Characterization, Conservation and Sustainable Utilization of Ethiopian Animal Genetic Resources: Status, Challenges and Opportunities. A review

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ABSTRACT

This review is carried out to show the status, challenges and opportunities of Characterization, Conservation and Sustainable Utilization of animal genetic resources that have been implemented in the country. Animal genetic resources are playing a vital role in ensuring food security and maintaining ecological integrity. However, indiscriminate crossbreeding exercises driven by the demand to increase productivity, increasing change in land use and production systems, unsustainable use of genetic resources, frequent drought; natural and manmade disasters as well as disease epidemic are identified to be potential threats deteriorating the animal genetic resource in the country. Conservation is an action to ensure that the diversity of animal genetic resource is maintained to support sustainable contribution to food production. The three methods used for conservation of animal genetic resources are In-situ, Ex-situ and the combined conservation approach. Effective conservation of animal genetic resources is possible, only if the breeds are identified and documented adequately. The Ethiopian Biodiversity Institute implemented various phenotypic characterization and established in-situ conservation on different sheep, goat, cattle and chicken breeds in different parts of the country following the small ruminant community-based breeding program guideline developed by the the International Center for Agricultural Research in the Dry Areas (ICARDA). Having huge livestock genetic diversity is an opportunity to the country, however, the conservation endeavors so far implemented are not fully effective and comprehensive due to many challenges. Some of the challenges for conservation and sustainable utilization of animal genetic resources include absence of nationwide characterization and identification, national breed population survey and census program to identify and quantify animal breeds/ecotypes, limited resource mobilization towards animal genetic resource conservation, lack of cryo-conservation facilities, absence of monitoring and evaluation system and weak collaboration among stakeholders

Key words; animal, conservation, ex-situ conservation, in-situ conservation

1. Introduction

Animal genetic resources are important subsets of biological diversity, composed of the breeds and strains of domesticated animals that humankind has developed out of some 40 wild species over the last 10,000 years (Mathias, 2003; Valle Zarate *et al*., 2005). Animal genetic resources fall under the horizon of the Convention on Biological Diversity as well as the Nagoya Protocol. Ethiopia is one of the top 25 biodiversity-rich countries in the world, and hosts two of the world's 34 biodiversity hotspots, namely: the Eastern Afromontane and the Horn of Africa hotspots (WCMC, 1994). This is attributed to the wide altitudinal and physico-geographic variations in the country that ranges from 126 meters below sea level (mbsl) in the Danakil depression to the highest peak of 4,620 meters above sea level (masl) on Mount Ras Dashen. Natural selection associated with highly variable macro and micro-climatic conditions of the country, seasonality and variability of rainfall distribution and the extent and wider temperature variations may have also favored adaptive diversity within the population, and endowed the country with diverse ecosystems that are inhabited by amazingly great diversity of animal, plant and microbial genetic resources (FAO, 2001). In addition to its diverse ecology, Ethiopia has served as one of a historic gateway to domestic animals from Asia (believed to be center of origin for most of the domestic animals) to Africa that favored also the diversification of animal genetic resources. Thus, Ethiopia is ranked first in Africa and among the top 10 countries in the world in major farm animal species populations (FAO, 2015).

The most common domestic farm animal genetic resources of the country can be categorized into mammalian, avian and honeybee species. According to a recent estimate (CSA, 2017), the Ethiopian farm animal genetic resources comprises of about 57.8 million Tropical Livestock Unit of cattle, sheep, goat, chickens, horses, mule, donkeys and camels. Within species diversity of domestic farm animal has been represented by a number of breeds/ecotypes in each species. Though breed characterization and identification endeavors are not exhaustive in the country, more than 75 breeds/ecotypes of cattle, sheep, goat, camel, horse, donkey, mule, and chicken are so far identified (EBI, 2013). The current rigorous efforts being carried out by all stakeholders in inventory and characterization works has been revealing distinct breeds and will be expected to boost the number of breeds of the country in each species. Domestic animals played significant role in sustaining the life of many rural people in Ethiopia as source of food and /or as major contributor of food production in the form of draught power. The animals are thought to possess

unique genetic traits which enabled their survival in diverse range of production environments and developed specific necessary features to deal with harsh environments such as severe feed and water scarcity, diseases challenges, extreme hot and cold environments and unpredictable long drought periods.

However, indiscriminate crossbreeding practices driven by the demand to increase productivity, increasing change in land use and production systems, unsustainable use of genetic resources, frequent drought, natural and manmade disasters as well as disease epidemic are identified to be potential threats deteriorating the animal genetic resource (EBI, 2015). Therefore, without application of strategically planned interventions that involve both *in situ* and *ex situ* conservation as well as promoting sustainable utilization approaches, genetic erosion of domestic animal genetic resources of the country will continue and may even accelerate. Moreover, inventory and characterization studies aiming at revealing population size and risk status of breeds to help in minimizing the ongoing trends of erosion and underutilization of genetic resources at risk are also crucial.

