive analysis into the variation of growth potential of the indigenous breeds has been undertaken. For example, almost none of the sheep breeds from the Ethiopian highlands are exported due to darkening of the meat after slaughter which is less liked by importers (Aklilu *et al*., 2005). But this 'defect' has not been investigated. The indigenous sheep breeds of Ethiopia, though often been considered low-producers without careful analysis of their output per unit of input, are highly adapted to low input systems or are naturally selected for survival under suboptimal and disease ridden environments. They thrive and produce on marginal and often uncultivable lands. These breeds need to be well characterized, documented, improved and conserved through proper utilization.

7.2.4. Transport and infrastructural problems

Include lack of road transport system. Sheep are often transported on-foot and trek long distance without water and feed. In some cases, they are transported in unsuitable vehicles or lying on top of public transport (bus) by immobilizing them with a rope. Overloading frequently occurs as well as driving for long hours without rest, water and feed. This predisposes them to infections, injuries, and stresses, the latter seriously affecting meat quality. Market yards do not have required facilities and operate without water and feed, shades, partitions, scales, crushes, loading ramps and toilets (Aklilu *et al*., 2005). Most abattoirs have no holding grounds and hence animals cannot be rested and treated.

7.2.5. Lack of trained personnel and absence of recording

Despite the contribution of the livestock sector to the household and national economy, trained manpower is very limited. Specialization in sheep is missing and trained personnel in onespecies may be on call to contribute in every species as necessary. Recording in general is hardly practiced in any livestock species. Incomplete records available for ruminants are mainly in research stations and government owned ranches. Farmers mix different livestock species as a strategy to meet the family food demand – cattle are kept mainly for traction and milk, sheep and goats for income and meat, equines for transport and chickens for income, egg and meat. This together with illiteracy at smallholders' level, lack of co-ordination and facilitation at the extension level, and inadequate knowledge and skill on genetic evaluations even in personnel of research stations, are all major impediments.

7.3. Growth and survival of sheep

Growth in animals can be measured by the increase in live weight. Early growth in lambs is influenced by breed, sex of lamb, litter size, season of birth as a reflection of seasonal fluctuation in feed availability and also milk yield of the dam. Due to seasonal fluctuation of forage availability in the tropics, animals lose weight during the dry season and gain weight during feed abundance in the wet season, deposit fat during the latter season and mobilize during unfavorable periods to meet energy demands as a coping mechanis (Negussie *et al*., 2000; Ermias *et al*., 2002). However, a slow growth rate has been limiting profitability of the indigenous sheep breeds

(Mukasa-Mugerwa *et al*., 1994). There is paucity of information on genetic variability for growth in indigenous sheep breeds of Ethiopia.

Lamb survival is of major economic importance to sheep producers' world-wide since most lambs are sold primarily for mutton. Literature reviews show that geographical variation in lamb mortality is considerable (e.g. Dalton *et al*., 1980; Peterson & Danell, 1985; Yapi *et al*., 1990). In South Africa, management inputs even with intensive care failed to reduce 'core' level of lamb losses below 15 %(Brand *et al*., 1985). It is generally accepted that during the first few days of life the majority of weak lambs will die and the mortality declines as survivors grew older. Why are these 'weakly' lambs born to die is the question to address. Information is scarce on genetic factors as a source of variation for lamb survival.

7.4. Causes of sheep mortality

Identifying all causes of mortality in lambs is generally difficult. Studies show, however, that important causes of lamb mortality tend to be similar in mostcountries studied (e.g. Bekele *et al*., 1992a, b; Green & Morgan, 1993; Binns *etal*., 2002). In general, during the perinatal period (less than 1 week after birth) lambs die from adaptation failure, hypothermia, dystocia, starvation-mis-mothering exposure (SME) complex and septicaemia consequent upon inadequate colostrum intake (e.g. Woolliams *et al*., 1983; Gama *et al*., 1991; Hinch *et al*., 1986). Between 1 and 3 weeks of age, deaths can result from trauma, abscesses and meningitis secondary to omphol ophlebitis (''navel ill'') (e.g. Green & Morgan,1993). Older lambs commonly die of various infections causing pneumonia, gastrointestinal diseases (e.g. enteritis or diarrhoea) and end parasitism along with malnutrition and predation (Weiner *et al*., 1983; Yapi *et al*., 1990; Nash *et al*.,1997; Baker *et al*., 2003).

In the Ethiopian highlands, pneumonia accounted for the majority of lamb deaths (Bekele *et al*., 1992a, b; Roger, 1996; Ayelet *et al*., 2001).are multi-factorial. Hence, the term respiratory disease complex (RDC) is used for the condition conventionally known as bronchopneumonia. It is locally identified as '*Engib*', '*Wozuwuz*/*Wotwut*', and '*Gifaw*'. The causative agents could be bacterial, mycoplasmal, viral, and parasitic lung worms (Njau *et al*., 1988a; Bekele *et al*., 1992a, b; Ayelet *et al*., 2004).

