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Community-based breeding programs for small ruminants in pastoral production systems

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Summary

The small ruminant production system in Ethiopia is predominantly at the subsistence level with very low productivity despite a huge potential due to the large animal numbers and genetic diversity. Growing market demand both at local and export market and the current attention given by the Ethiopian government are good opportunities to boost small ruminant productivity. Local breeds in the lowlands of Ethiopia, reared by pastoralists are highly preferred for export by slaughterhouses and live animal exporters. Even though successful breeding programs and specialized breeds are available worldwide, importing and adopting exotic breeds and technologies in Ethiopia has not been successful for the last four decades. Community-based breeding programs, born from the previous lessons, have shown promising results in the highland smallholder systems. However, flock mobility, very high temperature, frequent droughts and poor infrastructure in the pastoral systems limited designing and implementation of community-based breeding programs in pastoral areas. Tailoring these programs to fit the pastoral systems, considering its context, need to be considered. Mapping of the mobility pattern, use of mobile extension and organized youth/community group to assist the breeding program during mobility are crucial.

Keywords: sheep, goat, pastoral system, low input, breeding program

Introduction

In developing countries small ruminants contribute to food security, income generation and socio-cultural benefits. With 60.9 million heads, Ethiopia ranked 9th in the world in small ruminant population (CSA, 2017). Sheep and goats are the main choice in the extreme highlands and very hot areas of Ethiopia as those areas are less suitable for crop production and larger animals. Small ruminant production in Ethiopia is at the subsistence level with very low productivity despite its huge potential given the large animal numbers and genetic diversity.

Recent study by Mottet et al. (2017) revealed that about 86% of the global livestock feed intake in dry matter consists of feed material that are not currently edible for humans which includes grazing forage, residues and by-products. About 57% of the land used for animal feed are not suitable for food production. These shows livestock played an integral role in food system. However, animals in developing countries are inefficient in the overall feed conversion ratio due to sub-optimal animal husbandry and breeding practices.

A modest yield improvement strategy using genetic selection, herd management and animal health interventions can significantly improve feed conversion ratio of livestock. Developing and implementing a sound breeding program is crucial to enhance productivity. Animal identification and recording, genetic analysis to choose best animals, a planned mating system and dissemination of genetic gain are the major components of a breeding program. Breed improvement is highly successful in developed countries due to strong national breeding programs coupled with high level of input, good technical capacity and infrastructure and good enabling situations (Sölkner et al., 1998; Mueller et al., 2015). Attempts to adopt such breeding programs in developing countries has not been successful due to many reasons (Getachew et al., 2015; Gizaw et al., 2014; Kosgey et al., 2006). Researchers have now come up with a program called community-based breeding program (CBBP), which works under low-input system in developing countries (Haile et al., 2011; Mueller et al., 2015). However, setting up and implementation of any breeding program in pastoral areas of Ethiopia remain challenging due to mobility, high temperatures, recurrent droughts and poor infrastructure. This paper highlights context analysis of the pastoral system and suggest option to establish and implement CBBP under the challenging situations.

Overview of previous small ruminant breeding programs

Remarkable results have been achieved in small ruminant breed development in well-designed and organized breeding schemes. Such breeding programs are established in the developed world which have been favoured by resourceful environments and well-developed infrastructure and markets (Haile et al., 2011; Mueller et al., 2015). Developing countries have tried to achieve genetic improvement by importation of large and more productive breeds. These were tested on-station, multiplied and crossbred sires were distributed to smallholder farmers and pastoralists to improve their flock through crossbreeding (Awgichew and Gipson,

2008; Getachew et al., 2016). In addition, central nucleus flocks in research centers have been used as an option to improve local breeds through selective breeding (Gizaw et al., 2013). However, more than four decades of efforts seems ineffective mainly due to: Lack of supportive infrastructure and capacity (Haile et al., 2011), no attention to continuous support of the breeding programs which led to high level of mortality in government farms mainly due to disease associated with confinement and poor logistics and infrastructure (Gizaw et al., 2013; Getachew et al., 2015), poor efficiency in multiplication and dissemination (Gizaw and Getachew, 2009), poor adaptation of crossbreds to low-input subsistence production system (Ayalew et al., 2003) and introducing optimal selection and mating strategies is challenging due to uncontrolled mating resulting in lambing distributed throughout the year (Gizaw et al., 2014). In addition, majority of sheep and goats are kept in small flocks which is less suitable for conventional breeding program.

