Ultrasound Evaluation to Improve Carcass Merit

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Introduction

Since the 1950's, ultrasound technology for biological application has been available for use. The equipment used then is referred to as A-mode and was only capable of measuring fat and muscle depth. Ultrasound consists of very high frequency sound waves. Frequencies between one and 7.5 megahertz (MHz) are generally used for animal use with 3.5-5.0 MHz for live animal evaluation and 5.0-7.5 MHz most common for reproductive uses.

Pulses are produced in a transducer by the vibrations of piezoelectric crystals. These pulses are transmitted through tissue until they reach a tissue interface, such as between fat and lean tissue. At the interface, a portion of the sound wave continues to penetrate the tissue while part of the wave is reflected back to the transducer. The transducer acts as a receiver and the reflected waves produce mechanical energy as they strike and deform the piezoelectric crystals.

The B-mode ultrasound, ultrasound that is used currently, consists of a linear array of several transducers, that are fired in succession to send sound waves into the tissue. These sound waves interact to form patterns of energy within the tissue. This technique is used to focus the linear array transducers in order to optimize the depth resolution upon reception of the ultrasound signals. The display for B-mode is a two-dimensional display of dots or pixels. The brightness of each dot is proportional to the strength of the returning echo. Real-time ultra-sound is a version of B-mode, but the display of dots on the screen is updated almost instantly. Ultrasound images appear in various colors and shades on the display unit. Bone and fat will appear white in color, while muscle, tissue and the corpus luteum will appear a dense grey, and fluid (follicles and cysts) will appear black in color.

Methodology

Body composition measurements are taken with an Aloka 500 real-time ultrasound machine equipped with a 3.5 MHz transducer designed for animal use. In the normal scenario for estimating carcass traits via ultrasound, a **"Certified Technician"** travels to a designated location with portable ultrasound equipment. Upon restraint of an animal, the technician would apply a "couplant" (usually vegetable oil) to the back of the animal at a designated location. The couplant prevents the interference of air between the trans-ducer and the animal. This allows for maximum conduction of sound waves. Real-time ultrasound will allow for an image to be produced immediately. This image can be captured to a computer's hard drive allowing for the images to be interpreted at a later time. Ultrasound measur-ements for backfat thickness (BF; Figure 1) and longissimus dorsi area (Ribeye area, REA; Figure 1) are taken between the 12th and 13th ribs on each animal. A different ultrasound measurement for intramuscular fat (Marbling/ Percent Intra-muscular Fat, PIMF; Figure 2) is also taken across the area between the 12th and 13th ribs parallel to the spine. Lastly, the rumpfat (RF; Figure 3) measurement is taken on an imaginary line between the hip bone and the pin bone with the superficial gluteus medius muscle used as a landmark.

Ribeye Area

Ribeye area is measured in square inches and is positively and highly correlated with percent retail product (%RP). This trait is a moderately high heritable (>.4) trait. This means that the trait will be passed on to progeny. Ultrasound measurements of REA are accurate within one square inch of the actual REA measurement. Correlations between ultrasound REA and carcass REA vary between .62 and .94. Much of this variation may be due to the accuracy of the technician. Ribeye area per hundred weight (cwt) is a useful measurement as well. Depending on how animals are developed, REA/cwt may be a more accurate measurement than the REA measurement itself. How much REA/cwt should one expect from an animal? A table outlining various ranges for REA/cwt is provided (Table 1).

Backfat

Backfat thickness is measured in inches, and is a good indicator of %RP. However, unlike REA, it is negatively and highly correlated with %RP. This means, as BF increases, %RP decreases. This trait is similar to REA in heritability (>.4). Ultrasound measurements of BF are accurate to within 0.07 inches of the actual carcass BF. Ultrasound BF is highly corre-lated (.96) with carcass BF. Some believe ultra-sound BF may be more accurate than carcass BF, because of the fact that no BF has been removed during the ultrasound process. Unlike in the packing plant, varying amounts of BF may be removed when the hide is removed from the carcass.

Percent Intramuscular Fat

Marbling is measured as the percentage of intramuscular fat. When taking this measurement, the technician should be careful not to include the spinalis dorsi muscle, thus an inaccurate PIMF value could be interpreted. Ultrasound has the capability to predict the actual percent fat within the longissimus dorsi muscle which is what the USDA grader is attempting to visually evaluate. A table (Table 2) is shown that relates PIMF to amounts of marbling in the USDA Quality Grading system. The heritability for marbling is similar to those of REA and BF, and several research studies have indicated that correlations between marbling and BF are low. Using ultrasound, it is possible to predict PIMF too within 1% of the actual measurement. Ultrasound PIMF compared to carcass marbling has been variable in its accuracy. Correlations have ranged from .6 to .8. Once again, this is largely due to the accuracy of the technician. The ultrasound measurement is given in a percentage. This percentage is equivalent to the chemical ether extract procedure performed in the lab to determine intramuscular fat. This relationship is shown in Table 2.

