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Texas Adapted Genetic Strategies for Beef Cattle

IX: Selection for Carcass Merit

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More cattle are being marketed on carcass merit, prompting greater interest by producers. One way to improve carcass quality is through genetic selection—choosing parents based on carcass traits.

What Carcass Traits are Important?

The National Beef Quality Audit of 1991 examined factors affecting the desirability of beef. Some of the more important factors at least partially influenced by genetics were carcass size, composition, palatability, and uniformity. Specifically, the survey found significant numbers of carcasses that were too big, too fat, too unpalatable, or too variable.

Comparing the 1991 audit to 1974 USDA survey data

- The 1991 average carcass weight was 80 pounds heavier
- Ribeye area (an estimator of overall muscling) increased about in proportion to the increase in weight
- External fat did not change
- USDA Yield Grade (a predictor of cutability, percentage lean) slightly improved
- USDA Choice Quality Grade (a predictor of palatability) decreased from 75 percent to 55 percent

At least some of these changes can be attributed to the introduction in North America, starting in the late 1960s, of several large, lean Continental European breeds of cattle, along with an emphasis on increased size and leanness in established breeds.

Additional National Audits were conducted in 1995 and 2000. In 1995, fat decreased about 0.1 inch from 1991 levels, so Yield Grade improved, but Choice continued to decline by another 7 percentage points. In 2000, carcass weight increased 39 pounds, fat stayed about the same, ribeye area increased slightly (about in proportion to carcass weight), and there was little change in Quality Grade and Yield Grade from 1995.

In 2000, carcasses were leaner than in 1974, lower in Quality Grade, and heavier. Finished, live cattle of the same age and body composition averaged an estimated 250 to 300 pounds heavier in 2000 than in 1974.

Genetics of Carcass Merit

To change carcass merit through genetic selection, a producer must know the traits that are influenced by genetics and how they are related. Research has shown that fat thickness, ribeye area, cutability, marbling (intramuscular fat, the most important factor in Quality Grade), and tenderness are all moderately heritable, so change should be possible by selecting breeding stock based on those genetic traits.

What happens to other carcass characteristics when genetic selection is practiced for a specific carcass trait? Fat is the most important factor in Yield Grade. Based on documented genetic relationships, selection for reduced fat would markedly improve Yield Grade and ribeye area would be essentially unchanged, although tenderness might be slightly reduced.

There are conflicting estimates of the genetic relationship between external fat cover and marbling. Summaries of controlled research indicate that marbling declines somewhat as fat is reduced by genetic selection, However, some breed associations, using field data for developing carcass EPDs (expected progeny difference), have found essentially no genetic relationship within a breed between fat cover and marbling.

If genetic selection is used to increase marbling, this would be expected to be accompanied by a slight reduction in ribeye area and moderate improvement in tenderness. Based on research summaries, genetic selection for higher marbling would produce some reduction in cutability. However, breed association field data show virtually no genetic relationship between marbling and cutability.

In selecting for carcass merit, how might other important production traits be affected? Research shows that selection for increased marbling would be expected to reduce both weaning weight and yearling weight. Selection for higher cutability should increase weaning weight, yearling weight, and mature cow weight. There appears to be little genetic relationship between reproductive factors and higher marbling, other than the fact that higher-marbling genetic types also may be somewhat earlier in sexual maturity. Selection for higher cutability may have negative effects on calving rate and calving ease. Selection for extreme muscling appears to adversely affect reproduction in both males and females.

It may be possible to overcome the effects of any undesirable genetic correlations by concurrent selection for all of the traits concerned. However, as more traits receive selection emphasis, the rate of genetic change is slowed. And concurrent selection for genetically antagonistic traits slows the rate of change even more.

Several sources of information are available for genetic selection for carcass merit, the most complete coming from breed association programs for carcass EPD. At present, some breed associations may have EPDs for carcass weight, ribeye area, fat thickness, marbling, and percent retail product. The most useful of these EPDs are marbling (for palatability) and percent retail product (for cutability).

Genetic Selection Research Results

Estimates of heritability and genetic correlation predict what might occur in genetic selection. But what has been found in research where selection was implemented?

- Researchers at the University of Nebraska compared six high-marbling and six low-marbling siresof the same breed. The two

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groups differed greatly in EPD for marbling but were similar in EPDs for birth weight, weaning weight, ribeye, and fat cover. It was impossible to equalize all traits, and the low marbling sires averaged 10 pounds heavier in EPD for yearling weight.

Progeny were fed until they reached the same estimated levels of fat cover over the ribeye. The high marbling sire progeny averaged 20 pounds lighter when started on feed, gained at about the same rate, were slightly more efficient in feed conversion, and were fed 18 days fewer to reach the same fatness, so slaughter weight was 80 pounds lighter. Yield Grades were similar, but the high-marbling sire group had 74 percent Choice, compared to 47 percent (near the current industry average) for the low-marbling sire group. A later report of this study found that low-marbling-sired heifers reached puberty at essentially the same average age as high-marbling-sired heifers—371 versus 368 days.

