DIVISION OF AGRICULTURE
RESEARCH & EXTENSION
University of Arkansas System

Agriculture and Natural Resources

FSA3106

Ultrasound Scanning to Measure Body Composition in Beef Cattle

Charles Looney
Professor -
Cattle Improvement

Nicole Noga
Graduate Assistant -
Animal Science

History

Ultrasound technology began with the development of piezoelectric effects in 1880 by Pierre and Jacques Curie. During World War I the need for submarine detection created more interest in exploring piezoelectric technology. While the first iterations were rough models, their design influenced later forms in the 1930s, eventually evolving into SONAR (SOund NAvigation and Ranging) used in World War II. At the turn of the century, ultrasound began to be used for diagnostic imaging of soft tissue, and by the mid 1950s the livestock industry adopted the ultrasound technique as it was a humane, non-invasive method of quantifying muscle and fatty tissue of the live animal.

Current Practices

Recent advances in real-time ultrasonic technology have created new opportunities for accurate measurements of several body composition traits on live beef animals. Portable units, the desire for a low-cost and effective selection tool for breeders and the ability to accurately calculate the desired finishing plan make ultrasound an attractive solution for producers. Differences for carcass merit can be included in breeding programs, similar to maternal and growth EPDs (Expected Progeny Differences). Important carcass traits such as 12th-13th rib fat thickness, rump fat thickness, ribeye area, and intramuscular fat percentage for marbling estimation are evaluated. Heritability of these traits are moderate-to-high (0.40-0.45), making them economically relevant targets for animal selection.

Benefits of Using Carcass Ultrasound

Although carcass measurements may be collected at harvest, an obvious drawback is that the animal must first be slaughtered. A progeny test must then be conducted, which is both expensive and time-consuming. Another problem is that the data collection must occur at the harvest facility, a scenario that requires cooperation between the producers and packers and introduces many sources of human error. Scanning live animals minimizes these issues. Ultrasound is relatively inexpensive, quite reliable, has a shorter generational interval, and data is subject to less selection bias than older methods.

Also, because carcass traits are moderately heritable, seedstock producers can use ultrasound results toward EPDs for carcass traits. Commercial producers can then use the resulting EPDs to select their herd bulls for improvement of carcass traits in their future calf crops. Ultrasound seems to be especially beneficial in terms of marbling. While the naked eye can pick out fat animals or heavily muscled animals, marbling is a trait that evades the human eye. Immense progress can be made within a herd if selection pressure is put on carcass traits using ultrasound technology.

The most important aspect of this system relies on a skilled ultrasound technician, vital to accurate collection and interpretation of ultrasound images. Fortunately, many breed associations publish a list of proficient, certified technicians. Guidelines can also be found for body composition of live cattle ultrasound that are breed and age specific, with adjustment factors to a common endpoint.

Seedstock

Body composition measures must be adjusted to a common endpoint for traits with significant economic value in the carcass. Yearling bulls and developing replacement heifers can be scanned at approximately 365 days of age to provide a good indication of how sibling steer and heifer mates will perform in carcass valuation. Each breed association has developed an age-at-scanning window that must be met in order for the data to be used in national cattle evaluation (See: Table 1).

Feedlot Cattle

The endpoint for adjusting ultrasound measures in feedlot animals varies by breed association ultrasound program. Generally, the scanning endpoint should be consistent with the association's carcass data collection program and associated endpoint. Endpoints include scanning all animals within a contemporary group when the group averages 0.35 inches of external fat thickness over the 12th-13th rib, the group reaches some average designated age or weight, or just prior to when the first animals within the group are to be harvested.

Table 1. Acceptable Scanning Ages

Breed	Yearling Bulls	Developing Heifers	Feedlot Steers and Heifers
	---------------- Age in days ----------------		
Angus	320-440	320-460	320-480
Beefmaster	320-500	320-500	320-500
Brahman	365-487	365-487	365-487
Brangus	310-600	310-600	310-600
Braunvieh	320-420	320-420	320-420
Charolais	320-430	320-430	320-430
Chianina	320-440	320-460	320-460
Gelbvieh	320-420	320-420	320-420
Hereford	301-530	301-530	301-530
Limousin	300-450	300-450	300-450
Maine-Anjou	320-440	320-440	320-440
Murray Grey	320-410	320-410	320-410
Red Angus	320-440	320-460	320-460
Salers	330-450	330-450	330-450
Shorthorn	320-440	320-460	320-460
Simmetal	270-500	270-500	270-500
BIF Guidelines	320-410	320-410	320-410

