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# Analysis for prioritizing risk status and sustainable utilization of cattle, sheep, and goat breeds in Türkiye

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**Abstract:** Animal Genetic Resources (AnGR) are a warranty for future unknown conditions and needs. Due to this fact, sustainable use and conservation of AnGR have special importance, and to achieve reliable programs for these goals, the risk status of AnGR should be estimated accurately. The aim of this study was to estimate the risk status for three widely used domesticated livestock species of cattle, sheep, and goat in animal production: 6 cattle, 33 sheep, and 15 goat breeds were included in the analysis. Extinction probability (z) was taken as a criterion for the risk status of each breed. Data collection based on survey realized with 215 farmers, field observations and personal interviews were performed for different provinces between 2014 and 2017. Extinction probabilities estimated were ranged from 0.53 to 0.90 with an average of 0.71 for native cattle breeds. Çine Çaparı sheep and Abaza goat had the highest extinction probabilities of 0.97 and 0.87, respectively, while Kıl goat and İvesi sheep breeds had the lowest probabilities of 0.37 and 0.40, respectively. Present study demonstrated that risk analyses of survey data sets may provide useful information concerning the decision-making on conservation efforts for endangered breeds. It should be monitored risk status for breeds to create efficient conservation investments. Considering the limited resources, it is undeniable that while some breeds continued to protect, some others would be removed from conservation programs. To make this task an appropriate manner extinction probability may be used as a criterion for decision-making.

**Key words:** Animal genetic resources, extinction probability, genetic diversity, sustainability

## 1. Introduction

In Turkey as one of the domestication centers [1] with diversified geographic and climatic conditions, there is a huge amount of genetic diversity among species. Animal genetic resources (AnGR) are important for their present and future utility, scientific, cultural, historical, and genetic uniqueness [2], and insurance against unknown future changes, such as climate change and disease outbreaks [3]. However, native breeds of the country are at risk of degeneration owing to crossing pressures with exotic breeds or uncontrolled crossing in cattle and small ruminates. Currently, numerous livestock breeds have been lost or are in danger of extinction. Globally, the Convention on Biological Diversity and The Food and Agricultural Organisation of the United Nations (FAO) has put the need to conserve farm animal genetic diversity on the agenda [4–6].

An accurate measurement of the endangerment status of each breed and an effective information system are essential for determining the conservation policies of the breeds. However, most time reliable data cannot be obtained. Therefore, different approaches are suggested for risk assessment. Due to difficulties in integration of the effects of many complex factors, information on degree of endangerment for each breed of livestock is not consistent [7]. The degree of extinction risk of a breed provides a basis for conservation policies. In order to accurately predict the degree of extinction risk, it is recommended that genetic diversity within population should be evaluated [8]. On the other hand, it is clear that the main breeds of the species in farm animals will not be at risk unless the current market and production environment conditions change [9]. For this reason, current and future socio-economic conditions are important for prioritization in conservation in terms of determining which breed to be conserved. Animals or organisms with similar genetic makeup are susceptible to epidemics and may face the danger of extinction. Conservation of genetic diversity is beneficial in this respect. Moreover, native breeds are more preferable in organic animal farming.

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To optimize these limitations, a system established in the UK applies based on three criteria as numerical, geographical, and genetic. To enable the classification of breeds and their categorization into five class of endangerment ranging from 'critical' to 'transitional [7]. Gandini et al. [8] suggested both demographic and genetic criteria to determine the degree of endangerment. In addition to these, Verrier et al. [10] proposed that breeders' organization, technical support, and socio-economic criteria should be added to the model. Reist-Marti et al. [11] and Gizaw et al. [12] recommended a model which includes demographic criteria, socio-economic factors, and breed-specific features. Sustainability of a specific breed is necessary for compensation of economic, social, and cultural expectations. The requirements for a particular breed are needed to be clarified for sustainable and effective production of the breed in its natural production environment.

In Turkey, therefore, it is aimed to harmonize and implement an accurate methodology for determining the risk status for each breed to the specification of production systems and farmers' preferences in the current recording system according to national condition. Thus, the purpose of this study is to rank native cattle, sheep, and goat breeds for extinction probability and evaluate factors on sustainable utilization. The degree of risk of extinction should be also considered by taking into account - economic, scientific, ecological cultural values, and genetic uniqueness as well [2], and possibility of achieve success for conservation program carried out [8].