Rumpfat

Just like BF, RF is measured in inches. This is a good indicator of overall body fat composition in lean animals. Rumpfat has been shown to be a better indicator of overall body fat composition than BF measurement in lean animals. This measurement is used to help predict %RP by some breed associations. Since the RF measurement would be difficult to accurately measure in the cooler, little is known of the accuracy of this measurement.

How Does a Producer Use Ultrasound Information?

The most important thing to remember is comparisons should be made between sire groups and/or within contemporary groups. Differences between individuals should not be considered accurate unless these animals are within a contemporary group, and their differences in carcass traits are much greater than the standard devia-tions mentioned above for each of the traits. Since all animals are not developed the same, one should evaluate REA/cwt closely instead of the actual REA. For instance, a 500 pound (1.4 in^2/cwt) bull will have a greater REA/cwt than does a 2-year bull (.5 to .8 in^2/cwt). This is due to the normal physiological growth curve of animals. One should closely monitor BF, this is an indicator of development of the animal and/or the maturity status of the animal. In addition, research has shown animals with excessive BF have lower fertility and libido, although the exact reasoning is debatable. To relate PIMF to a USDA Quality Grade, 4.8% would be considered low choice. To relate bull PIMF levels to steer-mates or future steer and heifer progeny, add 1.5 to 2.0 PIMF to the bull's value. One must remember these are just a couple of traits to evaluate, and one should not get carried away with single-trait selection. With single-trait selection, one may be creating more problems than what they may be attempting to correct with single-trait selection. Before any selection on future genetics, one must have a defined set of goals established for their own operation.

Conclusions

The ability of ultrasound to predict carcass traits has made great strides in the last five to seven years, but there is still need for improvement in the area of PIMF to be made. Furthermore, the accuracy of a certified technician is very important to achieve the highest accuracy in data collection. Highly skilled technicians have demonstrated accuracy levels that compare favorably with measurements taken on the carcass. Accuracy is also dependant upon the ultrasound equipment and software being used to collect and process the images. With the initiation of value-based marketing, it will be essential for beef producers to use all available resources to increase carcass quality. Ultrasound technology enables the producer to make accurate and rapid decisions toward increasing carcass quality and subsequent profit. As ultrasound EPDs are being generated by various breeds, this is providing an invaluable tool for seedstock producers to produce breeding stock with genetics for high-quality, high-value beef carcasses for the future. In conclusion, ultrasound is another tool for a commercial cattleman, along with seedstock producers, to utilize to make more accurate and informed decisions about future genetics without having to wait four to five years for carcass data to be generated. Furthermore, the accuracy of the ultrasound data is as only as good as the accuracy of the technician, equipment and producers that are reporting the data to their respective breed associations.

Table 1. Number of observations, means and standard deviations of data analyzed for each trait.*

Trait	n	Mean	SD
Birth Weight, lb	1583	85	13
Weaning Weight, lb	1613	548	85
Weaning Ribeye area, in^2	**1613**	**6.9**	**1.2**
Weaning REA/cwt, in^2	**1613**	**1.26 in^2/cwt**	**NA**
Yearling Weight, lb	1296	904	176
Post-Weaning Gain, lb	1296	346	151
Yearling Frame Score	325	7.4	.87
Scrotal Circumference, cm	373	34.4	2.7
Yearling Ribeye Area, in^2	**1296**	**10.0**	**2.1**
Yearling REA/cwt, in^2	**1296**	**1.1 in^2/cwt**	**NA**
Yearling Fat Thickness, in	1111	.17	.07

*Johnson, M.Z. 1992. Brinks Brangus Field Day Proceedings.

Table 2. USDA quality grading system and marbling score.*

Quality	Grade Amount of Marbling	Numerical Score	Percent Chemical Fat (PIMF)
Prime+	Abundant	10.0-10.9	
Prime	Moderately Abundant	9.0-9.9	
Prime-	Slightly Abundant	8.0-8.9	>9.0
Choice+	Moderate	7.0-7.9	7.25
Choice	Modest	6.0-6.9	6.72
Choice-	Small	5.0-5.9	5.04
Select	Slight	4.0-4.9	3.80
Standard+	Traces	3.0-3.9	<3.0
Standard-	Practically Devoid	2.0-2.9	
Utility	Devoid	1.0-1.9	

*Wilson, D.E. 1997. Intermountain Cow Symposium.

