

Experimental Results to Take to the Bank

Kreg Leymaster, Brad Freking, and Eduardo Casas

**USDA, ARS, U.S. Meat Animal Research Center
Clay Center, NE 68933-0166**

Introduction

Broad diversity among breeds of sheep is a precious industry resource. This breed diversity can be managed to increase performance and profit through use of crossbred ewes mated to rams of a terminal sire breed. Differences among breeds in performance for survival, growth, carcass, wool, and reproductive traits are due to the unique genetic history associated with each breed. Beneficial genetic effects of each breed can best be realized in terminal crossbreeding systems that use sire breeds to complement characteristics of maternal line crossbred ewes, thus greatly improving efficiency of commercial lamb production. Evaluation of breeds for important traits is necessary to determine their appropriate use in terminal crossbreeding systems designed for specific production and marketing situations. The relative performance of breeds can best be determined from large-scale experiments that are designed to give unbiased results.

The above fundamental genetic concepts provided justification for an experiment to comprehensively evaluate several breeds of sheep. Comparative information on Romanov and Texel was limited in North America, whereas the relative performance of Montadale was unknown. The Romanov breed originated in Russia and was one of two prolific breeds (Finnsheep being the other) that was widely evaluated in numerous European, Middle Eastern, and North African countries beginning in the 1960's. Romanov sheep were imported into Canada from France in 1981 and a flock was established at the U.S. Meat Animal Research Center (MARC) in 1986. The Texel breed has been widely used as a terminal sire breed in Europe and, more recently, in many other countries. A Texel flock was established at MARC in 1985 based on importations from Denmark and Finland. A terminal sire evaluation of Texel was done at MARC, but comparative information on reproductive traits was missing. The Montadale breed was developed in the United States from crosses of Cheviot rams and Columbia ewes, but it had not been experimentally evaluated.

Experiments to gauge the merit of insufficiently characterized breeds should include one or more standard breeds to serve as a control. Dorset sheep are widely used in the U.S. sheep industry and have been included in many breed evaluations. Finnsheep contribute significantly to commercial sheep production due to high reproductive performance and have also been well characterized in genetic experiments. Therefore, Dorset and Finnsheep breeds were used as standards of comparison for general purpose and prolific breeds, respectively.

The experimental objective was to determine differences among Romanov, Finnsheep, Dorset, Texel, and Montadale for survival, growth, and carcass traits of crossbred lambs and for reproductive traits of crossbred ewes in both fall and spring breeding seasons. The practical goal was to provide unbiased information so that producers can select and use breeds that maximize profits in terminal crossbreeding systems.

Experimental Procedures

Overall Design. Romanov, Finnsheep, Dorset, Texel, and Montadale rams were mated to western whiteface and Composite ewes. The MARC Composite flock, created in 1980, has a breed composition of half Columbia, quarter Hampshire, and quarter Suffolk. The crossbred offspring of these five breeds were compared in three distinct phases of the experiment. In the first phase, differences among crossbred lambs for survival, growth, and carcass traits were evaluated in 1991 through 1993. In the second phase, crossbred ewes were appraised for reproductive traits after mating in August, October, and December of 1991 through 1995 to lamb at one, two, and three years of age. In the third phase, four-, five-, and six-year-old crossbred ewes were mated during March and May of 1995 through 1999 to investigate differences for percentage of ewes lambing after mating in the spring. Information collected during these three phases of the experiment was summarized to provide reliable estimates of the comparative performance of these breeds for a wide-ranging set of traits. The experiment was designed to use a large number of sheep so that results were conclusive and useful to producers. We used 102 purebred rams, 1,438 western whiteface or Composite ewes, and 1,799 crossbred ewes to produce 8,354 litters and 14,017 lambs.

Sampling of Breeds. The Finnsheep, Dorset, and Montadale breed associations were informed of the planned research and then asked to provide information relevant to the experiment and to advise on sources of purebred rams. This approach was taken to encourage participation of breed associations in the research. For each breed, four producers were designated in 1990 to each sell two rams from different sires. This process was repeated in 1991 and again in 1992, buying rams from three producers per breed each year. In total, 21 Finnsheep, 20 Dorset, and 19 Montadale rams produced lambs, each breed represented by rams purchased from 10 producers. Four Finnsheep rams and one Dorset ram were from purebred flocks at MARC. The purchased rams, particularly Dorset and Montadale, were generally of modern show-ring type.

