# The Uses of Crossbreeding

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## INTRODUCTION

In recent years, crossbreeding has assumed a role of importance in the Canadian sheep industry. At the same time, the practice is often the target of criticism. This is understandable when we consider that, until recently, the idea of purity of breed and purebreeding were emphasized as keystones in animal improvement. Now, however, there is a need for an objective statement setting out the advantages and disadvantages of crossbreeding, along with a discussion of the ways in which crossbreeding can be used, in sheep production.

When economic conditions are uncertain (as they are at present), knowledge of the effects and uses of crossbreeding becomes very important. As consumer demands change, the relative importance of productive characters is also likely to change, and breeding objectives may have to be modified. The availability of breeds differing in their production characteristics then becomes an important source of flexibility, allowing adjustments to changing economic conditions. Crossbeeding, however, is the only way in which this latent flexibility can be utilized rapidly – it is thus a valuable tool in producing change. Crossbreeding can be used in several ways:

1) To produce desirable first-cross animals.
2) To "grade up" to a different breed.
3) To introduce characters not present in a breed.
4) To provide crossbred animals to form the basis of a new breed.

In any given instance, the objectives to be achieved and the characteristics of the breeds forming the foundation stock will decide just how crossbreeding is to be used. Consequently, if one takes into account the different objectives and uses of crossbreeding in relation to the number of breeds available, the topic becomes very large and complex. Fortunately, the basic genetic principles remain the same and these will be discussed before the uses of crossbreeding are considered in detail. Indeed, lack of understanding of these principles has been the source of many of the erroneous statements on crossbreeding.

## THE BASIC EFFECTS OF CROSSBREEDING

To start with, it is necessary to recall that the characteristics of an animal are controlled partly by genetic factors contributed by its parents (genotype) and partly by its environment. This situation can be represented in the following way:

**Character = Genotype + Environment**

In crossbreeding, the main interest is in its effects on the genotype, because the environmental component is not normally changed. Two questions now need to be answered:

1) How does the performance of the crossbred compare with that of the two parent breeds?
2) What effect does crossbreeding have on the variability of the traits in question?

### *Level of Performance*

Since an animal inherits half of the units making up its genotype from each parent, its performance is expected to be halfway between the performance of its two parents. This is true only when the genetic factors combine their effects simply by adding – for example, a gene with an effect equal to two units of production, combines with a gene with an effect of three units of production to give five units of production. If, because one gene is dominant over the other (or because they interact in other ways) they combine to give a result different from five, the gene effects are said to be "non-additive". When different breeds are crossed, such non-additive effects are often brought to light and result in the appearance of what is widely known as hybrid vigour (or heterosis).

Hybrid vigour is usually measured as the amount by which the first-cross progeny differ from the average of their straightbred parents. The amount of hybrid vigour cannot be predicted in advance for any given cross. It can only be assessed by actually making the cross under carefully managed experimental conditions. As a general rule, however, hybrid vigour is most likely to occur in traits such as fertility, viability, and growth, which are closely related to the natural fitness of the animal.

A further important point about hybrid vigour is that it occurs to the greatest extent in the first-cross animals (*ie* the crossbred progeny of straightbred parents in the case of a two-breed cross). When crossbred progeny are mated together, much of this hybrid vigour is lost in later generations although in practice the situation is rather complex, especially when selection is applied.

### *Variability of the Crossbreds*

A common argument against the use of crossbreeding is that while the first-cross ($F_1$) animals are quite uniform, mating crossbred animals with one another results in later generations which are extremely variable. This argument is based on fundamental genetic principles, but in fact the increase in variation occurs only with traits such as coat colour, horns, etc., which are controlled by only a few genes and on which the environment has little effect. Thus if a ram of the Dorset Horn breed is mated to ewes from a hornless Dorset strain, all the progeny will tend to produce scurs, or small, light horns. If the progeny of this mating are interbred, the second generation will vary from completely polled through scurs and light horns, to full-sized large horns. Thus the second generation is more variable for horn development than is the first cross.

With most characters important in animal production, however (fertility, prolificacy, fleece weight, growth rate, etc.), the traits are controlled by many genes. In theory, when a trait is influenced by a large number of genes, only a small increase in genetic variability is to be expected in $F_2$ – far less variability than is to be expected when there are few genes. In practice, there is usually no recognizable increase in total variation since, if any increase in genetic variation occurs, this is swamped by the amount of variation present as a result of environmental factors.