## 2. Material and method

### 2.1. Breeds, survey, and data collection

In addition to farm animal breeds in Turkey, the breeds or genotypes that are considered to be genotypically different due to importing or crossing studies are discussed. In this context, a total of 54 different breeds [cattle (n = 6), sheep (n = 33), and goat (n = 15)] species were evaluated. In Turkey, studies on conservation and sustainable utilization of AnGR have been carried out more than 20 years under the national project of "Conservation and Sustainable Utilization of Animal Genetic Resources" by Ministry of Agriculture and Forestry, General Directorate of Agricultural Research and Policies. The survey carried out on 215 farms included in the in situ conservation project. Field observations, face to face interviews, complemented surveys contributed to determining ecologic and socio-economic factors on the breeds. Survey questions were grouped in four categories; 1) Socio-economic overview (e.g., farmer age, education, or farmer organizations), 2) breed management practices and production systems (e.g., crop production, feeding system, or pasture utilization), 3) difficulties and limitations (e.g., main problems related to breed, labor, marketing, cost, or disease), and 4) reasons for keeping specific breeds (e.g., cultural, product quality or high yield).

### 2.2. Determining extinction probability

A specific nongenetic scheme for determining threat status was set for reasonable estimates of extinction probabilities from FAO [4], Reist-Marti et al. [11], and Gizaw et al. [12]. The model aggregated as 1) demographic structure (TP; total population size. IC; indiscriminate crossbreeding. CP; change of total population size over the last 5 years. DB; geographical distribution of the breeds), 2) existence or nonexistence of the conservation program (CI; conservation in situ program, yes or no), and socio-economic factors (SP; special traits, SC; socio-cultural importance, EP; economic performance, EI; ecological importance and FA; farmers' assessment). The demographic structure was estimated from four indicators; total population size (TP), degree of indiscriminate crossbreeding (IC), change of total population size over the last 5 years (CP), and geographical distribution of the breed (DB). Demographic structure, as an important factor of the extinction probability, official population data records was extracted from the Ministry of Agriculture and Forestry. In terms of population size (TP), the natural production environment of the breed was taken as the basis. Numerical population values outside of the production environment are assumed to be ineffective by anticipating that they will lead to failure. Therefore (1) if TP < 1.000 = 0.3; 1.001–10.000 = 0.2; 10.001–100.000 = 0.1; > 100.001 = 0.0 and missing value = 0.2; (2) IC crossbreed/pure rate > 100% = 0.3; 50–100% = 0.2; and < 50% = 0.1; (3) CP was decreasing = 0.2; stable = 0.1; increasing = 0.0; and missing value = 0.1; (4) if DB in a certain location = 0.2; regional (more than one city) = 0.1; and national (more than one geographic region) = 0.0. The National Conservation Program (CI) for a breed has been implemented for two decades in Turkey. If there is a conservation program for a specific breed, it is considered as a positive determinant for the risk status of that breed. Therefore, (5) if CI maintained then scored as 0.0, if not then scored as 0.1. If a breed is included in situ conservation program, subsidies were given for each adult animal to the breeders. Economic, cultural, environmental and farmers' expectations are important criteria to determine breed value. Therefore, socio-economic and ecological importance were based on field studies, scientific reports, and survey data. These data were grouped according to breeds special traits (SP), socio-cultural importance (SC), economic performance (EP), ecological importance (EI) and farmers' assessment (FA) for keeping the breed in current conditions and then scored from poor to excellent. In total, 215 questionnaires were completed. The primary data source for the scoring of the breed criteria was the opinions of the breeders.

Surveys have served this purpose. In the scoring of the characteristics of the breeds, the average value obtained by scanning all known literature sources were determined by the breed registrations and research results [13]. The index method used is FAO [4], Reist-Marti et al. [11], and Gizaw et al. [12] for each breed. Thus, (6) if SP was no = 0.1; and yes = 0.0 (e.g., meat quality, disease resistance); (7) if SC was no = 0.1; partly = 0.05; and yes = 0.0 (e.g., religion, sacrifice day, traditional custom); (8) if EP was low then no = 0.1; partly = 0.05; and high = 0.0; (9) if EI was low = 0.1; partly = 0.05; and high = 0.0 (e.g., adaptation to the production environment), and (10) if FA was negative = 0.1; partly = 0.05; positive = 0.0; and missing value = 0.05. Using the total effect of the 10 factors described above, the extinction probability ($z_i$) of each breed was calculated using the equation:

$$Z = \frac{0.8}{1.2} * \sum_{a=1}^{10} Z_{ia} + 0.1$$

Extinction probabilities (Z) estimated for a breed ranged from 0.0 to 1.0. If the value is estimated as 0.1, it is assumed that there is no risk of extinction for the breed while Z = 1.0 indicated that the breed is completely at risk of extinction [11]. Breeds with very low extinction probability (<0.2) were considered relatively safe or not threatened [12].

