

Texas Adapted Genetic Strategies for Beef Cattle IX: Selection for Carcass Merit



Stephen P. Hammack*

More cattle are being marketed on carcass merit. This has prompted greater interest in breeding and feeding cattle that produce desirable carcasses. Improving carcass merit starts with genetic selection—choosing parents based on carcass traits.

What Carcass Traits are Important?

Consumers want beef that is tender, juicy, flavorful and lean. The primary indicators of these factors are USDA Quality Grade (which predicts eating satisfaction) and USDA Yield Grade (which predicts percent leanness, also called cutability). The most recent National Beef Quality Audit established ideal industry targets of 69 percent Low Choice or higher Quality Grade and 67 percent Yield Grades 1 or 2. The Audit found that the industry averages were 55 percent Low Choice or higher and 45 percent Yield Grades 1 and 2. Because targets for Quality and Yield Grades were not met, the Audit estimated an average industry-wide loss of \$47.73 per carcass.

Genetics of Carcass Merit

Changing carcass merit by genetic selection requires knowledge of genetic influences on carcass traits and how they are related. Research has shown that marbling (intramuscular fat, the most important factor in Quality Grade), ribeye muscle area (the best predictor of overall muscling), fat thickness over the ribeye (the best predictor of overall fatness), cutability, and tenderness are all moderately to highly heritable, so improvement should be possible if breeding stock are selected for those traits.

*Professor and Extension Beef Cattle Specialist–Emeritus,
The Texas A&M System



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

There are conflicting estimates of the genetic relationship between external fat thickness and marbling. Summaries of controlled research indicate that marbling declines somewhat as external fat is reduced by genetic selection. However, some breed associations have found little genetic relationship between fat thickness and marbling, based on field data collected for developing carcass EPD (Expected Progeny Difference, which estimates genetic transmitting ability).

Research shows that if genetic selection is used to increase marbling, it should cause a slight reduction in ribeye area, moderate improvement in tenderness, and slightly reduced cutability. However, breed association field data show little 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 will likely reduce both weaning weight and yearling weight, whereas selection for higher cutability should increase weaning weight, yearling weight, and mature cow weight. Cow-calf producers should consider these antagonisms in the context of their marketing system.

There appears to be little genetic relationship between reproductive factors and marbling, other than the fact that genetic types with more marbling also may reach sexual maturity somewhat earlier. Selection for higher cutability may have negative effects on calving rate and calving ease. Selection for extreme muscling appears to affect reproduction adversely in both males and females.

It may be possible to overcome the effects of any undesirable genetic correlations by concurrently selecting for all of the traits concerned. However, selection for more traits slows the rate of genetic change, and concurrent selection for genetically antagonistic traits slows the rate of change even more.

There are several sources of information on genetic selection for carcass merit, the most

complete being EPD. There are also some marker-assisted selection techniques. For a discussion of that topic see another publication in this series, E-352, *Texas Adapted Genetic Strategies for Beef Cattle XI: Marker Assisted Selection for Beef Improvement*.

Most breed associations have EPD for carcass weight. Some have carcass-derived EPD for marbling, ribeye area, fat thickness, Yield Grade, and percent retail product (another measure of leanness closely related to Yield Grade). Some have EPD for ultrasound measures of ribeye area, fat thickness, retail product, and intramuscular fat. Several have so-called \$Value Index EPDs that combine carcass/ultrasound measures with economic factors. A few have EPD for tenderness.

Carcass weight is closely related to yearling weight. Ribeye area and fat thickness are included in Yield Grade and percent retail product. Tenderness is certainly important in consumer satisfaction, but it is difficult or impossible for most producers to merchandise. So, in general, the most useful of these EPDs are marbling or ultrasound intramuscular fat, Yield Grade or percent retail product, and \$Value carcass indexes.

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 actually implemented?

- Researchers at the University of Nebraska compared six high-marbling and six low-marbling Angus sires. Progeny were fed until they reached the same estimated levels of fatness. The high-marbling-sire progeny gained at about the same rate, had slightly more efficient feed conversion, and were fed fewer days to reach the same fatness so slaughter weight was lighter. Yield Grades were similar, but the high-marbling sire group had a higher percent Choice grade.
- University of Florida researchers compared two groups of Angus sires. 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 had similar average birth weights, weaning

weights, carcass weights, and Yield Grades (or tenderness), but the group sired by high-EPD-marbling bulls had higher marbling scores.

- The University of Georgia studied Hereford sires with EPDs of either high-marbling/low-fat or low-marbling/average-fat. Steer progeny were fed for two lengths of time. In the group fed for the shorter time, the two sire groups averaged about the same in fat thickness and Yield Grade, but the high-marbling/low-fat group had more Choice. In the group fed for the longer time, the high-marbling/low-fat sire group had less fat and better Yield Grades. Feeding longer increased Choice 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, Angus females from a line that had been closed to outside genetics for several generations were bred either to 1) Angus sires selected for high EPDs for marbling and retail product, or to 2) sires produced in the closed line. Select-sired steer progeny had less fat cover, larger ribeye area, more marbling, and heavier carcasses.
- Pennsylvania State University researchers compared Angus sires that had high or low EPD for marbling. Offspring of the high-marbling sires had significantly higher marbling scores and a higher percentage grading Choice. There were no significant differences in any live production traits, other carcass measurements, or tenderness.
- A Kansas State University study compared high- and low-tenderness-EPD Hereford sires. There was no significant difference between the two sire groups in carcass weight, ribeye area, fat thickness, Yield Grade, marbling score, shear force, or tenderness. The researchers speculated that low EPD accuracy values (0.2 to 0.4) of sires may have affected results.

