British Columbia

Ministry of Agriculture, Food and Fisheries

# FACTSHEET

## BREEDING PROGRAMS FOR SHEEP PRODUCTION

**July 2003**

One of the primary tools which sheep breeders have at their disposal for the improvement of their livestock is selection.

That, of course, is a group term that includes many activities: recording, identifying, the use of formal programs involving Record of Performance (R.O.P) testing and so on. But, on some basis, the breeder makes a deliberate choice of which animals are going to be the parents of the next generation. That is really all that selection is; its genetic result is to alter the frequency of genes that are within the group with which we are working. Hopefully, we can accumulate a greater number of the "better" genes which produce the characteristics we want and decrease the frequency of the less desirable genes. Then, within that gene pool we can again make further advances by pure breeding or by hybridization with the improved lines that we have created. The foundation of livestock improvement is really this process of selection. We're applying more accurate systems of assessing the Breeding Value of animals as techniques develop in the field of statistics, indexing, R.O.P., and ultrasonics. As these refinements become more widely used, we can expect to make more rapid advances in the genetic capability of our stock.

In this discussion the genetic aspects of livestock improvements are emphasized, but I don't want anyone to get the impression that this is all that is involved. The environment within which the animals are developed certainly has a greater influence on the ability of the genes to express themselves. Genes may have the capability or potential, but if they don't have the opportunity, that is, if the environment isn't right, then all is for naught! You can't distinguish between the better performers and the poorer if you don't supply the right conditions. So, certainly the environment has a great deal to do with the expression of the genes as seen in performance traits and physical characteristics, conformation, etc.

### PUREBRED BREEDING PROGRAMS

**1) Close Breeding**

There are really only three breeding systems; perhaps we more often than we talk of only two. One of the systems involves using individuals which are more closely related to one another than average in the group with which we are working and is called INBREEDING. I suppose that actually all sheep are related if one goes back far enough. For definition purposes we can say that any mating involving any animals which have an ancestor in common within the last three or four generations would be related; and the closer the relationship the greater the degree of inbreeding. We find that inbreeding, on occasion, will result in the appearance of some undesirable characteristics. Usually we find that the trait that suffers first is the reproductive capabilities, followed by perhaps, its survival. But survival is due to all sorts of things: inefficient metabolic processes, hereditary diseases or things of this sort, which result in it being removed from the population; whether by death or by our selection efforts, the result is the same! So we would, from inbreeding, expect most flocks to have some sort of depression of performance, either reproductive or growth. Therefore, inbreeding is not a system which is used widely, simply because of the detrimental effects and experiences of people who have applied it. This is not to say that it shouldn't be applied – but there are certain conditions which should go along with that; such as large numbers of already good stock in the hands of a very knowledgeable person. This person must be prepared to apply the selection pressures necessary to make sure that contained within the population are only the best as breeding stock, with the rest being discarded. So, certain qualifications must be included in any system which would be using inbreeding.

Some people say, "Well, I don't inbreed, but I do linebreed!" Actually, they are really one and the same thing in the sense that they both create homozygous individuals. When identical genes for some characteristics are contributed by both parents, the resulting animal is said to be homozygous for that gene, having a double dose of that gene (home = alike, zygous refers to the zygote which is another term for the fertizilized egg). If in the fertilized egg there are two identical genes, one contributed by the sire, one by the dam, the resulting individual is homozygous at that locus or gene place. Any breeding system which results in an increase in this occurrence is referred to as CLOSE BREEDING, and the closer the relationship between sire and dam the greater the degree of inbreeding. LINEBREEDING refers to the system of inbreeding in which a single individual appears on both sides of the pedigree more frequently than it does in other pedigrees. This is when matings cause a certain ancestor to appear in the pedigree of an animal in several different places – you have linebred to that individual. An example is shown in Figure 1.

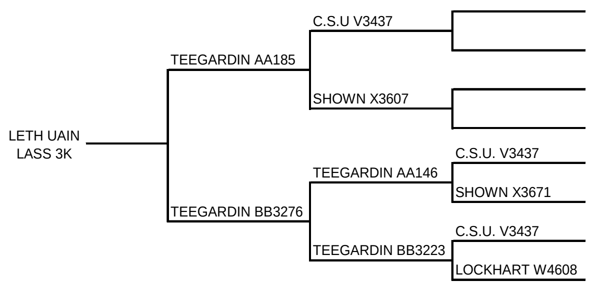


**FIGURE1**. Linebreeding

Linebreeding is an attempt to maintain a high degree of relationship to an outstanding individual, which is, perhaps, no longer with us. Livebreeding is known as a system of maintaining a high degree of relationship.

