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Crossbreeding Systems for Beef Cattle

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It has been well documented that crossbreeding improves the performance of beef cattle. Virtually all commercial beef cattle producers utilize some form of crossbreeding in their herds. Like any other management technique, crossbreeding must be done properly for the full benefits to be realized.

BENEFITS OF CROSSBREEDING

Crossbreeding offers two primary advantages: heterosis (also called hybrid vigor) and the opportunity for breed complementarity. When the performance of crossbred offspring exceeds the performance of the purebred parents, the difference is called heterosis. In other words, the whole can be greater than the sum of the parts. For instance, if straightbred Hereford and Angus calves average 500 pounds at weaning and Hereford x Angus calves average 525 pounds, the heterosis realized is (525-500)/500, or 5 percent.

Maximizing Heterosis

Realization of heterosis is the closest thing to a free lunch that can be found in the cattle business. Thus, all commercial beef cattle producers should seek to maximize heterosis in their herds. Some crossbreeding systems offer a greater degree of heterosis than others, and some traits respond more to crossbreeding than others. Heterosis is realized in inverse proportion to heritability for a given trait. In other words, lowly heritable traits offer the most heterosis, highly heritable traits the least. Table 1 lists beef cattle traits of economic importance and their heritability estimates. In general, reproductive traits are lowly heritable, growth traits are moderate and carcass traits are highly heritable. Thus, differences in reproductive performance between herds are virtually all due to environment and management, while differences in growth or carcass traits are due primarily to genetics. Also, reproductive traits will respond the most to crossbreeding, carcass traits the least.

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The more diverse the parent breeds are, the greater the heterosis will be. The best example of this is mixing of *Bos taurus* and *Bos indicus* (such as Brahman) breeds. Since these breeds actually represent different species, their great diversity will result in tremendous heterosis. Conversely, crossing of Hereford x Polled Hereford or Angus x Red Angus will result in less heterosis than crosses such as Hereford x Charolais or Angus x Simmental. Within breeds, if the cattle selected are somewhat inbred, heterosis will be greatest.

Breed Complementarity

No breed of cattle is perfect (although a few advertisements suggest otherwise); thus crossbreeding allows the opportunity to mix breeds to create a breed mix that is more ideal than any of the parent breeds would have been. Table 2 characterizes the most common breeds. Ideally, a crossbreeding plan would mix breeds that complement each other; that is, the strong points of one breed may offset the weaker characteristics of another, resulting in more complete, problem-free cattle.

CROSSBREEDING WITH A PURPOSE

Crossbreeding must be planned. Simply mixing breeds at random will not produce the benefits that a well organized, thoughtful crossbreeding system can provide. Producers must avoid "mongrelization" of their cowherds. Uniformity of the cowherd is an often unappreciated trait. If a cowherd varies greatly in size and nutrient requirements, feed will be wasted, since the cowherd will be fed to meet the needs of animals with the greatest requirements. Otherwise, the nutritional needs of many cows will not be met.

Before designing a crossbreeding system, the production environment and goals (collectively called the production scenario) must be described. When the scenario is considered, high- and low-priority traits can be listed. For instance, a producer who has an abundant feed supply and intends to sell his calves at weaning every year will consider milk production a very high priority. On the other hand, if a producer will feed the calves to slaughter, lower milk production and the opportunity to take advantage of compensatory gain after the calves are weaned might be a better choice.

Furthermore, if labor is abundant, pulling a few calves might be only a minor nuisance and calving ease would be only a moderate priority (it is the author's view that calving ease is never a low priority; it is either moderate or high). If, however, the cows will be observed only occasionally while calving, calving ease (unassisted births) could be the highest priority. When choosing priorities, a balance of traits is usually best. Remember that as the number of traits considered for selection increases, the amount of progress made in each trait will decrease. In other words, little progress will be made by a breeder who tries to select for everything at once.

