Crossbreeding Beef Cattle

Excerpts from "Crossbreeding Beef Cattle" by Scott P. Greiner, Extension Animal Scientist: Virginia Tech

The economic climate of today's beef business is challenging. Commercial cow-calf producers are faced with optimizing a number of economically important traits, while simultaneously reducing costs of production in order to remain competitive. Traits such as reproduction, growth, maternal ability, and end product merit all influence productivity and profitability of the beef enterprise. Implementation of technologies and systems that both reduce costs and enhance productivity is essential. One of the oldest and most fundamental principles that has a positive influence on accomplishing these goals is crossbreeding.

A well-designed, manageable crossbreeding system is an important aspect in making genetic progress in the various economically important traits that drive profitability in today's beef industry.

Why Crossbreed?

Crossbreeding beef cattle offers two primary advantages relative to the use of only one breed: 1) crossbred animals exhibit heterosis (hybrid vigor), and 2) crossbred animals combine the strengths of the various breeds used to form the cross. The goal of a well-designed, systematic crossbreeding program is to simultaneously optimize these advantages of heterosis and breed complementarity.

Heterosis or hybrid vigor refers to the superiority in performance of the crossbred animal compared to the average of the straightbred parents. Heterosis may be calculated using the formula:

% Heterosis = [(crossbred average - straightbred average) ÷ straightbred average] x 100

For example, if the average weaning weight of the straightbred calves was 470 pounds for Breed A and 530 pounds for Breed B, the average of the straightbred parents would be 500 pounds. If Breed A and Breed B were crossed and the resulting calves had an average weaning weight of 520 pounds, heterosis would be calculated as:

[(520 ÷ 500) ÷ 500] x 100 = 4 %

This 4% increase, or 20 pounds in this example, is defined as heterosis or hybrid vigor.

The amount of heterosis expressed for a given trait is inversely related to the heritability of the trait. Heritability is the proportion of the measurable difference observed between animals for a given trait that is due to genetics (and can be passed to the next generation). Reproductive traits are generally low in heritability (less than 10%), and therefore respond very slowly to selection pressure since a very small percentage of the differences observed among animals is due to genetic differences (a large proportion is due to environmental factors). The amount of heterosis is largest for traits that have low heritabilities. This has significance for commercial breeding systems, as crossbreeding can be used to enhance reproductive efficiency. Traits that are moderate in their heritabilities (20 to 30%) such as growth rate are also moderate in the degree of heterosis expressed (around 5%). Highly heritable traits (30 to 50%) such as carcass traits exhibit the lowest levels of heterosis.

Improvements in production from heterosis may be captured by having both a crossbred calf and a crossbred cow. The following two tables summarize the effects of individual heterosis in the crossbred calf (Table 1)

and maternal heterosis in the crossbred cow (Table 2). These tables include results from numerous crossbreeding studies conducted in the Southeast and Midwest involving several breeds. The advantage of the crossbred calf is two-fold: an increase in calf livability coupled with an increase in growth rate. Perhaps the most important advantage for crossbreeding is realized in the crossbred cow. Maternal heterosis results in improvements in cow fertility, calf livability, calf weaning weight, and cow longevity. Collectively, these improvements result in a significant advantage in pounds of calf weaned per cow exposed, and superior lifetime production for crossbred females.

Table 1. Individual Heterosis: Advantage of the Crossbred Calf[1]

Trait	Observed Improvement	% Heterosis
Calving rate, %	3.2	4.4
Survival to weaning, %	1.4	1.9
Birth weight, lb.	1.7	2.4
Weaning weight, lb.	16.3	3.9
ADG, lb./d	.08	2.6
Yearling weight, lb.	29.1	3.8

[1]Adapted from Cundiff and Gregory, 1999.

Table 2. Maternal Heterosis: Advantage of the Crossbred Cow[1]

Trait	Observed Improvement	% Heterosis
Calving rate, %	3.5	3.7
Survival to weaning, %	.8	1.5
Birth weight, lb.	1.6	1.8
Weaning weight, lb.	18.0	3.9
Longevity, yr.	1.36	16.2
Cow Lifetime Production:		
No. Calves	.97	17.0
Cumulative Wean. Wt., lb.	600	25.3

[1]Adapted from Cundiff and Gregory, 1999.

The other important advantage to crossbreeding is the ability to take advantage of the strengths of two or more breeds to produce offspring that have optimum levels of performance in several traits. As an example, British breeds generally excel in marbling potential whereas Continental breeds typically are superior for red meat yield (cutability). Combining the breed types results in offspring that have desirable levels of both quality grade (marbling) and retail yield (yield grade). Similarly, milk production and growth rate may be most effectively optimized by crossing two or more breeds.