In order to reverse the challenges and to enhance the contribution of the sector to the country's economic development, the Ethiopian Biodiversity Institute (EBI) as a national focal institution has to coordinate all stakeholders in the areas of characterization, conservation and sustainable utilization of animal genetic resources (AnGR) in the country. Thus, this review is aimed to assess the status of characterization, conservation and sustainable utilization of AnGRFA (Animal Genetic Resources for Food and Agriculture) in Ethiopia as well as to reveal the major challenges and opportunities facing the sector.

2. Animal genetic resources diversity in Ethiopia

Ethiopia can be considered as a center of livestock diversity. It is a route of livestock migration from Asia into Africa and has large livestock population (FAO, 2015) and diverse traditional livestock breeds spread across diverse ecology, communities and production systems. There are variety of breeds/strains/types within each livestock species contributing to the total genetic pool. The selection process, both environmental and human directed, has resulted in much of the diversity existing between the breeds. Differences among the breeds have been created by reproductive isolation, often imposed by human through the search of different breeding objectives and physical separation for long period of time. As a consequence of physical

separation, each breed/strain has been adapted to particular ecological condition to suit the local climate and the requirements of the community (IlseKöhler-Rollefson, 2004). Within species diversity of domestic animals has represented by number of breeds in each species in the country. Even though, characterization and identification animal genetic resources are not exhaustive, 28 breeds of cattle, 9 breeds of sheep, 8 breeds of goat, 7 breeds of camel, 6 breeds of donkey, 8 breeds of horse, 2 breeds of mule and 7 breeds of chicken breeds are identified so far (EBI, 2013).

The diversity of livestock in Ethiopia is closely related to the diversity of production systems and cultures. Over the past decades, the livestock sector has contributed substantially to food production, but accompanied by loss of diversity, including erosion in indigenous livestock genetic resources, and degradation of ecosystems, particularly with respect to their regulating and supporting services. Genetically diverse livestock populations provide societies with a greater range of options to meet future challenges. Therefore, livestock genetic resources are the capital for future developments and adaptation to the changing environments. If they are lost, the options for future generations will be severely curtailed.

In Ethiopia, the major focus for livestock production mainly aims at increasing food production rather than enhancing the genetic pool of the breeding stock, although this is slowly changing due to the implementation of different policies and strategies including the Global Plan of Action for Animal Genetic Resources (GPA) which has been adopted and implemented at national level. Although breeding has to focus on what the market requires (mass or niche market), other factors have also need to be taken into account. The choice of breeds/breeding used in the livestock sector needs to ensure the profitability of the farm, safeguard animal health and welfare, focus on conserving genetic diversity and promote human health. Therefore, intensification of livestock production systems, coupled with specialization in breeding and the harmonizing effects of globalization and phyto- sanitary standards, have led to a substantial reduction in the genetic diversity within domesticated animal species in developing countries (FAO, 2007).

Livestock adapted optimally to their habitat, in most cases not designed to specialized products like maximum meat or milk outputs, are increasingly being displaced by high performing breeds usually exotic breeds for use in large scale production at high external input systems. According to Alamargot (1987), about 99% of the Ethiopian chicken population were indigenous, while the

remaining 1% consists of imported exotic breeds of chicken during the 1970's and 1980's. However, there has been an increase in the number of exotic breeds of animal genetic resources, especially chicken and cattle. Thus, at present, it is estimated that exotic chicken and cattle genetic resources make up 11.81% and 1.74 % respectively of the national species population (CSA, 2018). In some central, urban and peri-urban areas of Ethiopia, about 70 to 80% of indigenous cattle and chicken genetic resources are either replaced by pure exotics or hybrid of the exotics (Getachew et al., in press).

3. Reasons for conservation of animal genetic resources diversity in Ethiopia

Previous attempt that has been used for the last 5 decades to increase productivity in Ethiopia is by crossbreeding of locally adapted breed with imported exotic animals (Haile et al., 2018). The approaches were failed in most cases due to poor adaptability of exotic breeds and resulted in dilution of genetic resources in urban and peri-urban dairy system. A new approach gaining global interest is a small ruminant community-based breeding program (CBBP) (Haile et al., 2018) and conservation-based utilization in all livestock species that has been run by EBI confirmed substantial genetic gain and economic benefit. For example, pilots conservation-based breeding programs in small ruminant CBBPs resulted in 0.11, 0.18 and 0.21kg genetic gain per year for six months weight, respectively (Haile et al., 2020). The values are equivalent to 16 to 22 % of the liveweight change over 20 years which indicated genetics alone able to meet the projection by the Livestock master plan that 20% of body weight increases over 20 years in small ruminant (Shapiro et al., 2015). Thus, the conservation of farm animal genetic resources embraces avoiding extinction, maintaining genetic diversity and/or the cultural, ecological or socio-economic values of breeds, to provide the right conditions for their evolution within an evolving production system (Gandini *et al*., 2004). According to Hunter (1996), maintaining within and among breeds/strains genetic variation is among the four major reasons to advocate conservation of genetic diversity. Thus, the four possible reasons include the high genetic diversity will likely increase the ability of animals to respond to environmental changes; satisfying ever increasing human needs for food and agriculture; sustainable cross-breeding require at least two viable purebred populations and finally the wide variety of livestock breeds and strains available today is part of people's cultural heritage thus deserves protection.