### 2.3. Statistical analyses

Data were extracted into a standardized excel sheet. All data generated were statistically analyzed using SPSS (Ver. 19) to perform Hierarchical Analyses [14].

## 3. Results

### 3.1. Estimation of extinction probabilities

Dendrogram was built using extinction probability linkage (between cattle (A), sheep (B), and goat (C) breeds) with hierarchical cluster analysis using measurements shown in the Figure. Extinction probabilities (Z) of cattle, sheep and goat breeds are given in Table 1. The average extinction probability over all breeds was 0.63. This value is a general average, not for all breeds. The highest extinction probabilities were 0.90, 0.97, and 0.87 for Native South Yellow cattle, Çine Çaparı sheep, and Abaza goat, respectively. While the lowest are 0.53, 0.40, and 0.37 for Anatolian Grey cattle, İvesi (Awassi) sheep, and Kıl goat, respectively.

### 3.2. Farmers' perception

The results obtained from survey are shown in Table 2 on the farmers' perception on the main problems or preferences for some specific native cattle, sheep and goat breeds. Among the farmers' preferences for farming a specific breed, high adaptation/resistance (n = 45), and milk-meat quality (n = 13) were the most stated factors, following easy management (n = 12), high performance (n = 9), being a specific breed (n = 8), and good grazing ability (n = 5). Marketing (n = 5), low mortality rate (n = 3), and low cost (n = 2) were stated lowest frequencies for the preferences. Among the main problems, feed cost (n = 27), marketing (n = 26), and diseases (n = 20) were the first three challenges. Main problems following shepherd/management (n = 13), pasture/water scarcity (n = 12), the high mortality rate (n = 11), predators (n = 10), low

