CROSSBREEDING TO MAXIMIZE HETEROSIS

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Heterosis (hybrid vigor) is the increase in performance over the average of the parents. The amount of heterosis varies by trait and is determined by the amount of relatedness of the parents. For example, if two Suffolk parents are mated we will not see any appreciable heterosis in the offspring because both parents are from the same breed. If a Rambouillet is mated to a Suffolk we will see heterosis in the offspring because the parents are highly unrelated. Likewise we will not see maximum heterosis if a crossbred animal is bred back to a breed of the parents.

So what is the purpose of purebred sheep in a commercial operation? The historical goal of developing breeds in livestock is to develop a genetic line that is related such that the offspring will have desirable traits of the parents or will breed true. For example, all offspring from a Suffolk ram or ewe will be muscular, fast-growing and will have a desirable carcass. All offspring from a Rambouillet parent will have a good quality fleece. Because sheep have been bred to relatives to form these breeds we can then cross one breed with another and expect a high level of heterosis because the parents are unrelated.

Therefore the purpose of crossbreeding is two fold. First of all by crossbreeding we can expect heterosis and secondly the offspring will have traits of both parents. This second point is commonly called breed complimentarity. In the case of breeding a Rambouillet ewe to a Suffolk ram we can expect a high amount of heterosis, a reasonably fast-growing offspring with a reasonably good carcass and reasonably good fleece. The Rambouillet brings fleece quality to the offspring and the Suffolk breed brings growth and carcass traits. While all these three traits may not be a good as the parent because of heterosis the crossbred lamb will be higher in these traits than the average of the parents.

In general traits that respond well to heterosis are traits that are considered to be of low heritability. Heritability is the ability of a trait to be inherited and thus passed on to the offspring. With traits that are highly heritable we can place selection pressure on the trait and make significant progress in improving the performance of the flock in that trait. Traits that are of low heritability do not respond well to selection and thus improvement in a flock is difficult. These traits however respond well to crossbreed and thus we can improve a flock greatly in one generation by cross-breeding.

There are a number of different breeding plans to maximize heterosis, breed complementarity and ultimately the performance of the flock. The most basic is a simple two breed terminal cross. In this situation purebred ewes are mated to purebred rams and produce cross-bred offspring that are raised for slaughter. The offspring are often referred to as F1 or first generation cross. F1 offspring have maximum heterosis and if the breeds are chosen fit the environmental conditions the flock will be very profitable. In this case the offspring are terminal, e.g. they are sold to market and replacement ewes need to be purchased.

In another crossbreeding system a producer may choose to run F1 ewes to maximize heterosis in the dam for traits such as survivability, milk production. In this situation ewes are bred to rams of another unrelated breed and the resulting F2 offspring are the end product. An example of this would be Dorset X Finn ewes bred to a Hampshire or Suffolk ram. Again in this situation all offspring would be sold to market.

Because of the cost of purchasing replacements many producers choose to do a rotational cross where replacements are retained. In a two-breed rotational cross the F1 offspring are bred back two one of the two breeds to produce a 1/4-3/4 crossbred lamb (F2 generation). However by breeding these F1 offspring back to one of the original breeds of their parents we loose heterosis in the F2 (1/4-3/4) crossbred lamb and our uniformity of lambs decrease.

To maximize heterosis in a rotational breeding plan and maintain uniformity in offspring some producers will use a 3-way rotational cross. In this case the F1 offspring are bred to a third breed and the F2 can then be breed back to one of the original breeds. While heterosis is not as high as in a terminal cross the resulting lambs have the maximum heterosis that can be achieved in a rotational breeding plan. The only flock additions are purebred rams and replacements come from within the flock. The other disadvantage is that at least three breeding pastures need to be maintained with at least one ram from each of the breeds. Therefore for a 3-way rotational cross to be a viable option the flock size needs to be larger (greater than 200 head).

In summary a cross-bred breeding program should be designed to maximize heterosis and breeds that are chosen should fit the environment and be complimentary. Start with the desired end product (market lamb) and work back to determine what breeds work well in your situation, which breeds will work better as rams and which will work better as ewes. For example if you choose a two breed terminal cross with Rambouillet and Suffolk it is more logical to have Rambouillet ewes bred to Suffolk rams than the other way around. Maximizing heterosis should always be a priority in commercial sheep production.