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A Review on Evaluation of Productive and Reproductive Performance and Major Constraints of Indigenous Sheep: An Ethiopian Perspective

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Abstract
The objective of this paper is to evaluate the productive and reproductive performance and major constraints of indigenous sheep in Ethiopian perspective. Ethiopia is home for at least 9 breeds and 14 traditional sheep populations. Sheep are the second most important species of livestock next to cattle in Ethiopia. The productivity of sheep mostly based on the reproductive performance of sheep. The age at first sexual maturity may be affected by weaning season and post weaning nutrition and thus through good management age at first sexual maturity could be substantially improved. Arsi Bale and Horro sheep have short lambing interval from other indigenous sheep. Litter size of Ethiopian sheep breeds like Menz and Afar sheep breeds is low (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. Ethiopian indigenous sheep are characterized by slow growth, late maturity and low production performances. Feed shortages, both in quality and quantity, high prevalence of diseases and parasites, shortage of water; lacks of markets are the major constraints sheep production in Ethiopia. As the conclusion reproductive performances like litter size, age at first lambing and lambing interval are important traits of sheep production. Ethiopian indigenous sheep are characterized by slow growth, late maturity and low production performances. Therefore, on farm performance evaluation of sheep is required to understand effect of seasons and year on productive and reproductive of small ruminants.
Keywords: Constraint; indigenous sheep; productive; reproductive; performance
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Introduction

Genetic diversity provides the raw material for breed improvement and for the adaptation of livestock populations to changing environments and changing demands. Information on the origin and history of animal genetic resources (AnGR) is essential to the design of strategies for their sustainable management [1, 2].

Ethiopia is the 2nd largest country next to Nigeria from Africa by sheep population. Ethiopia is home for at least 9 breeds and 14 traditional sheep populations [3] The country has a diverse sheep population of about 14 sheep types in four major groups, i.e. sub-alpine short fat-tailed, highland long fat-tailed, lowland fat-rumped/tailed and lowland thin-tailed [4, 5].

In Ethiopia, in spite of the large population of sheep and the great role of sheep both to the livelihood of resource-poor farmers and the national economy at large; the current level of on farm productivity in the smallholder production systems is low [6]. Their productivity is constrained by various complex factors involving biological and environmental aspects as well as socioeconomic factors.

Males and females play different reproductive roles, and in most animal species, the role of females is not completed until a viable offspring is produced. Even after birth, females play a significant role in the provision of post-natal care and, in mammals, must lactate to provide nourishment for their young. Understanding basic anatomy and reproductive physiology of sheep is important in implementing appropriate reproductive management [7]. Sheep production and productivity in the country is constrained by feed shortages, diseases, poor infrastructure, lack of market information and technical capacity, and an absence of planned breeding programs and breeding policies [8]. The aim of this paper is to review productive and reproductive performance and major constraints of indigenous sheep in Ethiopia.

Distribution of Sheep In Ethiopia

Sheep Breed Classification in Ethiopia

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, six sheep breeds are available in the country. Ethiopian indigenous sheep distribution is presented in Figure 1.

Table 1.Ethiopian sheep classification

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

Source: [4]

These falls into three breed groups: the fat-tailed hair sheep, the fat-tailed coarse wool sheep and the fat-rump hair sheep. The study of (Abegaz, 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.

