Biological and productive features of Kyrgyz mountain merino breed types in different climatic zones

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Abstract: The problem of global climate change on the planet requires the most effective use of the bioclimate to develop a production technology corresponding to the natural potential. The present research is aimed at studying the impact of climatic zones on sheep productivity to identify the resources of wool and mutton production. The research was conducted on sheep of fine-wool breed. The analysis and methods of variation statistics of digital data were used in the research. The significance criterion of the difference between the mean values is calculated by means of the MS Excel 2000 software. The external phenotypic indicators, meat (live weight) and wool (clip), productivity of 8,056 sheep in 13 flocks of Issyk-Kul, 24 flocks of Talas, and 10 flocks of South Kyrgyz sheep type for the period from 2012 to 2016 were used. By live weight (X±SX=58.20±0.31; CV=4.98;) ewes of the Issyk-Kul type surpass their ewes from other climatic zones with a significant difference ($P<0.01$; $P<0.05$). The research results enable farmers and livestock breeders to make the best use of existing sheep adaptation strategies and take climate change into account when developing and implementing agricultural policies.

Keywords: sheep, climate, adaptability, live weight, exterior, merino wool

1 Introduction

Kyrgyzstan is a mountainous country. More than three quarters of the territory is occupied by mountains, and it is located in the western and central part of the Tien Shan and Pamir-Alai mountain systems. The average altitude above sea level is 2,750 m. More than half of its territory is located at altitudes from 1,000 to 3,000 meters. Therefore, about 83% of agricultural lands is occupied by natural mountain pastures, only 6.8% of the total land area is used for crop growing [1].

Sheep breeding is a traditional and leading industry in Kyrgyzstan. Animals of Kyrgyz mountain merino (KMM) breed are common in all regions of the Kyrgyz Republic, differing in natural and climatic conditions [2]. Natural and climatic conditions contribute

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to the development of sheep breeding and the production of cheap, environmentally friendly products. Depending on the territorial settlement of the Kyrgyz mountain merino breed, we have identified three zonal types of sheep: Talas, Issyk-Kul, and South-Kyrgyz.

Therefore, the relevance of our research lies in the fact that for the first time we are studying the productive qualities of the Kyrgyz mountain merino breed in the context of climate change in Kyrgyzstan. Budolfson, McPherson, and Plunkett [3, 4] argues that animals matter for climate change and that climate change matters for animals. Food security in the face of climate change depends on our ability to adapt livestock systems to climate change.

2 Materials and methods

The research was conducted on the basis of three state stud farms located in different climatic zones.

One of the stud farms is located in the northwestern part of Kyrgyzstan, in the Talas Valley. In the northwest, the valley expands and borders with semideserts and deserts of the Turan lowland. The climate of the Talas region is dry continental. The average temperature in July is 15–25 °C, in January -6...-14 °C. The duration of the frost-free period is 157–163 days. The average annual precipitation is 300–400 mm and increases from west to east, from the foot of the mountains up the slope. Summer is dry, permanent snow cover is formed on the plain in December, and in the foothills in November [5, 6].

The second stud farm is located in the eastern part of the country of the Issyk-Kul valley. In the southern part, high-altitude plains are stretched at an altitude of more than 3,000 meters above sea level. The climate of the Issyk-Kul Valley is determined by the isolation of the valley and the presence of a large unfrozen lake. The lake makes the climate of the valley milder, there is no sweltering heat in summer and severe frosts in winter. The average temperature in July is about 18 °C, in January -2...-4 °C. The average annual precipitation in the east of the valley is about 600 mm, in the west – only 115 mm. The main amount of precipitation falls in the summer. On the slopes of the ridges surrounding the basin, climatic conditions are subject to vertical zonation: with increasing altitude, temperature decreases and precipitation increases. It has a heavy continental climate. The average annual temperature is 3–7 °C, the amount of precipitation is 200–300 mm [7, 8].

