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Review paper

Characterization of the production systems of sheep in tropics, the case of Ethiopia.

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About 31.30 million heads of sheep are estimated to be found in Ethiopia, out of which about 71.82 percent are females, and about 28.18 percent are males. Therefore, this review was attempted to characterize phenotypic and production Systems of sheep in tropics, the case of Ethiopia. The sheep are widely dispersed and adapted across the different agro-ecologies of the country, majority of the sheep are found in the highlands, while one-fourth of them are reared in the lowlands. Sheep is highly adaptable to a broad range of environments. In the lowlands of Ethiopia, livestock is comprised of large sheep flocks, where only surplus are sold at local markets or trekked to major consumption centers. Differences exist in reproductive performance between indigenous sheep breeds and their variation allow for the selection of suitable breeds for a given environment. Age at first lambing of some of Ethiopian sheep breeds are ranges from 13 to 24 months. Lambing interval has an important influence on a sheep production enterprise. Litter size is largely determined by ovulation rate but is also modified by fertilization rate and embryonic and fetal losses.

Keywords: breeds, Ethiopia, production, reproductive performances, sheep.

INTRODUCTION.

About 31.30 million heads of sheep are estimated to be found in Ethiopia, outof which about 71.82 percent are females, and about 28.18 percent are males (CSA, 2017/2018). The sheep are widely dispersed and adapted across the different agro-ecologies of the country, majority of the sheep are found in the highlands, while one-fourth of them are reared in the lowlands. Small ruminants are integral part of livestock keeping in Sub-Saharan Africa, Ethiopia and have a substantial contribution to smallholder farmers in generating income and securing food in developing countries (Kosgey et al., 2006). Ethiopia has diverse indigenous sheep breeds, at least 9 breeds and 14 traditional sheep populations, distributed across diverse ecology, production systems and communities or ethnic groups (SolomonGizaw,2007).

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As a result of their wide range of habitat, behavioral and reproductive adaptations, sheep have evolved into a large number of different geographically separate phenotypic forms or races varying in size, fleeces, conformation, muscling and coat color. Indigenous sheep breeds have a great to contribute more to the livelihood of people in low input, small holder and pastoral production systems (Markos T., 2006). Indigenous sheep breeds have great potential to contributing more to the livelihoods of the people in low-input, small-holder crop livestock and pastoral production systems (Kosgey and Okeyo 2007).

They considered as a living bank against the various environmental calamities (crop failure, drought and flooding) and have socio-cultural values for diverse traditional communities (Edea *et al.,* 2010). Moreover, indigenous sheep in Ethiopia have a multipurpose role for smallholder farmers as sources of income, meat, skin, manure and coarse wool or long hairy fleece. The importance of sheep production as a source of meat in

Ethiopia has been increasing during recent years. This sheep production has experienced changes regarding the use of introduced exotic breeds, in order to increase the growth rate of lambs. Hence, this review was attempted to characterize production Systems of sheep in tropics, the case of Ethiopia.

The Origin of Sheep production.

Sheep belong to the sub-family Caprinae, family Bovidae. The genus *Ovis* include all sheep, while domesticated sheep belong to the species *Ovis Aries.* Records of domestication of sheep date back to as early as 7000 in near east.

The home of wild sheep is the mountain ranges of central Asia, from where sheep spread westwards into Europe and eastwards into North America during the Pleistocene period (Ryder, 1983). Unlike other livestock species where the number of presumed wild progenitors is limited, for domestic sheep (*Ovis Aries*), a large number of wild and possibly ancestral species and sub-species exists (Ryder, 1984).

Further, all the wild species are capable of interbreeding with one another, as well as with domesticated sheep producing fertile hybrids (Franklin, 1997). Several wild sheep, notably the mouflon, urial, and argali have been proposed as ancestors of domestic sheep or are believed to have contributed to specific breeds (Ryder 1984).

Therefore, to distinguish domestic sheep from their wild relatives, all domestic sheep are classified as *Ovis aries.* The taxonomy of wild sheep is controversial hindering unequivocal identification and classification for conservation management of this important genetic resource for the major agricultural species (Geist, 1991).

There are a number of different theories regarding the origin of domestic sheep.

However, most sources agree that sheep originated from mouflon (Ensminger, 2002).

There are two wild populations of mouflons still in existence; the Asiatic mouflon which is found in the mountains of Asia Minor and Southern Iran and the European mouflon of which the only existing members are found on the islands of Sardinia and Corsica.

