# Meat productivity of cross-bred rams in comparison with pure-bred animals of the original breeds on the maternal line

*Vladimir* Fedorov[1*], *Rasul* Gekhaev[1], *Viktor* Fedyuk[1], and *Badrudi* Gekhaev[2]

[1]Don State Agrarian University, Persianovski set., Octyabrski district, Rostov region, 346493, Russia
[2]Peasant Farm, Rostov Region, Russia

**Abstract.** In this experiment, the meat productivity (morphological and varietal composition of carcasses, yield of anatomical cuts) of experimental rams of new genotypes was assessed: Texel x Soviet Merino and Texel x Ebilbaevskaya. Purebred animals of the Soviet Merino and Edilbaevskaya breeds were studied as control variants. As a result of the experiment, the pre-slaughter weight of crossbred animals was dominant relative to purebred animals, based on which the weight of the fresh carcass of crossbred animals naturally increased by 2.09 kg ($P < 0.01$) and 2.87 kg ($P < 0.01$), and the slaughter yield by 2.30% and 2.77% over purebred original breeds. It was found that the meat coefficient of F1 rams was higher due to the increase in the yield of pulp by 20.63% ($P<0.01$) and 16.63% ($P<0.05$) relative to purebreds. A stable change in fatty acids in the composition of lamb and subcutaneous fat towards optimizing the ratio of unsaturated to saturated was revealed. Hybridization, as a method of improving the meat productivity of sheep, using rams of meat breeds, has proven its effectiveness in our studies.

## 1 Introduction

The rapidly growing interest of consumers in safe and healthy food in their diet stimulates the development of sheep farming. Sheep farming is considered the most important, traditional, historically established branch of world agriculture. Being a complex production and economic system aimed at meeting the needs of the population for food and agricultural raw materials, it has no equal in the diversity and uniqueness of the products obtained from it [1-2].

In order to increase the volume of lamb used in human nutrition, scientists are engaged not only in increasing the livestock, modernizing the breeds of sheep used in enterprises (during cultivation), but also in forming new types of sheep that differ from their peers in shorter growing periods, as well as a high level of meat productivity. This indicates the development of global sheep breeding and, as the most efficient meat production, which is competitive and meets the ever-increasing demands of the modern market [3-6].

* Corresponding author: nauka.ross@yandex.ru

In modern realities, it is possible to achieve a highly productive type of sheep that meets all the requirements for meat qualities only by crossing several breeds, which is associated with improving the quality indicators of F1 crossbred animals [7-11].

The concepts of sheep farming development formed in a number of regions of the Russian Federation, including the Southern Federal District, together with the importance of this topic for the population, stimulate scientists to actively advance in the sheep farming industry. Dynamic economic changes in the global food market give us the opportunity to become a competitive player in the export of lamb meat [12-13].

The revision of economic values has recently reformatted the relevance of a number of sheep products. Several years earlier, we could observe a high demand for natural sheep wool, the cost of which could be equal to 20 kg of live weight of a young lamb. [14.]. The decrease in demand for this material led to a change in benchmarks, which made it possible to intensify the growth of meat breeds of sheep, thanks to hybridization and the sale of lambs in the year of birth to obtain high-quality mutton [15-17].

The meat of young lambs is a valuable food product, as it has taste and dietary properties, is characterized by a high concentration of B vitamins, pantothenic, para-aminobenzoic and folic acids, choline, vitamin E, physiologically active peptides that stimulate the bioactive regulation of the body. The presence of a significant concentration of fluorine in lamb helps to strengthen tooth enamel, without disrupting carbohydrate metabolism [18-20]. The advantage of the first generation as a result of crossing two or more breeds, relative to the original breed, is well known, but the available sources do not contain the results of studies on crossing Texel rams with Soviet Merino and Edilbaevskaya ewes in order to increase the meat productivity of F1 crossbreeds. Hybridization helps to activate metabolic processes in the body of crossbreed animals and, ultimately, prolongs the specified productivity.

## 2 Materials and methods

Experimental studies were conducted at the farm of B.N. Gekhaev's peasant farm (Savdya settlement, Zavetinsky district, Rostov region), using the following experimental design (Figure 1).

