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Review of Indigenous Sheep Breeds Production Systems in Ethiopia

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Abstract:- This paper reviews socio economic importance of sheep production in Ethiopia, origin and domestication of sheep, Ethiopia sheep breeds/populations, sheep production system in Ethiopia, flock demography, size and ownership pattern, reproductive performance and growth performance of indigenous sheep breeds in Ethiopia. Sheep are source of household income to poor farmers. Particularly, indigenous breeds are widespread and important to the subsistent and social livelihoods of a large human population in Ethiopia. Indigenous sheep breeds/populations in Ethiopia have a multipurpose role for smallholder farmers as sources of income, meat, skin, manure and coarse wool or long hairy fleece. Indigenous sheep production systems of Ethiopia are classified into five based on degree of integration with crop production and contribution to livelihood, level of input and intensity of production, agro-ecology, length of growing period and relation to land and type of commodity to be produced. These are highland sheep–barely system, mixed–crop-livestock production system, pastoral and agro-pastoral systems, ranching and urban and peri-urban production systems. The production system should be transformed into market oriented system using value chain framework (involvement of stakeholders).

Keywords:- *Indigenous Sheep, Production System, Ethiopia.*

I. INTRODUCTION

Sheep is the second most important livestock species in Ethiopia estimated at 39.89 million (CSA, 2020). There are diverse breeds and ecotypes distributed from cool alpine climate of the mountains to the arid pastoral areas of the lowlands. To date, there are nine genetically distinct breeds of sheep characterized through phenotypic and molecular methods (EBI, 2016). Indigenous sheep breeds provide farm households with cash income, meat, fiber, and manure and other services (skin). As compared to cattle, sheep have shorter production cycles, faster growth rate, ease of management, and low capital investment (Tadesse et al., 2015). However, sheep productivity is constrained by shortage of feed, prevalence of diseases and parasites and lack of market information (Hizkel et al., 2017).

Indigenous sheep production is a major component of livestock farming in Ethiopia. It contributes close to 30% of the total ruminant livestock meat output and 14% of the total domestic meat production (Workneh *et al*., 2004). The sheep enterprise in the Ethiopian highland, where crop and livestock production are integrated, it is the most important form of investment and cash income and provides social security in bad crop years. The livestock sector contributes 30 to 35% of the Ethiopian agriculture GDP, 19% of the total GDP and more than 85% of farm cash income (Benin *et al*., 2002). Small ruminants account for about 40% of the cash income earned by farm households, 19% of the total value of subsistence food derived from all livestock production, and 25% of total domestic meat consumption (Adane and Girma, 2008).

The level of production and productivity of sheep in the country is generally extremely low, due to several technical (genotype, feeding and animal health), institutional, environmental and infrastructural constraints (Markos, 2006). For instance, the average annual off-take rate and carcass weight per slaughtered animal for the years 2000 to 2007 were about 32.5% and 10kg, respectively, the lowest even among Sub-Saharan African countries (FAO,2009). But indigenous sheep breed has a great potential to contribute more to the livelihood of people in low input, smallholder and pastoral production system.

The dominant sheep production system in Ethiopia is traditional and subsistence. So far, only very limited efforts have been exerted to promote market-oriented sheep production in the country and hence the current income generating capacity of the sector is not at all justifiable. Production system approach, which involves designing an effective and informed breeding programme, is a necessity to bring about improvements sheep production system of the sector. This approach entails proper valuation of both traded and non-traded products and services generated from the system. Information on the economic value of populations, traits and processes would ease the management of animal genetic resources that requires many decisions (Scarpa *et al*., 2003). Proper identification and valuation of the different characteristics of the production systems and animals would make resource allocation decisions among the different livestock improvement interventions for commercialization of the system quite fast and smooth (Kassie, 2007). The objective of this paper is to review indigenous sheep breeds production systems in Ethiopia.

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II. LITERATURE REVIEW

2.1. Socio Economic Importance of Sheep Production in Ethiopia

The importance of small ruminants to the socioeconomic well being of people in developing countries in the tropics in terms of nutrition, income and intangible benefits (i.e., savings, an insurance against emergencies, cultural and ceremonial purposes) cannot be overemphasized. Small ruminants also play a complementary role to other livestock in the utilization of available feed resources and provide one of the practical means of using vast areas of natural grassland in regions where crop production is impractical (Markos *et al*., 2006). Small ruminants are not only advantageous for human being during periods of cyclical and unpredictable food shortages but they are also useful for balancing the energy and protein supply during normal variations occurring over the years as well as between different seasons.

