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Understanding Beef Carcass Information

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Introduction

Calves weaned on cow-calf operations throughout Arkansas eventually move on to stocker, feedlot and packer operations. Wide variations in carcass uniformity and consistency exist among these calves. Potential carcass problems can include inappropriate carcass size and weight, inadequate tenderness, insufficient intramuscular fat (marbling) and excess external fat cover. Many of these quality challenges facing the beef industry can be addressed through use of beef carcass information (parental and progeny) and improved genetic selection practices.

With information flow increasing throughout the beef industry, it is becoming increasingly important to learn more about how cattle perform postweaning. Producers who can provide carcass information to potential buyers will be in a position to be rewarded for producing a quality product. Carcass traits are an important consideration in bull selection, particularly when cattle ownership is retained and cattle are sold on value-based carcass grids.

Carcass Measurements

Understanding beef carcass information begins with understanding how individual carcass traits are measured and how they impact carcass grades and product value.

Hot Carcass Weight

Hot carcass weight (HCW) is the hot or unchilled weight after harvest and removal of the hide, head, gastrointestinal tract and internal organs. Hot carcass weight is sometimes simply reported as carcass weight. Carcass weight is a major factor in the determination of carcass value when cattle are sold on a dressed weight basis or on a grid. Carcass weight is also used in Yield Grade calculations to estimate carcass cutability.

Heavyweight (> 1,000 pounds) and lightweight (< 600 pounds) carcasses do not fit packer specifications and are severely discounted. Carcass size is genetically influenced and can be changed with an emphasis on frame size and growth rate in breeding decisions. Furthermore, breeding decisions should target carcass weights within the previous range when a desired finish is achieved. Breeding animal selection should also consider matching size of cattle to nutritional resources, because animal nutrient requirements increase with increasing cow size.

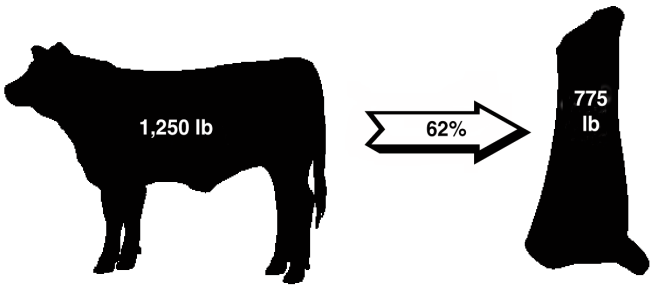
Dressing Percentage

Dressing percentage is hot carcass weight as a percentage of the live weight of the animal at harvest. Dressing percentage typically ranges from 60% to 64% for the majority of fed cattle and averaged 63% for the steers enrolled in the 2006-2007 Arkansas Steer Feedout Program

(Barham et al., 2008). Higher dressing percentages are preferred. To calculate dressing percentage, hot carcass weight is divided by animal live weight and expressed as a percentage. For example, if a 1,250-pound steer produces a 775-pound carcass, then the dressing percentage would be:

775 ÷ 1,250 × 100% = 62%.

Likewise, animal live weight times the dressing percentage yields the carcass weight (Figure 1).



1,250 lb steer x 62% dressing percentage = 775 lb carcass

Figure 1. Dressing Percentage Example

Ribeye Area

Ribeye area (REA) is an indicator of muscling and an important factor in determination of Yield Grade. As ribeye area increases, retail product yield increases. Ribeye area is determined by measuring the area of the *longissimus dorsi* (ribeye) muscle exposed by cutting or "ribbing" the carcass between the 12th and 13th ribs (Figure 2). Ribeye area is expressed in square inches.

An optimum range for ribeye area is 11 to 15 square inches. For average muscled cattle with average dressing percentage, live weight for these cattle would be approximately 967 to 1,500 pounds.