The control of respiratory diseases has continued to be difficult. The reasons behind are unawareness of smallholder farmers of the importance to bring sick animals to veterinary clinics at early stages of pneumonia; single dosing of animals with antibiotics due to negligence of the farmers to bring back the animals for subsequent injections resulting in development of drug resistance by the pneumonia causing micro-organisms. Furthermore, irregular and incomplete vaccination programmes for diseases such as pasteurellosis and PPR, and incompleteness of the available vaccine for pasteurellosis which does not include all species and serotypes for *Pasteurella haemolytica* (Ayelet *et al*., 2004) were important problems. Moreover, lack of practising strategic mass drenching against parasites and the emergence of non-treatable maedi-visna virus as an important agent in RDC were all major impediments. It has been argued that reductions in lamb mortality can be achieved only by identifying and targeting the specific causes of mortality on a given farm (Kirk & Anderson, 1982).

However, because specific causes of lamb deaths are similar under many different systems it might be more appealing to identify underlying factors associated with mortality from multiple causes and change general farm andlambing management practices accordingly (Rowland *et al*., 1992; Binns *et al*., 2002). For example, environmental and/or manage mental factors can act as stressors and hamper the immune response (Kimberling, 1988) and these, combined with increased exposure to pathogens, may lead to respiratory infection (Rook *et al*., 1990). An alternative to costly treatments for pneumonia is prevention through adjusting the management routines to reduce the risk of disease development. Although losses due to pneumonia have been reported to be high in Ethiopian highland sheep (Njau *et al*., 1988a; Bekele *et al*., 1992 a, b; Ayelet *et al*.,2001), risk factors predisposing sheep to pneumonia have not been systematically studied.

Conclusion And Recommendation

The appropriate proportion of indigenous and exotic breeds considering the existing management needs to be determined for different areas. Long-term strategies to achieve and maintain the optimal genotypes need to be devised. Experience of implementing community based sheep breeding either based on pure breeding or crossbreeding reveals that the success of any breeding program mainly depends on the full farmers' participation, continuous commitment and integrated effort of institutions. Continuous research and development interventions are crucial to develop and optimize crossbreeding scheme, replicate and scale up the models, establish pedigree and performance recording, determine appropriate level of admixture, and devise appropriate management for each areas. Optimizing the breeding programs considering new products (like milk and wool) created from crossbreeding might be helpful to increase the overall benefit but should be considered in relation to potential market demand Major constraints such as high cost of feed, seasonality of feeds, inadequate extension service that sheep owners faced and militates against their ability to manage their

sheep in different regions of Ethiopia were identified, so also were the possible solutions like better extension services, subsidized veterinary drugs and soft loans that could help the farmers alleviate these constraints.

The following recommendations were suggested;

- The process of providing of extension services need to be strengthened at the local level so that sheep owners can get access to information on ways of rearing and improving their flock management.
- Government needs to find ways of developing low- interest credit and inputs supply.

Arrangement/scheme that those farmers can easily access.

- Sheep farmers need to be encouraged to form cooperative societies so that they can constitute a formidable group that can approach government agencies on the way forward in addressing their major problems.
- Facilitating market opportunities by connecting the marketing route of big market players (traders, wholesalers, processors or exporters) and establishing big and standardized livestock market in nearby areas should be encouraged
- Integrated crop forage production especially under sowing legumes like desmodium species under enset crop is should be recommended and it helps to utilize the same land for more than one crop without affecting the yield of the perennial crops and reduce feed shortage
- Housing sheep in separate house was good practice, so sharing the practice for the others through training, experience share and field trip should be needed.
- In Ethiopia, there should be adequate supply of improved cross of sheep with least cost to farmers and awareness on the breed.
- Extension support should be needed by research institute and Agricultural office to improve institutional arrangements and management aspects of the farmers and reduce losses of sheep caused by disease.
- Genetic breed characterization (molecular characterization) is necessary to fully describe

And identify sheep breed types existing

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References

1. Abebe Mekoya, 1999. Husbandry practice and productivity of sheep in Lalo-mama Midir woreda of central Ethiopia. A M.Sc. Thesis presented to the School of Graduate Studies of Alemaya University of Agriculture, Dire Dawa, and Ethiopia. 99 pp.
2. Abegaz, S., Negussie E., Duguma G. and Rege J.E.O., (2002): Genetic parameter estimates for growth traits in Horro sheep. *Anim. Breed. Genet*. 119:35-45.
3. Aklilu, Y., Hawkes, P., King, A. & Sullivan, G. 2005. Sanitary and phytosanitary standards (SPS) and livestock-meat marketing assessment for Ethiopia. Consultancy Report for a project funded under the RAISE IQC for Sanitary and phytosanitary standards (SPS) of USAID in Washington, D.C. USAID/Ethiopia and EGAT Office of USAID/Washington. February 9, 2005.
4. Ameha, S., (2008): Sheep and Goat Meat Characteristics and Quality. In: Alemu Yami and R.C. Merkel (Eds). Sheep and Goat Production Handbook for Ethiopia. Ethiopian Sheep and Goats Productivity Improvement Program (ESGPIP), Addis Ababa, Ethiopia, 323-328.
5. Amelmal Alemayehu, 2011. Phenotypic characterization of indigenous sheep types of Dawuro zone and Konta special woreda of SNNPR, Ethiopia. M.Sc. Thesis presented to the School of Graduate Studies of Haramaya University, Dire Dawa, and Ethiopia.
6. Ann, W., Gegner L. and Earles R., (2000): Sustainable Sheep Production. NCAT Agriculture Specialists, 138..
7. ANRS-Bo ARD (Amhara National Regional State Bureau of Agriculture and Rural Development) (2004). Sheep improvement breeding strategy and program (Amharic version). Bahirdar, Ethiopia. 53p.
8. Ayalew, W., Ew Burns, J.M King and Rischkowsky B., (2002): Practicalities of sustaining a goat crossbreeding programme in eastern Ethiopia. *Ethiop. J. Anim. Prod*. 2: 71-85.
9. Ayalew, W., King, J.M., Bruns E. and Rischkowsky B., (2003): Economic evaluation of