Facilities and Animal Preparation

To ensure the safety of cattle, animal handlers, and ultrasound technician, cattle handling facilities must be adequate for animal restraint. Preferably, this includes a squeeze chute with fold-down side panels located under a roof adequate to block direct sunlight and provide protection from inclement weather. Some older ultrasound equipment will not operate efficiently or accurately when the ambient air temperature falls below 45°F. In these situations, breeders should provide a heated facility or some way to keep ambient air in the working area above 45°F. Technicians using a model that does not operate well in cold weather may opt to bring a towel or fabric cover to keep the unit at an optimal temperature. A dedicated electrical circuit, free from interference of other electrical equipment, with a clean and grounded power signal (110v) is required chute-side. Scanning weight should be recorded after animals have been held off feed overnight, since gut fill can have a significant impact on an animal's weight. It is strongly recommended that an animal blower be used to blow off any dust or debris that may interfere with the ultrasound transducer. The animal's coat then needs to be clipped to less than one-half inch prior to scanning. Finally, a few gallons of canola oil need to be accessible, preferably in a container with a dispenser, for the scanning technician. Applying the oil to clipped hair will ensure transducer contact.

Contemporary Groups

Animals of the same sex that have been reared and managed together form a contemporary group. It is also suggested that breeders define only calves that are within a 60-day age window as a contemporary group. Scanning contemporary group definition includes the herd code, weaning date or weaning lot date, weaning management group (pasture, creep, non-creep, etc.), scanning date or scanning lot date and post-weaning management group designation. The lot date is used in lieu of actual measurement date when weaning or scanning of a contemporary group must occur over more than one consecutive day.

For animals scanned at a central test, the contemporary group definition for an animal must include its herd of origin and other birth and weaning contemporary group information. National cattle evaluation requires that performance records be tied across contemporary groups or herds. The pedigree relationship matrix used in the prediction methodology allows for many indirect ties to be established. However, the best ties are made when sires have progeny represented across contemporary groups, herds, and years. All scanning contemporary groups should have at least two sires represented, and at least one of those sires should be used in another herd that is also participating in scanning for national cattle evaluation.

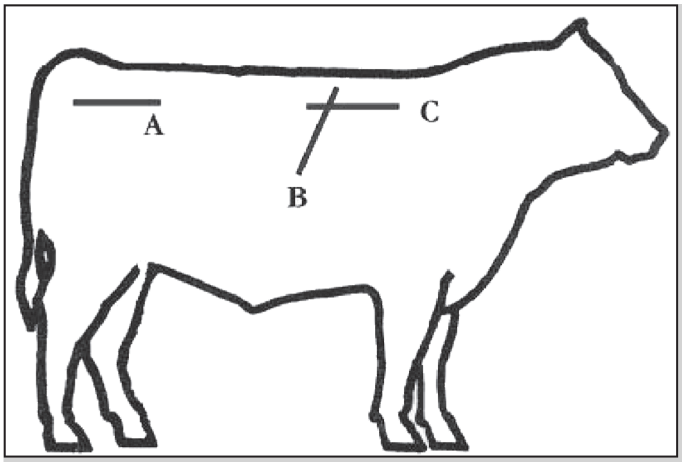

Figure 1. Areas of interest for ultrasound evaluation of body composition characteristics: A – rump fat image; B – cross-sectional image for ribeye area and 12th-13th rib fat thickness; C – longitudinal image for intramuscular fat.

Ribeye Area

Live estimation of ribeye area is measured at Position B in figure above. To generate accurate estimations of rib eye area, the transducer must have good contact without being positioned over any boney structure of the 12th or 13th rib. Distinct intercostal muscles under the *longissimus dorsi* will show the transducer is properly aligned between these ribs. Medial and lateral end borders must be well-defined.

12th-13th Rib Fat Thickness

The ultrasound rib fat thickness measurement can be made from the same image (See: Position B) used to estimate ribeye area. Fat thickness at the 12th-13th rib is measured at a point three fourths of the distance from the medial end of the *longissimus dorsi* muscle (12-13th rib interface) and perpendicular to the surface of the hanging ribbed carcass. Ultrasound scanning protocol requires the collection of an image made between the 12th and13th ribs using a linear-array transducer and standoff guide that conforms to the curvature of the animal's back.

