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Breeding Practices and Strategies for Genetic Improvement of Indigenous Goats in Ethiopia: Review

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ABSTRACT

This review was aimed to summarize and synthesize the fragmented information on breeding objectives, breeding practice of goat keeper's and effectiveness of existing goat cross breeding program as an input for suitable and sustainable genetic improvement strategies. Goats in Ethiopia are found in all agro-ecological zones. However, the selection criteria, breeding objectives and breeding practices of goat keepers are not similar across all agro ecologies and production systems. In arid and semi-arid lowlands of the country, the primary breeding objective of most of goat keepers was milk yield while in highland parts of the country goat owners keep goats for income generation to be used for different purposes like emergency cases and different household expenses. Cross breeding of goats as productivity improvement program had been implemented for nearly twenty seven years in the country via different projects. However, the result indicated that, in comparison to indigenous breeds, the crossbreds were not productive under village conditions where over 83.9% of Ethiopian human population is found. The reasons for fruitless ending of some of the projects were lack of clear targets aligned to the production environments, incompatibility of the genotype with the farmers breeding objectives, management methods and absence of involvement of all stakeholders in the productivity enhancement program. Therefore, there needs to be a concerted effort to formulate and implement suitable and sustainable breeding program. Community- based breeding program on the adapted indigenous breeds seems to be undoubted to increase and sustain the productivity of goats in the country so as to meet the demands of the ever growing human population.

INTRODUCTION

Small ruminants make a substantial contribution to the well being of the people in east Africa and Sub-Saharan Africa (De Leeuw and Rey, 1995). Goats are amongst the commonest farm animal species which sustain the livelihoods of smallholder farmers, pastoralists and agropastoralists (Workneh and Peacock, 1993). According to CSA (2016) there are about 29.70 million goats in Ethiopia, of which about 71.57 percent are females and 28.43 percent are males.

In Ethiopia, goats are one of the most important livestock species with eight genetically diverse breeds (Tesfaye, 2004). With respect to their originality, almost all of the goats are indigenous/native breeds, which account about 99.96 % (CSA, 2016). They become adapted to a range of environments from the arid lowlands (the pastoral and agro-pastoral production system) to the humid highlands (mixed farming systems) (Workneh, 1992, ESGPIP, 2008). In these different production systems, goats provide their owners with a vast range of products and services such as meat, milk, skin, hair, horns, bones, manure, security, gifts, religious rituals and medicine. They are also important protein sources in the diets of the poor and help to provide extra income and support (Notter, 2012).

Goat production is one of the low resource demanded and efficient farming types, since goats have broad feeding habit, adaptation to unfavorable environmental conditions, low cost of maintenance, inherent suitability for small scale production and their short reproductive cycle. These provide goats with comparative advantage over cattle and sheep to suit the circumstances of especially resource poor livestock keepers (Alemayehu, 1993; Silanikove, 2000; Misra and Singh, 2002; Degen, 2007). Their presence in mixed species grazing systems can lead to a more efficient use of the natural resource and add flexibility to the management of livestock (ESGPIP, 2008). They also have the reputation of being resistant to the majority of tropical diseases and parasites than chicken and other animals.

The present production levels of indigenous goats with existing breeding strategies and practice are far below their potential. Productivity per animal is reported to be very low and contributes only 16.8% of the total ruminant livestock meat output. The annual meat production is estimated at 3–3.5 kg per animal per year in the population and 8–10 kg per animal slaughtered. These values are very low when compared with those in neighboring countries that have goat population, 50–75% less than Ethiopia. The average carcass weight of Ethiopian goats is 10 kg, which is the second lowest in sub-Saharan Africa (Amha, 2008).

