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Sheep genetic resource conservation experience in Turkey and future prospects in Ethiopia: A Review

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Abstract

Conservation of native animal genetic resource is vital to maintain genetic diversity sustainably and to cope with the future challenging climate change. Thus, the aim of this paper was to review the experience of sheep conservation practice in Turkey and future prospects in Ethiopia. In Turkey, fifteen sheep types are extinct and other native sheep population decreased by 47% due to an unplanned crossbreeding program. For these reasons, sheep genetic resource ex-situ in vivo conservation project started in 1995 with three sheep breeds. The animal breeding law regarding registration of new breed and conservation of animal genetic resources was enacted in 2001 in Turkey. In-situ conservation subsidies of sheep breeds near to extinction have been continued since 2005. Following these events, in vitro conservation of germplasm of 13 sheep breeds have been initiated in 2007 and two gene banks have been established and thereby sperm, embryo, cell, and DNA of from each sheep breed conserved in the gene bank. Although they were successful in both in-situ and ex-situ conservations with some limitations, in-situ conserved sheep breeds had better productivity than ex-situ in vivo conserved sheep in Turkey. In the case of Ethiopia, in-situ conservation will be compatible with the existing infrastructure. Through balancing the genetic gain and inbreeding level, it is possible to integrate the existing community-based genetic improvement programs (with in breed selection) with sustainable in-situ conservation of native sheep genetic resources in Ethiopia.

Keywords: Crossbreeding, ex-situ conservation, in-situ conservation, genetic erosion

Introduction

The sheep population in Turkey was approximately 23 million in 2010. About 18% of meat and 6% of milk was produced from sheep. Despite their contribution, there has been a 47% decrease in the sheep population in Turkey during to the last 20 years and still declining (Turkstat, 2010, as cited by Sezenler et al., 2014). In Turkey, 35 sheep types are listed by the Domestic Animal Diversity Information System of the Food and Agriculture Organization and 15 of these are given as extinct (DAD-IS, 2010, as cited by Sezenler et al., 2014). Most livestock breeds worldwide are threatened by the loss of genetic resources (FAO, 2007). There are a number of factors which causes risk of loss and threaten domestic animal diversity. For example; in the developed countries, the utmost cause for genetic erosion is the growing trend to depend on a very limited number of modern breeds suitable for the high input and output needs of industrial agriculture (FAO, 2013). Due to the effect of this trend many indigenous breeds have lost their function (unique quality) and disappeared (FAO, 2013). For example; Kıvrıçık is one of the most commonly used sheep breeds which constitute 6 - 7% of the total sheep population in Turkey (Kaymakç et al., 2001). Although the breed is multipurpose, it has higher wool and meat quality than the other local sheep breeds (Kaymakç et al., 2001). Despite its numerically large population and important breed, uncontrolled crossbreeding pressure threatens the existence of purebred Kıvrıçık populations (Yılmaz et al., 2003; Oner et al., 2014). Between 1980 and 2000 47.4% of sheep have been lost (Oskam et al., 2005).

To solve the problem of genetic dilution and erosion, conservation of inhabitant sheep genetic resources was initiated in 1995 in Turkey (Goncagul, 2001). There are two types of conservation strategies: conserving animals in their environment or habitat (in-situ) and without their habitat (ex-situ). The ex-situ can be further classified into ex-situ in vivo conservation and ex-situ in vitro conservation (FAO, 2013). However, ex-situ in vivo conservation was started in 1995 (Goncagul, 2001) and in situ and ex-situ in vitro conservation was followed after some years in Turkey by farmers and non-governmental organizations in order to conserve their sheep genetic resources. Therefore, adopting the experience of Turkey in sheep conservation will be a good lesson for our country Ethiopia. Thus, the aim of this paper was to review the experience of sheep conservation practice in Turkey and future prospects in Ethiopia.