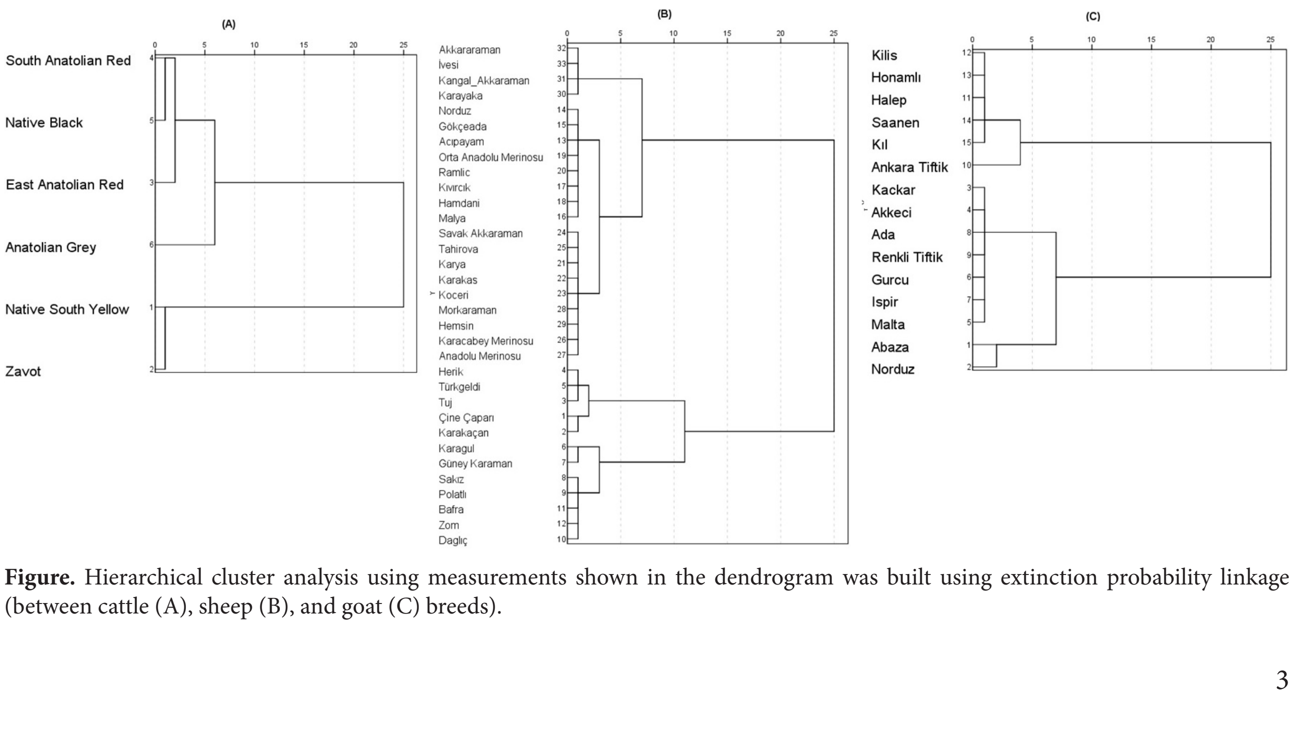


**Figure.** Hierarchical cluster analysis using measurements shown in the dendrogram was built using extinction probability linkage (between cattle (A), sheep (B), and goat (C) breeds).