Even though other factors like slaughtering goats at immature body weight, mostly before castration, and low input production, contributes for low meat yield (FAO, 2008), the cross breeding program designed and

implemented via different goat productivity improvement projects not ended as expected especially under farmer's goat production environment (Gebremeskel, 2000; Ayalew *et al.*, 2003). Identifying those traits that farmers would like to improve is the first step to be made in designing genetic improvement strategies (Hammond and Galal, 2000). While previous studies have identified breeding objectives of goat owners, criteria's for selection of breeding buck and doe, and general breeding practices associated with the rearing of indigenous goats in different production systems of Ethiopia (Alemayehu, 1993; Nigatu, 1994; Endeshaw, 2007; Belete, 2009; Tesfaye, 2009; Grum, 2010; Tesfaye, 2010; Mahilet, 2012; Dhaba *et al.*, 2013; Belete, 2013; Bruh, 2013; Alefe, 2014; Hulunim, 2014; Ahmed *et al.*, 2015; Alubel, 2014; Tsigabu, 2015; Feki and Berhanu, 2016; Zergaw *et al.*, 2016) organized information is not available. Therefore, the objective of this review is to summarize and synthesize the fragmented information on breeding objective, breeding practice of goat keeper's and efficacy of existing goat cross breeding program as an input for suitable and sustainable genetic improvement strategies.

Breeding Objectives of Ethiopian Goat Keepers

Many of the potential animal breeding strategies refer to a broader definition of breeding objectives, not aiming at higher production levels per animal only, but balancing higher productivity with improved functional traits such as health, fertility, and feed intake capacity (Olesen *et al.*, 2000).

Breeding objectives is the first step to be made in designing genetic improvement strategies. The breeding objective identifies those traits that farmers would like to improve. To able to identify the traits, the existing and future development objective of the agricultural production in the country is to be defined and the livestock production system to be characterized. The current livestock population structure should be described and opportunities, to better utilize it and hence, maximize the realization of genetic gain, should be sought for and some appropriate changes should be made (Hammond and Galal, 2000). Payne and Hodges (1997) stated that breeding objectives should match the expectations and values of the community. Furthermore, each trait in the breeding goal is given a 'goal value', indicating the contribution of the improvement of the trait to the realization of the development objectives. Since the relative rate of improvement will be faster for traits which have higher heritabilities, emphases should be given to traits with acceptable heritability. As a general guideline, traits with heritabilities less than 10% are considered lowly heritable and one cannot realistically expect to make much genetic progress (Funk, 1992).

According to Mohammad and Raed (2009), the breeding objectives of goat keepers differ based on agro ecologies, herd size, housing type and culture of the

communities. The primary breeding objectives of goat keepers in many parts of Ethiopia are producing marketable goats for generating income which is used for emergency cases, educational fees and for other household expenses (Tesfaye, 2009; Mahilet, 2012; Hulum, 2014; Ahmed *et al.*, 2015; Alubel, 2015; Tsigabu, 2015; Zergaw *et al.*, 2016) while milk production is the main breeding objectives in other parts of the country (Nigatu, 1994; Grum, 2010; Tesfaye, 2010; Belete, 2013; Alefe, 2014; Feki and Berhanu, 2016). In contrast, Endeshaw (2007) reported that, saving is the primary breeding objectives of goat keepers in Sidama Zone of south Ethiopia.

According to the previous studies (Nigatu, 1994; Endeshaw, 2007; Grum, 2010; Tesfaye, 2010; Mahilet, 2012; Belete, 2013; Alefe, 2014; Alubel, 2014; Hulum, 2014; Tsigabu, 2015; Feki and Berhanu, 2016; Zergaw *et al.*, 2016) goat keepers intended to have milk production as one of their breeding objectives are found in broad areas of the country (east Showa, west Arsi, Bale, Meta-Robi, Borena, eastern Hararghe of Oromia regional state, Konso and Sidama zone of south Ethiopia, Shabelle and Siti zone of Somali national regional state, Bati, Kalu, Wag Hmira zone of Amhara region, Central Tigray zone of north Ethiopia, Gambella region of south western Ethiopia, Afar national regional state and Dire Dawa). Since goats browse different variety of trees and shrubs, goat owners believed that goat milk has medicinal value for children and contribute much more for the wellbeing of human baby (Grum, 2010; Tesfaye, 2010; Mahilet, 2012). However, according to Ahmed *et al.* (2015) in Horro Guduru Wollega zone of Oromia region, Alubel (2014) in north Gondar zone of Amhara region, Belete (2009) in Jimma zone of Oromia region

