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Crossbreeding Considerations in Sheep

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Crossbreeding is the mating of individuals from different breeds. To a certain extent, it is a simple concept, but embarking upon a crossbreeding program, in sheep or any other livestock species, involves long-term decisions.

The primary benefits of a crossbreeding program are **heterosis** and **breed complementarity**.

Heterosis

Heterosis, or hybrid vigor, refers to the increased vitality or "doing ability" of the crossbreds as compared to the average of the parental breeds. The only way to get heterosis is through crossbreeding.

Heterosis is expressed by the crossbred lamb (individual) and by the crossbred ewe (maternal). Crossbred lambs, on the average, are more vigorous and have a higher survivability than purebred lambs. They may also have a faster preweaning growth rate. The F_1 (first cross) crossbred ewe exceeds the straightbred ewe in many traits, especially those related to reproductive fitness and longevity.

Do all traits respond to crossbreeding? Traits that are lowly heritable (reproductive traits, traits influencing resistance to stress, survivability and longevity) are the ones that respond the most to crossbreeding (that is, have the greatest amounts of heterosis). These are traits that are difficult or slow to improve through selection. In general, as heritability increases, the amount of heterosis decreases. Carcass traits, for example, are highly heritable. Selection results in fairly quick genetic improvement for carcass traits, but crossbreeding has little to no effect. Crossbreeding is often used to improve performance of low heritability traits. Average heterosis effects for various traits are shown in Table 1.

The effect of heterosis may seem minor when only one trait is considered. However, when total productivity (for example, lamb survivability and growth rate) is considered, heterotic effects accumulate to provide a rather substantial improvement over straightbred sheep. Also, mating F_1 ewes to a ram of a third breed to produce crossbred offspring can maximize heterosis.

Table 1. Potential heterosis effects in sheep

Crossbred Lamb (Individual)		Crossbred Ewe (Maternal)	
Trait	**Heterosis (%)**	**Trait**	**Heterosis (%)**
Birth weight	3.2	Fertility	8.7
Weaning weight	5.0	Prolificacy	3.2
Preweaning ADG	5.3	Body weight	5.0
Postweaning ADG	6.6	Fleece weight	5.0
Yearling weight	5.2	Lamb birth weight	5.1
Survival to weaning	9.8	Lamb weaning weight	6.3
Carcass traits	≈ 0	Lamb survival to weaning	2.7
		Lambs born/ewe exposed	11.5
		Lambs reared/ewe exposed	14.7
		Weight of lamb weaned/ewe exposed	18.0

Source: Sheep Production Handbook, American Sheep Industry Assoc., Inc., 2002 ed., vol 7.

Breed Complementarity

No one breed of sheep is best for all traits. So, the second primary benefit of a crossbreeding program is the advantageous use of breed complementarity. **Complementarity** refers to the *combining of desirable traits from two or more breeds into one animal.* The idea is that the strengths of one breed will make

up for the weaknesses of another breed. For example, the Hampshire is known as a heavy mature-weight breed that produces fast-growing lambs with desirable carcass characteristics. However, Hampshires are not especially noted for prolificacy or mothering ability. Because of this lack, the Hampshire is referred to as a specialized "sire" or "ram" breed. The Polypay is known primarily as a specialized "dam" or "ewe" breed because of its prolificacy, milk production and overall mothering ability. They are not as well known for rapid growth rate, muscling or carcass quality. So, if a Hampshire ram is mated to Polypay ewes, the offspring benefit from the maternal environment provided by the ewe breed and can be expected to grow faster and have more desirable carcasses as a result of the ram breed's contribution. Because the Polypay is a more prolific breed than the Hampshire, the producer can also expect to wean more lambs than would be weaned from straightbred Hampshire sheep.

The efficiency of mating Hampshire rams to Polypay ewes would be much greater than the reciprocal mating of Polypay rams to Hampshire ewes. Although the resulting offspring are genetically the same (half Hampshire and half Polypay), fewer lambs would be expected and production costs would likely be increased due to higher feed requirements of the heavier Hampshire ewes as compared with Polypay ewes.

Instead of Hampshire rams, Southdown or Suffolk rams could be bred to the Polypay ewes. Like the Hampshire, these breeds are considered to be ram breeds. Or, Hampshire rams might be used on White Dorper ewes. On the ram side, this takes advantage of the traits described previously. Work at the University of Kentucky has shown that the White Dorper, although not generally thought of as a ewe breed, has enough maternal ability to be used on the dam side and has the advantage of not having to be sheared. Classification of some common breeds is shown in Table 2.

In general, specialized ram breeds are characterized by rapid growth, muscularity and carcass quality. Most ram breeds are blackfaced. Maternal (ewe) breeds tend to have high fertility, high milk production, longevity and good mothering ability. Most ewe breeds are whitefaced. Some breeds are classified as general purpose because they possess traits that make them equally suitable as either a ram breed or a ewe breed. General purpose breeds provide a balance between meat and wool, are adaptable to a range of environmental conditions and are the best choice for small flocks where crossbreeding programs are not feasible.

