



Crossbreeding Beef Cattle

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Commercial beef breeders have two breeding program alternatives for their cow-calf operation — straight breeding and crossbreeding. Straight breeding is by far the simpler alternative. It requires much less management expertise and facilitates marketing since the resulting product will be relatively uniform.

Crossbreeding, on the other hand, requires more managerial ability. That requirement varies depending on the complexity of the crossing program. Usually crossbred cattle, at least after the first generation, are less uniform.

However, the benefits from hybrid vigor or heterosis should be extensive. Hybrid vigor is the superiority of the crossbred progeny compared to the average of the two straight breeds that produced them.

Hybrid vigor — or heterosis — is the boost in productivity that results from crossing two unrelated breeds of cattle. The more UNRELATED the breeds, the greater the effect of hybrid vigor — so it may be good to choose breeds with wide genetic variation.

Breeds of beef cattle are crossed primarily to take advantage of heterosis in some traits economically important in commercial beef production. Crossbreeding is an attempt to combine breeds to use the strong traits, breed strengths or traits each breed excels in and produce an over-all better-performing animal than the straightbreds of either breed. Crossbreeding is also used in an attempt to combine desirable characteristics of established breeds into new breeds. A perhaps less common use of crossbreeding is as a method of changing from one breed to another in commercial herds.

Usually, crossbred animals have better survival rates than straightbreds. The heterosis (hybrid vigor) expresses itself from conception through maturity. Heterosis is greater in those traits that have to do with reproduction and adaptability in early life than in traits of higher heritability such as growth rate and carcass merit. The most important traits a cow can contribute to production efficiency in a herd are fertility, ease of calving, milk production, growth rate, and disposition. Crossbred females reach puberty earlier, conceive earlier in the breeding season, and wean a higher percentage calf crop of heavier calves.

SELECTION TRAITS

Many production traits are sufficiently high in heritability to provide a sound basis for selection. Heritability estimates may be defined as the proportion of the total phenotypic variation that is due to heredity. Weaning weight heritability estimates are approximately 30 percent, meaning 30 percent of the variation in a group of individuals is due to genetics and the remaining 70 percent to the environment in which they were raised.

HERITABILITIES OF VARIOUS TRAITS IN BEEF CATTLE

TRAIT	HERITABILITY (percent)
Calving Interval	10
Birth Weight	40
Weaning Weight	30
Cow Maternal Ability	40
Feedlot Gain	45
Pasture Gain	30
Efficiency of Gain	40
Final Feedlot Weight	60
Conformation Score:	
Weaning	25
Slaughter	40
Carcass Traits:	
Carcass Grade	30
Rib Eye Area	70
Tenderness	60

THE DEGREE OF HERITABILITY DETERMINES THE RESPONSE TO SELECTION

High heritability traits respond strongly while medium heritability traits respond well to selection. Low heritability traits respond poorly to selection but are improved dramatically through crossbreeding.

Differences in performance among individuals or groups of animals are due to genetic and environmental causes. The observed or measured performance of each animal for each trait is the result of its heredity and the total environment in which it is produced. Genetically superior individuals can be more readily identified when the animals are maintained under the same management systems and their performance records are adjusted for known environmental differences. There are also many random or chance environmental variables which contribute to errors in estimating the breeding value of animals.

Crossbreeding is not necessarily for every beef cattle producer. Each breeder-producer will determine his own breeding scheme, be it straightbred or crossbred. Crossbreeding has definite advantages and disadvantages. Crossbreeding produces some desirable consequences, such as the opportunity to incorporate desirable genetic material quickly and the chance to combine desirable traits from different genetic sources into market animals.

WHAT IS HETEROSIS?

Heterosis is said to exist when crossbreds tend to be better for a trait than the average of the two parent breeds. Heterosis or hybrid vigor applies to individual traits. Different traits, such as weaning weight and feedlot gain, may exhibit different degrees of heterosis in a crossbred animal.

Examples of Expressions of Heterosis

Calculations of Heterosis Using a Combination of Traits.

The average percent calf crop (Figure 1) for breed X was 90% and the average for breed Y was 80 percent. The average of the two straight breeds was 85 percent whereas the average percent calf crop was 89 percent for the same two breeds when crossed.