**Table 1.** Extinction probabilities of cattle, sheep, and goat breeds/genotypes in Turkey.

| *Species* | *Breed/genotype* | *Variable** | | | | | | | | | | *Z* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *TP* | *IC* | *CP* | *DB* | *CI* | *SP* | *SC* | *EP* | *EI* | *FA* | |
| Cattle | Native South Yellow | 0.20 | 0.20 | 0.20 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.00 | 0.10 | 0.90 |
| | Zavot | 0.30 | 0.30 | 0.10 | 0.10 | 0.10 | 0.00 | 0.10 | 0.05 | 0.05 | 0.05 | 0.87 |
| | East Anatolian Red | 0.10 | 0.30 | 0.10 | 0.05 | 0.10 | 0.00 | 0.10 | 0.05 | 0.05 | 0.05 | 0.70 |
| | South Anatolian Red | 0.10 | 0.20 | 0.10 | 0.05 | 0.10 | 0.00 | 0.10 | 0.10 | 0.00 | 0.05 | 0.63 |
| | Native Black | 0.10 | 0.10 | 0.10 | 0.00 | 0.10 | 0.10 | 0.10 | 0.10 | 0.05 | 0.05 | 0.63 |
| | Anatolian Grey | 0.20 | 0.10 | 0.10 | 0.00 | 0.10 | 0.00 | 0.10 | 0.05 | 0.00 | 0.00 | 0.53 |
| Sheep | Çine Çaparı | 0.30 | 0.30 | 0.20 | 0.10 | 0.00 | 0.10 | 0.10 | 0.05 | 0.00 | 0.10 | 0.97 |
| | *Karakaçan* | 0.30 | 0.30 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.05 | 0.00 | 0.10 | 0.93 |
| | Tuj | 0.30 | 0.30 | 0.10 | 0.05 | 0.10 | 0.10 | 0.10 | 0.05 | 0.05 | 0.05 | 0.90 |
| | Herik | 0.30 | 0.30 | 0.10 | 0.05 | 0.10 | 0.10 | 0.10 | 0.05 | 0.05 | 0.00 | 0.87 |
| | Türkgeldi | 0.30 | 0.30 | 0.10 | 0.05 | 0.10 | 0.10 | 0.10 | 0.05 | 0.05 | 0.00 | 0.87 |
| | Karagül | 0.30 | 0.30 | 0.10 | 0.05 | 0.00 | 0.10 | 0.10 | 0.05 | 0.00 | 0.05 | 0.80 |
| | Güney Karaman | 0.20 | 0.30 | 0.10 | 0.05 | 0.00 | 0.10 | 0.10 | 0.05 | 0.05 | 0.05 | 0.77 |
| | Sakız | 0.20 | 0.30 | 0.10 | 0.05 | 0.00 | 0.00 | 0.05 | 0.05 | 0.10 | 0.10 | 0.73 |
| | Polatlı | 0.30 | 0.10 | 0.10 | 0.05 | 0.10 | 0.10 | 0.10 | 0.05 | 0.05 | 0.00 | 0.73 |
| | Dağlıç | 0.20 | 0.20 | 0.10 | 0.05 | 0.00 | 0.10 | 0.10 | 0.05 | 0.00 | 0.10 | 0.70 |
| | Bafra | 0.20 | 0.10 | 0.10 | 0.05 | 0.10 | 0.10 | 0.10 | 0.05 | 0.05 | 0.00 | 0.67 |
| | Zom | 0.20 | 0.30 | 0.00 | 0.05 | 0.00 | 0.10 | 0.10 | 0.05 | 0.05 | 0.00 | 0.67 |
| | Acıpayam | 0.20 | 0.10 | 0.00 | 0.05 | 0.10 | 0.10 | 0.10 | 0.05 | 0.05 | 0.05 | 0.63 |
| | Norduz | 0.20 | 0.10 | 0.10 | 0.05 | 0.00 | 0.10 | 0.10 | 0.05 | 0.05 | 0.05 | 0.63 |
| | Gökçeada | 0.20 | 0.10 | 0.10 | 0.10 | 0.00 | 0.10 | 0.10 | 0.05 | 0.00 | 0.05 | 0.63 |
| | Malya | 0.20 | 0.10 | 0.00 | 0.05 | 0.10 | 0.10 | 0.10 | 0.05 | 0.05 | 0.00 | 0.60 |
| | Kıvırcık | 0.20 | 0.30 | 0.00 | 0.05 | 0.00 | 0.00 | 0.10 | 0.05 | 0.00 | 0.05 | 0.60 |
| | Hamdani | 0.00 | 0.30 | 0.00 | 0.05 | 0.10 | 0.10 | 0.10 | 0.05 | 0.05 | 0.00 | 0.60 |
| | Orta Anadolu Merinosu | 0.20 | 0.10 | 0.00 | 0.05 | 0.00 | 0.10 | 0.10 | 0.05 | 0.10 | 0.00 | 0.57 |
| | Ramlıç | 0.20 | 0.10 | 0.00 | 0.05 | 0.00 | 0.10 | 0.10 | 0.05 | 0.10 | 0.00 | 0.57 |
| | Karya | 0.30 | 0.10 | 0.00 | 0.05 | 0.00 | 0.00 | 0.10 | 0.05 | 0.05 | 0.00 | 0.53 |
| | Karakaş | 0.20 | 0.10 | 0.00 | 0.05 | 0.00 | 0.10 | 0.10 | 0.05 | 0.05 | 0.00 | 0.53 |
| | Koçeri | 0.20 | 0.10 | 0.00 | 0.05 | 0.00 | 0.10 | 0.10 | 0.05 | 0.05 | 0.00 | 0.53 |
| | Şavak Akkaraman | 0.20 | 0.10 | 0.00 | 0.05 | 0.00 | 0.10 | 0.10 | 0.05 | 0.05 | 0.00 | 0.53 |
| | Tahirova | 0.20 | 0.10 | 0.00 | 0.05 | 0.00 | 0.10 | 0.10 | 0.05 | 0.05 | 0.00 | 0.53 |
| | Karacabey Merinosu | 0.10 | 0.10 | 0.00 | 0.05 | 0.00 | 0.10 | 0.10 | 0.05 | 0.10 | 0.00 | 0.50 |
| | Anadolu Merinosu | 0.00 | 0.10 | 0.00 | 0.05 | 0.10 | 0.10 | 0.10 | 0.05 | 0.10 | 0.00 | 0.50 |
| | Morkaraman | 0.00 | 0.30 | 0.00 | 0.00 | 0.00 | 0.10 | 0.10 | 0.05 | 0.00 | 0.00 | 0.47 |
| | Hemşin | 0.10 | 0.10 | 0.00 | 0.05 | 0.00 | 0.10 | 0.10 | 0.05 | 0.05 | 0.00 | 0.47 |
| | Karayaka | 0.00 | 0.10 | 0.00 | 0.05 | 0.00 | 0.10 | 0.10 | 0.05 | 0.05 | 0.05 | 0.43 |
| | Kangal Akkaraman | 0.00 | 0.10 | 0.00 | 0.05 | 0.00 | 0.10 | 0.10 | 0.05 | 0.05 | 0.00 | 0.40 |
| | Akkararaman | 0.00 | 0.20 | 0.00 | 0.00 | 0.00 | 0.10 | 0.10 | 0.05 | 0.00 | 0.00 | 0.40 |
| | İvesi | 0.00 | 0.20 | 0.00 | 0.00 | 0.00 | 0.10 | 0.10 | 0.05 | 0.00 | 0.00 | 0.40 |

