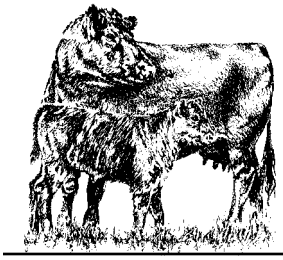

Western Beef Resource Committee *Fourth Edition*

Cattle Producer's Handbook

Genetics Section 842

Using Carcass Data in the Cowherd To Make Genetic Improvement Decisions

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Returns to cow-calf producers are increasingly being tied to the quality of the beef products ultimately derived from the calves sold. Carcass data demonstrating quantity and quality of past calf crops sold can be used to estimate future performance on the rail. The appeal of any carcass will vary depending on the intended market. Some markets require Choice or Prime quality grades, while others may place a premium on yield grade with little regard to quality grade.

The first step in using carcass data for genetic decisions in the cowherd is to determine the desired carcass characteristics or attributes for your market. Cattle producers participating in alliances or other forms of vertical or coordinated integration will usually have clear guidelines for desired carcass attributes. The National Beef Quality Audit conducted in 2005 identified attributes that would be reasonable targets for U.S. beef producers (Table 1). After determining which type of carcass fits a local market, producers then have specifications to compare with their herd's production.

Table 1. Suggested standards or goals for carcass traits.

Carcass traits	Industry goals
Carcass weight (lb)	600-850 (ideal 725-750)
Quality grade (%)	
Prime	7
Choice	21
Choice –	34
Select +	38
Standard	0
Yield grade, %	
YG 1	14
YG 2	53
YG 3	32
YG 4	1
YG 5	0
Ribeye area (sq in)	11 to 15
Fat thickness (inches)	0.2 to 0.4

Source: 2005 National Beef Quality Audit.

The ideal way for producers to obtain carcass data on their herd is to collect the data on the entire calf crop once the calves are finished and harvested. This information is sometimes difficult to obtain unless producers have developed a good rapport with the feeder and processor. Retained ownership of calves may provide another avenue to obtain carcass data. Steer futurities, such as ranch to rail programs, can provide limited carcass quality data, but usually the number of calves is restricted and variation may lead to mistaken conclusions.

Ultrasound carcass measurements of calves at weaning or as stockers usually are not valid in predicting final carcass attributes since many carcass traits such as backfat and marbling are affected by how the calves are finished. If using ultrasound measurement, the ideal time to collect the data is once the calves are finished and just before they are shipped to the processor for harvest.

Occasionally, group data for a lot or pen of cattle may be available from the processor when individual data cannot be collected. While inferior to individual data, group data represents an average, and some inferences about the herd's carcass attributes may be made.

Generally, producers will find carcass data far more extensive than growth data, which are typically birth weaning and yearling weights. The large amount of carcass data can be difficult to manage without handling by computers. Fortunately, the common computer spreadsheet is adequate to handle most carcass data processing. Spreadsheets offer the producer the ability to develop indexes, which allow each animal to be compared to the average of all carcasses in the herd. When using indexes, anything over 100 is above average and anything below 100 is below average. This then gives the producer a numeric measurement to use in determining which cows will go with which bull and

even which cows may need to be culled on the basis of poor production.

What do I need to measure?

Five carcass attributes will provide a substantial basis for assessment: carcass weight, ribeye area, quality grade, yield grade, and back fat thickness. These attributes are most likely tied to market price, and thus improvements may result in increased financial return. Tenderness is an important attribute of beef but is difficult to measure and is usually not related to market prices, and therefore may be better addressed through DNA analysis (see later).

Producers should summarize each of these five carcass attributes by determining an average and estimated variability by the high and low, range or standard deviation (Table 2). Table 2 shows that the majority of steer carcass values in a study of five ranches, when averaged for the entire ranch, were within the range for suggested standards. However, the percentage of carcasses within the suggested range for all five carcass categories varied from 8 to 31 percent (Drake and Forero 2001).

Steers must be kept separate from heifers in the calculations. It is important for not only the average to meet the desired levels, but there should be little variability as measured by no or few individuals either too high or too low. A final assessment can consist of a percentage of carcasses that meet the desired levels for all of the five attributes (Table 2). The goal is carcasses that satisfy all of the desired attributes since consumer dissatisfaction can arise from just a single undesirable attribute.