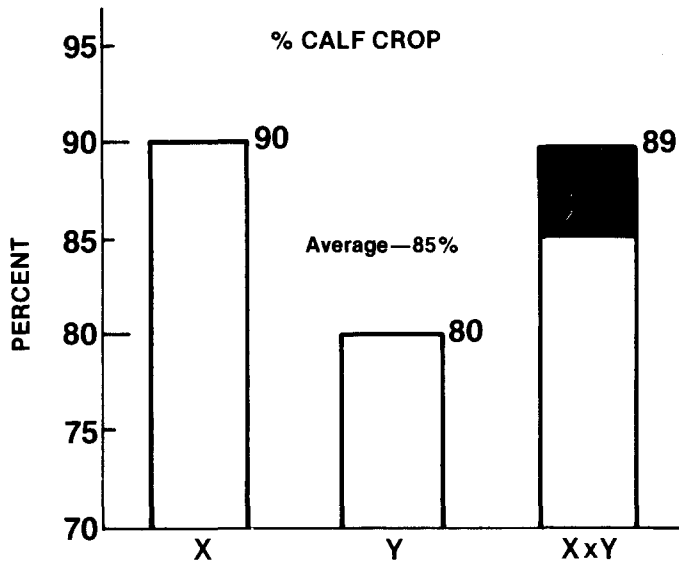


Figure 1.

Figure 2 indicates an average weaning weight of 400 pounds for breed X and 500 pounds for breed Y. The average for the two breeds was 450 pounds as compared to 475 pounds when the same two breeds were crossed.

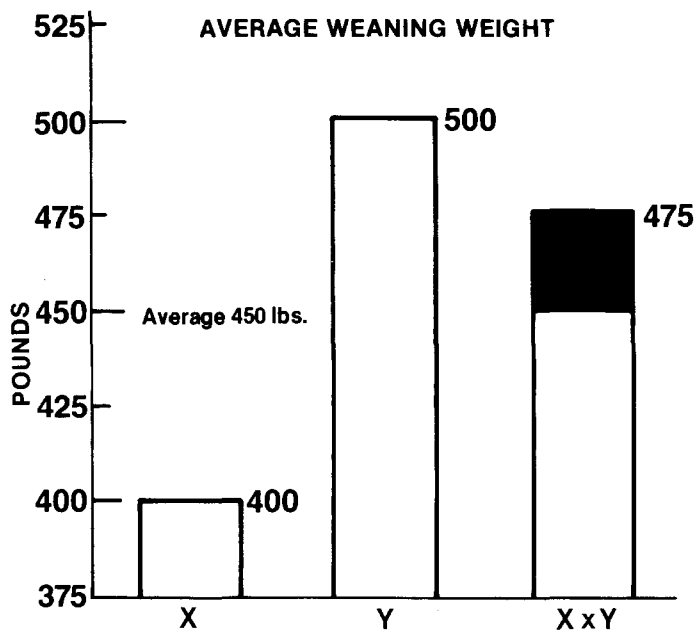


Figure 2.

In Figure 3 the pounds of calf weaned per cow exposed was 360 pounds for breed X and 400 for breed Y. The average for the two breeds was 380 pounds. The average for the two breeds when crossed was 423 pounds.

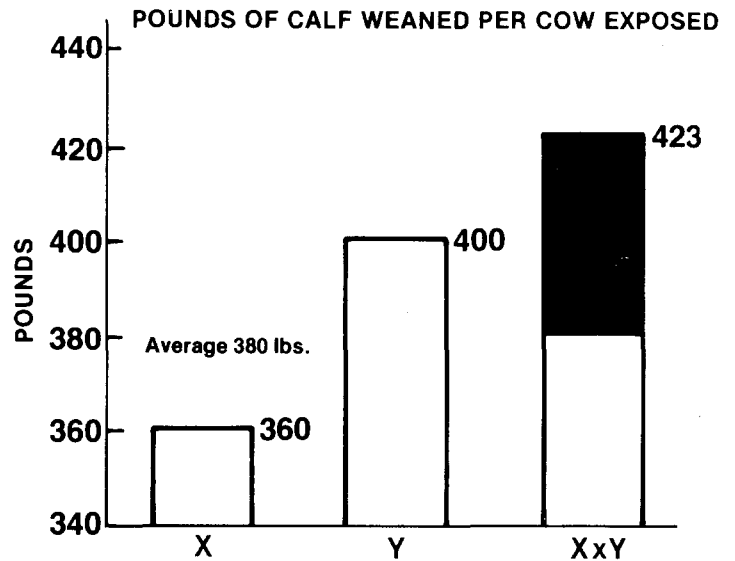


Figure 3.