- University of Florida researchers selected two groups of sires of the same breed. One group was near breed-average EPD for weight traits and maternal effects (with no consideration of carcass traits), and the other group was high in the breed for marbling (with no consideration of any other traits). Progeny of the two groups did not differ in averages for birth weight, weaning weight, carcass weight, Yield Grade, or tenderness, but the high marbling group had more marbling (Small 37 versus Small 10).
- The University of Georgia studied sires of the same breed with EPDs of either high-marbling/low-fat or low-marbling/average-fat. Steer progeny of both sire groups were fed for two lengths of time. In the shorter-fed cattle, the two sire groups averaged about the same in fat thickness and Yield Grade, but the high-marbling/low-fat group had 12 percentage points more Choice. In the longer-fed cattle, the high-marbling/low-fat sire group had about 0.1-inch less fat and were improved 0.3 units in Yield Grade. Feeding longer increased Choice by 15 to 20 percentage points in both groups. So it was possible, through intensive concurrent genetic selection, to improve both Quality Grade and Yield Grade.
- At the University of Maryland, females from a line that had been closed to outside genetics for several generations were bred either to sires selected for high EPDs for marbling and retail product or to sires produced in the closed line. Select-sired steer progeny had 0.08-inch less fat cover, 1.0 sq. in. larger ribeye area, 0.4 degrees higher marbling, and 66-pound heavier carcasses.
- Michigan State University researchers compared high-Yearling EPD sires to low-Birth/high-Milk EPD sires. At the start of post-weaning feeding, high-Yearling-sired steers weighed 31 pounds more, but subsequent average daily gain and feed efficiency did not differ from low-Birth/high-Milk sires. Although high-Yearling-sired steers had significantly heavier final weights, larger frame scores, and less external fat, there was no significant difference in ribeye area, Yield Grade, Quality Grade, or tenderness.
- At the U. S. Meat Animal Research Center, genetic lines selected on low calving difficulty score and average Yearling EPD were compared to controls selected on average Birth and Yearling EPD. Compared to controls, select progeny were 9.9 pounds lighter at birth and calving ease of heifers was improved. There were no significant differences in other weights, select progeny being 3 pounds lighter at weaning, 2 pounds heavier at yearling, 4 pounds lighter out of the feedyard, and 2 pounds lighter in the carcass. So, it was possible to select for improved calving ease without depressing weight gain after birth. However, select line carcasses had significantly more fat cover (by 0.05 inches) and were slightly higher in marbling, but not significantly larger in ribeye area.

Although these studies reported somewhat different results, the sire-selection criteria and research protocol also differed. This emphasizes the importance of experimental design and of considering more than one piece of research. Overall, these studies showed that EPDs can be used effectively to improve carcass merit.

Possibilities for Genetic Improvement

How much improvement might be expected by selecting sires within a breed? Using Angus as an example, the reported EPD range within the entire breed is about one and-one-half degrees of marbling between the highest and lowest individuals. In a commercial herd producing finished cattle averaging High Standard Quality Grade, an increase of one-and-one-half degrees of marbling would improve the average to Low Choice. In a herd averaging High Select, the improvement would be to Average Choice.

The top-ranking individual sire in the Angus breed is about two-thirds of a degree higher in Marbling EPD than breed average. But if a sire at the 5th percentile in the breed is selected (meaning that sire would rank higher than 95 percent of the breed), increase in progeny marbling, compared to a breed-average sire, would be only about one-third of a degree, half as much as from the top-ranking sire. Other breed associations have reported data showing somewhat smaller ranges for marbling, but the percentile relationships are similar.

That same picture generally holds true for other traits. So, selecting within a breed, one of the few outstanding sires must be used, almost certainly by artificial insemination, to make significant improvement quickly in a particular trait. For commercial producers, the fastest genetic change can be made by using superior sires from a breed noted for high expression of a specific trait. It must be understood, however, that other changes might accompany a substitution of breeds. Considering the many important traits in beef production and their sometimes conflicting relationships, a combination of moderate levels of traits, not extremes, is often most beneficial.

Many factors affect carcass merit. The U.S. Meat Animal Research Center has identified the following as important determinants of tenderness—genetics, age, time on feed, feed rations, growth implant programs, animal temperament, pre-harvest techniques, harvest procedures, electrical stimulation, chilling conditions, calcium chloride injection, blade tenderization, and carcass aging time and conditions. Genetics is only one factor, and new non-genetic technology will probably be developed.