## 2) Random Breeding

The second system of breeding is referred to as RANDOM BREEDING. In actual fact, however, there is no such system in our industry! Random breeding, by definition, means that every individual born has an equal opportunity to contribute genetically to the next generation. This implies that no selection forces are applied at all – there is no choice of which sires leave more progeny than others, which dams leave progeny, and which potential dams go down the road – every individual has an equal opportunity. This system truly doesn't apply to our industry, which is why I mentioned earlier that there are really only 2 systems which exist in sheep breeding; crossbreeding and outbreeding.

## 3) Outbreeding

In the outbreeding system, if we're staying within a breed, we can do one of two things. First, we could outcross among individuals which are outbred. When we mate unrelated heterozygous animals within a breed this is called OUTCROSSING. Figure 2 shows an example where no individual appears more than once in a pedigree.

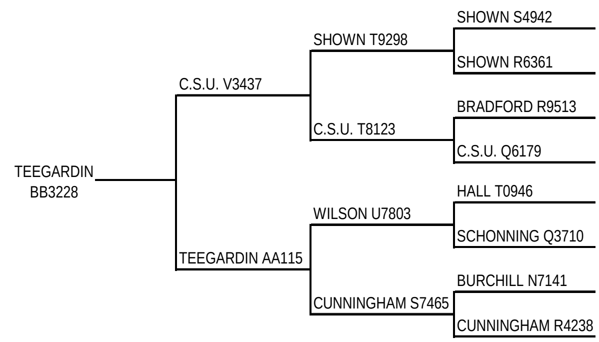


**FIGURE 2**. Outcrossing

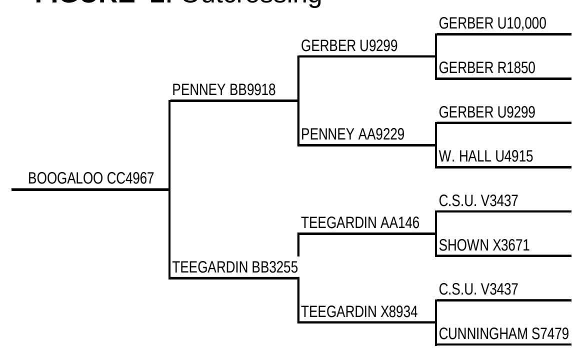


**FIGURE 3**. Linecrossing

Outcrossed animals are not as dissimilar among themselves as would be the case between inbred lines of different ancestry within a breed. However, we don't have many inbred lines within our breeds in Canada. Very few people conduct inbreeding or linebreeding. The essential use of any inbred line is not to compete with outbred animals in the production phase of a commercial enterprise, but they are designed specifically to be crossed. Inbred lines oftentimes do not perform well within themselves, but when combined with unrelated individuals of other lines, they result in the production of somewhat superior progeny. This excess of superiority is called HYBRID VIGOUR, which will be discussed in a moment.

CROSSBREEDING is another form of outbreeding which employs the device of crossing between breeds. Outbred animals of one breed are mated with outbred (or heterozygous) animals of another breed. Many producers are performing this sort of breeding technique because of the benefits which they have observed and been told about. These benefits are from something called the hybrid vigour effect. Hybrid vigour effect results in an increase in: reproductive capacity (prolificacy and fertility), milking ability, mothering ability, survival and growth rate in the lambs, and in particular preweaning.

Then of course as with the case of linecrossing within a breed we can, LINE CROSSBREED. That is to mate individuals of a definite inbred line to individuals of an inbred line of another breed, as in Figure 4.

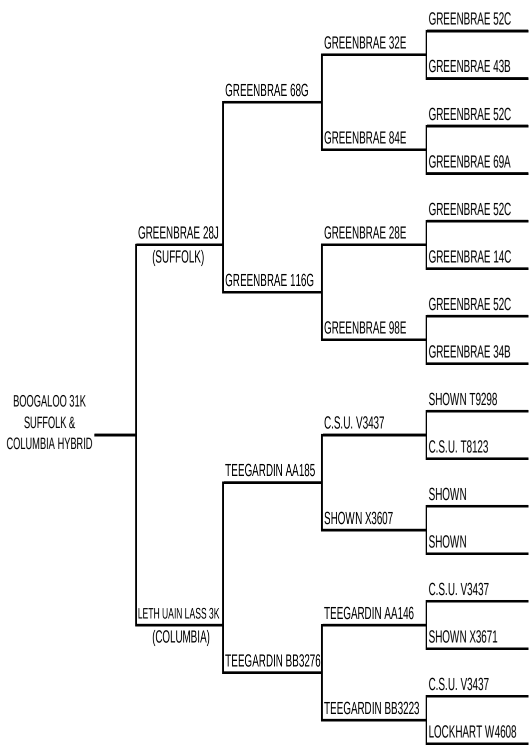


**FIGURE 4.** Line Crossbreeding

A summary of these purebred breeding programs is depicted in Figure 5.

