



Biological and productive features of fine-fleeced sheep in purebred breeding and crossbreeding in south-eastern Kazakhstan

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Abstract. In Kazakhstan, sheep farming remains an important sector, providing both food and raw materials for industry. In the context of declining wool value, the development of meat production has become particularly relevant, making the selection of suitable breeds essential for improving productivity. The aim of the study was to assess imported fine-wool rams from Australia and the Kyrgyz Republic when used for crossbreeding with Kazakh Fine-Wool ewes under the foothill conditions of the Akbulak farm in Almaty region. Three groups of ewes, each consisting of 150 head, were formed, using 3 Australian Meat Merino (AMM) rams, 3 Kyrgyz Mountain Merino (KMM) rams and 3 Kazakh Fine-Wool (KF) rams. Both purebreeding and industrial crossbreeding methods were applied, enabling accelerated modification of hereditary and physiological characteristics. The results showed that the experimental rams exhibited a strong constitution, high live weight and excellent wool yield. Clinical indicators in all groups remained within physiological norms, with no significant intergroup differences. Haematological parameters were maintained at an optimal level and varied seasonally, reflecting the intensity of oxidative-reduction processes. The highest fertility was recorded in Group I (KF × KF) at 121.0%, which exceeded Groups II (AMM × KF) and III (KMM × KF) by 1.65% and 3.30%, respectively. Lamb survival to weaning in Group I reached 97.3%, surpassing that of contemporaries by 1.4% and 1.7%. The practical value of the research lies in demonstrating that the use of AMM and KMM rams in Kazakh Fine-Wool flocks can improve wool fineness, enhance the histomorphological structure of the skin-fleece system, increase ewe fertility and lamb survival, and contribute to higher mutton production in the foothill regions of south-eastern Kazakhstan

Keywords: Kazakh Fine-Fleeced breed; Australian Meat Merino; Kyrgyz Mountain Merino; fertility; live weight; body measurements; physiological and haematological parameters

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Introduction

Sheep farming remains one of the most important areas of animal husbandry in the Republic of Kazakhstan, providing meat, wool and milk and making a significant contribution to the socio-economic development of pastoral regions. However, the modern development of the industry requires the introduction of technological solutions aimed at increasing the efficiency of pasture management and improving the productive qualities of breeds used in Kazakhstan. It is becoming increasingly important to develop fast-growing animals that are resistant to climatic factors and capable of producing high yields of mutton and wool. Productivity can be increased both by improving existing breeds and by combining genetic lines that are highly adaptable and productive. One of the effective tools for increasing the efficiency of sheep breeding is the use of crossbreeding, which allows for the acceleration of the consolidation of desirable traits. Practice shows that correctly selected combinations of producers contribute to the improvement of the constitution, meat productivity and quality characteristics of wool in offspring (Iskakov *et al.*, 2017). In this regard, it is important from a scientific and practical point of view to study the breeding efficiency and productivity of Kazakh Fine-Wool sheep in various combinations with producers of other highly productive fine-wool breeds that differ in wool and meat characteristics.

The development of sheep breeding in modern conditions is determined by a complex of factors, among which the improvement of selection work and the increase in the adaptive and productive potential of animals play a key role. The global market is seeing steady growth in demand for high-quality fine wool and young lamb, which increases the need to improve fine-wool sheep in two areas simultaneously: improving wool fibre characteristics and increasing meat productivity. Data from E. Islamov *et al.* (2021) confirm that the productivity of fine-wool breeds can increase significantly with the optimal organisation of breeding and genetic programmes. The market situation in Kazakhstan is also shaping a trend towards increased lamb production, which requires adaptation of breeding approaches. A significant portion of lamb is produced on farms where industrial crossbreeding is considered an effective method for rapidly improving the meat quality of the livestock. It is important to note that low sheep productivity is often due to improper breeding practices, including the prolonged use of the same producers, which leads to inbreeding and a decrease in reproductive performance (Vijayakumar *et al.*, 2025). At the same time, preserving the genetic integrity of breeds and stable exterior traits is only possible through consistent purebred breeding, which is especially relevant for regional genotypes of fine-wool sheep (Lakota, 2025). One of the indicators of the breeding value of fine-wool sheep is wool fineness. As noted by A. Rahim *et al.* (2025), this trait

determines the quality of yarn, the strength of textile products and the marketability of wool products. Moreover, fibre fineness largely correlates with the physiological condition of animals and their potential for high productive performance. Modern approaches to breeding also involve the use of technological innovations to improve the accuracy of selection and assessment of animal behavioural characteristics, which allows the most valuable individuals to be identified without additional stress on the herd (Emsen *et al.*, 2025).

A summary of the scientific data presented shows that improving the efficiency of fine-wool sheep breeding requires a comprehensive approach, including the improvement of genetic resources, the scientifically based organisation of the selection process, and the adaptation of crossbreeding schemes to the natural and climatic conditions of the regions. However, the question of the optimal selection of combinations of producers for specific areas of Kazakhstan remains open, which makes further research in this direction scientifically and practically significant. The aim of the study was to evaluate the biological and productive characteristics of Kazakh Fine-Wool sheep in purebred breeding and crossbreeding in south-eastern Kazakhstan. To achieve this goal, the following tasks were set: to identify the reproductive qualities of the breeding stock; to analyse the productive and adaptive characteristics of animals of different genotypes; to evaluate clinical and haematological indicators in relation to the conditions of keeping.