CROSSBREEDING SYSTEMS

The most commonly utilized crossbreeding systems include:

1. Two-Breed Cross
2. Two-Breed Rotational Cross
3. Three-Breed Rotational Cross
4. Static Terminal Sire
5. Rotational Terminal Sire

Table 1. Heritability estimates of beef cattle traits.

Trait	Percentage heritable
Low Heritability	
Conception rate	0-10
Calving interval	0-10
Moderate Heritability	
Milking ability	15-25
Calving ease	10-40
Gestation length	30-40
Cancer eye susceptibility	25-30
Birth weight	35-40
Weaning weight	25-30
Weaning conformation score	20-25
Postweaning daily gain—pasture	30-35
Postweaning feed conversion	35-40
Slaughter conformation score	35-40
Dressing percentage	35-40
Percentage retail product	25-30
Moderate to High Heritability	
Scrotal circumference	40-55
Postweaning daily gain	40-45
Postweaning daily feed consumption	50-55
Final feedlot weight	50-55
Yearling weight	50-55
Ribeye area	60-65
Fat thickness	40-55
Marbling score	40-45
Tenderness score	50-60

These systems are listed in order from least to most demanding in terms of facilities and labor. The same ranking applies to the realized benefits; the two-breed cross is the easiest to manage but results in the least heterosis and little opportunity for breed complementarity. Use of artificial insemination (A.I.) or multiple breeding pastures is required for use of complex systems. Following is a brief description of each system:

Two-Breed Cross. Use of a two-breed cross involves maintaining straightbred cows of a single breed and mating all females to a bull of another breed. This is a simple system that requires only one breeding pasture, but realizes less than half of the possible heterosis. Use of a two-breed cross allows realization of direct heterosis (advantages of a crossbred calf), but not maternal heterosis (advantages of a crossbred cow). All other systems result in both direct and maternal heterosis. A further drawback is that straightbred females must be purchased as replacements to continue the breeding program. A possible use of this system is for generation of F1 (purebred x purebred) replacements for sale to producers who are using more complex systems. This would be a means for owners of small cowherds to "add value" to their cattle.

Two-Breed Rotational Cross. In this system, bulls of two breeds are used. Females sired by a bull of a particular breed are mated to a bull of the other breed. Thus, after several generations, approximately two-thirds of the genetics of each calf result from breed it was sired by, one-third from the other breed. The two breeds will be equally represented within the cowherd if the number of each breed culled each year is equal. If natural service is used, this system requires at least two breeding pastures and requires that both breeds used be approximately equal in terms of size, nutritional requirements and maternal potential.

Three-Breed Rotational Cross. Nearly all of the possible heterosis is realized with proper management of a three-breed rotational crossbreeding system. This system is similar to the two-breed rotational cross except that three breeds are used. As in the two-breed rotational cross, females are mated to a bull of the breed that is least related to them (the sire breed of their maternal grandam). Benefits include a high degree of heterosis and potential for outstanding breed complementarity. However, this system is more difficult to maintain than the two previously described and at least three breeding pastures are required if A.I. is not used. In herds of less than 100 cows, the cost to maintain adequate bull power in each of three breeds may be prohibitive. Furthermore, inclusion of three breeds may make it difficult to maintain a uniform cowherd.

Static Terminal Cross. In this system the cowherd consists entirely of F1 females that are mated to bulls of a third, terminal sire breed. All calves are marketed. Only one breeding pasture is required and heterosis and breed complementarity can be nearly maximized.

However, F1 replacement females must be purchased. Locating a steady supply of economical, high-quality replacements can be difficult in most areas.

Rotational Terminal Sire. This system, which is used in many swine herds, is similar to the static terminal sire system except that a portion of the herd (typically 20 to 30 percent) is designated for production of replacement females. These females are maintained separately from the rest of the herd and mated to bulls of a maternal breed, possibly in a two-breed rotational system. The majority of the cows in the herd are mated to a terminal sire and all calves marketed. This can be a demanding system to maintain but will produce excellent results.