These two species are closely related with the only difference being the redder coloration and different horn configuration of the Asiatic mouflon. Some sources hypothesize that the European mouflon actually developed from the first domesticated sheep in Europe being allowed to become feral and that all sheep are actually descendants of the Asiatic mouflon. Sheep belong to the suborder Ruminantia, the order Artiodactyla, the genus Ovis, and the family Bovidae.

The domesticated sheep is classified as *Ovis Aries*, the bighorn sheep as *Ovis canadensis*, and Dall's sheep as *Ovis dalli*.

The Population and Distribution of Sheep in Ethiopia.

Ethiopia is second in Africa and sixth in the world in terms of sheep population. In Ethiopia, sheep breeds have developed to live in a wide variety of environments, from desert to humid rainforests. Breeds which have to survive a long dry season often have a fat tail or rump which is a store of energy equivalent to the hump of camels or cattle. Breeds which walk long distances have long legs. Flock structure is a reflection of the system of management that explains to some extent the management objectives and strategies. The flock size in Ethiopia is smaller in the highlands compared with the lowlands (Wilson, 1982). The mean flock size of Menz sheep at Debre Berhan area was 23.8 head and ranged from 2 to 83 (Agyemang *et al.,*1985).

The unique characteristics of Sheep.

Sheep is highly adaptable to a broad range of environments. They can utilize a wide variety of plant species and can be raised under mixed grazing condition complementary to goats, cattle and camels. They can efficiently utilize marginal and small plot of land as well. There is a faster turnover of capital because sheep sexually mature early and are young at slaughter. Smaller carcasses are also easier to market and consume in a short period.

Sheep produce lower absolute quantities of milk than cattle. However, when their body weight is taken in to account, their milk yield is higher than other species with the possible exception of camels (Wilson, 1991). Under tropical environmental conditions, sheep is raised primarily for meat. Although milk is an important asset from sheep, it is rarely milked in Ethiopia. Pastoralists keep large flocks of sheep for subsistence, income, breeding, restoring wealth and social prestige. At a subsistence level, sheep is kept for occasional slaughter for meat. Sheep is sold regularly in exchange for small commodities and food items. Some male sheep are kept for reproduction purposes. At the age of four-five years, such male sheep are castrated for fattening. They have a high reproductive rate. In favorable conditions, a ewe can give birth every eight months, and the generation interval is less than two years. A high reproductive rate is important in an unfavorable environment where even now and then the numbers of animals are reduced by natural events, such as drought. After drought when the environment again becomes favorable, the numbers of sheep build up quickly (Gatenby *et al.,* 1991).

The Origin and Genetic Diversity of Ethiopian Sheep Breeds.

A number of theories have been advanced as to the time and the routes by which sheep were introduced into Ethiopia. The earliest sheep in Africa were thin-tailed and hairy and introduced to East Africa through North Africa. The second wave of sheep introduction to Africa

constitutes fat-tailed sheep entering North Africa via the Isthmus of Suez straits and East Africa via straits of Bab-el-Mandeb (Ryder, 1984). Accordingly, African sheep have been traditionally described and classified based on their tail type (Epstein, 1971; Ryder,1984). Ethiopia is believed to be one of the major gateways for domestic sheep migration from Asia to Africa. Ethiopia has a vast genetic resource of sheep. Although in the country as many as 14 sheep breeds/types have been identified so far, sizable populations of sheep are non-descript due to indiscriminate breeding and mixing of breeds.

They are widely distributed across the major agro-ecological zones and geographical regions. About 75% of the sheep population inhabited the highland part of the country while the remaining 25% are distributed in the lowlands (Tibbo, 2006). Indigenous sheep genetic resources have developed specific adaptations to survive and produce under adverse local environmental conditions (climatic stresses, poor quality feed, seasonal feed and water shortage, endemic disease and parasite challenge) that make them suitable for use in the traditional, low-input production system(IBC, 2004). As a result, they are less subjected to selection for functional traits and their productivity is low .Sheep types in Ethiopia are highly affiliated to specific ethnic communities. A number of traditional breeds are reared by and named after specific communities. As could be noted, the indigenous sheep breeds are usually named after specific ethnic groups (e.g. Afar) or geographical locations (e.g. the Horro, Menz).

Similarly, the classification of these major types is largely based on morphological or physical characteristics. Most of the investigations up to now have been carried out on research stations; on-farm performance studies are very few.

This in turn affects the understanding of the factors which influence sheep production at the farm level and also the introduction of specific interventions by development organizations. According to the review by Workneh *et al*. (2004), there are six recognized indigenous sheep breed types in the country which falls into three breed groups: the fat-tailed hair type, the fat tailed coarse wool sheep and the fat-rumped hair sheep. Sisay (2002) classified the sheep population of Amhara region based on their geographical location into four major clusters.

