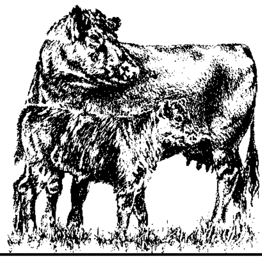

Composite Cattle for Commercial Cow-Calf Producers

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Composites, **Synthetics**, or **Hybrids** are names used somewhat interchangeably to signify new breeds or new lines of breeding. Two or more breeds are crossed with the intention of obtaining genetic superiority not found in any one breed. A carefully planned breeding program results in obtaining: (1) a combination of genetic merit from each breed and (2) hybrid vigor (heterosis) that can be maintained through successive generations without further crossbreeding. The breeding program should combine a balance of selection for reproduction, growth, and carcass traits so that the cattle will fit the most economical production and marketing environments.

Some breeders use the term "composite" to identify a closed breeding program (a fixed number of breeds with a certain percentage of genetic material from each breed). Other breeders use "synthetic" as an open breeding concept where new breeds can be added at any time and with no fixed percentage from each breed. "Hybrid" could imply either composite or synthetic cattle.

What distinguishes them from typical crossbreds is not their genetic makeup *per se*, but rather the way in which they are used. Composites are expected to be bred to their own kind, retaining a level of hybrid vigor we normally associate with traditional crossbreeding systems but without further crossbreeding with outside breeds.

For example, consider the standard black baldy cow. She is a hybrid, typically the result of mating a purebred Angus bull to a purebred Hereford cow, or vice versa. In all likelihood, she will be bred back to a purebred bull of one of the parent breeds or perhaps to a third breed. Because she is to be used as part of a conventional crossbreeding system (e.g., a rotation of some kind), we would not consider her a composite animal.

If her owner, however, decided to breed her to black baldy sires, saving daughters and perhaps even sons as replacements, we would have to consider her a composite. She became a composite (as opposed to simply a crossbred) because the breeder chose to mate her to her own hybrid kind with the expectation of retaining a degree of hybrid vigor without further crossbreeding.

Admittedly, this definition leaves a little to be desired. What if a cattle producer has a herd of composite animals and one day that producer decides to breed them to terminal sires or make them part of a conventional rotational crossbreeding system? Are they still composite cows? Whether you answer "yes" or "no" depends on how strict you want to be in your definition of a composite. Being fairly liberal in this regard, we would say "yes" because these cows were bred to be part of a composite breeding system and still have that potential. Others may disagree.

"Composites" Comes from Plants

Most information and experience with composites comes from plants. Plant breeders developed composites as a practical way for farmers in third world countries to take advantage of hybrid vigor. The new plant populations were termed "synthetic varieties."

The analogous term in animal populations is "composite breeds." In keeping with the definition of a composite animal, a composite breed is then a breed that is made up of two or more component breeds and is designed to benefit from hybrid vigor without further crossing with other breeds.

Many breeds in this country are made up of component breeds. Brangus, Santa Gertrudis, Simbrah, and RX_3 are just a few examples. Whether these breeds have been bred in such a way that they retain significant hybrid vigor (e.g., whether they have successfully avoided inbreeding) remains an open question. If they have, then they can legitimately call themselves composite breeds. If they have not, then they are not composites but simply newer breeds.

Why Composites?

Perhaps the best way to answer this question is to compare the merits of a commercial breeding program involving composite cattle with the merits of more traditional systems. First, however, we need to decide how to make the comparison—to set the criteria by which any given system will be evaluated. Following is a list of the criteria to use:

1. Merit of component breeds.
2. Level of hybrid vigor produced.
3. Simplicity.
4. Replacement considerations.
5. Complementarity.
6. Consistency of performance.
7. Accuracy of genetic prediction.

Merit of Component Breeds

For any crossbreeding system to be effective, the breeds in the system must be well chosen. If you were a horse breeder, for example, and were designing the ultimate crossbred stadium jumper, you would be unlikely to include the Shetland Pony as a component breed. Shetlands are simply too small to be viable candidates given the needs of stadium jumpers.