Genetic erosion and measures taken in Turkey

Sheep population trend and previous genetic improvement efforts

Sheep population of Turkey increases at increasing rate up to 1980 and decreasing at increasing rate starting from 1980 to 1995 (Figure 1). Associated to the loss in numbers, there has been a reduction in the genetic resource with the result that at least three local sheep breeds of Turkish become extinct and several others breeds are also decreased in numbers (limited geographic distribution) that they are considered to be endangered and at possible risk of extinction in the future (Yilmaz et al., 2013).
The product which expected from sheep industry also decreased with the sheep population. Government and universities was tried to improve the performance of their local breeds through crossbreeding with highly productive exotic breeds starting from 1928. However, the success of the crossbreeding program was negligible (Yilmaz et al., 2013). After more than eighty years of effort, there is little evidence of improvement in the sheep industry (Yilmaz et al., 2013). Thus, crossbreeding programmes terminated due to a variety of reasons including unorganized programmes serving the interests of individual scientists rather than the industry as a whole, susceptibility of crossbreeds to disease, poor adapted nature of the crossbreds to local conditions, inadequate financial support and lack of eagerness by farmers to make use of the new genetic material (Yilmaz et al., 2013). Now, the government is understands the impact loss of this important aspect of biodiversity and has established programmes for conservation of several native breeds to ensure that the local gene pool is preserved and can thus continue to contribute to biodiversity and sustainable livestock production.

Conservation priority of Turkey sheep breeds

The ex-situ invivo conservation program in 1995 was started without prioritization of native sheep breeds based on their contribution to genetic diversity and non-genetic factors. In order to fill the gap prioritization was conducted later in 2012.

Contribution to genetic diversity

In order to evaluate the contribution breeds to genetic diversity based on genetic data, four different approaches were used; these are allelic richness, Weitzman approach, Metapopulation, and kinship score set approach. Based on allelic richness Ivesin, Hemin, Karayaka and Sakiz; based on Weitzman approach Sakiz, Karagul, and Ivesi (Awassi); with respect to Meta population consideration Sakiz, Kivircik, Karayaka, and Ivesi; and in the kinship score set approach Ivesi, Sakiz, Gokceada were the breeds that were suggested to have priority (Acan, 2012). Generally, Ivesi, Sakiz, Karayaka, Kivircik, Hemin, and Akkaraman would be important breeds to cover total genetic diversity including allelic richness, distinctness, and products of different evolutionary histories, different geographies and perhaps different environmental adaptations (Acan, 2012).

Utilities of the Turkish Sheep Breeds

To be successful in the conservation program, in addition to genetic diversity, the extinction risks, adaptability of the breeds, possession of unique traits of economic and socio-cultural importance should also be considered (Ruane, 2000; Gandini and Villa, 2003). The contribution of the breed to the genetic diversity, the risk of extinction of the breed, and conservation value of the breed are three components for the evaluation of the utility of the breeds (Acan, 2012). According to the report of Acan (2012) the extinction risks were standardized to fit in the range between 0.1 and 0.9. The breeds that had extinction risks above average were Doglic, Herik, Kivircik, Karagul, and Sakiz. The same author states that the main reason for the high risk is the already small population sizes, the small area of distribution, extensive hybridization and most importantly the low esteem of the farmers for the breed (Acan, 2012). Nevertheless, it could be argued that better performing breeds (Ivesi, Morkaraman), or breeds with high adaptability to the marginal environment (Gökeada, Karayaka, Hemşin) have lower risks of extinctions (Acan, 2012).

As part of the prioritization process of the breeds, their relative merits in terms of the economic values of the breeds, the adaptive values of the breeds and the socio-cultural importance of the breeds were considered. Acan (2012) tested three scenarios. When meat production was twice as important as milk production, Norduz, Akkaraman, and Sakiz were the selected breeds (Acan, 2012). When milk production was considered as important as meat production, Norduz, Akkaraman and Sakiz ranked as the top prioritized breeds (Acan, 2012). On the other hand, when adaptive and socio-cultural values had the same weights with the production values, Norduz, Hemşin, and Akkaraman sheep breeds are top three breeds (Acan, 2012). Based on utilities of the breeds; Akkaraman, Sakiz, Norduz, Hemşin, and Ivesin have high priorities for conservation (Acan, 2012).

