

Production Performance, Consequence and Constraints of Small Ruminants in Ethiopia: A Review

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Abstract

Livestock are an integral part of agriculture that contribute to 35 to 49% of the agricultural GDP, 37 to 87% of the household incomes, and 15 to 17% of the foreign exchange earnings of the country. There are about 33.02 million heads of sheep and 38.96 million heads of goats' population in Ethiopia. They are important components of the livestock subsector and are sources of cash income, milk, meat, wool, manure, and saving or risk mitigation during crop failures, property security, monetary saving and investment in addition to many other socioeconomic and cultural functions. Despite their large number, the reproductive, as well as productive traits of small ruminant are affected by several factors including breed, a season of conception, interval between parturitions, age, sex and health and nutritional status of the individual animal. Therefore, this paper is to review of concerned issue on reproductive and productive performances, consequence and constraints of small ruminants in Ethiopia.

Keywords: Lambing, Kidding, Productive, Reproductive, Small ruminant.

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1. Introduction

Agriculture is the base of Ethiopia's economy, accounting for 45 to 50% of its GDP (AGP, 2013). Livestock are an integral part of agriculture that contribute to 35 to 49% of the agricultural GDP, 37 to 87% of the household incomes, and 15 to 17% of the foreign exchange earnings of the country (Endalew and Ayalew, 2016). Livestock are playing a vital role in generating income to farmers, creating job opportunities, ensuring food security, providing different services, contributing to the asset, social, cultural, and environmental values, and sustaining livelihood strategies of peoples (Adem, 2019).

There are about 33.02 million heads of sheep and 38.96 million heads of goats' population in Ethiopia (CSA, 2019). They are important components of the livestock subsector and are sources of cash income, milk, meat, wool, manure, and saving or risk mitigation during crop failures, property security, monetary saving and investment in addition to many other socioeconomic and cultural functions (Umata *et al.*, 2011; Gobena, 2016; Abraham *et al.*, 2017; Hagos *et al.*, 2018b; Nwogwugwu *et al.*, 2018). Their productions are contributing significantly to the national and household economy in many countries.

In Ethiopia, small ruminants account for 40% of cash income earned by farm households and 25% of total domestic meat consumption (Merkel and Yami, 2008). Based on annual off-take rates of 31.1% for sheep and 35.4% for goats, the potential production is estimated at 8.70 million sheepskins and 8.10 million goat skins (FAO, 2011). Additionally, the increase in international demand for meat in general and the high demand for sheep and goat meat in the Middle East are another incentive for sheep and goat production in the country (Hassen *et al.*, 2013). This has created an opportunity for sheep and goat producers to sell more animals at better prices (Legese *et al.*, 2014). Farmers and pastoralists depend on small ruminants for much of their livelihood, often to a greater extent than cattle, because small ruminants are generally owned by the poorer sectors of the community as reviewed by Gizaw *et al.* (2013).

Despite their large number, 72 million heads of small ruminants having an enormous contribution to the national economy, their production and productivity are low (CSA, 2019). Also, small ruminant production is not well developed due to constraints such as a shortage of water, high prevalence of diseases, parasites, lack of genetic improvement, lack of market access and information (Abebe *et al.*, 2010; Abebe, 2018; Eshetu *et al.*, 2018). Other workers also suggested that feed shortage, inadequate veterinary services, and lack of capital are the main constraints of small ruminant production (Dhaba *et al.*, 2012; Tesfay, 2018; Etalema and Abera, 2018). Additionally, the genetic improvement of small ruminants could contribute to bridging the productivity gap (Haile *et al.*, 2019). Therefore, the objective of this paper is to review on reproductive and productive performances, consequence and constraints of small ruminants in Ethiopia

2. Literature Review

2.1. Genetic Diversity and Distribution of Small Ruminants in Ethiopia

Domestic sheep (*Ovis aries*) and goats (*Capra hircus*) were the first ruminants to be domesticated in southwestern Asia (Iran and Iraq) between 10,000 and 6,000 BC and distributed to various ecological niches of

the world (Kassahun, 2004). Ethiopia is a home for diverse indigenous sheep and goat populations. Sheep in Ethiopia are adapted to a wide range of environments, including extreme habitats (Edea *et al.*, 2017). Small ruminants maintained virtually under the traditional subsistence-oriented management systems constitute an important livestock component in all ecological zones and agricultural systems in the country.