A note of caution must be raised since numerous factors may influence carcass attributes. Therefore, carcass data from a single year must be viewed with caution. The primary management factors that will influence carcass traits include: breed composition of the herd, pre-weaning management, post-weaning management, feedlot days on feed, feedlot rations, animal health status throughout the pre- and post-weaning feeding period, as well as other environmental factors that may vary. Therefore, before crediting improvements or declines in carcass quality to genetic changes, consider whether management changes may have accounted for the differences.

What does my carcass data mean?

Carcass Weight

Carcass weight is an indicator of the amount of lean meat the carcass will yield. Heavier carcasses generally produce more product. However, heavy carcasses may also tend to carry waste in the form of excess fat deposits and increased bone content. Carcass weight is also used in calculation of yield grade. In traditional "commodity" markets, carcass weight is an important carcass attribute. It is also one of the categories most often discounted, if the carcass weight falls outside the 600- to 850-pound target.

From a processing efficiency standpoint, larger carcasses are more efficient in processing time and labor. However, most retail markets have minimum and maximum sizes of specific cuts, so there is a range of acceptable carcass weights. Additionally, larger carcasses produce larger hides that are of greater value. Carcass weights outside the desired range will result in increasingly severe discounts.

Due to the genetic correlation among weight, frame size, and carcass weight, many producers selecting for increased growth, by default, select for both increased carcass weights and increased mature weights for retained replacements. Using expected progeny difference (EPD) for carcass weight, producers can select sires or dams for smaller or larger carcasses depending on their needs. If smaller carcass weight EPD sires are used, there may be decreases in weaning weight due to the genetic correlation among these traits. When using carcass weight EPDs, attention must be given to the corresponding EPDs for weaning, yearling, and mature weights and frame score to ensure that improvements in one trait do not lead to defects in another.

Another way to increase carcass weight is to use terminal sires. Producers with small cows, which may be appropriate for their environment, may also produce

Table 2. Carcass attributes summarized with an average and standard deviation demonstrating variability in samples representing five (5) ranches in northern California (outliers are in *bold italic*).

			RANCH				
			A	B	C	D	E
	Suggested standards*				Steers		
Number	Lower	Upper	129	130	243	107	55
Carcass wt (lb)	600	800	754±6.4	765±6.4	798±4.6	***871±7.0***	756±9.7
Yield grade	1.5	3.5	3.05±.04	3.00±.04	3.37±.03	3.45±.05	3.06±.06
Ribeye area (sq in)	11	15	12.9±.12	14.0±.12	13.1±.08	14.1±.13	13.5±.18
Backfat thickness (inches)	0.1	0.6	0.43±.02	0.44±.02	0.55±.01	0.56±.02	0.44±.03
Marbling score	4.7 (Sel.+)		***4.6±.06***	***4.6±.06***	4.8±.04	5.0±.06	***4.6±.09***
% meeting all 5 criteria			26	26	16	8	31

± represents standard deviation: 2/3 of the carcasses will be between minus the value or plus the value shown. For example 754 ± 6.4 means 2/3 of the carcasses were between 747.6 and 760.4 pounds (Drake and Forero 2001).

**Note:* This research was conducted in 2001 and the results reported here are not reflective of the suggested standards in the most recent NCBA Beef Quality Audit.

calves with carcasses that are too small for industry standards when bred to comparable small-framed bulls. Using a larger framed bull can increase carcass weight of offspring. However, if replacement heifers are kept from this cross, it will also eventually result in larger-framed cows.

Also, if large-framed terminal sires are used on heifers, calving problems could occur. This can be minimized by using only mature cows that have attained mature pelvic size. When adult cows are bred to larger-framed terminal sires, they usually do not have calving difficulties and produce calves with intermediate weaning and carcass weights. When "terminal" sires are used, the temptation to retain heifers must be strongly avoided.

Ribeye Area

Ribeye area is measured as the surface area of the *Longissimus dorsi* or ribeye muscle between the 12th and 13th rib. Ribeye area is an indicator of the overall musculature of the carcass. As the ribeye area increases, generally the overall yields of meat in the wholesale cuts increase, leading to a lower yield grade.