smallholder subsistence livestock production: lessons from an Ethiopian goat development program. *Ecol. Eco*., 45: 473-485.
10. Ayelet, G., Roger, F., Tibbo, M. & Tembely, S. 2001. Survey of maedi-visna (MV) in Ethiopian highland sheep. *Veterinary Journal*. 161(2), 208–210.
11. Ayelet, G., Yigezu, L., Gelaye, E., Tariku, S. & Asmare, K. 2004. Epidemiologic and serologic investigation of multifactorial respiratory disease of sheep in the central highland of Ethiopia. *International Journal of Applied Research in Veterinary Medicine*.2 (4), 275–278.
12. Baker RL, Mugambi JM, Audho JO, Carles AB, Thorpe W (2002). Comparison of Red Maasai and Baker, R.L. and Gray G.D., (2004): Appropriate breeds and breeding schemes for sheep and goats in the tropics. In: Sani, R.A., Gray, G.D., Baker, R.L. (Eds.), Worm Control for Small Ruminants in Tropical Asia, Monograph, No. 113. Australian Centre for International Agricultural Research (ACIAR), 63–95 available at http://www.worminfo.org.
13. Bekele, T., Otesile, E.B. & Kasali, O.B. 1992a. Causes of lamb morbidity and mortality in the Ethiopian highlands. *Veterinary Research Communications* 16, 415–424.
14. Bekele, T., Woldeab, T., Lahlou-Kassi, A. & Sherington, J. 1992b. Factors affecting morbidity and mortality on-farm and on-station in the Ethiopian highland sheep. *Acta Tropica* 52 (2-3), 99–109.
15. Belachew, H. and Jemberu E., (2003): Challenges and opportunities of livestock marketing in Ethiopia. In Proceedings of the 10th annual conference of the ESAP, Addis Ababa, Ethiopia,1 -13.
16. Belete, S., (2009): Production and marketing systems of small ruminants in goma district of Jimma zone, western Ethiopia. Msc. Thesis. Hawassa University Hawassa, Ethiopia, 38-54.
17. Berhanu, G. Hoekstra D. and Azege T., (2006): Improving the Competitiveness of Agricultural Input Markets in Ethiopia: Experiences since 1991. Paper presented at the Symposium on Seed-fertilizer Technology, Cereal productivity and Pro- Poor Growth in Africa: time for New Thinking 26th Triennial Conference of the International Association of Agricultural Economics, Gold Coast, Australia, 56- 78.
18. Binns, S.H., Cox, I.J., Rizvi, S. & Green L.E. 2002. Risk factors for lamb mortality on UK sheep farms. *Preventive Veterinary Medicine*. 52, 287–303.
19. BOA (Bureau of Agriculture) (2000): Report on the preliminary investigation of sheep disease at sheep ranches and ram distribution sites in North Shoa. Disease Investigation Report, Bahir Dar, Ethiopia, 2-5.
20. Brand, A.A., Cloete, S.W.P. & De Villiers, T.T. 1985. Factors that influence mortality amongst lambs in the Elsenburg Dormer and SA Mutton Merino flocks. *South African Journal of Animal Science*. 15, 155–161.
21. CSA, 2012. Report on livestock and livestock characteristics, Federal democratic republic of Ethiopia Central Statistical Agency Agricultural sample survey 2011/12(2004 E.C.), Volume II, Statistical Bulletin 532, Addis Ababa, Ethiopia.
22. CSA (Central Statistics Agency) (2013). Agricultural Sample Survey, 2012/13 2005 EC, Volume II: Report on Livestock and livestock characteristics Private peasant holdings) Statistical Bulletin 570. Federal Democratic Republic of Ethiopia, Addis Ababa.
23. Dalton, D.C., Knight, T.W. & Johnson, D.L. 1980. Lamb survival in sheep breeds on New Zealand hill country. *New Zealand Journal of Agricultural Research*. 23, 167–173.
24. DBSBMC (Debre Berhan Sheep Breeding and Multiplication Center) (2007). Synthesis report of the 39 years activity of the center Debre Berhan, Ethiopia.
25. De Waal H, Combrinck W (2000). The development of the Dorper, its nutrition and a perspective of the grazing ruminant on veld. Small Rumin. Res. 36:103-117.
26. Demeke S, Thwaites CJ, Lemma S (1995). Effects of ewe genotype and supplementary feeding on lambing performance of Ethiopian highland sheep. Small Rumin. Res. 15:149-153.
27. Deribe, G., (2009): On-farm performance evaluation of indigenous sheep and goats in Alaba, Southern Ethiopia. Msc. Thesis. Hawassa University, November, 2009, Awassa, Ethiopia.
28. Desta, L., Kassie, M., Benin, S. & Pender, J. 2000. Land degradation in the highlands of Amhara region and strategies for sustainable land management. In: Jabbar, M.A., Pender, J. & Ehui, S.K. (eds). Policies for sustainable land management in the highlands of Ethiopia: Summary of papers and proceedings of a seminar held at ILRI, Addis Ababa, Ethiopia, 22–23 May 2000. *Socio-economics and Policy Research Working Paper 30*. ILRI (International Livestock Research Institute), Nairobi, Kenya.
29. Dibissa, N. 2000. Sheep production on smallholder farms in the Ethiopian highlands – afarming system approach. *A PhD thesis*. Humboldt Universität Berlin, Institür Nutztierwissenschaften. Verlag Dr. Koster.