Materials and Methods

The research was conducted in 2018-2024 at the Akbulak farm in the Zhambyl district of the Almaty region (Kazakhstan), located in the foothills at an altitude of 650-820 m above sea level. The experiment included 450 ewes of the Kazakh Fine-Wool breed aged 3-4 years, class I according to the bonitation, with a live weight of 65-68 kg, normal reproductive history and confirmed veterinary status. Nine rams of three genotypes were used for crossbreeding: Kazakh Fine-Wool, Kyrgyz Mountain Merino and Australian Meat Merino. The 3-3.5-year-old producers were brought in from certified breeding farms in the respective countries and had documents confirming vaccination, infection diagnosis and the absence of parasitic diseases. The ewes were divided into three groups by randomisation, taking into account age, body weight and physiological condition, with 150 animals in each group. The animals were kept on autumn, winter and summer pastures. All animals were kept under the same grazing conditions: during the warm season, they were grazed on natural wormwood-grass and mixed-grass pastures, and in winter, they were fed alfalfa hay (2.5-3 kg per head) and barley bran (0.3-0.5 kg). The nutritional value of the feed was determined using laboratory

methods in accordance with GOST 31675-2012 (2013) and GOST 13496.4-2019 (2020). Climatic factors (temperature, humidity, wind, precipitation) and the epizootic situation were monitored daily. The experiment used a flock of Class I ewes of the KF 450 breed, with a live weight of 66.2 kg, original wool yield of 5.9 kg, washed wool yield of 3.12 kg, wool length of 9.15 cm, and wool fineness of 22.96 μm .

The ewes were inseminated between 20 October and 10 November each year with freshly collected sperm using an artificial vagina (IMV Technologies, France). The quality of ejaculates (volume, concentration, motility, morphology) was assessed using a SpermVision photometer (Minitube, Germany) and an MBS-10 microscope (MICROmed, Ukraine). For insemination, 0.1 ml of semen containing at least 80 million actively motile spermatozoa was used. Pregnancy in ewes was determined using a Dramiński ANIMAL profi ultrasound machine (Dramiński, Poland) on the 45th day after insemination. The physiological parameters of the animals (body temperature, respiratory rate and pulse rate) were measured seasonally three times a day – at 08:00, 13:00 and 18:00 – using a Vet-100 veterinary thermometer and counting physiological cycles for 1 minute. Blood for analysis was taken on an empty stomach from the jugular vein into VACUETTE tubes with EDTA (Greiner Bio-One, Austria), after which laboratory tests were performed on a Mindray BC-2800Vet haematology analyser (Mindray, China) in accordance with ISO/IEC 17025:2019 (2021). Haemoglobin, erythrocyte, serum protein and mean erythrocyte diameter were determined. All procedures were performed in accordance with ethical standards according to the Code of Practice... (2014).

To assess the external characteristics of the sheep, linear measurements were taken, including height at the withers and sacrum, oblique body length, chest depth and width, chest circumference behind the shoulder blades, and pastern circumference. The measurements were taken with a metal tape measure and a measuring stick with an accuracy of 0.5 cm by two specialists independently of each other, after which the average value for each animal was calculated. Based on the measurements obtained, body conformation indices were calculated using standard zootechnical analysis methods regulated by GOST R 57784-2017 (2019) and methodological recommendations for the evaluation of meat-wool sheep. The body elongation index was determined as the ratio of the oblique length of the body to the height at the withers, multiplied by 100%. The massiveness index was calculated as the ratio of chest circumference to height at the withers, also expressed as a percentage. The bone index was determined as the ratio of the metacarpal circumference to the live weight of the animal, multiplied by 1,000 to facilitate comparison of indicators. The compactness index was calculated using the formula: chest circumference \times 100/oblique body length. The pelvic-chest shape index was

determined based on the ratio of chest width to width at the hocks. All indices were calculated in accordance with generally accepted zootechnical methods that allow assessing the proportionality, muscle development, and body type of animals. To ensure accuracy, each indicator was calculated twice, after which the average value was analysed (Zhumadillayev *et al.*, 2021). The coefficient of variation (Cv) for assessing the degree of variability in lamb weight at different ages was calculated using the classic biometric formula (1):

$$Cv = \frac{s}{\bar{x}} \times 100\%, \quad (1)$$

where S is the standard deviation of the trait, and \bar{x} is its arithmetic mean. The mean values and standard deviations were calculated automatically using R 4.1.2, SPSS 26.0, and MS Excel 2019 software. The obtained coefficients of variation (in the range of 8.1-11.9%) reflected the low level of variability of the trait within each group. The calculations were performed in three repetitions, which ensured the statistical reliability of the results.

The reproductive qualities of ewes were assessed based on the percentage of inseminated and lambing animals, the number of lambs born, and their survival rate up to 4.5 months. The weight of the animals was determined before morning feeding with an accuracy of 0.1 kg using Kern FKB 65K0.1 electronic scales (Kern & Sohn, Germany). External measurements – height at the withers and sacrum, body length, chest depth and width, chest circumference and pastern – were taken using a Stanley PowerLock metal tape measure (Stanley Black & Decker, USA) and a Zootech Measuring Stick MS-250 (Kaixin, China). Based on linear measurements, body conformation indices (stretch, massiveness, bone structure, etc.) were calculated using formulas regulated by GOST R 57784-2017 (2019). Each measurement was performed by two independent specialists with double repetition per animal. Wool productivity was determined by measuring the fleece and analysing the fibre fineness using the OFDA 2000 device (BSC Electronics, Australia). Statistical data processing was performed using methods of variational statistics, Student's criterion, one-factor ANOVA and Tukey's post-hoc test at a significance level of $p < 0.05$. The calculations were performed using R 4.1.2 (R Foundation for Statistical Computing, Austria), IBM SPSS Statistics 26.0 (IBM, USA) and Microsoft Excel 2019 (Microsoft, USA) software.

Throughout the study period, the experimental groups of sheep were kept in accordance with seasonal pasture rotation, which is a mandatory element of the traditional system of pastoral animal husbandry in foothill areas. In spring and autumn, the animals were kept on lowland pastures with poorer vegetation cover, while in the summer months they were transferred to highly productive foothill pastures with more diverse and nutritious grass cover. The herds were moved along established routes twice a year – at the end of May

and the beginning of September – with an adaptation period of 5-7 days. Pasture conditions, grass composition and land productivity were documented annually based on an assessment of botanical composition, grass height and estimated green mass yield.