Table 2. Classification of some common sheep breeds

Specialized Sire (Ram) Breeds	Specialized Dam (Ewe) Breeds	General Purpose Breeds
Cheviot	Border Leicester	Cheviot
Dorper/White Dorper	Columbia	Columbia
Hampshire	Corriedale	Corriedale
Oxford	Finn	Dorset
Shropshire	Katahdin	Montadale
Southdown	Merino	Polypay
Suffolk	Polypay	Texel
Texel	Rambouillet	
	Romanov	
	Romney	
	Targhee	

To maximize the benefits of breed complementarity, breeds must be chosen wisely. A rule of thumb noted by various authors about other livestock species is, "If you aren't happy with the performance of the straightbreds then you probably won't like the crossbreds either." Almost all sheep producers will choose to include the breed of ewes currently in their flock, simply by default. The key is to find the breeds that complement each other in a production system.

Crossbreeding Systems

What crossbreeding system works best? Answering this question involves balancing complexity and flock size with the ability to maintain heterosis. There are two types of crossbreeding systems that are feasible for most commercial sheep producers: **terminal** (two- and three-breed) and **rotational** (criss-cross and three-breed). Terminal cross systems are widely used to maximize production of market lambs. Rotational systems use rams of two or three breeds in alternating generations. Heterosis increases with the number of ram breeds used, but management is more complicated because ewes must be separated into different flocks during the breeding season. The primary advantage of rotational systems is that, unlike terminal systems, they generate replacement ewes.

Two-Breed Terminal Cross

In the two-breed terminal cross system (Figure 1), rams of one breed are mated to ewes of a second breed, resulting in crossbred lambs. This system allows flexibility in establishing selection goals, takes maximum advantage of breed complementarity and yields 100 percent of the potential heterosis in the crossbred offspring. The method is relatively simple because it involves one breed of ewes and one breed of rams. Only one breeding flock is necessary. However, the two-breed terminal cross is not a self-perpetuating system. All crossbred lambs are marketed (hence, the name, "terminal cross"). Therefore, it requires input of straightbred ewes into the

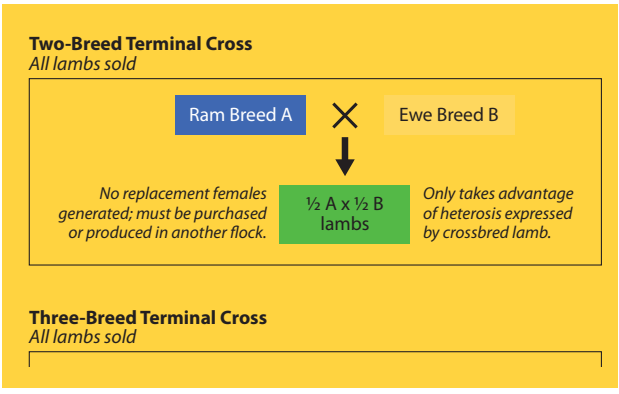

Figure 1. Crossbreeding systems involving two or three breeds in terminal and rotational systems

system at some point. Replacement ewes must either be purchased, or a portion of the original ewes must be bred to rams of that breed to produce replacement ewe lambs.

Three-Breed Terminal Cross

The three-breed terminal cross (Figure 1) mates two-breed cross (F_1) ewes to a ram of a third breed. The resulting offspring are a mix of three different breeds. This system takes advantage of 100 percent of the potential heterosis in the crossbred ewe and 100 percent of the potential heterosis in the crossbred lamb. Like the two-breed terminal cross, the three-breed terminal cross allows flexibility in establishing selection goals and takes maximum advantage of breed complementarity. It also has the same disadvantage in that it is not self-perpetuating. Crossbred replacement ewes have to be purchased or generated in another flock.

Criss-Cross (Two-Breed Rotational Cross)

The criss-cross, or two-breed rotational (Figure 1), is the simplest long-range crossbreeding system. Two breeds are mated and replacement ewes are saved from the crossbred offspring to breed back to one of the parent breeds. This is called a backcross. In each successive generation, replacement ewes are bred to rams of the opposite breed than their sire. Two ewe flocks are necessary, one to mate to each breed of ram. Replacement rams are the only animals that will originate from outside the operation. This system does not require a large flock, uses crossbred ewes and is easily managed. The main disadvantage of the criss-cross system is that it maintains only about 67 percent of the potential heterosis.

Three-Breed Rotational Cross

The three-breed rotational cross (Figure 1) is not too different from the criss-cross except that it requires three breeds and does not include a backcross. It requires three breeding flocks. Replacement rams are the only animals that have to be purchased. The main advantage of the three-breed rotational cross over the criss-cross is that it maintains a higher degree (87%) of the potential heterosis.

In terminal cross systems, specialized ram (meat) and ewe (maternal) breeds work best. Rotational systems necessitate use of general purpose breeds. For most commercial sheep producers, flock size and management considerations limit choice of a crossbreeding system to either a two-breed terminal or a criss-cross.

Summary

What is the bottom line? Commercial sheep producers should take advantage of a crossbreeding program. However, they must plan carefully and have reasonable expectations. Producers should choose the system that best fits their production situation with regard to flock size, potential markets, level of management, facilities and pastures. A long-term plan is necessary to gain maximum benefits from crossbreeding.

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