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. They are also a means of risk avoidance during crop failure. Thus, increasing the current level of productivity of sheep is essential to meet the demands of the ever-increasing human population. On the other hand, by improving the productivity of sheep, export earnings as well as the income of the household will be improved. There are however, a number of constraints that affect the productivity of sheep such as mortality, feed scarcity and inadequate indigenous breed utilizations to production. Various scholars from different corners of the world have been advising that the performance of indigenous sheep could be improved through management and there is also potential for genetic improvement through selection.

In all regions, small ruminant contribute significantly to food production and economic output. About 31-38% and 21-33% of the Ethiopian smallholder farmers own sheep and goat (Asfaw and Jabbar, 2008), The livestock sector contributes 30% to 35% of the Ethiopian agriculture GDP, 19% of the total GDP and more than 85% of farm cash income (Benin *et al*.,2002). Small ruminants account for about 40% of the cash income earned by farm households, 19% of the total value of subsistence food derived from all livestock production, and 25% of total domestic meat consumption (Adane and Girma, 2008). The demand and prices for sheep are also increasing locally due to increased urbanization and increased income in the cities. The demand is especially pressing given that the current population of the country is expected to rise to about 129 million by the year 2030 (IBC, 2004).

2.2. Origin and Domestication of Sheep

The domestic sheep is one member of the genus Ovis, and is thought to be descended from the wild mouflon of South-West Asia. Sheep (*Ovis aries*) are quadruped ruminant mammals typically kept as livestock. Like all ruminants, sheep are members of the order Artiodactyla, the even-toed ungulates. Although the name "sheep" applies to many species in the genus Ovis, in everyday usage it almost always refers to *Ovis aries*. Sheep, *Ovis aries*, (Mammalia, Artiodactyla, Bovidae, Caprinae) are a highly versatile and adaptable species. From their domestication in the Fertile Crescent, approximately 11,000 years ago, sheep now span the diverse terrains of each inhabited continent where they are exploited for a variety of uses including the production of food (milk, fat, meat) and clothing (skin, wool) (Dwyer,2008).

African sheep are thought to be of Near-Eastern origin (Epstein 1954, 1971; Ryder, 1984). 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 included fat-tailed sheep entering North Africa via the Isthmus of Suez straits and East Africa via straits of Bab-el-Mandeb (Ryder 1984). Fat-rumped sheep entered East Africa much later (Epstein 1954, 1971; Ryder, 1984). Accordingly, African sheep have been traditionally described and classified based on their tail type (Epstein, 1971; Ryder, 1984). However, the relationship between the traditional classification and genetic variation across currently recognized breeds are unknown. Recently, the study by Solomon (2008) indicated that Ethiopian sheep are classified in to 6 major breed groups and breeds.

2.3. Ethiopia Sheep Breeds/Populations

Ethiopia is believed to be one of the major gateways for domestic sheep migration from Asia to Africa (Devendra and McLeroy, 1982). Ethiopia is a home of most populous and diversified indigenous sheep breeds. Ethiopian sheep breeds have been traditionally classified into four broad categories based on tail type and fiber type: the hairy thin tailed, woolen thin tailed, fat tailed and fat rumped (MoA, 1975). Accordingly, attempts have been made to group some of the indigenous sheep types in to these different categories. Previous studies on Ethiopian sheep limited only on few specific sheep types in the country such as such as Horro, Menz, Afar and Bonga and/or are based on few animals (Galal, 1983; Kassahun, 2000; Solomon, 2002; Sisay, 2002; Zewdu *et al*., 2010; Getachew *et al*.,2010;). Morphologically characterized sheep types in Gamogofa, Sidama-Gedeo, Gurage -Silte, Kembata Tembaro –Hadya and Wolaita zones and very few woredas of SNNPR were undertaken(Abera *et al*., 2013). Molecular characterization of 14 sheep types was also studied by Solomon (2008). However, information on sheep types in some pocket areas of Southern Nation Nationalities and Peoples Region is lacking.