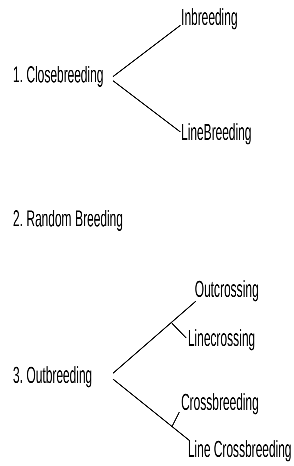


**FIGURE 5**. Purebred Breeding Systems

## COMMERCIAL BREEDING PROGRAMS

The necessary beginning point in the design of a breeding program is always the system we use when we stay within a breed; that is, we PUREBREED or STRAIGHT BREED. This is where you continue to use males of the same breed as the females. For example, Suffolk X Suffolk – (SS) and Columbia X Columbia = (CC).

### 1) Single Cross

If we combine two breeds, we have what is commonly referred to as a SINGLE CROSS, otherwise known as a first cross or an F1 (which means the first filial generation). This may be followed by the F2, F3, etc. The F1 is this single cross which could be exemplified by a Suffolk being mated to a Columbia and we can symbolize it by S X C = SC.

### 2) Backcross

We can then go from that SINGLE CROSS into some other directions, one of which could be a BACKCROSS. Backcrossing simply means taking those single cross females and mating them to a sire of one of those original parental breeds. As an example, we could have a Suffolk ram mated to a group of hybrid Suffolk X Columbia ewes. This Suffolk ram, of course, would not be the same animal used to produce the hybrid SC ewe; but would be an unrelated Suffolk sire since we don't want to get into inbreeding, certainly not in a commercial system of production. We want to maintain the widest possible degree of genetic difference between the parents in order to have the greatest amount of hybrid vigour. These come from the fact that the parents contribute different phases of the same gene, maintaining heterozygosity.

In this BACKCROSS, the resulting offspring would be composed of roughly ¾ of the Suffolk and ¼ of the Columbia <u>on average</u>. This is what one would expect <u>on average</u> because variation can take place within the hybrid (SC) female in the formation of egg cells to be fertilized by the sperm. From this Suffolk male it can include all proportions of the Suffolk genes and the Columbia genes in the dam (remember that she has obtained half her genes from each of these two breeds). <u>On average</u>, the best estimate we could make would be that the eggs she produces would contain half of the genes from her Suffolk parent and the other half from her Columbia parent. However, it might very well happen (although it is highly improbable), that all of the genes contributed to any one egg would be those from the ewe's Suffolk parent, in which case, the lamb would be 100% Suffolk. Or, it could very well happen that all of the genes contributed to this egg by the hybrid ewe could have come from her Columbia parent, in which case, you would have another Single Cross (SC) lamb. However, <u>on average,</u> she will have lambs with 75% Suffolk genes and 25% Columbia genes. It is partly because of this variation in gene complement that we see differences among individuals in the three-quarter or backcross generation. Some of the lambs tend to look quite like the Suffolk and others are more like the hybrid dam, with many variations between the two extremes visible in the lamb drop.

We could, however, have gone the other way or made the reciprocal cross; using a Columbia ram on a Suffolk X Columbia hybrid ewe. In this case we would simply reverse the proportions of the genes in the lambs. That is Columbia X (Suffolk X Columbia) = 75% C: 25% S <u>on average</u>.

It turns out that some breeds of sheep are better mothers than they are sires. We know that some breeds are better able to look after their young; they provide more milk, they are perhaps more fertile, or they are perhaps more prolific. These are the breeds that we wish to use as the dam breeds in making single crosses, and then mate the hybrid females to males of a breed which have superior post-weaning growth characteristics and carcass traits. The more rapid-gaining breeds, and the meatier breeds, would be used as sire breeds.