**Table 1.** (Continued).

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Goat* | Abaza | 0.30 | 0.30 | 0.10 | 0.05 | 0.10 | 0.10 | 0.10 | 0.05 | 0.00 | 0.05 | 0.87 |
| | Norduz | 0.30 | 0.20 | 0.10 | 0.05 | 0.10 | 0.10 | 0.10 | 0.05 | 0.00 | 0.05 | 0.80 |
| | Kackar | 0.20 | 0.20 | 0.10 | 0.05 | 0.10 | 0.10 | 0.10 | 0.05 | 0.00 | 0.05 | 0.73 |
| | Akkeci | 0.30 | 0.10 | 0.10 | 0.05 | 0.10 | 0.10 | 0.10 | 0.05 | 0.00 | 0.05 | 0.73 |
| | Malta | 0.10 | 0.30 | 0.10 | 0.05 | 0.00 | 0.10 | 0.10 | 0.05 | 0.05 | 0.05 | 0.70 |
| | Gürcü | 0.20 | 0.10 | 0.10 | 0.05 | 0.10 | 0.10 | 0.10 | 0.05 | 0.00 | 0.05 | 0.67 |
| | ispir | 0.20 | 0.10 | 0.10 | 0.05 | 0.10 | 0.10 | 0.10 | 0.05 | 0.00 | 0.05 | 0.67 |
| | Ada | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.00 | 0.05 | 0.67 |
| | Renkli Tiftik | 0.20 | 0.10 | 0.10 | 0.05 | 0.00 | 0.10 | 0.10 | 0.10 | 0.00 | 0.10 | 0.67 |
| | Ankara Tiftik | 0.10 | 0.10 | 0.20 | 0.05 | 0.00 | 0.00 | 0.00 | 0.10 | 0.00 | 0.10 | 0.53 |
| | Halep | 0.10 | 0.30 | 0.00 | 0.05 | 0.00 | 0.00 | 0.05 | 0.00 | 0.00 | 0.00 | 0.43 |
| | Kilis | 0.00 | 0.20 | 0.00 | 0.05 | 0.00 | 0.10 | 0.10 | 0.00 | 0.05 | 0.00 | 0.43 |
| | Honamlı | 0.10 | 0.10 | 0.00 | 0.05 | 0.00 | 0.10 | 0.10 | 0.00 | 0.05 | 0.00 | 0.43 |
| | Saanen | 0.00 | 0.30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.10 | 0.00 | 0.05 | 0.00 | 0.40 |
| | Kıl | 0.00 | 0.10 | 0.00 | 0.00 | 0.00 | 0.10 | 0.10 | 0.10 | 0.00 | 0.00 | 0.37 |

[*] TP; total population size. IC; indiscriminate crossbreeding. CP; change of total population size over the last 5 years. DB; distribution of the breed, CI; conservatio*n* in situ program, SP; special traits, SC; socio-cultural importance, EP; economic performance, EI; ecological importance, and FA; farmers' assessment.

**Table 2.** Frequencies of farmers' answers on the main problems and preferences of keeping the native cattle, sheep, and goat breeds in certain production environment by breeders.

| **Main problems** | **Freq.** | % | **Preferences** | **Freq.** | % |
|---|---|---|---|---|---|
| Marketing | 26 | 19.5 | Marketing | 5 | 4.9 |
| Mortality rate | 11 | 8.3 | Mortality rate | 3 | 2.9 |
| Low performance | 4 | 3.0 | Performance | 9 | 8.8 |
| Grazing ability | 1 | 0.8 | Grazing ability | 5 | 4.9 |
| Disease | 20 | 15.0 | Adaptation/resistance | 45 | 44.1 |
| Feed cost | 27 | 20.3 | Easy management | 12 | 11.8 |
| Lack of organisation | 1 | 0.8 | Low cost | 2 | 2.0 |
| Low income | 8 | 6.0 | Meat and milk quality | 13 | 12.7 |
| Pasture/water scarcity | 12 | 9.0 | Special breed | 8 | 7.8 |
| Predator | 10 | 7.5 | | | |
| Shepherd | 13 | 9.8 | | | |
| **TOTAL** | **131** | **100.0** | | **102** | **100.0** |

income (n = 8), low performance (n = 4), while lack of organization, and low grazing ability were lowest (n = 1) among main problems for farming native breeds.