The same principle applies to cattle. Every breed included in the system must bring favorable attributes to the mix. Because this is true regardless of the type of crossbreeding system, merit of component breeds is not a useful criterion for comparing kinds of systems, and we will not, therefore, use it to compare the composites with other crossbreeding systems. It is an extremely important criterion, however, for evaluating any particular crossbreeding program.

Level of Hybrid Vigor Produced

One of the chief reasons for crossbreeding beef cattle is to take advantage of hybrid vigor or heterosis. Any worthwhile crossbreeding system must provide an adequate amount of hybrid vigor, and within the limits of practicality, the more hybrid vigor the better. Composite animals exhibit considerable hybrid vigor. For those knowledgeable in the importance of crossbreeding for maintaining hybrid vigor, the idea of getting sustained vigor without crossbreeding may seem too good to be true. In fact, it is an algebraic consequence of hybrid vigor theory.

The amount of vigor depends on the number and proportions of component breeds in the composite. To get an idea of the fraction of maximum (F_1) hybrid vigor that is maintained in advanced generations of a composite, you can use the following formula:

$$\text{Proportion of } F_1 \text{ vigor retained} = 1 - \sum_{i=1}^{n} p_i^2$$

where p_i is the proportion of the "i_{th}" breed in a composite made up of n component breeds, and Σ is the mathematical symbol for summation.

The formula looks worse than it really is. Take the RX_3 breed for example. RX_3's are 1/4 Hereford, 1/4 Red Holstein, and 1/2 Red Angus. Fraction of maximum hybrid vigor retained in RX_3's can be estimated as:

$1-[(1/4)^2+(1/4)^2+(1/2)^2]$

$= 1-[1/16 + 1/16 + 1/4]$

$= 5/8$ or 63%.

In other words, RX_3 cattle can be expected to exhibit 63 percent of the hybrid vigor typical of a first-cross animal. A four-breed composite with equal fractions of each component breed would be expected to show 75 percent of F_1 vigor, a similar eight-breed composite 88 percent. These are considerable amounts of hybrid vigor.

Breeders often ask, "After a while, won't a composite breed become just another breed?" In other words, won't composites lose their ability to retain hybrid vigor over time? The answer is "no" if inbreeding is avoided. On the other hand, if the composite breed is allowed to become inbred, as purebreds are, it will indeed become just another pure breed.

Simplicity

Crossbreeding systems should be relatively simple in terms of resource and management requirements. Expensive systems or systems that require an unrealistically high level of management are unlikely to remain in place very long. From a management standpoint, breeding composites is like breeding straightbreds; only one breeding pasture is needed (two if heifers are bred separately). All the problems associated with having multiple breeds are eliminated, and for this reason, the greatest virtue of a composite program may well be simplicity. Composites can be used successfully in small herds, even herds with only one sire, and with composites there should be no conflict between the breeding program and forage management.

Replacement Considerations

Some crossbreeding systems produce the replacement females needed for the cow herd. Others require replacements to be purchased or bred in a separate population. Producers should evaluate both kinds of systems from the standpoint of economics and personal preference.

Like straightbreds, composites produce their own female replacements, so composites score well for replacement considerations. Composites have the potential to produce their own replacement males as well, though for most commercial producers, the extra level of management and record keeping required to do a good job of home-raised bull selection is probably impractical. Most composite bulls will be purchased from composite seedstock producers.

Complementarity

Complementarity refers to the production of a more desirable offspring from the mating of parents that are genetically different from each other but have "complementary" attributes. The classic example in beef cattle is "big bull x small cow" complementarity. The big bull provides growth and leanness to the offspring. The small cow requires less feed to maintain herself. The result is a desirable market animal economically produced. We can also have growth x milk complementarity and cutability x quality complementarity to list just a couple of examples.

Unlike hybrid vigor, which is sort of gene-level magic causing a boost in the performance of hybrids, complementarity is the logical result of "mixing and matching" different biological types. Some crossbreeding systems, terminal sire systems in particular, make good use of complementarity; other systems do not.