Therefore, producers should choose between these two backcross systems according to the market they are trying to satisfy, the availability of the breeds, or the special attributes of the breeds that they wish to combine. You know that differences exist even within a breed. Some Suffolks are better than others. The results of these combinations of breeds depend as much on the individuals within the breeds as it does on the breeds chosen. I don't think that I can emphasize that too much! Cross breeding is not a substitute for poor breeding, a poor environment, or for poor anything! The best of all of these inputs has to be provided.

### 3) **Criss-Cross**

We could now proceed into a CRISS-CROSS system of breeding which is an extension of backcrossing in that you have males of these two breeds (Suffolk & Columbia) that you can use on ¾ hybrid females. If you use a Columbia ram on the ¾ bred female (75% Suffolk; 25% Columbia) you come up with, <u>on average</u>, the following gene distribution in the offspring, 37 ½% S : 62 ½% C.

Logically, if we want to maintain the highest degree of heterozygosity or gene mix-up of difference in the genotypes of the resulting offspring, the thing to do would be to use a male of the breed which is least represented within the hybrid female to be mated. The next step in this crisscross program would therefore be to use an unrelated Suffolk ram on the cross bred ewes. This should bring the Suffolk gene contribution back up from the 37 ½% level to the 68 ¾% level, on average, and reduce the Columbia contribution from 62 ½% in the dam down to 31 ¼% in the lambs.

The breed least represented in these resulting crossbred lambs, the Columbia (31 ¼%) is the ram breed chosen to use next in the cycle in this continuous crossing system. This produces lambs with the following gene distribution, on average, Columbia X (68 ¾% S : 31 ¼% C) = 34 3/8% S : 65 5/8% C. This ewe would then be crossed to a Suffolk ram and so on down the line in order to maintain the greatest degree of heterozygosity in the resulting offspring. It roughly switches from 1/3 of one breed : 2/3 of the other and then 2/3 the first breed : 1/3 the second from generation to generation.

### 4) **Three-Breed Rotational Cross**

Proceeding from a two bred cross we can include a third breed, but there would have to be some really good reason to do this. You don't simply indiscriminately choose the breeds to be combined; they have to perform a function or be capable of contributing something beneficial to the offspring. Therefore, you go to a third breed which has something to add to the product or is capable of improving it in some way. This of course depends on what you are trying to produce for whatever specialized market you supply.

As an example, a Hampshire ram could be used on this single-cross Suffolk X Columbia ewe. By using a Hampshire ram on the half-blood ewes, we maintain a greater amount of hybrid effect in the resulting offspring than in the single cross.

Each parent in the cross contributes one gene of each of its gene pairs to the offspring. The resulting offspring will each have received ½ of its genes or genotype from the Hampshire parent and ½ of its genotype from its cross-bred dam, which was 50% Suffolk, 50% Columbia herself. Therefore, the lamb would be ½ Hampshire, ¼ Suffolk, and ¼ Columbia, <u>on average</u>. The eggs produced by this crossbred ewe will <u>on average</u> contain half Suffolk and half Columbia genes, which must be combined with the Hampshire genes in the sperm cell to produce the lamb which will therefore have ½ Hampshire : ¼ Suffolk : ¼ Columbia genes.

Where do you go to select a ram to use on these three-way crossbred lambs? You cold go to either the Suffolk or the Columbia breeds for a ram. Each ram is represented in the genotype of the ewes to the same extent (25%), and each of them are less than the third breed, the Hampshire. For the purposes of illustration, we will come back to the Columbia ram on these females which are a combination of three breeds yielding lambs which are, 25% H : 12 ½% S : 62 ½% C.

When we breed the ewes obtained from this cross to produce the next generation, we go to the breed least represented in the ewes, which in this case is the Suffolk. We then cross Suffolk rams to these ewes produce our next generation of lambs, producing the following results, 12 ½% H : 56 ¼% S : 31 ¼% C.

The next generation would use Hampshire rams, since they are the breed least represented in the ewes, and so on down the line. All we are trying to do in each generation is to maintain the maximum degree of genetic difference or heterozygosity in the resulting lambs in order to sustain the hybrid effects or heterosis effects which are so important, particularly in the mother.

The CRISS-CROSS and the THREE BREED ROTATIONAL CROSS are continuous systems which you can create your own replacement ewe generation after generation. In this system you stay within your own flock and the pressures against females are in contrast to the situation where you buy replacements; and in which case you are buying someone else's second best. You would, of course, purchase the ram or rams which are to be used making sure that you don't purchase rams which are relatives of the rams you have already used, because you want to avoid inbreeding as much as is possible.