and Tesfaye (2009) in Metema district of Amhara Region, goat milk is not consumed by the community and milk production is not the breeding objective of goat owners. The other commonly reported breeding objectives of goat keepers are meat for home consumption, ceremony (meat for holy days), sign of wealth & strength and using by products (manure and skin) (Nigatu, 1994; Endeshaw, 2007; Grum, 2010; Tesfaye, 2010; Mahilet, 2012; Belete, 2013; Alefe, 2014; Alubel, 2014; Hulum, 2014; Tsigabu, 2015; Feki and Berhanu, 2016; Zergaw *et al.*, 2016).

Breeding Practice of Goat Keepers in Ethiopia

Breeding bucks and does selection criteria

Buck is the most important animal in the flock. It contributes 50% of the genetic makeup of kid born and determines overall pregnancy rate of the flock. The choice of good breeding buck is an important factor and fundamental in goat production. Accurate selection of does also raise the average productivity of the flock, however buck selection is the main driver of ongoing genetic improvement in the flock.

In different parts of Ethiopia goat owners understood the advantage of using superior bucks and developed their own breeding criteria to select the best performing buck (Table 1). As indicated by different authors, coat color type/pattern, body conformation, growth rate and Libido are important selection criteria of breeding buck (Mahilet, 2012; Alubel, 2014; Hulum, 2014; Ahmed *et al.*, 2015; Tsigabu, 2015; Zergaw *et al.*, 2016).

Table 1: Farmers selection criteria for breeding bucks and does

Breeds/Goat types	Major selection criteria/traits of interest	Production system	Sources
Horro Guduru Wollega goat types (Western highland)	Doe: liter size, growth rate, age at first Kidding, Appearance Buck: growth rate, appearance, coat colour type	Mixed farming	Ahmed <i>et al.</i> 2015
Hararghe Highland Goat	Doe: size / appearance, age at 1st sexual maturity, twinning ability and high milk yield Buck: size / appearance, absence of horn and growth rate, coat colour type	Mixed crop–livestock	Mahilet, 2012,
Abergelle Goats	Doe: Milk production, Twining ability, Body Conformation, Frequent kidding Buck: Coat color, Body conformation, Growth rate	Mixed crop–livestock	Alubel,2015
Meanit and Sheko (Keffa) Goats	Doe: Twinning ability, kid growth, mothering ability and body size; Buck: body size, pedigree and growth rates	Mixed crop–livestock and agropastoral	Tegegne, 2012
Arsi-Bale goats	Doe: milk production, family history, twinning ability, mothering ability, kid growth rate, coat colour and kidding interval; Buck: coat colour, family history, testicular characteristics, libido, growth rate, prolificacy and disposition/ character	Mixed crop–livestock	Tesfaye et al. 2012b
Afar goats	Family history (progeny of superior sire and high milk producing doe), large body size, conformation; coat colour	Pastoral and agropastoral	Feki 2013.
Goat types in Shabelle (Somalia)	Buck: Appearance, growth rate and color Doe: High milk yield, Kidding interval, Kid growth, Age at sexual maturity, Size/Appearance	Pastoral and agropastoral	Alefe, 2014
Gambella goats (Western Low land)	Doe: size/appearance, color and prolificacy Buck: Size, color, horn availability	Pastoral Agropastora/ Mixed farming	Tsigabu, 2015

Like selection of bucks, goat keepers also practiced selection of breeding does and had different selection criteria. The selection criteria of farmers to identify the breeding doe were different according to agro ecology, production system and culture of the community. According to Mahilet (2012), size / appearance, age at 1st sexual maturity, twinning ability and high milk yield were considered as the first four reasons for doe selection in Harrerghe highland of Ethiopia. However, some authors (Belete; 2009; Ahmed et al., 2015; Alubel, 2015) reported that milk yield was not the selection criteria of goat owners to select their breeding does.