The indigenous small ruminant genetic resources of Ethiopia have high within breed genetic variations and desirable characteristics (Kebede *et al.*, 2012b). The genetic diversity exists between and within breeds which can provide the raw materials for breed improvements and for the adaptation of the populations to changing environments and changing demands (FAO, 2015). As reported by Gizaw *et al.* (2010), some communities attach special cultural values to their sheep and exclude the use of breeding stock from other populations, resulting in a cultural barrier to gene flow.

2.2. Reproductive performance of small ruminants in Ethiopia

Reproductive performance is a prerequisite for any successful livestock production program. Poor reproductive performances of Ethiopian small ruminants can be associated with genetic factors, poor management, seasonal fluctuations in feed resources, and diseases (Mukasa-Mugerwa *et al.*, 2002; Abebe *et al.*, 2013; Ashebir *et al.*, 2016; Haile *et al.*, 2019). The reproductive, as well as productive traits, are affected by several factors including breed, a season of conception, interval between parturitions, age, sex and health and nutritional status of the individual animal (Salem, 2010; Etalema and Abera, 2018; Joshi *et al.*, 2018; Welay *et al.*, 2018).

2.2.1. Age of buck and ram at first service

Age of buck and ram at first service is the age at which ram and buck are sexually matured. The average age at sexual maturity of ram is 7.07 months in Bensa district of Southern Ethiopia (Kenfo *et al.*, 2018). As reported by Neme (2016) in the West Shoa Zone, age at first service was 8.39 months for goats and 8.91 months for sheep. Age at sexual maturity for Afar ram is 7.10 months under pastoral management (Gizaw *et al.*, 2013). The average age at first service of the buck in Dire Dawa Administration was 9.88 months reported by (Eshetu *et al.*, 2018). The average age at first service (mating) in Metema Woreda of male goats was 7.40 months (Tsegaye, 2009).

2.2.2. Age at first kidding and lambing

Ages at first kidding/lambing and kidding and lambing interval are economically important reproductive traits. They are an indication of the overall flock productivity. Age at first kidding is an important indicator of sexual maturity and lifetime productivity in does, the earlier the doe starts to kid the more the productive life of the animal (Deribe and Mengiste, 2014). Lifetime production can be increased by decreasing age at first kidding (Zewde and Welday, 2015). On average, age at first lambing for most of the indigenous sheep in Ethiopia is between 11.0 and 16.0 months and most sheep breeds tend to have their first offspring before they are two years old (Ayele and Urge, 2018).

Ali and Bushara (2010) stated that supplementation promoted early puberty of the female kids (5.77 months) as compared to the non-supplemented group (6.93 months). Similarly, supplemented ewe lambs reached puberty at a younger age (6.22 months) than the controlled group (8.43 months) (Zohara *et al.*, 2014). The AFL was 14.29 months for sheep and AFK was 13.85 months for goats in West Shoa Zone (Neme, 2016). Hailemariam *et al.* (2013) reported an average AFL was 12.4 months in Gamo Gofa Zone, Southern Ethiopia. Age at first parturition of Arsi-Bale breeds was 12.7 months for sheep and 12.1 months for goats in Alaba districts (Kocho, 2007). Age at first parturition of small ruminants was 12.4 and 11.9 months, respectively in Alaba districts (Gemiyu, 2009). Arsi-Bale goats give their first kids at age of about 12 months in the traditional management system (Woldu *et al.*, 2004).