Community-based breeding programs

Community-based breeding program is an alternative approach to conventional nucleus schemes and is better suited to low-input systems in developing countries. In CBBPs, communities take a leading role and fully participate in designing and implementation of the components of the breeding programs which are adapted to their specific conditions (Haile et al., 2011; Mueller et al., 2015). Sheep and goat CBBPs have been successfully established in the Ethiopian Highlands, which are characterized by sedentary mixed crop livestock system. Establishing animal identification, performance and pedigree recording systems, participatory sire selection and devising a mechanism to manage and use selected sires among communities under smallholder situation are considered a big achievement of CBBP. Furthermore, reasonable genetic gain in growth and reproductive traits have been achieved through CBBP (Gizaw et al., 2014; Haile et Al., 2019).

Pastoral small ruminant production system - Situation analysis

Pastoral areas in Ethiopia are characterized by herd mobility, high temperature, erratic weather conditions and recurrent droughts. These conditions limit the scope of breeding and other interventions and lead to recurrent losses of valuable genetic resources. Globally there are very few experiences in implementing CBBPs in pastoral communities (Mueller et al.,

2016). An earlier attempt to implement CBBP in the pastoral system in the Afar region of Ethiopia was discontinued due to lack of progress and a failure of adapting the approach to the challenging circumstances. However, there is a growing interest of the Ethiopian government and the research community to implement CBBPs in the pastoral areas following successful implementation in the highland mixed crop-livestock system. Understanding situations of the pastoral system and developing schemes of how to adapt the modalities of CBBPs are needed. Adopting CBBPs to pastoral areas requires a contextual analysis of the system (Table 1).

Table 1. Challenges and opportunities of CBBP in pastoral areas

Challenges	**Opportunities**
• Mobility makes animal identification, data collection, animal treatment difficult • Loss of valuable genetic resources due to recurrent drought and climate change • High temperature and erratic weather conditions • Lack of supportive infrastructure • Poor animal health services leading to high mortality rates of about 30 % • Sale of fast growing animals (Negative selection)	• Relatively large flock size • High dependency on livestock • Existence of sire sharing practices • Potential for export and local market • Government focus for intensification in agriculture • Indigenous knowledge of pastoralists in selection, animal identification, controlled mating • Presence of diverse, adaptive and reasonable milk yield producer animals • Goat milk and the processed butter are used as medicine in traditional treatment of sick people. Goat milk is important for prevention of cardiovascular disease, cancer,

allergy and microorganism and used for stimulation of immunity (Zenebe et al, 2014)

Flock mobility

High mobility is one of the major restrictions to establishing proper animal identification and recording schemes and implement breeding programs in pastoral areas. Study in Borena and Konso pastoral systems revealed that majority (91%) of the goat owners reported that they move their goat temporarily to other places in search of feed and water mainly during the dry season (Getachew et al. xxxx in press). When drought hits (water shortage) they evaluate the situation about possible migration place and move.

They have clear mobility pattern where they go and establish their own sites. Usually they migrate to river side. The communities have permanent settlement area (house) and part of the family takes the animals, spend part of the year and return with their animals when situations improve. Usually mobility is practiced once in a year; usually they migrate in January and come back home in April. Goat owners reported that all goat classes migrate except with very few goat owners who reported that kids and goat for fattening are maintained and managed in permanent places. Mating and kid rearing were continued in new places as were practiced in permanent place. Indeed, carrying newborn animals during migration and preparing new house for the newborn kids were a common practice by many goat keepers (Getachew et al., 2020).