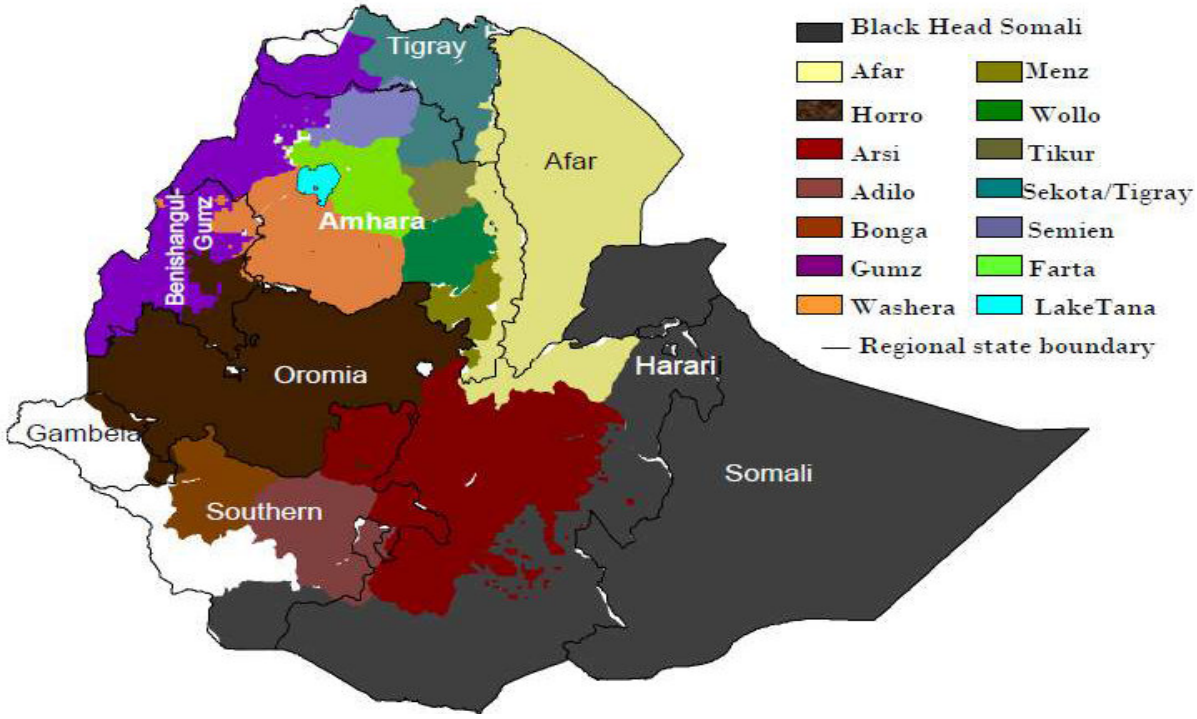

Figure 1. Ethiopian sheep distribution [4]

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

Productive and Reproductive Performance of Indigenous Sheep

Reproductive Performance

Good reproductive performance is a prerequisite for any successful genetic improvement and it determines production efficiency of the flock as a whole. Where farm resources are severely limited, as it is often the case in SSA (sub - Sahara Africa), reproduction failure is the first sign of decreased productivity. Poor reproductive performances of Ethiopian sheep can be associated with genetic factors, poor management, seasonal fluctuations in feed resources and diseases [9]. Different studies have suggested that differences that exist in reproductive performances between the indigenous sheep breeds and their variation allow for the selection of suitable breeds/types for a given environment. Reproductive performance depends on various factors including age at first lambing, litter size, lambing interval and the life time productivity of the ewe. However, it is influenced more by environmental factors such as nutrition, management and climate rather than genetic factors [10]. Reproductive performances like litter size, age at first lambing and lambing interval are important traits of sheep

production. Such traits are more related to most of the economically important traits. Some Ethiopian reproductive performance is presented in Table 2.

Age at puberty

Puberty is generally defined as the point of sexual development at which the animal becomes capable of reproduction (first ovulation in the female and first spermatozoa in the ejaculate of the male), but animals are not yet fully sexually mature at this stage. Sexual maturity is the time when the animal expresses its full reproductive capacity. In both the male and female sheep, puberty may often be reached without adequate physical growth to support reproduction, and in females the first ovulation may not necessarily coincide with first estrus. The age at first sexual maturity may be affected by weaning season and post weaning nutrition and thus through good management age at first sexual maturity could be substantially improved [11].

In males, puberty is the time when complete separation of the prepuce and the penis occurs and motile spermatozoa are first detected in the ejaculate. In immature rams, the penis has adhesions that prevent it from being fully extended. At puberty, these adhesions dissolve under the influence of testosterone and the penis can be fully extended. This may occur as early as 5 months. However, full reproductive competence may not occur until 15 months of age. Spermatogenesis has been found to begin as early as 84 days of age, with spermatozoa present in the epididymis at 140 days of age. Several factors such as nutrition, body weight and breed, season of birth and growth rate are known to influence the age at puberty. Nutrition is among the most significant factors influencing reproductive development and the onset of puberty. Complete separation of males and females during the early growth period may delay the onset of puberty [7].

Age at first lambing

Age at first lambing can be defined as the age at which ewes give birth for the first time. It is a function of puberty, age at first breeding and conception and successful completeness of pregnancy. In small ruminants, AFP is an economically important trait because it determines rate of genetic progress and population turnover rate. According to [12] average age at first lambing of Bonga and Horro sheep were 14.9 months and 13.3 months, respectively. Total lifetime production (life time lamb crop) can be increased by encouraging first lambing at an early age. Age at first lambing is based on breed; husbandry and management practices and it has wide variation among African sheep. In most traditional systems, first lambing occurs at 450-540 days when ewe weights are 80-85 percent of mature size and different report deals the age of ewes for first lambing is in between this range (450-540 days).