The physical condition of the animals was assessed seasonally using a set of indicators: body condition (1-5-point scale), skin turgor, coat condition, respiratory and heart rates, body temperature, as well as a visual assessment of activity and behaviour. Overall body condition was determined by palpating the lumbar and spinous processes of the spine, which made it possible to record changes in the animals' energy status against the background of seasonal fluctuations in feed availability. In addition, physiological parameters were recorded before blood sampling, which served as additional indicators of the functional state of the organism. The analysis of seasonal shifts in blood parameters (haemoglobin, erythrocytes, serum protein) was compared with data on pasture type, diet composition and climatic conditions, which made it possible to take into account the influence of barometric pressure, air temperature and oxygen content in the summer and autumn periods. All results were interpreted taking into account the movement of animals between pastures at different altitudes and changes in their feeding status throughout the year.

Results and Discussion

In Kazakhstan, the Kazakh Fine-Wool breed was developed in 1946 by crossbreeding Kazakh fat-tailed ewes with Prekos rams. An analysis of the long-term results of breeding and selection work to improve the Kazakh Fine-Wool breed of sheep has established that their average wool fineness is 22.5-23.4 microns (Zhumadillayev *et al.*, 2021). Consequently, the most important

task for the future is to improve the technological qualities of the wool of the Kazakh Fine-Wool breed. At the same time, it is necessary to preserve the meat qualities and good adaptability to natural climatic and feed conditions, which will significantly increase the profitability and cost-effectiveness of Kazakh Fine-Wool sheep.

In solving this problem, considerable importance is attached to enriching the gene pool of Kazakh Fine-Wool sheep by using the best breeds from other countries. According to D. Rasali *et al.* (2006), Australian Merino wool best meets the current requirements of the global market, as the light industry obtains 30% more yarn from it. Modern merino sheep in Australia and the Kyrgyz Republic are well developed, with high (3-4 kg) yields of washed wool of high quality and a clean fibre yield of 60-70%. The most interesting breeds in this regard are the Australian Meat Merino and Kyrgyz Mountain Merino. Australian Meat Merinos optimally combine high wool quality with good meat productivity and reproductive capacity. In the best flocks, they yield 8-9 kg of wool. According to A. Ombayev *et al.* (2020), Kyrgyz Mountain Merinos, which are bred for wool and meat, are characterised by good reproductive capacity, early maturity, high wool fineness and meat quality. On average, 5-6 kg of wool with a fineness of 18-22 microns is sheared from each sheep. They easily adapt to changing environmental conditions. The improvement of selection and breeding work in sheep farming is carried out on the basis of selecting rams according to economically useful traits and identifying improvers for their widespread use, since the genetic improvement of sheep is mainly achieved through producers. Studies have confirmed that the effectiveness of breeding work increases with a comprehensive assessment of rams, taking into account their biological and productive characteristics (Table 1).

Table 1. Productivity of experimental sheep

Sex and age group	Breed	n	Live weight, kg	Wool yield, kg		Wool length, cm	Quality of fine wool, μm
				greasy	clean		
Rams	KF	3	109.5 \pm 4.00	11.20 \pm 0.58	6.37	10.57 \pm 0.22	23.5 \pm 0.37
	AMM	3	112.6 \pm 4.28	10.23 \pm 0.39	6.45	10.21 \pm 0.30	21.00 \pm 0.71
	KMM	3	106.3 \pm 5.31	11.16 \pm 0.43	7.09	11.10 \pm 0.49	20.60 \pm 0.24
Ewes	KF	450	66.2 \pm 0.51	5.9 \pm 0.20	3.12	9.15 \pm 0.09	22.96 \pm 0.05

Note: KF – Kazakh Fine-Wool breed; AMM – Australian Meat Merino; KMM – Kyrgyz Mountain Merino; n – number of animals in the group; $X \pm m$ – arithmetic mean value of the trait and its error

Source: compiled by the authors based on research results

As shown in Table 1, the live weight of rams was quite high (106.3-112.6 kg). Kazakh Fine-Wool rams slightly exceeded KMM rams in this respect by 3.2 kg, or 2.9%. In terms of unwashed wool yield, AMM rams were inferior to KF rams by 0.89 kg, or 7.9%, and to KMM rams by 0.78 kg, or 7.0%. No significant differences were found in the yield of washed wool, which ranged from 6.37 to 7.09 kg. KMM rams had longer wool – 11.10 cm, which is their distinctive feature. Their superiority over

Kazakh Fine-Wool rams was 0.43 cm, or 4.8%, and over AMM rams – 0.89 cm, or 8.0%. During visual assessment during bonitation, the wool of the rams was fine merino, with a fineness of 23.5 microns for the Kazakh Fine-Wool breed, 21.0 microns for the AMM breed, and 20.60 microns for the Kyrgyz Mountain Merino breed. The imported AMM and KMM breeds had finer wool than the KF breed, by 2.5 μm , or 10.6%, and 2.9 μm , or 12.3%, respectively. In order to obtain a more complete description

of the rams and ewes used in the experiment, their external characteristics were studied. For this purpose, body measurements were taken from all rams and 30 ewes, which are presented in Table 2.