30. Dinksew Taye and Girma Abebe, 2000. Socio-economic aspects and Husbandry practices of sheep kept in Awassa. In: R.C. Merkel, G. Abebe and A.L. Goetsch (eds). The opportunities and challenges of enhancing Goat production in East Africa. Proceedings of a conference held at Debub University, Awassa, Ethiopia from November 10 to 12, 2000.
31. EARO (Ethiopian Agricultural Research Organization) (2000). National Small Ruminants Research Strategy Document. EARO, Addis Ababa, Ethiopia.
32. EARO (Ethiopian Agricultural Research Organization) (2001): Small ruminant research Strategy. EARO, Addis Ababa, 59.
33. Ehui S.K., S., Benin. And Nega Gebreselassie, 2000. Factors affecting urban demand for live sheep: The case of Addis Ababa, Ethiopia. Socio-economic and Policy Research Working Paper 31. ILRI (International Livestock Research Institute), Nairobi, Kenya. 32 pp.
34. Emana B (2009). Cooperatives: a path to economic and social empowerment in Ethiopia. International Labour Office. Dar es Salaam: ILO, 2009. 1v (Coop AFRICA working paper; no 9).
35. Endrias, G. and Tsedeke K. (2006): Production and marketing of livestock in Wolaita and Dawuro zones, SNNPR. Paper presented in Annual Workshop of the Agricultural Economics Society.
36. Ensminger, M.E., 2002. Sheep and Goat Science, 6th ed. Interstate publishers, Inc. U.S.A. 693p.
37. Ermias, E., Yami, A. & Rege, J.E.O. 2002. Fat deposition in tropical sheep as adaptive attribute to periodic feed fluctuation. *Journal of Animal Breeding and Genetics*. 119, 235–246.
38. FAO (Food and Agricultural Organization), 1991. Small ruminant production and small ruminant genetic resource in Africa. Animal Production and Health Paper. No. 88. FAO. Rome, Italy.
39. FAO (Food and Agricultural Organization), 2000. World watch list for domestic diversity, 3rded. B. D. Scher (ed.). FAO. Rome, Italy.
40. FAO (Food and Agriculture Organization of the United Nations) (2004): Beyond production systems, Available at www.fao.org/docrep/x5303e/x5303e0e.htm.
41. FAO (Food and Agriculture Organization of the United Nations) (2007): The State of the World's Animal Genetic Resources for Food and Agriculture, edited by Barbara and Dafydd (eds). Rome, Italy.
42. Fekerte Ferew, 2008. On-farm characterization of blackhead Somali Sheep breed and its production system in Shinile and Erer districts of Shinile zone. M.Sc. Thesis Presented to the School of Graduate Studies of Alemaya University of Agriculture, Dire Dawa, Ethiopia. 115p.
43. Gama, L.T., Dickerson, G.E., Young, L.D. & Leymaster, K.A., 1991. Effects of breed, heterosis, age of dam, litter size, and birth weight on lamb mortality. *Journal of Animal Science*. 69, 2727–2743.
44. Gatenby, R.M., (2002): Sheep production in the tropics and subtropics Long man, London, UK.178.
45. Gemeda, D., Takele, K., Ulfina, G., Solomon, A., Gebregziabher, G., 2005. Mortality and Reported Clinical Signs in Horro Sheep at Smallholder Farms in East Wollega and West Shoa Zones. Ethiopia. Eth. J. Anim. Prod., 5(1), 33-42.
46. Getachew Assamenew, 1988. Economic aspects of sheep production in the Ethiopian highland vertisol areas. International Livestock Centre for Africa, Addis Ababa, Ethiopia (mimeo).
47. Getachew T, Gizaw S, Wurzinger M, Abegaz S, Sölkner J (2013). Effect of Crossbreeding Indigenous Sheep with Awassi and Corriedale Sires on Reproductive Performance under Smallholder Production System in Agric. Conspec. Sci. 78:187-191.
48. Getahun Legesse, Girma Abebe, Siegmund M. and Valle Zarate A., 2008. Small ruminant production in two-farming systems of southern Ethiopia, University of Hawassa, Ethiopia. http://www. journals.Cambridge.org/action/displayAbstract 22 October, 2009.
49. Getahun, L., (2008): Productive and Economic performance of Small Ruminant production in production system of the Highlands of Ethiopia. PhD Dissertation University of Hohenheim.
50. Gicheha, M.G., Kosgey, I.S., Bebe, B.O. and Kahi, A.K., (2006): Evaluation of the efficiency of alternative two-tier nucleus breeding systems designed to improve meat sheep in Kenya. *Anim. Breed. Genet.* 123: 247 - 257.
51. Gizaw, S., van Arendonk, J.A.M., Komen, H., Windig, J.J. and Hanott, O. (2007). Population structure, genetic variation and morphological diversity in indigenous sheep of Ethiopia. Animal Gene. 38:621– 628.
52. Gizaw, S. (2008) Sheep Resources of Ethiopia: Genetic Diversity and Breeding Strategy. Ph.D. Thesis, Wageningen University, Wageningen.
53. Gizaw, S., Komen, H., Hanotte, O. and Van Arendonk, J.A.M., (2008): Indigenous sheep resources of Ethiopia: types, production systems