2.2.3. Kidding and lambing intervals

Kidding interval (KI) and Lambing intervals are the numbers of days between successive kidding and Lambing. Besheer *et al.* (2016) noted that does that kid in the wet season have heavier weight at the time of kidding (25.08 kg) and weaning (22.01 kg) than those does that gave the kid in the dry season (24.15 and 21.21), respectively, that might be contributing to differences in kidding intervals between the seasons. The birth type was affected by kidding intervals of Begait goat in western Tigray (Abraham *et al.*, 2019). Under the traditional management condition, the kidding interval for Abergelle does kidding in the wet season has short kidding interval (227 days) than does that gave birth in the dry season (281 days) and the cool season (362 days) while the average was reported to be 9.63 months or 289 days (Derbie and Mengiste, 2014).

According to Neme (2016), the lambing interval in the West Shoa Zone was stated to be 8.83 months and the kidding interval was 8.25 months. Lambing/kidding interval of Arsi-Bale breeds was 7.8 months for sheep and 6.9 months for goats in Alaba districts (Kocho, 2007). Lambing/kidding intervals of small ruminants were 9.19 and 9.05 months, respectively in Alaba districts (Gemiyu, 2009).

Table 1. Reproductive performance (months) of some local goats as reported by different authors

Goat types	AFSM	KI	AFK	Sources
Arsi-Bale	Na	6.9	12.1	Kocho (2007)
Arsi-Bale	Na	9.05	11.9	Gemiyu (2009)
Arsi-Bale	Na	7.74	14.71	Kebede (2009)
Arsi-Bale	Na	9.76	28.47	Dadi <i>et al.</i> (2008)
Arsi-Bale	Na	9.33	19.17	Kebede <i>et al.</i> (2012b)
Central highland goat	Na	10.26	13.6	Taye <i>et al.</i> (2013)
Abergelle goat	Na	9.63	14.93	Deribe and Mengiste (2014)
Bati	Na	8.83	16.5	Tadesse <i>et al.</i> (2014a)
Harerghe Highland	Na	8.43	15.7	Tadesse <i>et al.</i> (2014a)
Short-eared Somali	Na	8.75	18.3	Tadesse <i>et al.</i> (2014a)
South Western (Nuer goat)	7.06	7.46	16.76	Gebreselassie (2015)
West Shoa goat	8.39	8.25	13.85	Neme (2016)
Begait	7.41	8.4	14.18	Abraham <i>et al.</i> (2017)
Short-Eared Somali Goats	9.88	7.93	16.54	Eshetu <i>et al.</i> (2018)

AFSM= age at first service of the male; AFK = age at first kidding; KI = kidding interval; Na= not available

Table 2. Reproductive performance (months) of some local sheep as reported by different authors.

Sheep types	AFSM	LI	AFL	Sources
Arsi-Bale	Na	7.8	12.7	Kocho (2007)
Arsi-Bale	Na	9.19	12.4	Gemiyu (2009)
Gumz	Na	6.6	13.67	Abegaz <i>et al.</i> (2011)
Horro	Na	9 - 10	10 - 11	Dhaba <i>et al.</i> (2012)
Adilo sheep	Na	7.34	12.4	Hailemariam <i>et al.</i> (2013)
Adilo sheep	Na	Na	14.6	Mekuriaw and Haile (2014)
Arsi-Bale	Na	7.8	12.7	Mekuriaw and Haile (2014)
Bonga	Na	8	13	Mekuriaw and Haile (2014)
Menz	Na	7-10	14-16	Mekuriaw and Haile (2014)
Washara	Na	15	9	Mekuriaw and Haile (2014)
West Shoa sheep	8.91	8.83	14.29	Neme (2016)
Wolayita breed	7.11	7.9	13.5	Lakew <i>et al.</i> (2017)
Central zone of Tigray	6.93	7.68	14.86	Hagos <i>et al.</i> (2018a)
Wollo highland	6.3	6.1	11.9	Amare (2018)

AFSM= age at first service of a male; AFL = age at first lambing; LI = lambing interval; Na= not available

2.2.4. Seasonality of breeding

The season had a significant effect on most reproductive traits including fertility, lambing rate, and weaning rate. The higher percentages of parturitions for ewes/does in the Goma district of Jimma zone were increased starting from April to October while the decrease was observed starting from October to February (Shenkute, 2009). Urgessa *et al.* (2013) indicated that lambing/kidding occurred year-round, with the majority of lambing/kidding occurring in September to October and late April to June and lowest in January to early April, which characterize dry period under the Ethiopian conditions.