Romanov and Texel rams were sampled entirely from within flocks at MARC. The Romanov breed was established at MARC in 1986 with sheep provided by Agriculture Canada. This sample represented the genetic diversity of Romanov available in North America. Geneticists at MARC imported Texel from Denmark and Finland in 1985 and this research flock was the only source of Texel in the United States during the experiment. A total of 19 Romanov and 23 Texel rams was used to produce crossbred offspring.

General Management. Lambs were born in an enclosed building. Ewes giving birth to triplets or quadruplets were generally limited to rearing only two lambs, with excess lambs artificially reared in a nursery. Male lambs were castrated at about 14 days of age, at which time all lambs were offered a total-mixed creep diet. Dam-reared lambs were weaned at about 56 days of age and nursery-reared lambs at about 32 days of age. All lambs were switched to a total-mixed growing diet at about ten weeks of age. Lambs were reared in a drylot facility with access to an open-front building. Lambs were weighed at birth, weaning, 10 and 20 weeks of age. Productivity of ewes (litter weight) is often measured to weaning, but dam- and nursery-reared lambs were weaned at different ages in this experiment. Therefore, it was not reasonable to summarize weights of dam- and nursery-reared lambs at weaning. We chose to measure ewe productivity at 20 weeks of age, when lambs of both rearing types were weighed. Also, litter weight at 20 weeks of age is a better indicator of income per ewe rather than litter weight at weaning. Throughout the experiment, crossbred ewes were culled only for reasons that limited their ability to produce or raise lambs. The primary culling reasons were poor health, pneumonia, udder problems, and vaginal prolapses.

Crossbred Lambs. Western whiteface and Composite ewes were exposed in 1990, 1991, and 1992 to Romanov, Finnsheep, Dorset, Texel, and Montadale rams beginning about August 5, October 15, and December 15 each year. Each distinct breeding season was 35 days in length. The resulting

crossbred lambs were evaluated for survival to weaning and weight at 20 weeks of age. Samples of wether lambs from October matings were harvested at the MARC abattoir to investigate carcass traits. Wethers were harvested at 25, 29, and 33 weeks of age each year at an average carcass weight of 63 pounds. Carcass data were collected on about 110 wethers produced by each ram breed.

Crossbred Ewes in Fall Breeding. Crossbred ewes were mated in the fall to measure reproductive traits at one, two, and three years of age. Performance of 1,799 crossbred ewes produced in the first phase of the experiment was summarized. Crossbred ewes were exposed to groups of Suffolk rams for 35 days beginning about August 5, October 15, and December 15. Ewes exposed in August were with teaser rams for 16 days before being turned in with fertile Suffolk rams. Fleeces from 540 crossbred ewes were collected before lambing at two years of age and sent to the Texas Wool and Mohair Laboratory for objective measurement of fleece traits.

Crossbred Ewes in Spring Breeding. After lambing in the spring at three years of age, crossbred ewes were held open the following fall and switched to a spring-breeding production system. A total of 1,099 crossbred ewes was used to determine the relative performance of breeds for percentage of ewes lambing after spring breeding at four, five, and six years of age. Crossbred ewes were exposed to groups of Suffolk rams for 42 days beginning about March 12 and May 14. In both breeding seasons, crossbred ewes were with teaser rams for 16 days before being turned in with Suffolk rams. Suffolk rams were photoperiod treated and semen tested to ensure ample ram fertility during spring breeding.

Results

Crossbred Lambs (Table 1). Romanov and Finnsheep crossbred lambs had higher survival to weaning than crossbred lambs by Dorset, Texel, and Montadale, whereas differences among all crossbred types in weight at 20 weeks of age were slight. When compared at a common carcass weight of 63 pounds, Romanov and Finnsheep crossbred lambs had lower dressing percentages than other crossbreds. Crossbred lambs by Dorset and Montadale had the least fat depth at the 12th rib and the longest carcasses. Carcasses of Texel crossbred lambs were most compact, being shortest in length and having the largest rib-eye area. Finnsheep crossbred lambs had the smallest rib-eye area, followed by Romanov crossbred lambs.