Does a composite breeding program make use of complementarity? Strictly speaking, "no." Because the cattle within a composite population are all of the same basic biological type, there is little opportunity for complementarity from composite matings—no "big bull x small cow" possibilities.

Complementarity does come into play, however, in the "formation" of composite breeds. We could, for example, include both Herefords and Holsteins in a composite to take advantage of their complementary characteristics.

NOTE: This would be an unlikely pair of breeds to use in a rotational system using purebred sires; the fluctuation in offspring types would be too large.

Consistency of Performance

Ideally, a crossbreeding system should produce a consistent product. It is much easier to market a uniform set of animals than a diverse one. It is also easier to manage a cow herd that is essentially one biological type than a herd made up of several types, each with different requirements. Crossbreeding systems vary in their ability to provide consistency.

Composites score high for consistency of performance. This comes as a surprise to many. Classical genetics texts are full of examples of increased variation in the progeny of hybrids. The books are not wrong, but the examples inevitably involve traits that are affected by just a few genes, or simply inherited traits.

In beef cattle, coat color is an example of a trait of this kind, and if the component breeds in a composite differ in color, the composites will be of many colors as well. The same is not true for polygenic traits, or traits affected by many genes. These include the majority of economically important traits: fertility, survivability, growth rate, milk production, carcass characteristics, and so on.

Experimental data suggest that composites are as uniform for these traits as purebreds, and when compared to hybrids from a rotational crossbreeding system, composites are inevitably more uniform because they do not vary in breed composition.

Accuracy of Genetic Prediction

By now, most thoughtful commercial producers are sold on the idea of performance testing as a way of identifying genetically superior animals. Weights are okay, trait ratios are better, and EPD's are even better predictors because they are more accurate. They are more likely to provide a true picture of an individual's genetic merit. Crossbreeding systems that use bulls with extensive EPD information allow more precise control over the genetic contribution of the sires.

It is hard to say how composites will rate in the category of accuracy of genetic prediction. Currently, few composite bulls have EPD's and fewer have accurate EPD's. Purebred bulls have a big advantage here. This does not have to be the case, however. It is quite possible to calculate reliable EPD's for composites. What are needed are mechanisms for accumulating performance information on composites and the cooperation of purebred organizations in analyzing composite data.

The Composite/Terminal System

Simply breeding composites to composites as though they were purebreds is not the only way to use composites commercially. A modified scheme is the composite/terminal system. In this system, about half the herd of composite females, typically consisting of the heifers and younger cows, is bred to composite bulls, and the other half is bred to terminal sires.

Replacement heifers come from the composite x composite matings, and all terminally sired offspring are marketed. Such a system involves an additional breeding pasture, but this modest loss in simplicity comes with an additional measure of complementarity (big bull x small cow) and hybrid vigor.

How Are Composites Formed and Used?

It is important to differentiate between composite developers (breeders) and composite users (commercial producers). Developing a composite requires a large population of females (25 or more sires per generation of approximately 500 to 750 cows). It takes a considerable amount of time to make the initial crosses, get through several generations of *inter se* matings (within-herd matings of the crosses) and liquidate the original parent stock. (Although it takes about three generations to reach equilibrium of individual and maternal hybrid vigor, the first generation composite is equally viable as seedstock.)

Obviously, this represents a sizable investment of money, time, and patience. After all of that, there is no guarantee that the composite will be acceptable to the breeder or to the industry.

In contrast, users have an easy time of it because they are simply attempting to select bulls for their commercial operations just as they always have. Initially, however, the potential user could have a problem because there may not be a composite that fits the herd's specific needs.

Other Considerations

"Niche" Cattle

As you can see from above, composite cattle have a lot going for them and relatively few drawbacks. Composites have some additional attributes not readily apparent. They can be designed to fit a specific environment or niche. The Barzona breed is a good example.

Barzonas were developed specifically for the desert Southwest, and they combine characteristics from several breeds that make them particularly adapted to that environment. Wherever the environment poses unique challenges, there is an opportunity for an appropriately designed composite breed.