The majority of studies report the age of first lambing for Ethiopian sheep within the range of 411-475 days. Ewes under village management conditions in southwestern Ethiopia, demonstrated a mean age of 404 days at first lambing [13]. The same pattern was found for Afar sheep under pastoral management [8].

As reported [14] 12.7 months for lambing months in Alaba southern Ethiopia. [13] reported an average age at first lambing (AFL) of 12.4 months in Gamo Goffa Zone, Southern Ethiopia. [16] reported average AFL of 18.10 months at eastern Amhara region. The average age of sexual maturity 7.1 months reported by [5] for Afar rams. As reported [18] age at sexual maturity 8.42 and 8.8 months for ram in HL and ML of Tigray region, respectively. Age at puberty of male and female 7.5 and 7.1 month for Bonga sheep 9.3 and 7.8 month for Horro sheep reported by [12].

Lambing interval

Lambing interval is the interval between two consecutive parturitions that determines reproductive efficiency in sheep production [11]. It has three phases: the gestation period, the postpartum anoestrus period and the service interval. Lambing interval is one of the main components of reproductive performance which is affected by season [19], year of lambing, parity of ewes, post-partum body weight and management practice, nutrition, type of mating and restrictions on breeding also prolong the interval between lambing.

Table 2. Some Ethiopian indigenous sheep reproductive performance

Breed	Reproductive traits						Sources
	AFP		AFL	LI	LS	RLS	
	Male	Female					
Adilo	NA	NA	14.6	NA	1.42	NA	[20]
Afar	7.10	NA	13.52	9.02	5.49	NA	[17]
Arsi	NA	NA	12.7	7.8	1.7	NA	[20]
Bale							
BHS	13.65	17.97	23.6	10.46	1.04	9.12	[21]
Bonga	7.51	9.3	14.9	8.9	1.4	7.4	[12, 20]
Farta	NA	NA	13.66	9.4	NA	NA	[20]
Gumz	NA	NA	13.67	6.64	1.17	8.5	[22]
Horro	7.1	7.8	13.3	7.8	1.57	7.5	[12, 23]
Menz	10.47	10	15.67	8.50	1.04	NA	[5, 24]
Washera	NA	NA	15.46	9.04	1.11	NA	[19]
Wollo	NA	NA	21.2	9.2	NA	NA	[17]

AFP = Age at first puberty, AFL = Aga at first lambing, LI = Lambing interval, LS = Lambing size and RLS = Reproductive life Span

In condition of good management adequate nutrition lambing interval of 8 months can be achieved in other words it can be possible to attain three lambing from indigenous sheep in two years. According to [46] in association with the above thought Gumuz breed had an average lambing interval of 6.64 months so the breed can produce three lambing in two years even under the traditional management system but the work of [12] indicates that lambing interval of around 8.9 month for Bonga ewes and 7.8 month for Horro ewes. Among other breeds of sheep in Ethiopia that had short lambing interval are Menz (8 and half month) and Afar sheep (9 month) [5].The overall least-squares mean survival rate of Washera sheep from birth to one month was 93 percent, at three months it was 86 percent, at six months it was 78 percent, at nine months it was 72 percent, and at 12 months it was 67 percent [25].

Lambing interval is the interval between two parturitions that determines reproductive efficiency in small ruminant production. At least three times lambing is expected per two years under normal circumstances [7]. To attain this lambing interval should not exceed 8 months (245 days). There are reports on the possibility of attaining three parturitions from indigenous small ruminants in two years [26]; 9.16 month for Washera sheep [19] and 7.34 month [15].

Litter size

Prolificacy or litter size is defined as the number of progenies born per parturition. Prolificacy or litter size (LS) is largely determined by ovulation rate but is also modified by fertilization rate and embryonic and fetal losses. 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 (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 [5, 19] reported low twining rate of both Menz and Afar sheep breeds.

According to [12] a twining rate of 39.9 % or litter size of 1.40 and 36 % or litter size of 1.36 were obtained for Horro and Bonga sheep breeds, respectively and the two breeds showed relatively better multiple births under the existing feed shortages. Under traditional management conditions the percentage of twining rate or number of lambs per lambing in some breeds tends to fall below 10 percent.

