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Applying Principles of Crossbreeding

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One of the most powerful tools available to cattle producers to improve the efficiency of production in a herd is the use of crossbreeding. Effective use of a crossbreeding system allows producers to take advantage of heterosis (hybrid vigor), complementarity and breed differences to match cattle to available feed resources and to predominant market preferences.

Failure to adequately think through a crossbreeding program can be potentially devastating. It could result in nothing more than a mongrel herd, which lacks both uniformity and the ability to produce under a given set of available resources.

Heterosis

Heterosis, or "hybrid vigor," is defined as the superior performance of an offspring over the average of the parent breeds. This can have a marked effect on the profitability of a cattle operation. Heterosis is greatest when crossing two parent animals of totally unrelated ancestry. Hybrid vigor can be exhibited through a variety of traits such as increased survivability and growth of crossbred calves or higher reproduction rates of crossbred cows. The main reason a producer enters into a crossbreeding system should be to optimize cattle performance and quality. The amount of heterosis that is maintained in a herd depends on the type of crossbreeding system the producer selects.

Breed Differences and Complementarity

Generally speaking, the amount of variability between breeds for most traits is comparable to the amount of variability one would expect to find between individuals within a breed. All breeds manifest superiority in some of the economically important traits, but no breed can boast excellence in all traits.

A crossbreeding program should be designed to capitalize on those traits which each of the parent breeds bring to the mix. This is known as complementarity, or a cross which combines the strengths of different breeds.

Complementarity helps match the genetic potential for economically important traits such as growth rate and carcass composition with climate, feed resources and market preferences. Simply put, breed complementarity means that the strengths of one breed can complement or mask the weaknesses of another breed.

In practical terms, a producer looking to utilize complementarity would choose a bull breed that would pass on rapid growth and desirable carcass traits to breed to his crossbred cows that would provide adequate milk for the rapidly growing calf and produce a live, healthy calf each year.

In poorly conceived crossbreeding programs, complementarity could have negative effects on productivity. For example, if a large, terminal sire breed was bred to small, immature or "hard-calving" cows, the result could be an increase in dystocia problems.

Cattle breeds can be separated into different biological types, with each type exhibiting differing levels of production for various production characteristics. Table 1 lists some breeds grouped by biological type.

One extreme crossbreeding example which demonstrates breed differences and complementarity is a scheme which was popular in some areas of the country in the 1970's. A Jersey bull would be crossed onto Angus cows to produce medium frame, high milking F_1 females. These were then crossed with Charolais bulls to produce terminal calves. The Jersey provided the genes for milk production and marbling ability; the Angus, the genes for carcass quality; and the Charolais, the genes for superior growth.

Crossbreeding Systems

Crossbreeding systems use heterosis, breed differences and complementarity with varying degrees of success. Table 2 contains data on how effective various crossbreeding systems are in using these three mechanisms to increase productivity and the estimated increase in weaning weight one might expect.

Table 1. Cattle breeds grouped by biological type.[a]

Breed	Milk Production	Growth Rate and Mature Size	Percentage Retail Product	Age at Puberty
Jersey	*****	*	*	*
Herford	***	**	*	***
Angus	***	**	*	**
Brahman	***	***	***	*****
Tarentaise	****	***	****	**
Simmental	****	*****	*****	**
Gelbvich	****	****	****	*
Main Anjou	**	*****	****	**
Limousin	*	***	*****	****
Charolais	**	*****	*****	****
Chiania	**	*****	*****	****

[a]Increasing number of *'s indicates greater value for a particular trait. For example, ***** = greatest milk production or oldest age at puberty and ** = below average percentage of retail product. From Gosey.

Table 2. Expected levels of heteorsis, use of breed effect and complementarity for various crossbreeding options.

Mating Scheme	% of Maximum Heterosis*	Breed Effects	Complementarity	Estimated Increase in Calf Wt. Weaned per Cow Exposed
Terminal sire x F_1 females	100	★	★★★★	23-28
Two-breed rotation	67	★★	0	16
Three-breed rotation	86	★★	0	20
Two-breed rotation with Terminal sire	90	★★	★★★	21
Two breed composite	50	★★★	★★	12
Three-breed composite	63	★★★	★★	15
Four-breed composite	75	★★★	★★	18

* Relative to F_1 @ 100%.

Rotational Crossing Systems

In a two-breed rotation, cows sired by breed A are always bred to bulls of breed B, and cows sired by breed B are always mated with bulls of breed A (Figure 1). In a three-breed rotation, a third breed (breed C) is added to the rotation (Figure 2).

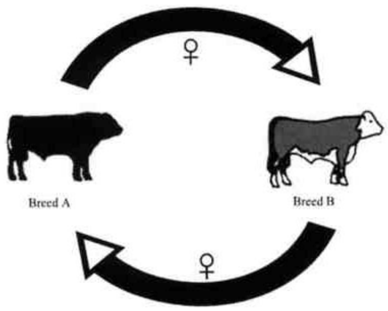

Figure 1. Two-Breed Rotation.