## 4. Discussion

In this study, a total of 6 cattle, 33 sheep, and 15 goat breeds were ranked for risk status in terms of conservation purposes. According to the extinction probabilities, some of the native cattle, sheep, and goat breeds are at a critical position. These extinction probability values may be used for prioritization to conservation. Gizaw et al. [12] reported an extinction risk value <0.20 is considered safe or not endangered. However, breeds with a high risk of extinction do not mean it has the highest conservation priority because the contribution to genetic diversity with other closely related breeds becomes important [12]. In this study, the general average Z-value was found to be 0.63. Reist-Marti et al. [11] suggested that a breed may be considered completely safe from (z = 0) or entirely doomed to (z = 1) extinction. The agricultural system in the Turkey during the 20th century favored of more productive bovine, sheep and goat breeds and changes in the production systems led to the decline of those local breeds or even close to their extinction. Consequently, Turkey Governmental authorities launched conservation programs based on ex-situ-in vivo, ex situ-in vitro, and in vitro actions to conserve AnGR [15,16]. The main starting point of the loss of genetic diversity is uncontrolled intensive crossbreeding activities due to changes in production systems and productive expectations. Population size, structure, and distribution patterns of breeds are important factors on breeds' risk of extinction. Depending on the country's conditions sufficient data may not be available for a limited number of indicators of biodiversity in which case the use of existing data and the introduction of new indicators are important for the conservation of biodiversity [5]. For cases where there are no reliable records of the number of purebred females and males of the breeds, the approximate population size was used as an explanatory parameter in terms of risk status. Therefore, determining current demographic structure in the production system and extinction probability of breeds will be an important basis for further prioritizing conservation and sustainable utilization at the national level.

Another important factor is the size of the breeding area of the breed or genotype. Conservation of breeds bred in a very narrow geographical area and breeds currently at risk should be given priority [3–4]. The limited geographical distribution of breeds makes them vulnerable particular risk of a disease epidemic, but geographically concentrated breeds are also expected to experience a higher rate of inbreeding [1]. A breed is categorized in one of the five categories of endangerment if 75% or more of its population lies within a circle of a 25 km radius [7]. Carson et al. [17] identified 95% population of the 10 sheep breeds concentrated within a 65 km radius of the breeds' mean center. Thus, the geographic location of populations belonging to a particular breed should be also integrated into the model for estimation.

There are differences in Z-value averages and observed variation among cattle, sheep, and goat species. For this reason, it would be more useful to evaluate the Z-values found for each species relatively within their own species. In terms of conservation priorities, it can be said that the breeds with the highest value within the species should be considered as a priority. The result obtained from molecular tools in previous studies and Z-value estimated in this study are not fully consistent with each other, nevertheless, there are some consistencies. It should be considered that these studies were carried out in different time scales. Keeping in mind that the influence of many factors on the extinction probability of the breeds in the future, the probability should be estimated by considering all factors as much as possible including pedigree records.

Since the extent to which the AnGR meets the needs of the producer is important in terms of conservation priorities, not only genetic variation studies but also socio-economic factors should also be considered in terms of prioritization in conservation programs [3]. Production systems have evolved into more intensive and commercially-oriented high-yielding breeds have become increasingly preferred and largely kept for their production traits [18]. Local breeds should have maintained hardiness and natural adaptation for low-input production systems; therefore, these breeds could have advantages for functional traits, such as fertility, disease resistance, and longevity, which have a large impact on profitability of dairying [19]. Collado et al. [20] stated that production systems and farmers are the most important strengths and weaknesses and the most important opportunities were marketing new products for determining driving factors of local cattle breeds in EU. In addition to their genetically unique characteristics when deciding on the risk status in terms of protection, the adaptation of breeds to a certain environment, their economic importance, certain characteristics and cultural and ecological characteristics should be considered [21]. Moreover, factors such as population size, rate of population decline, degree of crossbreeding, organizational structure of producers and distribution of animals over geographical areas belonging to the breed should be considered. While studies revealing genetic differences using DNA-based markers are very important in conservation studies, the economic, scientific, ecological, historical and cultural significance of breeds are also of great importance in revealing risk situations. Significant erosion was observed in the diversity of AnGR due to changes in production systems, breeding conditions, and market conditions [8]. Assessing the risk status for AnGR is a key part of country-based early warning and response systems for sustainable utilization and conservation of livestock breeds [10]. In the present study, it is seen that the sustainability factors, especially the adaptation of the breed to the specific environment, durability, ease of keeping and feeding, and product quality are important in terms of producer views (Table 2). The ability to transform natural feed resources into high-quality animal product and adaptive ability to marginal areas are well known by breeders. On the other hand, breeders prefer crossbreeding or abandoning existing breeds due to unfavorable conditions affecting production such as disease and feed costs, deficiencies in the marketing conditions of products of existing breeds, and having low-yielding breeds. Farmers stated that exotic breeds or their crossbreeds could not productive in these marginal production environments. Many farmers prefer cross-breeding their native breeds with exotic breeds to take advantage of the combination of adaptive and production traits. Therefore, crossbreeding rate is main determinant of the existing probability. Crossbreeding pressure on the breeds should be also considered.