Intramuscular Fat (IMF)

IMF percentage is highly correlated with USDA marbling score but is one of the most difficult traits to measure accurately. At least four independent images should be averaged for percentage IMF predictions.

Figure 2. Example ultrasound image of the ribeye muscle (Longissimus dorsi) taken at location B in Figure 1. Courtesy of UltraInsights Processing Lab, Inc.

Measurements are made from images collected across the 11th-13th ribs (or 12th-13th ribs) at a lateral position from the animal's midline at a point three-fourths of the distance from the medial end of the *longissimus dorsi* muscle (See: Position C).

Rump Fat Thickness

Rump fat thickness is highly related to 12th-13th rib fat thickness, with genetic correlation greater than .70 on a 0 to 1 scale where 0 indicates no correlation and 1 indicates identical traits. This can be very useful when scanning lean animals such as yearling bulls by improving the overall accuracy of external fat estimation. For this image, the transducer should be placed between the hooks and pins without a standoff guide (See: Position A).

Adjustment Factors

Adjusting individual animal ultrasound measures to a common endpoint allows for the fairest comparison

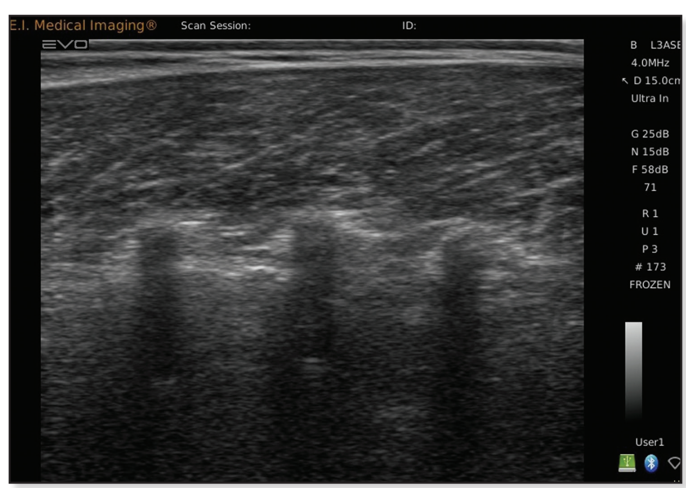

Figure 3. Example image of intramuscular fat. Courtesy of UltraInsights Processing Lab, Inc.

among animals within a contemporary group. Factors such as an animal's age, age of dam, weight, and weight gain may affect its ultrasound measures. Therefore, a scanning weight should be recorded within seven days of scanning cattle. Many adjustment formulas may also use rate of gain to adjust ultrasound measurements to a common endpoint. It is recommended that an additional weight and date be recorded at weaning for seedstock animals measured at one year of age. For feedlot animals, a weight and date should be recorded when animals go on feed.

Figure 4. Example ultrasound image of rump fat. Courtesy of UltraInsights Processing Lab, Inc.

Equipment

Historically in the United States, beef cattle are scanned using an Aloka 500 V with a 17cm linear array 3.5 MHz transducer (See: Figure 5) or using a Classic Scanner 200 with an 18 cm linear array 3.5 MHz transducer. Because Aloka 500 machines are no longer produced and therefore difficult to repair, some technicians are beginning to replace them with E.I. Medical EVO machines. A frame grabber board (FGB) may also be required depending on the ultrasound machine being used. A FGB takes an analog image and digitizes it. There are also multiple versions of image capturing software available from the labs that provide a method for saving the images for submission to the lab. While EVO machines do not need a FGB, most other approved ultrasound machines still require them. A field technician using an ultrasound machine other than the EVO would have a computer chute-side with a FGB and image capturing software so that the images can be stored in a usable format. Note that only certain FGBs are recognized by UGC (Ultrasound Guidelines Council).

Figure 5. Accessories for the collection of carcass images: 1 – Standoff pad for attachment to ultrasound probe for collection of ribeye image; 2 – A 3.5 Mhz linear ultrasound probe, commonly used in the collection of beef carcass measurements.