and farmers preferences. *Anim. Genet. Res. Info*., 43: 25–40.
54. Gizaw S, Getachew T (2009). The Awassi × Menz Sheep Crossbreeding Project in Ethiopia: Achievements, Challenges and Lessons Learned Proceedings of mid-term conference of the Ethiopian Sheep and Goat Productivity Improvement Program, Achievement, Challenge and Sustainability March 13-14, 2009, Hawassa, Ethiopia. pp. 53-62.
55. Gootwine E, Pollott GE (2000). Factors affecting milk production in Improved Awassi dairy ewes. Anim. Sci. 71:607-615.
56. Green, L.E. & Morgan, K.L. 1993. Mortality in early born, housed lambs in south-west England. *Preventive Veterinary Medicine*. 17, 251–261.
57. Hadera Gebru, 2002. ESAP (Ethiopian Society of Animal Production), 2002. Livestock in Food Security –Roles and Contributions. Proceedings of 9th annual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia, August 30- 31, 2001. ESAP (Ethiopian Society of Animal Production) 433pp.
58. Haile A, Tembely S, Anindo D, Mukasa-Mugerwa E, Rege JE, Yami A, Baker R (2002). Effects of breed and dietary protein supplementation on the responses to gastrointestinal nematode infections in Ethiopian sheep. Small. Rumin. Res. 44:247-261.
59. Haile A, Wurzinger M, Mueller J, Mirkena T, Duguma G, Okeyo M,Sölkner J Rischkowsky B (2011). Guidelines for setting up Community-based Sheep Breeding Programs in Ethiopia. ICARDA –tools and guidelines No1 Aleppo, Syria, ICARDA.
60. Hayes BJ, Bowman PJ, Chamberlain AJ, Goddard ME (2009). Invited review: Genomic selection in dairy cattle: progress and challenges. J.Dairy Sci. 92:433-443.
61. Hinch, G.N., Davis, G.H., Crosbie, S.F., Kelly, R.W. & Trotter, R.W. 1986. Causes of lamb mortality in two highly prolific Booroola crossbred flocks and a Romney flock. *Animal Reproduction Science*. 12, 47–61.
62. Hirpa, A. and Abebe, G., 2008. Economics significance of sheep and goats. In: Yami A and Merkel RC (Edition), Sheep and goat production handbook for Ethiopia, ESGPIP, Ethiopia, pp. 1-4.
63. IBC (Institute of Biodiversity Conservation), 2004. The State of Ethiopia's Farm Animal Genetic Resources: Country Report. A Contribution to the First Report on the State of the World's Animal Genetic Resources. IBC. May 2004. Addis Ababa, Ethiopia.
64. Ibrahim H., 1998. Small Ruminant Production Techniques. ILRI Manual 3. ILRI (International Livestock Research Institute), Nairobi, Kenya. 207 pp.
65. Jaitner, J., Soweb, J., Secka-Njieb, E., Dempec, L., (2001): Ownership pattern and management practices of small ruminants in The Gambia implications for a breeding programme, Germany, *Small Rumi. Res*., 40: 45-50.
66. Kassahun Awgichew and Solomon Abegaz, 2006. Breeds of sheep and goats. Sheep and goat production Handbook for Ethiopia. Ethiopian sheep and goat productivity improvement program (ESGPIP) htttp://www.texascampuscompact.org /prairieviewsheeppgm.pdf/ 22 October, 2009.
67. Kassahun Awgichew, 2000. Comparative performance evaluation of Horro and Menz sheep of Ethiopia under grazing and intensive feeding condition. A PhD Dissertation Humboldt- University. 129p.
68. Kimberling, C.V. 1988. Diseases of the respiratory system. In: *3rd Jensen and Swift's Diseases of Sheep*. Lea and Febiger, Philadelphia. pp. 173–181.
69. Kirk, J.H. & Anderson, B.C., 1982. Reducing lamb mortality: a two-year study. *Veterinary Medicine*. 77, 1247–1252.
70. Kosgey, I.S., Van Arendonk, J.A.M. and Baker, R.L., (2003): Economic values for traits of meat sheep in medium to high potential areas of the tropics. *Small. Rumin. Res.*, 50: 187–202.
71. Kosgey, I.S., (2004): Breeding Objectives and Breeding Strategies for Small Ruminants in the Tropics. Ph.D Thesis, Wageningen University, Netherlands.
72. Kosgey IS, Baker RL, Udo HMJ, and Van Arendonk JAM (2006). Successes and failures of small ruminant breeding programmes in the tropics: a review. Small Rumin. Res. 61:13-28.
73. Kosgey, I.S. and Okeyo, A.M. (2007). Genetic improvement of small ruminants in low-input, smallholder production systems: Technical and infrastructural issues. *Small Rumin. Res.*70:76–88.
74. Kosgey, I.S., G.J. Rowlands, J.A.M. van Arendonk, R.L. Baker, 2008. Small ruminant production in smallholder and pastoral/extensive farming systems in Kenya. *Small Rumin. Res.*, 77: 11–24.
75. Legesse, G., Abebe G., Siegmund-Schultze M. and Valle Zárate A., (2008): Small ruminant production in two mixed-farming systems of southern Ethiopia: Status and prospects for improvement. *Experi. Agri*., 3:399-412.