Breeding bucks ownership and mating system

Several studies have shown that most goat keepers in Bati, Borena, Somali, Wag Hmira, Central Tigray, south Omo and East Gojjam have used their own breeding bucks to mate their breeding does (Biruh, 2013; Demissie *et al.*, 2014; Alubel, 2014; Hulunm, 2014) while, in Horro Guduru Wollega, Ilu Abba Bora, Jimma and Arsi-Bale of Ethiopia, goat keepers used neighbors breeding buck to mate their breeding does (Belete, 2009; Tesfaye, 2010; Dhaba *et al.*, 2013; Ahmed *et al.*, 2015).

According to Ahmed *et al.* (2015), most goat keepers in Horro Guduru Wollega zone of Oromia region allowed does to be served by any buck when the does show signs of heat. Similarly, from goat keepers which have breeding buck, most of them allowed their bucks to mate does other than their own flock. The primary reason for this was bucks run with does throughout the year and the flock was mixed with neighboring household's flock during communal grazing and watering. According to Workneh and Rowlands (2004) in Oromia, Hulunm (2014) in Bati and kalu district of Amhara region, Dhaba *et al.*, (2013) in Ilu Abba Bora zone of Oromia region, uncontrolled natural mating system had been practiced by goat keepers. Farther more, due to all goats grazed/browsed together in communal grazing land and housed together at night, farmers also allowed the breeding buck to mate his own mother, daughter and sister (Alubel, 2014; Ahmed *et al.*, 2015). The advantage of natural uncontrolled mating is that it allows for all year round breeding (Kosgey, 2004). In contrary, uncontrolled mating together with small flock sizes and poor/absent record keeping on pedigree are expected to result in severe inbreeding which leads to poor growth rates (Saico and Abul, 2007). Goat keepers in some parts of Ethiopia did not practice special

management for breeding bucks (Alubel, 2014; Hulumn, 2014; Ahmed *et al.*, 2015).

Culling as flock Management Tool and Reasons of culling from the flock

Culling in goat flocks is an important tool for the development of a good flock. Culling should be stringent and used as a means of improving the genetic quality and productivity of a flock. Flock size can be maintained by replacing culled goats doelings in the flock (ESGPIP, 2008). Reasons of culling could be different for different production systems and agro-ecologies.

According to different authors (Belete, 2009; Belete, 2013; Dereje *et al.*, 2013, Demissie *et al.*, 2014; Ahmed *et al.*, 2015) culling practiced by goat owners in Ethiopia. As indicated by Belete (2009), Dhaba *et al.*, 2013 and Ahmed *et al.* (2015), goat owners in western part of Ethiopia cull their goats from the flock based on reproductive problem, old age, sickness, unwanted physical characteristics and physical defect. Productivity problems, disease, persistent poor body condition and synergetic effects of all these factors were the common top four reasons for destocking goat flock in west Hararghe, Eastern Ethiopia (Dereje *et al.*, 2013). Demissie *et al.* (2014) also reported that health problem was the primary reason of the goat keepers for culling of their goats in East Gojjam Zone of Ethiopia.

Goat keepers in Bale zone of Oromia region culled their goats at average age of 8.17 years for males and 8.5 years for females (Belete, 2013). However, the report of Girma (2008) showed that from reproductive point of view, it is essential to intensively cull does after 5–6 years of age. Most goat owners used sealing and slaughtering as a means of culling unproductive goats and kids that did not fit the selection criteria of goat keepers.