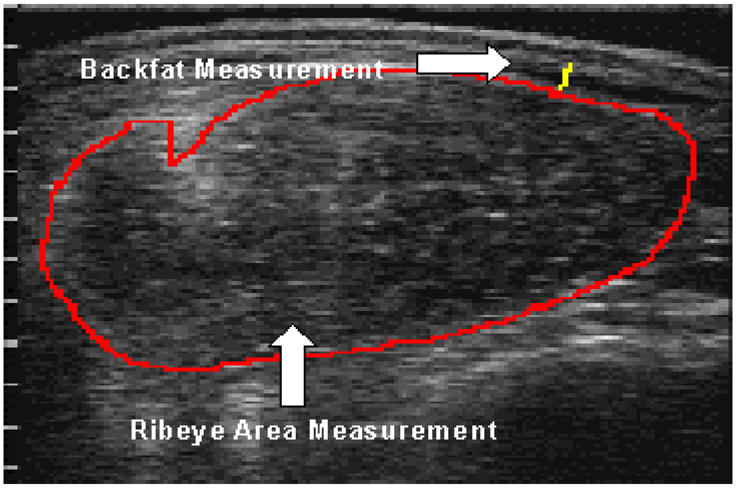

Figure 1. An ultrasound image of REA and BF thickness.

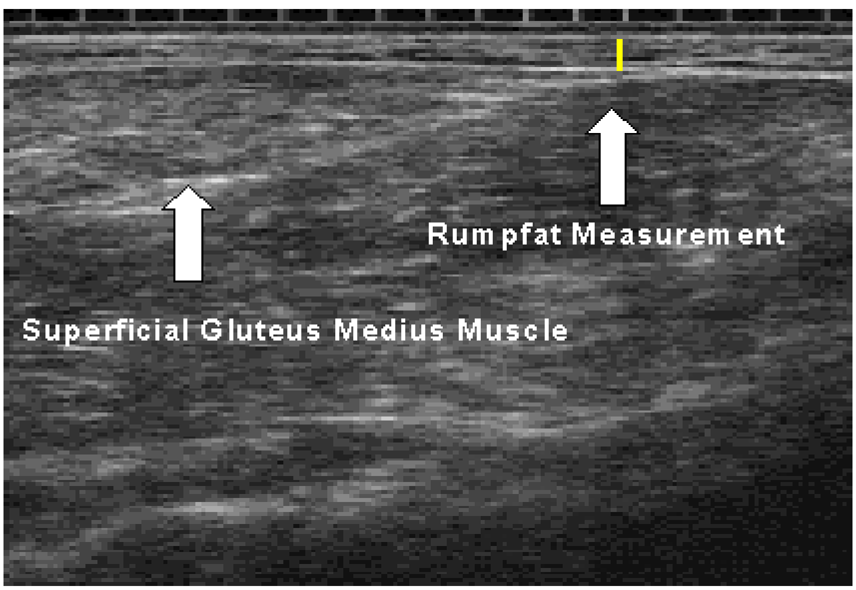

Figure 2. An ultrasound image of PIMF (Marbling).

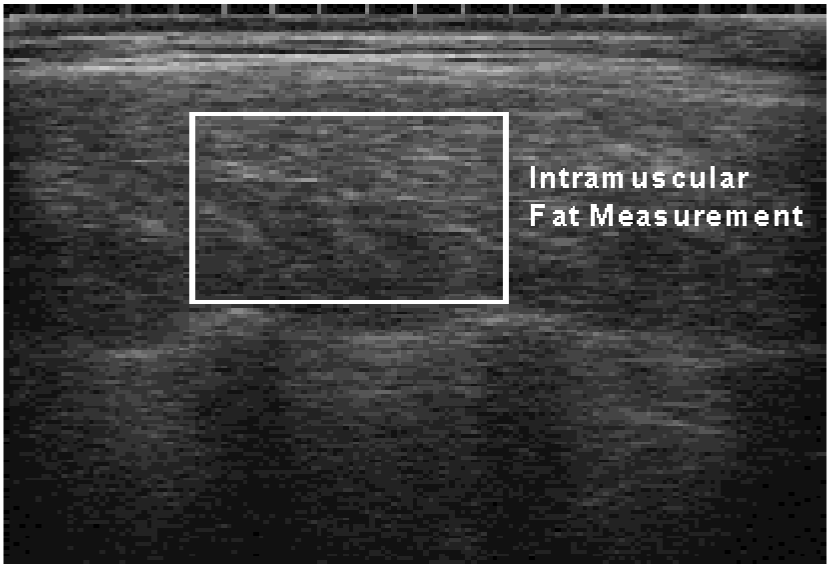

Figure 3. An ultrasound image of RF with the superficial gluteus medius muscle.

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