

Crossbreeding for the Commercial Beef Producer

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Structured crossbreeding programs are utilized by beef producers to optimize productivity. Most commercial cattlemen know that mating cattle of different breeds results in increased performance in the crossbred calves relative to the average of the parental breeds, particularly when calves are kept as replacement females. However, market price differences and perceptions about the advantages of some breeds and color patterns have led many beef producers to drift away from a structured crossbreeding program. The purpose of this informational sheet is to illustrate the benefits and economic importance of crossbreeding to the commercial producer.

The two primary reasons to crossbreed are (1) heterosis (hybrid vigor) and (2) breed complementarity (breeds have characteristics which complement each other and fit the environment). When crosses are made, one breed's strengths can complement the other breed's weaknesses. Since no single breed is superior in all traits, a planned crossbreeding program can significantly increase herd productivity. Prior to committing to a crossbreeding system, producers must consider logistics, costs, benefits and the feasibility of the chosen system in the context of their own unique environment, feed resources and market specifications.

Heterosis

Heterosis refers to the superiority of the crossbred animal relative to the average of its straight bred parents. Generally, heterosis generates the largest improvement in lowly heritable traits. Heritability is the proportion of the observable variation in a trait between animals that is due to the genetics that are passed between generations and the variation observed in the animal's phenotypes, which are the result of genetic and environmental effects. Traits such as reproduction and longevity have low heritability. These traits usually respond very slowly to selection since a large portion of the variation observed in them is due to environmental factors and non-additive genetic effects, and a small percentage is due to additive genetic differences. Heterosis generated through crossbreeding can significantly improve an animal's performance for lowly heritable traits. Crossbreeding has been shown to be an efficient method to improve reproductive efficiency and productivity in beef cattle. The greatest impacts on profitability from heterosis are the increases in overall production and the longevity of crossbred cows (Table 1).

The benefit of increased longevity should not be underestimated. Crossbred cows will stay productive longer. Cows are most productive between five and ten years of age. From an economic standpoint in a commercial herd it is best to have a high

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Table 1. Summary of heritability and level of heterosis by trait type.

Trait	Heritability	Level of Heterosis
Carcass/end product Skeletal measurements Mature weight	High	Low (0 to 5%)
Growth rate Birth weight Weaning weight Yearling weight Milk production	Medium	Medium (5 to 10%)
Maternal ability Reproduction Health Cow longevity Overall cow productivity	Low	High (10 to 30%)

percentage of the cow herd in the 5 to 10 year age group and minimize the number of replacement heifers that are retained each year.

Improvements in cow-calf production due to heterosis are attributable to having both a crossbred cow and a crossbred calf. Producers should try to utilize a crossbreeding system that achieves a high level of heterosis in both the cows and the calves. As a goal, try to keep replacement females that do not exceed 75% of any one breed.

When production is measured as weaning weight of calves produced per cow exposed, which takes into account reproductive rate, calf survival, milk and growth, the increase in production from heterosis can be as high as 24%.

Breed Complementarity

Beef breeds in the US have different average levels for performance traits. Finding a combination of breeds that will perform optimally in your environment (management) is critical to developing a successful breeding program.

Complementarity is the result of crossing breeds that are from different, but complementary, biological types. Breed complementarity results from the choice of breeds that go into your cross.

In order to optimize performance, specialized sire and dam breeds may be used in a crossbreeding system to capitalize on desired characteristics that will be passed on to the progeny. When considering crossbreeding from the standpoint of producing replacement females, one should select breeds that have complementary maternal traits such that females are most ideally matched to their production environment. Matings to produce calves for market should focus on complementing the traits of the cows and fine tuning calf performance (growth and carcass traits) to the market place.

Crossbreeding Systems

Crossbreeding systems must be planned for each operation depending on herd size, potential market, level of management, and facilities. A long-term plan is necessary to gain maximum benefits from crossbreeding. There are also considerations such as whether to purchase or raise your own replacements. Purchasing crossbred F_1 replacement females can be the simplest and fastest method of obtaining maximum hybrid vigor as crossing a bull to crossbred heifers is simple and maximizes heterosis, but there needs to be an available supply of high quality, disease-free females. The advantages and disadvantages of various crossbreeding systems are listed in the following pages and in Table 2.

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Two-breed Terminal Cross — uses straight bred cows and a bull of another breed. It is a terminal cross if stopped at this point (Figure 1). The resulting offspring are typically called an F1. An example would be Angus cows bred to Charolais bulls. In this system, replacements must be bought from another source, or part of the herd (perhaps heifers and young cows bred to Angus bulls to generate replacement heifers). This is not a desirable system because it does not realize any heterosis in the cow since she is straight bred.