These three figures do not include actual data, but the data used should be relatively close to what would be expected in additional pounds or percentages when crossbreeding.

IMPORTANT CONSIDERATIONS IN PLANNING CROSSBREEDING PROGRAMS

Substantial effects of heterosis can be used through crossbreeding:

- Results with Hereford, Angus, and Shorthorns indicate that heterosis can increase pounds of calf weaned per cow in the breeding herd 23 percent.

- Crossbreeding programs should involve crossbred cows because more than half of this advantage is dependent on their use.

Crossbreeding can also be used to combine desired characteristics of breeds and synchronize genetic resources with feed and other resources:

- In certain situations, large size breeds with lean carcasses can be mated to cows of small to medium size to increase efficiency of production; that is, to increase amount and value of retail product relative to calf and cow feed costs.

- Advantages of mating sires of large size to cows of medium size are tempered by a high degree of calving difficulty when the cows are calving at two and three years of age.

- To avoid calving difficulty and associated calf crop losses from calf mortality and reduced re-breeding, cows should be mated to bulls of other breeds that are similar in size until they are four years of age or older. In cows calving at four years or older, calving difficulty has not been a serious problem.

- Maternal breeds of which the cow herd is comprised should be well adapted to the climatic-feed environment and production situation.

- Nutrient demands to support growth, maintenance, and lactation of the cow herd need to be stabilized from one year to the next in most situations.

CROSSBREEDING AND THE PUREBRED INDUSTRY

Some breeds may not survive the impact of crossbreeding — others will thrive and expand. Some crossbreeding programs will be built on crossbred dams bred to top-performing purebred sires.

WHAT IS AN F-1?

An F-1 is a “first cross” between two purebreds or two different genetic lines or strains.

WHAT IS AN F-2?

An F-2 is a cross between an F-1 bull and F-1 female with similar breeding.

A backcross is achieved through breeding an F-1 to one of its parent breeds. The need for superior seedstock herds to make permanent genetic improvement in the population and to furnish superior sires for use in commercial herds will always be with the industry.

Crossbreeding programs usually consist of two types: 1) the maintenance of straightbred females that are mated to a purebred sire of a different breed, and 2) the maintenance of crossbred females generation after generation, with matings to purebred sires of different breeds on a rotation basis.

RESEARCH FROM USDA AND UNIVERSITY OF NEBRASKA

British breeds and their crosses reveal an advantage for crossbred calves over straightbred calves when they were out of straightbred cows. The effect of heterosis for percent calves born was negligible, but 3 percent more crossbred calves were born alive than straightbreds. At two weeks of age there were 4 percent more crossbred calves alive than straightbred. This indicates hybrid vigor for the crossbreds for survival during their first two weeks. At weaning there were 3 percent more crossbred calves and they weighed 19 pounds more than straightbreds. The 3 percent more calves at weaning and 19-pound weaning weight advantage gave the crossbred calves an

8.5 percent increase in pounds of calves weaned per cow exposed in the breeding herd.

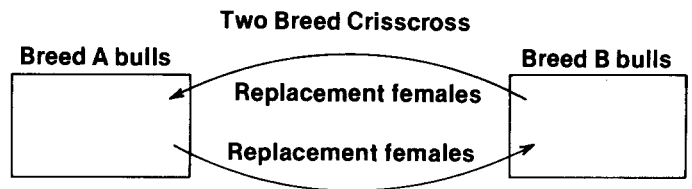
BREED SELECTION

First, choose the breeds that supply the needs of your program. Next, select from within those breeds the cattle that are superior performers. The primary requirement for profitable crossbred cattle is superior breeding stock — either purebreds or crossbreds from performance proven lines. Find the best animals available, with traits you want to improve in your herd. The better the individuals, the better your crossbreds will be.

CROSSBREEDING SYSTEMS USING PUREBRED BULLS

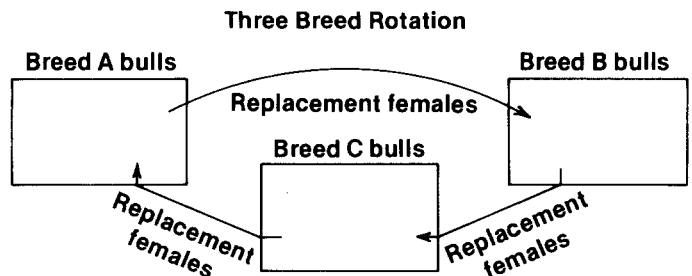
Crisscrossing is a two-breed rotation or systematic backcrossing.