Table 2. Measurements of breeding rams and ewes

Indicator	Breeding rams			Ewes
	Breed	KF	AMM	KF
n		3	3	30
Height at withers, cm		80.5	80.0	81.5
Height at the croup, cm		81.5	82	83.5
Oblique torso length, cm		82	81	81.5
Chest depth, cm		42.5	42.0	41
Chest width, cm		38	35	36
Chest circumference, cm		123.5	122.0	120
Wrist circumference, cm		10	10	10.5
				9.0±0.12

Note: KF – Kazakh Fine-Wool breed; AMM – Australian Meat Merino; KMM – Kyrgyz Mountain Merino; n – number of animals in the group; ewe indicators are presented as the mean value ± standard error of the mean ($X \pm m$)

Source: compiled by the authors based on research results

For selection purposes, tall animals with well-developed meat conformation and a strong constitution are of greatest interest. As can be seen from Table 2, no significant differences in basic measurements were found. The rams in the experimental groups are tall and fairly large, as evidenced by their height measurements. They have well-defined meat conformation, a long torso, and a deep and broad chest, characteristic of meat animals. Characteristically, they have well-filled thighs, combined with a developed hindquarter, which determines their good meatiness. The animals are of strong constitution, with pastern circumference measurements ranging from 10.0 to 10.5 cm across breeds. A similar pattern was found in ewes. When assessing the exterior of farm animals, it is important to know the development of body conformation indices. This is necessary to evaluate the proportions and harmony of the animal's body and its suitability for a particular economic use. The body conformation indices, as well as body measurements, characterise the experimental rams and ewes as long-legged animals with a long torso, deep and broad chest, strong constitution, and pronounced meat conformation. Thus, in the growth and overall development of the studied sheep breeds, general biological patterns characteristic of fine-wool sheep of meat productivity and some features depending on their origin have been identified. At the same time, a slight decrease in productivity in imported rams of the AMM and KMM breeds is probably explained by their lesser adaptability to the foothill conditions of south-eastern Kazakhstan and year-round grazing (Khamzina *et al.*, 2025).

In addition to comparing the exterior of the experimental breeding rams, the experiment aimed to study the individual characteristics of each ram depending on their origin as a potential sire of future offspring. As pointed out by N. Ruziboev & B. Ashurov (2025), a ram selected for its phenotype and origin is of breeding value only if it has sufficient sexual activity, is

capable of long-term exploitation with year-round grazing on natural pastures, and produces good quality semen. Thus, the studies conducted show that the experimental rams of various breeds have the best sperm production indicators, which characterises their high reproductive capacity.

The study of the acclimatisation of imported experimental sheep in the foothill zone of the south-eastern region of Kazakhstan includes the body's responses to new, unfamiliar climatic factors – high temperatures and dry air in the summer months, as well as increased atmospheric pressure and thin air in the foothill pastures (Dossybayev, *et al.*, 2019). Fine-wool sheep tolerate high ambient temperatures and direct sunlight easily. Table 3 shows the results of two years of experiments measuring the temperature, respiratory rate and pulse rate of sheep. In the morning, the body temperature, respiration, and pulse rate of the animals in the compared groups were at their lowest, and increased during the day. This is probably due not only to the increase in ambient temperature, but also to the large number of stimuli that cause a certain reaction in animals, as indicated in the work of V. Dvalishvili & V. Milchevsky (2021). As the ambient air temperature increased, the body temperature, respiratory rate and pulse rate of the rams in groups I and II were significantly lower than those of the other groups. The relative increase in body temperature, respiratory rate and pulse rate in the rams in groups I and II was significantly lower than that in the rams in groups III and IV. The results obtained for physiological indicators confirm the conclusions of A. Abdulmuslimov *et al.* (2024) and Y. Islamov *et al.* (2025) on the need to take regional characteristics into account when selecting breeds for crossbreeding. Rams of Australian and Kyrgyz origin showed stable clinical parameters (Table 3), however, during the summer period at an air temperature of +27°C, KMM rams showed an increase in respiratory rate to 49 breaths/min and an

increase in body temperature to 39.6°C, which indicates a lower adaptability to the hot climate of the foothills compared to the local Kazakh Fine-Wool

breed. This is consistent with the data of Y. Islamov *et al.* (2025) on the importance of animals' adaptive capabilities when moving to new climatic zones.

Table 3. Average body temperature, number of breaths and heartbeats per minute (average over 2 years)

Time and place of observation	Time of day, hours	Air temperature, °C	I (KF) n = 3			II (AMM) n = 3			III (KMM) n = 3			IV ewes (KF) n = 3		
			body temperature, °C	breathing	pulse	body temperature, °C	breathing	pulse	body temperature, °C	breathing	pulse	body temperature, °C	breathing	pulse
Winter	8	4	38.9	14	71	38.6	22	73	38.9	22	68	38.5	21	66
	13	6	39.5	22	72	39.2	23	70	39.0	23	69	39.2	21	67
Early spring	8	6	39.2	23	78	39.4	24	75	39.2	21	74	39.4	22	74
	13	11	39.4	21	77	39.6	22	75	39.7	21	84	39.5	22	85
	19	12	39.6	25	24	39.2	25	24	38.8	20	80	39.2	21	81
Spring	8	16	39.6	89	85	39.3	86	81	38.9	37	98	39.1	34	96
	13	19	40.0	196	103	39.6	190	96	39.3	39	102	39.3	36	104
Summer	8	20	39.2	34	86	39.2	36	85	39.2	26	84	38.6	24	83
	13	26	39.5	71	95	39.4	69	95	39.3	46	90	39.6	49	88
	19	22	39.6	74	94	39.6	71	92	39.4	74	92	39.4	74	91
Autumn	8	9	39.3	62	82	39.3	62	81	38.9	24	69	38.4	23	68
	13	14	39.5	82	83	39.2	79	85	39.0	26	83	38.3	24	85

Note: KF – Kazakh Fine-Wool breed; AMM – Australian Meat Merino; KMM – Kyrgyz Mountain Merino; n – number of animals in the group; breathing – number of respiratory movements per minute; pulse – number of heartbeats per minute; I – group of Kazakh Fine-Wool rams; II – group of Australian Meat Merino rams; III – group of Kyrgyz Mountain Merino rams; IV – group of Kazakh Fine-Wool ewes

Source: developed by the authors based on research results

In winter and spring pastures, when the ambient temperature was no higher than 14-17°C, the experimental rams of groups I and II felt satisfactory and grazed well. Although their physiological indicators remained normal, they still differed slightly from the same indicators in rams of group III and ewes of group IV. When the ambient air temperature in the pasture rose to 27°C and above in summer, the body temperature of some animals in groups III and IV rose to 39.6°C, their breathing rate to 49 and their pulse rate to 88 beats per minute. During the heat, they were depressed, did not respond to external stimuli, did not graze, some had diarrhoea, and their body condition score decreased. Normal rapid breathing and increased body temperature for rams in groups I and II is an ecological feature. Their physical thermoregulation mechanism is highly

developed for hot climates and is probably different in nature from that of rams in groups III and ewes in group IV. The data obtained show that imported test animals from different geographical areas differ in clinical indicators, probably due to their constitutional structure. They possess the necessary plasticity to adapt to the foothill pastures of south-eastern Kazakhstan with increased partial oxygen pressure and tolerate high temperatures normally, which causes normal shifts in their vital functions. According to N. Zhumadillayev *et al.* (2022), an important indicator is the change in the morphological composition of blood in farm animals in connection with changes in living conditions. Studies have shown that experimental sheep from different natural and climatic zones in different seasons of the year differ in their red blood cell patterns (Table 4).

