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The Role of Population Genetics for Ethiopian Farm Animal Genetic Resources Conservation

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ABSTRACT

This review work is focused on the theory of genes and chromosomes as they occur and vary in members of populations. Conservation of local breeds of farm animal genetic resources should be a part of animal management and the communities should be informed by pertinent parties for the distribution, structures, and trends, productive and adaptive performances of populations of the existing breeds. Conservation farm animal genetic resources still not practiced and managed well in the whole or all over the country except for few breeds such as three cattle breeds and one sheep at research centers. The responsible constraints are lack and gap (is avail) of information of about farm animal genetics resource, climate change the anther driving force to change animal production system, increase the exposure of breed populations to un familiar epidemic disease and lack of awareness of AnGR among decision makers and lack of consultation with livestock keepers and other relevant stake holder. But there are also opportunities in the country such as practice in little research centers. Farm animal genetic resources conservation must be practice by well-designed management, support by national breeding policy strategy and economic wise to attain the food security of many societies finally to the GDP of the country as the whole. Farm animal genetic resource information should be accessible available for every interested specially for animal keepers and other stakeholders as well. Perceptions and thought s of the community should include during design and implementation of animal conservation in the country. Animal conservation must have support by government and non-government organization to facilitate, fund and other related aspects.
Keywords: Population Genetics, Conservation, Ethiopia

I. INTRODUCTION

Population genetics is dealing the theories of genes and chromosomes number of every member of a population. Genes, chromosomes and environmental influence are controlled the development of organisms. We observe that different species are different because they develop differently. Population genetics could supply answers these differences having with essential step in animal, human and plant species through demographic cultural developments (Diamond 2002). This subject has effective management dream of farm animal genetic resources (AnGR) that requires comprehensive knowledge of the breeds ‘characteristics, population size and structure, geographical distribution, the environment and genetic diversity. Strategic priority areas and Global Plan Action for Animal Genetic Resources is adopted by 109 countries at the first International Technical Conference held in Switzerland and endorsed by the FAO Conference (FAO, 2007a).

As the genetic diversity, low-production breeds are contributed to current or future traits of interest for maintaining future breeding options (Natter, 1999; Bruford *et al.*2003; Toro *et al.* 2009). According to the FAO reported that from 7600 breeds about (20%) worldwide, belonging to 18 mammalian species and 16 avian species are at risk and 62 breeds became extinct within the first 6 years of this century (FAO, 2007b). A breed that is common in other countries is likely to be a lower priority for national conservation. A basic requirement is to know whether a given national breed is genetically distinct or whether it is part of a larger population spread across several countries. In a recently developed classification (FAO, 2007b), breeds present in only one country are termed local breeds and those present in more than one country are termed trans-boundary breeds, the latter being further differentiated into regional and international trans boundary breeds. Depending on the extent of their distribution, in 2008, about 7040 local breeds, 500 regional trans-boundary breeds and 551 international trans-boundary breeds were recorded in FAO Domestic Animal Diversity Information System (DAD-IS; http://www.fao.org/dad-is/) (FAO, 2009). Therefore, this review paper was initiated to review the role of population genetics for farm animal genetic resources conservation for present and future uses.

The Roe of Population Genetics for Ethiopian Farm Animal Genetic Resources

Conservation

According to IBC (2013) cited by CSA, 2009, Ethiopia has served as a gateway of domestic animals migration from Asia to Africa. In terms of livestock population, Ethiopia stands first in Africa and 10th in the world. The domestic animal population of the country is estimated to be 47.5 million cattle, 26.1 million sheep, 21.7 million goat, 1 million camel, 39.6 million chickens, 1.8 million horses, 0.4 million mules and 5.6 million donkeys (CSA, 2009). Though, this increased population size doesn't necessarily show the state of the animal diversity; given more than 99% of the livestock population (excepting poultry) being indigenous breeds. However, the trend and the state of individual breeds are needed to be scrutinized, since some of the breeds are threatened. At present there are about 30 cattle, 14 sheep, 14 goat, 4 camel, 4 donkey, 2 horse, 2 mule, 5 chicken and 5 honey bee breeds/strains/populations are identified. However, the status and trend of most of the breeds is not known. At the moment population genetics stated that Sheko cattle is the only Taurus breed in East Africa appears to be highly threatened as a result of interbreeding with the local zebu and change in the system of production. Whereas, Fogera, Begayit, Irob, Ogaden, Afar and Borena cattle breeds, Sinner donkey breed, and afar sheep breed are also facing various degrees of endangered species.