## USES OF CROSSBREEDING

Crossbreeding has had and will continue to have several roles in the Canadian sheep industry. In broad lines, crossbreeding may be used with the following objectives.

### *Production of Desirable First-Cross Animals*

Crossbreeding has been used widely to produce desirable market lambs. Crossbreeding has always resulted in the introduction of genes for carcass characteristics, growth rate, and viability from the sire breeds and has also permitted utilization of any hybrid vigour for these characteristics. Any breeder presently using Suffolk, Southdown, or Dorset rams on ewes of different breeds is taking advantage of this fact.

Crossbreeding to produce first-cross females, which are then mated to meat breeds to produce market animals, is receiving wide attention these days. Because this method does not go beyond the stage of the first-cross female, it makes the best use of any hybrid vigour for reproductive performance and mothering ability. The popularity of the commercial ewes with Finnish Landrace blood is in itself an undeniable proof of the advantage of this type of crossing.

*"Grading Up" to a New Breed*

The process of "grading up" involves the continuing use of sires of the breed being introduced. The first-cross females are mated to the new breed to produce three-quarterbreds, which in turn produce seven-eightbreds, which in turn produce 15/16ths and so on until the herd is indistinguishable from the new breed. In effect, grading up is the only practical and economical way to replace one breed with another. The speed of grading up is primarily limited by the number of sires of the new breed available. Although this process was not used on a large scale in Canada, its use in developing countries to replace low-producing native breeds is well documented.

*Introduction of a New Characteristic Into a Breed*

Crossbreeding is an effective means of introducing genes for particular characteristics from one breed to another. An example is the development of the Polled Dorset by crossing Dorset Horns with Corriedales or Ryelands to introduce polled genes. Continued back-crossing to Dorset Horns, combined with selection for polledness, has given a polled strain with the other characteristics of the Dorset Horn. However, this system is likely to be effective only when the characteristic is determined by a few genes.



*Formation of New Breeds*

Crossbreeding has played a part in the development of most new breeds. The simplest system involves the use of two parent breeds in the initial stage to produce crossbreds. The crossbreds are then interbred with selection for the desired characteristics.

In recent years, there has been a tendency to combine more breeds before interbreeding the crossbreds. The object is to form a larger "gene pool" so that the chance of having all the desirable genes available in the pool is improved. Then selection is applied for the desired traits in order to increase the proportion of the genes favouring high expression of these traits. Advocates of this system believe that even if the initial stock is not quite so good as existing breeds, more rapid improvement will be possible as a result of the greater variability. In general, more hybrid vigour occurs and a greater proportion of this hybrid vigour is maintained into the later generations, when more parent breeds are used.

The most famous result of this approach is the Colbred, produced in Great Britain to compete with the Border Leicester as a sire to mate with hill ewes to produce highly fertile crossbreds. The breeds contributing to the Colbred gene pool were the Border Leicester (with high fertility), the East Friesian (with fertility and high milk yield), the Clun Forest (with good fertility, mothering ability and survival) and the Dorset Horn (with high fertility and an extended breeding season). The Canadian experience in this field, the developing of the DLS (*Sheep Canada*, Volume 1, Issue 1) involved three breeds – the Leicester breed was chosen for its fertility, and mothering ability; the traits of rapid growth and carcass quality were introduced by the Suffolk breed; and the genes responsible for the extended breeding season came from the Dorset breed.

*In Issue 12, Dr. Fahmy will go on to discuss the results of several crossbreeding experiments.*

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# The Uses of Crossbreeding (part 2)

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## CROSSBREEDING SYSTEMS

Crossbreeding systems can be broadly classified into two categories, discontinuous and continuous. In each category the number of breeds involved depends on the characteristics of the breeds available, market demand, economic consideration, breeders' preference among others.

Several studies were carried out to compare the different systems of crossing, many of these involved economic considerations of the costs of raising breeds. As it presently stands the optimum discontinued crossbreeding system is using crossbred ewe with terminal sire line. The crossbred ewe is usually obtained from breeds with high fertility, prolificacy and milking ability where as the sire breed is usually of mutton type to transmit to the progeny the traits of rapid growth superior carcass and meat qualities. As for continuous crossbreeding systems, rotational 3 or 4 breed crossing has proved to be the best.