The transducer is seated in a standoff pad (See: Figure 5) that conforms to the shape of the animal to be used for ribeye imaging. The type of ultrasound equipment and software used to collect and interpret ultrasound images can impact measurement accuracy.

Per the UGC, approved ultrasound machines include:

- Aloka 500
- Aquila
- Classic Scanner 200
- E.I. Medical Evo
- ExaGo
- Falco 100
- E.I. Ibex Pro
- Sonovet 2000

For the most current list of approved machines, visit the UGC website, http://ultrasoundbeef.com/.

Image Interpretation

As in scanning, accurate interpretation of real-time ultrasound images for external fat thickness, ribeye area, and percentage IMF each require a high degree of skill by ultrasound lab technicians. When carcass

Figure 6. Using an EVO ultrasound machine with larger monitor for better viewing of carcass images.

ultrasounding was in its infancy, collecting technicians were responsible for the interpretation of images. However, due to the wide variation of image interpretation between different independent technicians, a centralized processing facility will collaborate with certified field technicians, with the primary objective of interpreting images and reporting the data. Presently, there are three ultrasound processing labs accredited by UGC: The Centralized Ultrasound Processing (CUP) Lab LLC, International Livestock Image Analysis (ILIA), and UltraInsights Processing Lab, Inc.

Accredited labs follow all UGC guidelines, use only UGC-certified interpretation software, and employ UGC-certified lab technicians. It is also important to note that UGC-member breed associations will only accept analyzed ultrasound data from UGC-accredited labs based on images collected by UGC-certified field technicians. Each method should strive to provide an accurate and timely assembly of data. There are programs currently recognized within the beef cattle industry that technicians can participate in to obtain training and certification in beef cattle scanning and interpretation.

Figure 7. Using an EVO ultrasound machine with the transducer seated in the standoff pad to take ribeye images.

The Future of Carcass Ultrasound

Artificial intelligence technology and automated interpretation systems are currently being explored as tools to augment existing carcass ultrasound procedures. The automated systems that are being tested are, unfortunately, of inadequate quality and thus are not acceptable for genetic evaluation. Automation could potentially offer rapid, more consistent results and ultimately decrease costs to both practitioners and producers. Potential issues with the development of this technology include precise detection of the targeted scanning regions particularly the ribeye area. Marbling convolutes the muscle boundaries and would be difficult for an automated system to correctly detect. The success with creating and launching such systems is dependent on both the ability of the computer system to be as accurate as the trained human eye and carcass ultrasounding becoming more mainstream in the world of producers.

Resources

Dr. Tommy Perkins, Ph.D, Associate Professor, West Texas A&M University.

Becky Hays, Owner and Certified Technician, UltraInsights Processing Lab, Inc.

Beef Improvement Federation. (2010). Guidelines for uniform beef improvement programs. *Beef Improvement Federation, 9th edition* (ed LV Cundiff, LD Van Vleck and WD Hohenboken), 44-48. beefimprovement.org/wp-content/uploads/2018/03/BIFGuidelinesFinal_updated0318.pdf.

The Centralized Ultrasound Processing (CUP) Lab LLC: https://www.cuplab.com/.

International Livestock Image Analysis (ILIA): http://www.designergenesusa.com/ILIA/about.htm.

Katzir, S. (2012). "Who knew piezoelectricity? Rutherford and Langevin on submarine detection and the invention of sonar". Notes Rec. R. Soc. 66 (2): 141–157. doi:10.1098/rsnr.2011.0049.

Perkins, T., Meadows, A., & Hays, B. (1996). Study Guide for the Ultrasonic Evaluation of Beef Cattle for Carcass Merit. Ultrasound Guidelines Council Study Guide Sub-Committee.

Ultrasound Guidelines Council (UGC): http://ultrasoundbeef.com/Home_Page.php.

UGC Field Tech List: http://ultrasoundbeef.com/uploads/2019_Field_Tech_List_12312019.xlsx.

UltraInsights Processing Lab, Inc.: http://www.ultrainsights.com/.

CHARLES LOONEY is a professor - cattle improvement with the Department of Animal Science, University of Arkansas System Division of Agriculture, Southwest Research and Extension Center in Hope. **Nicole Noga** is a graduate assistant - animal science at the University of Arkansas in Fayetteville.

FSA3106-PD-10-20N