76. Lemma, S., (2002): Phenotypic classification and description of indigenous sheep types in the Amhara National Regional State of Ethiopia. MSc Thesis, University of Natal, Pietermaritzburg, South Africa.
77. Leymaster, K.A., 2002. Fundamental aspect of cross breeding of sheep: Use of breed diversityto improve efficiency of meat production. Sheep and Goat Research Journal. 17(3):50-59.
78. MacRea, J.C. 1993. Metabolic consequences of internal parasitism. In: *Proceedings of Nutrition Society*. 52, 121–130.
79. Markos Tibbo, 2006. Productivity and health of indigenous sheep breeds and crossbreds in the central Ethiopian highlands. Doctoral Thesis, Swedish University of Agricultural Sciences. Uppsala, Sweden.
80. Markos Tibbo, J. Philipsson, and Workneh Ayalew, 2006. Sustainable Sheep Breeding Programs in the Tropics: a Framework for Ethiopia. October 11-13, 2006 Conference on International Agricultural Research for Development, University of Bonn.
81. Melesse, A., Banerjee, S., Lakew, A., Mersha, F., Hailemariam, F., Tsegaye, S. and Makebo, T., (2013): Morphological characterization of indigenous sheep in Southern Regional State, Ethiopia. *Anim. Breed. Genet*., 52: 39–50.
82. Mengiste Taye, 2008. On–farm performance of Washera sheep at Yilmanadensa and Quarit districts of the Amhara national Regional State. M.Sc. Thesis presented to the School of Graduate Studies of Hawassa University, Awassa, Ethiopia. 117p.
83. Mengistu, A. 2000. Country pasture/forage resource profiles, Ethiopia. (Accessed on 15-Mar-06: http://www.fao.org/waicent/faoinfo/agricult/agp/agpc/doc/pasture/pasture.htm).
84. Mukasa-Mugerwa, E., Said, A.N., Lahlou-Kassi, A., Sherington, J. & Mutiga, E.R., 1994. Birth weight as a risk factor for perinatal lamb mortality, and the effects of stage pregnant ewe supplementation and gestation weight gain in Ethiopian Menz sheep. *Preventive Veterinary Medicine*. 19, 45–56.
85. Mukasa-Mugerwa, E. and A. Lahlou-Kassi, 1995. Reproductive performance and productivity of Menz sheep in the Highlands of Ethiopia. *Small Rumin. Res.*. 17:167-177.
86. Nash, M.L., Hungerford, L.L., Nash, T.G. & Zinn, G.M. 1997. Risk factors for respiratory disease mortality in lambs. *Small Ruminant Research*. 26, 53–60.
87. National Regional State of Ethiopia. An M.Sc. Thesis presented to the School of Graduate Studies of Haramaya University.
88. Negussie, E., Rottman, O.J., Pirchner, F. & Rege, J.E.O., 2000. Allometric growth coefficients and partitioning of fat depots in indigenous Ethiopian Menz and Horro sheep breeds. In: Merkel, R.C.; Abebe, G. & Goetsch, A.L. (eds). The Opportunities and Challenges of Enhancing Goat Production in East Africa. Workshop Proceedings
89. Niftalem Dibissa, 1990. On-farm study of reproductive and growth performance of the Menz sheep in Debre Berhan-Ethiopia. An M.Sc. Thesis Presented to the School of Graduate Studies of Alemaya University of Agriculture, Dire Dawa, Ethiopia. 93p.
90. Njau, B.C., Kasali, O.B., Scholtens, R.G. & Mesfin, D. 1988a. Field and laboratory studies of causes of sheep mortality in the Ethiopian highlands, 1986/87. *ILCA Bulletin*, No 31, 23–26.
91. Olsson A, Beyene T (1990). Performance of indigenous and crossbred sheep in the highlands of Ethiopia in: Proceedings of the Fourth Wld. Cong. Genet. Appl. Livest. Prod. 15:406-409.
92. Peterson, C.J. & Danell, Ö. 1985. Factors influencing lamb survival in four Swedish sheep breeds. *Acta Agriculturæ Scandinavica*. 35, 217–232.
93. Pollott GE, Gootwine E (2004). Reproductive performance and milk production of Assaf sheep in an intensive management system. J. Dairy Sci. 87:690-703.
94. Rege, J.E.O, 1999. Economic valuation of farm animal genetic resources. In: J.E.O., Rege (ed.). Economic valuation of animal genetic resource. Proceedings of an FAO /ILRI workshop Held at FAO Head Quarters, Rome, Italy, 15-17 March, 1999. ILRI (International Livestock Research Institute). Nirobi, Kenya. 80 p.
95. Rewe, T.O., Ogore, P.B. and Kahi, A.K., (2002): Integrated goat projects in Kenya: Impact on genetic improvement. In: Proceedings of the Seventh World Congress on Genetics Applied to Livestock Production, Montpellier, France. August 19–23, 2002. *Appli. Live. Prod*., 3: 19-23.
96. Rook, J.S., Scholman, G., Wing-Proctor, S. & Shea, M.E. 1990. Diagnosis and control of neonatal losses in sheep. *Veterinary Clinicians of North American Food Animal Practice*. 6, 531–562.
97. Rowland, J.P., Salman, M.D., Kimberling, C.V., Schweitzer, D.J. & Keffe, T.J. 1992. Epidemiologic factors involved in perinatal lamb mortality in four range sheep operations.