4. Methods of animal genetic resources conservation

Conservation of livestock diversity has been defined as the total sum of all operations involved in the management of animal genetic resources so that the pool of genetic diversity is maintained over time (Hammond, 1993). It encompasses management of human activities in such a way that animal genetic resources are best utilized and developed to meet immediate and short-term human needs for future generations. Before going for managing a breed, FAO (1995) has recommended the following strategies for effective management of domestic animal diversity at global level for each species: Identifying and listing all breeds, describing and characterizing breeds in order to understand their unique qualities and potential contributions; monitoring the population size and structure for each breed, and regularly reporting about the population that are currently at risk of extinction. Moreover, Ruane (2000) proposed a framework that incorporates both genetic diversity and non-genetic criteria for prioritizing breed management at national levels. Whereas Barker (2002) asserted that the primary focus in the conservation of domestic animal diversity is on conservation of breeds that fulfill the following three criteria: The conserved livestock breed must contribute to the national food security program, the particular livestock breed must have high integrity with social, religious and culture of the society and the genetic resources currently have high commercial/export values. These conservation criteria are vital to the sustainable use of livestock genetic resources in the country. Whereas, the Ethiopian Biodiversity Institute is undertaking its conservation and sustainable utilization activities using indigenous breed as a unit and the priority is given based on the level of threats (whether a particular breed is endangered or vulnerable) and by considering its economic importance. These conservation criteria are identified through generating knowledge on characterizing that particular breed and its production system concerned.

4.1. Phenotypic characterization

Phenotypic characterization of animal genetic resources is the practice of systematically documenting the observed characteristics, geographical distribution, production environments and uses of these resources (FAO, 2011). Conservation usually involves characterization of animal genetic resources and the subsequent development of inventories, including information on the spatial distribution of breeds and valuable breeding stocks, and priority setting. Conservation of local breeds of farm AnGR is part of animal husbandry and should ideally be based on complete information on distribution, structures and trends, productive and adaptive

performances of populations of the existing local breeds. Characterization and identification of breeds and ecotypes are being carried out by many stakeholders including universities and research institutions. Many of the characterization activities are carried out by university students for fulfilling their MSc thesis and PhD decertation's which are reviewed and documented by EBI to identify the gaps. Ethiopian Biodiversity Institute (EBI) is also working in characterization and identification of indigenous animal genetic resources to understand the breeds performances for further research and development efforts as well as to prioritize breeds for conservation. In addition to reviewing and using characterization outputs carried out by other stakeholders, EBI alone has undertaken more than 30 characterization works (eg. in table1) to fill the gap where other stakeholders couldn't reach. The phenotypic characterization follows two approaches FAO (2011), exploratory carried out to investigate the existence of distinct breeds, where there is lack of reliable background information whereas, a confirmatory approach has been done to validate breed identity.

Table 1: **Some examples of characterization works carried out so far by EBI**

No	Name of the characterized breeds and species	Region where the breed is found
1	Guji chicken	Oromia
2	Metekel chicken	Benishngul Gumuz
3	Consumer survey on chicken genetic resources	Benishngul Gumuz
4	Sinnar and Abysinian donkey	Benishngul Gumuz
5	Highland goats in Minjar Shenkora district	Amhara
6	Highland goats in Boset district	Oromia
7	Ruthana, Begait and Felata sheep	Western lowland of Ethiopia (Amhara, Tigray and Benishangul Gimuz)
8	Local ducks	Gambela and Benishangul Gumz
9	Donkeys in South Omo zone	SNNPRS
10	Afar goats	Afar
11	Raya/Harmo cattle	Tigray and Amhara
12	Borana cattle locally known as Borena	Oromia
13	Identification of the dilution rate of cattle breeds	Amhara and Oromia Regions

These and other characterization and identification efforts helps in prioritization and deciding which breed should be conserved first, and thus three methods are used for conservation of livestock genetic resources: *in-situ, ex-situ* and combined conservation approaches.

4.2. *In-situ* conservation:

In-situ conservation, also called 'on-farm conservation', can be defined as conservation of animals at their natural production environment or the continuous husbandry of populations by farmers in the agro-ecosystems where those populations have evolved (Hammond, 1994). Thus, *in-situ* conservation encompasses entire ecosystems, including immediately useful species of animal that form part of the system. Therefore, an understanding of the overall contribution of particular farm animal genetic resources to society must examine all the direct as well as the indirect contributions it makes in the agro-ecosystems. The advantages of this approach are that the animals are still being utilized, the performance characteristics can be properly recorded and evaluated, and the breeds have the opportunity to evolve. The disadvantages are that selection and genetic drift may result in unfavorable genetic changes, if the population is small. There is a risk of increasing inbreeding and hence homogeneity, which is associated with reduced fitness. The animals sometimes are at risk from disease and other natural disasters.