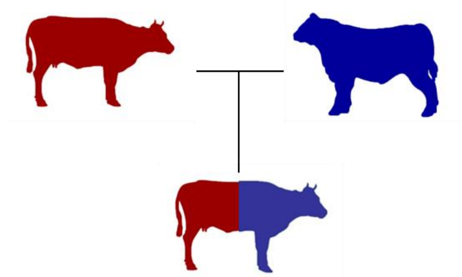

Figure 1. Two breed Terminal Cross

Three-breed Terminal Cross — uses a two-breed cross (F1) female and a bull of a third breed (Figure 2). It produces maximum hybrid vigor in the cow and calf. This is an excellent system because hybrid vigor is realized for both growth rate and maternal ability. Replacement females for this system must be purchased or raised from another source. This is a good system for any size herd if high quality replacement females are available.

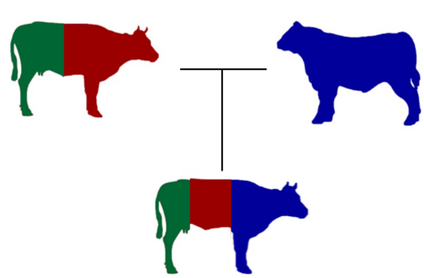

Figure 2. Three breed Terminal Cross

Two-breed Rotation or Crisscross — a simple crossbreeding system involving two breeds and two breeding pastures. A two-breed rotation is started by breeding cows of breed A to bulls of breed B. In each subsequent generation, replacement heifers are bred to bulls of the breed that is the opposite of their sire (Figure 3). Two breeds of bulls are required after the first two years of mating. The two breeds chosen should be comparable in birth weight, mature size, and milk production. This minimizes calving difficulty in first calf heifers and simplifies management.

Three-breed Rotation — follows the same pattern as the two-breed rotation, but a third breed is added (Figure 4). The three-breed rotation maintains a higher level of hybrid vigor than the two-breed system. Mating plans can be confusing, but individual cows are not moved from one breeding group to another. Three distinct groups of cows are eventually created, and they are mated to the sire to which they are least related. This scheme continues for the life of the cow.

Modified Rotation — this involves using a bull of one breed for a set number of years (recommendation of four years) then rotating to a different breed of bull. Only one breeding pasture is required, and replacement heifers are generated within the herd. This system sacrifices some hybrid vigor when compared to a two-breed rotation, but it is simple enough to be practical for many producers and works well in small herds.

2-Breed Rotation Terminal Sire — the two-breed rotation with terminal sire system is sometimes called a rota-terminal system. It includes a two-breed rotational crossbreeding system of maternal breeds A and B. This portion of the herd produces replacement females for the entire herd, so maternal traits of the breeds included are very important. In this system approximately half of the cow-herd is committed to the rotational portion of the breeding system and half to the terminal sire portion. The older crossbred cows are then mated to the terminal sire breed (breed C). All of the terminal cross offspring are marketed. This system maintains a high level of heterosis but also requires a high level of management. Nearly all heifer calves

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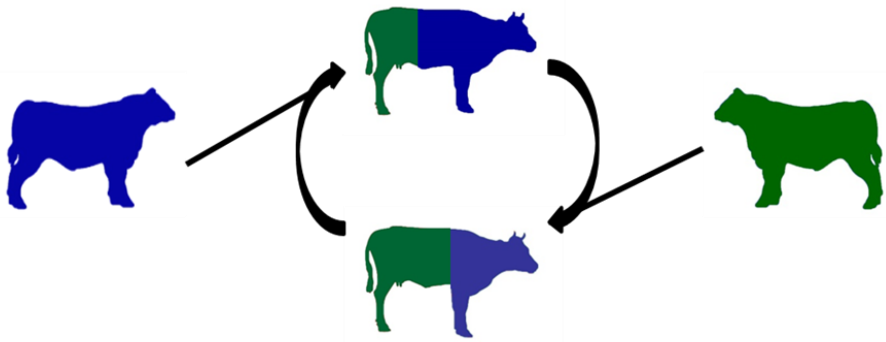

Figure 3. Two breed Rotation

produced by the rotational mating must be kept to maintain herd numbers.

Composites — this system "blends" traits of economic importance from a number of breeds to create a composite which is then maintained as a straight-bred herd (Figure 5). This system has the advantage of being very easily managed once the composite breed is established (which takes many generations/years) and it can capture a higher amount of existing genetic variation among breeds than other crossbreeding systems.

