Proceedings, The Range Beef Cow Symposium XX
December 11, 12 and 13, 2007, Fort Collins, CO

ULTRASOUND-BASED SELECTION: PITFALLS AND REWARDS

Steve Paisley*, Chris Loehr and Frances Niemela
Department of Animal Science
University of Wyoming-SAREC
Lingle, Wyoming

INTRODUCTION

Ultrasound has become widely used by the seedstock industry as a selection and evaluation tool. Ultrasound estimates of Ribeye Area, or REA, Intramuscular fat, or %IMF (marbling), and Rump Fat have been used to develop several EPD's for many breed associations. Despite widespread use by seedstock producers, there is still some apprehension by commercial producers. Additionally, the use of ultrasound for commercial herd replacement decisions, used by some producers, is worth discussing. There are both benefits, as well as cautions, to using ultrasound generated information in a commercial beef herd.

BACKGROUND

Ultrasound is sound waves that have a frequency beyond the audible range for human ears, above 20,000 hertz. Tissue imaging or live animal evaluation frequencies range from 1 to 10 MHz, with carcass evaluation most commonly using a frequency of 3.5 MHz and reproductive evaluation uses 5.0-7.5 MHz. The technology was first utilized in World War II (1940's) in the form of SONAR (**SO**und **NA**vigation and **R**anging). However, ultrasound has been used for diagnostic imaging of soft tissues in the livestock industry since the mid 1950's. Real time linear array ultrasonic equipment, the first generation of the equipment that we use today, was developed for medical applications and was adapted for live animal evaluation in 1984.

The advent of ultrasound as a research tool in beef animals has certainly changed the understanding we have of biology in cattle. However, even this information pales in comparison to the potential that ultrasound holds as a management tool to improve beef production systems. This technology has implications from seedstock producers to the feedlot (Williams, 2002).

The motivation for using ultrasound is explained by Wilson (1992), as ultrasound technology offers a way to record anatomical measurements while the animal is still living. When used in conjunction with other measurements, this information is a good estimator of body composition and carcass merit. This information is then an effective way to find genetic differences among animals (Wilson, 1992). Using ultrasound traits, measured in young cattle, as a means of selection holds the possibility of progressing genetics more quickly and economically then has been possible in the past.

Selection based on traits such as longissmus muscle should be effective as it has been found to be a moderately heritable trait (Johnson et al, 1993). Bergner et al. (1997) indicated that because of the moderate heritability of 12th rib fat and longissimus muscle, combined with the degree of phenotypic variation within each breed, has potential to make ultrasound a valuable tool for genetic improvement programs for carcass traits.

Ultrasound can also be used as a means for assessing carcass composition pre-slaughter. According to May et al. (2000), ultrasound estimates of back fat, used singularly or in conjunction with other live evaluations such as visual assessment, when determining carcass composition pre-slaughter. In this way, cattle that possess a higher degree of cutability can be identified and selected. However, May et al. also found that in comparison to estimates of back fat, estimates of longissimus muscle area were not an adequate estimator of body composition, but they most likely would be as ultrasound technology improves. In a study conducted by Realini et al. (2001), alternate ultrasound measures were tested in order to evaluate their legitimacy and accuracy. They found that measures of rump fat thickness and gluteus medius depth are beneficial data to collect, especially in addition to the more common measures of 12th-rib fat thickness and longissimus muscle area, because these measures account for the variation in the amount of trimmable carcass fat. These additional measures are also easy to obtain and there for offer the possibility of automated measurements (Realini et al, 2001).

It is also possible to predict the retail product that will be produced from a beef carcass by using ultrasound on the live animal. In a study conducted by Williams et al. (1997), they found that ultrasound measurements were useful for predicting the retail yield and amount of trimmable fat on carcass. These measurements were comparable to predictions using the current USDA retail yield equation. According to a study by Tait et al. (2005), ultrasound measurements are a more accurate tool to estimate percentage of a carcass that can be used for retail product then are carcass measurements. Additional studies have also shown the ability of ultrasound to predict actual carcass measurements.

Table1. Means of live animal and carcass traits, adapted from Greiner et al., 2003[a,b,c]

	Greiner I yr. 1	Greiner I yr. 2	Greiner II	Greiner III yr. 1	Greiner III yr. 2
UFAT cm	1.00 ± 0.35	1.05 ± 0.35	1.02 ± 0.35	1.00 ± 0.35	1.05 ± 0.35
AFAT cm	1.04 ± 0.41	1.14 ± 0.46	1.09 ± 0.44	1.04 ± 0.41	1.14 ± 4.46
ACFAT cm	0.98 ± 0.41	1.05 ± 0.44	1.01 ± 0.42	-	-
ULMA cm_	77.0 ± 7.5	80.8 ± 7.3	78.8 ± 7.6	77.04 ± 7.49	80.79 ± 7.27
CLMA cm_	76.0 ± 8.0	80.5 ± 8.8	78.1 ± 8.7	75.99 ± 7.99	80.45 ± 8.83

UFAT: Ultrasound 12th rib fat thickness, cm
AFAT: Actual carcass 12th rib fat thickness, cm
ACFAT: Adjusted carcass 12th rib fat thickness, cm
ULMA: Ultrasound longissimus muscle area, cm_
CLMA: Carcass longissimus muscle area cm_

POTENTIAL FOR COMMERCIAL PRODUCERS

Many commercial cow-calf producers are now trying to determine whether or not the use of ultrasound estimates can assist in selection decisions within their own herds. As rainfall patterns become more variable, the tendency in the West is a movement towards smaller herds, fewer retained heifers, and smaller bull batteries. Many operations have created a situation where they been able to "redefine" their herds. Some have called it "core" or "foundation" herd,– but for every operation, there were specific reasons why those select cows remained on the ranch to graze the sparse vegetation.