In-situ and ex-situ in vivo conservation of sheep breeds

Indigenous breeds can be reared with extensive management conditions and with low-quality feed resources. These breeds have special qualities and are very well adapted to their original breeding conditions of the poor environment in which they are able to live and reproduce (Koncagül et al., 2011). Since climate change associated with heat stress, quantity, and quality of feed resources, spatial and temporal
distribution of diseases the existing conditions of feed and health-related situations can be change in the future due to climate change. Different breeds had a different response for such type of events of climate change. Thus, maintaining the existing variation through conservation will provide the ability to adapt to the possible situations resulted from climate change. Conservation could be applied for endangered breeds and breeds that are not being utilized efficiently (Barker, 2001). Conservation aims of farm animal genetic resources range from avoiding extinction, maintaining genetic diversity, ecological or socio-economic values of breeds, to providing the right conditions for their evolution within an evolving production system (Gandini et al., 2004).

Animal genetic resource conservation project started in vivo conservation program in 1995 with three sheep breeds (Golceada, Sakiz and Turkish Merino) and other livestock species (Goncagül, 2001). Consequently, the animal breeding law which contains two articles regarding registration of new breed and conservation of animal genetic resources was enacted on 21 March 2001 (Goncagül, 2001). After ten years, in-situ conservation subsidies of farm animals including cattle, sheep, goats, bee, water buffalo breeds possess extinction risks has been continued in their original habitat since 2005 (Koncagül et al., 2011). So as, to support the in-situ conservation of breeds, farmers, expansion areas and project coordinators were determined, and the projects were created for each breed accordingly. In this context, incentive payment was allowed to 236 breeders for the purpose of conservation of the total of 3131 heads (20 breeds and 5822 bee colonies) in 18 sites (Koncagül et al., 2011). About ten native sheep breeds including not endangered breeds were conserved in their habitat and some of them out of their habitat in different parts of Turkey (Table 1). Based on this review Kivircik, Karayaka and Sakiz sheep breeds were conserved both in their habitat and out of their habitat. This type of practice is important and could be a good lesson for other countries.

Table 1. In-situ and ex-situ in vivo conservation of Turkey sheep breeds

<table>
<thead>
<tr>
<th>Breed</th>
<th>Purpose</th>
<th>Status</th>
<th>Popn. Conserved</th>
<th>Conserved by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Norduz</td>
<td>Good growth rates and good quantity of milk</td>
<td>Endangered</td>
<td>200</td>
<td>Group of 11 farmers</td>
</tr>
<tr>
<td>White Karaman</td>
<td>Meat type with poor milk production and moderate coarse wool</td>
<td>Not endangered</td>
<td>24 m and 22 f</td>
<td>International Bahri Dagdas Agricultural Research Institute</td>
</tr>
<tr>
<td>Hemin</td>
<td>Meat, fair amount of milk and moderate clip of coarse wool</td>
<td>Endangered</td>
<td>200</td>
<td>One farmer in Ardanuc County of Artvin Province</td>
</tr>
<tr>
<td>Herik</td>
<td>Meat type but produces coarse wool</td>
<td>Endangered</td>
<td>200</td>
<td>Three farmers in its home tract in Amasya Province</td>
</tr>
<tr>
<td>Daglic</td>
<td>Coarse wool and meat type</td>
<td>Severely at risk</td>
<td>200</td>
<td>Three farmers in Bolvodin County in Afyon Province</td>
</tr>
<tr>
<td>Cine Capari</td>
<td>Resistant to disease, meat, milk and coarse carpet wool</td>
<td>Nearly extinct</td>
<td>120</td>
<td>Two farmers in Aydin Province</td>
</tr>
<tr>
<td>Karakul</td>
<td>Meat, milk and skin</td>
<td>High risk</td>
<td>200</td>
<td>Two farmers in Tokat Province</td>
</tr>
<tr>
<td>Kivircik</td>
<td>Meat, milk and coarse wool type</td>
<td>Not endangered</td>
<td>286 (15m and 271f)</td>
<td>Marmara Agricultural Research Institute (MARI)</td>
</tr>
<tr>
<td>Kivircik</td>
<td>Meat, milk and coarse wool type</td>
<td>Not endangered</td>
<td>120f and 4-6m/year</td>
<td>Bandirma Sheep Research Station</td>
</tr>
<tr>
<td>Kivircik</td>
<td>Meat, milk and coarse wool type</td>
<td>Not endangered</td>
<td>200</td>
<td>Farmer in Kirklareli</td>
</tr>
<tr>
<td>Karayaka</td>
<td>Meat, wool and milk</td>
<td>-</td>
<td>94 (18m and 76f)</td>
<td>Marmara Agricultural Research Institute (MARI)</td>
</tr>
<tr>
<td>Karayaka</td>
<td>Meat, wool and milk</td>
<td>-</td>
<td>200</td>
<td>Farmer in Gokceada and Canakkale</td>
</tr>
<tr>
<td>Sakiz</td>
<td>Coarse wool, milk and meat</td>
<td>Critically at risk</td>
<td>130 (35m and 95f)</td>
<td>Marmara Agricultural Research Institute (MARI)</td>
</tr>
<tr>
<td>Sakiz</td>
<td>Coarse wool, milk and meat</td>
<td>Critically at risk</td>
<td>113</td>
<td>Four farmers in Cesme in Izmir Province</td>
</tr>
<tr>
<td>Golceada</td>
<td>Milk and meat</td>
<td>Not endangered</td>
<td>-</td>
<td>Bandirma Sheep Research Station</td>
</tr>
</tbody>
</table>

