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Assessment of Demographic, Geographical and Genetic Risks in Markhoz Goat Population

[1]Hamid Reza Bahmani, [1]Mojtaba Tahmoorespur, [1]Ali Asghar Aslaminejad,
[2]Mokhtar Ali Abbasi and [3]Rahman Ebnabbasi
[1]Department of Animal Sciences, Faculty of Agriculture,
Ferdowsi University of Mashhad, P.O. Box 91775-1163, Mashhad, Iran
[2]Animal Sciences Research Institute of Iran, P.O. Box 1483, Karaj, Iran
[3]Agricultural and Natural Resources Research Center of Kurdiustan,
P.O. Box 714, Sanandaj, Iran

Abstract: Decline of native area, population size and breeding herds are indicators of imminent danger of breed extinction in the near future. Because of occurrence and continuation of these conditions for Markhoz goat population, this research was conducted to determine its spread, latest demographic data and the most important criteria and degree of endangerment. Data were collected through interview with the herders and monitoring the flocks in their native area and other locations in mating season. Distribution map was prepared using GIS and demographic data were used to evaluate Degree of Endangerment (DE). In the latest year, population size, the number of breeding females and males, effective population size and inbreeding rate were 2456, 1332, 70, 266 heads and 0.19% in each generation, respectively. Except for inbreeding rate, other criteria in 2009 were lower than those in 2008. In this study, herders mentioned economic factors as the main reason for decreasing of the population. Investigation of criteria in four major evaluation systems to determine DE showed that Markhoz goat is in demographic and geographical risks and imminent danger of decreasing variation within breed. Intense concentration of 77% of its population within a circle of 7 km radius has exposed the breed at the risk of epidemic diseases and other natural disasters. Thus, the primary conservational measures by the government as well as complimentary studies for providing comprehensive conservation program appear to be necessary.

Key words: Conservation, degree of endangerment, demography, distribution, Markhoz goat, population size

INTRODUCTION

In recent years, some reports have been presented about decreasing of Markhoz goat population size by Agricultural Jihad Organization of Kurdistan (AJOK). A long time ago, Markhoz goat was scattered in the Provinces of Western Azarbaijan, Kurdistan and Kermanshah however, it is currently distributed only in a small part of Kurdistan and a few villages of Western Azarbaijan. In 1996, population size was over 22000 heads in the country and 15387 heads in the main native area (Baneh city). Having been on a downward trend, population size in Baneh was reported by AJOK about 5000 heads in 2005.

Loss of genetic diversity in livestock species mainly takes place due to the permanent extinction of breeds. According to the FAO report, only 39% of the breeds of the world are not at risk (Scherf, 2000). To prevent the extinction of livestock breeds, endangered populations must be identified and protected. The conservation of genetic diversity may be valuable to meet future market demands and changes of production environments. Prior researches have mentioned further reasons for this necessity including social and economical values of livestock breeds for rural communities, their contribution to management of agro ecosystems and to maintenance of rural cultural diversity (Gandini *et al*., 2004).

Decreasing of population size, breeding herds and locations; use of animals of other breed (s) for reproduction; low effective population size and presence of the threatening factors of survival are indicators of imminent danger of breed extinction (Scherf, 1995; Simon, 1999). Based upon these conditions, Degree of Endangerment (DE) must be determined for providing

Corresponding Author: Hamid Reza Bahmani, Department of Animal Sciences, Faculty of Agriculture,
Ferdowsi University of Mashhad, P.O. Box 91775-1163, Mashhad, Iran

conservation program. Several assessment systems have been introduced for classifying breeds as to their DE by governmental bodies, NGOs and scientists (Henson, 1992; Alderson, 1994; Simon, 1999; Scherf, 2000; European Commission, 2002; Gandini *et al*., 2004; Alderson, 2009). These systems use one or a combination of several criteria for evaluating DE. Lack of harmonization between different systems is the main problem. Population size, number of breeding females and males, geographic concentration, effective population size and the rate of inbreeding are most important criteria for assessment.