Table 4. Red blood cell patterns of breeding rams and ewes from different geographical zones by season

Groups	Seasons	n	Haemoglobin content, g/l	Erythrocyte content, million/ μ l	% protein in serum	Average red blood cell diameter, μ m
I (KF)	Autumn	10	57.3±0.41	11.3±0.50	7.4±0.09	3.96
	Spring	10	50.6±0.44	10.4±0.47	–	3.94
	Summer	10	61.0±0.33	14.4±0.68	8.4±0.26	3.97
II (AMM)	Autumn	10	56.4±0.30	9.3±0.29	7.2±0.24	3.96
	Spring	10	49.7±0.31	8.6±0.31	–	3.94
	Summer	10	60.0±0.40	12.5±0.64	8.1±0.29	3.98

Table 4. Continued

Groups	Seasons	n	Haemoglobin content, g/l	Erythrocyte content, million/ μ l	% protein in serum	Average red blood cell diameter, μ m
III (KMM)	Autumn	10	56.7 \pm 0.26	10.4 \pm 0.41	6.4 \pm 0.20	3.84
	Spring	10	48.5 \pm 0.40	9.8 \pm 0.31	–	3.86
	Summer	10	59.7 \pm 0.52	13.4 \pm 0.40	7.1 \pm 0.24	4.04
IV (ewe lambs KF)	autumn	10	58.4 \pm 0.51	10.4 \pm 0.29	7.4 \pm 0.22	3.99
	Spring	10	49.7 \pm 0.31	9.8 \pm 0.32	–	3.96
	Summer	10	60.7 \pm 0.38	14.4 \pm 0.46	8.1 \pm 0.16	4.06

Note: KF – Kazakh Fine-Wool breed; AMM – Australian Meat Merino; KMM – Kyrgyz Mountain Merino; n – number of animals in the group; I – group of Kazakh Fine-Wool rams; II – group of Australian Meat Merino rams; III – group of Kyrgyz Mountain Merino rams; IV – group of Kazakh Fine-Wool ewes; indicators are presented as the mean value \pm standard error of the mean ($X \pm m$)

Source: compiled by the authors based on research results

The data obtained are consistent with the results of S. Ceccobelli *et al.* (2023), who found that fine-wool sheep show significant variability in physiological parameters depending on the season and housing conditions. In the experiments conducted on Kazakh Fine-Wool rams, seasonal variation was also noted: erythrocytes increased from 10.4 million/ μ l in autumn to 14.4 million/ μ l in summer, reflecting the body's adaptive response to changes in pasture altitude and oxygen levels. The highest blood haemoglobin and erythrocyte content, as well as serum protein content in the experimental sheep, was observed in the summer when the sheep were on summer pastures located at an altitude of 600-800 m above sea level. The increase in haemoglobin and red blood cell content in all groups of sheep during the summer period is associated with their transfer to high-altitude pastures (600-800 m above sea level) with lower barometric pressure. Haemoglobin in KF rams increased from 50.6 units in spring to 61.0 units in summer (+20.5%), indicating a compensatory response of the haematopoietic system to high-altitude hypoxia. O. Karatieieva *et al.* (2022) emphasise that such physiological adaptations are closely related to the constitutional characteristics of animals and are an important criterion in selection. A comparison of the results of blood composition studies in experimental sheep from different natural and climatic zones showed that in all seasons of the year, rams in groups I and III had lower levels of haemoglobin in the blood and protein in the serum, they had fewer erythrocytes per unit of diameter, and they were smaller than the rams and ewes in groups I and IV. There are probably grounds for saying that the rams in groups II and III have a reduced ability to adapt to the conditions of the foothills of south-eastern Kazakhstan.

Sheep production and its profitability depend to a large extent on the number and quality of young animals raised. In modern sheep farming, in a market economy, one of the important factors contributing to an increase in the industry's production is the proper organisation of herd reproduction (Deniskova *et al.*, 2019). To achieve this, it is necessary to ensure

maximum hereditary determination, fertility of ewes and lamb survival. This leads to the most important problem of intensive use of the reproductive composition of the flock to obtain the largest number of lambs in a short biologically acceptable period of time, which is one of the most difficult problems in sheep breeding. A certain level of fertility is a breed characteristic and an important component of their adaptive qualities to environmental conditions and the system of keeping and feeding. The adaptive ability of animals allows them to adapt to frequently changing environmental conditions in which they can reproduce, grow, develop and produce stable yields. In this study, the reproductive qualities of Kazakh Fine-Wool ewes in purebred breeding and two-breed crossbreeding with Australian Meat Merino and Kyrgyz Mountain Merino rams were studied, and the following indicators were examined in the resulting purebred and crossbred young stock: the ability of ewes to conceive, their fertility, and survival during the suckling period (Table 5). A total of 450 ewes were inseminated, with a fertility rate of 97.3-98.0%. The highest fertility rate (98.0%) was observed in ewes of group I inseminated with rams of the Kazakh Fine-Wool breed. A total of 176-182 live lambs were obtained in the experimental groups. A higher percentage of barren ewes was observed in ewes of groups II and III inseminated with semen from rams of the AMM and KMM breeds – 2.7%. Fertility in all groups of ewes was good – 117.0-121.0%. At the same time, the fertility of ewes in group I, inseminated with semen from KF rams, was 2.0-4.0% higher than that of ewes inseminated with semen from imported rams. During the suckling period, the highest survival rate was observed in lambs obtained from KF rams – 97.3% and from AMM rams – 95.9%, rather than from imported KMM rams – 95.6%. The fertility rates obtained correspond to the data of A. Azhibekov *et al.* (2023) and K. Yessengaliev & G. Kassimova (2023) for fine-wool sheep in the south-eastern region. The higher fertility of KF \times KF ewes (121.0%) compared to industrial crossbreeding variants (119.0% and 117.0%) is explained by the better adaptation of the local genotype to pasture conditions. K. Yessengaliev & G. Kassimova (2023)