Like in the case of characterization and identification activities, *in situ* conservation works have been implemented by many national and international research institutions. The Ethiopian Biodiversity Institute in collaboration with other stakeholders is carrying out *in situ* conservation as first prioritized conservation method on sheep, goats, cattle and chicken genetic resources (a good examples are given in table 2), whereas, success stories on cattle and horse breeds are given in (plate 1 and 2). There are also many more conservation-based breeding programs in different livestock species that has been implemented by other national and international research institutions. For example, small ruminant CBBPs has been implemented by the International Center for Agricultural Research in the Dry areas (ICARDA) in collaboration with the National Agricultural research system in 4 sheep (Menz, Horro, Bonga and Doyogena) and 3 goat (Abergelle, Konso and Borana) breeds in more than 2400 household and 30 villages (Haile et al., 2020). Participatory identification of breeding objectives, animal identification, performance recording, selection of best animals based on recorded performance and farmers criteria, pooling small flocks and arrange sire use/sharing systems are an integral component of the breeding programs (Haile et al., 2018). Breeders cooperatives, enumerators and nearby

researchers has been used to run the breeding program, data collection and recording, and run data analysis for animal ranking, respectively. Sire rotation among different mating groups has been implemented to control the level of inbreeding.

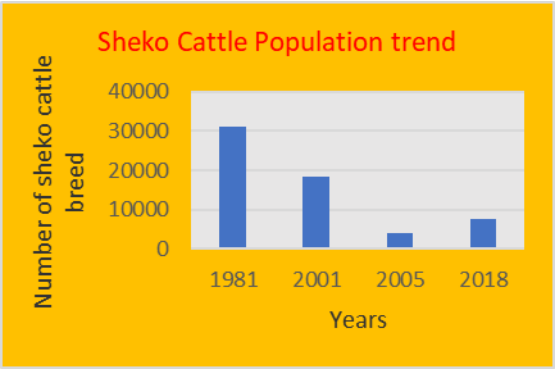
Table 2. Some examples of animal breeds/ecotypes that are under *in situ* conservation

No	Breed (local) Name	District and Region of conservation
1	Sheko cattle	SNNPR
2	Fogera cattle	Amhara
3	Begaria cattle	Benishangul Gumuz
4	Raya (Harmo) cattle	Tigray
5	Washera sheep	Amhara
6	Short fat tailed (Wollo) sheep	Amhara
7	Horro (Ginchi) sheep	Oromia
8	Gedeo sheep	SNNP
9	Highland (Boset) Goat	district, Oromia
10	Arsi-Bale Goat	Oromia
11	Debate chicken	Benishangul Gumuz
12	Jarso chicken	Oromia

Plate 1. Community Based Breeding and Conservation Program: The case of threatened Sheko cattle breed

Sheko cattle breed is found in Bench Maji, Kaffa and Shaka Zones of South Nations Nationalities and Peoples Regional State (SNNPRS), Ethiopia. The breed is the only humpless taurine cattle breed of Eastern Africa. It is known for its milk yield, adaptive capacity and exhibits superior trypano-tolerance than any other indigenous cattle populations found in the country. Early castration or removal of males because of the aggressive nature of the breed and consequent crossbreeding with surrounding ***Zebu*** breed are major threats to the existence of this breed. As a result of the threats, the breed's population has declined from **31,100** in 1981 to **4040** in 2015 – manifestation that the breed was in danger of extinction. This called for an appropriate intervention which led to the designing of community-based breeding and conservation strategy through collaboration of SNNPRS Environment Protection and Forest Authority, Ethiopian Biodiversity Institute (EBI) and other stakeholders. Accordingly, the following major activities have been undertaken.

- Awareness raising campaigns were conducted and trainings were given to the stakeholders,
- Appropriate in situ conservation sites, communities and farmers were selected,
- The SNNPRS allocated budget to finance implementation of the strategy
- Two nucleus farms have been established at Mizan-Tepi University and Tepi Agricultural Research Center,
- Fifty-nine breeding community cooperatives were established, and selection and distribution of best Sheko bulls for use by cooperatives,
- Artificial insemination was conducted using cryo-preserved semen in order to enhance population of the breed, and
- Semen were collected from Sheko bulls maintained ex-situ and cryo-conserved for further restoration, research and development. As the result of implementation, the strategy, ***Sheko*** cattle breed population has increased from **4040** in **2005** into **7600** in **2018**.



Conclusions and recommendations:

Community based breeding and conservation through effective utilization of the available resource is a feasible way to revive population of endangered breeds. Furthermore, the approach is relatively easier to implement with a comparatively lower cost.