However, in order to develop the composite animals, intense, strategic breeding practices must be employed, making composite development an unwise choice for producers with less than 500 cows. It can also be difficult to integrate new genetics into the herd without re-developing the composite breed. Trait selection needs to be carefully considered for males and females since both have to fit the environment and produce progeny that can hit market targets. Another option is to locate a source of composite cattle and consistently purchase your bulls from that source and retain your own females. With this system you retain approximately half of the heterosis from the foundation animals (In the example, the foundation animals are a 4-way cross with 100% heterosis, so the heterosis retained in the composites will be approximately 50%).

Rotating Unrelated F_1 Bulls - The use of F_1, or first cross, bulls is becoming more wide spread. F_1 bulls provide a simple alternative to the formulation of composite breeds. Additionally, the F_1 systems may provide more opportunity to incorporate

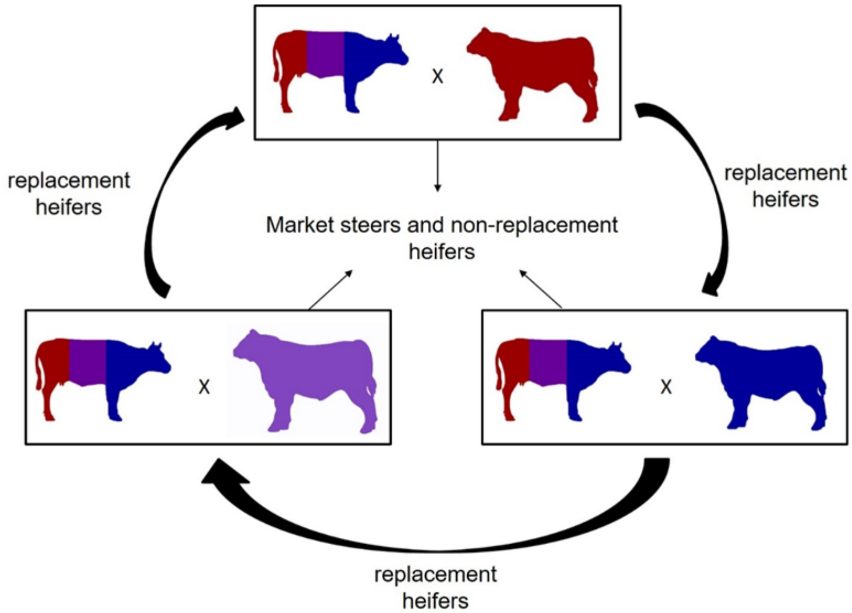

Figure 4. Three breed Rotation

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superior genetics as germplasm can be sampled from within each of the large populations of purebreds rather than a smaller composite population. The use of unrelated F_1 bulls with the same breed composition in a mating system with cows of the same breeds and fractions (A*B x A*B) will result in a retention of 50% of maximum calf and dam heterosis and an improvement productivity (defined as the increase in weaning weight per cow exposed) of 12%. A system that uses F_1 bulls that have a breed in common with the cow herd (A*B x A*C) results in heterosis retention of 67% and an expected increase in productivity of 16%. The use of F_1 bulls on F1 cows that don't have breeds in common with the bulls (A*B x C*D) retains 83% of maximum heterosis and achieves productivity gains of 19%. This last system is nearly equivalent to a three breed rotational system in terms of heterosis retention and productivity improvement, but much easier to implement and manage.

Crossbreeding Challenges

Although crossbreeding has many advantages (Table 2), there are some challenges to be aware of during your planning and implementation.

1. More difficult in small herds

Crossbreeding can be more difficult in small herds. Managing greater than 50 cows provides the opportunity to implement a wider variety of systems.

Small herds can still benefit through utilization of terminal sire, composite or F_1 systems.

2. Requires more breeding pastures and breeds of bulls

Purchasing replacements and maximum use of A.I. can reduce the number of pastures and bulls. However, most operations using a crossbreeding system will expand the number of breeding pastures and breeds of bulls.

3. Requires more record keeping and identification of cows

Cow breed composition is a determining factor in sire breed selection in many systems. Colored ear tags can provide a way of tracking sire breed for mating management.

4. Matching biological types of cows and sires

Breed complementarity and the use of breed differences are important advantages of cross breeding. However, to best utilize them care must be given in the selection of breeds and individuals that match cows to their production environment and sires totheir progeny's purpose or market endpoint. Divergent selection of biological type can result in wide swings in progeny phenotype in some rotational systems. These swings may require additional management input, feed resources, and labor to manage as cows or at marketing points.