Loss of valuable genetic resources

High level of animal mortality associated with drought, feed shortage, disease and poor animal health service is common in pastoral systems. Very low kid survival (42.4 to 62.2 %) during the dry season was observed in Borena and Konso pastoral systems (Getachew et al.

2020). This would have negative effect on breeding program as it limits the number of candidate animals available for selection. Feed and water shortages have mostly been reported as the major constraints limiting animal productivity in the pastoral areas (Gebreyesus et al., 2012).

Considering the resource base and other comparative marketing advantages of Ethiopia, the export volume to the Middle East has been low. However, sheep and goat breeds from pastoral areas are the most preferred for live animal export in the middle East market. In addition, male with good condition and at younger age are the most preferred in the middle east market. This would make fast growing and adapted animals (with good condition) attract the buyers and those with poor growth potential remain in the flock and are used for mating. This resulted in negative selection and loss of valuable genetic resources.

Designing small ruminant breeding program in pastoral system

Designing and implementation of sustainable small ruminant breeding programs in pastoral systems should focus on the peculiar conditions existing in the system. The major issues that need to be considered include the following:

Identification of fitting breeding objectives

Breeding objectives in pastoral system are more influenced by social and cultural factors, which makes it more difficult to identify them via conventional approaches (Haile et al., 2010; Gebreyesus et al., 2012). Gebreyesus et al., 2012) identified a high economic value for adaptation traits in agro-pastoral and pastoral system in addition to growth and body size. Breeding objectives in pastoral areas need to consider economic and non-economic interests of pastoralists. For example, a behavioral trait like alertness in females is considered an

important trait which helps to lead the flock and protect it from predators (Gebreyesus et al., 2012). Grazing and walking ability, good body condition during drought time, mothering ability and other socio-cultural interests like animal associated with special person are important for pastoralists. In addition, traits having positive association with kid survival like good milk yield and optimum birth weight (Oseni and Bebe, 2010) need to be considered in the selection index. Two stages of selection: selection based on records and participation of the community to approve selected animals based on their preference (Haile et al., 2011) is crucial to accommodate pastoralists preference of morphological characters.

Simplified measurement and recording system

To ensure success of a breeding program in low input systems, traits to be considered in selection program should be few and easy to measure (Sölkner et al., 1998). Positive relationship among different traits (pre-weaning kid survival, twining rate, growth and size traits and dam milk yield) observed in Borena and Konso goats (Getachew et al., 2020) suggested that selection index considering few among the list would suffice. Pre-weaning kid survival which is the major challenge in the pastoral system is positively associated with kid growth, size measurements and milk yield of its dam in Konso and Borena goat. Positive association between lamb growth and survival were also reported in Menz sheep (Getachew et al., 2015). Highest correlation coefficient between doe milk yield and rank (0.69) and doe's fast kid growth and doe rank given by the owner (0.72) were found in Borena and Konso goat. Significant correlation found between milk yield and other traits suggests that using this trait as selection criterion is the most promising option to ensure reasonable kid growth and better kid survival. Significant and positive genetic progress has been achieved for number of kids survived to weaning age and weaning weight in the Egyptian Nubian sub-tropical goat breed

when selection was made based on total milk yield (Afoul-Naga et al., 2012). Castañeda-Bustos et al. (2014) also found milk yield as one of the most important indirect prediction of real production life of goats in the US. Thus, due to its higher association with top ranked does and good correlation with other traits in many studies (list few), moderate to high heritability (Aboul-Naga et al., 2012; Castañeda-Bustos et al. 2014) and significant contribution of milk as staple food (Gebreyesus et al., 2013) inclusion of milk yield alone or giving more weight for milk yield in the breeding program could generate better genetic benefit. Recurrent drought in pastoral areas and low survivability of kids during the dry season justifies the importance of considering adaptation trait in the breeding program. However, measuring adaptation traits remains a challenge and selection for indirectly associated traits like milk yield and higher birth weight in the given environment will be more feasible and practical.