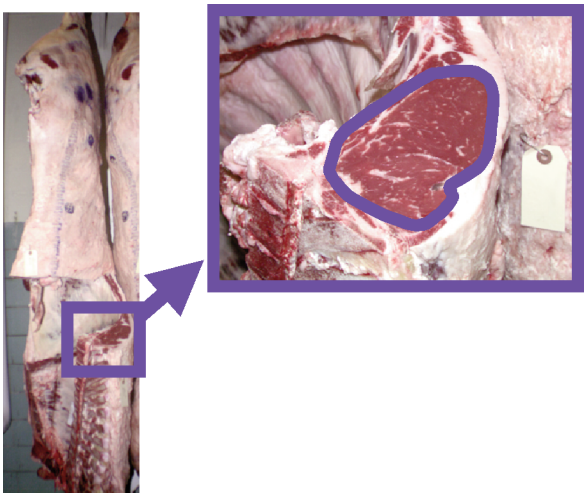
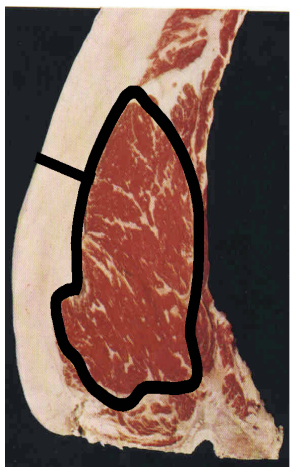


Figure 2. Ribeye Area Exposed for Measurement

However, it is advantageous to achieve these ribeye areas with cattle to avoid live weights on these extremes. Ribeye area targets should be approximately 1.6 to 1.9 square inches per 100 pounds of carcass weight for 900-pound to 550-pound carcasses, respectively. Results from the 2006-2007 Arkansas Steer Feedout Program showed the ribeye area per 100 pounds of carcass weight averaged 1.64 square inches.

Fat Thickness

Fat thickness, otherwise referred to as backfat, is a measure of external fat thickness on a carcass. External fat is the most important determinant of retail yield and therefore Yield Grade. Fat thickness is measured at a point three-fourths of the length of the *longissimus dorsi* muscle from the split chine bone (Figure 3). As fat thickness increases, cutability decreases resulting in less desirable Yield Grades and decreases in percentage of retail product. Cutability is the percentage yield of closely trimmed, boneless cuts. Excessively low amounts of external fat on a beef carcass are undesirable as well, as this can increase the risk of cold shortening (chilling of the carcass too rapidly, leading to increased toughness). An optimum range for fat thickness is 0.2 to 0.5 inch with a good target being 0.3 inch. Arkansas Steer Feedout Program steers averaged 0.52 inch of backfat.



Fat thickness = 1.1 inches

Fat thickness = 0.2 inch

Figure 3. Differences in Fat Thickness

Internal Fat

Kidney, pelvic and heart (KPH) fat is also referred to as internal fat. Internal fat or KPH fat is expressed as a percentage of hot carcass weight. Carcass % KPH is used in Yield Grade determination. The percentage of retail product yield decreases as KPH fat increases.

Intramuscular Fat

Intramuscular fat (IMF) is often called marbling. Marbling refers to the flecks of fat within the muscle tissue. Sufficient marbling is important for beef tenderness, juiciness and flavor. Degree of marbling is the primary factor determining Quality Grade in market age animals. For official grading purposes, marbling is assessed in the *longissimus dorsi* muscle cut and exposed between the 12th and 13th ribs. Each marbling score is divided into 100 subunits. Superscripts ranging from 00 (least amount of marbling) to 99 (greatest amount of marbling) are assigned to marbling scores.

Maturity

Maturity is another factor affecting carcass Quality Grades. The physiological maturity of a carcass is determined by evaluating the size, shape and ossification of bone and cartilage (especially the split chine bone) and the color and texture of the lean tissue. Physiological age may not be the same as the actual animal age, so this is an estimate of actual animal age. Carcass maturity is scored using letters A through E, with A being the least mature and E being the most mature (Table 1). Carcasses displaying advanced skeletal maturity are referred to as "hardbones," and associated price discounts normally apply.

Table 1. USDA Maturity Scores and Associated Cattle Ages

Maturity Score	Cattle Ages
A	9 to 30 months (2 1/2 years)
B	30 to 42 months (2 1/2 to 3 1/2 years)
C	3 1/2 to 6 years
D	6 to 8 years
E	Greater than 8 years

Tenderness

Inadequate tenderness of beef was cited as the No. 1 quality challenge facing the beef industry. Although tenderness is not used in Quality or Yield Grade calculations, it plays a key role in consumer satisfaction. Tenderness is objectively measured with a Warner-Bratzler shear force device. A good industry target for tenderness is a Warner-Bratzler shear force value below 6 pounds. Acceptable shear force values depend in part on where and how the product will be marketed. Certainly, fine dining establishments would typically have higher standards for beef tenderness than lower-end restaurants. There is likely to be an increased emphasis on selection of cattle for beef tenderness. To this end, an effort is underway to identify genetic markers for tenderness and develop selection tools based on this information.