According to Bushara and Abu-Nikhaila (2012), female kids born in the season with sufficient feed availability grow faster, attain sexual maturity earlier and produce kids at a younger age as compared to those born during the dry season. The higher parturitions occur from April to June in both species (Neme, 2016). Ewes lambing in the rainy season period returned to oestrus earlier, conceived earlier, and had shorter lambing intervals compared to ewes that lambed in the dry season period and this effect was largely attributed to the availability of pasture during the rainy season period (Salifu *et al.*, 2018).

2.3. Production performance

2.3.1. Market/slaughter age

Nutrition, especially dietary protein and energy, is a key factor affecting live weight gain and meat production of small ruminants (Bathaei and Leroy, 1996; Abera *et al.*, 2014). Since the quality and quantity of the natural pasture vary with season, animals dependent on it are subject to nutritional stress in the dry season leading to

decreased animal productivity (Abusuwar and Ahmed, 2010; Melesse *et al.*, 2015). The average slaughter age was 6.43 months for sheep and 6.27 months for goats in the west Shoa zone of Oromia Region (Neme, 2016). The average age for marketing/slaughtering in the Bale Zone of Oromia Region was 11.67 and 12.33 months for male and female goats, respectively (Asefa, 2013).

Although, Nigussie *et al.* (2013) reported that male sheep in eastern Ethiopia could be ready for market at age six months if cash was needed urgently, though the normal selling time was between ages 1-to-2 years of which fetch a premium price. Age at the slaughter age of Bati, Hararghe highland, and short-eared Somali goat were 12.9, 16.4, and 22.7 months, respectively (Tadesse *et al.*, 2014a). The overall average age of marketing/slaughtering of goats in the Dire Dawa Administration was 15.69 months as reported by Eshetu *et al.*, (2018). Male goat and sheep are slaughtered for family consumption at 7.10 and 7.20 months, respectively, and females are slaughtered from an age of 7.40 months for kids and 7.70 months for lambs (Kocho, 2007). The slaughter age of sheep in Southern Ethiopia was 8.60 months (Hussein, 2018).

2.3.2. Milk production

Sheep milk is one of the functionally active dairy foods and it is also considered as a nutritional powerhouse (Mohapatra *et al.*, 2019). In the central rift valley, in the Eastern, Southeastern, and Northeastern parts of the country, goat milk is consumed by the farming communities (Ayalew *et al.*, 2004). Sheep and goat milk account for 36.5% and 63.5%, respectively of the world's total small ruminant milk production (FAO, 2017). According to Dereje *et al.* (2015), the average milk yield estimated for Afar goats was 24 kg per lactation and 0.28 kg per day under the station management system. The average daily milk yield, lactation length, and lactation yield of Arsi Bale goats are 296 g/day, 83.4 days, and 21.7 kg, respectively, in the Arsi Negelle (Woldu *et al.*, 2004). The average milk yield and lactation length of Arsi bale goats in Alaba district were 151 ml per day and 39 days, respectively (Gemiyu, 2009).

2.4. Importance of Small Ruminants in Livelihoods of Smallholder Farmers in Ethiopia

Small ruminants are an important source of income for the agricultural community and are also one of Ethiopia's major sources of foreign currency through the exportation of live animals, meat, and skin (Shiferaw *et al.*, 2012). Small ruminants are relatively cheap when compared to cattle and are often the first asset acquired, through purchase or customary means, by a young family or by a poor family recovering from a disaster such as a drought or war (Gizaw *et al.*, 2010). The purposes of keeping small ruminants vary from area to area due to ecological, economic, and cultural factors (Nigussie *et al.*, 2013). However, they are mainly maintained for fulfilling multiple roles, such as cash income, meat, milk, skin, wool, manure, security, gifts and religious rituals as many authors (Getachew *et al.*, 2010; Umeta *et al.*, 2011; Kebede *et al.*, 2012a; Hailemariam *et al.*, 2013). According to Eshetu *et al.* (2018), cash income and milk are the most important purposes of goat rearing in the Dire Dawa Administration.