indicate that when using meat genotype producers, there is a 2-4% decrease in fertility, which is compensated by an increase in the live weight of offspring. In

this experiment, lambs from AMM exceeded their peers in weight by 2.7-5.7%, which confirms the feasibility of industrial crossbreeding to increase meat productivity.

Table 5. Reproductive qualities of ewes

Indicator	Group			Total
	I	II	III	
	KF × KF	AMM × KF	KMM × KF	
Number of inseminated ewes, heads	150	150	150	450
Ewes that have given birth, head	147	146	146	439
Fertility, %	98	97.3	97.3	97.5
Lambs obtained, head	182	179	176	537
Fertility, %	121.0	119	117.0	119.0
Survival rate during the suckling period, %	97.3	95.9	95.6	96

Note: KF – Kazakh Fine-Wool breed; AMM – Australian Meat Merino; KMM – Kyrgyz Mountain Merino; I – crossbreeding group Kazakh Fine-Wool × Kazakh Fine-Wool (KF × KF); II – crossbreeding group Australian Meat Merino × Kazakh Fine-Wool (AMM × KF); III – crossbreeding group Kyrgyz Mountain Merino × Kazakh Fine-Wool (KMM × KF); fertility (%) – ratio of ewes that lambed to the number of ewes inseminated; prolificacy (%) – number of lambs born per 100 ewes; survival rate (%) – survival of lambs during the suckling period

Source: developed by the authors based on research results

In meat sheep farming, live weight is a comprehensive indicator that characterises the growth, development and meat productivity of animals. Ultimately, it determines the amount of product obtained (Lakota, 2025). According to J. Young *et al.* (2011), changes in average live weight, its increase or decrease over the years, serve as a clear illustration of the state of breeding work with the breed. An increase in live weight is a consequence of improved animal development and

a more sophisticated selection and matching system. Against the backdrop of higher live weight, the effectiveness of sheep selection and the formation of animals of the desired type increases. A special criterion determining the growth and development of animals should be considered to be the dynamics of live weight variability with age. Based on the indicators of this trait and its variability, it is impossible to plan breeding and selection work or to select and match parent pairs (Table 6).

Table 6. Age-related variability in the live weight of lambs of different genotypes

Group	Sex	n	At birth		4.5 months		12 months	
			X ± mX	Cv	X ± mX	Cv	X ± mx	Cv
I KF × KF	rams	10	3.7 ± 0.13	11	37.3 ± 0.85	7.5	56.6 ± 0.51	4.8
	ewes	16	3.5 ± 0.10	11.7	36.7 ± 0.56	6.4	47.0 ± 1.50	5.9
II AMM × KF	rams	38	3.8 ± 0.66	9.6	38.6 ± 0.30	6	57.9 ± 0.54	4.2
	ewes	20	3.6 ± 0.10	11.4	37.0 ± 0.43	6.8	48.3 ± 0.59	5.5
III KMM × KF	rams	14	3.9 ± 0.13	11.9	37.8 ± 0.71	8.4	56.9 ± 0.48	3.9
	ewes	10	3.6 ± 0.10	8.1	37.0 ± 0.67	6.8	47.0 ± 1.52	5.7

Note: KF – Kazakh Fine-Wool breed; AMM – Australian Meat Merino; KMM – Kyrgyz Mountain Merino; n – number of animals in the group; X ± m – mean value of the trait and standard error of the mean; Cv – coefficient of variation, %; I – crossbreeding group Kazakh Fine-Wool × Kazakh Fine-Wool (KF × KF); II – crossbreeding group Australian Meat Merino × Kazakh Fine-Wool (AMM × KF); III – crossbreeding group Kyrgyz Mountain Merino × Kazakh Fine-Wool (KMM × KF)

Source: developed by the authors based on research results

The experimental lambs from all crossbreeding options had average indicators at birth: the average live weight of rams in groups II and III was 3.8 and 3.9 kg, respectively, and that of ewe lambs was 3.6 kg. Newborn rams in group I were significantly inferior to their peers in live weight by 2.7 and 5.7%, respectively. The difference in live weight between ewe lambs of all groups is insignificant and mathematically unreliable. At the same time, it should be noted that at birth, the variability of live weight is still insignificant and amounts to 11.9% for rams and 11.7% for ewe lambs.

The differences in live weight observed in lambs at birth were significantly smoothed out by the age of 4.5 months, as evidenced by the coefficients of variation. In terms of live weight, both rams and ewes had the highest growth energy when weaned from their mothers. In absolute terms, the live weight gain in rams was in the range of 33.3-34.9 kg, and in ewes – 33.4 kg.

The high early maturity of lambs in all groups mainly depends on the genotype of the parents, in this case on the maternal side. As can be seen, they pass on these abilities well through inheritance. In addition,

this can be attributed to the high milk yield of Kazakh Fine-Wool ewes, which ensures enhanced growth and development of lambs. The early maturity of young animals and their weight in the first year of life are of exceptional importance in the formation of meat qualities in sheep. In young animals of all groups at one year of age, it was quite high in all crossbreeding options. The average live weight of ewe lambs, depending on the crossbreeding options, ranged from 47.0 to 48.3 kg and reached 70-75% of the live weight of their mothers. According to the data obtained, the most intensive live weight gain of lambs in all crossbreeding options from birth to 4.5 months of age was within the range of 98.4-103.1%; from 4.5 months to one year – 65.9-66.6%, and ewes, respectively, 97.2-99.1% and 76.6-78.0%. Analysis of the data obtained showed that lambs in all crossbreeding variants differed in terms of better growth and development during the suckling period, after which the growth rate decreased significantly until one year of age.