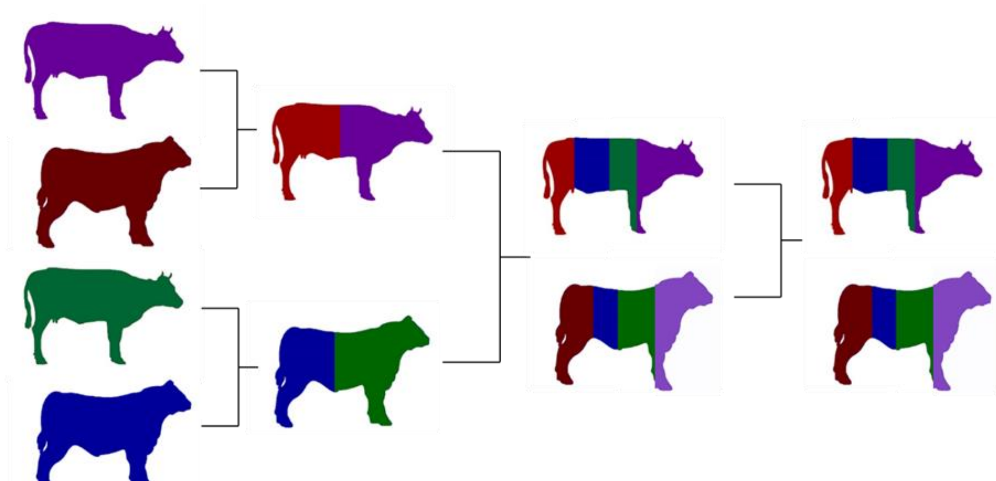

Figure 5. Four breed Composite

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5. System continuity

Replacement female selection and development is a challenge for many herds using crossbreeding systems. Selection of sires and breeds for appropriate traits (maternal or paternal traits) is dependent on ultimate use of progeny. Keeping focused on the system and providing labor and management at appropriate times can be challenging. Discipline and commitment are required to keep the system running smoothly.

Many of the challenges that have been associated with crossbreeding systems in the past are the result of undisciplined implementation of the system. With that in mind, one should be cautious to select a mating system that matches the amount of labor and expertise available to appropriately implement the system. Crossbreeding systems range in complexity from very simple programs such as the use of composite breeds, which are as easy as straight breeding, to elaborate rotational crossbreeding systems with four or more breed inputs. The biggest keys to success are the thoughtful construction of a plan and then sticking to it!

Table 2. Summary of crossbreeding systems by amount of advantage (% increase in lb of calf weaned per cow exposed) and other logistical considerations

Type of System	% of Cow Herd	% of Marketed Calves	Advantage (%)[a]	Retained Heterosis (%)[b]	Minimum # of Breeding Pastures	Minimum Herd Size	# of Breeds
Two-breed Terminal Cross (Figure 1)							
T x (A)	100	100	**8.5**	0 [c]	1	Any	2
Terminal Cross with Purchased F1 Females (Figure 2)							
T x (A*B)	100	100	**24**	100	1	Any	3
2-Breed Rotation (Figure 3)							
A*B Rotation	100	100	**16**	67	2	50	2
3-Breed Rotation (Figure 4)							
A*B*C Rotation	100	100	**20**	86	3	75	3
2-Breed Rotational / Terminal Sire							
A*B Rotational	50	33			2		
T x (A*B)	50	67			1		
Overall	100	100	**21**	90	3	100	3
Composite Breeds (Figure 5)							
2-breed	100	100	**12**	50[d]	1	Any	2
3-breed	100	100	**15**	67	1	Any	3
4-breed	100	100	**17**	75	1	Any	4
Rotating Unrelated F1 Bulls							
A*B x A*B	100	100	**12**	50	1	Any	2
A*B x A*C	100	100	**16**	67	1	Any	3
A*B x C*D	100	100	**19**	83	1	Any	4

[a] Measured in percentage increase in lb. of calf weaned per cow exposed,
[b] Relative to F_1 with 100% heterosis,
[c] Straightbred cows are used in this system which by definition have zero (0) percent maternal heterosis; calves produced in this system exhibit heterosis which is responsible for the expected improvement in weaning weight per cow exposed.
[d] Estimates of the range of retained heterosis. The lower limit assumes that for a two breed system with stabilized breed fractions of 50% for each breed; three breed rotation assumes animals stabilize at a composition of 1/3 of each breed. Breed fractions of cows and level of maternal heterosis will vary depending on sequence of production.

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