These criteria along with information about breed and its native area are applied to do the primary actions of conservation to analyze population viability (Lacy, 1993) to predict the probability of extinction (Bennewitz and Meuwissen, 2005; Al-Atiyat, 2009) and to conduct other complementary studies for programming conservation.

Based on the findings, there are no published results to identify DE for Iranian endangered breeds or how to conserve them from extinction. Endangerment status of Iranian breeds is incompletely available in FAO reports. So far, Caspian horse and Kurdi cow (Scherf, 2000) and Bactrian camel, Dareshuri and Torkaman horses (FAO, 2007) have been introduced as Iranian endangered breeds. In other countries, there are several reports about identifying endangered breeds using population size (Rege, 1999) or more perfect criteria such as: inbreeding rate and geographical concentration needed modern technologies (Simon, 1999; Alderson, 2009).

In recent years, applicable researches have been conducted to determine DE to analyze population viability and to predict extinction probability of endangered breeds used in conservation programs (Nomura *et al*., 2001; Reist-Marti *et al*., 2003; Bennewitz and Meuwissen, 2005; Al-Atiyat, 2009).

The objectives of this study were to specify latest distribution and population data of Markhoz goats to identify affecting factors on decreasing its population size to determine its criteria and degree of endangerment and to provide information needed for primary conservational measures and complementary studies.

MATERIALS AND METHODS

Markhoz goat: Markhoz goat is the only single coat goat producing shiny fine fibers in Iran. Its fibers are seen in white, different spectra of brown, grey and black colors. The most important characteristics of its fiber are luster, high length (14-15 cm), high efficiency (79%), low kemp and medullated fibers (totally 4-8%), high true fibers (92-96%) and low diameter (29-34 μ) (Taherpourdari and Hassaninejad, 1997; Bahmani, 1999; Rashidi, 2000). Worthy textile and clothes are made from its fibers in traditional workshops. In comparison with sheep and haired goat breeds, its milk products and meat are more acceptable in Baneh.

Main native area: Markhoz goats are mainly distributed in the county of Armardeh in Baneh city. This region is mostly covered with Oak trees and pasture plants. Herders in their farm called Kokh, breed Markhoz flocks alone or along with some sheep and haired goats. In addition to animal husbandry, farming and gardening are briefly performed in these farms. The main sources of feed in the region are pasture plants and the leaves of oak trees. Flocks are grazed on pastures through the growing season and are mainly fed with the leaves of oak trees and stored pasture plants from the end of autumn to the beginning of spring. Oak leaves are harvested in 2-3 years periodic pruning and are mostly stored on Oak trees called Taieh.

Data collection: The whole Markhoz goat population of the country was included in the study. Data were collected through census from 23 farms or villages in the province of Kurdistan (21 farms in the city of Baneh and 2 villages in other locations), 3 villages in the province of Western Azarbaijan and 2 stations in Sanandaj and Saghez in the 2008 and 2009 mating seasons. Geographical data were entered using GPS. Herder information, population size, the number of breeding males and females, apparent purity status, mating status, mating ratio, reasons for decreasing population size and the problems of the herders were collected through interview with the herders (42 people in Baneh and 5 people in other locations) and monitoring the 47 flocks.

Data analysis: Using the softwares of Ozi explorer and Arc view, length and latitude data were converted to the maps to assess the geographical distribution and concentration of the population. Data related to the questionnaires were analyzed applying SPSS software. Descriptive statistics of demographic data were computed.

Also, paired-samples t-test was used to compare means. Demographic data were used to calculate the effective population size (N_e) and inbreeding rate per generation (F). Owing to the number of breeding males (N_m) and breeding females (N_f), Ne and F were estimated using the equations of $N_e = 4 (N_m \times N_f) / N_m + N_f$ and $F = 1/2 N_e$, respectively (Falconer, 1989).