Reduced Variation Industry-Wide

Composites have the potential for "standardizing" commercial cattle, thus reducing the variation we currently see in market animals. This statement may seem counterintuitive; how can variation be reduced by adding more breeds to the already large number of breeds available?

Look at it this way. Today's problem cattle from a feedlot and carcass perspective tend to be biologically extreme animals. They are either purebreds or high percentage animals from extreme breeds or crosses of similarly extreme breeds. In other words, they are the result of poor crossbreeding decisions by commercial cattle breeders.

With a composite breed, crossbreeding decisions are made when the breed is formed. Thus, the decisions as to what breeds to put in the crossbred mix are taken out of the hands of commercial producers and placed in the hands of a much smaller number of composite seedstock breeders.

Yes, commercial producers still decide what composite breed to use, but they are unlikely to find an extreme one. That is because (with rare exceptions) composites are expected to be complete and balanced in performance, and only those composite breeds that fulfill this expectation are likely to survive. In other words, the variation among composite breeds will be considerably less than the variation we now have among pure breeds.

Commercial or Seedstock?

Finally, composite cattle break the seedstock/commercial barrier. With traditional crossbreeding systems, crossbreds are the commercial cattle of choice due to their hybrid vigor, but only purebreds can be seedstock. Composites can be either or both. There is no genetic reason why a herd of good commercial composite cattle could not become a seedstock herd.

Will composite breeding systems be the wave of the future? That depends on the willingness of both seedstock and commercial breeders to break with tradition. It took a long time for cattle producers to accept the idea of crossbreeding. Acceptance of the composite concept may take just as long. However, the case for composite cattle is a strong one, and if common sense prevails, we will see increasing numbers of composites in the relatively near future.

What Are the Advantages for Commercial Producers?

Compared to traditional rotational crossbreeding systems, composites are attractive to commercial herd owners for the following reasons:

1. Less cumbersome to manage, especially in small herds.
2. Easier to manage under intensive short-duration grazing systems.

Table 1. Levels of expected heterosis for various mating systems.

Mating system	% of maximum possible heterosis*	Estimated increase in calf wt. weaned per cow exposed
		(%)
Pure breeds	0	0
2-breed rotation at equilibrium	67	16
3-breed rotation at equilibrium	86	20
Terminal sire x purchased F_1 females	100	23-28
Rotate sire breed every 4 years (2 breeds)	50	12
Rotate sire breed every 4 years (3 breeds)	67	16
2-breed rotation and terminal sire	90	21
2-breed composite (1/2 A, 1/2 B)	50	12
3-breed composite (1/2 A, 1/4 B, 1/4 C)	63	15
4-breed composite (1/4 A, 1/4 B, 1/4 C, 1/4 D)	75	18
Rotating F_1 bulls:		
AB, AB	50	12
AB, AD	67	16
AB, CD	83	19

*Relative to F_1 @ 100%.

3. Avoids the wide swings in biological type (size, milk, carcass composition, etc.) that often occur from one generation to another in rotational systems, thereby helping reduce mismatches between biological type and the production environment and between biological type and market specifications.
4. Can help overcome certain genetic antagonisms like lean yield and marbling because such traits can be balanced rather precisely when the parent breeds are selected.
5. A relatively high percentage of heterosis can be maintained as long as inbreeding is avoided.

Summary

In summary, composites and/or hybrid bulls have the potential of offering the following to commercial cow-calf producers, especially smaller herds:

1. Simplicity.
2. Breed complementarity so as to match economically important traits with the environment and with market specifications.
3. A reasonable percentage of retained heterosis if inbreeding is minimized.
4. A reduction in the impact of negative genetic antagonisms.
5. Reasonable uniformity from generation to generation.
6. Little or no difference in variation in polygenic traits between composites and pure breeds.

Following are potential problem areas:

1. Variation in simply inherited traits (color, horns, etc.).
2. The perception of wide variation in polygenic traits.
3. Sources of unrelated seedstock so as to avoid inbreeding.
4. Use of less-than-desirable parent stock.
5. Marketing, advertising, etc.
6. Database to generate EPD's.

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