Sources:

EBI (2018), Zelalem Admasu (2018)

EBI and SNNP Regional state environment Forest and Climate Change Authority (2018)

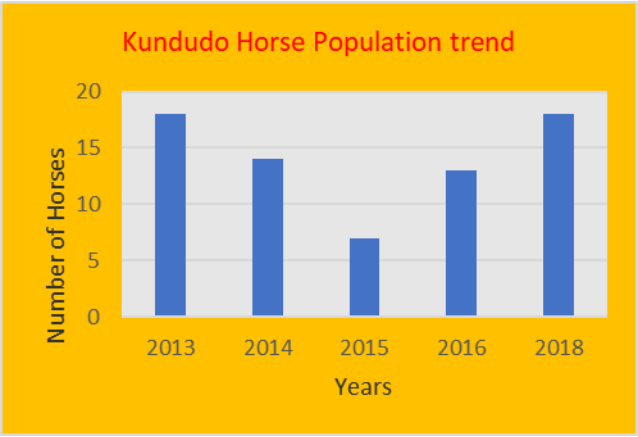
Plate 2: Community Based Breeding and Conservation Program: The case of threatened Kundudo feral horse breed in Ethiopia

Kundudo feral horse breed is found on Kundudo Mountain (Eastern Hararghe Zone, Oromia National Regional State) at an altitude above 2900 m. ***Kundudo*** **horse is** the only feral out of the 8 horse breeds that constitute the largest horse population in Africa (the population of the 8 horse breeds is estimated to be more than 2 million, about a quarter of the whole African population). The population of ***Kundudo*** feral horse breed was declining at an alarming rate from **18** in 2013 to **seven** in 2015 due to the fact that the animals became vulnerable to wild predators, a situation caused by degradation of environmental resources, and also because local community members started to bring them and keep under captivity for various purposes. This called for an appropriate intervention which led to the designing conservation strategy by increasing the population size of the breed.

through collaboration of Oromia Environment, Forest and Climate Change Authority, Ethiopian Biodiversity Institute (EBI) and other stakeholders. Accordingly, the following major activities have been undertaken.

- Awareness raising campaigns were conducted and trainings were given to the stakeholders,
- The horse's natural habitat, Kundudo Mountain, was recognized as an *in-situ* site by the community,
- The Oromia National Regional state allocated budget to compensate farmers who kept the horses under their custody,
- The horses moved to their original place on the mountain,
- Personnel were hired to monitor the status of the horses under *in-situ* condition, and
- A management manual prepared to lead conservation program.

As the result of implementation of the strategy, the ***Kundudo*** feral horse breed population increased from **7** in **2015** into **28** in **2020**; and expected to rise in the years to come.



Conclusions and recommendations

Community-based conservation through restoration and captive breeding of feral animals is a feasible way to revive

Source:

EBI and Oromia Regional state environment Forest and Climate Change Authority (2018)

4.3. *Ex-situ* conservation

Ex-situ approaches involve conserving adequate samples of as many breeds as possible generally in the form of frozen semen, ova, embryos and live animals to reconstruct/restore lost populations of animals. In marked contrast to the situation in plants, *ex situ* conservation, especially cryo-preservation in animals is technically feasible for very few livestock species. However, breeding technologies as artificial insemination (AI) and embryo transfer (ET) may provide support for this approach. Frozen storage of semen and embryos are relatively expensive, but it has an advantage after the initial investment. During storage, frozen genetic materials are at less risk from disease and natural disasters than live animals, but obviously at risk from technological failures. The disadvantages are that reproductive technologies are not uniformly successful or available in the places where it is needed most. Moreover, the breeds conserved in this way are not able to adapt to changes in the production environment over time or new disease challenges. There is good experience in this regard, where the conserved semen is used for research and restoration purposes for threatened Sheko, Fogera and Borana cattle breeds. Currently, more than 90,000 straws of semen are conserved invitro for the five breeds mentioned in (table 3) in collaboration with Ethiopian Biodiversity Institute (EBI) and National Animal genetic Resources Improvement Institute (NAGI).

Table 3. Different cattle breeds that are under *ex- situ* conservation using frozen semen

No	Name of the breed	Type of material conserved	Participant Institutions
1	Borana cattle	Semen	EBI and NAGII
2	Sheko cattle	Semen	EBI and NAGII
3	Begait cattle	Semen	EBI and NAGII
4	Fogera cattle	Semen	EBI and NAGII
5	Irob cattle	Semen	EBI and NAGII

4.4. Creating a conservation herd (gene pool)

This involves crossing several rare breeds together, then breeding them to maintain genetic variability. It is an effective way of conserving genetic variation for two or three breeds. Maintenance of genetic diversity is almost better served by pooling five breeds in a conservation herd (Notter *et al.,* 1994). However, there is a greater risk of losing useful genes when more populations are combined. The disadvantage of this approach is that, although useful genes may

be conserved, the identity of individual breeds is lost. For example, there is a plan by stakeholders to cross the Kundudo feral horse with other horse breed to avoid inbreeding due to very their small population.

