lom del 7-27-77

FACT SHEET

L-1536

SYSTEMS FOR CROSSBREEDING BEEF CATTLE

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Crossbreeding to increase efficiency is commonly practiced in crop production. In animal agriculture, poultry and swine producers have made the greatest use of crossbreeding, while beef producers have been slow to take advantage of this technique.

Beef producers have been reluctant to use crossbreeding primarily because: (1) cattle have a low reproductive rate relative to most agricultural plants and animals, so a high percent of a herd is required to produce replacement breeding animals; and (2) when crossbreds first appeared they were often discriminated against in the market place; this practice has largely ceased in light of biologic and economic reality. Unfortunately, the basics of animal reproduction are not so easily changed.

Basis of Crossbreeding Systems

Heterosis. One benefit of crossbreeding is heterosis or hybrid vigor. Heterosis is defined as the percentage of difference in performance between crossbreds and the average of the parental breeds.

Total performance is important in assessing the value of heterosis. The performance of crossbreds for a particular characteristic is frequently below that of the best parental breed. Also, heterosis may be low for any one trait. However, heterosis for total performance, or net economic merit, has proved significant, and the net merit of crossbreds usually exceeds that of the best parental breed. Otherwise, crossing is useless.

Production traits vary in the level of heterosis expressed. Fortunately, those characteristics which rank lowest in heritability (the likelihood of transmission from parent to offspring) are generally highest in heterosis, including such economically important characteristics as mothering ability, calving interval, conception rate and general vigor and livability. Obviously, the producing female is of paramount importance in using heterosis to the fullest.

Heterosis varies according to the genetic similarity of the breeds involved. Closely related breeds produce little heterosis. Heterosis for net merit among crosses of British breeds has been reported to be about 10 to 20 percent, compared to 20 to 50 percent in some environments for crosses of British and Indian breeds.

Breed Combinations. Favorable breed combinations produce an increase in the frequency of desired traits above that which may be found within a breed. Thus, benefits might be obtained from combining breeds even if heterosis was absent.

Examples of favorable breed combinations are numerous. In the Gulf Coast area, producers combine the environmental adaptability of Brahmans with the best qualities of other breeds, such as earlier maturity and higher fertility. Crosses between Hereford and Angus have been widely accepted by cattle feeders. These so-called "black baldies" combine the gainability of Herefords with the carcass quality of Angus.

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Complementarity. Another benefit of crossbreeding is termed complementarity. This involves matching, in a mating system, the desirable points of breeds, while eliminating or reducing the effect of their undesirable features.

An example of complementarity is the use of large muscular bulls such as Charolais or Simmental on Angus-Jersey crossbred cows. These particular cows combine the advantages of small mature size, early puberty, high fertility and desirable milking qualities. Gaining ability and red meat production are furnished by the sire's breed, thus avoiding the high nutritional requirement of large cows.

Notice that complementarity is a feature of a breeding system. Breed combinations may be expressed by an individual animal.

The benefits of crossbreeding are greatest in a system which uses the advantages of heterosis, beneficial breed combinations and complementarity. The operation of a crossbreeding scheme may be complicated, and benefits and liabilities of crossbreeding vary. Therefore, each producer should study his circumstances before employing this technique, and should understand the characteristics of crossbreeding systems.

There are two basic crossbreeding systems — terminal systems and rotation systems.

Mechanics of Systems

Every crossbreeding system begins with a two-breed cross where purebred animals of different breeds are mated. High quality purebreds are a must in crossbreeding. The efficiency of high quality purebreds may easily exceed that of mediocre crossbreds. So much of the success of any crossing system depends on the performance of the purebreds used.

The offspring of these two-breed matings are called first-cross or F1. (In the South there is a common misconception that F1 refers only to a Brahman-Hereford cross; actually, any cross of two pure breeds produces an F1.) Actions beyond the first-cross determine the type of crossing system.

Classification of systems depends a great deal on the intent of the breeder. By definition, terminal systems end at some planned point where a particular cross is made. Rotations, however, are intended to be continuous.

Terminal Systems. A first-cross can be terminal if the system is stopped at this point. If Charolais-Angus F1 "Smokeys" are produced, and all are intended for sale, this is a two-breed terminal cross.

A three-breed terminal cross is an extension of the two-breed design. Here, F1 females are bred to bulls of a third breed. The genetic make-up of the offspring is 1/2 the breed of the sire and 1/4 of each of the breeds represented in the F1 dam. Other arrangements and combinations of larger numbers of breeds are possible. A three-breed terminal cross is seen in Figure 1.