RESULTS AND DISCUSSION

Population size and distribution: Distribution of Markhoz goats in 26 farms and villages and 2 stations is shown in Fig. 1. In recent years, its distribution in the main native area and in the country has significantly been limited. In comparison with 1996, there is no Markhoz goat in Kermanshah Province; it exists only in a few villages in Western Azarbaijan and its native area has been extremely limited in Kurdistan province.

Decreasing native area is one of the indicators of endangerment. The number of breeding males and females as well as population size in different years and locations are shown in Table 1. Main native area, other locations and stations include 77, 3 and 20% of the population, respectively. Most of the population (77%) lies within a circle of 7 km radius in the county of Armardeh (Fig. 2). The limited geographical distribution of a breed makes it vulnerable. It is at particular risk of the event of an epidemic disease as the most important threat. Extinction of Blue Albion cattle in 1967 and losing >50% of British Milksheep population in 2001through FMD outbreak in UK are some cases of the vulnerability of geographically concentrated breeds (Alderson, 2009).

The data shows a downward trend in breeding goats and population size. About 26% of the goat population has decreased in its native area during 2 consecutive years. Decline has probably been more than this figure since some eliminated flocks have not been presumably taken into account in 2008. Markhoz population size in its native area has reduced >90% in comparison with 1996. The mean of flock size in the main native area has

Table 1: Population size (N), the number of breeding males (N_m) and females (N_f), effective population size (N_e) and inbreeding rate (F) of Markhoz goats in different years and locations

Years	Location	N	N_m	[1]N_f	N_e	F
2008	Country	3202	83	1760	317	0.0016
	Native area	2634	64	1453	245	0.0020
	Stations	568	19	307	72	0.0069
2009	Country	2456	70	1332	266	0.0019
	Native area	1960	51	1051	195	0.0026
	Stations	496	19	281	71	0.0070