It is possible to find carcasses with ribeye areas that are too large to meet today's consumer needs. In order to achieve a satisfactory cooking and eating experience, steaks need to have a minimum thickness. For an 8 to 12-ounce steak to meet a thickness requirement of one inch, the ribeye area needs to be 12 to 15 sq in (Dunn et al. 2000). If the ribeye area is too large, steaks cut to the desired thickness are too large and costly for the consumer and are harder to cook by the restaurateur to the desired doneness. Conversely, if cut to the desired weight (8-12 oz), the steaks end up being too thin and tend to be dry and unpalatable.

Ribeye size tends to increase with larger carcasses. To compare the ribeye size of different carcasses it is necessary to convert them to a common carcass weight (ribeye area per hundredweight). This is accomplished by dividing the ribeye area by the carcass weight, then multiplying by 100 (e.g. 13.5 sq in/750 lb carcass x 100 = 1.8 in^2/cwt). This calculation can also be performed on live animals if using ultrasound evaluation. A good method to use for selection purposes is that the ribeye area per hundredweight of live weight should be 1.0 or slightly greater.

Quality Grade

Quality grade is determined by the amount of marbling or intra-muscular fat (IMF) between the 12th and 13th ribs. In young finished cattle marbling is subjectively estimated by a USDA grader, and then converted into the appropriate quality grade. For calculation purposes, marbling and quality grades are converted into numerical scores, and marbling is usually the measurement of interest (Table 3).

Variability within a marbling score is denoted by using a superscript such as $Small^{20}$. This represents where within the range of "small" marbling the carcass falls. Since a "small" marbling score is represented by the numeric score range of 5.0 to 5.9, there can be considerable variability within the numeric scale. Thus, a "$Small^{20}$" visual score would convert to a 5.2 numeric score, and a "$Small^{80}$" would represent a 5.8 numeric score. This allows for some fine tuning of the visual score system.

Table 3. Numeric equivalents between USDA quality grade, visual marbling appraisal, and marbling score.

Quality grade*	Marbling	Score
Prime	Abundant	10.0 – 10.9
Prime	Moderately abundant	9.0 – 9.9
Prime	Slightly abundant	8.0 – 8.9
Choice	Moderate	7.0 – 7.9
Choice	Modest	6.0 – 6.9
Choice	Small	5.0 – 5.9
Select	Slight	4.0 – 4.9
Standard	Traces	3.0 – 3.9
Standard	Practically devoid	2.0 – 2.9

Source: Beef Improvement Federation Guidelines for Uniform Beef Improvement Programs. 2006.

Table 4. Relationship between marbling score and percentage of intramuscular fat.

Marbling score	Intramuscular fat (%)
Slightly abundant	10.13
Moderate	7.25
Modest	6.72
Small	5.04
Slight	3.83
Traces	2.76

Source: Beef Improvement Federation Guidelines for Uniform Beef Improvement Programs. 2006.

If using ultrasound evaluation of finished cattle, Table 4 outlines the percentage of intramuscular fat (% IMF) required to attain the various visual marbling scores. Since these are already numeric scores, they can be used directly for evaluation purposes.

Specific DNA tests for markers that are associated with genes for marbling are available. Current research has verified that some of these markers are associated with increases in quality grades. However, research also suggests a number of genes determine marbling.

The best method to target improvement of a suite of genes is by the use of EPD. Marbling EPDs incorporate both actual carcass data from sires' progeny and ancestors and their own ultrasound data, and therefore are the preferred EPD for improved marbling. Ultrasound marbling (usually published as "IMF") will provide additional information when the accuracy of the marbling EPD is low. Genetically, marbling is not closely associated with fat cover (external fat), and individuals can be selected that excel in marbling while maintaining acceptable fat cover (see 1041 for more details).

Yield Grade

Yield grade (YG) estimates the amount of boneless, closely-trimmed, retail cuts (BCTRC) that a carcass is

Table 5. Relationship between yield grade (YG) and boneless, closely-trimmed, retail cuts (BCTRC).

Yield grade	% BCTRC
1	≥ 52.3
2	52.2 – 50.0
3	49.9 – 47.7
4	47.6 – 45.4
5	< 45.3

Source: Hicks 2007.

likely to yield. Yield grades range from 1 to 5, with a YG1 yielding the most retail cuts and a YG5 yielding the least (Table 5). Typical USDA reporting gives only whole numbers for YG, but carcass data being used as selection criteria should use YG to the closest one-tenth (e.g., 2.3 YG) rather than whole numbers.