Economics of Improving Carcass Merit

What is the expected economic return from improving carcass merit? In recent years, improvement in Quality Grade has been stressed more than any other carcass trait. As an example, consider the Nebraska study discussed above, where Choice increased from approximately 50 percent to 75 percent. Considering all factors from the study and using average feedyard costs and the last five-year average Choice-Select price spread of $7/cwt (hundred-weight) carcass, there is a slight advantage of $4/head (hd) financial return for the high-marbling sire group. The price advantage of the high-marbling group is almost offset by the extra weight of the low-marbling group. If the average Choice-Select spread is doubled (to $14/cwt), the high-marbling group would average about $17/hd advantage. Conversely, if there is no difference in price for Choice and Select, the high marbling group would have a disadvantage in return of about $9/hd compared to the low-marbling group.

It might seem that increasing Choice to 75 percent from the industry average of 50 percent would have a greater effect on monetary returns. At a $7 Choice-Select spread, the value of average-weight Choice carcasses, compared to Select carcasses, increases about $50/hd. But going from 50 percent to 75 percent Choice changes the value of only 25 percent of the cattle. So, for the entire pen, the per-head return averages about $12-13 more for each 25 percent increase in percent Choice. If the cow/calf producer receives $1.25-1.50/cwt more (about $6-7/hd) for weaned calves estimated to eventually grade 75 percent Choice instead of 50 percent Choice, that is about half of the average value to the feeder.

An extra return of $12-13/hd is certainly important in cattle feeding if the cost of production is not higher. Returns could be increased about that same amount per head by such things as raising the weaned calf crop percentage 2 to 3 percent, weaning calves 10 to 15 pounds heavier (depending on calf price), getting $2 - 3/cwt more for calves at weaning, decreasing death loss by about 1 to 2 percent, or lowering the cost of production by $2-3/cwt. Net return depends on the combination of these factors.

Premiums for superior carcasses may be relatively small and, considering possible tradeoffs, sometimes not economically beneficial. But discounts for inferior carcasses are not small and are always detrimental. Discounts of $10-20/cwt carcass are common for Standard Quality Grade, Yield Grade 4 and 5, dark-cutting lean (usually caused by pre-harvest stress), and excessively heavy (and light) carcasses.

Economic benefit from improving carcass merit can vary depending on the prevailing trait level of a particular herd. For example, for a herd that is producing some highly discounted Yield Grade 4 carcasses, slight improvement in average cutability could produce significant economic benefit. But in a herd producing mostly Yield Grade 2, there is not as much to be gained. Or, in the example above, using a sire at the 5th percentile, marbling would be improved by one-third of a degree above a breed-average sire. That would be economically important to a herd producing some Standards but less so to a herd already producing mostly Choice.

As with carcass price, similar severe discounts occur for undesired live animals all the way back down the production cycle. Regardless of when and how cattle are marketed, producers should understand price discounts. However, avoiding discounts should not be the only goal. The goal should be to optimize all the factors affecting production, product, and cost, thereby maximizing monetary return.

Can the Problems be Solved?

The four important problems of beef desirability with a genetic influence are:

- **Excess size**—Unquestionably, excess size can be genetically influenced, and average cow size can be reduced without decreasing total herd production, because larger numbers of smaller cows can be maintained on a fixed set of resources. And cows of more moderate size may be better suited to some production conditions.
- **Excess fat**—Although fat can be reduced very effectively genetically, easy fleshing is important for reproductive efficiency, at least under conditions of variable forage production where most beef cows are maintained. So fleshing ability probably should not be reduced in most cow herds. Consequently, much of the opportunity to reduce fat in fed cattle through conventional genetic selection will be through terminal crossbreeding systems, where heifers are not retained for herd replacements. But in continuous breeding systems, where heifers are retained as brood cows, little reduction may be feasible for inherent fattening ability.
- **Marbling and palatability**—Although marbling and palatability can be improved by conventional genetic selection, non-genetic techniques, some yet to be implemented or developed, might offer more opportunity. And marbling would become less important if practical techniques are developed to measure and merchandise tenderness, flavor, and juiciness.
- **Carcass variation**—Without question, carcass variability can be addressed through genetic selection, but that does not mean that all cattle will be alike. For purely economic reasons, beef cows are unlikely to be managed in confinement in this country. Beef cows will be managed under a variety of conditions, requiring different genetic types of cows. And there is not just one beef market but several, from white-table-cloth restaurant to fast-food, requiring products ranging from high-quality steak to ground beef.

Conclusions and Recommendations

Cow/calf producers will adjust genetic programs to create a more desirable end-product if economic signals are strong enough. However, they should not be expected to assume responsibility alone for improving the desirability of beef. All segments of the industry must work together. A more desirable product should be accomplished by:

- Intelligently choosing breeds suited to production conditions
- Judiciously selecting within those breeds for carcass merit, along with other important traits
- Implementing complementary crossbreeding systems where feasible
- Employing beneficial, cost-effective, non-genetic techniques.

Beef products can be improved through genetic selection, biotechnological manipulation, and alterations in management, harvesting, and processing. Success can come to those producers who use all these avenues to improve, document, and merchandise carcass merit.

For further reading

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