The third stud farm is located in the southern part of the country. A significant part of the region's territory is covered by the Pamir-Alai and western Tien Shan mountains. Altitude fluctuations range from 500 m in the north to 7,000 m in the south. In general, the continental climate prevails in the region. At an altitude of 600–1,100 m, the climate is warm and semi-arid. Winter is moderately warm, the average temperature in January is -3 – +4 °C, short. The summer is hot and dry, the average temperature in July is 24–25 °C. The vegetation of the region is also subordinated to the vertical zonation [9].

The research material was sheep of fine-wool breed — Kyrgyz mountain merino. The conditions for feeding and keeping sheep in all three zonal types were normal, adapted in the flocks of state stud farms throughout the entire period of our research. The indicators of meat and wool productivity were used in 8,056 sheep in 13 flocks of Issyk-Kul, 24 flocks of Talas, and 10 flocks of South Kyrgyz sheep type for the period from 2012 to 2016.

Zootechnic methods and techniques were used for the study. Typical animals meeting the requirements for productivity indicators of zonal types were selected in the study groups. To evaluate by the method of variation statistics and to determine the relationship between climatic zones, 20 main and replacement ram, and 30 ewes and gimmers, body weight and measurements were measured during the spring assessment.

The evaluation was carried out according to the instructions for sheep of fine-wool breeds [10]. The physic-mechanical and technological properties of wool were studied under evaluation according to GOST 17514-93 [11], GOST 28491-90 [12].

The live body weight was studied by weighing on a scale with an accuracy of 500 g. The obtained data were compared with body weight depending on the sex and age of the sheep.

The constitution of the animals was studied on the basis of taking measurements of the body. Typical animals from each age-sex group were selected, six main body measurements were taken into account: height at the withers, cross trunk height, chest width, chest depth, chest girth behind the shoulder blades, and pastern girth. Body measurements of sheep were used to calculate constitution indices, such as long legs, elongated, chest, blockiness, massiveness, and bone, in % [13].

Wool samples were taken before shearing from the side area (behind the shoulder blade) during evaluation, and in the period of shearing during wool classification to determine the yield of pure fiber. A stencil screen with round cells was used to take wool samples. During the shearing period, wool clips were taken into account separately.

The main parameters of wool quality, such as fineness and length, and their biometric constants, were carried out on the Australian device OFDA-2000. The clean equivalent weight was determined in each animal using a hydraulic device GPOSH-2M.

The results of the study were processed by methods of variation statistics [14], with the calculation of significance criteria of the difference between the average indicators by means of the MS Excel 2000 software.

The work objective of our research was an adaptive approach to sheep breeding in high-altitude environments, which could effectively use climatic conditions and meet the natural potential.

3 Results

Table 1 shows the body weight of ewes in different zonal types and their difference from each other. Ewes of the Issyk-Kul type (IKT) surpass ewes from other climatic zones. South Kyrgyz ewes are inferior in body weight by 2.15 kg, or 3.8% with a high significant difference of $P < 0.01$, with a small difference of CV = 0.23. At the same time, Talas-type (TT) ewes are inferior by 0.85 kg, or 1.5% with an insignificant difference ($P > 0.05$). The difference between the Talas and South Kyrgyz types (SKT) is 1.3 kg, or 2.3% ($P < 0.05$), and here there is a large difference in the variation coefficient (CV = 1.5) between them.

Table 1. Live weight of sheep in different climatic zones, kg.

Zonal type of ewes	n	$X \pm S_X$	C_V factor
Talas	30	57.35±0.34	3.25
Issyk-Kul	30	58.20±0.31	4.98
South-Kyrgyz	30	56.05±0.49	4.75

To compare the characteristics of the exterior and constitutional qualities of ewes in different zonal types, a comparison was made with the ewes of Australian merinos, which are presented in Figure 1. Thus, in the height at withers, Issyk-Kul ewes are 0.20 cm, or 0.3% ($P > 0.05$) higher than Talas, and 0.42 cm, or 0.6% ($P > 0.05$) of the South-Kyrgyz type. The difference between the Talas and South-Kyrgyz zonal types is 0.22 cm, or 0.3% ($P > 0.05$). The maximum difference between the Australian merino ewes and the zonal types of the Kyrgyz mountain merino is 1.69 cm, or 2.5% (in comparison with South-Kyrgyz type), and the minimum difference is 1.27 cm, or 1.8% in comparison with Talas type.