Mobile technicians/enumerators to support pastoralist

Once the mobility patters including movement period, distance travelled and route of movement, and sharing of the breeding animals are weather the group members sharing breeding animal in permanent place move together or not is understood, strategies to identify and recruit mobile enumerators should be devised. Data management systems and support staff needs to be mobile to undertake breeding programs. Thus, a mobile and strong extension system needs to be put in place to facilitate input supply, health service, animal identification and pedigree recording, data collection and market linkages following their mobility route. Application of an electronic data collection system which has been used in the highlands of Ethiopia could as well be used in these systems. Digitizing and integrating animal health information record in in to pedigree and performance recording system is crucial not only to provide appropriate treatment and control measures but also to consider health traits in the breeding objective.

Organized youth groups to support pastoralist breeders

Organizing pastoral breeder cooperatives is crucial to create enabling situations to facilitate breeding programs. The organized breeder cooperative engaged in organizing breeding activities that are planned, designed and implemented by pastoralists themselves in collaboration with technical stakeholders to effect genetic improvement within their sheep and goat flocks. They mainly in participatory selection of best sires and arrange sire uses and management among community members. Another strong youth/community group need to be organize and can be engage in profit-oriented breeding business. The youth/community group possible be arose from the community and should have strong affiliation with the community. This group assists many breeder's cooperatives being a bridge between breeder's cooperative and external institutions (extension, research and other service providers). Government and other institutions should support this group at the beginning in developing investment plan, availing land, establish farm facilities (like barn, developing watering points, performance measurement facilities) and facilitate credit options. Extension system should provide basic knowledge in breeding, animal management, feed and range land development and health service.

Organized youth/community need to have the following roles:

- Purchasing candidate sires, extra animals from pastoralists during drought time and immediately before movement.
- Managing purchased animals in a better feeding and health situations, and performance recording.
- Organize participatory selection event in collaboration with stakeholders engaged in CBBP to identify best sires.
- Selected sires should be sold back to the pastoral community flocks. Breeder cooperatives within the pastoral community should be responsible to buy selected sires and arrange sire utilization among groups and members within a group.
- Non-selected and culled males will be sold to the local or export market after value addition through fattening. Generating profit for the youth group relay on the returns obtained from the sale of well managed breeding sires back to the breeder cooperative and sale of non-selected fatten animals to markets. Though, complete business plan need to be developed for the youth group

- Establish market linkage between pastoralists and feed suppliers, animal traders, abattoirs and consumers.
- Link pastoralists with extension service providers

- Reducing the unemployment rate of youth is high priority by the Ethiopian government and large funds are allocated to develop investment options. Therefore, the government and other institutions are very likely to support setting up youth groups to be engaged in profit-oriented businesses. However, realizing CBBP in pastoral areas requires long term commitment and well-integrated activities among stakeholders working in pastoral areas.

Infrastructure development to assist breeding programs

Development of infrastructure (secondary roads), communications (mobile phone networks) and market facilities in pastoral areas is crucial to make breeding programs sustainable. This assists poorer households to access local traders more easily and negotiate more effectively over prices; for traders, transaction costs are reduced; trader monopolies become less likely; access to remote dry season grazing areas for traders, especially during drought, becomes easier and less costly. Urgent interventions are also needed to minimize the harsh effect of dry season and thereby reduce kid mortality and contribute to safeguarding the livelihood of pastoral communities. Successful pilot development interventions like water development and range land management in pastoral areas which resulted in a year-round grazing (Homann et al., 2008) need to be implemented at a larger scale.

Conclusion

Situation analysis and full understanding of the pastoral production system is prerequisite to plan and implement breeding programs in pastoral area. Developing a digital database and mobile extension system which moves with the community during herd mobility need to be an integral component of the pastoral breeding programs. Establishing breeder cooperatives

and youth group need to be in place to boost input supply, health service, animal identification and pedigree recording, data collection and market linkages. Urgent interventions are also needed to minimize the harsh effect of dry season and thereby reduce kid mortality and contribute to safeguarding the livelihood of pastoral communities. Realizing CBBP in pastoral areas requires long term commitment and well-integrated activities among stakeholders working in pastoral areas.

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