Rotation Systems. The simplest rotation system is a *two-breed rotation* or *criss-cross.* First-cross females are bred to bulls of one of the parent breeds. This is called a *backcross.* In subsequent generations, females are bred to bulls of the breed other than their sire. The system eventually will stabilize with two distinct populations. Each population will contain approximately 2/3 of the breeding of the sire and 1/3 of the breeding of the grand sire. For this system, two breeding pastures are required unless artificial insemination is practiced.

In a *three-breed rotation,* the first-cross females are mated with a sire of a third breed. Up to this point the system is like a three-breed terminal cross. But in a rotation system, the three-breed cross females are bred back to sires of one of the two breeds used in the first-cross stage of the rotation.

Three distinct groups are eventually created. The genetic make-up of each group is about 4/7 of the breed of the sire, 2/7 of the breed of the dam's sire, and 1/7 of the remaining breed. Females are mated to sires of this remaining breed.

A three-breed rotational cross is represented in Figure 2. The rotation of more than three breeds is possible, but is even more complex.

Mating plans of rotational breeding programs can be confusing unless one remembers that individual cows are not moved from one breeding group to another. The breed composition of a female determines her mating. Females are mated to the breed of sire to which they are least related, and this scheme continues for the life of the cow. Variations are not necessarily undesirable, but such modifications are not true rotations.

Features of Systems

Terminal Systems. Replacement females are not produced as an inherent part of terminal systems, since all offspring are removed intentionally from the herd for growing, feeding or slaughter. Their fitness as breeding animals is of no consequence. Therefore, highly specialized sire breeds and dam breeds may be used. Indeed, specialization should be included in terminal systems for maximum efficiency. This is the greatest advantage of these breeding systems.

Since heifer replacements are not produced, they must either be purchased or produced in a separate herd. In a first-cross, only one pasture is required since all cows, whether producing purebred or crossbred calves, are of the same breed. Bulls of both breeds are used. With usual death losses and replacement rates, about 40 to 50 percent of these matings must be purebred to generate the required number of replacement heifers.

In a three-breed terminal cross, separate breeding

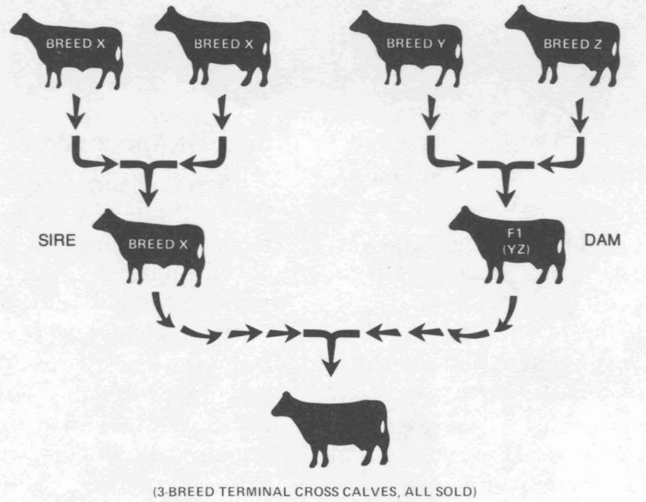

Fig. 1 Three-breed terminal crossbreeding system.

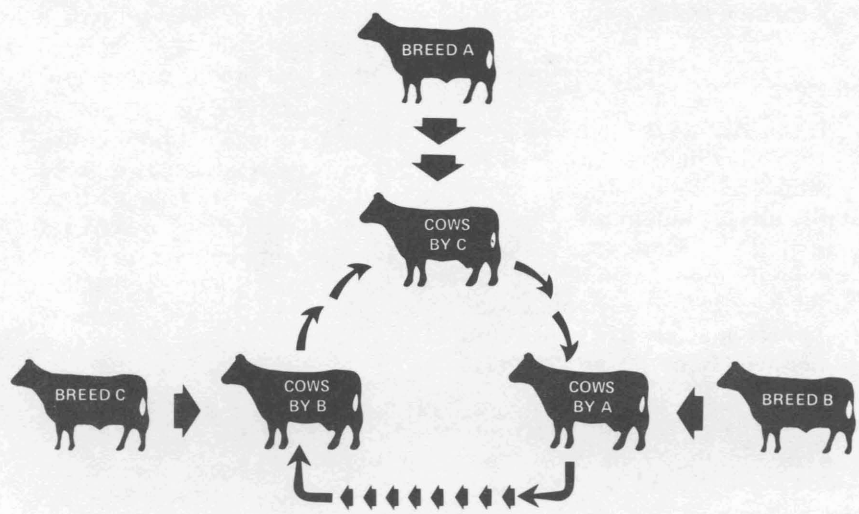

Fig. 2 Three-breed rotational crossbreeding system.

pastures are required to produce all replacements for the system. Purebred females are required to produce the crossbred females used in the three-breed cross. Thus, production of replacements for a three-breed cross constitutes a first-cross system. Again, some 40 to 50 percent of all females must be used to produce replacements unless uncommonly high levels of reproduction, survival and longevity are obtained. If the operator of the terminal cross does not produce replacements, someone else must.