A more feasible variant may be to mate all heifers to maternal breed bulls and keep replacements from them while the mature cowherd produces only terminal-sired calves. The logic behind this is that heifers should be managed separately from mature cows anyway and that most (but by no means all) maternal breed bulls are easier calving than terminal breed bulls. This may make A.I. of heifers to high-quality maternal bulls a practical way to upgrade the maternal performance of the herd over time.

MATCHING SYSTEMS WITH SITUATIONS

Obviously, no single crossbreeding system is ideal for all situations. Following are examples of common situations and the systems that may be appropriate for them.

Situation

Small herd size (under 50 cows); natural service; one breeding pasture; limited labor; limited capital:

System

1. Raise straightbreds.
2. Rotate bull breed every 3 to 4 years.
3. Composite breed (if and when available).
4. Terminal sire x purchased F1 females.

Situation

Herd of 50 cows; natural service; at least two breeding pastures; limited labor and capital:

System

1. Rotate bull breed every 3 to 4 years.
2. If F1 females are available economically, purchase them and mate to terminal sire.
3. Composite breed (if and when available).
4. Two-breed rotation may be feasible.

Situation

Herd of 75 to 100 cows; natural service; at least three breeding pastures; adequate labor and capital:

System

1. Terminal sire x F1 females (if available).
2. Three-breed rotation.

Situation

Over 100 cows; natural service; at least three breeding pastures; adequate labor and capital:

System

1. Three-breed rotation.
2. Rotational-terminal sire system.

Situation

Under 50 cows; one breeding pasture; A.I. service; adequate facilities, labor and capital:

System

1. Two-breed rotation.
2. Three-breed rotation is feasible.

Situation

Between 50 and 100 cows; one breeding pasture; A.I. service; adequate facilities, labor and capital:

System

1. Two-breed rotation.
2. Three-breed rotation.

COMPOSITE BREEDS

Since managing heterosis can be difficult, some breeders have developed composite breeds such as Barzona, Santa Gertrudis, etc. A composite breed results from a planned mix of purebreds that has been conducted in a manner such that a consistent population is produced. Individuals of the composite breed can be mated to each other with successive generations retaining the same percentage of the original breeds. The advantages of composite breeds include ease of management, consistently high heterosis and the possibility that a particular composite breed may be ideal in an environment for which it was specifically developed. On the other hand, some would argue that the heterosis is diminished after several generations. Also, few sources of breeding stock exist for any new composite breeds that are developed. Most composite breeds developed to date were designed for stressful environments such as desert. Currently scientists at universities and at the USDA research center in Clay Center, Nebraska, as well as individual breeders, are attempting to develop composite breeds for other environments.

SUMMARY

Crossbreeding is one of the most effective low-input, high-output management practices that a beef cattle producer can adopt. There is little justification for straightbred commercial cattle. Effective crossbreeding is more than simply purchasing a bull of a different breed than the last one that was used, however. Crossbreeding systems with varying degrees of complexity offer benefits in proportion to the increased management that they require.

Table 2. Characterization of breeds based on their biological type[a]

Very high lean, low marbling, low milk, late puberty

Charolais—very high growth
Chianina—very high growth
Limousin—moderate growth

High lean, moderate marbling, high milk, moderate puberty

Simmental—very high growth
Maine Anjou—very high growth
Gelbvieh—very high growth
Brown Swiss—high growth

Moderate lean, moderate marbling, high milk, early puberty

South Devon—moderate growth
Tarentaise—moderate growth
Pinzgauer—moderate growth

Moderate lean, low marbling, high milk, very late puberty, heat tolerant

Brahman—high growth
Sahiwal—low growth

Low lean, high marbling, moderate milk, moderate puberty

Angus—moderate growth
Hereford—moderate growth
Red Poll—low growth
Devon—low growth

Very high milk, high marbling, early puberty

Holstein—moderate lean, high growth
Jersey—low lean, low growth

[a] *Adapted from Cundiff, et al. (1988).*

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