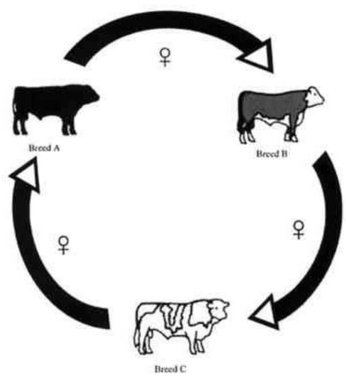

Figure 2. Three-Breed Rotation.

Heterosis remains high in rotational crossing systems. However, large variation can occur between generations, especially if the breeds used differ greatly. This variation can be reduced by selecting breeds that are similar in body size and milking ability for the cross. Another rotational cross that adds a little twist and slightly greater performance is the two-breed rotation crossed to a terminal sire breed.

In this system, shown in Figure 3, the first- and second-calf heifers are retained in the two-breed rotation and all the mature cows or those not meeting the selection criteria to remain as replacements are bred to a third ‘terminal’ breed sire. All offspring from this cross must be marketed and none will remain in the herd for replacements. This system retains as high a percentage of heterosis as any of the rotations while taking advantage of complementarity.

Rotational crossing systems can be quite effective, however, they are not without their problems. One disadvantage of rotational systems is that multiple breeding pastures are required or the producer must get the cows bred via artificial insemination. Additionally,

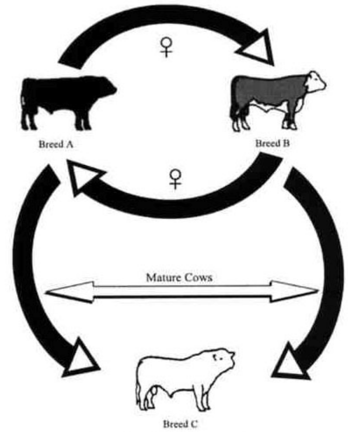

Figure 3. Two-Breed Rotation with mature cows bred to a terminal bull.

in the case of the three-breed rotation, replacement females must be identified as to the breed of their sire so they can be mated with the breed to which they are most distantly related. Finally, the rotational crossing systems allow for little, if any, use of complementarity.

One rotational system which solves *some* of the problems associated with rotations would be to rotate *sire breeds* every four years. In this system all cows are mated to bulls from breed A the first four years. The sire breed is changed to breed B for the next four years, and finally to breed C for the final four years. This system approximates the three-breed rotation as far as performance is concerned, but eliminates the need for keeping sire records on cows, or for having multiple breeding pastures.

Composite Populations

Composite populations are formed by mating similar animals which come from crosses of two or more breeds. An example of developing a four-breed composite is seen in Figure 4. The development phase of

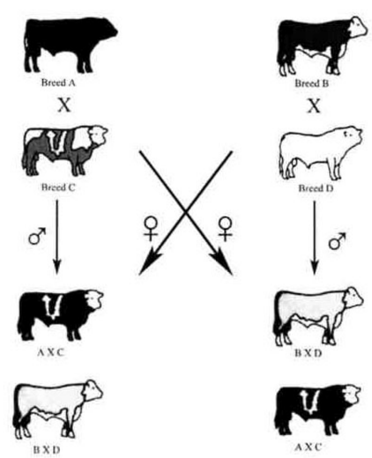

Figure 4. Four-Breed Composite Population Development 1/4A, 1/4B, 1/4C, 1/4D.

this crossing scheme is quite complex. However, following development the herd can be managed as a straight-bred herd. Composite populations can maintain a relatively high amount of heterosis, providing there is an adequate number of sires used in each generation to avoid inbreeding. It should also be noted that as the number of foundation breeds used to develop the composite population increases, the amount of heterosis retained in the population also increases.

Additionally, you will note that composite populations also make effective use of additive breed effects and complementarity in addition to heterosis to achieve increased productivity.

The main disadvantage is that this option does not work well many times for small producers (smaller than 500 head), in that replacements from within the herd are difficult to obtain without risking inbreeding. Furthermore, it is also often hard to find replacements outside the herd since all animals within the herd come from specific crosses.

Many variations of the examples above can be designed if a producer wishes to put in the time and effort necessary to make them work.

Summary

Crossbreeding can be a powerful tool to improve the productivity and profitability of a beef cattle operation when it is used correctly. Conversely, it can reduce profitability if it is not thought through fully before implementation.

Regardless of what type of crossbreeding system is decided upon, the producer must plan ahead for several generations, and not just for a few years. Initial decisions made at the outset of a program will impact the operation for many years to come.

No single crossbreeding system should be expected to fit every commercial cattle operation. When embarking on a crossbreeding program, each of the following facets must be either resolved, or at least thoroughly considered, for the program to be implemented successfully:

- Number of breeding pastures needed.
- How replacement heifers will be obtained.
- Optimum herd size.
- Biological type and source of breeds to be used.
- Source of bulls.
- Feed resources required.
- Availability of labor.
- Potential use of artificial insemination.

Perhaps the most important question that must be answered following careful consideration of the above, is whether or not the new system will fit the resources available to the operator. If all of these can be resolved, the producer can move forward with confidence toward optimal production and profitability.

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