The major threats of livestock genetic resource are feed shortage as a result of degradation of rangelands/grazing areas, overgrazing and overstocking; sporadic invasion of rangelands by weeds and shrubs, expansion of crop cultivation, illegal trafficking, inbreeding and interbreeding and Trypanosomiasis. The major threats for indigenous chicken are the random distribution of exotic breeds, diseases and predations. While the major threats to honeybees are agro-chemicals (pesticides/herbicides) diseases, pests and predators. Some indigenous domestic animals (e.g. Sheko and Ogaden cattle) are interbreeding with other breeds and are losing their unique features. In addition, drought, desertification and abandoning of irrigated areas due to salinity are affecting the pastoralists and possibly the animal genetic resource. Crossbreeding of Menz sheep with Awassi exotic breed is likely to dilute the indigenous Menz sheep breed. Boran cattle breed is also a subject of dilution as a result of crossbreeding and replacement by other breeds during restocking after drought. Introduction of new breeds to a new area is also resulting in appearance of diseases which were not recorded before. Gumboro is a disease of poultry which is being seen in Ethiopia only since recent times.

As a result of increased market demand, the number of cattle, goat, sheep and camel being exported legally and illegally seems to threaten the resource since the size of export is not equal to the off-take rate. This can be verified by the large proportion of young and breeding animals supplied to the market. Conservation of the domestic animal diversity is not getting the attention it deserves. Fogera cattle breed is interbreeding with other cattle breeds and consequently the pure line is declining. Ranches were established in Chagni, Metekel and Andasa for this breed with major objectives of breed Improvement and retaining the pure lines. A ranch was also established for Washera sheep in north western Ethiopia (Amhara region).

The national artificial insemination coverage for cattle is 1%. Exotic or crossbreed bulls, chicken and sheep are also distributed to some parts of the country. Excepting poultry the level of current introduction is low and for cattle is mainly restricted to urban areas. However with the aggressive extension program to increase the artificial insemination service and due to more focus on certain breeds and areas there is serious threat of dilution to some local population.

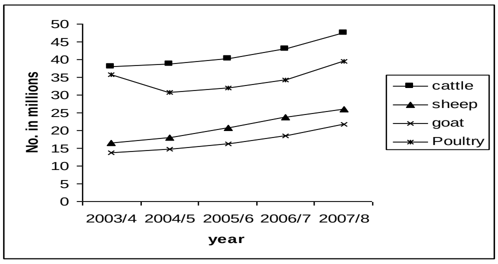

Figure 1: Change in Population Size of the cattle, sheep, goat and poultry in the period

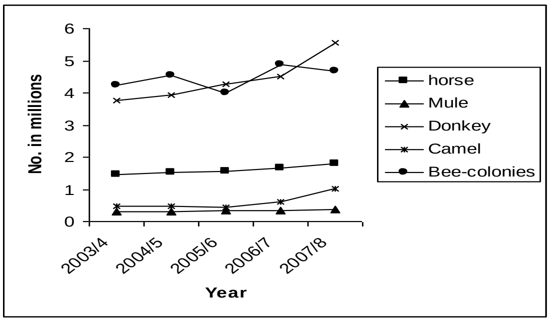

Figure 2: Change in Population size of horse, mule, donkey, camel and bee-colonies

Currently as a result of changes in production system and interbreeding with Zebu animals, the breed (Shako cattle) is under severe threat of extinction. The recent estimate of the population is around 4,000 (Takele, 2005) against 31,000 and 18,307 reported by FAO in 1999 and 2001, respectively.

Diversity of Farm Animal Genetic Resource

According to Moritz (1994), degrees of genetic differentiation are relevant to endangered species conservation. A measure of distinct species is strong application idea to know patterns of distinctness and identify entire systems. This whole idea of prioritization is very controversial. However, genetic distinctness and ecological importances are not necessarily correlated and more important unanswerable issue. Genetic distinctness should be viewed as only one of many criteria in assessing conservation merits.