According to J. Oberpenning *et al.* (2025), the study of the external characteristics of animals is not only scientifically significant but also a production necessity. Under the conditions of the existing technology in the industry, constitutional strength and optimal size are of vital importance for increasing meat productivity with round-the-clock grazing in the foothills of south-eastern Kazakhstan. In the studies conducted, the method of measuring basic external measurements was used to obtain a more complete and objective assessment of the growth and development of animals. To fully characterise the physique of the test animals, the most important physique indices were calculated for the animals under study. In doing so, both the patterns common to all groups and the characteristics specific to each animal selection variant were identified. Lambs in groups I and II differed in their more intensive growth during the suckling period. Thus, in rams and ewes of group II, the height measurements at the withers during this period increased by 46.6 and 41.9%, respectively, in group I – by 48.6 and 48.2%, and in group III – by 43.6 and 44.7%. By the age of one year, the growth rate had decreased significantly and varied between 16.3-20.5% for rams and 13.6-23.2% for ewes, depending on their origin. Similar data were obtained for the growth of cross-sectional height measurements for the specified periods and amounted to 37.3-21.2% and 31.8-25.0% for groups I and II, respectively, and 40.0-18.8 and 41.0-12.5% for group III. Measurements characterising the meat qualities of group II: lambs – 68.0-35.4%, 51.8-21.6%, 71.3-30.9% and ewe lambs 62.4-26.0%; 61.2-8.4%; 63.9-31.6%, in group I – 54.7-18.3%; 69.8-30.0%; 60.0-18.3% and 42.7-29.1%; 39.3-31.8%; 70.8-33.3%; and in group III – 60.7-20.5%; 49.3-20.0%; 65.7-33.5% and 44.6-27.3%; 37.1-30.3%; 63.8-31.9%.

As can be seen, the lambs of group II slightly surpassed the lambs of groups I and III in terms of growth

and development intensity according to the main exterior measurements. Moreover, the greatest oblique body length at one year of age was observed in the rams and ewe lambs of group II, followed by the rams of group I. The difference in chest width between the experimental animals is quite significant. Both rams and ewes of group II differ particularly in these measurements, surpassing their peers by 7.7-9.0% and 11.0-14.8%, respectively. The chest of the experimental animals is characterised by an increase not only in width but also in depth. Thus, depending on their origin, the depth of the chest in rams ranges from 35.1 to 35.9 cm, and in ewes from 33.0 to 34.7 cm. The chest circumference behind the shoulder blades in the experimental animals varies significantly depending on their origin. The largest chest circumference at one year of age is also found in rams and ewes of group II (106.0-104.7 cm). Differences in limb development between the test animals of all groups are not particularly evident, with the exception of ewes of group III, which slightly exceed their peers in terms of metacarpal circumference.

The differences noted in the measurements of individual body parts of the experimental animals only partially reflect their overall exterior type. As a result, body type indices are of great importance, as they fully characterise and, to the greatest extent, allow for judging the development of the organism, its body proportions and overall constitutional type. The animals studied are characterised by varying degrees of development of the elongation (or format) index with age. At the same time, a higher format index is characteristic of meat-type animals. According to the data obtained, the highest value was recorded at birth in rams and ewe lambs of group III (64.4-64.2%). At the age of 4.5 months, lambs of groups I and III, and at the age of one year, ewe lambs of groups I and III exceeded rams in size by 2.3-4.6%. At birth, the lowest compactness index was observed in lambs of group III (90.7-93.2%), and the highest in lambs of group II (102.7-103.1%). Rams and ewe lambs of group I differed insignificantly from each other. However, at 4.5 months of age, some differences appeared depending on origin. Thus, the indicators of this index were slightly higher for ewe lambs in group II (172.4%) and ram lambs in group III (169.0%). At 12 months of age, the lowest value of this index was recorded in rams of group I (152.4 cm) and ewes of group III (153.6 cm). It should be noted that the values of this index in the studied animals changed unpredictably with age. The highest values of the mass index in all age periods were observed in lambs of group II, and at the same time, at 4.5 months of age, they were slightly inferior to animals of group III. No significant differences were found in the bone index of the animals in the compared groups. Thus, based on the studies conducted, it can be concluded that in the selection process, in order to increase the productivity of Kazakh Fine-Wool sheep at the Akbulak farm, along with purebred breeding

(KF × KF), it is advisable to use Australian Meat Merino and Kyrgyz Mountain Merino rams with Kazakh Fine-Wool ewes in industrial crossbreeding.

Conclusions

The studies conducted showed that the genetic resources of fine-wool sheep brought to the foothills of south-eastern Kazakhstan are highly diverse and form pronounced differences in a number of productive and biological traits. It was established that Australian Meat Merino rams demonstrated a statistically significant advantage in live weight compared to producers of the Kazakh Fine-Wool breed and Kyrgyz Mountain Merino; the magnitude of superiority was 2.83% and 5.92%, respectively, with a coefficient of variation $C_v = 12.7\%$, which indicates a fairly high stability of the trait within breed groups. The results confirm the presence of a pronounced growth potential in AMM rams, which is of important breeding and production significance for the foothill zone conditions. Analysis of clinical, physiological and haematological blood parameters showed that all the groups of rams studied, despite their different origins and the specific natural and climatic conditions of their habitats, demonstrated a sufficient level of adaptation to the new environmental conditions. Haemoglobin, erythrocyte and serum protein levels were within the physiological norm and changed predictably depending on the season, which indicates the high adaptive potential of the genotypes studied. Such stability of homeostatic mechanisms allows for the

effective use of compact meat-wool genotypes in the region's pasture-based livestock farming conditions.