YG is calculated on the basis of the amount of external fat cover or fat thickness, the percentage of fat in the kidney, pelvic and heart areas, the ribeye size, and carcass weight. Fat thickness is the most influential factor affecting YG. As external fat covering increases, yield grade increases. This translates into more waste on the trim floor and a lower percentage of boneless, closely-trimmed, retail cuts from the carcass.

Since YG is a combination of carcass attributes, each of those attributes could be the target of selection. Fat thickness and ribeye area are the attributes that have readily available EPDs from breed associations. The genetic correlations between both fat thickness (-0.85) and ribeye area (0.59) with the American Angus Association's percent retail product, which is very similar to yield grade, shows that using those EPDs particularly for fat thickness will be nearly as effective as using percent retail product EPD itself. Each of these traits has about the same heritability (about 0.25). Note that external fat thickness is not closely associated to marbling (intramuscular fat) so producers can select for less external fat with EPDs without significantly impacting marbling.

Fat Thickness

Fat thickness (backfat thickness) is measured as the amount of fat outside the ribeye at the cut surface between the 12th and 13th ribs. As previously stated, fat thickness is used to calculate yield grade. As the fat thickness increases, yield grade also increases leading to a less desirable carcass. External fat over about 0.2 inch is generally considered a waste product. However, some external fat is important in providing protection against cooler shrink and to aid in the aging process.

External fat is the source of stored energy for cows. The ability to store excess energy as fat is important. The cowherd needs to retain the ability to store fat for times of seasonal fluctuations in nutrition. Producers should avoid reducing the genetic capability to store external fat too much, which would likely result in "hard-doing" cows. These cows would be thin and are likely to have reduced reproductive capacity and milking ability.

Other Factors to Consider

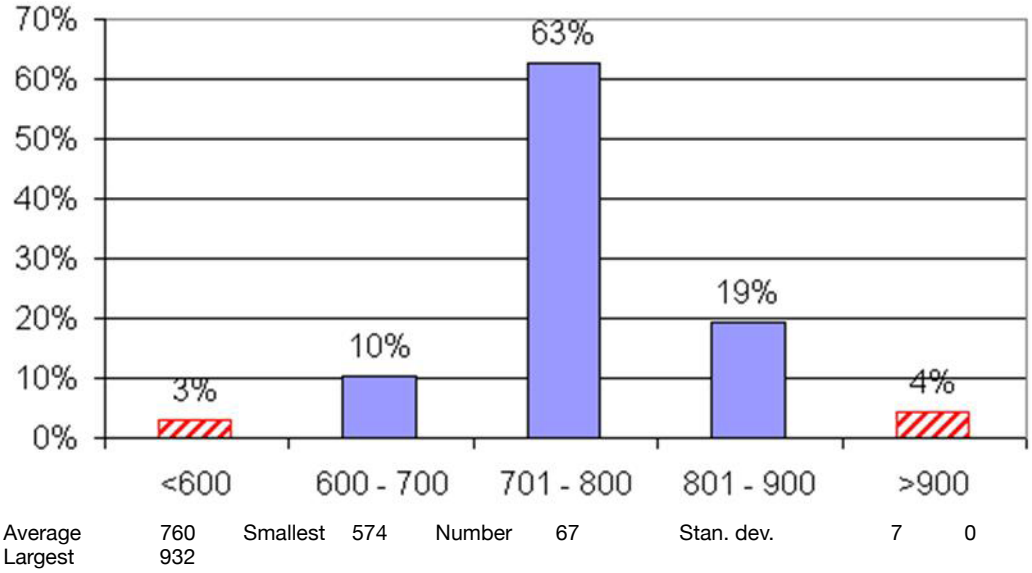
Uniformity

Uniformity of carcasses produced within a specific herd is a valuable marketing tool. It is also one of the more difficult things to measure since carcass data collected across a number of years and from different feeding regimes may lead to erroneous conclusions. For this reason, cattle producers should try to form long-term relationships with the entities that feed out their calves so that these variations can be minimized.

Averages for carcass traits help describe the overall group but poorly depict uniformity. Fig. 1 demonstrates this point well. The average carcass weight, 760 pounds, is ideal, but 7 percent of the carcasses in this fictional group of cattle were too small or large.