To familiarize the breeders with results obtained from the various crossbreeding experiments conducted in North America, Dr. C.E. Terrill of the USDA reviewed the existing literature and wrote an article from which the following extracts are presented.

Advantages in heterosis from crossbreeding in growth were generally evident though relatively small in two-breed crosses. 1- Heterosis of 2.2% for gain to weaning and weaning weight was observed in Columbia x Targhee crosses. 2- Heterosis was observed in two-breed cross lambs ranging from 3% for Columbia x Targhee to 6% for Columbia x Suffolk crossbreds.

Two-breed cross ewes generally excel over purebreds because heterosis is expressed both through the maternal effect and also through the direct effect in the offspring. 1- Crossbred ewes excelled over the average of the parent Suffolks and Corriedales by 22.5% in productivity of lambs and wool. The advantage in pounds of lamb per ewe bred in crossbred matings was 33% as compared with 11% in wool. Furthermore, the advantage of crossbred mothers was 26% in lambs raised per ewe bred as compared with 5% in average weaning weight. 2- Lambs marketed per ewe year under accelerated lambing were 1.49 in Dorset x Rambouillet ewes as compared with 1.25 and 1.26 in the parent breeds. 3- Heterosis of 14.6% for multiple birth and 17.1% for fleece weight were reported in Suffolk and Oxford crosses.

Gain from successive crosses is thought to be due to an increasing proportion of heterosis expressed both through the maternal advantage in the crossbred mothers and through the additional vigor in the offspring as the number of breeds involved increases up to three or four. 1- A three-breed cross was slightly advantageous over a backcross of Hampshire and Suffolk rams mated to Hampshire x and Suffolk x western ewes in daily gain, 120-day weight and grade. 2- Advantages of crossbreds from Hampshire x Columbia and Hampshire x Targhee over purebreds, varied from 8% in lambs born of ewes lambing to 26% in lambs weaned of ewes bred.

3- In a Canadian experiment, body weight and gain were improved considerably by crossing breeds of sheep to produce two- and three-breed crosses. 4- In another Canadian experiment comparing purebreds, two- and three-breed crosses among Romnelet, Columbia, Suffolk and North Country Cheviot breeds, the two- and three-breed crosses were superior over purebreds in weaning weight of 5% and 14.6% respectively. Gain of the three-breed over the two-breed cross was attributed mainly to the maternal ability of the crossbred dam. Crossbred lambs gained 7% more than purebreds in the feedlot. Two- and three-breed crosses were 7.3% and 11.4% respectively, heavier than purebreds in final market weight. The number of pounds of lamb produced at market per ewe bred was increased on the average by 16.6% or 32.5% when two- or three-breed crosses were compared with purebred averages. 3- Triple-cross matings in Dorset x Dorset-western ewes had an advantage of 5 lambs born per 100 ewes, 3% death loss and an overall advantage of 9% more lambs reared.

Some crossbreeding experiments have failed to show an advantage of heterosis. 1- There was no difference in number of lambs per ewe at weaning in crosses of Columbia, Suffolk or Corriedale with Hampshire as compared with the number in straighbred Hampshires. 2- Rambouillet or Columbia x Rambouillet ewes had no advantage over fine wool types. 3- Panama x Targhee and Panama x Targhee x Rambouillet crosses had little advantage over the pure breeds. In general, failure to show heterosis was associated with very good conditions and high production records, in well-adapted purebreed types or in breeds with similar levels of performance.

Crossbred sires have usually shown some advantages over purebred rams. 1- Hampshire, Suffolk and Hampshire x Suffolk cross rams were tested on commercial ewes. Crossbred-sired lambs showed an advantage of about 4% in survival over lambs from the two purebred parent groups. Use of crossbred rams resulted in mean performance at least equal to and variability no greater than that obtained by using purebred rams. Average years of service was 3.4 for Suffolk x Hampshire crossbreds as compared with 3.0 years for Hampshires and 3.2 years for Suffolks. 2- Ewes mated to Columbia x Targhee rams produced 1.34 lambs born per ewe mated as compared with 1.22 for straightbred rams. 3- Straightbred matings resulted in 1.20 lambs born of ewes mated as compared with 1.41 for crossbred matings. Lambs sired by crossbred rams from straightbred ewes performed similarly to lambs from two-breed crosses. 4- Multiple births of purebred and crossbred lambs were very similar, but those from three-bred crosses from crossbred ewes were highest and those from three-breed crosses from purebred ewes were next highest. Those from purebred rams in two-breed crosses and in purebred matings were much lower.