USDA Beef Carcass Grades

Quality Grade

Marbling and carcass maturity are determinants of Quality Grade. Better Quality Grades are achieved with higher degrees of marbling and younger carcass maturity (Table 2, page 4). Note the differences in marbling at the same level of maturity between the different Quality Grades in Figure 4. It is important to note that B maturity carcasses with small or slight marbling are Standard Quality Grade, whereas A maturity carcasses are Choice and Select Quality Grades, respectively.

Figure 4. Beef Quality Grades at Various Degrees of Marbling

Beef Quality Grades are typically divided into thirds or halves for meat judging, carcass evaluation and value-based marketing programs. The most common divisions in order from the highest quality grade to the lowest quality grade are:

- ✓ Prime (thirds)
- ✓ Choice (thirds)
- ✓ Select (halves)
- ✓ Standard (halves)
- ✓ Commercial (thirds)
- ✓ Utility (thirds)

Symbols often used to designate these grade divisions are: + (high), o (average) and – (low). For example, Choice– indicates the lower one-third of the Choice grade. A "no roll" category refers to all carcasses that do not meet the requirements for the USDA Select grade and would likely grade USDA Standard if graded. A grade stamp is not rolled on

Table 2. Effects of Maturity and Marbling on Beef Carcass Quality Grade[1]

Degrees of Marbling	Maturity[2]				
	A[3]	B	C	D	E
Very abundant					
Abundant		Prime			
Moderately abundant					
Slightly abundant	Prime			Commercial	
Moderate		Choice			
Modest	Choice				
Small				Utility	
Slight	Select	Standard			
Traces					
Practically devoid	Standard			Cutter	

[1]Assumes that firmness of lean is completely developed with the degree of marbling and that the carcass is not a "dark cutter."
[2]Maturity increases from left to right (A through E).
[3]The A maturity portion is the only portion applicable to bullock carcasses.

these carcasses. Bull beef is not quality graded, and cow beef is not eligible for the Prime grade. In addition, Commercial, Cutter and Canner grades are not applicable to bullock beef.

Yield Grade

Yield Grades classify carcasses for differences in cutability or yield of boneless, closely trimmed retail cuts from the round, loin, rib and chuck. The five Yield Grades are numbered 1 through 5. Carcasses in Yield Grade 1 have the highest cutability, while carcasses in Yield Grade 5 have the lowest cutability.

The Yield Grade of a beef carcass is determined by considering four characteristics: (1) the amount of external fat (backfat), (2) the amount of kidney, pelvic and heart fat, (3) the area of the ribeye muscle and (4) the hot carcass weight (Table 3). Yield Grades are based on the following equation:

Yield Grade = 2.50 + (2.5 × adjusted fat thickness, inches, 12th rib) + (0.2 × percentage kidney, pelvic and heart fat) + (0.0038 × hot carcass weight, pounds) – (0.32 × area of ribeye, square inches)

Carcass Defects

Dark Cutters

Dark-cutting meat is characterized by a color that ranges from dark red to nearly black and has both a sticky texture and a high water-holding capacity. Dark-cutting beef results from low muscle glycogen at the time cattle are slaughtered. Glycogen depletion in muscles of cattle can be caused by strenuous muscular activity, stress-induced adrenalin secretion and rather severe energy restriction for several days prior to slaughter. Colorado State University research indicates that highly excitable cattle are more likely to produce dark cutter carcasses than calmer cattle.

The greatest problem with dark-cutting beef is consumer rejection because of its color. It has significantly shorter shelf life than normal beef and greater water-holding capacity, which are more conducive to bacterial growth. For these reasons, dark-cutting beef is severely discounted.

Table 3. Effects of Various Factors on Beef Carcass Yield Grade

Characteristic Affecting Yield Grade	Change in Characteristic	Resulting Change in the Numerical Yield Grade
Fat thickness	Increase	Increase
Percent of kidney, pelvic and heart fat	Increase	Increase
Carcass weight	Increase	Increase
Ribeye area	Increase	Decrease

Blood Splash

"Blood splash" is a term used to describe localized hemorrhaging within the muscles of a beef carcass. This condition results when the capillaries in the muscles rupture due to abnormally high blood pressure before exsanguination (draining of blood). Lengthy delays between stunning and sticking during harvest may cause this condition.

Callused Ribeyes

Trauma to the *longissimus* muscle can result in "callused" ribeyes. Connective and fatty tissues can spread into areas of damaged muscle creating a callus or section of fatty tissue within the muscle. Improper use of pour-on medications is another potential source of calluses.