[1]Females bred with haired goats are not included

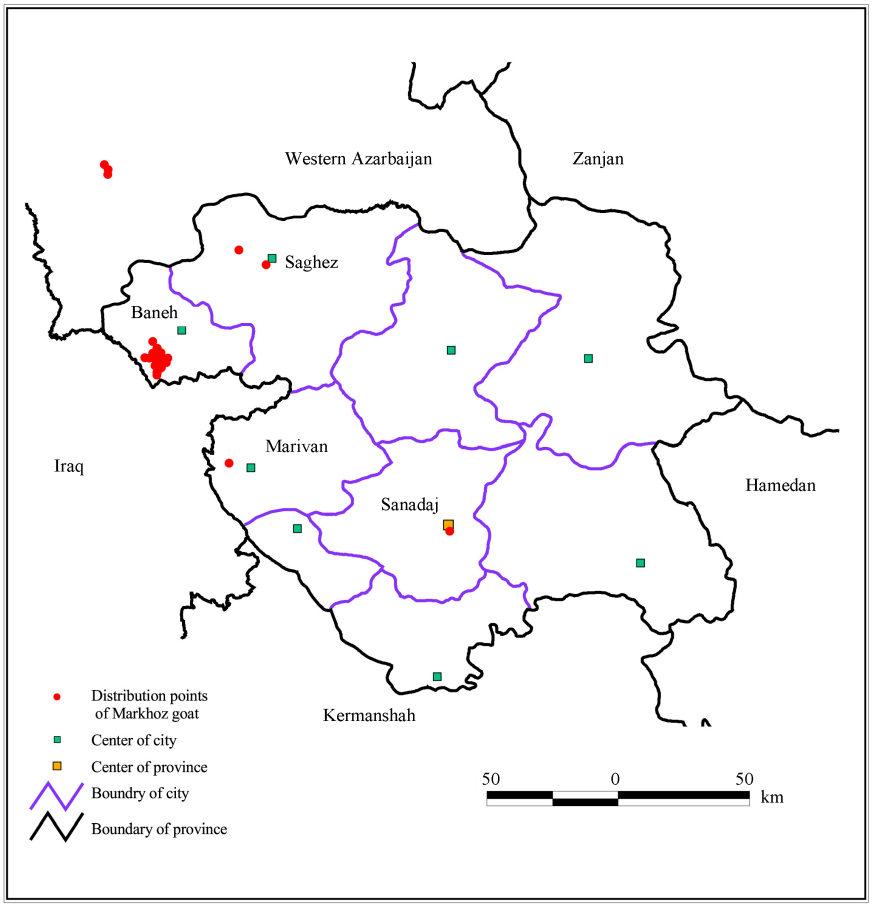

Fig. 1: Distribution of Markhoz goats in the provinces of Kurdistan and Western Azarbaijan, Iran

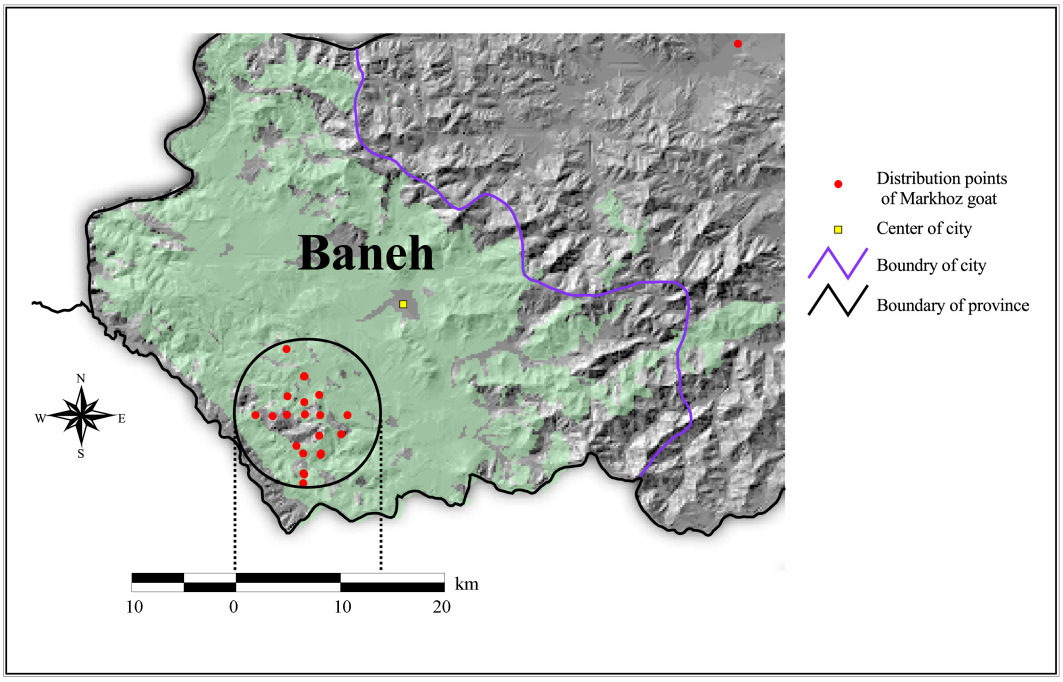

Fig. 2: Geographical concentration of Markhoz goats within circle of 7 km radius in the main native area, Baneh, Kurdistan, Iran

significantly ($p<0.05$) decreased from 59.4 in 2008 to 44.7 in 2009. In addition, the flocks were not in a stable condition. Only 33 of the 42 flocks had a stable condition since 6 flocks had haired male goats alone or along with Markhoz male goats in the 2009 mating season and 3 herders had decided to sell their flocks after the mating season. Decreasing trend in population and flock sizes are undesirable indicators of increased vulnerability. Small populations are subjected to genetic drift and are encountered with losing genetic diversity over time.