Use of the Finnsheep breed in crossbreeding to combine the meat conformation and adaptability of domestic breeds with the high prolificacy of the Finnsheep breed presents a rapid means of increasing efficiency of lamb meat production. 1- Lambs born per ewe lambing were 1.56 in Finnsheep x Minn. 100, and 1.25 in Finnsheep x Suffolk as compared with 1.00 and 1.11 in straightbred yearling ewes. 2- Lambing rate was 1.50 lambs per Targhee ewe lambing and 2.22 lambs per Finnsheep x Targhee ewe.

In a similar comparison, Finnsheep x Targhee ewes lambing at 1 and 2 years of age were 38 to 48% superior to contemporary Targhees in numbers of lambs born and 21 to 39% superior in numbers of lambs weaned. 3- More Finnsheep-sired ewe lambs (71%) than Rambouillet-sired (37%) crosses or purebreds (34%) of seven dam breeds reached puberty by 8 months of age, with little difference in growth, but with mean ages at puberty of 218, 238 and 245 days, respectively, due largely to heterosis in Finnsheep crosses.

Carcass evaluations of Finnsheep cross lambs indicate that acceptable carcasses are produced, but internal fat tends to be higher than that in domestic breeds and less fat at heavy slaughter weights would be desirable.

An intensive crossbreeding experiment with sheep has been carried out at Beltsville, Maryland, using Columbia-Southdale, Dorset (Horn), Hampshire, Merino (American), Shropshire, Southdown, Suffolk and Targhee breeds. Matings involved the production of both purebred and crossbred offspring simultaneously from the same sire.

Crosses of Hampshire, Shropshire, Southdown and Merino breeds showed that fertility, prolificacy, lamb livability and overall reproductive ability were generally higher for crossbred than for purebred matings. Fertility, or percentage of ewes lambing of ewes exposed to the ram, averaged 89.6 and varied from 88.0 for purebred matings to 92.3 for four-breed crosses, but the difference was not significant. Prolificacy, or percentage of lambs born of ewes lambing, averaged 140.2 and varied from 137.3 for purebreds to 149.0 for four-breed crosses; prolificacy was significantly higher in three- and four-breed crosses than in two-breed crosses and purebreds. Lamb livability was the most important aspect of overall reproduction. Percentage of lambs born alive of all lambs born averaged 95.2 and varied from 93.2 for purebreds to 97.0 for four-breed crosses. Percentage of lambs weaned of live lambs born averaged 84.6 and varied from 80.4 for purebreds to 89.4 for four-breed crosses.

There was an upward trend in overall reproductive ability, or percentage of lambs weaned of ewes exposed to the ram. Compared with averages of the purebred parents, average increases were 2.1% for two-breed crosses, 14.9% for three-breed crosses and 27.1% for four-breed crosses. Two-breed crosses tended to rank in the same order as the dam breed. Four-breed cross lambs were all sired by Southdown and Merino rams and excelled over the best purebreed in overall reproduction in five of six crosses.

On weights at birth, weaning and gain from birth to weaning showed that two-breed cross offspring followed the same trends as the dam breeds; Hampshires were heaviest, Merinos lightest and Shropshires intermediate. Crossbred rams mated to purebred ewes excelled over purebred rams but not over purbred rams mated to crossbred ewes. Advantages of all crossbred lambs over purebred lambs involving the same breeds were 3.2 Kg for weaning weight, 0.25 Kg for birth weight and 2.9 Kg gain from birth to weaning. Crossbreds always excelled over comparable averages for purebreds for each trait. The average gains in weaning weight over the purebreds were 2.4 Kg for two-breed crosses, 4.3 Kg for three-breed crosses and 4.7 Kg for four-breed crosses.

Crosses among Hampshire, Columbia-Southdale, Targhee, Suffolk and Dorset breeds showed that fertility, prolificacy, livability and overall reproduction efficiency were generally higher for crossbred than for purebred matings. The overall crossbred average for percentage of lambs weaned of ewes bred was 94.0 compared with 78.8 for the purebred average. Two-breed cross lambs exceeded the purebred lambs by 0.11 Kg in birth weight, 1.3 Kg in both weaning weight and gain from birth to weaning and 0.015 Kg in average daily gain.