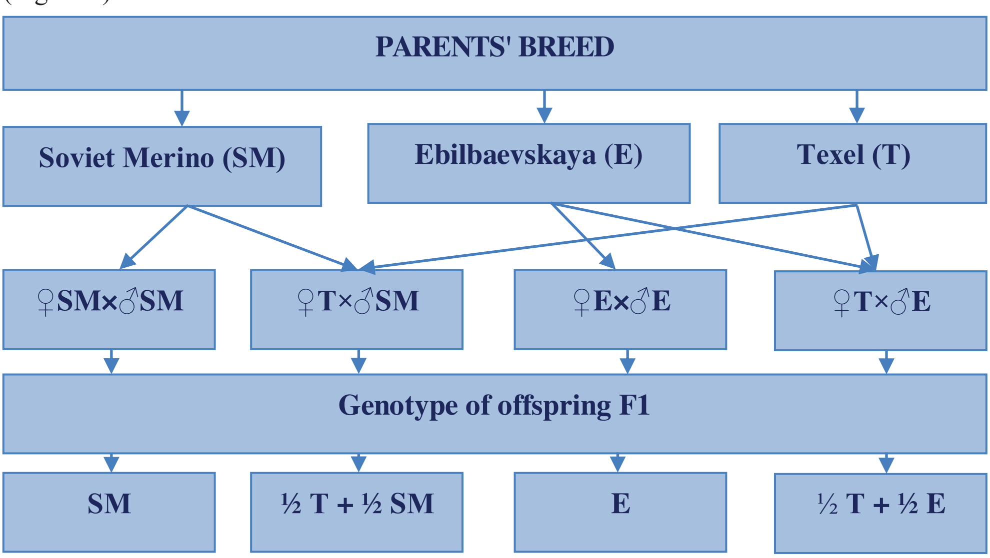


**Fig. 1.** Scheme for obtaining experimental rams.

The ewes for the experiment were randomly divided into four groups (40 heads in each): Group I - ewes and rams of the Soviet Merino (SM) breed were used in the crossing, Group II - ewes of the Soviet Merino (SM) breed and rams of the Texel (T) breed were used in the crossing, Group III - ewes and rams of the Edilbaev breed (E) were used in the crossing, Group IV - ewes of the Edilbaev breed (E) and rams of the Texel (T) breed were used in the crossing.

The mating age of the ewes varied from 14 to 18 months. After lambing of the ewes, four groups of rams of 20 heads each were formed from the resulting offspring of the corresponding groups for fattening and further research. Fattening was carried out until the animals were 8 months old.

Control slaughter, in order to study meat productivity, was carried out according to the VIZh method (1978), taking into account the pre-slaughter and slaughter weight, slaughter yield. The pre-slaughter weight of the rams was recorded after a 24-hour fast. The carcasses were subjected to varietal cutting according to GOST 7596-81. The morphological and varietal composition of the carcass was determined according to GOST R. 52843-2007. The individual composition of fatty acids in lamb and subcutaneous fat (mass fraction, %) was determined by gas chromatography (GOST R 55483-2013).

Statistical data processing was carried out using the ONLYOFFICE computer programs, the reliability of differences was assessed using the Student criterion.

## 3 Research results and discussion

As is known, the goal of any crossbreeding is to improve some trait, in this case, meat productivity. At the end of fattening the crossbred rams, at the age of 8 months, the experimental animals were slaughtered, five heads from each group (Table 1).

**Table 1.** Weight and yield of the main slaughter products (n=5).

| **Studied parameters** | **Group/genotype** | | | |
|---|---|---|---|---|
| | **I<br>SM** | **II<br>½T + ½SM** | **III<br>E** | **IV<br>½T + ½E** |
| Absolute mass, kg: | | | | |
| pre-slaughter | 38.93 | 41.66** | 44.17 | 47.58** |
| steamy carcass | 16.74 | 18.83** | 19.25 | 22.12** |
| internal fat | 0.28 | 0.34** | 0.39 | 0.35** |
| tail fat | - | - | 3.62 | 2.98 |
| Relative mass, %: | | | | |
| steamed carcass | 43.00 | 45.20 | 43.58 | 46.49 |
| internal fat | 0.70 | 0.82 | 0.88 | 0.74 |
| tail fat | - | - | 8.19 | 6.26 |
| Slaughter weight without fat tail, kg | 17.02 | 19.17 | 19.64 | 22.47 |
| Slaughter yield, % | 43.72 | 46.02** | 44.46 | 47.23** |
| Slaughter yield with fat tail, % | - | - | 52.66 | 53.49 |