It is important to realize that the crossbred offspring will not excel both of the parent breeds for all traits. In the example given previously, straightbred calves of Breed B would have had heavier weaning weights (530 pounds) than the Breed A x Breed B crossbreds (520 pounds). However, Breed B females may be larger in mature size and have higher milk production potential resulting in increased nutitional requirements and higher production costs. Limited feed resources coupled with very high milk production may result in lower reproductive performance. Therefore, the cumulative effect of crossbreeding when several traits are considered is more important than the effect on any one particular trait. Effective crossbreeding programs must be designed to optimize performance, not necessarily maximize it.

Sire Selection for Crossbreeding Programs

As with any breeding system, sire selection is critical for genetic improvement. With crossbreeding systems, more than one breed of sire is typically used. As a result, the calf crop and female replacements are potentially sired by different breeds and individual bulls within those breeds. It is the differences between the breeds utilized, as well as differences in individual sires used, which contribute to variation in a set of cows or a calf crop. Therefore, for a crossbreeding system to be viable, sire selection (both within and between breeds) is critical for maintaining uniformity from one generation to the next, while at the same time taking advantages of the strengths of the various breeds used in the system.

Breed Selection

The most fundamental sire selection decision is the choice of breed. Choice of breeds to be used in the cross will be dependent on several factors, including the resources of the operation and the marketing program for the calf crop (specifically the targeted carcass merit endpoint). Considerable differences between breeds exist and may be effectively utilized by crossbreeding. As mentioned previously, optimum performance rather then maximum performance is desired for virtually all economically important traits. For this reason, 1/2 to 3/4 British x 1/4 to 1/2 Continental females tend to optimize mature size, milk production, and adaptability for many regions of the United States. Similarly, a tremendous amount of growth potential can be added through breed selection. The breeds chosen and the percentage of each breed represented in the calf crop also have a pronounced impact on carcass characteristics. Coupling the general superiority of the British breeds for marbling potential with the red meat yield advantages of the Continental breeds results in offspring that have desirable levels of both quality grade (marbling) and retail yield (yield grade). The specific end product target will dictate the combination/percentage of breeds that are most likely to generate cattle with the desired carcass traits. Utilizing breed differences for carcass traits to match marketing grids will be important for producers as more retained ownership and value-based marketing is practiced.

Crossbreeding Sire Selection Using EPDs

Selection of bull within breed is equally important. EPDs are a very useful and important tool in accomplishing this task. At the same time, breed strengths and weaknesses and the genetic merit of a breed as a whole for a particular trait also need to be considered when bulls are selected for use in a crossbreeding system. In other words, EPDs need to be considered on both a within and across-breed basis for effective bull selection in a crossbreeding program. Using the EPDs in this manner will assist the producer in minimizing large fluctuations in performance and production from one generation to the next when using more than one breed.

Table 3 shows the Meat Animal Research Center (MARC) Across-Breed Adjustment Factors, which can be used to compare the EPDs of bulls from two different breeds. For example, consider a Simmental bull with a WW EPD of +16 and a Red Angus bull with a WW EPD of +43. To fairly compare the WW EPDs of these two bulls of different breeds, the EPDs must first be adjusted using the across-breed table. Using the table, the Simmental bull would have an across-breed WW EPD of +40.4 (16 + 24.4 = 40.4) and the Red Angus bull an across-breed WW EPD of +38.3 (43 + -4.7 = 38.3). In this example, we would expect progeny of the Simmental bull and Red Angus bull to be very similar on the average for weaning weight (across-breed EPDs of 40.4 vs. 38.3, for only a 2.1 pound difference), even though their within-breed EPDs were quite different. Across-breed EPDs may be calculated for the growth and maternal traits of any breed listed in the table.

Table 3. 2007 MARC Across-Breed EPD Adjustment[1]

Breed	BW	WW	YW	Milk
Angus	0.0	0.0	0.0	0.0
Brangus	5.0	24.3	26.5	-3.1
Braunvieh	6.3	30.3	17.4	24.5
Charolais	9.6	40.9	48.7	3.5
Gelbvieh	4.4	7.0	-21.2	6.2
Hereford	2.7	-3.1	-12.7	-15.7
Limousin	4.0	-1.3	-24.0	-12.6
Red Angus	2.5	-4.7	-0.7	-5.1
Salers	4.2	30.7	43.5	12.8
Shorthorn	7.0	32.5	46.1	16.6
Simmental	5.7	24.4	17.0	13.7

[1]Adapted from Kuehn, Van Vleck, Thallman, Cundiff, 2007.

These across-breed adjustments may be used to compare bulls of different breeds that are being used in the crossbreeding program for similar purposes (i.e. milk production in Gelbvieh and Simmental, or growth in Simmental

and Charolais). The adjustment factors may also be useful in managing uniformity when breeds are rotated in a crossbreeding system to avoid large fluctuations in traits such as birth weight and milk. For example, using these adjustments, it can be demonstrated that a Gelbvieh bull with a milk EPD of +7 will add similar milk genetics to an Red Angus bull with a milk EPD of +18. Both the bulls would be +13 on an across-breed basis. This demonstrates the differences between the breeds that exist, as a Gelbvieh bull that is +7 for milk EPD ranks in the lower 5% of the Gelbvieh breed while a Red Angus bull that is +18 for milk EPD ranks in the top 45% of the Red Angus breed. Therefore, little selection pressure for milk is needed when choosing a Red Angus bull to compliment a Gelbvieh cow herd. Similar calculations can be made for birth weight and growth. The key is to recognize the basic genetic differences between breeds, and then select bulls within those breeds with optimum genetics while avoiding extremes.