*In issue 13, Dr. Fahmy will conclude with a discussion of commercial uses of crossbreeding.*

# The Uses of Crossbreeding (part 3)

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## COMMERCIAL USE OF CROSSBREEDING

Dr. Terrill concluded from the results obtained from the Beltsville study that two-breed crosses gave about a 12% gain in overall lamb production over the purebred parents. Each additional breed used in crossing gave an additional 8 to 20% gain up to four breeds in the cross. These results support the recommendation of commercial production of essentially three- or four-breed rotational crossing or a continuous system of crossing involving at least three or four sire breeds.

The additional gain beyond the specific three-breed cross would have to come from heterosis in sire fertility or through the grand dam's maternal effect on the mother. In rotation crossing, heterosis might increase as the number of breeds increase, but maximum heterosis would be approached with the four-breed combination. At Beltsville, the four-breed crosses excelled over the three-breed crosses in each aspect of reproduction. The four-breed crosses did not excel in weaning weight, but the sire breeds for these crosses (Southdown and Merino) were far below average in weaning weight. However, the four-breed cross excelled in calculated overall weight of lambs weaned per ewe exposed. The overall reproductive rate of the four-breed crosses over the three-breed crosses was highly significant. However, the four-breed cross matings were not balanced among breeds, and there was also some confounding of year, type of mating and age of ewe. In general, the three-breed cross advantage might be underestimated, and the four-breed cross advantages might be overestimated. In a continuous system of multiple-breed crossing, there will probably be no disadvantage of the four-breed as compared with the three-breed cross provided highly productive breeds are involved.

Gains in productivity from crossbreeding would largely be expected to increase net returns because the gains would come mainly through increased livability, reproduction rate and growth rate. These would generally not increase overhead costs. Neither would they increase other costs to an extent that would not be offset by an equivalent or greater return.

## NEW SYSTEM OF CROSSBREEDING

Dr. Terrill proposed a system of continuous multibreed crossing for increasing efficiency of production. For commercial production, purebreds could be used only to produce crossbred rams and thus minimize the number of purebreds in the sheep population. At the same time, the equivalent of three- or four-breed crosses would be approached in commercial flocks to maintain a high level of heterosis. Crossbred sires would not only aid in obtaining maximum heterosis but would also increase efficiency of use of commercial rams. They would also help attain a balance between meat and lamb-producing ability in all offspring. Thus, ewe lambs could either be kept for replacements or sent to slaughter. Terminal crosses would no longer be made because the system would be continuous. Replacement crossbred ewe lambs would then involve a combination of several breeds. The new system would not require a commitment of the commercial producer to any long time sequence or rotation of breeds. Rather, a decision would be made each time rams were purchased as to what breed combinations in the sires would give the best results when mated to the particular breed combination of the ewes on hand or to be purchased.

The system would be most useful for lamb meat production rather than wool production with breeds available in North America. Any three or more breeds with high prolificacy or meat quality attributes would likely include one or more breeds with low quantity or quality of wool. However, wool would still be a valuable product, and fleece weight would usually be enhanced by heterosis.

With conventional crossbreeding, breed A (meat type) is mated to B (usually a wool type), and all offspring (AxB) are sent to slaughter. Sometimes a rotation system can be used, such as AxB, CxAB and DxCAB. Also, crossbred sires such as ACxB have been used, and crossbred ewes sometimes mated to a third breed such as CxAB.

The proposed crossbreeding system, using highly productive domestic breeds, might be ABxC, DEx(AB)C and BcX(DE)(AB)C, or ABxEF, CDx(AB) (EF) and EFx(CD) (AB) (EF). Obviously, breeds lower in productivity may need to be included as the number of breeds involved is increased. Results at Beltsville indicated that the gain from heterosis generally overbalanced the loss from addition of breeds with lower productivity up to four-breed rotation combinations. This advantage of heterosis might not hold under the best of conditions or where the additional breed was extremely low in merit or where the important production traits did not involve prolificacy.