According to the cross trunk height among the ewes, the minimum and maximum difference compared to the Australian merino (AuM) ewes and between the zonal types was 5.70 and 6.43 cm, or 8.2 and 9.4 percent.

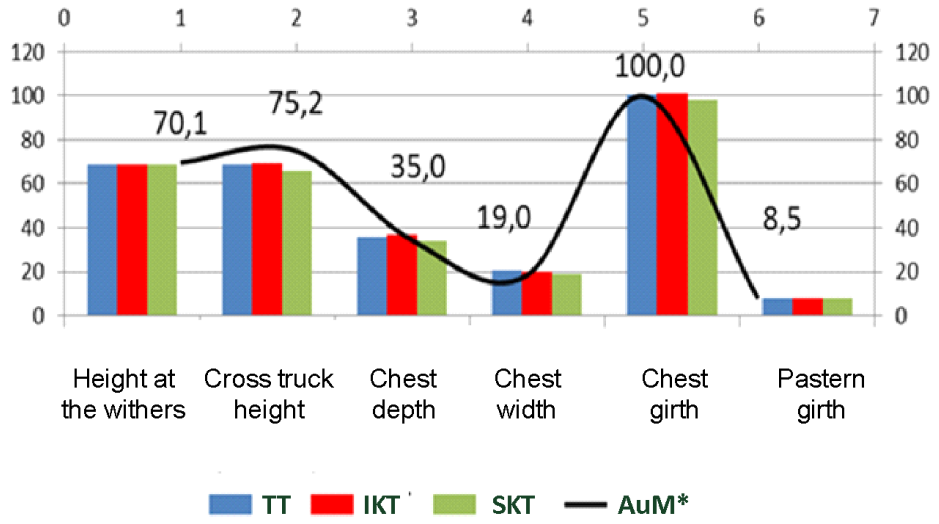

Fig. 1. Exterior profile of ewes of intrabreed zonal types.

The trend remains in terms of chest depth. Thus, by 3.16 cm, or 9.4% ($P<0.001$) and by 1.96 cm, or 5.8% ($P<0.001$), there was a difference between the Issyk-Kul and Talas types over the South-Kyrgyz type. The difference between the Issyk-Kul and Talas types was 1.20 cm, or 3.4% with a significant difference ($P<0.05$). It should be noted that in terms of chest depth, there is a tendency for the superiority of two types of Kyrgyz mountain merino breed over Australian merinos, except for the South-Kyrgyz type. This difference is, respectively, 0.63 cm of the Talas and 1.83 cm of the Issyk-Kul type, or 1.8 and 5.2%. Apparently, this is due to the fact that Kyrgyz mountain merino sheep are adapted to high-altitude environments where more oxygen is required. In her research, Ulimbasheva [15] comes to the conclusion that sheep in high-altitude environments provides an increase in the protective mechanisms and redox reactions of the body.

Thus, our research indicates that the exterior of the zonal types of the Kyrgyz mountain merino breed have well-developed body measurements, with an average height and sufficiently developed limbs.

The noted phenotypic differences of zonal types create a certain heterogeneity of the Kyrgyz mountain merino breed and allow maintaining good animal vitality. Taking into account that phenotypic traits are determined by heredity, i.e. genotype, as well, therefore they are directly or indirectly related to biochemical processes and metabolism, and, therefore, to productivity.

The wool clip in the original is higher in animals of the Talas type. However, by having a significantly high clean equivalent weight, sheep of the Issyk-Kul type are superior in wool clips of the main intrabreed types [16]. The wool productivity of the zonal types is quite high and meets the requirements of the Kyrgyz mountain merino breed standard.