The question might be asked, “What happens if you use a fourth breed?” There may be a fourth breed which will complement what you are trying to develop; however, repeated trials have shown that there appears to be no significant advantage in going to a fourth breed. You derive about the maximum degree of hybrid vigour by combining just three breeds. The fourth breed doesn’t give you an additional boost which is really meaningful. If it turns out that one of the breeds you are using is not the best to be used, you’d be further ahead to replace the rams of that breed with rams of another breed which will combine better; don’t just throw in a fourth breed.

5) **Terminal Cross**

We hear a lot about terminal sire lines. We also hear of repeatable three-way and repeatable four-way crosses. These are terminal crosses, meaning that all of the offspring of the cross are fed-out and sold. These animals are not retained as breeding animals, it’s not a continuous system, and you don’t derive a replacement among the offspring of a repeatable or terminal cross. What’s involved is going part way (the first round) in a three breed system, for example, HAMPSHIRE X (SUFFOLK X COLUMBIA) with all offspring marketed.

You could then choose two of the breeds to produce, the best performing hybrid mother with: the most fertility, the best milker, and is the most prolific. This provides the optimum maternal environment to the offspring.

You then pick the sire line or breed, to be put with that hybrid female, one which has proven itself on test to produce both rapid and efficient growth rates, and has the best carcasses. These are traits which the sire can best contribute.

## HERITABILITY

It turns out that preweaning traits are those most affected by cross-breeding. We can elevate the performance of the dam for the preweaning characteristics by hybridization. The postweaning traits are affected to a greater extent by using a purebred sire which has been shown to be superior in these traits. The term for this is called HERITABILITY. Heritability is simply an estimate of the proportion of the differences among animals which can be transmitted to the next generation. The effectiveness of selection for improvement in traits which have a high heritability is based upon the fact that the group selected to produce the next generation is genetically superior to the group from which they were selected.

Certainly, some of that difference is a result of a better environment provided to the group which has the higher average, or a poorer environment provided to the individuals within the group which had the lower average. For example, maybe some of the animals in the lower group had foot-rot or perhaps pinkeye, something which suppressed their productivity. Perhaps the ones we have chosen were better because they had been favored with better feed and shelter. So a portion of performance is genetically induced, otherwise called the heritability estimate.

Traits with low heritability are the preweaning traits which are greatly affected by the environment. Perhaps the fact that the ram was infertile is the reason the ewe didn’t settle. It might not be her fault! She may be fertile enough, but the ram wasn’t. We can’t say that she is infertile, or less fertile than the others – she just didn’t have the chance or the opportunity. Perhaps we squeezed a whole bunch of pregnant ewes through a barn door and injured some to the point that instead of having twins or better, they delivered only one or maybe none. Perhaps the fact that they have a decreased number of lambs delivered is not because they have a genetic deficiency, but because they have been injured.
Diseases, nutritional deficiencies, etc. may affect the preweaning traits. The milking ability of the ewe, for instance, is affected greatly by the ingredients and the nutritional composition of her ration.

These preweaning traits are less heritable than postweaning traits and respond much more to hybridization and to improvements in the environment. So, you can improve the preweaning performance by two things – crossbreeding and/or improving the environmental conditions under which these animals are kept.

The postweaning traits, the highly heritable traits, are improved within pure lines through mass selection by testing and removing the poorer ones and retaining the better ones to be used as breeding stock in the pure line. The rams used are those which have demonstrated superiority in the highly heritable traits rate of gain efficiency, and carcass traits. Heritability estimates for several traits are shown below (Table 1)

**TABLE 1** Heribavilities of Several Traits

| Trait | Heritability (%) Average | Range |
|---|---|---|
| Birth weight | 30 | 9-61 |
| Weaning weight (60 days) | 10 | |
| Mature body wt. | 40 | |
| Rate of gain | 30 | 9-58 |
| Face cover | 56 | 13-78 |
| Grease fleece wt. | 38 | 17-61 |
| Multiple birth | 15 | 7-40 |
| Milk production | 26 | 17-34 |
| Loin eye area | 53 | 23-93 |
| Carcass wt/day of age | 22 | 16-27 |

This is the basis upon which you would rationalize the choice of breeds and the method of combination of breeds to produce the desired market animal.

## TERMINAL vs ROTATIONAL CROSSING

Returning to our illustration of TERMINAL CROSSING, we would end up with a market lamb which is ½ Hampshire, ¼ Suffolk, ¼ Columbia and then we would stop there. In a terminal cross we don't carry on down to the next cross system. All of the offspring (1/2 Hampshire, ¼ Suffolk, ¼ Columbia) are fed out, both rams and ewes, and are slaughtered. That is why it's called a terminal breeding system.