Of particular importance are the results related to the evaluation of offspring from different crossbreeding options. Lambs obtained from the combination of AMM × KF demonstrated more intensive live weight gain at all age stages and significantly outperformed their peers from the KF × KF and KMM × KF combinations by 2.7-5.7%. This confirms the effectiveness of including Australian Meat Merino rams in breeding programmes to improve the meat productivity of fine-wool sheep in south-eastern Kazakhstan. The data obtained form a scientific and practical basis for further improvement of crossbreeding schemes aimed at increasing the productivity and adaptability of sheep. Prospects for further research include studying the multigenerational dynamics of productive traits, assessing the stability of the genotypes obtained in various climatic conditions, and determining the long-term impact of crossbreeding on the meat, wool, and reproductive qualities of animals.

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Conflict of Interest

None.

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Аннотация. Казакстанда кой чарбачылыгы азык-түлүк менен камсыздоодо жана өнөр жай үчүн чийки зат берүүдө маанилүү тармак бойдон калууда. Жүндүн наркынын төмөндөшүнө байланыштуу эт багытын өнүктүрүү өзгөчө актуалдуу болуп, продуктивдүүлүктү жогорулатууга багытталган породаларды тандоо зарыл. Изилдөөнүн максаты – Австралиядан жана Кыргыз Республикасынан алынып келген тункорундуу асыл тукум кочкорлорун Казакстандын тункорундуу кой породасынын качкындары менен, Алматы облусунун тоо этектериндеги “Акбулак” фермердик чарбасында жүргүзүлгөн аргындаштыруу учурунда баалоо болгон. Ар биринде 150 баштан турган үч топ түзүлүп, алар үчүн Австралиялык эт мериносу (АВММ) породасынан 3 кочкор, Кыргыз тоо мериносу (КГМ) породасынан 3 кочкор жана Казак тункорундуу (КТ) породасынан 3 кочкор колдонулган. Иште таза тукум багуу жана муун өзгөрүүсүн тездеткен өнөр жайлык аргындаштыруу ыкмалары колдонулган. Натыйжалар көрсөткөндөй, катышкан кочкорлор бекем конституциясы, чоң тирүү салмагы жана жүндүн жакшы настригине ээ болушкан. Клиникалык көрсөткүчтөр бардык топтордо физиологиялык норманын чегинде болуп, олуттуу айырмачылыктар аныкталган эмес. Кан аралашмасынын гематологиялык көрсөткүчтөрү оптималдуу деңгээлде сакталган жана мезгилдерге жараша өзгөрүп турган, бул кычкылдануу-калбасуу процесстеринин интенсивдүүлүгүн чагылдырган. I топтогу (КТ × КТ) качкындардын туут боюнча көрсөткүчү эң жогору – 121,0 % түзүп, II (АВММ × КТ) жана III (КГМ × КТ) топтордон тиешелүүлүгүнө жараша 1,65 % жана 3,30 % жогору болгон. Козулардын эмчектен чыгарганга чейинки сакталуусу I топто 97,3 % түзүп, бул көрсөткүч теңтуштарына караганда 1,4 % жана 1,7 % жогору болгон. Иштин практикалык мааниси – АВММ жана КГМ породасындагы кочкорлорду Казакстандык тункорундуу кой породасынын үйүрлөрүндө колдонуу жүндүн жукадыгын жакшыртууга, тери-тал чачынын гистоморфологиялык түзүлүшүн өркүндөтүүгө, тууттуулук менен козулардын сакталуусун жогорулатууга жана эт багытындагы өндүрүштү көбөйтүүгө өбөлгө түзөрүн көрсөтөт.

Негизги сөздөр: казак уяң жүндүү койлору; австралиялык эт мериносу; кыргыз тоо мериносу; төлдөө; тирүү салмагы; дененин өлчөөлөрү; физиологиялык жана гематологиялык параметрлер

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Аннотация. В Казахстане овцеводство сохраняет важное значение как источник продовольствия и сырьевой базы промышленности, а в условиях обесценивания шерсти особую актуальность приобретает развитие мясного направления. Цель исследования заключалась в оценке завезенных тонкорунных баранов-производителей из Австралии и Кыргызской Республики при их использовании в скрещивании с матками казахской тонкорунной породы в предгорной зоне фермерского хозяйства «Акбулак» Алматинской области. Были сформированы три группы маток по 150 голов, для которых использовали три барана австралийского мясного меринуса (АВММ), три барана кыргызского горного меринуса (КГМ) и три барана казахской тонкорунной породы (КТ). Применялись чистопородное разведение и промышленное скрещивание, обеспечивавшие ускоренное изменение наследственных и физиологических характеристик животных. Результаты показали, что подопытные бараны обладали крепкой конституцией, крупной живой массой и отличным настригом шерсти. Клинические показатели у всех баранов находились в пределах физиологической нормы, существенных различий между группами не выявлено. Гематологический состав крови сохранялся на оптимальном уровне и изменялся по сезонам, отражая интенсивность окислительно-восстановительных процессов. Плодовитость маток I группы (КТ × КТ) была самой высокой – 121,0 %, что на 1,65 % и 3,30 % выше по сравнению со II (АВММ × КТ) и III (КГМ × КТ) группами. Сохранность молодняка до отъема у маток I группы составила 97,3 %, что превышало показатели сверстниц на 1,4 % и 1,7 %. Практическая ценность работы состоит в том, что использование баранов АВММ и КГМ в стадах казахской тонкорунной породы способствует улучшению тонины шерсти, формированию гистоморфологических структур кожно-волосяного покрова, повышению плодовитости и сохранности ягнят, а также увеличению производства баранины в предгорных зонах юго-востока Казахстана

Ключевые слова: казахская тонкорунная порода; австралийский мясной меринос; кыргызский горный меринос; плодовитость; живая масса; промеры тела; физиологические и гематологические показатели