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Table 1. Indigenous sheep types of Ethiopia

Breed group	Breed type	Population	Tail type/shape	Fiber type
Short-fat-tailed	Simien	Simien	Fatty and short	Fleece
		Sekota,Farta, Tikur,Wollo, Menz	Fatty and short	Fleece
Washera	Washera	Washera	Fatty and short	Hair
Thin-tailed	Gumuz	Gumuz	Thin and long	Hair
Long-fat-tailed	Horro	Horro	Fatty and long	Hair
	Arsi	Arsi-Bale, Adilo	Fatty and long	Hair
Bonga	Bonga	Bonga	Fatty and long	Hair
Fat-rumped sheep	Afar	Afar	Fat rump/fat tail	Hair
	BHS	BHS	Fat rump/tiny tail	Hair

Source: Solomon (2008) BHS = Blackhead Somali;

2.4. Sheep Production System in Ethiopia

The choice of farmers/pastoralists of agricultural enterprises in Ethiopia depends on the production environment (availability of resources, particularly land, water and climate), long-standing tradition of agricultural production in the community, socio-economic circumstances (awareness and skill, access to inputs and markets), and government support (inputs and services) which stems from agricultural policies. In subsistence-oriented traditional production system, goats and sheep are important because they require low initial capital and maintenance costs, are able to use marginal land and crop residues, produce milk and meat in readily usable quantities, and are easily cared for by most family members. Furthermore, they are important in feeding the rapidly expanding population of the developing world under typical harsh environmental conditions (Markos *et al*., 2006).

Ethiopia is one of the countries that have predominantly traditional sheep production system. The major sheep production systems in Ethiopia include the traditional sheep production system, which consists mixed crop- livestock systems, and pastoral and agro-pastoral system and the government ranches for breeding and multiplication centers, characterized by different production goals and priorities, management strategies and practices, and constraints (Markos, 2006).

The sheep production systems of Ethiopia are classified into five based on degree of integration with crop production and contribution to livelihood, level of input and intensity of production, agro-ecology, length of growing period and relation to land and type of commodity to be produced (Solomon *et al*., 2008).

2.4.1. Highland sheep-barley system

This production system prevails in the high altitude areas (above 3000 m.a.s.l.) where the major crops grown are barley and pulses such as faba beans, lentils, etc. Sheep are the dominant livestock species. The main feed resource-base includes wasteland grazing, stubble and sometimes straw. Sheep flock sizes range from 30 to several hundred head. Although sheep are reared mainly for meat but skins and coarse wool production for the cottage industry of the central highlands are subsidiary products (Solomon *et al*., 2008).

2.4.2. Mixed crop-livestock production system

This system is predominantly found in highland agro-ecological zones where the climatic factors are conducive for farming of crops and raising livestock. This system is generally found in areas where the altitude ranges between 1500 and 3000 m.a.s.l. The area has adequate rainfall and moderate temperature and is thus suitable for grain production. In this production system, livestock and crops are maintained as complementary enterprises. The average land size per household is often less than two hectares (Solomon *et al*., 2008). Within the mixed crop-livestock system, small ruminant production systems are found associated with the different agricultural production systems which vary in potentials, intensity of the mixed farming operation, natural resources base including grazing and livestock resources. Furthermore, in highland agro–ecology, as in central Ethiopia, increased human population has led to decreased farm size and a gradual shift from keeping large to small ruminants, mainly goat and sheep (Peacock, 2005).

2.4.3. Pastoral and agro-pastoral systems

Pastoral and agro-pastoral systems are found in the lowlands are characterized by extensive production based largely on the rangeland (Tembely, 1998; EARO, 2000). Small ruminant production is associated with the purely livestock based nomadic and transhumance pastoral production systems based largely on range, primarily using natural vegetation. In the lowlands of Ethiopia, livestock is comprised of large flocks and herds of sheep and goats, cattle and camels mainly transhumant's, 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 (Tembely, 1998; EARO, 2000).

2.4.4. Ranching system

Ranching system is a range-based system of livestock production similar to the pastoral systems but with different production parameters, livestock functions and management. The system can be considered as a modern land use system. The main function of this system is to generate cash income. Both highland and arid/semi-arid ranching can be undertaken in Ethiopia (Solomon *et al*., 2008).

