Development and Use of Composite Breeds: A Summary

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Introduction

In recent years, there has been increased interest in the use of composites in beef cattle production systems. It is a controversial topic among cattle producers. The goal of this publication is to summarize results of recent research on the subject. It is not intended to be either an endorsement or a rejection of the concept.

Answers to Frequently Asked Questions

What is a composite? A generally accepted definition would be: a population made up of two or more component breeds, designed to retain heterosis (hybrid vigor) in future generations without crossbreeding and maintained like a pure breed.

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 or approximately 500 to 750 cows). It takes a considerable amount of time to make the initial crosses, get through three generations of inter se (within-herd matings of the crosses) and liquidate the original parent stock. Obviously, this represents a sizeable 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 are simply attempting to select bulls for their commercial operations just as they always have. However, the potential user could have difficulty in locating a composite that fits the herd's specific needs.

What are the advantages for commercial producers? Compared with traditional rotational crossbreeding systems, composites are attractive to commercial herd owners for the following reasons: Such a system is less cumbersome to manage, especially in small herds. It is easier to manage under management-intensive, short-duration grazing systems. It 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. It can help overcome certain genetic antagonisms such as lean yield and marbling because such traits can be balanced rather precisely when the parent breeds are selected. A relatively high percentage of heterosis can be maintained as long as inbreeding is avoided.

What about the variability of composites? Research at the Meat Animal Research Center (MARC), Clay Center, Neb., has shown that, for economically important traits controlled by many genes (quantitative traits), the amount of variation (as measured by coefficients of variation) is similar for composites and for the average of the contributing purebreds. However, for qualitative traits that are controlled by only a few genes (e.g., color, horns, etc.), composites may exhibit considerably more variation than purebreds, depending on the specific breeds that go into the formation of a particular composite.

Besides variation in qualitative traits, what other challenges may arise? Inbreeding and subsequent loss of heterosis can be a serious problem unless the genetics of each breed is widely sampled (15 to 20 sires per breed). Use of inferior seedstock in the formation of the composite will lead to unsatisfactory results. Breeds selected may fail to match long-term industry goals. Name recognition, marketing, etc., may be problems. Expected Progeny Differences (EPDs) will eventually be needed to remain competitive.

How can inbreeding be avoided? Breeders developing composites can avoid inbreeding by maintaining a large population (500 cows or more), by joining a group of cooperating breeders who are forming the same composite or by opening the population to outside genetics from time to time. For commercial producers using composite bulls, it is recommended they seek out sources of unrelated seedstock within the composite population they are using.

If inbreeding is avoided, how much heterosis can be retained in a composite? The more breeds in a composite, the more heterosis can be retained. Heterosis can range from 50 percent of the maximum possible heterosis for a two-breed composite to 87.5 percent for an eight-breed composite. Retained heterosis can be estimated from the formula $\frac{n-1}{n}$, in which n is the number of breeds in the composite. For example, a four-breed composite would be expected to retain 75 percent of maximum possible heterosis ($\frac{4-1}{4} = \frac{3}{4} = 75\%$). Levels of heterosis for various mating systems are given in Table 1.

Are there other considerations in forming a composite? Selection of the breeds that go into the composite is a critical step. Breed differences (complementarity) should be fully exploited so as to match the composite with the environment in which it will be used and to match it with market specifications (carcass size, percent retail product, marbling, etc.). In addition, special attention should be paid to lowly heritable traits and to traits that are difficult to measure (e.g., mammary system, sheath, skeletal soundness, etc.) to minimize problems at the outset.

What about using crossbred (hybrid) bulls? Hybrid bulls offer an alternative method of utilizing the composite concept. As indicated in Table 1, rotating unrelated F_1 bulls composed of the same two breeds (A·B↔ A·B) can result in retention of 50 percent of maximum possible heterosis. Rotating F_1 bulls that have one breed in common (A·B↔ A·D) can result in 67 percent heterosis. Rotation of F_1 bulls having no breeds in common (A·B↔ C·D) can offer 83 percent of maximum heterosis, nearly equal to what can be achieved with a three-breed rotational system. The first system (A·B↔ A·B) would be especially useful in small herds because it requires only one breeding pasture. Another system not shown here would be to rotate different breeds of F_1 bulls (A·B, C·D, E·F, etc.) every 4 years. To avoid wide intergenerational swings in biological type, breeds A, C and E should be similar in type, as should breeds B, D and F.

Is there an ideal mix of biological types in a composite or hybrid? Most scientists who are heavily involved in breed evaluation research agree that a 50-50 mix of British and Continental breeding would be near ideal for much of North America. In those regions where feed resources are limited, a higher percentage of British breeding may be needed. In regions of abundant feed and/or when maximum lean yield is desired, the ideal composite could conceivably contain more Continental breeding. In subtropical regions, one-quarter to three-eighths *Bos indicus* breeding is usually recommended. To maximize heterosis, it is advisable not to overuse any one breed.

What about phenotypic look-alikes? A few large breeders are developing several breeds of cattle that are alike in color, frame size, body shape, polledness, etc., and offering them in the pure state or as hybrid look-alikes. The idea is to further enhance uniformity of a crossbreeding program by avoiding the wide swings in biological type that often occur from generation to generation in traditional crossbreeding systems. This is a valid concept if productive genetics in each breed can be identified and incorporated into the program.

Table 1. Levels of expected heterosis for various mating systems.[a]

Mating system[b]	% of maximum possible heterosis[b]	Estimated increase in calf wt. weaned per cow exposed
	(%)	(%)
Pure breeds	0	0
Two-breed rotation at equilibrium	67	16
Three-breed rotation at equilibrium	86	20
Static terminal sire system	86[c]	20
Two-breed rotation & terminal sire (roto-terminal)	90[c]	21
Terminal sire x purchased F_1 females	100+[c]	28
Rotate sire breed every 4 years (two breeds)	50	12
Rotate sire breed every 4 years (three breeds)	67	16
Two-breed composite (½ A, ½ B)	50	12
Three-breed composite (½ A, ¼ B, ¼ C)	63	15
Four-breed composite (¼ A, ¼ B, ¼ C, ¼ D)	75	17
Rotating unrelated F_1 bulls:		
A·B ↔ A·B	50	12
A·B ↔ A·D	67	16
A·B ↔ C·D	83	19

[a] See "Crossbreeding Systems for Beef Cattle," Extension Bulletin E-2701

[b] Based on heterosis effects of 8.5% for individual traits and 14.8% for maternal traits

[c] Assumes a 10% increase in breeding value for calf weight produced per cow exposed to terminal sires.

Summary

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

- Simplicity.
- Breed complementarity so as to match economically important traits with the environment and with market specifications.
- Reasonable percentage of retained heterosis, if inbreeding is minimized.
- Reduction in the impact of negative genetic antagonisms.
- Reasonable uniformity from generation to generation.
- Little or no difference in variation in quantitative traits between composites and pure breeds.

Use of composites or hybrid bulls also has some potential challenges:

- Variation in qualitative traits (color, horns, etc.).
- Perception of wide variation in quantitative traits.
- Need for sources of unrelated seedstock to avoid inbreeding.
- Possible use of less than desirable parent stock.
- Marketing, advertising, promotion, etc., needed to achieve name recognition.
- Database to generate EPDs.
- Availability of the desired composite or hybrid seedstock within a given locale.

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