Small ruminants are mainly kept for income generation in many parts of Ethiopia to obtain cash income for household expenses, such as buying grains for household consumption, buying agricultural inputs such as fertilizer and improved seed and paying the medical and school expenses of household members (Dhaba *et al.*, 2012). Many authors reported that small ruminants are primarily used for milk production for home consumption and meat production for sale (Gizaw, 2010; Abraham *et al.*, 2017; Hagos *et al.*, 2018b). With the increased environmental degradation and drought cycle due to climate change, the pastoral community is expanding goat production as a means of adaptation.

Ethiopian sheep and goat skins are preferred for leather garment and glove manufacturing in addition to being used for shoes upper, and the goat skins in particularly known for their quality and international acceptance (Boario, 2012). According to the Ethiopian small ruminant synthesis report, the increase in international demand for meat in general and the high demand for sheep and goat meat in the middle east countries is also another incentive for increased sheep and goat production in Ethiopia (Legese *et al.*, 2014). However, traditional small ruminant production technologies and practices render production and productivity, as well as benefits to producers, falls below expectations. This is due to health constraints, inadequate feed, low genetic potential, and various management problems (Hailemariam *et al.*, 2013; Abebe, 2018).

Ethiopian sheep and goat meat are exported mainly to the Middle East and North Africa countries. However, domestic demand for sheep and goat meat is quite seasonal as it follows the religious calendar of fasting periods and festivities such as New Year, Christmas, Easter, Ramadan, and Arafa. Consumption of small ruminant milk gives high nutritional value and considers it as a medicine and consumed either in its fresh state (boiled whole milk) or skimmed milk (Legese *et al.*, 2014). The increased domestic and international demand for Ethiopian small ruminants has established them as important sources of Inland Revenue as well as foreign currency (Gizaw *et al.*, 2010). In Ethiopia, the consumption of red meat by 2020 is expected to increase by 58% (Shapiro *et al.*, 2015). This implies that they are operating in a lucrative business environment.

2.5. Constraints of Small Ruminant Production in Ethiopia

2.5.1. Disease and parasites

Diseases and parasites are also contributing to higher production losses of small ruminants. Prevalence of disease and parasites are the major constraints of sheep and goat production across production systems according to the report of many authors (Abebe *et al.*, 2010; Gizaw *et al.*, 2010; Umata *et al.*, 2011; Tadesse *et al.*, 2014b; Beyene and Anja, 2018). Ectoparasites have transmission ability for many infections due to bloodsucking habits and skin damage is the most important cause of losses in the livestock industry (Tadesse *et al.*, 2011).

Parasites such as mange mites, lice, and ticks are widely distributed in all agro-ecological zones in Ethiopia, causing a serious economic loss in smallholder farms (Kumsa *et al.*, 2012). Mange mites are common in Ethiopia and reported from many regions and different agro climates. They are most prevalent in four national regional states of Ethiopia namely, the Amhara, Oromia, Tigray, and Southern Nation and Nationalities regional states (Mulugeta *et al.*, 2010; Fekadu *et al.*, 2013).

In western Oromia, it is indicated that pasteurellosis, diarrhea, liver fluke (fasciolosis), and lungworm were the most important diseases of sheep at different seasons of the year in western and south-western Ethiopia (Edea *et al.*, 2012). Pasteurellosis, Pest des Petit Ruminants, Anthrax, Foot and Mouth diseases, and mange mites were reported as the most prevalent disease for goat productivity and survivability in northern Ethiopia (Hagos *et al.*, 2018b). Lungworms are one of the most common causes of the respiratory problem of small ruminants in Asella Municipal Abattoir (Teketel and Alemu, 2019).