There are advantages to each system. In this terminal cross system you can continue to use the same ram as long as he is fertile and active, capable of settling the ewes and producing market quality offspring. You are also able to continue to use the same ewes year after year, as well.

Naturally, you are going to lose some of these brood ewes, and your flock numbers are going to be reduced unless you can provide some replacements. Therefore, there is a problem with this program, as it requires you to supply or find a supplier for replacement ewes. If you are going to breed them yourself you would maintain a purebred ewe flock of the Columbia, and buy Suffolk rams to generate these hybrid ewe replacements. Or, you could undertake a contract with someone who has a Suffolk flock, and would be willing to put a Columbia ram with some of them. You would then develop a contract to purchase the entire offspring created from this breeding, or whatever other arrangement you come to. So you could, by purchase, sustain this hybrid ewe flock, or maintain it by your own breeding.

Another system would be to save all of the females from the second last lambing to replace all the females in the flock at once. This would be difficult to do in most circumstances, as there are seldom enough females born in any one lambing to enable you to replace the entire flock. This might mean that you would have to use all the ewe lambs from the last two lambings to totally replace your hybrid ewe flock.

In pigs we could do this type of manipulation very handily and still leave lots of room for selection. This points out one of our major problems. You have to save <u>all</u> of the ewe lambs from two lambings to give you any latitude for selection at all, and to replace all of your breeding ewes within those two years.

You could also maintain two purebred flocks and continue to generate hybrid ewes by a reciprocal cross mating system (Suffolk on Columbia, Columbia on Suffolk) and purchase sires of the third breed to produce the terminal cross lambs. This is a more intricate system to maintain, and remember that you have to maintain the purebred flocks as well. A variation of this system would be to maintain the hybrid ewe flock by criss-crossing, and use rams of a 3$^{rd}$ breed on a portion of them.

It is easy to see that in rotational continuous systems, it is an easier task to provide your own replacement females than it is in terminal cross systems.

On the other hand, you can see that for best results in the rotational continuous system it requires identification of the breeding ewes to separate them into the right flocks to be put with the proper breed of ram. The terminal system would not present you with that problem.

With these facts in mind, I would like to show you some of the results of a program we conducted some years ago. The results of the trials are just as valid now as they were then. I think that this program illustrates some of the things we have been discussing.

## APPLICATION OF BREEDING SYSTEMS

At the time of this experiment, we had flocks of Hampshires, Suffolks, Shropshires, Columbias and Rambouillets at our disposal. Initially, we bred from within; that is, we bred rams to ewes of the same breed. (Hamp on Hamp, Suffolk on Suffolk, etc. for all 5 breeds). The average ewe weighs within these groups: Hampshires 123 lb, Suffolk 156 lb, Shrops 131 lb, Columbias 158 lb, and Rambouillet 136 lb. If these weights are much different than your flock, you shouldn't worry as we generally do find differences existing between flocks.

We gathered data comparing it on the basis of productivity per ewe, which is simply the total weight of lambs produced per ewe. We used at that time the common factor of 140 days because we were under a range type of operation in the summer – the flock did not come in until late September, early October, at which time the lambs were weaned. We added the weight of the fleece times 3, because at that time the fleece was worth about three times as much per pound as the lamb! We therefore, just had equivalent lamb value basis by this manipulation, and adding that to the total lamb weight produced by the ewe at 140 days.

At that time we divided the sum of these values by the number of ewes that lambed. However, we should have divided by the number of ewes exposed to the rams to produce a more realistic value. These tables provide an inflated value for the average productivity of these ewes. Since we were interested in the potential of a <u>lambed</u> ewe, perhaps our manipulations of these values were not so wrong after all.

If the environment supplied to the sheep is so poor that we don't get the ewe in lamb, for some reason, or the winter was severe and we left them outside and lost the lambs by chilling, and end up with only half the exposed ewes weaning lambs, that's no fault of the ewe – that's our poor management! The figures in Table 2, should be taken more as an indication of a lambed ewe's potential, rather than as a general productivity value.