American Journal of Veterinary Research. 53, 262–267.
98. Rummel, T., Valle Zárate, A. and Gootwine, E., (2005): The worldwide gene flow of the improved Awassi and Assaf sheep breeds from Israel. The Report on Microsatellite use. Verlag Grauer, Beuren, Stuttgart, 27–29.
99. Samuel, M., (2005): Characterization of livestock production system: a case study of yerer watershed, ada'a liben Woreda of east showa, Ethiopia, MSc. Thesis Submitted to the Department of Animal Science, School of Graduate Studies, Haromaya University, Dire Dawa. School of Graduate Studies of Alemaya University of Agriculture, Dire Dawa, Ethiopia. 89 p.
100. Shigdaf, M., Zeleke M., Mengistie T., Hailu M., Getnet M. and Aynalem H., (2013): Reproductive performance and survival rate of Washera and Farta sheep breeds under traditional management systems in Farta and Lay Gayint Districts of Amhara Regional state, Ethiopia. *Ethiop. J. Anim. Prod.,* 13: 65- 82.
101. Shrestha JNB (2005). Conserving domestic animal diversity amongcomposite populations. Small Rumin. Res. 56:3-20.
102. Sisay Lemma, 2002. Phenotypic classification and description of indigenous sheep types inthe Amhara national regional state of Ethiopia. An M.Sc. Thesis Submitted to the Departmentof Genetics, University of Natal. Pietermaritzburg, South Africa. 104p.
103. Sisay Lemma, 2009. Phenotypic characterization of indigenous sheep breeds in the Amhara.
104. Solkner J., H. Nakimbigwe and A. Valle-Zarate, 1998. Analysis of determinants for success and failure of village breeding programmes. Proc. 6th World Congr. Genet. *Appl. Livestock Prod.* 25: 273 – 280.
105. Solomon Abegaz Guangul, 2007. In situ characterization of Gumuz sheep under farmers' management in north western lowland of Amhara region. An M.Sc. Thesis Presented to the Solomon Gizaw, Sisay Lemma, H. Komen and J.A, M. van Arendonk, 2007. Estimates of genetic parameters and genetic trends for live weight and fleece traits in Menz sheep. *Small Rumin.* Res. 70, 145-153.92-96.
106. Solomon G (2008). Sheep resources of Ethiopia: Genetic diversity and breeding strategy. A PhD Thesis Presented to Wageningen University. 145p.
107. Solomon, A., Girma A. and Awigichew K., (2008): Sheep and goat production system in the tropics. Alemu Yami and R.C. Merkel (eds.). IN: Sheep and goat Production Hand Book for Ethiopia. Ethiopia Sheep and Goats Productivity Improvement Program (ESGPIP), Addis Ababa, Ethiopia, 57-72.
108. Stuttgart-Hoheinheim, Germany. Awgichew, K., (2000): Comparative performance evaluation of Horro and Menz sheep of Ethiopia under grazing and intensive feeding conditions. PhD Dissertation, Humboldt University, Berlin, Germany.
109. Sundquist, B. 2003. (http://home.alltel.net/bsundquist1/og4.html, accessed on 15-Apr-06).
110. Taye, M., Abebe G., Gizaw S., Lemma S., Mekoya A. and Tibbo M., (2009): Growth performances of Washara sheep under smallholder management systems in Yilmanadensa and Quarit districts, Hawassa, Ethiopia *South. Afri. Anim. Sci.,* 42:1-11.
111. Tesfaye G., (2008): Characterization of Menze and Afar Indigenous Sheep Breeds of Smallholders and Pastoralist for Desighing Community Based Breeding Strategies in Ethiopia. An M Sc Thesis presented to the School of Graduate Studies of Haramaya University, Dire Dawa, Ethiopia.
112. Tesfaye, K., Madsen J.O., Azage T., (2004): Manure Production, Handling and Use around Holetta Agricultural Research Center. In Proceedings of the 13th a nnual conference of the Ethiopian Society of Animal Production (ESAP) held in Addis Ababa, Ethiopia.
113. Tessema, Z., Aklilu A. and Ameha S., (2003): Assessment of the livestock production system, available feed resources and marketing situation in Belesa District: A Case Study in Drought Prone Areas of Amhara Region, Ethiopia. In: Proceedings.
114. Tibbo, M. (2006). Productivity and health of indigenous sheep breeds and crossbreds in the central Ethiopian highlands. PhD dissertation. Department of Animal Breeding and Genetics, Faculty for Veterinary Medicine and Animal Sciences, Swedish University of Agricultural Sciences (SLU), Uppsala, Sweden. http://dissepsilon.
115. Tsedeke, K. (2007): Production and marketing of sheep and goats in Alaba, SNNPR. Msc thesis. Hawassa University. Awassa, Ethiopia, 25-54.
116. Tsedeke, K., Girma A., Azage T. and Berhanu G., (2011): Marketing value-chain of smallholder sheep and goats in crop-livestock mixed farming system of Alaba, Southern Ethiopia. *Official J. Inter. Goat Asso.,* 96: 102.
117. Tsegay, T., Mengistu U., Yoseph M. and Merga B., (2013). Pre weaning growth performance of crossbred lambs (Dorper x indeginous sheep