2.4.5. Urban and peri-urban production systems

Urban and peri-urban production systems involve the production of sheep and goats within and at the periphery of cities. In this system the feed resource of livestock are usually household wastes, market area wastes, mill leftovers, by-products and roadside grazing. Currently, small-scale sheep and goat fattening is emerging as an economic activity in many growing cities (Solomon *et al*., 2008).

2.5. Flock Demography, Size and Ownership Pattern

Flock structure or flock composition is the proportion of the flock which is formed by different age and sex classes. This is determined by flock owner 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 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). For example, in Konta special Woreda of SNNPR sheep flock consisted of breeding ewes, castrates, ram lambs, rams, ewe lambs, ewes, breeding rams account for about 20.2, 18.6, 16 13.1, 12.1,10.4 and 9.3% respectively (Amelmal, 2011) of the flock while On the other hand, 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.

Under farmers management condition both breeding ram and ewe graze together throughout the year with all age class of sheep and in most cases with other species of livestock (Abebe, 1999; Aden, 2003). Report on male to female ratio of different studies range from 1:5.21 to 1:29 (Niftalem, 1990; Abebe, 1999; Aden, 2003; Solomon, 2007; Tesfaye, 2008; Dejen, 2010).

2.6. Reproductive Performance

Reproduction is the process by which animals produce offspring for the purpose of continuing the species. It is a series of events comprising of gamete production, fertilization, and gestation, reproductive behavior, calving, lambing and kidding. Reproduction is one of the most important considerations determining the profitability of livestock production, whether one is talking about dairy or beef animals. Good reproductive performance is a prerequisite for any successful livestock production programme. In any livestock production system, high reproductive performance is a very important attribute and a major component of the overall production efficiency. Reproductive performances like age at first lambing, lambing interval, litter size and annual reproduction rate of the breed are the most important traits of sheep production.

2.6.1. Age at first lambing

Age at first lambing is the age at which a breeding ewe-lamb could give her first birth. It is a function of puberty, age at first breeding and conception and successful completeness of pregnancy. The age affected by genotype or breed, nutrition, season and other environmental factors (e.g., climate) affects the age at first lambing (Habib, 1998), which in turn affects the total number of lambs a ewe produces in her lifetime. Age at first lambing of some of Ethiopian sheep breeds are summarized in Table 2.The type of birth of the ewe significantly affects the age at which the ewe first lambed. Lambs in multiple litter attained age at first lambing later than single born contemporaries (Wilson and Murayi, 1988). Maternal parity also significantly affects the age at first parturition. Offspring of young and old ewes mature later than those from dams in the intermediate age groups.

Table 2. Age at first lambing (AFL) for some Ethiopia sheep breeds/types

Breed/type	AFL (months)	Management system	Source
Gumuz	13.67	On-farm	Solomon (2007)
Menz	15-22	On-farm	Abebe (1999)
Washera	15.46	On-farm	Mengiste (2008)
Blackhead Ogaden	19.36±3.75	On-farm	Abraham (2013)
Bonga	15±3.1	On-farm	Zewdu(2008)
Horro	13.3 ± 1.7	On-farm	Zewdu(2008)
Afar	13.5	On-farm	Tesfaye (2008)
Dawuro sheep	13.8	On-farm	Amelmal (2011)
Adilo	14.6	On-farm	Getahun(2008)
Arsi-bale	12.7	On-farm	Tsedeke(2007)

2.6.2. Lambing interval

Lambing interval (LI) refers to the number of days between successive parturitions. It is one of the major components of reproductive performance that has an important influence on a sheep production enterprise. LI affected by the breed, season and year of parturition, the parity of the ewes, and post partum weight of the dam (Devandra and McLeroy, 1982). Shorter lambing interval is desirable if the fertility (regular production of viable offspring) and productivity of the flock is to be maintained. Wilson and Durkin (1984) reported a longer lambing interval on the station flocks of African long fat-tailed sheep in Rwanda than most of the intervals from African traditional systems where no practices to control breeding were employed. Mukasa-Mugerwa and Lahlou-Kassi (1995) reported that lambing interval of local sheep from field studies are highly variable and ranged from 223 to 336 and the variability is attributed due to the effect of season, parity, management and genotype**.**