4.5. Combined conservation approach

Both *ex-situ* and *in-situ* approaches have limitations. Hence, combining a range of available *ex-situ* and *in-situ* options is the best strategy. Thus, management of farm animal genetic resources will consist of a set of actions to which the whole or part of a farm animal population is subjected to a process of genetic and environmental manipulation with the aim of sustaining, utilizing, restoring, enhancing and characterizing the quality and quantity of the animal genetic resources and its products (Rege, 2001). For example, endangered Sheko breed is conserved *ex-situ* using semen while the semen stored is used for restoration and multiplication at *in situ* condition.

4.6. Sustainable utilization of AnGR

Sustainable management includes those actions, including policy and strategy, which ensure that the animal genetic resources meet present needs, while also retaining its genetic integrity so as to be available for longer term needs (Rege, 2001). It requires careful formulation and implementation of breeding policy and goals, establishment and maintenance of effective and efficient animal identification and performance recording as well as breeding strategies so that the well adapted local breeds should sustain and continue as a functional part of a production system. The unique and rare genotypes of the breed must be identified through surveying for characterization and evaluation to exploit for further conservation and genetic enhancement. Development and implementation of genetic improvement programs is a component of animal genetic resources management (Gizaw et al., 2013). However, in Ethiopia these conservation approaches have not been given adequate attention for sustainable utilization of livestock genetic resources. As a result, various factors are threatening Ethiopian livestock sector such as global climate change, indiscriminate cross-breeding and replacement, change in the traditional production systems, priority for single productive traits and degradation of environments that aggravate unsustainable utilization (EBI, 2014). Ethiopian Biodiversity Institute in collaboration with other stakeholders is trying to improve the situation through implementation of policies and strategies that encourages sustainable use of animal genetic resources of the country. Thus, it coordinated implementation of the Ethiopian National Strategy and Plan of Action for

Conservation and Sustainable Utilization of Animal Genetic Resources, promoting the role of indigenous knowledge, innovations and practices relevant to the conservation of animal genetic resources and their sustainable use. Valuation animal genetic resources and mainstreaming of AnGR issues in to different development sectors are among the action carried out so far. Institutions like the Ministry of Agriculture (MoA), the National Agricultural Research System (NARS) and the National Animal Genetic Resources Improvement Institute (NAGII) have also developed and implemented a breeding policy, different breeding programs, and animal recoding schemes that encourage sustainable utilization practices of AnGR. Those actions by carried out by stakeholders are coordinated through intensive awareness raising and capacity building activities as part of the sustainable utilization programs.

5. Challenges and Opportunities

There are many challenges that have been encountering the animal genetic resources conservation and sustainable utilization programes in the country.

5.1. Challenges

Conservation of livestock genetic resources in Ethiopia has been encountered with many challenges while having many opportunities. The diversity of cattle, sheep, goat and chicken genetic resources as well as other farm animal breeds represents a huge opportunity for livestock development in the face of changing environmental, technological and human needs. However, these genetic resources are being eroded as a result of many challenges including changing economic situation and environmental factors coupled with ineffective conservation measures that have been taken so far. Among the various factors that have limited conservation and sustainable utilization of AnGR, is poverty (IBC, 2004; Solomon *et al*., 2010) which is the most severe issue that restricts the attention that would have to be given by governmental and non-governmental institutions. Conservation of genetic resources cannot be discussed without setting up a sound poverty alleviation and development program in place. Additionally, lack of conservation facilities and human resource capacity, deficiency in technical knowledge and expertise is another challenge confronting better utilization of AnGR. Challenges related to methodology, analytical approaches, data management and conservation are crucial challenges hindering to know the number of locally adapted breeds and the number of breeds classified as at risk, not at risk and unknown. There is also lack of periodical breed level census in the country, that creates a serious lack of information on the population size and structure of breeds/ecotypes

to determine the risk status so that to design appropriate conservation and sustainable utilization strategy.

Many national and international research institutions, Universities and EBI are working in the areas of livestock genetic resource research, conservation and development in Ethiopia. However, stakeholders lack integration in their activities and these, together with the poor institutional set ups make their efforts less successful in reducing the degradation of livestock genetic resources (EBI, 2015; 2016). Other challenges include limited resource mobilization towards animal genetic resource conservation as more focus has been given for crossbreeding though not successful. Lack of cryo-conservation facility, limited information on the geographic distribution and structure of the genetic variation in the existing breeds/populations to develop sound production and conservation strategies, absence of monitoring and evaluation system on indiscriminate use of genetic material in the form of artificial insemination and distribution of exotic live animals for crossbreeding purposes as well as lack of interest and incentives to promote the use of indigenous breeds were also mentioned among the challenges (EBI, 2013; 2015; 2016)