breeds) under semi intensive management in Eastern Ethiopia. *Trop. Anim. Health Prod*., 46: 455.
118. Webb, E.C. and Mamabolo, M.J. (2004): Production and reproduction characteristics of South African indigenous goats in communal farming systems. *South. Afri. Anim. Sci.,* 34:236-239.
119. Weiner, G., Woolliams, C. & Macleod, N.S.M. 1983. The effects of breed, breeding system and other factors on lamb mortality. 1. Causes of death and effects on the incidence of losses. *Journal of Agricuktural Science*. 100, 539–551.
120. Winrock International. 1983. Sheep and goats in developing countries: Their present and potential role. World Bank, Washington DC, USA.
121. Wollny, C.B.A., Banda, J.W., Mlewah, T.F.T., Phoya, R. K.D., (2002): The lessons of livestock improvement failure: revising breeding strategies for indigenous Malawi sheep? In: Proceedings of the 7th World Congress on Genetics Applied to Livestock Production, Montpellier, France. 33: 345 – 348.
122. Woolliams, C., Wiener, G., Macleod, N.S.M., 1983. The, breeding systems and other factors on lamb mortality. 3. Factors influencing the incidence of weakly lambs as a cause of death. *Journal of Agricultural Science*. 100, 563–570.
123. Workneh, A., (2000): Do smallholder farmers benefit more from crossbred (Somali x Anglo-Nubian) than from indigenous goats? PhD Dissertation, Georg-August University of Goettingen, Goettingen, Germany.
124. Workneh Ayalew, Ephrem Getahun, Markos Tibbo, Yetnayet Mamo and J.E.O. Rege. 2004. Current State of Knowledge on Characterization of Farm Animal Genetic Resources in Ethiopia. Proceedings of the 11th Annual conference of the Ethiopian Society of Animal Production, Pp: 1-22.
125. Yapi, C.V., Boylan, W.J. & Robinson, R.A. 1990. Factors associated with causes of lamb preweaning mortality. *Preventive Veterinary Medicine*. 10, 145–152.
126. Zeleke, E., (2009): Smallholder Farmers' Decision Making in Farm Tree Growing in the Highlands of Ethiopia. A PhD dissertation, Oregon State University, 34-40.
127. Zewdu Edea, 2008. Characterization of Bonga and Horro indigenous sheep breeds of small holders for designing community based breeding strategies in Ethiopia. M.Sc. Thesis submitted to the department of animal science, school of graduate studies, Haramaya University. 33 pp.

8/25/2017