Other Important Considerations

Another key factor for crossbreeding sire selection is the matching of frame score across the individual bulls selected. Frame score has a strong relationship with cow size. Therefore, minimizing differences in the frame scores of the bulls used to produce replacement females will assist in minimizing differences in mature size of the resulting cowherd. Mature size and milk production are important traits to manage when designing a cowherd that is uniformly adapted to the resources of the operation.

For many feeder cattle producers, coat color is an economically important trait. Today's genetics offer the opportunity to stabilize coat color and still maintain a crossbreeding program. Technological advances such as DNA genotyping have made it possible to more easily manage coat color in several breeds. Therefore, coat color does not need to be a limiting factor to maintain a crossbreeding program.

Summary

A well-designed, manageable crossbreeding system is an important aspect in making genetic progress in the various economically important traits that drive profitability in today's beef industry. To accomplish this task, bull selection must consider both within and across-breed differences to optimize genetic progress in these traits that influence reproductive efficiency, maternal performance, growth and feed efficiency, and end product merit. ■

The Red Angus CrossBreeding Fact Sheet...

Many commercial cow/calf producers enhance profitability through planned application of cross-breeding's two primary benefits: **Heterosis...** is the increased performance that a crossbred calf exhibits compared to the average of its straightbred parents. Heterosis has the greatest benefit on traits of low heritability, and has been shown to increase the lifetime production of a beef cow by 20-25%, by influencing a range of traits such as fertility, longevity, weaning rate, etc. **Breed Complementarity...** is the combining of desirable characteristics of two or more breeds to achieve a higher frequency of desired genes among crossbreds than could be found in a single breed. Because this crossbreeding benefit utilizes additive gene differences between breeds, it is most noticeable in traits of higher heritability, such as carcass composition, growth rate, mature size, calving difficulty, etc. Red Angus' unique ability to predict beef cattle reproduction and maintenance energy requirements in addition to growth and carcass traits make them profitable crossbreeding specialists.

Red Angus Crossbreeding Formulas

Red Angus x Terminal Continentals

Red Angus crossed with terminal Continental breeds like Charolais and Limousin, produce feedlot cattle that can excel in feedlot efficiency while reaping premiums for both Yield and Quality grade. While these Continentals are known to improve Yield Grade through increased leaness and ribeye area, Red Angus complements both with improved marbling and fewer days to finish. The feedlot industry values the intangible traits of Red Angus crosses, such as improved docility; fewer bruises when handling and ease of starting on feed.

Red Angus x Maternal Continentals

When crossed with maternal Continental breeds such as Simmental and Gelbvieh, Red Angus can improve production efficiency. Through breed complementarity, Red Angus can lower birthweights, moderate mature size, decrease cow maintenance requirements, extend longevity and thus, improve the overall functionality of the replacement females resulting from such crosses.

Red Angus x British Breeds

The "Baldy" female is still a favorite for many commercial ranch environments, and are produced in uniform fashion when Red Angus and Hereford are crossed. Added maternal traits and marbling genetics are produced in the polled, pigmented progeny of this British x British cross. The Red Angus component of highly efficient baldy steers helps them reach choice grade faster. Red Angus can be used on other British breeds to reduce maintenance costs and add fleshing ability.

Red Angus x Brahman Derivatives

In regions that require added heat tolerance, Red Angus and Angus Plus bulls work well on Brahman derivatives or other heat tolerant Bos taurus breeds, such as Senepol. The replacements resulting from such crosses make adaptable, heat tolerant, easy fleshing brood cows, while their steer mates should express improved carcass traits due to Red Angus' superior marbling genetics. Additionally, higher levels of heterosis should be seen when Red Angus are used on cattle of such divergent origins.

Various biotypes of cattle ranked by cost of gain.

Biotype	% Choice[a]	%YG 1 & 2[a]	Feed[b] Conversion	Cost of gain[b] /cwt[c]
1/4 Continental 3/4 British	66	52	6.52	$54.00
1/2 Continental 1/2 British	56	56	6.49	$54.80
100% British	70	38	6.76	$57.50
100% Continental	30	89	6.78	$59.80
3/4 Continental 1/4 British	43	83	6.72	$60.10

[a] Adapted from U.S. MARC data (Cundiff, 1999).
[b] Swift & Co. and Gelbvieh Alliance data (T. Schiefelbein, 2003 and D. Schiefelbein, 1998).
[c] Includes interest.