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TEXAS ADAPTED GENETIC STRATEGIES FOR BEEF CATTLE IX:
GENETIC SELECTION FOR CARCASS MERIT

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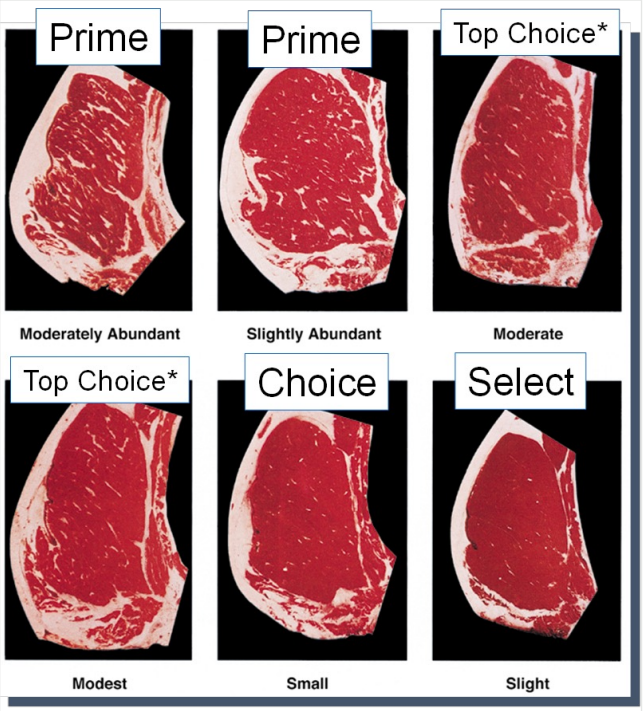

Figure 1. Degrees of beef marbling for USDA Quality Grades.

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 U.S. Department of Agriculture (USDA) Quality Grade (Fig. 1), which predicts eating satisfaction, and USDA Yield Grade (Fig. 2), which predicts percent leanness, also called cutability. Over time, Quality Grade has become more important in determining carcass value, whereas Yield Grade has become less important.

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 (best predictor of overall muscling), fat thickness over the ribeye (best predictor of overall fatness), cutability, and tenderness are all moderately to highly heritable. Therefore, improvement should be possible if breeding stock are selected for those traits.

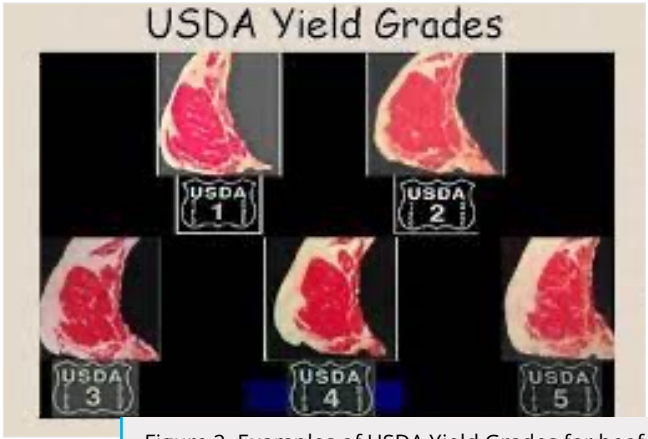

Figure 2. Examples of USDA Yield Grades for beef.

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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 the 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 slightly 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 Expected Progeny Difference (EPD), which estimates genetic transmitting ability.

Research also shows that if genetic selection is used to increase marbling, it could cause a slight reduction in ribeye area, moderate improvement in tenderness, and slightly reduced cutability. However, breed association field data shows 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 likely will 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 production and 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, with the most complete being EPD. There also are some marker-assisted selection techniques. For a discussion of that topic see another publication in this series: *Texas Adapted Genetic Strategies for Beef Cattle XI: Marker Assisted Selection for Beef Improvement (ANSC-PU-040)*.

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. A few have EPD for tenderness. Several have $Value Index EPDs that combine carcass or ultrasound measures with economic factors. Use of these $Value Indexes allows effective selection for several economically important traits simultaneously using the genetic associations between them and the economic values associated with those traits. Using $Value Index EPDs is the best way to improve overall carcass merit specifically, or performance in multiple traits in general.

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 for most producers to merchandise. Thus, in general, the most useful of these EPDs are marbling or ultrasound intramuscular fat, Yield Grade or percent retail product, and $Value Indexes for carcass.

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 explicitly 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-

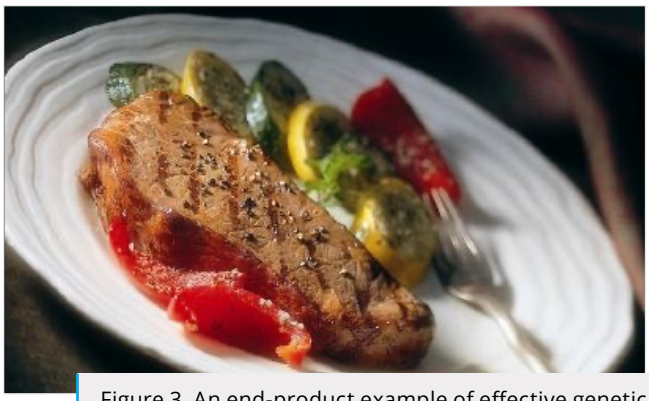

Figure 3. An end-product example of effective genetic selection is a desirable eating experience.

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 Grade. 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 Grade in both groups. Therefore, 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, 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 sample of research. Overall, these studies showed that EPD can be used effectively to improve carcass merit and a desirable eating experience (Fig. 3).

POSSIBILITIES FOR GENETIC IMPROVEMENT

How much genetic variation exists within a breed that could be used for genetic improvement? For example: In Hereford, the reported EPD range within the entire breed is 1.65 degrees of marbling between the highest and lowest individuals. The top-ranking individual sire in the Hereford breed is about 1 degree higher in Marbling EPD than the breed average; but if a sire at the fifth 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 1/4 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. Therefore, to make a significant improvement quickly in a particular trait by selecting within a breed, one of the few outstanding sires must be used. Such sires almost always are available only through artificial insemination (AI). For the majority of commercial producers (who do not use AI), the fastest genetic change can be made by using superior sires from a breed noted for high expression of a specific trait. However, it must be understood 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 that are 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, chilling conditions, and carcass aging time and conditions. Genetics is only one factor in carcass merit. New, non-genetic technology probably will be developed.

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. Discounts for heavy carcasses once started at 900 pounds and heavier, but in recent years have been at 1,050 pounds. 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. Also, 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 certainly can be improved by genetic selection. In recent years, more progress overall has been made in marbling than in any other carcass trait (principally driven by economics and demand), but it seldom impacts producers who sell at weaning. Most of the progress has been through sire breeds used in crossbreeding. Non-genetic techniques—some probably 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. However, for the near future, Quality Grade will continue to be the main indicator in the industry 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, most beef cows will not be managed in confinement in the U.S. 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 high-end "white-tablecloth" restaurants to fast-food, each requiring products ranging from high-quality steak and roast to ground beef.

Figure 4. A USDA Prime, Yield Grade 1 carcass.

CONCLUSIONS AND RECOMMENDATIONS

Cow-calf producers likely will adjust genetic programs to create a more desirable end-product if economic incentives are strong enough (Fig. 4). 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, non-genetic techniques.

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