It is known that clean equivalent weight clip is an important indicator characterizing the true value of wool productivity of sheep. We found that the Talas type is inferior to other zonal types in terms of the yield of pure fiber (60.0%). Thus, the difference between the Issyk-Kul type was 4.1% and the South-Kyrgyz type — 3.8%. These fluctuations are probably due to the wool clogging, and not to the individual peculiairities of Talas sheep. It

is evidenced by the indicators of the physical mass of the washed fiber, where there is no significant difference between the Talas and Issyk-Kul types, but they are superior to the South-Kyrgyz type, respectively by 0.27 kg, or by 10.6%, and by 0.4 kg, or by 15.7% with an insignificant difference (P>0.05).

In terms of the yield of pure fiber, a high index of 64.1% is observed in the Issyk-Kul type. It can be explained by the fact that during the period of transformation of the Kyrgyz fine-wool breed, mainly Australian ram of the "strong" wool type were selected for crossing with ewes in the eastern part of the country. In this regard, academician Moroz [17] writes in his article that there are four distinct main types of merino sheep in Australia. At the same time, there is a clear superiority of sheep in the "strong" type in the yield of washed fiber, which was achieved due to the fact that these sheep are larger and produce a longer wool fiber than other types. It is noted by Biltuev et al. [18] that the animals of the line from Australian merinos of the "strong" type are distinguished by high clip and clean equivalent weight, greater length and thickness of wool fibers.

However, sheep of the South-Kyrgyz type have a slightly low clip indicator in pure fiber. Apparently, it is due to the wool density, in addition to heredity, which is confirmed by our research. In ewes of the South-Kyrgyz type, the wool mass of satisfactory quality is only 74.1%, in Talas and Issyk-Kul types, 84.8 and 85.1%, respectively.

4 Discussion

The adaptation of the breeds takes place following their natural history of habitat. The conditions of natural habitats are variable and the resulting combinations of environmental factors are very diverse. Therefore, the surviving organism must be well adapted to any possible combination of environmental factors, i.e. have adaptability [19].

Climatic conditions depend on the latitude and altitude of the area above sea level, its topography and other physical and geographical features. "The main areas of sheep breeding are located within 35–55 degrees north latitude in Europe and Asia and between 30–45 degrees south latitude in South America, Australia, and New Zealand," notes Morris [16]. Kyrgyzstan stretches within 39–44 degrees north latitude. "Domesticated sheep (Ovis aries) have many genotypes that are adapted to a wide range of environments — from the tropics to extreme seasonal fluctuations of high latitudes and from deserts to areas with high amount of precipitation. Such a variety of genotypes (numbering more than 2,000 breeds) means that this species easily adapts to extreme environmental/climate conditions," believes Hinch [8]. The same opinion is shared by researchers Petit, Boujenane [20], and Hoffmann [21].

"The results show, writes Seo et al. [22], that climatic variables are very significant determinants of the choice of primary species after controlling for soils, geography, farm characteristics, and fixed effects of the country. The effects of climate change will vary depending on species and climate scenarios."

Discussions on agriculture are continuing in order to find an acceptable approach to addressing climate change-related problems faced by agriculture around the world and to ensure that food production is not under threat [23-27]. Globally and in an unstable climate, the agricultural sector will have to feed more people without degrading the ecosystem services on which production depends.

5 Conclusion

The results of the study revealed the resources for obtaining high-quality wool and mutton from sheep in high-altitude environments, taking into account the climatic conditions of

Kyrgyzstan. Based on the conducted research, three purebred zonal types of the Kyrgyz mountain merino breed have been identified — Talas (northwestern), Issyk-Kul (eastern), and South-Kyrgyz (southern).

Studies have shown that in the conditions of the Issyk-Kul zone, ewes with a large weight of 58.20 kg have an advantage in breeding. The animals of the southern zone occupy an intermediate position between the animals of the stud farms named after Luschikhin and "Orgochor."

It was found that according to the requirements of the procedure and conditions for the evaluation of pedigree sheep of fine-wool breeds, the wool productivity of purebred zonal types according to the minimum productivity indicators of pedigree sheep of meat-wool breeds and the requirements for purebred zonal types of the Kyrgyz mountain merino breed exceeds by 17.4–20.0 %.

The research results will enable practicing farmers and livestock breeders to make the best use of available sheep adaptation strategies and take climate change into account when developing the best management strategies in the sheep industry.

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