Source: Anon., 2009; Ertugrul et al., 2009; Yilmaz et al., 2013; Sezenler et al., 2014

Ex-situ in vitro conservation of genetic materials of Turkey sheep breeds

Ex situ in vitro conservation (cryopreservation) is the collection and deep freezing of semen, ova, embryos, and tissues which may be used for future breeding or regenerating animals (FAO, 2013). Conserving genetic diversity by keeping live animals outside their production (ex situ in vivo) not always will be able to guarantee the maintenance of the genetic diversity of a breed (FAO, 2013). That means live animal conservation will prone to diseases, drought, and other threats. Therefore, it is important that in vivo conservation be integrated with cryopreservation of germplasm (ex situ in vitro conservation). In other words, long-term in situ in vivo conservation programs may benefit from a germplasm repository (FAO, 2013).

In Turkey, ex-situ in vitro conservation of indigenous sheep germplasm was initiated in 2007 by the project named, In vitro Conservation and Preliminary Molecular Identification of Some Turkish Domesticated Animal Genetic Resources - I. Two gene banks have been established in Lalahan HMAE and TUBITAK Marmara Research Institute (Koncagül et al., 2011) and germplasm from 13 sheep breeds (Herik, Karayaka, Karakul, Gokceada, Morkaraman, Kivircik, Akkaraman, Ivesi, Daglic, Hemsin, Cine Capari, Sakiz, and Norduz) have been conserved.

Comparative performance sheep under in-situ conservation and ex-situ conservation

Growth performance of lamb

According to Sezenler et al. (2014a) the least square
were 39.01, 30.95 and 30.27 kg, the average daily weight weights were 32.87, 26.95 and 24.15 kg, yearling weights were 31.01, 25.44 and 23.67 kg, the sixth month live weights were 3.64, 3.91 and 3.28 kg, the weaning weight was 3.7 kg, 24.9 kg, and 234.3 g/day respectively. This demonstrates the ex-situ conserved lambs had lower growth performance than the in-situ conserved lambs. The difference could result from the management conditions of the lambs and the feeding level of ewes before or after lambing and also the quality of pasture. Moreover, ex-situ conserved flock was conserved out of their habitat (variation of climatic variables, variation in feed availability and quality), this may have own influence on them.

In the other study Sezenler et al. (2014b) reported that, the birth weights were 3.64, 3.91 and 3.28 kg, the weaning weights were 31.01, 25.44 and 23.67 kg, the sixth month live weights were 32.87, 26.95 and 24.15 kg, yearling weights were 39.01, 30.95 and 30.27 kg, the average daily weight gains were 271, 257 and 202 g/day in Kivircik, Sakiz and Gökçeada (Imroz) lambs conserved in their habitat under on station, respectively. The birth weight of Kivircik lambs was lower than the report of Sezenler et al. (2014a). Whereas the weaning weight was lower than the report of Sezenler et al. (2014a). The birth and weaning weights of ex situ conserved Kivircik lambs were significantly (P<0.05) higher than those of Imroz lambs (4.1±0.1 Vs 3.3±0.1 kg for birth weight and 28.0±0.6 Vs 19.8 kg for weaning weight). Generally, growth performance of lambs under in situ conservation was higher than ex-situ conserved lambs.