Table 1 — Summarizes the most common systems involving 2, 3 & 4 breeds in discontinuous crossing.

| Number of breeds | Type of crossing | Type of mating Sire | Dam | Expression of heterosis |
|---|---|---|---|---|
| 2 (A,B) | First crossing ($F_1$) | A | B | Maximum expression of direct heterosis in the progeny in the traits related to survival, growth rate, feed efficiency and to a lesser extent in traits related to cass. |
| | Back crossing | A | (AxB) | Theoretically, half the direct heterosis expressed in first crossing in the progeny + heterosis caused by maternal effect in traits such as milk production, fertility, etc. |
| | Interbreeding $F_1$ | (AxB) | (AxB) | Theoretically, half the direct heterosis of $F_1$ + Maternal heterosis as in backcross + paternal heterosis in traits such as libido, fertility, etc. |
| 3(A,B,C) | 3-breed-cross (crossbred ewe) | C | (AxB) | Maximum expression of direct heterosis + maximum expression of maternal heterosis. |
| | 3-breed-cross (crossbred ram) | (AxB) | C | Maximum expression of direct heterosis + expression of paternal heterosis |
| | Partial back-crossing | (AxC) | (AxB) | Partial expression of direct heterosis + maximum expression of both paternal and maternal heterosis. |
| 4(A,B,C,D) | From crossbred | (AxB) | (CxD) | Full expression of direct, maternal and paternal heterosis. |
| | From crossbred ewes and pure-bred rams | D | C(AxB) | Full expression of direct heterosis and maternal heterosis. |

**Table 2 – Continuous crossing takes the following forms.**

**WITH 2 BREEDS:**

**1 – Grading up or sometimes called recurrent backcrossing.**

| Generation | Sire | | Dam | | Progeny |
|---|---|---|---|---|---|
| 0 | A | x | B | = | 1/2A 1/2B |
| 1 | A | x | 1/2A 1/2B | = | 3/4A 1/4B |
| 2 | A | x | 3/4A 1/4B | = | 7/8A 1/8B |
| 3 | A | x | 7/8A 1/8B | = | 15/16A 1/16B |
| 4 | A | x | 15/16A 1/16B | = | 31/32A 1/32B |

**2 – Crisscrossing.**

| Generation | Sire | | Dam | | Progeny |
|---|---|---|---|---|---|
| 0 | B | x | A | = | 1/2A 1/2B |
| 1 | A | x | 1/2A 1/2B | = | 3/4A 1/4B |
| 2 | B | x | 3/4A 1/4B | = | 3/8A 5/8B |
| 3 | A | x | 3/8A 5/8B | = | 11/16A 5/16B |
| 4 | B | x | 11/16A 5/16B | = | 11/32A 21/32B |

**WITH 3 BREEDS:** **Rotational Crossing.**

| Generation | Sire | Dam | | Progeny |
|---|---|---|---|---|
| 1 | C | 1/2A 1/2B | = | 1/2C 1/4A 1/4B |
| 2 | A | 1/2C 1/4A 1/4B | = | 2/8C 5/8A 1/8B |
| 3 | B | 2/8C 1/8A 1/8B | = | 2/16C 5/16A 9/16B |
| 4 | C | 2/16C 5/16A 9/16B | = | 18/32C 5/32A 9/32B |
| 5 | A | | | |

The proposed crossbreeding system seems particularly useful in taking advantage of a highly prolific exotic breed such as the Finnsheep (A). For example, a series of matings such as DAxA(BC), FAx(DA) (ABC) and CAx(EA) (DA) (ABC) would maintain about 50% of Finnsheep blood but would also lead to a level of heterosis somewhat less than that of a three-breed rotation cross. This series of crosses would be expected to give maximum productivity in lambs marketed per year from once-a-year lambing. The advantage would result from a balance of the contribution from the Finnsheep breed and heterosis resulting from the rotation of the four other breeds involved. Other breeds used might be all meat-type breeds such as the Suffolk, Hampshire, Dorset and Oxford and thus provide acceptable slaughter lambs.

Under many conditions, a combination that would maintain one-quarter Finnsheep blood might be desired. This could be obtained by using backcross sires such as BBAxCD, EEAx(BBACD), DDAx(EEA) (BBACD) and CCAx(DDA) (EEA) (BBACD). Here, heterosis would reach a higher level than in the example that maintained the Finnsheep blood at 50%. This combination with one-quarter Finnsheep blood might be useful to increase the lamb crop while producing under very rigorous conditions.

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