Genetic diversity provides a way for populations to adapt to changing environments and more variation is more likely to possess variations of alleles determining traits that are suited for the environments. In applying the principles of population genetics to recommend endangered species conservation and biologists are interested to see genetic variation, distribution and maintenance. However, opposite situation are faced on endangered species, with a small number of populations which are isolated from one another having a small number of individuals. Applying population genetic theory to such situations may point the way to management strategies which will maximize the maintenance of existing variation.

Connectedness is generally measured by examining the frequencies of different alleles, or forms of a specific gene, at several different genes. If the frequencies differ significantly between two areas, it is likely that there is some restriction in gene flow between them. If it appears that there is no difference in frequencies from one area to another, it may be some genetic connection preventing differentiation (other interpretations are, of course, possible). Strong inter population connectedness (presumably through frequent migration) will be good for promoting the maintenance of overall genetic diversity; rare alleles are less likely to disappear in a larger population. However, a disadvantage to strong inter population connectedness is that deleterious alleles and diseases may more easily spread through a species whose populations are in frequent contact with each other. It is important to understand the threats to a species in order to properly interpret information on inter population structure.

In addition to this Avise (1994) said that Meta populations are frequently mentioned in conservation of endangered species. On a landscape scale, this situation arises when appropriate habitats are small and dispersed. Numerous subpopulations must be protected and allowed to maintain and survive in order for the Meta populations. Habitat fragments are often preserved in isolation. While all such efforts should be applauded, it also must be recognized the necessary steps in the protection of some diversified species.

Figure 3: Show differences possible in livestock breeds and species over time and space

How population genetics play role in conserving farm animals

Conservation of animal genetic resources for food and agriculture (AnGR) may be undertaken for a number of reasons (FAO, 2012). In developed countries, traditions and cultural values are important driving forces in the conservation of risk breeds and the emergence of niche Markets for livestock products. However, in developing countries the immediate concerns are food security and economic development. Allendolf et al., 2006 and Avise, 2004 stated that conservation genetics is an interdisciplinary science that aims to apply genetic methods to conservation and restoration of biodiversity. Interdisciplinary of conservation genetics is based on the interaction of several field including population genetics, molecular ecology, biology, evolutionary biology, and systematic, Genetic diversity is one of the three fundamental levels of biodiversity with direct impact on conservation of species and ecosystem biodiversity. According Kefyalew, 2013, conservation of animal resources should ideally be undertaken at global level, because of the existence of non- and trans-boundary breeds. However, national conservation programs better serve specific local Interests, such as conservation with the objectives of improving indigenous breeds. There are obviously m any reasons why genetic conservation should be considered, e.g. cultural, historic, and scientific interests and on the one hand for more practical and economic considerations.

Conservation is management of animal genetic resources by communities and pertinent parties. Although in Ethiopian much information is lacking for the conservation of farm Animal Genetic Resources (AnGR) from the rational utilization and protection of existing genotypes from genetic erosion (IBC, 2004) cited in Kefyalew, 2013. Therefore, insitu (in which animals are maintained within the environments or production systems in which they were developed) and ex situ conservation strategies are recommended. The latter can be further divided into ex situ– in vivo conservation and cryo conservations (FAO, 2012).

In situ Conservation: In the context of domestic animal diversity, in situ conservation primarily involves the active breeding of animal populations for food and agricultural production in such a way that diversity is optimally utilized in the short term and maintained for the longer term. Activities pertaining to in situ conservation include performance recording schemes, development of breeding programmes and management of genetic diversity within populations. In situ conservation also includes steps taken to ensure the sustainable management of ecosystems used for agriculture and food production.

Ex-situ Conservation: In the context of domestic animal diversity, ex situ conservation means conservation away from the habitat and production systems where the resource developed. This category includes both the maintenance of live animals and cry conservation.