The reasons for decreasing trend in population size were mentioned in order of priority as: discouragement in youth and family members (23.7%), shortage of shepherds (18.3%), nutrition problems (17.2%), existence of haired goat breeds with higher income (12.9%), low income of goat raising (11.8%), lack of governmental support (11.8%), low financial feasibility of herders (3.2%) and natural disasters (1.1%). In spite of high interest of herders, there was less interest among youth and family members towards Markhoz goat breeding. The reasons for this discouragement were mentioned in order of priority as: possibility of earning jobs with higher income (36.7%), low income gained from goat raising (30.6%), dissatisfaction with animal husbandry, tendency to living and studying in urban areas and hardness of animal breeding. This apathy has extremely affected the sheepherding job. This survey showed that providing forage (purchase and shipment), providing oak leaves (purchase, pruning and shipment), lack of governmental support, high expense of feedstuff, low extent of pasture and water shortage with 37.5, 32.2, 8.9, 8.9, 8.9 and 3.6% had effective role on making nutritional problems, respectively. The mentioned reasons emphasize on two main factors affecting this downward trend: decrease in economic and social incentives with the former been more important. Reduction in socio-economic incentives is the most important reason for putting breeds in danger of extinction throughout the world (Henson, 1992; Scherf, 2000).

Breeding location, government policy and history of natural disasters through previous years have intensified this trend. Owing to lying Markhoz goat native area in the vicinity of Iran-Iraq borderline, animal husbandry have prominently affected by government's foreign policy and border exchanges. Lack of governmental support for animal fiber production and governmental support towards natural resources (forest and pasture) through conducting the projects of decreasing small domestic animals have probably affected Markhoz goat population. Natural disasters such as droughts have likely reduced the population of Markhoz goat every few years. In many cases, due to weak financial ability of herders, replacement of sold or removed goats has not presumably been possible.

Criteria and degree of endangerment: Most important measures of population vulnerability such as: population size (N), the number of breeding males (N_m) and females (N_f), effective population size (N_e) and rate of inbreeding (F) for Markhoz goat population in different years and locations are shown in Table 1. These include two main demographic and genetic criteria. Other criteria including change trend and expected cumulated inbreeding over a number of years can be calculated using contents of Table 1.

Population decline is obviously observed in 2 recent years. Except for F, other criteria were higher in 2008 than those in 2009. These criteria are assessed for classifying breeds as to their Degree of Endangerment (DE) in four major systems: the FAO (Henson, 1992; Scherf, 2000), the European Union (European Commission, 2002), the European Associations of Animal Production (Simon, 1999; Gandini *et al*., 2004) and NGOs (Alderson, 1994).

Assessment within the FAO and the EU systems are based on demographic risk (Gandini *et al*., 2004). Scherf (2000) defined 4 categories of endangerment. A breed is categorized as at risk if the total number of breeding females and males are ≤1000 and 20, respectively or If the population size is ≤1200 and the overall population size is decreasing. In addition to demographic data and change trend, the percentage of females being bred to males of other breeds is considered to select the category.

Not only are there fundamental differences between species derived especially from variation in length of breeding life but also from mating ratios and reproductive rate. These are not recognized in the FAO procedure (Alderson, 2009). Based on defined thresholds of this method, Markhoz goat is not at risk. However, breeding females decline to <1000 heads in view of the decreasing trend is probably possible in the near future. According to another proposed method (Henson, 1992), Markhoz goat with population between 1000 and 5000 heads is at risk and is located in vulnerable category. In this method, crossing >20% of females with other breeds or geographical concentration influences increscent of DE. This survey showed about 66 females (4.7% of breeding females) bred with haired goats; however, about 77% of the population is concentrated in a limited area. Thus, Markhoz goat is categorized in upper level (endangered category) according to this method.