Cross Breeding for Goat Genetic Improvement in Ethiopia

Production from the indigenous livestock under traditional management of subsistence farmers is generally considered too low, and hence crossbreeding and improved level of care should be promoted as a quick way of attaining higher production and productivity under private commercial farms as well as smallholder management in selected sites in the highlands with a conducive climate for intensification. This is the basis for the policy of the Ethiopian government on livestock development in general (Gebremeskel and Tedla, 1995).

In Ethiopia, crossing the existing genetic resource with exotic genetic blood levels were started around twenty seven years ago with main focus on improving milk production and growth rates (Teressa, 2004). Since then, cross breeding works of goats were implemented by non-governmental organizations like FARM Africa, Agri-service Ethiopia, and governmental organization like Ministry of Agriculture (MoA), higher learning institutions, research institutions and agricultural

development offices as part of the Ethiopian Sheep and Goat Productivity and Improvement Program (ESGPIP) with USAID funding (Solomon *et al.*, 2014).

In eastern part of the country, indigenous goats were crossed with Anglo-Nubian goats with the help of FARM-Africa dairy goat development project (Gebremeskel, 2000). There were also different crossbreeding projects at Werer (Afar and Saanen) and Holetta (highland and saanen) research centers by Institute of Agricultural Research (Aschalew *et al.*, 2000). Research on Arsi-Bale and Boran goats at the Adami Tulu Research Center was also the longest-running project on goats in Ethiopia, running for more than 15 years from 1992 (Solomon *et al.*, 2014).

However, most of the implemented projects lacked functional institutional synergies and exit strategies. In comparison to indigenous breeds, the crossbreds were not profitable, under village conditions where over 83.9% (CSA, 2007) of Ethiopian population is found especially, when returns per unit live weight or metabolic weight were taken into account (Workneh, 2000). Moreover, the adoption rates of crossbred genotypes by farmers were found to be very low, in some cases as low as 20% with most of the adopters being better-off households rather than poor farmers (Teressa, 2004). The reasons for unsuccessful ending of some of the projects were lack of clear targets aligned to the production environments and farmers breeding objectives. Cross breed goats from Werer research centers, could not adapt arid and semi-arid agro-ecologies. On the other hand, since Holetta is a cool highland where goats are not an important livestock species, focusing on goat development was ill-conceived (Solomon *et al.*, 2014). In general, many small ruminant cross breeding programs in tropical country were not successful because of the incompatibility of the genotype with the farmers breeding objectives, management methods, absence of involvement of all stakeholders in the designing of breeding strategies and the prevailing environment of the tropical low input production systems ((Rischkowsky, 1996; Ayalew *et al.*, 2003; Wollny, 2003; Kosgey *et al.*, 2006).

Although there has been some effort by international organizations along with the national institutions to improve production and productivity of goats in Ethiopia, there needs to be a concerted effort to formulate and implement suitable and sustainable breeding program and strategy for goat production in view of its importance to the national economy. Selective pure breeding of the adapted indigenous breeds seems to be essential to increase and sustain the productivity of goats in the country so as to meet the demands of the human population.

CONCLUSION

The review reveals that the selection criteria, breeding objectives and breeding practices of goat keepers varied based on agro ecology and culture of the community. In

arid and semi-arid lowlands of the country, the primary breeding objective of goat keepers was milk yield while in highland parts of the country goat owners keep goats for income generation to be used for different purposes. This indicates that when designing breeding program, such differences should be considered. In addition, uncontrolled mating together with small flock sizes and poor/absent record keeping on pedigree especially in highlands of Ethiopia may direct to severe inbreeding which leads to poor growth rates. Therefore, goat keepers should take training about importance of buck exchange and controlled mating.

The performance of indigenous breeds were appreciable than crossbred goats particularly under village conditions. Therefore, community-based selective breeding program of the adapted indigenous breeds seems to be undoubted to increase and sustain the productivity of goats in the country so as to meet the demands of the ever growing human population. For evolving possible selection and breeding strategies for goat production in Ethiopia, one should have to keep in mind the various agro-climatic and socio-economic aspects along with the production constraints, as they have an important bearing on the overall success of such programs.

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