**Survival rate of lambs**

The survival of lambs up to weaning is imperative for profitability in sheep breeding program. The overall mean lamb survival rates of the in-situ conserved lambs were 96.4% with a range from 93.5% to 99.5%, and the value
ranged from 81.8% to 95.0% with an overall mean of 90.0% for the ex-situ conserved lambs (Sezenler et al., 2014a). This implies that in-situ conserved lambs had higher survival up to weaning than ex situ conserved lambs. The same author states that, the high lamb survival rate of the in-situ enterprise shows that the enterprise employs effective methods of lamb breeding, feeding, and management until the weaning period. On the other hand, in the ex-situ flock, the insufficient quality of the pastures affects the milk yield efficiency of the ewe, which thereby indirectly influences the survival rate of the lambs.

The survival rate of ex-situ in vivo conserved Kivircik and Imroz lamb up to weaning age were 97.9% and 96.4% respectively (Yilmaz et al., 2003). The survival rates until weaning of the Imroz and Kivircik lambs were high and similar. This result could be taken as a sign of the effective adaptation of these breeds to the environmental conditions of the Marmara Region and the Institute.

**Reproductive performance of ewes**

The average lambing rate, multiple birth rate, fecundity and litter size of in-situ conserved flocks were 83.9%, 27.1%, 1.1 and 1.31 respectively. For ex-situ conserved flock lambing rate, multiple birth rate, fecundity and litter size were 74.7%, 27.4%, 1.0 and 1.3 respectively (Sezenler et al., 2014a). The in-situ conserved flocks had higher lambing rate and multiple birth rates than the ex-situ conserved flock. However, in both flocks the average number of litter size at birth and fecundity was approximately the same (P > 0.05). The average lambing rate in ex-situ and in-situ flocks were 74.7% and 83.9% respectively which was statistically significant (Sezenler et al., 2014a). According to the same author, the difference exhibited might be due to the way the ex-situ enterprise manages the mating (natural or hand mating), the overall management and feeding of the flock and the poor condition of the pastures. Possibly, the fact that the flock is kept at the research station in conjunction with other flocks may imply that the flock size is larger and therefore more difficult to manage efficiently.

Average first oestrus live weights for these breeds were found to be 37.93, 33.35 and 29.75 kg, respectively. The highest first oestrus live weight was observed in Kıvırcık breed and this was followed by Sakız and Gökçeada sheep breeds (Sezenler et al., 2014b). The first oestrus age for the Kıvırcık, Sakız and Gökçeada breeds were found to be 315.13, 320.35 and 337.37 days, respectively, and the breeds that showed oestrus earlier displayed the same order as well. The oestrus lengths were determined as 30.99, 25.85 and 20.28 hours for the Kıvırcık, Sakız and Gökçeada breeds, respectively (Sezenler et al., 2014b).

**Future prospect in Ethiopia**

What information we have regarding to conservation?

Sheep production is a major component of the livestock sector in Ethiopia owing to the large population of 30.70 million head (CSA, 2016/17) and the diverse genetic resources (Gizaw 2008). At the smallholder level, sheep are the major source of food security serving a diverse function including cash income, savings, fertilizer, socio-cultural functions, and fiber. Sheep are particularly important for the pastoralist/agro-pastoralist and for farmers in the subalpine highlands where crop production is unreliable. Sheep are also important foreign currency earners accounting for 34% of the live animal exports (Gizaw et al., 2013).

Despite of their contribution threat status of most of the sheep breeds were not safe according to Gizaw et al. (2008), which is alarming for action in terms of conservation of native sheep breeds compatible with the existing production system.