2.6.3. Litter size

The combination of ovulation rate and embryo survival, number of lambs or kids born per parturition is the litter size. It is largely influenced by ovulation rate and is a major determinant of ewe reproductive efficiency. Ovulation rate varies between breeds of sheep; increase with age of ewe up to six years, and is greater for seasonally breeding ewes in the first half of the breeding season(Hafez, 1974) It is also affected by age (parity), season and to a large extent ewe body weight at mating which itself modulated by nutrition. Parity had a significant effect on litter size. Litter size increases with increase age of the dam up to about five years or fourth parity, and decreases slightly thereafter (Wilson and Durkin, 1984).

Table 3. Average litter sizes of some Ethiopian sheep

Breed	Litter size	Management system	Source
Gumuz	1.17	On-farm	Solomon (2007)
Bonga	1.4	On-farm	Belete(2009)
Adilo	1.42	On-farm	Getahun(2008)
Menz	1.03	On-farm	Abebe (1999)
Washera	1.11	On-farm	Mengistie (2008)
Arsi-bale((Alaba)	1.7	Traditional	Tsedeke (2007)
Arsi-bale((Alaba)	1.52	On-farm	Deribe(2009)

2.6.4. Annual reproductive rate

Annual reproductive rate is defined as litter size times 365 days divided by lambing interval in days. It is used to measure flock fertility and reflects the total number of lambs weaned per ewe reproductive age per year (Mukasa-Mugerwa and Lahlou-Kassi, 1995). The annual reproduction rate is also a convenient measure for direct comparison of reproductive output in the different African systems, especially in the traditional ones where breeding is completely uncontrolled and where the number of females " joined " or mated is not exactly known. ARR influenced by litter size, lamb mortality and lambing interval in years. According (Niftalem, 1990) annual reproductive rate of Menz sheep was highest when the ewes lambed during the small rainy season and lowest when lambing occurred during the dry season. This was due to the fact that ewes that lambed during dry season had longer subsequent lambing interval than those born during rainy season.

2.7. Growth Performance

The growth performance of sheep is also influenced by age of the dam/parity, pre-mating weight of the dam, type of birth, sex, the season and month of birth. Birth weight is an indicator of the size and vigor of the lamb at the beginning of postnatal development and an important factor influencing later growth. Birth weight which itself is affected by dam size, dam body condition and litter size influences the survival rate and pre-weaning growth performance of the off springs. Birth type and sex are sources of variation in lamb pre-weaning growth rate. Lambs which are heavier at birth are usually singles or are those produced by ewes with larger body sizes and good feeding conditions. The indication is that lambs heavier at birth have larger adult weight and higher growth capacity (Kassahun, 2000).

Weaning weight is a trait of great economic importance in meat sheep production since it has influence on growth rate and survival. Weaning weight and post-weaning growth rate of lambs is as important as the pre-weaning growth performances, mainly when the objective is producing meat through lamb production. Weaning weight influenced by season of birth, sex of lamb and type of birth (Kassahun, 2000; Gbangboche *et al*., 2006); ram lambs and single-born ones were heavier than their counterparts. Parity and postpartum ewe body weight had significantly influenced weaning weight; dams with higher parity and heavier postpartum weight produced heavier lambs at weaning (Gbangboche *et al*., 2006).

III. CONCLUSION AND RECOMMENDATION

Indigenous sheep breed are the most important livestock species which have been adapted to a range of environments extending from the cool alpine climate of the mountains to the hot and arid pastoral areas of the lowlands. It play an important economic role and make a significant contribution to both domestic and export markets through provision of food (meat and milk) and non-food (manure, skin and wool) products. However, indigenous sheep production is constrained by various factors in Ethiopia that needs to be addressed by systematically describing and characterizing the production systems to prioritize and design appropriate interventions technologies (research and development) through the involvement of stakeholders to address the challenges. The production system of indigenous sheep breeds in Ethiopia is extensive with little market orientation (producers do not target the market or lack of focus on consumer preference). Thus, effort should be geared to transform the system into market oriented system using value chain framework (involvement of stakeholders.

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