2.5.2. Feed shortage

Feed shortage is often mentioned as one of the main challenges facing sheep and goat production and it may arise due to prolonged drought resulting in a period of below-average rainfall leading to feeding and water shortage (Behnke and Metaferia, 2011; Legesse *et al.*, 2014). As reported by Dhaba *et al.* (2012), the dry season extends from 3- 6 months during which chronic feed shortage occurs in the Ilu Abba Bora Zone (mid-January to mid-April). Feed shortage is one of the limiting factors of livestock production in most parts of the country because of its availability and poor quality. Animals have to walk long distances in search of fodder and water during dry seasons. In most parts of the country where mixed farming is practiced, feed shortage occurs mainly from July to the end of October when croplands are covered by food crops (Dhaba *et al.*, 2012).

Poor nutrition is a key systemic bottleneck and challenges to the productivity of small ruminants in Ethiopia (Hailemariam *et al.*, 2013; Gurmessa *et al.*, 2015; Melesse *et al.*, 2015; Eshetu *et al.*, 2018). Abebe *et al.* (2013) reported there is an existence of a relationship between feed shortage and sheep disease and death incidence period. According to this report sheep, morbidity and death are high from July to the end of October due to feeding shortage and the availability of poisonous plants which may predispose the animals to low disease resistance in the Burie District. During such seasons the quality of available forage is low and browse species that provide higher levels of proteins and energy are sparsely grown (Fikru and Gebeyew 2015).

2.5.3. Lack of market access and information

A marketing channel refers to the sequence of enterprises and markets by which product is moved from producer to consumer. Market locations in primary and secondary markets are usually not fenced; traders and exporters are also faced with marketing problems (Gizaw *et al.*, 2010). Households selling small ruminants are often interfered with by a lack of price information and access to the incentive market, seasonality of markets, and brokers (Tadele, 2015). The absence of a market-oriented production system; lack of market information and seasonality of market price was the major constraint for sheep production in the case of Sodo Zuria District (Beyene and Anja, 2018). Market accesses were the constraints mentioned for goat production in the Dire Dawa Administration (Eshetu *et al.*, 2018). The price of sheep fluctuates over the year and it was found high on holidays such as Easter, Christmas, Muslim holidays, and the Ethiopian New Year and low during the wet and drought season (Mekuriaw *et al.*, 2012).

2.5.4. Water shortage

Water shortages are a common problem for both human and livestock consumption in most Rift Valley parts of the country. Water shortage is reported as a limiting factor in most lowland areas to a limited extent in mid-latitudes. In the eastern, northeastern, and southeastern parts of the country, there is a critical shortage of water; however, small ruminants are somehow adapted to these agro-ecologies through their physiological adaptation mechanisms (Gizaw *et al.*, 2010; Umata *et al.*, 2011). Restrictions of water may result in poor nutrition and digestion, because there is a relationship that exists between water intake and consumption of roughages, particularly during the dry season.

Long-distance travel of small and large ruminants in searching for water was another problem (Yami *et al.*, 2013). According to Tadesse *et al.* (2014b), water scarcity was the major constraint of goat production across production systems in Ethiopia.

2.5.5. Lack of genetic improvement

The main reasons for unsuccessful genetic improvements were indiscriminate crossbreeding with no plan on how to maintain a suitable blood level, lack of clear breeding and distribution strategy, lack of farmer's

participation and trait preferences as well as the incompatibility of introducing genotype with management practices (Kosgey *et al.*, 2004). According to Gizaw *et al.* (2013), the earlier works of genetic improvements were not well planned, unsuccessful, and unsustainable. Genetic improvement through selection takes time and is not one time sometimes challenges come from officials (Abebe, 2018). A wide range of 375 to 854 days of age at first kidding was reported in different management and breeds of Ethiopian goats which are influenced by genotype, management, season and type of birth (Kebede *et al.*, 2012b).

3. Conclusion

There are about 33.02 million heads of sheep and 38.96 million heads of goats' population in Ethiopia. They are important components of the livestock subsector and are sources of cash income, milk, meat, wool, manure, and saving or risk mitigation during crop failures, property security, monetary saving and investment in addition to many other socioeconomic and cultural functions. Their productions are contributing significantly to the national and household economy in many countries. The reproductive, as well as productive traits are affected by several factors including breed, a season of conception, interval between parturitions, age, sex and health and nutritional status of the individual animal.

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