Crossbred Ewes in Fall Breeding (Table 2). Crossbred ewes by Dorset and Montadale were the heaviest at three years of age and ewes of the other crossbred types were similar in weight. The percentage of ewes lambing fell into four groups: Romanov crossbred ewes had the highest percentage lambing, followed by Finnsheep, then Texel and Dorset, and crossbred ewes by Montadale were lowest. As expected, crossbred ewes by Romanov and Finnsheep produced the greatest number born per ewe lambing. Romanov crossbred ewes had the heaviest litters at 20 weeks of age per ewe lambing for both dam- and nursery-reared lambs, followed by Finnsheep, then Dorset and Montadale, and finally Texel. Fleeces of crossbred ewes by Montadale and Texel were heaviest. Stayability was measured as the percentage of sound ewes remaining in the breeding flock at three-and-a-half years of age. Romanov and Montadale crossbred ewes stayed in the flock at a higher rate than crossbred ewes by Finnsheep, Dorset, and Texel.

Crossbred Ewes in Spring Breeding (Figure 1 and Table 3). Differences among crossbred types in percentage of ewes lambing depended on breeding season (Figure 1). In March breeding, percentage lambing was 92% for crossbred ewes by Romanov, 91% for Finnsheep, 90% for Texel, 88% for Montadale, and 83% for Dorset. In May breeding, a more challenging month, percentage lambing was 89% for Romanov, 72% for Finnsheep, 62% for Dorset, and 52% for both Texel and Montadale.

Results averaged over both March and May breeding seasons are presented in Table 3. Percentage lambing was highest for crossbred ewes by Romanov, intermediate for Finnsheep, and

lowest for Dorset, Texel, and Montadale. The same ranking of breeds was detected for number born. The 20-week litter weight of dam-reared lambs per ewe lambing was heaviest for crossbred ewes by Romanov, intermediate for Finnsheep, Dorset, and Montadale, and lowest for Texel. Romanov and Finnsheep crossbred ewes produced the heaviest litters of nursery-reared lambs.

Discussion

Crossbred Lambs. Survival and growth of purebred Romanov and Finnsheep lambs are often less than other breeds, causing some producers to shy away from using these two prolific breeds for commercial lamb production. The reduced performance occurs primarily because purebred Romanov and Finnsheep lambs are generally born and reared in large litters (triplets and quadruplets). Consequently, the mothering ability of purebred Romanov and Finnsheep ewes may not allow lambs born as triplets or quadruplets to reach their true genetic potentials for survival and growth. However, in this experiment, crossbred lambs were reared as singles or twins by whiteface and Composite ewes. Survival of Romanov and Finnsheep crossbred lambs exceeded other crossbred types in this situation, whereas differences among all crossbred types for weight of crossbred lambs at 20 weeks of age were small. Therefore, the genetic potentials of Romanov and Finnsheep for survival and growth to 20 weeks of age should not adversely affect their use as crossbreds for commercial lamb production.

In general, carcasses of crossbred lambs by Romanov and Finnsheep were inferior (lower dressing percentage, greater fat depth at the 12th rib, shorter carcass length, and smaller rib-eye area) to carcasses of lambs by Dorset, Texel, and Montadale. Preliminary results from an ongoing experiment at MARC (www.ars.usda.gov/npa/marc) include percentage fat in carcasses that average 65 pounds. Texel crossbred lambs are leanest (25.7% fat), followed by Dorset (27.8%), and then Romanov (30.7%) and Finnsheep (31.4%). The Montadale breed is not included in the ongoing experiment. Considering all carcass information, it seems that carcasses of Texel crossbred lambs were superior, Dorset and Montadale were intermediate, and Romanov and Finnsheep were inferior. However, current industry marketing systems do not directly measure fat weight to determine percentage of fat in the carcass, relying instead on live weight, dressing percentage, carcass weight, or yield grade. In these situations, the market value of sheep would not reflect true differences among crossbred types in percentage fat. Therefore, commercial producers are encouraged to understand the actual impact of carcass traits on income received from their specific marketing system.