As a result of the experiment, the pre-slaughter weight of crossbred animals was found to be dominant compared to purebred animals. Thus, in Group II (½T + ½SM), the pre-slaughter weight increased by 2.73 kg (7.01%; $P<0.01$) compared to Group I (SM), and in Group IV (½T + ½E) – by 3.41 kg (7.72%; $P<0.01$) compared to Group III (E), on the basis of which the weight of the fresh carcass of crossbred animals naturally increased by 2.09 kg (12.49%; $P<0.01$) and 2.87 kg (14.91%; $P<0.01$) compared to purebred original breeds. The mass of internal fat in carcasses of crossbred rams (½T + ½SM) increased by 21.42%

(P<0.01), when compared with purebred (SM), and crossbred (½T + ½E) - by 11.43% (P<0.01) decreased against the background of purebred (E). Considering that the Edilbaev breed of sheep is fat-tailed, for a more objective assessment, we calculated the slaughter yield in all experimental groups without the fat tail, and in groups III and IV - additionally with the fat tail. In crossbred rams of group II, an advantage of slaughter yield of 2.30% was found over purebred from group I, in crossbred rams of group IV: without fat tail - by 2.77%, with fat tail - by 0.83%, due to a decrease in the fat tail mass, over group III.

Meat productivity, which is characterized by morphological and varietal composition, was determined after deboning the carcasses (Figure 2).

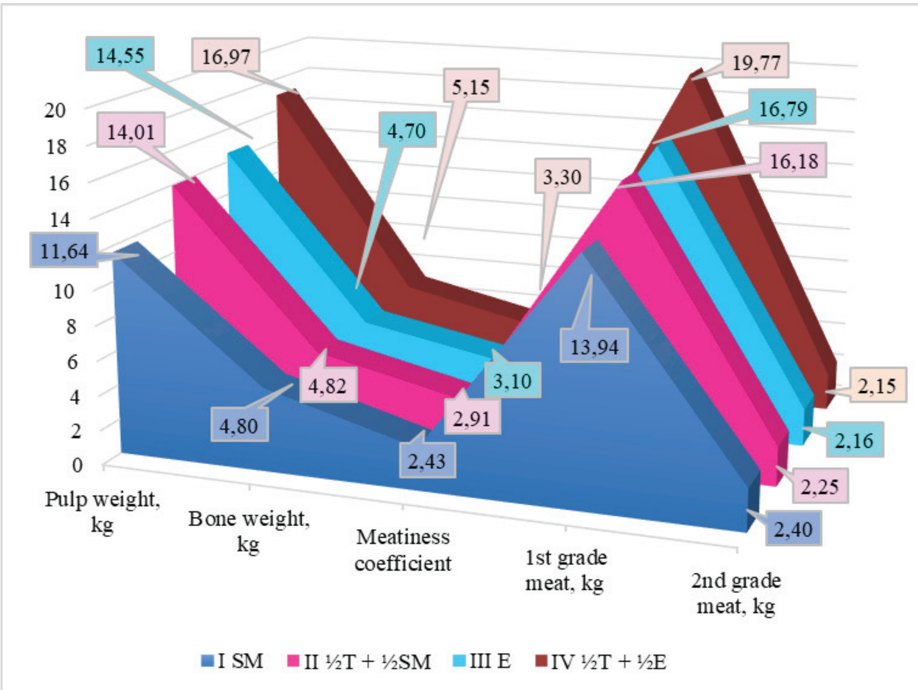


**Fig. 2.** Meatiness indicators of carcasses of experimental animals.

The meat coefficient of rams with the genotype ½T + ½SM exceeded the similar indicator of purebred animals of the Soviet Merino breed by 19.75%, due to an increase in the yield of meat by 20.63% (P < 0.01). In crossbreeds ½T + ½E, the meat coefficient exceeded this parameter of purebred rams of the Edilbaev breed by 6.45%, due to the dominance of the yield of meat by 16.63% (P < 0.05). The obtained data allow us to conclude that the use of rams of the Texel breed improves the meat qualities of carcasses of crossbreed animals, but it should be noted that in crossbreeds ½T + ½E these indicators increased less than in ½T + ½SM, due to the fact that the Edilbaev breed initially has high meat qualities.