**<u>TABLE 2</u>** Productivity (140) days of purebred ewes mated to rams of the same breed

| | | | | | |
|---|---|---|---|---|---|
| Ram Breed | Hampshire | Suffolk | Shropshire | Columbia | Rambouillet |
| Ewe Breed | Hampshire | Suffolk | Shropshire | Columbia | Rambouillet |
| Ewe weight (lb) | 123 | 156 | 131 | 158 | 135 |
| Productivity/ewe1 | 86 | 102 | 72 | 115 | 91 |
| Prod./100 lb. ewe2 | 70 | 65 | 55 | 73 | 68 |

[1]Productivity per ewe = $\frac{\text{Total 140 day lamb weights + (fleece weight X 3)}}{\text{number of ewes lambing}}$

[2]Productivity per 100 lb. ewe = $\frac{\text{Productivity per ewe X 100}}{\text{Ewe weight}}$

We have 86 lbs of product/ewe of the Hampshire breed, 102/ewe of the Suffolk, 72/ewe on the Shropshire, 115/ewe on the Columbia and 91/ewe on the Rambouillet. We have some pretty obvious difference there. Notice that the Columbia and Suffolk ewes were somewhat heavier than the other breeds. The above figures penalize the lighter breeds unfairly unless we take into account the maternal weight difference between the breeds. That may be an even more accurate measurement yardstick to use; the productivity per unit weight of ewe.

We selected the common maternal weight of 100 lbs, thus allowing for the fact that weights of the breeds do vary.

This also allows for the fact that the heavier the maternal breed, the greater the annual maintenance cost will be for individuals of that breed. Sustaining them and keep maternal breeds functioning is different because they consume more feed than ewes of the lighter weight breeds.

If we select on the basis of productivity/100 lb of ewe, this might result in our selecting the smallest ewe capable of producing the greatest amount of lamb in 140 days of range production. Instead of getting into the very large breeding females, which the offspring have the capacity to grow readily, but are perhaps less efficient than the smaller brood ewes. We might find it more economical to select for smaller ewes because they may be more productive on a per 100 lb of ewe basis.

Our calculations reveal that on this basis the Hampshire and Columbia ewes exceeded the other breeds, although not by much. The one that didn't do well was the purebred Shropshire, on the basis of that information we chose to dispose of our Shropshire flock.

We then took these purebred ewes and mated them to rams of the other four breeds. That is, we made the first cross and its reciprocal. We had the Hampshire ram on the Columbia ewe and the Columbia ram on the Hampshire ewe to see if there was any difference in the reversed situation; the Columbia x Suffolk, Suffolk x Columbia, etc. We can see the results of this experiment in Table 3.

**TABLE 3** Productivity (140 days) of purebred ewes mated to rams of different breeds

| | | | | |
|---|---|---|---|---|
| Ram breed | Columbia | Hampshire | Columbia | Suffolk |
| Ewe breed | Hampshire | Columbia | Suffolk | Columbia |
| Ewe weight (lb) | 140 | 149 | 141 | 150 |
| Productivity/ewe (lb) | 96 | 116 | 73 | 107 |
| Prod./100 lb ewe (lb) | 68 | 78 | 52 | 72 |

When we compared data across Table 3, the values led us to believe that the Columbia was a better mother breed than our other four breeds. On the basis of productivity per 100 lb of ewe, Columbia continually comes out on top when she is used as the dam in a cross. It appears that her mothering ability, her capacity for producing milk, and for looking after her lambs is superior to ewes of the other four breeds.

We studied a whole series of crosses and combinations of breeds in backcrosses, reciprocal backcrosses, etc. to see what crossbreeding program would be the most productive in our situation. We tried the purebred matings, the first cross mating, and three way cross matings using the various purebreds available to us. Tables 4, 5, and 6 give the results we obtained from the many different matings done at the University of Saskatchewan and shows productivity/ewe at 140 days of lamb age.

**TABLE 4** Productivity (140 days) of purebred matings

| **Mating** | | Average weight of lamb Produced per ewe (lbs) |
|---|---|---|
| **Ram** | **Ewe** | |
| Columbia | Columbia | 103 |
| Range[1] | Range[1] | 94 |
| Suffolk | Suffolk | 114 |
| Hampshire | Hampshire | 105 |

In Table 4 we see that a purebred mating using Range ewes gave us a productivity/ewe of 94, Columbia 103, Suffolk 114, and Hampshire 105.

We then combined the various breeds remaining in reciprocal crosses with one another and obtained the results shown in Table 5.