Crossbred females are retained and bred to one of the parental breeds. Daughters are always bred to the breed that sired their dams.



Consider the blocks in the two-breed crisscross diagram as two breeding pastures. Replacement females sired by bulls of Breed A will be mated to bulls of Breed B for their productive life. Replacement females sired by bulls of Breed B will, in turn, be mated for their entire life to bulls of Breed A. Two breeding pastures or artificial insemination are required to make this system work.

Individual and maternal heterosis will stabilize at about 67 percent of the maximum, which is attained in the first cross. This system seems best suited for moderate-size operations. Disadvantages of the system include the sacrifice of some heterosis and it does not provide the possibility for using separate bull and cow breeds in a specialty role.



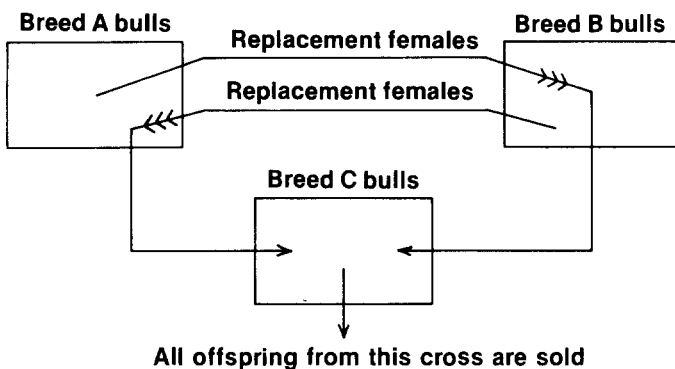
Consider the blocks in three-breed rotation diagram as three breeding pastures, each assigned to bulls representing a different breed. Replacement females sired by bulls of Breed A will be mated to bulls of Breed B; replacement females sired by bulls of Breed B will be mated to bulls of Breed C; replacement females sired by bulls of Breed C will be mated to bulls of Breed A each for their entire life.

Three breeding pastures or artificial insemination will be required to make this system work. It would appear to be practical only in large commercial operations.

Individual and maternal heterosis in this system stabilizes at about 86 percent of maximum, about 20 percent greater than with the two-breed crisscross.

Disadvantages of this system will often be related to the management input required. It does not provide the possibility for using separate bull and cow breeds in a specialty role and adds the challenge of finding three breeds which will complement each other.

Specialized three Breeding Crossing System



Replacement females sired by bulls of Breed A will be mated as one-, two- and three-year olds to bulls of Breed B. Replacement females sired by bulls of Breed B will be mated as yearlings, twos and threes to bulls of Breed A. Replacement females are only kept from these matings. Cows four years old and over will be matched to bulls of Breed C. All offspring from this cross will be used for commercial slaughter purposes.

Management requirements will be similar to that of a three-breed rotation. This system seems most suitable for larger herds.

Maternal heterosis will stabilize at about 67 percent of maximum. However, it provides several other potential advantages:

- Allows one to utilize breeds superior in maternal traits on the female side and mate slightly more than one-half the cow herd to bulls from a specialized bull breed.

- Maximizes individual heterosis in a majority of the offspring.

THREE-BRED TERMINAL CROSSING SYSTEM

A three-breed terminal crossing system is a program where the producer buys or purchases F-1 heifers and breeds to bulls of a third breed with all offspring going to market.

If a cow-calf producer were to produce his own F-1 heifers instead of buying them, he would have to maintain three or more breeds of bulls and would have to have a cow herd of 200 head or more to keep a self-perpetuating herd producing his own crossbred females from a purebred foundation and using a third or "terminal sire" breed bull on the crossbred females.

THE CROSSBRED COW

Hybrid vigor in the maternal traits results in a substantial increase in pounds of calf weaned per cow bred — the most important measure of productivity in the cattle business. Many traits that contribute to a cow's lifetime productivity and mothering ability have low heritability and are improved only slowly by selection. But these traits — and others — improve rapidly and dramatically through crossbreeding. Crossbred females generally mature earlier, have higher conception rates and calf crop percentages, present fewer health and calving problems, produce more abundant milk, wean significantly heavier calves and remain in the breeding herd longer.