Indigenous breeds of sheep in Ethiopia.

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

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

The Major Production Systems of Sheep in Ethiopia.

In the lowland part of the country small ruminant production is associated with the purely livestock based nomadic and transhumance pastoral production systems based largely on range, primarily using natural vegetation. The pastoral systems are found mainly in the medium-to-low potential areas where crop production is difficult due to low and erratic rainfall. In this system though there are cultivations in some areas, livestock production forms an integral part of the socio-cultural life for the vast and diverse human populations. Most of the livelihoods of the inhabitants depend on livestock products and live animals sales or exchange (Coppock, 1994). Risk avoidance is an important integral part of the breeding objectives in those areas. People moves periodically with their livestock in search of feed and water for their animals. In the lowlands of Ethiopia, livestock is comprised of large sheep flocks, where only surplus are sold at local markets or trekked to major consumption centers. Extensive livestock keeping is the backbone of the economies of the lowlands (EARO, 2000).The government ranch is accounted for very small proportion of sheep production system in Ethiopia. It was found in government sheep breeding, and multiplication centers (Tibbo,2006). This include government owned ranches such as Horro Guguduru ranch, which was closed due to high sheep mortality, the Debre Berhane and Amed Guya ranch involved in the production and distribution of crossbred rams to the farmers. According to FAO (2000), a production environment encompasses all input-output relationships, over time, at a particular location. The relationships will include biological, climatic, economic, social, cultural, and political factors, which combine to determine the productive potential of a particular livestock enterprise.

Animal uses, genetic variance, and abundance of genetic diversity change across production systems.

As different production systems evolve varying pressures are placed upon the existing breeds (FAO, 2004). Marked differences between production systems, such as product needs and prices, disease occurrence, spread and control methods and climatic differences will often require, for each environment, the use of quite different genetic resources to realize sustained production of food and agriculture (FAO, 2000).The major sheep production systems in Ethiopia include the traditional management system(the pastoral and agro-pastoral and mixed crop-livestock systems) and the government ranches, characterized by different production goals and priorities, management strategies and practices, and constraints (Tibbo, 2006). Generally, the mixed crop-livestock systems are the most densely populated and hold the largest number of ruminant livestock.
In the mixed farming system of the highlands of Ethiopia sheep depend mostly on grazing fallow lands, waterlogged lands, natural pasture and crop residues usually with no extra-supplement and receive minimum health care.

The Sheep flock structure and Ownership Patterns.

Flock structure is the proportion of the flock which is formed by different age and sex classes. It may indicate the production objectives of the producers. Low proportion of young animals in the flock would imply high pre weaning lamb mortality or adult mortality is minimal. On the other hand it may mean that more lambs were sold during the year. In pastoral areas like Afar where the livelihood is primarily dependent on milk, they keep female animals that account for over 90% of the total flock (Wilson, 1982). Study carried out in the central highlands of Ethiopia indicated that out of the total sheep considered 64.4% were females, 28.1% males and 4.6% castrates (Abebe, 1999). Results of production system study conducted in eastern Wollega and western Shoa zones (Solomon *et al*., 2005) have also indicated that about 72.2% of the sheep flocks are female animals of which 65.2% are above 1 year of age.
The flock structure or flock composition refers to the age and sex profile of the flock this means, the relative numbers of sheep with respect to age and sex. The flock owner determines the flock composition on the basis of economic and management considerations. The composition is also influenced by reproductive and mortality rates. Determination of the best flock structure is strongly influenced by the production objective. Information on flock structure shed light on the owner's management objectives, whether the main interest is in the production of milk or meat, the prevailing constraints in the system and it can further provide the basis for calculating or for casting flock productivity (ILCA, 1990). Average flock sizes of 24 animals were reported in the central highlands of Ethiopia (Abebe, 1999). Lower flock sizes of 6.3 for Horro sheep (Solomon *et al*., 2005) and 6.97 for sheep breed found around Dire Dawa (Aden, 2003) were reported.

The Reproductive Performances of Sheep.

Good reproductive performance is a prerequisite for any successful genetic improvement and it determines production efficiency. Study suggests that differences exist in reproductive performance between indigenous sheep breeds and their variation allow for the selection of suitable breeds for a given environment (Mukasa-Mugerwa and Lahlou-Kassi, 1995). Where breeding males are available in the flocks, age at first parturition is a good indicator of early sexual maturity in ewes. It is an economically important trait as greater population turnover and more rapid genetic progress can be obtained when sheep produce their first progenies at an earlier rather than later age. Early maturing females are also known to have a relatively long and fruitful reproductive life (Mukasa-Mugerwa and Lahlou-Kassi, 1995).