Assessing variation may help to prioritize which carcass traits need to be the focus for future improvement. Those traits with the largest variation may be the highest priority to improve. If average carcass values are within a producer's desired range,

Fig. 1. Graphic depiction of the variation within a fictional group of cattle together with the statistical values such as average, standard deviation, smallest, largest, and the number of cattle shows how pen averages can be misleading. In this example, 3% of the carcasses were smaller than the standards, with 4% too large.



then reducing the variation may become the goal of improvement plans.

Carcass data from five ranches (Table 2), all finished at the same feedlot and processed at the same plant and with at least 50 percent Angus breeding, show that the average values may be within standards, while the number of cattle that satisfy all of the standards was relatively low and varied. Ranches C and E had average carcass values within standards, however, twice as many ranch E cattle satisfied all of the criteria, indicating much greater uniformity.

As the variation within a herd is reduced, the ability of the calves from that herd to "fit" into a marketing grid will improve. Attention can then be paid to improvement of those traits, which will move those calves into a higher price category within the grid.

Much variability within a herd is a function of management and can be reduced as management improves. Factors such as calving season length, animal health program, and stress management of the herd will impact uniformity, as will days on feed and genetic factors such as breed. Genetically, consistency of sire breeds and selection of sires with similar carcass EPDs will assist with uniformity. When possible, records of female production could allow selective mating to correct carcass deficiencies on the female side. Culling those females that consistently produce calves with poor carcasses would also increase uniformity.

Tenderness

Tenderness is an important attribute of beef but is difficult to measure. The standard test has been a measure of the shear force of a meat sample (Warner Bratzler Shear Force test). More recently DNA tests have been developed for genes involved in tenderness. Research suggests the markers these tests use are influential in tenderness. Using bulls with favorable genes and testing replacement heifers could improve overall tenderness.

Breed associations do not currently have EPDs for tenderness, and the data are difficult to collect. A very limited number of associations publish EPDs for Warner Bratzler Shear Force. Therefore, DNA tests are good approaches for improving tenderness. Currently, tenderness is not receiving widespread marketing premiums, but that may change with time.

Conclusions

Carcass data can be used when making genetic decisions for the cowherd in a step-by-step process:

1. Obtain carcass data from progeny and prepare summary statistics and graphs (Table 2 and Fig. 1).
2. Assess carcass data in light of desired carcass standards for the producer's market objectives.
3. Determine actions that will change genetics to improve the assessed carcass deficiencies. These might include breed choices, EPD levels, crossbreeding, terminal sires, DNA-based marker selection, selective breeding, and culling.
4. Consider management factors appropriate for the assessed changes such as preventative health programs, length of the calving season, breeds, and breeding schemes.
5. Re-examine selection plans and criteria for possible negative impacts on growth or reproductive traits.
6. Evaluate changes in carcass quality over time; modifying goals and plans as appropriate.

As the beef industry and niche markets continue to evolve, they will provide producers with opportunities to target their production for specific end-products, potentially resulting in greater demand and price for their cattle. Vertical coordination and alliances with other segments in the production chain enhance the opportunities for the cow-calf producer to obtain carcass data. New EPDs and genetic tests offer improved tools to change herd genetics based on carcass data and market standards. Genetic composition of the product arises solely from the genetic decisions made by the cow-calf producer.

Literature Cited

Beef Improvement Federation. 2006. Guidelines for Uniform Beef Improvement Programs. Available at: http://www.beefimprovement.org/library/06guidelines.pdf Accessed: Aug. 25, 2007.

Drake, D. J., and L. C. Forero. 2001. Meeting carcass quality specification and carcass characteristic of Northern California cattle in alliance, futurity and youth programs. Proc. West. Sec. Amer. Soc. Anim. Sci. 52:239.

Dunn, J. L., S. E. Williams, J. D. Tatum, J. K. Bertrand, and T. D. Pringle. 2000. Identification of optimal ranges in ribeye area for portion cutting of beef steaks. J. Anim. Sci. 78:966.

Hicks, C. 2007. Understanding beef carcass reports. Univ. of Georgia Coop. Ext. Bull. 1326. Available at: http://pubs.caes.uga.edu/caespubs/pubcd/B1326/B1326.htm#YieldGrade Accessed: Sept. 23, 2008.

National Cattlemen's Beef Association. 2006. 2005 National Beef Quality Audit. As quoted by K. E. Belk. Available at: http://meat.tamu.edu/nonconform/BelkNBQA.pdf Accessed: Oct. 25, 2007.

Fourth edition; December 2016 Reprint