Litter size is influenced by genotype, parity, season, and ewe body weight at mating [27]. For Horro sheep, litter size increased with parity from 1.26 in primiparous ewes to 1.44 for ewes of parities five and above. With respect to weight of ewes at mating, litter size increased by 2.5 percent for each kilogram increase in weight [46]. The management system is also a major source of variation in litter size as reported by [25]; this is indeed the case of Washera sheep for which performances were significantly higher under farm management in comparison to on-station.

Litter size varies between 1.08 and 1.75 with the average of 1.38 for tropical breeds [7]. Liter size of Ethiopian sheep breeds like Menz and Afar sheep breeds is low [28] which is almost close to one lamb per lambing. The LS reported for Horro ewes ranged from 1.29 – 1.57 and 1.13 for Bonga sheep. Reported [29] that Washera sheep breed is large in body size and also prolific. The authors reported a litter size of about 1.11 for the breed.

Reproductive life span

Long reproductive life span (RLS) 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 [12]. According to [3] 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.

Productive Performance

The productivity of sheep mostly based on the reproductive performance of sheep. To obtain meat, milk and fiber the existence of birth and survival is necessity [5]. The demand from both domestic and export markets for small ruminant products especially mutton, is increasing in Ethiopia [30]. The productivity of indigenous sheep is currently too low to meet this demand. Ethiopian indigenous sheep are characterized by slow growth, late maturity and low production performances. Appearance of rams, which most of the owners associated with high carcass output and premium price across all the production systems, includes wide chest, conformation and long body size [31]. Report showed [29] that the overall appearance of sheep is an important economic trait that influences value, particularly in the traditional markets of Ethiopia. While coat color was an important selection criterion, its index varied with satisfaction of producers in the production system.

Growth performances of sheep

Growth is an important trait for meat production which determines the overall productivity of the flock and the economic return from small ruminants' enterprises. Growth rate of lambs particularly during the early stages of growth, is strongly influenced by breed (genotype), milk yield of the ewe, the environment under which the animals are maintained including the availability of adequate feed supply in terms of both quantity and quality [19, 32]. Parity, pre-mating weight of the dam, type of birth, sex, season and month of birth also contributes for growth performances of small ruminants.

Birth weight and pre-weaning growth performances

Birth weight of animals is one of the most important factors influencing the pre-weaning growth of the young and has a positive correlation between birth weight and subsequent live body weight development [32]. Birth type and sex are sources of variation in lamb pre-weaning growth rate [33]. 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 [32 and 33]. Parity can also affect pre-weaning growth rate, from birth to 30 days of age. Lambs from second and third parity dams grew better than first and fifth parities [6, 32 and 33]. Genotype showed significant difference on birth weight of lambs'. Growth performances of lambs under different conditions are compiled on Table 3.

Weaning (90-day) weight and pre-weaning Average Daily Gain (ADG)

Weaning weight is a trait of great economic importance in meat sheep production since it has influence on growth rate and survival [33] Different values of weaning weight were reported by different authors. Thus, 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. Seasonal variation in growth rate is observed in tropics because feed supply varies remarkably [32]. Because of weaning shock, lower growth rate was observed at weaning time [33].

Significant effect of season on post-weaning weight was reported on lamb's growth ([6 and 33] while there was non-significant effect of sex and birth type [33]. Other studies found the significant influence of type of birth [34] and sex [6, 32] on post-weaning growth rate. The literature assessed on birth weight, weaning weight, pre-weaning Average Daily Gain (ADG) is presented in Table 3.

Table 3. BWT, WWT and ADG of Ethiopian sheep under different management conditions

Breed	Management Type	BWT (Kg)	WWT (Kg)	ADG (gm/day)	Sources
Adilo	Traditional	2.29	11.18	98.77	[26]
Arsi Bale	Traditional	2.89	12.23	102.01	[26]
Bonga	Traditional	2.86	11.60	NA	[35]
Horro	On station	2.40	9.48	78	[6]
Horro	On station	2.60	12.00	100.4	[22]
Menz	On station	2.06	8.64	72.6	[6]
Menz	Traditional	2.90	14.38	105	[39]
Menz	On station	2.50	9.50	78	[40]
Washera	Traditional	2.70	11.90	59.1	[33]

BWT = birth weight, WWT = weaning weight and ADG = average daily gain

Survival (Mortality) rate of sheep

Pre-weaning mortality of some Ethiopian indigenous sheep is presented on Table 4. Reproductive losses during pre-weaning period due to poor milking ability of dam, poor management and pneumonia are very high. As assessed from literature results compiled in Table 4, lamb losses before one year of age vary from 6.4 % to 45%. This could be a major influencing factor of productivity of a flock [22, 27 and 32]. Lamb mortality rate varies from one flock to another depending mostly on management level [32].