5.2. Opportunities

Having huge livestock genetic diversity is an opportunity to the country, as it is the basis for a response to present day diversified living systems, economic opportunities and future genetic improvement needs in the face of climate change. It will be an asset, if this diversity should be properly conserved, improved and utilized. The relatively huge number of livestock resources, good quality meat, hides and skin, proximity to the export markets, especially to the Middle East, conducive investment policies, the liberalization of the economy and the supports and attentions given by the government to export trade gives the country comparative advantages in livestock trade (Workneh Ayalew *et al*, 2003). There are also enough spaces for tremendous genetic improvement opportunity due to having different production systems and production environments that exist in the country (Gizaw *et al*., 2013). Furthermore, the presence of wide areas of rangelands in most of the low land areas is encouraging for integrated farming for both crops and animals. Increase in human population growth and urbanization in different regions of the world is a potential trade opportunity for Africa and other developing nations (Delgado et al., 1999). As indicated by Solomon *et al*. (2010) that, there are availability of organizations producing and disseminating enhanced livestock technologies, giving credits and health services

to small holder farmers. The opening of many universities and their focus on livestock research is becoming a driving force to encourage farmers and stakeholders working in the sector.

Even at the global and regional levels, the need to reduce the degradation of farm animal genetic resources and establish programs for their conservation and sustainable use is well recognized. This is the reason that the issues of AnGR is embodied in the objectives of the Convention on Biological Diversity, the Global strategy for the management of Farm Animal Genetic Resources coordinated by the Food and Agriculture Organization of the United Nations (FAO) and Intergovernmental Authority on Development (IGAD) regional policy and legal framework. At national level, the focus for conservation, sustainable use and development programs by key stakeholders are getting a momentum. A good example is that Ethiopian national animal breeding policy and livestock master plan has been implemented; breeding programs exist at species level whereas breeding strategy has been devised for sheep and goats, dairy cattle, beef, poultry and camel. National advisory Steering Committee has been established to lead the collaborative activities of stakeholders related to naming of breeds, harmonization of inventory activities and standardization of tools for characterization. Moreover, both national and international research institutions are driving a shift towards community-based breeding and improvement programs to boost production and productivity of indigenous livestock resources. The community-based breeding and improvement programs which are being carried out by ICARDA and Ethiopian Agricultural research institutions to improve and sustainably utilize the indigenous genetic resources can be mentioned as a notable example (Haile et al., 2018; 2020). This is an additional opportunity for the national conservation and sustainable utilization endeavors of the country.

6. Conclusion and Recommendation

It is a fact that Ethiopia is the home of diverse livestock genetic resources and this resource is the bases of life of the people providing diverse functions ranging from provision of food and income to society, and support many social and cultural functions in addition to their ecological roles. However, the sector is challenged with many limitations, among the major problems that should be mentioned include limitation of molecular based characterization studies, and well-organized conservation and sustainable utilization programs.

Thus, in order to minimize the challenges and maximize the opportunity through sustainable development and use of the animal genetic resources, stakeholders need to work focusing on the following measures: build infrastructural as well as human capacity, generate knowledge through characterization and identification, adopt conservation through utilization as the preferred conservation strategy, promote sustainable breeding programs and breeding for sustainability, use reproductive technologies to enhance efficiency of conservation, promote niche market and value addition for livestock products and carefully improve environmental as well as the genetic factors. Promoting existing achievements on conservation-based breeding programs that helps to convince policy makers and even the livestock keepers to give more attention for the breeding programs focusing on local breeds is an important issue that needs due attention. In order to achieve those objectives, it is imperative to allocate sufficient financial resources from both internal and external sources in addition to strengthening stakeholder collaboration in the sector.

References

Alamargot, A.J. (1987). Avian pathology of industrial poultry farms in Ethiopia. Proceeding of the 1st National Livestock Improvement Conference, February 11-13, 1987, Institute of Agricultural Research, Addis Ababa, pp: 114-117.

CSA (2017). Agricultural sample survey 2016/17. A report on livestock and livestock characteristics (private peasant holdings). Federal Democratic Republic of Ethiopia, Central Statistics Agency, Addis Ababa, Ethiopia.CSA (2018). Livestock and Livestock characteristics, (private peasant holdings). Agricultural Sample survey 2017/18. Statistical bulletin volume II, Central Statistics Agency. Addis Ababa. Ethiopia.

Delgado, C., Rosegrant, M., Steinfeld, H., Ehui, S., Courbois, C. (1999). The Next Food Revolution. 2020 Vision for Food Agriculture and the Environment Discussion Paper 28. International Food Policy Research Institute, Washington D.C.

EBI, 2013. The State of Ethiopia's Farm Animal Genetic Resources: The Second Report on the State of the World's Animal Genetic Resources for Food and Agriculture, including sector-specific data contributing to The State of the World's Biodiversity for Food and Agriculture, Addis Ababa, Ethiopia.

EBI (2014). Government of the Federal Democratic Republic of Ethiopia, Ethiopia's Fifth National Report to the Convention on Biological Diversity. Addis Ababa. Ethiopia.

EBI (2015). Government of the Federal Democratic Republic of Ethiopia; Ethiopia's National Biodiversity Strategy and Action Plan 2015-2020. Ethiopian Biodiversity Institute. Addis Ababa. Ethiopia.