Genetic diversity within breeds should be monitored for all conserved breeds. In Turkey, several studies have been carried out on genetic diversity for the breeds, although they were focused on certain breeds, especially sheep and goats. These studies in which molecular genetic tools used for the genetic structure of native breeds belonging to several livestock species revealed an extremely high level of genetic diversity among and within breeds. In the recent two decades, the number of studies on genetic diversity performed by using microsatellite markers has increased. However, these studies have not been integrated with the studies carried out in the field where animal production practice is realized. Furthermore, the majority of them have not been consistent with each other. For instance, the studies on cattle were included most native breeds, but the findings obtained were not consistent with each other. For example, while Özşensoy et al. [22] found the highest Fıs value (as 0.066) for NSY breed, Öner et al. [23] estimated this value as 0.059 and 0.064 for SAR and NBC breeds. This inconsistency indeed may be attributed to years between the studies. This situation showed that regular measurement of genetic diversity and inbreeding how much important are. In terms of molecular inbreeding coefficient estimation for sheep and goats, the situation is more complex than the cattle have. In Turkey, there are more than 30 breeds registered or broadly accepted. There are so many types and varieties within these breeds. Genetic diversity studies by microsatellites showed that genetic diversity between breeds is not big as much as the ovine species has. In the past 20 years with the forces on conservation of genetic resources, diversity measurement studies for sheep breeds have been cumulated. Although the studies focused on major sheep breeds and their varieties they revealed remarkable results. In one of the most important studies performed on 13 native sheep breeds, it was found that Karayaka, Kıvırcık, and İvesi sheep breeds captured the total genetic diversity of Turkish native sheep breeds [24]. They suggested that specially Karayaka sheep breed has great importance as a potential connection between European and Asian sheep breeds. According to the authors conserving the three breeds will be a sort of guarantee for protecting total genetic diversity and potential connected breeds between the two continents. On the other hand, a molecular diversity study [25] carried out to figure out the genetic structure of Karayaka sheep breed population raised different geographic localizations indicated that Fıs value for the total population was quite high as 0.630. This value could be caused by uncontrolled breeding, the low number of microsatellites used. Other studies on Akkaraman breeds and their varieties have also estimated quite high Fıs values for each population except Şavak Akkaraman [26]. In addition to Akkaraman and its varieties, the authors also estimated genetic diversity in İvesi, Norduz, and Morkaraman sheep breeds and the Fıs values have been found even higher than those of Akkaraman and its varieties. The Fıs values were 0. 660, 0. 628, 0.734 for İvesi, Norduz, and Morkaraman breeds, respectively.

For goat breeds we observed similar situation according to Z-values given in Table 1. Although there are only two groups of the species indicated as Angora and Hair Goat by TUİK [27], eventually, fifteen goat breeds were registered, and a Z-value was estimated for all of them. The inbreeding coefficient was estimated for some native goat breeds as Angora, Kıl, Honamlı, and Norduz [9, 28] by microsatellite markers. Although this kind of study is more abundant for cattle and sheep, inbreeding indicators calculated by using molecular markers for goat breeds showed that Fıs values were not as high as those for the other two species. It can be explained that there is no systematic selection program for these breeds.

Risk status estimation and monitoring are essential for more appropriate conservation programs and sustainable animal production. The risk of extinction probability can be useful criterion for decision making of conservation and sustainable utilization of the breeds. In particular, we would recommend that comparable surveys in AnGR populations consider the use of current population and data set presented here. Adaptations to particular environments and traditional production systems are main factors for sustainability. In many cases, local breeds populations have declined because of lower profit compared with other breeds in intensive production systems [18]. It was clear that simply subsidy policies for conservation cannot fulfill the breeders' requirements and sustainable production of AnGR. There is a need for comprehensive approach according to breed, farmers' expectation and market condition for each native cattle, sheep, and goat breeds.

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**Informed consent**

All authors contributed equally to the study. We declare that our research, the information of which is given above, is among the studies that do not require ethical committee approval since it was produced from a survey study between 2014–2017.

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