Most discussions of crossbreeding indicate there are fairly specific rules to follow to develop and maintain a crossbreeding system which maximizes heterosis. The following rules are generally advocated to accomplish this goal. The breeder should: consider the use of a systematic crossbreeding program; identify all females by breed of sire and year of birth; avoid backcrossing by making the most diverse matings possible; must have two or more breeding pastures; must use two or more breeds of bulls.

While these rules do help maximize heterosis, they are frustrating for those producers who want the benefits of crossbreeding but because of limited facilities, time, labor or level of management simply cannot comply with the rules.

PLANNING THE CROSSBREEDING SYSTEM

It is impossible to plan a single, ideal crossbreeding system to fit all commercial herd situations. Regardless of the system employed, it is very important to plan ahead several generations, not just several years.

Questions concerning optimum herd size, number of breeding pastures needed, how replacement

heifers will be generated, feed resources required, availability of labor, facilities, sources of bulls (breeds) and possible use of artificial insemination must be answered or at least thought through in the planning phase of a crossbreeding program.

SIMPLIFIED CROSSBREEDING SYSTEMS

In many herds the level of management required to use some of the more intricate crossbreeding systems, which maximize heterosis and utilize complementarity through terminal-sire breeds, are simply not feasible.

Many cow herds are small or are the second or third enterprise to farming or feeding within the operation, so relatively simple systems of mating would be more practical. Also, the managers of the relatively large herds may find the more complex crossbreeding systems difficult to handle.

It is possible, with some modification, to use basic principles from intricate crossbreeding systems. Some systems are designed to allow simplified crossbreeding systems that produce some of the benefits of crossbreeding, yet avoid some of the complexities of the traditional system.

Simplified crossbreeding systems may sacrifice some heterosis when compared to the more traditional crossbreeding systems. However, the simplified systems require less management and are a viable alternative to traditional systems. Producers who want some of the benefits of crossbreeding but, due to some of their complexities, are hesitant to use a traditional system should find simplified systems favorable.

Breed selection and bull selection within the chosen breeds definitely will be as important to total production as the level of heterosis maintained in the crossbreeding system.

PURCHASED CROSSBRED FEMALES

This system is more of a management decision than it is a crossbreeding system, yet it is the simplest and fastest method of utilizing crossbreeding. Purchased two- or three-breed crossbred females can be bred to a different terminal sire breed, thus maximizing both individual and maternal heterosis.

Only one breed of bull is needed (the terminal-sire breed), and only one breeding pasture is required.

HETEROZYGOSITY OF DIFFERENT MATING TYPES AND ESTIMATED INCREASE IN PERFORMANCE AS A RESULT OF HETEROSIS

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Mating type	Heterozygosity % relative to F ₁	Estimated increase in weight weaned per Cow exposed ^a %
Pure breeds	0	0
Two-breed rotation	66.7	15.5
Three-breed rotation	85.7	20.0
Four-breed rotation	93.3	21.7
Two-breed composite:		
F ₃ — $\frac{1}{2}$ A, $\frac{1}{2}$ B	50.0	11.6
F ₃ — $\frac{5}{8}$ A, $\frac{3}{8}$ B	46.9	10.9
F ₃ — $\frac{3}{4}$ A, $\frac{1}{4}$ B	37.5	8.7
Three-breed composite:		
F ₃ — $\frac{1}{2}$ A, $\frac{1}{4}$ B, $\frac{1}{4}$ C	62.5	14.6
F ₃ — $\frac{3}{8}$ A, $\frac{3}{8}$ B, $\frac{1}{4}$ C	65.6	15.3
Four-breed composite:		
F ₃ — $\frac{1}{4}$ A, $\frac{1}{4}$ B, $\frac{1}{4}$ C, $\frac{1}{4}$ D	75.0	17.5
F ₃ — $\frac{3}{8}$ A, $\frac{3}{8}$ B, $\frac{1}{8}$ C, $\frac{1}{8}$ D	68.8	16.0
F ₃ — $\frac{1}{2}$ A, $\frac{1}{4}$ B, $\frac{1}{8}$ C, $\frac{1}{8}$ D	65.6	15.3
Five-breed composite:		
F ₃ — $\frac{1}{4}$ A, $\frac{1}{4}$ B, $\frac{1}{4}$ C, $\frac{1}{8}$ D, $\frac{1}{8}$ E	78.1	18.2
F ₃ — $\frac{1}{2}$ A, $\frac{1}{8}$ B, $\frac{1}{8}$ C, $\frac{1}{8}$ D, $\frac{1}{8}$ E	68.8	16.0
Six-breed composite:		
F ₃ — $\frac{1}{4}$ A, $\frac{1}{4}$ B, $\frac{1}{8}$ C, $\frac{1}{8}$ D, $\frac{1}{8}$ E, $\frac{1}{8}$ F	81.3	18.9