The high meat productivity of crossbred rams is confirmed by the varietal composition of the cuts, the results of which are presented in Figure 3.

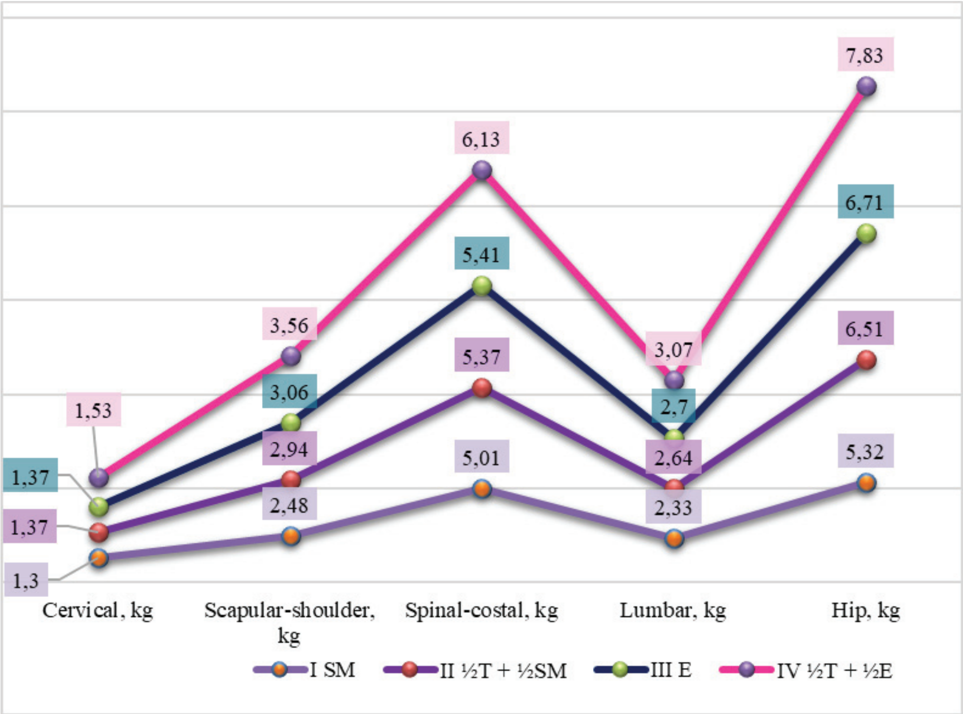


**Fig. 3.** Composition of ram carcasses by anatomical cuts.

Hybridization as a method of improving meat productivity of sheep using rams of meat breeds, in our studies, confirmed its effectiveness. Carcasses of crossbred rams after cutting into commercial cuts had superiority in absolute and relative weight, over similar indicators of the original breeds for all anatomical cuts. Moreover, reliable differences were established in the weight of the shoulder-scapular, lumbar and hip cuts: in crossbred rams ½T + ½SM (Group II) by 18.55 ($P<0.01$), 13.31 ($P<0.05$) and 22.37% ($P<0.001$) relative to the Soviet Merino breed (Group I), and in crossbred animals ½T + ½E (Group IV) – by 16.34 ($P<0.01$), 13.70 ($P<0.05$) and 16.69% ($P<0.01$) compared to the Edilbaev breed (Group III).

Considering the fact that in lamb, regardless of breed and growing conditions, the level of short-chain fatty acids prevails over other types of meat, and the ratio of long-chain fatty acids to short-chain fatty acids is one of the quality characteristics of meat, based on which, we studied the fatty acid composition of lamb and internal fat (Table 2).