Slow growth rate associated with mortality has been limiting factors for profitability of the indigenous sheep breeds. More than half of the causes of mortality were similar and attributed to pneumonia as reported from the study on Horro and Menz sheep of Ethiopian highlands [9]; [6]. The same author reported that coughing (23.8%) and diarrhea (23.5%) are among the major clinical signs for mortality of sheep. Similar report [35] also reported for Bonga sheep of south western Ethiopia.

Table 4. Pre-weaning mortality of some Ethiopian indigenous sheep under different management conditions

Breed	Management type	Pre weaning mortality rate (%)	Sources
Adilo	Traditional	19.5	[26]
Arsi Bale	Traditional	20	[26]
Arsi Bale	Traditional	28.4	[14]
Bonga	Traditional	20.87	[35]
Horro	On station	25.3	[6]
Horro	On station	24.3	[32]
Menz	On station	8.8	[6]
Menz	On station	10.6	[32]
Washera	Traditional	6.4	[19]

Birhan and Van Arendonk (2006) reported significant age and seasonal effect on mortality rate. Mortality rate was higher for lambs born in dry season, compared to those born in the wet season. There is a paucity of information on genetic variability for growth rate and mortality in indigenous sheep breeds of Ethiopia.

Age at weaning

As reported [14] weaning age 4 months for lambs in Alaba, Southern Ethiopia. According to[12] in western and south-western Ethiopia reported that the overall average weaning ages for both sexes and breeds of indigenous sheep was 4.80 months, within a range of 1 to 9 months. According to reported [18] 4.4 for lambs in high and midland of Tigray region.

SHEEP PRODUCTION CONSTRAINTS

In mixed crop-livestock systems, relatively high inbreeding coefficient because of uncontrolled mating and absence of sharing communal land for communal herding might potentially increase the risk unless appropriate measure is taken [12]. Flock management in groups due to resource endowment, parity, litter size, and season (due to seasonal fluctuations in both quantity and quality of feed) were important factors that need to be considered in the improvement plan of sheep.

Feed shortage

Lack of adequate feed resources as the main constraint to animal production was more pronounced in the mixed crop-livestock systems, where most of the cultivated areas and high human population are located [36]. Many authors described the seasonal feed shortages, both in quality and quantity, and the associated reduction in livestock productivity in different parts of the country [26, 37 and 38].

Health constraints

Another serious constraint for sheep production in Ethiopia has been the high prevalence of diseases and parasites. This causes high mortality amongst lambs, diminishing the benefits of their high reproductive performance [6]. Animals with good adaptive potential are needed in these stressful environments to sustain the livelihoods of the communities [12, 28, 29, and 31].

Water shortage

Water shortage is a limiting factor in most lowland areas and to a limited extent in mid altitudes. In eastern, north-eastern and south-eastern part of the country there is also critical shortage of water; however, there are breeds adapted to lowland agro ecologies through their physiological adaptation mechanisms [35]. Long distance travel of sheep in searching of water was another problem [38].

Marketing constraints

The major problems in traditional management system were that the system is not market oriented, underdeveloped marketing and infrastructure system, and poor financial facility, etc. [41 and 42]. The role of brokers in marketing sheep has two views; one group describes them favorably as they facilitate transaction between buyers and sellers while others see them as problems in marketing as they are the ones who mainly decide the price [14, 43,44 and 45].

Conclusion

Based on this review conclude that good reproductive performance is a prerequisite for any successful genetic improvement and it determines production efficiency of the flock as a whole. Poor reproductive performances of Ethiopian sheep can be associated with genetic factors, poor management, and seasonal fluctuations in feed resources and diseases prevalence. Reproductive performances like litter size, age at first lambing and lambing interval are important traits of sheep production. From Ethiopian indigenous sheep population Afar, Bonga and Horro sheep are sexually matured at early age. Arsi Bale and Horro sheep have short lambing interval from other indigenous sheep. Ethiopian indigenous sheep are characterized by slow growth, late maturity and low production performances.

Seasonal feed shortages, both in quality and quantity, prevalence of diseases and parasites, shortage of water especially in eastern, north-eastern and south-eastern part of the country there is also critical shortage of water; however, there are breeds adapted to lowland agro ecologies through their physiological adaptation mechanisms and lack of market information are the major sheep production constraints.

Therefore, it should be important to increasing the study of different breeds will help unlock more information on the productive and reproductive potential of indigenous sheep, which are widely distributed in the different agro-ecological areas throughout the country.

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