Crossbred Ewes in Fall Breeding. The percentage of ewes lambing at one year of age was greatest for Romanov crossbred ewes (80%), intermediate for Finnsheep (64%), and lowest for Dorset (54%), Texel (58%), and Montadale (47%). Effects of crossbred types on percentage of ewes lambing at one year of age were much greater than differences at two (from 87 to 93%) and three (from 90 to 94%) years of age. Although Romanov and Finnsheep are both prolific breeds, Romanov ewes are known to give birth to more lambs than Finnsheep. These results documented that number born to Romanov crossbred ewes was 0.15 lambs greater than number born to Finnsheep crossbred ewes. Crossbred ewes by Dorset, Texel, and Montadale were similar to one another for number born, but about 0.60 lambs less than Finnsheep crossbred ewes and 0.75 lambs less than Romanov crossbred ewes. Many producers are aware that Romanov and Finnsheep are prolific breeds, but believe the advantage is only realized if nursery facilities are used to raise lambs artificially. These results show that Finnsheep and, especially, Romanov crossbred ewes produce heavier litters at 20 weeks of age than Dorset, Texel, and Montadale crossbred ewes, even if nursery-reared lambs are not included. Remember that ewes were not allowed to rear more than two lambs. The advantage in productivity of Romanov and Finnsheep crossbred ewes is even greater if nursery facilities are used to rear excess lambs. Despite greater productivity, Romanov and Finnsheep crossbred ewes weighed from 10 to 15 pounds less at

three years of age than crossbred ewes by Dorset and Montadale. We did not do research to determine if crossbred ewes by Romanov and Finnsheep therefore required less feed to maintain body condition throughout the production cycle than other crossbred types. However, if one uses sheep NRC requirements, annual costs for maintenance of smaller prolific ewes are expected to be reduced by at least 4% relative to more traditional crossbred ewes.

At current prices, the additional value of wool produced by Texel and Montadale crossbred ewes would hardly increase overall income from sheep production. Wool value from Romanov crossbred ewes was decreased due to more fleeces with nonwhite wool than other crossbred types.

Stayability is an important trait because it reflects the number of replacement ewes that must be purchased or produced each year to maintain the breeding flock. Stated another way, the more ewe lambs that one has to keep for breeding, fewer lambs are available to sell. As the productivity of young ewes is less than older ewes, breeding flocks with higher stayability are more productive than flocks with lower stayability. The Finnsheep breed is perceived by some producers to have lower stayability than other common breeds, due perhaps to greater susceptibility to respiratory diseases. In this experiment, the stayability of Finnsheep crossbred ewes was similar to Dorset and Texel, but lower than Romanov and Montadale. The high stayability of crossbred ewes by Romanov establishes an important distinction between the Romanov and Finnsheep breeds.

Crossbred Ewes in Spring Breeding. Essentially all breeds of sheep have high conception rates from October through January, resulting in widespread lambing during the winter and spring seasons, followed by harvesting of many market lambs in summer and fall. One approach to supply lambs more evenly throughout the year is to identify and use breeds that are highly fertile during most, if not all, of the year. Therefore, this phase of the experiment focused on percentage of mature ewes lambing after March and May breeding seasons.

The Dorset and Finnsheep breeds are commonly used in spring-breeding production systems. Interestingly, Dorset crossbred ewes had the lowest percentage lambing from March breeding, whereas crossbred ewes by Romanov and Finnsheep were the most fertile (Figure 1). May is a challenging month for breeding, but Romanov crossbred ewes still did exceptionally well (89%), showing only a slight decrease of 3% compared to March breeding. Percentage lambing decreased considerably from March to May breeding for the other crossbred types (Finnsheep, down 19%; Dorset, 20%; Texel, 37%; Montadale, 36%). The extraordinary performance of Romanov crossbred ewes in May breeding is certainly noteworthy. Our current results are consistent with previous research reporting that Finnsheep breed better in mid to late spring than Dorset. The Texel and Montadale breeds are less suitable than Dorset for spring-breeding production systems, particularly late spring.

The interpretation of number born and litter weights at 20 weeks of age per ewe lambing from spring breeding is essentially the same as discussed above for fall breeding. The importance of using prolific crossbred ewes is emphasized, especially for spring-breeding production systems.