The advisability of purchasing replacement females is debatable. Some operators specialize in such production, and many of them do an excellent job. However, heifers from unknown sources may have been subjected to haphazard and unsatisfactory management practices.

Little culling is usually done when producing specialized heifers, since the purpose is to use the smallest number of animals in the production of replacements. Therefore, there is little opportunity to improve the herd through selection among females.

Heterosis is low in a two-breed terminal system, since all producing females are purebred and the advantages of crossbred females are lost. An estimated 60 to 75 percent of the heterosis available is not obtained. Conversely, three-breed crosses result in high heterosis. Complementarity also may be high in three-breed crosses. Since they maximize both heterosis and complementarity, three-breed terminal crosses are the most efficient if the terminal cross is considered alone. However, the lower heterosis involved in producing replacements reduces the superiority of a three-breed terminal system when all phases of the system are considered.

Rotation Systems. In rotation systems, replacement females are inherently produced. The only introductions required are sires. Each breed used is always present, in varying degrees, in the genetic make-up of females. Each breed also is used at some point as a sire. Thus, highly specialized sire and dam breeds should not be chosen for rotations. Instead, breeds should complement each other as much as possible while containing a blend of important production characteristics. Faults cannot be masked as they may be in terminal systems.

In rotations the number of potential female replacements is relatively large, since all heifers produced may be used for breeding. Selection and culling of females can further improve the herd. Also, the producer controls the development and management of replacement females in a rotation system.

Once a rotation has been established, all breeding groups consist of crossbred cows. However, since more than half of the genetic content of females derives from their sire's breed, heterosis is reduced. In a two-breed rotation, potential heterosis is lowered by about 33 percent; in a three-breed rotation this reduction amounts to about 15 percent. However, even the least efficient rotation results in two-thirds of maximum heterosis.

Systems for Small Herds

One-bull Herds. Herds of this size obviously restrict the choice of cross-breeding systems. Perhaps the simplest scheme is to purchase females for mating to a terminal sire. With only one bull in use, a normal rotation cannot be carried on. However, a three-breed rotation may be closely approximated by changing the breed of bull every 3 years. To maximize heterosis and eliminate breeding a heifer to her sire, replacements should be saved from the last 2 years of the 3-year cycle.

Two-bull Herds. Herds large enough to require two bulls provide more flexibility in choosing a crossbreeding system. Females could be purchased, as in a one-bull herd, or a normal two-breed rotation may be used.

Perhaps the best system with two bulls is a combination three-breed rotation and terminal sire system. Here replacements for both the rotation and the terminal sire group are produced in the rotation. In this combination, females are mated in the rotation system while young, and moved when 4 to 5 years old to the terminal bull group. The breed of bull used in the rotation should be changed every 2 years. Under this scheme, a female is moved to the terminal group by the time her breed of sire is used again in the rotation. For this system, two breeding pastures are required.

Since most heifers from the rotation are retained for breeding, about 70 percent of cattle sold come from the terminal matings. This combination results in high heterosis and complementarity.

Special Applications

Replacement Females. As has been mentioned, some producers specialize in producing crossbred females to be used in terminal crosses. If techniques of controlling the sex of an animal are developed, this practice undoubtedly will expand.

Minimizing Calving Difficulty. Sires of small mature size may be used on first-calf heifers to reduce calving problems. This is often accomplished by choosing sires of a breed other than that of the females. Producers should be cautious, however, since there may be much variation in mature size within a breed.

Creation of New Breeds. New breeds are created by planned, systematic crossing of existing breeds to obtain desired characteristics. These crosses are inter-mated until breed type is fixed. Eight officially recognized breeds have been created in the U.S. Other new breeds will undoubtedly appear.

Crossbred Bulls. There are a number of advantages to using crossbred bulls. Combinations of more than two breeds, or two-breed crosses other than an F1, can be most easily produced with crossbred bulls. Such combinations or crosses might be desired as female replacements, or used to create new breeds. Some established breeds allow the use of crossbred bulls to more quickly produce purebreds.

Summary

Highly productive purebreds are the basis for all sound crossbreeding programs. As is true of any breeding system, most of the long-term genetic improvement comes from intense selection of sires.

Managing a planned crossbreeding system is more complicated than managing a purebred operation. This may account partially for the low number of such schemes. There are millions of crossbred cattle produced in this country, but many of these crosses are the result of haphazard breeding systems which are not likely to increase efficiency.

Planned crossing can raise production effectiveness. But no crossbreeding system can alleviate the effects of poor nutrition, inadequate health programs or other management problems. A crossbreeding system can be beneficial only as part of a sound, overall management program.

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