**TABLE 5** Productivity (140 days) of 2 breed hybrid matings

| Mating | | Average weight of lamb Produced per ewe (lbs) |
|---|---|---|
| **Ram** | **Ewe** | |
| Suffolk | Range | 109 |
| Range | Suffolk | 98 |
| Suffolk | Columbia | 116 |
| Columbia | Suffolk | 104 |
| Hampshire | Range | 112 |
| Range | Hampshire | 111 |
| Hampshire | Columbia | 129 |
| Columbia | Hampshire | 112 |

Here we have Columbia rams on Suffolk ewes producing 104 lbs/ewe, and the Suffolk rams on Columbia ewes (the reciprocal cross) producing 116 lbs/ewe. This reinforced the data we had obtained the year before that the Columbia seemed to be a good mother breed. The Columbia/Hampshire cross produced 112 lbs/ewe on the same basis and the reciprocal Hampshire/Columbia produced 129 lbs/ewe. Again, apparently indicating the good preweaning contribution of the Columbia ewe.

If we just look at the single crosses and their reciprocals, we can conclude that some breeds seem to be better sire breeds than others and some breeds seem to be better dam breeds than others.

When we continued the experiment to produce three-way crossbred animals, we began to see some real advantages beginning to appear in certain crosses.

**TABLE 6** Productivity (140 days) of 3 breed hybrid matings using crossbred ewes
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| Mating | | Average weight of lamb produced per ewe (lbs) |
|---|---|---|
| **Ram** | **Ewe** | |
| Hampshire | Suffolk-Range | 128 |
| Hampshire | Range-Suffolk | 115 |
| Hampshire | Suffolk-Columbia | 145 |
| Hampshire | Columbia-Suffolk | 153 |
| Suffolk | Hampshire-Range | 126 |
| Suffolk | Range-Hampshire | 109 |
| Suffolk | Hampshire-Columbia | 114 |
| Suffolk | Columbia-Hampshire | 133 |

Hampshire rams on crossbred Suffolk-Rambouillet ewes had a productivity value of 128 lb/ewe, while a Hampshire ram on Rambouillet-Suffolk crossbred ewes had a productivity value of 115 lb/ewe. It appears that the Suffolk-Rambouillet ewe is the better dam in this three-way cross. If we look at the Hampshire ram used on the Columbia-Suffolk crossbred ewes we have a productivity value of 153 lb/ewe while a Hampshire ram used on the reciprocal crossbred ewe (Suffolk-Columbia) had a productivity value of 145 lb/ewe. The Suffolk ram on the Columbia-Hampshire crossbred ewe had a productivity value of 133 lb/ewe and the Suffolk ram on the Hampshire-Columbia crossbred ewe had a productivity value of 144 lb/ewe – a considerable difference.

**ED. NOTE**

Basically the table points out the fact that if we use good mother breeds and good sire breeds, in the proper place, we are going to increase productivity; but if we reverse the procedure, we are going to shaft ourselves – end comment.

**SUMMARY**

Out of these trials we have derived the following ABC's of crossbreeding:

1. Crossbreeding, by definition, is designed to increase the productivity of an operation by marketing a greater quantity of product at the least cost – more lambs marketed on less feed.

2. The hybrid vigour, which is characteristic of the crossbred, results in a boost in the: vitality, survival, reproductive capacity, growth, disease tolerance or resistance to environmental stress, and hence an increase in the productivity (production, growth and feed efficiency) of the animals involved.

3. We must not lose sight of the fact that the quality of the individuals utilized in the production of the hybrid is every bit as important as the choice of breeds which are combined. The quality of the sires and the quality of the dams are as important as the breeds which you use.

4. The key to increased productivity is the use of hybrid females. When you make a single cross between two pure breeds, you have produced a hybrid animal. But you haven't reaped the full benefit of hybrid vigour because the lambs are being suckled by a purebred dam, which can't provide the beneficial maternal environment to the same extent as the hybrid female.

5. The recommended procedures would be the criss-cross or continuous mating system to generate a continued succession of crossbred dams and to purchase superior, tested sires of the appropriate breeds. Criss-crossing, the rotational continuous systems, or the three way repeatable systems are good to use because they utilize the hybrid female and selected purebred sires.

6. It is certainly important, in my opinion, to have a plan. That is, you establish by experience, or by trial-and-error, the system you wish to use and stay with. If you depart from it, you increase greatly the possibility of confusion, and mongrelization. Your system is then no longer a planned, orderly, and organized enough to capitalize on this hybrid effect. It is just a mongrelization, a mixing of males and female sheep, and you are lost, as far as production improvement is concerned.

7. And, finally, crossbreeding should never be considered as a substitute for poor management or poor feeding. Crossbreeding is complementary to good feeding and good management and acts as a tool for improving flock productivity. Without good management, proper feeding, disease control and a good breeding stock, you don't get anything out of hybrid

vigour or out of crossbreeding! It is simply an additional technique to be used alongside a system of proper management and feeding.

Adapted from an article by:

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