Ex situ– in vivo conservation: Ex situ – in vivo conservation is ex situ conservation in which germ plasma is maintained in the form of live animals. As in the case of in situ conservation, it is accepted that improve-ment and natural selection may alter gene frequencies in the conserved population. A key question with respect to this strategy is whether or not long-term finances and commit-ment are available to maintain generations of animals to the standards required for success-full conservation.

Quantify the practice made to conserve farm animals in Ethiopia

Unfortunately, except for limited activities that are meant to maintain pure stocks of 3 cattle breeds and 1 sheep breed, no conservation activities of farm AnGR have so far been In Ethiopia, information for sustainable utilization and conservation of the farm animal genetic resources are very limited and, if available, are full of gaps (IBC, 2004) cited in kefyalew,2013. Conservation of Farm animal genetic resources (FAnGR) refers to all human activities including strategies, plans, polices, and actions undertaken to ensure that the diversity of FAnGR is maintained to contribute to food and agricultural production and productivity, now and in the future (ILRI, 2006). For example, Indigenous breeds of sheep and goats may produce less milk or meat than improved breeds. But they usually fulfill a wider range of functions for their owners and are much easier to manage. Many marginal areas can be exploited only by locally (IRLI, 2006).

Opportunity and constraints farm animal conservation in Ethiopia

Opportunity: In situ conservation of livestock breeds is primarily the active breeding of animal populations and their continued use as part of an ongoing livelihood strategy (Solomon et al., 2008). Village-based breed improvement programs must be a complementary to in situ livestock conservation objectives with the concept conservation through sustainable utilization. In such a context, it can be viewed as part and parcel of a comprehensive conservation plan, and not as a separate genetic improvement activity, that entails significant additional costs. In the meantime, there are more feasible conservation methods at hand under the current circumstances including in vivo conservation. In vivo conservation includes in situ and ex situ methods. Ex situ in vivo conservation is the maintenance of pure-bred nucleus flocks in an organized government farms or research farms which can form a repository of the pure breed. A conservation-based breeding program should be based on broader breeding objectives that incorporate the needs and perceptions of the community and maintenance of the genetic diversity Such as adaptation traits. Involvement of the farmers in the design and implementation of the breeding program in line with the principles of in situ conservation of genetic resources is one of the options which must be considered.

Trypanotolerant traits of Shako (Workineh et al., 2004; Stein et al., 2011) and Nuer/Abigar cattle breeds and the adapted breeds or species. For example, camels are the only livestock in areas with less than 50 mm of rainfall. If these animals die out, it will no longer be possible to use large areas of arid lands to produce food. Additionally, the genetic diversity they embody enables breeders to respond to changes in production, marketing and the natural environment. The adaptation of different species and breeds to a broad range of environments provides the necessary variability that offers opportunities to meet the increased future demands for food and provide flexibility to respond to changing markets and needs. However, currently, there is a threat of loss of genetic diversity in livestock populations to the extent that some breeds may be approaching extinction. This calls for strong conservation activity which is important, among others, in maintaining genetic diversity to meet the needs of current and future utilization; providing options for adaptation to changing environmental conditions; and preserving cultural and historical values (Gibson et al., 2006). The first step in conservation is to know which breed to conserve (characterization).

Basically, conservation is categorized into ex situ and in situ conservation. The combined use of live animals and frozen semen appears to be the best strategy. For instance, a pure breeding strategy is necessary for breed conservation and it may be accompanied by a well-organized community based breeding program supported by a nucleus herd of purebred Sheko animals (Stein, 2011). Conserving the Ethiopian Boran in Borana lowlands of Ethiopia will secure the future use of the Borana genetic material at very little costs per animal (Kerstin, 2006). Priority should be given to breeds that have reached critical or endangered status, genetically diverse stocks, breeds with unique characteristics and Stocks with high overall economic merit. Some researches in Ethiopia like analysis of genetic diversity and conservation priorities for six north Ethiopian cattle breeds (Zerabruk et al.,2007) and Ethiopian sheep breeds (Gizaw et al.,2008) can also provide valuable information on conservation program.