The threshold for eligibility for financial incentives in the EU is 10000 heads for sheep and goats (European Commission, 2002). Based on this assessment system, Markhoz goat is at risk. Proposed EU system takes little into account of mating ratio and no account of reproductive rate (Alderson, 2009).

Assessment within the EAAP system is based on genetic risk (Gandini *et al*., 2004). In this evaluation system, the main criterion is predicted cumulated inbreeding in 50 years (F-50).

Therefore, species specific minimum values of effective population size (N_e) for five classes of endangerment, depending on the maximum values of acceptable inbreeding, F-50 after 50 years of conservation have been determined. Resulting N_e for goats being considered at risk is 95. Breeding females (f) are defined as the number of females which are registered and used in 100% pure breeding.

In case these requirements are not met f is estimated. By comparing N_e of the breed with the minimum values of N_e for the relevant species the breed is allocated to one of the five classes of endangerment. Finally, downgrading the breed into one class of higher endangerment is done based on the number of breeding herds, change trend and the percentage of matings for reproduction of the breed with animals of other breeds (Simon, 1999). Given purity of 1332 breeding females, computed N_e (266) is higher than threshold N_e (95). So, Markhoz goat is not at risk according to this system. However, N_e decline and its consequences are probably possible owing to the fact that some of the females may be impure and decreasing trend may persist. The amount of heterozygosity or genetic variation begins to decrease at an accelerated rate, once the N_e falls below 100. Minimum population sizes of an effective population of 250 animals should form the basis of a conservation program (Henson, 1992).

Alderson (1994) formulated the earliest NGO procedure to identify populations as endangered for Rare Breeds Survival Trust (RBST) in 1975. After that he offered a developed and refined procedure that its principles are based initially on genetic integrity and thereafter by degree of vulnerability from either numerical scarcity or geographical concentration or genetic erosion (Alderson, 2009). The system applies these three criteria to enable the classification of breeds into five degrees of endangerment.

Each breed is categorized by the application of criteria for each factor. Finally, the breed is classified according to its most critical factor. The basis of numerical criterion is 1000 breeding females for goats. Assuming purity of 1332 breeding females, Markhoz goat is not threatened by this factor. A breed is classified as endangered if 75% or more of its population lies within circle of 25 km radius. About 77% of Markhoz population locates within circle of 7 km radius. Therefore, Markhoz goat is extremely threatened by this factor and is located

in highest class of endangerment (critical level). Breeds which are projected to reach an average inbreeding coefficient of >10% over 25 years are classified as endangered. This measure is derived from current inbreeding plus the expected increase. Since the current rate of inbreeding is not determined for Markhoz goat, the genetic criterion could not be computed. However, Markhoz goat is classified at critical status according to its most perilous factor which is geographical concentration. As emphasized by the Convention on Biological Diversity *in situ* conservation, i.e., the maintenance of endangered breed within its production system is considered as a priority for conservation. The *in situ* approach provides the opportunity to evaluate breed qualifications over time and allows the valorization of the ecological, cultural and socio-economic values of the breed.

Ex situ method, storage of gametes or embryos is seen as complementary to *in situ* and as insurance against breed extinction. This approach does not affect the degree of endangerment (Gandini *et al*., 2004). Thus, native area of Markhoz goat should be particularly considered as a priority for the primary measures of *in situ* conservation and conducting complimentary studies. Of course, stations should be used in proposed conservation program.

CONCLUSION

Investigation in the different systems of assessment shows that Markhoz goat is at risk based on demographic and geographical criteria. Intense concentration of its population has exposed the breed at the risk of epidemic diseases and other natural disasters. According to the result, this breed currently is not at genetic risk but might be at an imminent danger of reduction in genetic variation due to the downward trend.

Of course, genetic erosion must be verified by more researches. Owing to the fundamental role of economic factors on reducing the population of Markhoz goat, the initial conservational actions by the government through subsidies payment to herders and hygienic control of the native area are suggested. In addition, complimentary researches should be conducted for providing comprehensive conservation program.

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