Key Traits Affecting Production Efficiency (Table 4). Other scientists have previously investigated the relative importance of genetic changes in various traits on the economics of sheep production. It is necessary to know the relative impact of traits to select breeds that maximize profit. Traits examined were number born, growth rate, wool growth, milk production, percentage of ewes lambing, age at puberty, carcass leanness, lamb survival, and length of seasonal fertility. For the common annual production system of fall breeding and spring lambing, production efficiency was most affected by lamb survival, percentage of ewes lambing, and number born. Length of seasonal fertility was an additional critical trait when spring-breeding production systems were studied. These key traits, all reproductive fitness traits, jointly determine number of lambs marketed per ewe maintained in the breeding flock.

To focus on traits that most affect production efficiency and to summarize results in a simple manner, crossbred types are classified for these four key traits in Table 4. This approach clearly separates Romanov and Finnsheep from Dorset, Texel, and Montadale. Furthermore, based on actual performance, Dorset, Texel, and Montadale are fairly similar to one another. In contrast, Romanov and Finnsheep plainly differ from each other, with Romanov crossbred ewes outperforming crossbred ewes by Finnsheep for percentage lambing, number born, and length of seasonal fertility, as well as stayability.

Total Weight, the Revealing Trait (Figure 2). Small advantages of breeds for individual traits can accumulate to create a large effect on overall product value, much as money compounded over time can increase several fold. To account for differences among crossbred types in percentage of ewes lambing, number born, lamb survival, lamb growth, and ewe stayability, a comprehensive trait was calculated. Total weight of lambs produced from one to three years of age by each ewe entering a fall-breeding flock was calculated as the sum of 20-week weights for dam- and nursery-reared lambs. At one extreme, a ewe that died before lambing at one year of age would have a total weight value of 0 pounds. A ewe that produced one lamb (88 pounds at 20 weeks of age) at one year of age, two lambs (75 and 82 pounds) at two years of age, and two lambs (80 and 85 pounds) at three years of age would have a value of 410 pounds for total weight. To account for length of seasonal fertility, total weight was also calculated in a similar manner for each mature ewe in the spring-breeding flocks (total weight of lambs produced from four to six years of age by each ewe entering a spring-breeding flock). Values of crossbred types for total weight in fall- and spring-breeding seasons are illustrated in Figure 2.

Total weight of lambs produced by Romanov crossbred ewes in fall breeding (394 pounds) was 24% greater than Finnsheep crossbred ewes (318) and 63% greater than the average of crossbred ewes by Dorset (242), Texel (228), and Montadale (252). Crossbred ewes by Finnsheep were 32% more productive, on average, than crossbred ewes by Dorset, Texel, and Montadale.

In the spring breeding flocks, mature Romanov crossbred ewes (312 pounds) produced 55% more lamb weight than crossbred ewes by Finnsheep (201) and 110% more weight than the average of crossbred ewes by Dorset (171), Texel (117), and Montadale (157). The advantage of Finnsheep crossbred ewes relative to Dorset, Texel, and Montadale crossbred ewes averaged about 36%.

Conclusions

Whereas differences among young Dorset, Texel, and Montadale crossbred ewes in total lamb weight in fall breeding were minor, mature Texel crossbred ewes were considerably less productive in spring breeding. Considering these and other research results, Texel rams should be used as terminal sires to complement characteristics of crossbred ewes in terminal crossbreeding systems. The appropriate use of Dorset and Montadale sheep is likely for crossing with prolific breeds to make crossbred ewes. Recognizing this crossbreeding role, the development and application of appropriate selection procedures by producers of purebred Dorset and Montadale sheep would improve the usefulness of the Dorset and Montadale breeds for commercial producers.

Romanov and Finnsheep should provide the reproductive foundation for maternal lines used in terminal crossbreeding systems. As the number born to purebred Romanov and Finnsheep ewes is often too high for practical use by commercial producers, these breeds are typically used to produce crossbred ewes. The crossbred ewes can be produced by first cross (F₁), rotation, or composite mating systems so that breed composition is optimized to match production resources such as labor, facilities, land, feedstuffs, managerial skill, etc. The Polypay breed is an example of a maternal composite based on one-quarter Finnsheep genetics.