^aBased on heterosis effects of 8.5% for individual traits and 14.8% for maternal traits and assumes that loss of heterosis is proportional to loss of heterozygosity. This assumption has not been validated for composite breeds.

Since all progeny are marketed, no identification by sire breed and year of birth would be required.

While this system is simple and easy to manage, it obviously does not generate replacements. Consequently, the operator is dependent on an outside source of replacements. The available supply of high quality, disease-free crossbred females in the area is an important consideration.

The table on page 6 indicates the estimated increase in weight weaned per cow exposed as a result of the different crossbreeding systems.

CROSSBRED BULLS

There should be a reason for using crossbred bulls. Either they should be more fertile, breed more cows or compound the hybrid vigor already available through the use of half-breed females.

Will they breed true? If the hybrid bull is from superior parents, that portion of his inherited superiority may be passed on. Progeny of crossbred bulls will tend to be more variable than those from a purebred sire.

If the bull is an average crossbred, about 15-20 percent of the time you will get a greater degree of variation or segregation. If the bull is from the top 20 percent of a herd of above average uniformity and performance, top crossbred bulls can be better than top straightbred bulls.

Guidelines for using crossbred bulls—

- Make wide crosses to avoid breed overlap between sire and dam. This maximizes hybrid vigor.
- Superior performing bulls are essential.
- Choose breed combinations adaptable to the environment.

Crossbred beef bulls should be used only by specialists for a specific purpose. A large portion of the benefits from heterosis comes from using the crossbred female in terms of reproductive efficiency.

No breed of bull has all the desired characteristics nor necessarily the ability to transmit them to offspring. The economic contribution of a bull in beef breeding will be reflected principally by the extent of his influence on the production of his daughters. In order to evaluate this ability, the calf production of his daughters must be measured with "contemporary" groups under common management and environment.

As commercial producers adopt crossbreeding programs, they should become much more selective

in their bull buying than they were when they were on a straight breeding program. No breed or breeder will benefit long from crossbreeding without actually having superior genetics in the herd. The success of any crossbreeding program will always be dependent upon genes from superior cattle of all breeds. Records of identification and performance data should be a must. To the commercial cattleman, crossbreeding is not the solution to all problems and could create new ones if discretion is not practiced, because the success of the resultant crosses depends on the merits of the individual parents.

DON'TS FOR CROSSBREEDING

- Don't crossbreed unless you have a 10-15 year plan.
- Don't crossbreed unless you use top-tested bulls.
- Don't crossbreed unless your management will give it a chance to succeed.
- Don't crossbreed unless you have a planned marketing program.
- Don't make your program a "planned mongrelization;" make it a planned success.

SUMMARY

Crossbreeding is a system of mating to take advantage of heterosis in the commercial production of beef. Crossbreeding is not a substitute for good management nor is it a cure-all for unproductive cattle. The merit of a group of crossbred animals is determined more by how good their parents were than by the fact that they are crossbred.

Current research information indicates that productivity per cow can be increased by a planned crossbreeding system. However, a producer must pay a price to obtain this increased productivity. He must follow a rather specific breeding plan which may involve additional breeding pastures and maintaining bulls of different breeds unless artificial insemination is used.

Certain traits such as carcass traits and feed conversion efficiency show little or no heterosis benefits. It should also be remembered that crossing two lines within a breed, especially inbred lines, will give some benefits of heterosis or hybrid vigor.

A breeding program designed to maintain maximum heterosis is not well designed for making permanent genetic improvement in beef cattle. Therefore, crossbreeding is limited to only a portion of the total population of beef cattle. Crossbreeding should have much to offer beef cattle producers who are mainly interested in producing more pounds of beef per cow unit.

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