Trim Loss and Bruising

Trim loss can have a considerable impact on carcass value, particularly when high-value sections of the carcass are involved. Trim loss is often due to deep tissue bruising or severe abscesses. Trimming that damages the major muscle groups of the wholesale round, loin, rib or chuck is considered a "major" defect. Following Beef Quality Assurance guidelines (e.g., adhering to recommended injection site locations) and using proper animal handling techniques can help minimize trim loss and bruising.

Selection for Carcass Traits

Selection Effectiveness

Carcass traits such as fat thickness, ribeye area, cutability, marbling and tenderness are all moderately to highly heritable (genetically transmittable to calves). As a result, rapid genetic change in carcass merit is possible by the selection of breeding stock. By comparison, reproductive traits are generally less heritable than carcass traits, and genetic improvement in reproductive traits proceeds at a slower rate. Heterosis effects for reproductive traits, however, are higher than for carcass traits. In other words, improvement in carcass traits through crossbreeding is less effective than improvement in reproductive traits through crossbreeding.

Performance Tradeoffs

When selecting for carcass traits, there are performance tradeoffs. Selection for reduced fat deposition can increase lean yield and simultaneously decrease marbling percentage. In addition, selection for increased carcass leanness can negatively affect fertility in beef females. These performance tradeoffs are not always set in stone. There are bulls with desirable levels of performance for both lean yield and marbling or both lean yield and fertility, but it can be more challenging to find these sires.

Reducing fat thickness can be accomplished through genetic selection and management. However, a balance must be struck with reproductive efficiency. As fleshing ability is decreased, reproduction can suffer, particularly under less than optimum nutritional programs. Daughters of sires selected for reduced fat trim often reach puberty later, require more services per conception and have an increased gestation length that could inflate birth weights and increase the risk of calving difficulty. Reducing fat thickness through genetic selection can be appropriate, though under a terminal crossbreeding system where no heifers are retained as replacements.

Expected Progeny Differences

Expected progeny differences (EPDs) are an effective genetic selection tool for improving carcass traits. Several breed associations publish EPDs for live animal ultrasound and carcass measures, including carcass weight, marbling, ribeye area, rib fat thickness and percent retail product. Tenderness, grid merit and value-based EPDs that account for different cumulative carcass trait goals are also available for certain breeds. When used in conjunction with EPDs for other economically important traits and visual appraisal, carcass EPDs can be a valuable part of a balanced selection approach. Likewise, since carcass traits are moderately to highly heritable, investments in breeding animals can pay direct dividends for increased value of progeny sold.

Sources of Carcass Information

Live Animal Ultrasound Scanning

For cow-calf producers, collection of carcass data has historically been done using progeny testing, requiring a bull's calves be harvested for data collection. This was a slow, tedious, expensive process to "prove" a sire. Ultrasound carcass scanning technology allows objective carcass information to be collected on live animals instead of having to wait until cattle are harvested to obtain carcass information. Ultrasound scanning of live cattle allows a sire to be "proven" for carcass merit in a shorter period of time with less expense. In addition, feedlots can use ultrasound data to identify which animals are ready for market. Predictions of optimal harvest endpoints and how animals should grade can also be made using ultrasound technology.

Yearling calves out of potential herd sires may be ultrasound carcass scanned for 12th to 13th rib fat thickness, rump fat thickness, ribeye area and marbling. Each of these traits is significant in determining red meat yield and quality, and each is at least moderately heritable. Ultrasound scanning of yearling bulls provides valuable information on live breeding stock that facilitates the production of calves that fit market specifications.

Yearling bulls can be scanned at approximately 365 days of age to provide an indication of how sibling steer and heifer mates will perform on the rail. Each breed association has established an age range within which scanning must be performed in order for the data to be used in the national cattle evaluation program. A certified technician can perform this service for a fee. Many breed associations have additional breed specific ultrasound guidelines and publish a list of certified technicians. It may be advantageous for several producers in an area to arrange for a technician to service multiple farms. This may help lower the cost of scanning for an individual farm by spreading the travel costs of the technician out across several farms.