Romanov crossbred sheep had superior performance for lamb survival, percentage of ewes lambing, number born, and length of seasonal breeding. In addition, stayability of crossbred ewes by

Romanov was greater than Finnsheep crossbred ewes. Two issues with Romanov bear attention. First, the behavior of purebred Romanov ewes in intensive production situations is often described as “flighty”. Second, decreased wool and pelt values are associated with this breed. Nonetheless, we strongly recommend greater industry use of Romanov crossbred ewes as maternal lines in terminal crossbreeding systems, especially for annual or accelerated production systems that breed in the spring. Research is underway at MARC to evaluate the Dorset, Rambouillet, Dorper, and Katahdin breeds for their ability to complement Romanov genetics as crossbred ewes in fall- and spring-breeding production systems.

Table 1. Performance of crossbred lambs.

Trait	Crossbred type				
	Romanov	Finnsheep	Dorset	Texel	Montadale
Survival to weaning, %	94	93	90	91	89
Weight at 20 weeks, lb	95.8	95.6	97.9	94.6	96.0
Dressing percentage	53.8	54.4	55.5	55.8	55.6
12 th rib fat depth, in	0.29	0.31	0.25	0.29	0.24
Carcass length, in	23.6	23.8	24.0	23.2	24.1
Rib-eye area, in ²	2.24	2.12	2.35	2.54	2.41

Table 2. Performance of 1-, 2-, and 3-year-old crossbred ewes in August, October, and December breeding seasons.

Trait	Crossbred type				
	Romanov	Finnsheep	Dorset	Texel	Montadale
Weight at three years, lb	164	166	176	166	178
Percentage lambing	89	83	78	80	75
Number born ^a	2.20	2.05	1.45	1.41	1.44
20-week litter weight, lb					
Dam-reared lambs ^a	140.1	124.3	110.9	100.5	110.4
Nursery-reared lambs ^a	22.2	20.5	7.0	5.7	8.4
Clean fleece weight, lb	4.55	4.58	4.71	5.10	5.17
Stayability, %	77	70	66	69	76

^aPer ewe lambing.

Table 3. Performance of 4-, 5-, and 6-year-old crossbred ewes in March and May breeding seasons.

Trait	Crossbred type				
	Romanov	Finnsheep	Dorset	Texel	Montadale
Percentage lambing	91	82	72	71	70
Number born ^a	2.09	1.98	1.46	1.40	1.44
20-week litter weight, lb					
Dam-reared lambs ^a	116.6	100.1	98.3	79.2	94.4
Nursery-reared lambs ^a	32.1	30.8	10.1	12.8	8.8

^aPer ewe lambing.

Table 4. Relative performance of crossbred types for key traits affecting production efficiency.

Trait	Crossbred type				
	Romanov	Finnsheep	Dorset	Texel	Montadale
Lamb survival	High	High	Low	Low	Low
Percentage lambing	Highest	High	Low	Low	Lowest
Number born per ewe lambing	Highest	High	Low	Low	Low
Length of seasonal fertility	Longest	Long	Average	Short	Short