These studies reported somewhat different results, but the sire-selection criteria and research protocols also differed. This demonstrates the importance of considering more than one piece of research. Overall, these studies showed that EPD can be used effectively to improve carcass merit.



The end product of effective genetic selection is a desirable eating experience.

Possibilities for Genetic Improvement

How much genetic variation exists within a breed that could be used for genetic improvement? In Hereford, for example, the reported EPD range within the entire breed is about one and one-half degrees of marbling between the highest and lowest individuals. The top-ranking individual sire in the Hereford breed is about one degree higher in Marbling EPD than the breed average. But if a sire at the 5th percentile in the breed were selected (meaning that sire would rank higher than 95 percent of the breed), the increase in marbling of progeny would be only about one-third of a degree higher than if the sire were breed average. Other breed associations have reported similar percentile relationships.

That same picture generally holds true for other traits. So, to make significant improvement quickly in a particular trait by selecting within a breed, one of the few outstanding sires must be used. Such sires are almost always available only through artificial insemination. For the majority of commercial producers, who do not use artificial insemination, 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. Many traits are important in beef production and they are sometimes negatively related. The greatest benefit usually results from a combination of moderate levels, not extremes, of traits economically important to a particular producer.

Many factors affect carcass merit. According to the U.S. Meat Animal Research Center, important factors affecting tenderness include

genetics, age, time on feed, feed rations, growth implant programs, animal temperament, pre-slaughter techniques, slaughter procedures, electrical stimulation, chilling conditions, calcium chloride injection, blade tenderization, and carcass aging time and conditions. Genetics is only one factor in carcass merit and new nongenetic technology will probably be developed.

Economics of Improving Carcass Merit

What is the potential economic return from improving carcass merit? In recent years, improvement in Quality Grade has been stressed more than any other carcass trait. What are the economics of increasing percent Choice from 50 percent to 75 percent in a pen of fed cattle? That depends on the price difference between Choice and Select, often called the Choice-Select spread. If carcasses average 800 pounds and the spread is \$5/cwt, then every Choice carcass returns \$40 more than a Select carcass. But going from 50 to 75 percent Choice increases average return by only \$10 per carcass because only one-fourth of the carcasses increase in value. At a spread of \$10 the average increase is \$20; at a spread of \$20 the average increase is \$40.

There are also bonuses for carcasses in the premium or “certified” category (Certified Angus Beef® and others) that require grading above the lower one-third of Choice. These bonuses above Low Choice are typically in the \$5 to \$6/cwt range; Prime carcasses usually bring another \$5 to \$6/cwt above the certified programs.

What about Yield Grade? Premiums for superior Yield Grade are generally consistent but low compared to those for Quality Grade. A Yield Grade 1 typically brings \$2.50 to \$3.00/cwt more than Yield Grade 3.

In these comparisons of economic value for carcasses of differing merit it is assumed that other factors stay the same. But if producing some high-merit product adversely affects other production traits, then the effect of any carcass price premium on economic return may be diminished or eliminated. It could even result in net economic loss.

Premiums for superior carcasses may be relatively small and, considering possible trade-offs, sometimes not economically beneficial. But discounts for undesirable carcasses are not small. Discounts of \$10 to \$30/cwt carcass

are common for Standard Quality Grade, Yield Grade 4 and 5, dark-cutting lean (usually caused by pre-slaughter stress), and excessively heavy or light carcass weight. Avoiding these discounts can improve economic returns significantly.

The economic benefit of improving carcass merit can vary depending on the prevailing trait level of a particular herd. For example, in a herd that is producing some Yield Grade 4 carcasses, a slight improvement in average cutability could have significant economic benefit. But in a herd producing mostly Yield Grade 2, there is not as much to be gained. Or, as shown above, using a sire at the 5th percentile of the Hereford breed would improve marbling 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, there can be similar severe discounts 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 affecting their particular operations. However, avoiding discounts should not be the only goal. Producers should try to optimize all factors affecting production, product and cost, thereby maximizing monetary return.

Can the Problems be Solved?

The four important genetically influenced problems of beef desirability, as identified by National Beef Quality Audits, are:

- **Excess size**—Unquestionably, excess size can be genetically influenced. 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 marginal production conditions.
- **Excess fat**—Although fat can be reduced very effectively by genetic means, easy fleshing in cows is important for reproductive efficiency, at least under conditions of variable and often low-quality forage, where most beef cows are maintained. Consequently, fleshing ability should not be reduced in most herds. Much of the opportunity to reduce fat in fed cattle by 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, it is generally not feasible to reduce inherent fattening ability.

- **Marbling and palatability**—Marbling and palatability can certainly be improved by genetic selection. Nongenetic techniques, some yet to be implemented or developed, also offer opportunity. Marbling will become less important if practical techniques are developed to directly measure and merchandise factors affecting palatability, especially tenderness, rather than using Quality Grade as a predictor of palatability.
- **Carcass variation**—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 will not be managed in confinement in this country. They 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 restaurants to fast-food, each requiring products ranging from high-quality steak to ground beef.

Conclusions and Recommendations

Cow/calf producers likely will adjust genetic programs to create a more desirable end product if economic incentives are strong enough. However, they should not be expected to assume sole responsibility 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 economically important traits
- Implementing complementary crossbreeding systems where feasible
- Employing beneficial, cost-effective, nongenetic techniques

Beef products can be improved through genetic selection, biotechnological manipulation, and alterations in management, slaughtering and processing. When all these avenues are implemented to improve, document and merchandise carcass merit, improvement will result.

For further reading

To obtain other publications in this Texas Adapted Genetics Strategies for Beef Cattle series, visit the AgriLife Extension Bookstore (<http://agrilife/bookstore.org>) or the Texas A&M Animal Science Extension Web site (<http://beef.tamu.edu>).

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