EBI (2016). Farm Animal Diversity of Ethiopia: Breeds and Ecotypes Catalogue. Ethiopian Biodiversity Institute (EBI), Addis Ababa, Ethiopia.

EBI (2018). Successes Stories Under the Convention on Biological Diversity: The Case of Ethiopia. Addis Ababa.

EBI and Oromia EFCCA (2018). A joint annual report on the state of Kundudo Feral Horse.

EBI and SNNPR EFCCA (2018). Annual report on the state of community-based conservation of Sheko breed.

FAO (2001). FAOSTAT. FAO statistical databases on agriculture, fisheries, forestry and nutrition, Food and Agriculture Organization, Rome, Italy.

FAO (2011). Draft Guideline on Phenotypic Characterization of Animal Genetic Resources. CGRFA-13/11/Inf.19. Italy, Rome.

FAO (2015a). FAO statistical pocketbook world food and agriculture 2015. Food and Agriculture Organization of the United Nations, Rome. 2015.

FAO (2015b). The second report on the state of world´s: animal genetic resources for food and agriculture. (B. Scherf & D. Pilling, Eds.). Rome. (available at http://www.fao.org/3/ ai4787e/index.html). http://doi.org/http://www.fao.org/3/a-i4787e/index.html.

Fikru S, Gebeyew K (2015) Sheep and Goat Production Systems in Degehabur Zone, Eastern Ethiopia: Challenge and Opportunities. J Adv Dairy Res 3:134.

Gizaw, S., Abegaz, S., Rischkowsky, B., Haile, A., Okeyo, A.M., Dessie, T. (2013) Review of sheep research and development projects in Ethiopia. ILRI Project Report. Nairobi, Kenya.

Haile, A., Getachew, T., Mirkena, T., Duguma, G., Gizaw, S., Wurzinger, M., Soelkner, J., Mwai, O., Dessie, T., Abebe, A., Abate, Z., Jembere, T., Rekik, M., Lobo, R.N.B., Mwacharo, J.M., Terfa, Z.G., Kassie, G.T., Mueller, J.P., Rischkowsky, B. (2020). Community-based sheep breeding programs generated substantial genetic gains and socioeconomic benefits. Animal 1–9. https://doi.org/10.1017/S1751731120000269

Haile, A., Wurzinger, M., Mueller, J., Mirkena, T., Duguma, G., Rekik, M., Mwacharo, J.M., Okeyo, M., Soelkner, J., Rischkowsky, B. (2018). Guidelines for setting up community-based small ruminants breeding programs Second edition.

IBC (2004). The State of Ethiopia's Farm Animal Genetic Resources: Country Report. A Contribution to the First Report on the State of the World's Animal Genetic Resources.IBC. May 2004, Addis Ababa, Ethiopia.

IlseKöhler-Rollefson (2004). Farm Animal Genetic Resources. Safeguarding National Assets for Food Security and Trade. A Summary of workshops on farm animal genetic resources held in the Southern African Development Community (SADC). Eschborn 2004.

Rege, J.E.O, Kahi, A.K., Okomo-Adhiambo, M.O., Mwacharo, J. and Hanotte, O., (2001). Zebu cattle of Kenya: Uses, Performance, Farmer Preference, Measures of Genetic Diversity and Options for Improved Use. Animal Genetic Resources Research 1. ILRI (International Livestock Research Institute), Nairobi, Kenya.

Shapiro, B., Gebru, G., Desta, S., Negassa, A., Negussie, K., Aboset, G., Henok, M. (2015). Ethiopia livestock master plan Roadmaps for growth and transformation: A contribution to the Growth and Transformation Plan II (2015-2020). ILRI Proj. Report. Nairobi, Kenya Int. Livest. Res. Inst. (ILRI).

Solomon, G., Azage, T., Berhanu, G., Dirk, H. (2010). Sheep and goat production and marketing systems in Ethiopia: Characteristics and strategies for improvement. IPMS, Ethiopian Farmers Project Working Paper 23. ILRI, Nairobi, Kenya. 58 pp.

Valle Zárate, A., Musavaya, K., Schäfer, C. (2005). Gene flow in animal genetic resources. A study on status, impact and trends. University of Hohenheim and GTZ.

WCMC (1994). Biodiversity Data Sourcebook. World Conservation Monitoring Centre, World Conservation Press, Cambridge, UK.

Workneh, A., Shiferaw,Y., Amaldegn, A., Alemayehu, M., Yilma, J, Getachew, G., Nemera, O, Kahsay, A., Gebre, D., Alemayehu, R. (2003). Challenges and Opportunities of Livestock Marketting in Ethiopia.EIAR. Addis Ababa. http://www.eiar.gov.et/

Zelalem, A. (2018). Assessment on current population size and risk status of indigenous Sheko cattle breeds in their entire breeding tract of Bench Maji, Sheka and Kaffa zones, South Western, Ethiopia. Msc Thesis, Mitzan Tepi University, Ethiopia.