Identification, classification, and description of sheep genetic resources began in the 1970’s, Fat-tailed (Arsi-Bale sheep), thin-tailed (Horro sheep) and coarse-woolled sheep (Menz and Tikur sheep) (Abegaz and Gizaw, 2015). Following this identification, phenotypic characterizations of indigenous breeds were conducted at the district level by many MSc students and researchers in different parts of the country. Characterization includes on-station and on-farm performance evaluation, the character of the production system and genetic parameter estimation for few sheep breeds (Menz, Horro, Awassi, Afar, and BHS). Moreover, national morphological and molecular characterization identified 14 sheep breeds and conservation priority was identified by Gizaw et al. (2008). Based on their total utility (combining their threat status, current merits and contributions to genetic diversity) the highest five priority.
breds were Simien, Gumz, Afar, Menz, and BHS in ranking order but had no consequences on the national genetic resources conservation program (Abegaz and Gizaw, 2015). These all synthesized information will be used as preliminary information (base) for future tasks as characterization and identifying utility is the first step of the ladder of the conservation program.

The way forward?

In Ethiopia, different exotic breeds are imported starting in 1944 when Merino sheep were introduced from Italy by an American aid organization (Getachew et al., 2016). Following Merino sheep Romney, Corriedale, Hampshire, and Rambouillet were introduced from Kenya in 1967. Recently, Awassi were introduced from Israel in 1980 and Dorper sheep from South Africa in 1980s to Jijiga and in 2007 by Ethiopian Sheep and Goat Productivity Improvement Program (Awickchew and Gipson, 2009). Therefore, Ethiopia exercises sheep crossbreeding program for about 74 years due to believing of low productivity of indigenous sheep breeds. However, except Awassi and Dorper sheep the contribution of other exotic breeds was not well-defined (we can say no contribution at all). This type of unplanned and unstructured crossbreeding program causes genetic erosion. With a similar indiscriminate crossbreeding program, Turkey lost three native breeds totally and many of the other sheep breeds are endangered and extinct. Therefore, delineating crossbreeding areas and controlling breed introduction should be considered as critical steps to reduce the risk of genetic dilution due to indiscriminate crossbreeding. Crossbreeding might focus on sheep populations along the roads, near towns and cities, near market places and buffer zones between two geographically separated areas as those populations are mixed and non-descript (Getachew et al., 2016). Therefore, the existing crossbreeding should be organized in this way so as to maintain the existing genetic diversity.

Before facing the challenge of genetic erosion like Turkey, it is paramount to conserve our highly adaptive indigenous sheep breeds. Although it is at infancy stage community-based breeding program was started for some sheep breeds/ populations such as Bonga, Horro, Menze, Doyogena, Atsibi, Gumz, and Farta sheep. This community-based breeding program is important for genetic improvement and in-situ conservation simultaneously. This simultaneous advantage will be realized only when the genetic gain and inbreeding level within the flock is balanced. That means the selection program should be implemented moderately and the genetic variation within sheep breed must be maintained. By considering this principle, in-situ conservation should be implemented for other sheep breeds their threat status is not safe (Afar, BHS, and Semien sheep breeds).

Genetic material conservation is the other important technique which used to conserve parts of animals for a long period of time. Now a day’s in case of Ethiopia semen collection from ram is possible and conducted around Debire Birhan from Menze ram by MSc students. Thus, conservation of semen will be possible as the storage does not need advanced technologies. However, conservation of other genetic materials such as ova, embryo, DNA, and cell will be difficult as they need sophisticated technologies to change to a living organism.

Conclusions

Conservation of native animal genetic resource is paramount to maintain genetic diversity sustainably and to cope with the future challenging climate change. However, native sheep population and diversity is reduced due to unplanned crossbreeding program in Turkey. Although they lose some breeds before initiating conservation program, in-situ, ex-situ in vivo and in vitro conservation methods are implemented in Turkey. Combining in-situ conservation with ex-situ in vitro conservation is ideal for sustainability of conservation program as learned from Turkey. However, in the case of Ethiopia in-situ conservation will be compatible with the existing production system, infrastructure, and technology. Strengthening inventory, monitoring and balancing genetic gain and inbreeding level is used for integrating existing community-based genetic improvement programs with sustainable in-situ conservation of Ethiopian native sheep genetic resources.

References


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