According to Workneh et al., (2004), there are encouraging developments from FAO (DAD-IS) and ILRI (DAGRIS) as part of their global research programs for characterization, documentation and conservation of Farm animal genetic resources. Potential candidate institutions in Ethiopia for characterization and conservation are MOA (Ministry of Agriculture), IBCR, EIAR (Ethiopian Institute of Agricultural Research) and Academic institutions Governments are sufficiently concerned about the erosion of livestock breeds to issue a Global Plan of Action for Animal Genetic Resources(FAO 2007a). This contains recommendations on monitoring the loss of breeds, their sustainable use and development, their conservation, and policies, institutions and capacity building to manage animal genetic resources. Supporting livestock keepers to add value to their traditional breeds also contributes to achieving two of the eight Millennium Development Goals (Goal 1 and 7) (UNDP, 2000). The Convention on Biological Diversity (Article 8 and 10) obliges governments to support traditional life styles, biological diversity and cultural practices – of which local breeds and species are an integral part (CBD, 1992).

Constraints: In Ethiopia, information for sustainable utilization and conservation of the farm animal genetic resources are very limited and, if available, are full of gaps (IBC, 2004). It would no doubt be of interest to future generations of animal breeding specialists, as well as to interested laymen, if it were possible to maintain representative samples of some of the once important animal breeds especially in ex situ conservation, which are now on the verge of disappearing (FAO, 1990). Practical and economic needs ought to be the most important reason for conservation in future; one could perhaps argue that, farmers with economically competitive breeds or genetic types should take care of their own preservation. Numerous attempts made to introduce 'improved' breeds with poor success in terms of achieving genetic potential. Fertility and longevity of introduced breeds so poor that continual importation of exotic breeds necessary. Rare breeds often crossed with 'improved' breeds due to small population, dilution of breed characteristics and creation of gene pool from which it is then difficult to identify and utilize favorable local breeds genetic characteristics are also the main threats to animal genetic resources in Ethiopia. Unfortunately, the situation is more complex.

The economic and environmental conditions are changing and genetic types which are superior under one set of conditions may be inferior under a different set of conditions. As the changes are gradual and different breeds or types are not generally compared under exactly the same conditions, the individual breeder or leader of a breeding program has usually no interest in, or possibility of, conserving for future use animals which, at any given time, considers slightly inferior to those selected for breeding (Rendel, 1975). However, sustainable use of genetic resources should effectively deal with semen and embryos preservation as part of the ongoing utilization and improvement programe.

Climate change has the potential to drive gradual changes in production systems (e.g. affecting the availability of feed resources), to cause more frequent climatic disasters, and to increase the exposure of breed populations to unfamiliar epidemic diseases. Other cross-cutting threats include lack of awareness of the significance of AnGR among decision-makers and lack of consultation with livestock keepers and other relevant stakeholders (FAO, 2009a), both of which contribute too many threats arise because of policy and management decisions.

In Ethiopia, indiscriminate breeding, disease, feed shortage and agro-chemicals are some causes of threats to maintenance of animal genetic diversity. (IBCR, http://www.ibc.gov.et/ biodiversity/ conservation). Feed shortage and disease burden exacerbated by climate change. Livestock health problems such as the high prevalence of Trypanosomiasis in the lowlands are among the challenges that affect livestock fertility.

II.CONCLUSION

Population genetics is the study in theory, in the laboratory and in the field of genes and chromosomes in members of populations. Effective management of farm animal genetic resources (FAnGR) requires comprehensive knowledge of the breeds 'characteristics, including data on population size and structure, geographical distribution, the production environment, and within- and between-breed genetic diversity.

The major threats to the livestock genetic resource are feed shortage, agro-chemicals (pesticides/herbicides) for honeybees, diseases, pests and predators, inbreeding and interbreeding. Conservation a mandate for all but, still not practiced and managed well in the whole or all over the country except for few breeds.

Recommendations

- Farm animal genetic resources conservation must be practice by well-designed management, support by national breeding policy strategy and economic wise to attain the food security of many societies finally to the GDP of the country as the whole.
- Farm animal genetic resource information should be accessible available for every interested specially for animal keepers and other stakeholders as well.
- Perceptions and thought s of the community should include during design and implementation of animal conservation in the country.
- Animal conservation must have support by government and non-government organization to facilitate ,fund and other related aspects

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