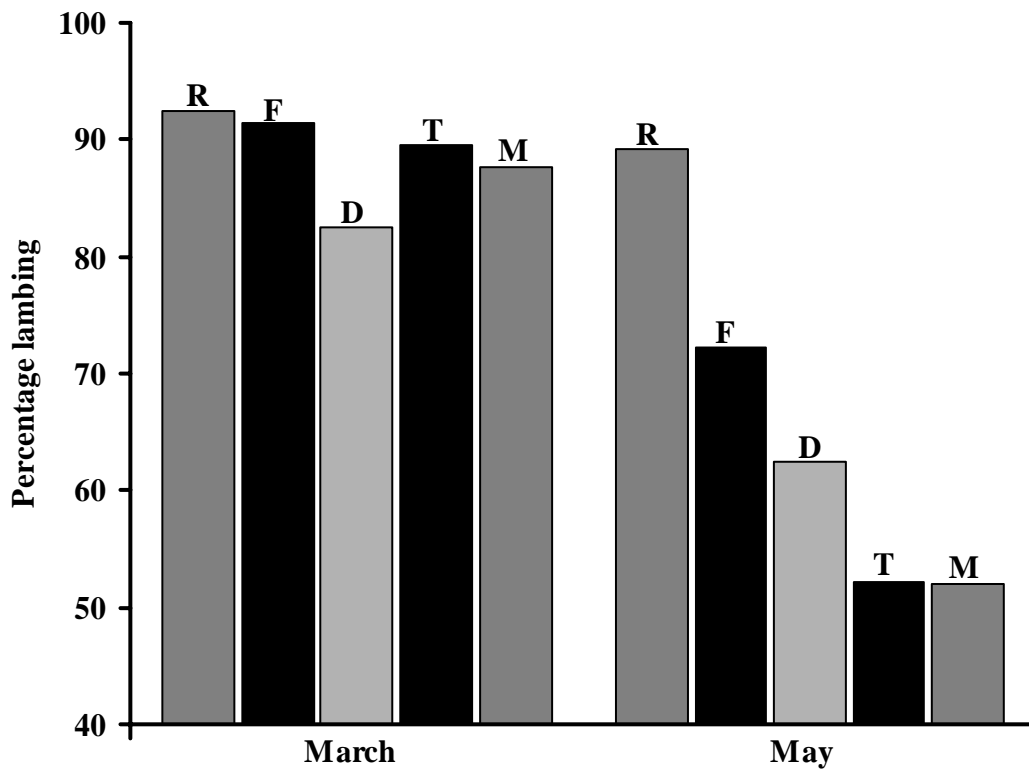


Figure 1. Percentage of crossbred ewes lambing after March and May breeding seasons (R, Romanov; F, Finnsheep; D, Dorset; T, Texel; M, Montadale).

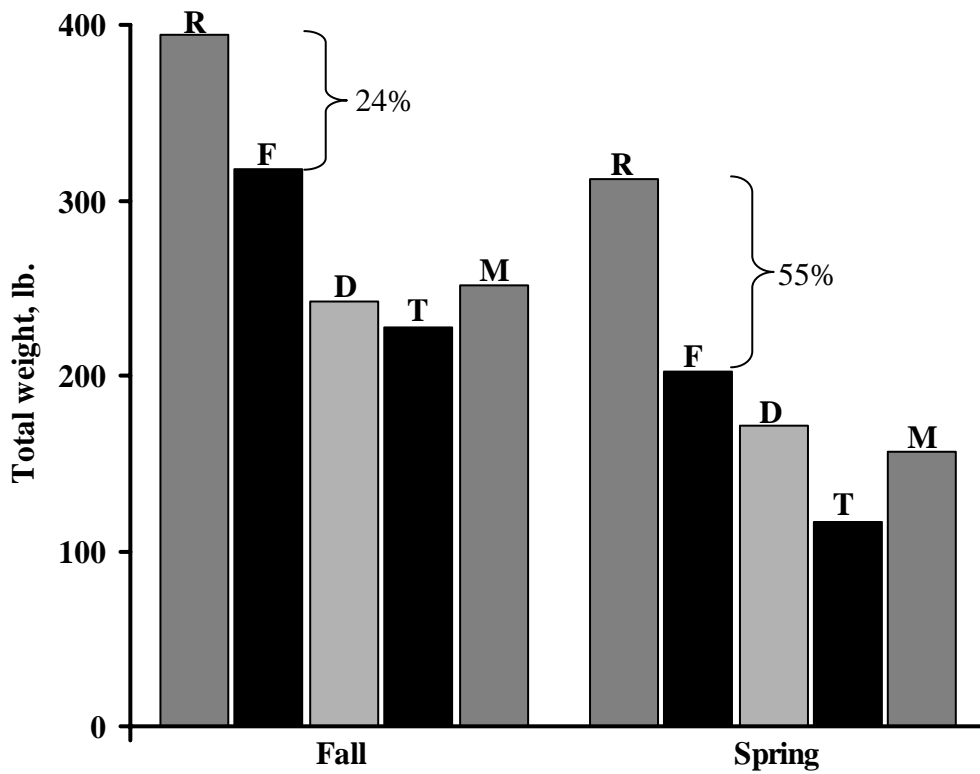


Figure 2. Total 20-week weights of lambs produced per crossbred ewe from 1 to 3 years of age in fall breeding seasons and from 4 to 6 years of age in spring breeding seasons (R, Romanov; F, Finnsheep; D, Dorset; T, Texel; M, Montadale).