The examination of lamb for the presence of carboxylic acids showed a certain decrease in the limiting fatty acids in crossbred animals, with unreliable values, relative to purebreds, but in total a reliable decrease was recorded: in animals with the genotype ½T + ½CM it was 0.63% ($P < 0.05$) against the background of purebreds (M), and with the genotype ½T + ½E - 0.91% ($P < 0.05$) compared to Edilbaevskaya (E). Among unsaturated (polyunsaturated), a reliable difference in the level of oleic acid was found in F1 rams, towards an increase, relative to the original breeds: in ½T + ½SM crossbreeds - by 0.94% ($P < 0.05$), in ½T + ½E crossbreeds - by 0.97% ($P < 0.05$), as a result of which the total amount for this type of fatty acids exceeded the same indicator in groups I and III by 1.13 ($P < 0.05$) and 1.16% ($P < 0.05$) in groups II and IV. An increase in the level of unsaturated (polyunsaturated) carboxylic acids was observed in groups II and IV when compared with groups I and III, but only for linoleic acid a reliable increase was noted, which amounted to 0.63 ($P < 0.05$) and 0.59% ($P < 0.05$) in crossbreed animals over the control. The total increase in this group of acids in the mutton of crossbred animals of group II (½T + ½ SM) reached 0.68 (P<0.05) when compared with group I (SM), and in IV (½T + ½E) – 0.73% (P<0.05) relative to group III (E).

**Table 2.** Fatty acids of lamb and subcutaneous fat, % (n=5).

| **Studied parameters** | **Group/genotype** | | | |
|---|---|---|---|---|
| | **I SM** | **II ½T + ½SM** | **III E** | **IV ½T + ½E** |
| Fatty acids in lamb | | | | |
| Saturated: | | | | |
| myristic (C14:0) | 8.02±0.07 | 7.97±0.08 | 8.08±0.06 | 8.04±0.09 |
| palmitic (C16:0) | 24.21±0.13 | 23.94±0.17 | 24.30±0.14 | 23.82±0.16 |
| stearic (C18) | 22.11±0.12 | 21.80±0.15 | 22.15±0.11 | 21.75±0.17 |
| Total | 54.34±0.22 | 53.71±0.14* | 54.53±0.24 | 53.62±0.20* |
| Monounsaturated: | | | | |
| palmitoleic (C16:1) | 1.38±0.04 | 1.49±0.06 | 1.42±0.05 | 1.51±0.07 |
| gentadecenoic (C17:1) | 0.57±0.06 | 0.65±0.05 | 0.61±0.03 | 0.66±0.08 |
| oleic (C18:1) | 33.84±0.23 | 34.78±0.19* | 34.22±0.24 | 35.24±0.21* |
| Total | 35.79±0.27 | 36.92±0.25* | 36.25±0.26 | 37.41±0.29* |
| Polyunsaturated: | | | | |
| linoleic (C18:2) | 5.09±0.21 | 5.71±0.16* | 5.27±0.17 | 5.86±0.19* |
| linolenic (C18:3) | 0.96±0.07 | 1.05±0.05 | 0.99±0.06 | 1.07±0.09 |
| arachidic (20:4) | 0.31±0.08 | 0.38±0.06 | 0.34±0.07 | 0.40±0.05 |
| Total | 6.36±0.17 | 7.14±0.20* | 6.60±0.21 | 7.33±0.23* |
| Ratio unsaturated/saturated | 0.78 | 0.82 | 0.79 | 0.83 |
| Fatty acids found in subcutaneous fat | | | | |
| Saturated: | | | | |
| capric (C10:0) | 0.42±0.05 | 0.41±0.04 | 0.46±0.06 | 0.45±0.03 |
| lauric (C12:0) | 0.23±0.02 | 0.21±0.03 | 0.24±0.04 | 0.22±0.02 |
| myristic (C14:0) | 5.08±0.13 | 4.55±0.16* | 5.12±0.14 | 4.53±0.17* |
| pentadecanoic (C15:0) | 1.45±0.06 | 1.43±0.07 | 1.52±0.08 | 1.51±0.05 |
| palmitic (C16:0) | 27.71±0.25 | 26.66±0.28* | 27.83±0.31 | 26.64±0.27* |
| gentadecanoic (C17:0) | 0.51±0.03 | 0.47±0.05 | 0.52±0.04 | 0.49±0.06 |
| stearic (C18:0) | 9.33±0.11 | 9.02±0.09 | 9.27±0.13 | 8.87±0.12 |
| Total | 44.73±0.43 | 42.75±0.38** | 44.96±0.46 | 42.71±0.39** |
| Monounsaturated: | | | | |
| myristoleic (C14:1) | 0.81±0.07 | 0.96±0.09 | 0.84±0.08 | 0.97±0.06 |
| palmitoleic (C16:1) | 3.08±0.11 | 3.44±0.10 | 3.09±0.13 | 3.47±0.12 |
| gentadecenoic (C17:1) | 4.04±0.16 | 4.57±0.14* | 4.01±0.15 | 4.62±0.17* |
| oleic (C18:1) | 41.22±0.13 | 41.89±0.17* | 41.32±0.12 | 41.99±0.18* |
| Total | 49.15±0.32 | 50.86±0.29** | 49.26±0.35 | 51.05±0.27** |
| Polyunsaturated: | | | | |
| linoleic (C18:2) | 3.23±0.27 | 4.48±0.21** | 3.19±0.24 | 4.52±0.29** |
| linolenic (C18:3) | 0.66±0.15 | 0.89±0.14 | 0.69±0.13 | 0.91±0.16 |
| arachidic (C20:4) | 0.17±0.03 | 0.18±0.02 | 0.18±0.04 | 0.19±0.03 |
| eicosapentaenoic (C20:5) | 0.35±0.05 | 0.37±0.07 | 0.36±0.06 | 0.38±0.04 |
| docosapentaenoic (C22:5) | 0.25±0.02 | 0.26±0.04 | 0.26±0.03 | 0.27±0.05 |
| docosahexaenoic (C22:6) | 0.26±0.04 | 0.27±0.02 | 0.25±0.05 | 0.26±0.03 |
| Amount | 4.92±0.36 | 6.45±0.25** | 4.93±0.33 | 6.53±29** |
| Ratio unsaturated/saturated | 1.21 | 1.34 | 1.21 | 1.35 |