Genomic testing is another tool that can be used to identify cattle, such as replacement heifers, with greater genetic potential for reaching carcass trait goals. Genomic testing for rate of gain, tenderness, marbling score, quality grade, yield grade, backfat thickness and ribeye area is available. These tests will commonly score animals on a scale such as 1 to 10. For example, a calf that scores an 8 for % Choice will be more likely to grade Choice or more likely to produce offspring that grade Choice than a calf that scores 4. Purebred breeders are utilizing gene testing to produce genomic-enhanced EPDs; however, the tool is available as a commercial herd management tool as well. While just a few years ago this practice may not have been financially feasible, enhancements in analytical techniques have helped lower cost, making this option more affordable today and going into the future.

Marketing Alliances

The purpose of marketing alliances is to increase revenues for producers. These producer groups secure marketing agreements with beef packers. Numerous marketing alliances exist, each with different specifications and various premium/discount schedules. Some reward lean high-yield carcasses, while others pay more for superior carcass quality (good marbling). Three basic types of beef cattle marketing alliances include breed association sponsored (e.g., Certified Angus Beef and Certified Hereford Beef); commercial (e.g., U.S. Premium Beef); and natural/implant-free (e.g., Creekstone Farms, Laura's Lean Beef) alliances. Marketing alliances collect valuable carcass information that can be used by participating cow-calf producers in adapting breeding programs to meet specific market targets.

Grid Pricing Systems

Fed cattle are sold several different ways including live weight, dressed weight, rail grade, forward contract and formula or grid pricing systems. Cattle sold on a live weight basis are sold to the packer "live" at the feedlot. The packer is then responsible for transporting the animals to the slaughter facility.

Cattle sold on a dressed weight basis are sold to packers based on dressed or hot carcass weight. Rail grade sales are usually private treaty with cattle slaughtered and the carcasses priced according to grade. The producer sells directly to the packer and is paid according to the weight and grade of the carcass. In forward contract pricing, cattle are presold for a determined price and later delivered to the buyer. These legal contracts designate specific weight targets for payment. Formula or grid pricing involves premiums and discounts based upon set standards. This value-based carcass pricing starts with a base price then adjustments are made for Quality Grade, Yield Grade, heavy and lightweight carcasses, dark cutters, bullocks/stags, dairy types, etc. Table 4 gives an example of a value-based pricing grid at one moment in time. The pricing grid changes as market demand and supply dictates. These premium and discount schedules can greatly differentiate between carcasses in terms of value. Use of carcass information in animal selection and marketing allows producers to target grid specifications and be more competitive in a value-based marketing system.

Here are some examples using the pricing grid in Table 4.

Example 1
Hot carcass weight = 875 pounds (within base carcass weight range)
Quality Grade = Choice (base Quality Grade)
Yield Grade = 2 ($1.50 per cwt premium)

244.49 + 1.50 = $245.99 per cwt

Example 2
Hot carcass weight = 1,023 pounds ($23.00 per cwt discount for heavyweight carcass)
Select Yield Grade 1 = $14.00 per cwt discount

244.49 – 14.00 = $230.49 per cwt

Table 4. Value-Based Pricing Grid Example					
Quality Grade	**Yield Grade**				
	1	2	3	4	5
Prime	17.00	15.50	14.00	4.00	-1.00
Certified Angus Beef	8.00	6.50	5.00	NA	NA
Choice	3.00	1.50	Base	-10.00	-15.00
Select	-14.00	-12.50	-11.00	-21.00	-27.00
Standard	-26.00	-24.50	-23.00	-33.00	-45.00

Carcass Weights		**Other**	
600-900 lb	Base	Dark cutter	-35.00
900-1,000 lb	-4.00	Hardbone	-33.00
Less than 600 lb	-27.50		
More than 1,000 lb	-23.00		
Base Price = $244.49 per cwt			

NA = not applicable

Example 3
Hot carcass weight = 607 pounds (within base carcass weight range)
Quality Grade = Dark Cutter ($35.00 per cwt discount)
Yield Grade = 3 (base Yield Grade)

244.49 – 35.00 = $209.49 per cwt

Summary

Beef consistency and uniformity is a problem that all segments of the beef cattle industry must work together to solve. Seedstock producers can do their part by selecting breeding stock with desirable carcass traits (carcass weight, marbling, ribeye area, etc.). Commercial cow-calf producers should match sire genetics with their cow herds to complement frame score, muscle score, breed type, etc., to produce a calf that will perform well in the feedlot and on the rail. In positioning herds to best balance reproductive traits, growth traits and carcass traits, cattle producers can take advantage of a variety of marketing options, including value-based marketing programs. For more information on beef carcass traits or related topics, contact your local county Extension office.

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