The Age of sheep at puberty.

Puberty in the ewe lamb is the time at which estrous cycle starts. The age at puberty depends primarily on the growth of the lamb, which depends on the supply of sufficient and quality nutrition during the growth period. Well-fed lambs may reach puberty at nine months, but within adequate nutrition, puberty may not be realized until twenty months (Gatenby *et al.,* 1991).Females, however, are somewhat slower than males in reaching sexual maturity. The age of puberty for females ranges from 5 to 20 months depending on breed, nutrition, and date of birth (Ensminger, 2002). Age at puberty in the ram is the time at which the ram lamb is able to successfully mate for the first time. As in the ewe, the age at puberty in the ram depends very much on management, particularly on the level of feeding. Age of puberty influences both the production and reproductive life of the female through its effect on her life time lamb crops.

Age at first lambing of sheep.

Average age at first lambing ranged from 11 to 24 months for west and central Africa ewes. West African Dwarf sheep tend to have their first offspring before they are two years old. Age at first lambing of some of Ethiopian sheep breeds are ranges from 13 to 24 months. The average age at first lambing of 17 months were reported for sheep in Adaa Leben and Menz sheep around Debre Berhan area, respectively (Niftalem, 1990; Samuel, 2005). Season of birth influences age at first lambing through its effect on feed supply and quality. Year and season in which the ewe lamb was born, influence the age at first lambing.

Lambing interval sheep.

Lambing interval is defined as the interval between two consecutive parturitions. It has three phases: the gestation period, the postpartum anoestrus period and the service interval. Lambing interval has an important influence on a sheep production enterprise. Lambing interval is one of the main components of reproductive performance which is affected by the breed, season (Mengiste, 2008) parity of ewes, post-partum body weight and management practice, type of management, nutrition, type of mating (Gbangboche *et al*., 2006). Management practices and restrictions on breeding also prolong the interval between lambing. Mengiste (2008) working on Washera sheep reported shorter lambing interval for ewes lambed in wet season than those delivered in dry season of the year.

Litter size of sheep.

The percentage of ewes having twins in tropical sheep breeds, generally range between 0 and 50% and while under traditional management conditions the percentage tends to fall below 10%. Mean litter size of Horro sheep was reported to be 1.34 (Solomon and Gemeda, 2000). Litter size is largely determined by ovulation rate but is also modified by fertilization rate and embryonic and fetal losses. The main factors influencing ovulation rate in the ewes are breed and level of nutrition while season and age-related factors are also important. Level of nutrition has effect on litter size in that, poor nutrition during service period lead to reduced ovulation rates and increase embryonic mortality and consequently decrease litter size (Gautsch, 1987).

The Annual reproductive rate of sheep.

Annual reproductive rate is defined as litter size times 365 days divided by lambing interval in days. Annual reproductive rate of sheep was 1.03 lambs /ewe/year for sheep around Debre Berhan area (Agyemang *et al*., 1985). Annual reproductive rate of Africa sheep varies from 1.10 to 1.36. It is affected by the year and season of lambing; being highest during the small rainy season and lowest when lambing occurred during the dry season. This may be due to the fact that ewes that lambed during the dry season had longer subsequent lambing interval than those that lambed during the rainy season (Gautsch, 1987; Niftalem, 1990).

CONCLUSION

Sheep belong to the sub-family Caprinae, family Bovidae. The genus *Ovis* include all sheep, while domesticated sheep belong to the species *Ovis Aries.* Ethiopia is second in Africa and sixth in the world in terms of sheep population. In Ethiopia, sheep breeds have developed to live in a wide variety of environments, from desert to humid rainforests. Sheep is highly adaptable to a broad range of environments. Flock structure is the proportion of the flock which is formed by different age and sex classes. Good reproductive performance is a prerequisite for any successful genetic improvement and it determines production efficiency. Puberty in the ewe lamb is the time at which estrous cycle starts. The average age at first lambing of 17 months were reported for sheep in Adaa Leben and Menz sheep around Debre Berhan area, respectively. Lambing interval is defined as the interval between two consecutive parturitions. It has three phases: the gestation period, the postpartum anoestrus period and the service interval. Litter size is largely determined by ovulation rate but is also modified by fertilization rate and embryonic and fetal losses. Annual reproductive rate of Africa sheep varies from 1.10 to 1.36. It is affected by the year and season of lambing; being highest during the small rainy season and lowest when lambing occurred during the dry season. Finally, to maintain the present diversified appearances of sheep for future uses,the genetic potential improvement should be contained in the breeding program of the country.

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