The range of the presence of the studied saturated carboxylic acids in the subcutaneous fat of the experimental animals expanded, among which the level of myristic and palmitic acids in crossbreds ½T + ½SM significantly decreased by 0.53 (P<0.05) and 1.05%

(P<0.05) when compared with purebreds (SM), and in crossbreds ½T + ½E – by 0.59 (P<0.05) and 1.19% (P<0.05) against the background of purebreds (E). The tendency to reduce the level of other acids of this type in the subcutaneous fat of crossbred rams, against the background of the original breeds, led to a significant decrease in their total amount by 1.98 (P < 0.01) and 2.25% (P < 0.01). The highest accumulation of monounsaturated carboxylic acids was established in the subcutaneous fat of crossbred rams in comparison with purebred ones by 1.71 (P < 0.01) and 1.78% (P < 0.01) due to the reliable prevalence of gentadecenoic and oleic acids: in group II (½T + ½SM) - by 0.53 (P < 0.05) and 0.67% (P < 0.05), and in IV (½T + ½E) - by 0.66 (P < 0.05) and 0.67% (P < 0.05). In the series of polyunsaturated carboxylic acids of subcutaneous fat, the content of linoleic acid increased reliably in crossbred rams of groups II and IV by 1.25 (P < 0.01) and 1.33% (P < 0.01) in comparison with groups I and III of purebred animals of the original breeds. The difference in the level of other acids of this type was within the statistical error, but in the direction of increase, which affected the final indicator, which in the groups of crossbred animals was higher by 1.53 (P < 0.01) and 1.60% (P < 0.01) than in purebred animals.

## 4 Conclusion

The assessment of meat productivity of rams (F1), as a result of crossing the breeds Soviet Merino and Edilbaevskaya with rams of the Texel breed, revealed the prevalence of pre-slaughter and slaughter weight, slaughter yield relative to purebred. The meat coefficient of crossbred rams exceeded this parameter of purebred rams, due to the dominance of the yield of pulp. Carcasses of crossbred rams after cutting into commercial cuts had superiority in absolute and relative weight, over similar indicators of the original breeds in the weight of the shoulder-scapular, lumbar and hip cuts. A stable change in carboxylic acids in the composition of mutton and subcutaneous fat towards optimizing the ratio of unsaturated to saturated was found. Hybridization, as a way to improve the meat productivity of sheep, using rams of meat breeds, in our studies, confirmed its effectiveness.

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