The next question is: what criteria are we going to use as we continue to maintain the foundation herd, or possibly increase the herd? For most operations, many of those replacement females will be developed from the base herd. Selection of heifers will definitely influence the future herd, including their stayability, feed efficiency, and carcass merit, for example.

The "art" of selecting replacement heifers hasn't necessarily changed, but some of the targets have changed. Marketing fed cattle on grids has moved the emphasis away from averages, and more on individuals. Anyone who has marketed cattle on grids knows that one yield grade 4 or "no roll" steer can have a dramatic effect on average price for the group. Just as some of the targets have changed, some of the tools we have to evaluate replacement heifers has also changed.

To improve longevity, heifers still need to be structurally correct, moderate in frame, etc. Other considerations are equally important, such as temperament, mothering ability, and dam's udder confirmation. However, gene marker technology and ultrasound are two newly-emerging tools that have the potential to be used in selection of breeding females. While marker-assisted selection (tenderness and marbling, for example) may currently be better focused on sire selection, ultrasound may be an important selection tool to consider for heifers, helping us to "look inside" the animal, and evaluate the carcass merit potential of these replacement females. Estimates of backfat, ribeye area (REA) and marbling (% intramuscular fat, or %IMF) might be important measurements to collect, helping us to eliminate those "outs" in future calf crops, those fed calves that appear on our closeout sheet, bringing down the average price of our fed cattle.

There are several researched items that make ultrasound estimates of carcass merit a useful tool. First, carcass traits are highly heritable, ranging from 45% to 65% heritable. Second, ultrasound technology has improved dramatically in recent years. Experienced technicians can estimate ribeye area and marbling (%IMF) with increasing accuracy, ranging from 80% to 85% in fed cattle. The improved accuracy of ultrasound, combined with the heritability of carcass traits, might make ultrasound worth considering when evaluating replacement heifers.

As mentioned previously, there are several important selection criteria to use. Obviously fertility, production measurements, as well as structural and temperament criteria need to be followed. However, ultrasound measurements may be an additional tool that helps us find that bottom 10 or 15% of heifers with small ribeyes, or considerably lower %IMF. If, because of forage availability and favorable prices, operations are retaining fewer heifers, then it may be an opportunity to apply some additional selection pressure. Ultrasound estimates on weaned heifer calves, or replacement heifers prior to breeding may help to eliminate some of those few animals with inferior carcass merit.

INDUSTRY CHALLENGES

The beef industry continues to face challenges in meeting market demands for choice and premium choice cattle. Marbling is a heritable trait (Herring, 2006), and selection decisions should have an effect on the number of cattle grading USDA choice and higher. There still appears to be a range in carcass attributes, even within breeds. As an example, previous reports have shown variation within the Angus breed (Table 2). Selecting for sires with favorable values will improve quality grade or cutability, as carcass traits in general are highly heritable. More rapid improvements can be made by also evaluating replacement females, as mentioned above, helping to reduce the variability in the breeding herd.

Table 2. Comparison in progeny carcass traits between the top and bottom 10% of Angus sires.

Trait	Top 10%	Bottom 10%	Difference
No. of progeny	2728	1751	
No. of sires	109	110	
% Prime	7.7	0.7	+7.0
% CAB	47.4	.7	+46.7
% Choice and above	93.7	48.1	+45.6
% Select	6.1	35.0	-28.9
% Standard	0.2	16.9	-16.7
% YG 1&2	60.0	38.2	+21.8
% YG 4&5	1.4	18.2	-16.8
Carcass price/cwt	$110.19	$94.15	$16.04
Carcass Value	$822.27	$616.36	$205.91

Source: Angus Beef Bulletin, January 2000.

An immediate concern is whether selection for carcass traits will have an impact on the reproductive performance, stayability, or overall profitability of the cow-calf enterprise? If we make selection decisions based on consumer and marketing demands, can it negatively impact our own sustainability? A report to CAB prepared by Dr. Twig Marston suggests that selecting for marbling does not affect age at puberty. In evaluating the Spring 2007 Angus Sire summaries, there appeared to be mild correlations for lighter birth weights, easier calving, and a positive trend for milk production. The summary suggests that responsibly selecting for increased marbling, both through sire selection as well as herd replacements, should not impact many of the traits that are important for profitable cow calf operations

CONCLUSIONS

Using ultrasound, and selecting for specific carcass traits, is an important consideration, but the technology should be used in the proper context and with the proper amount of selection "weight". Although ultrasound is a viable technology, there are certainly concerns. Some concluding ideas are:

1) Although there is potential to make selection decisions based on ultrasound information, especially with replacement females, the information needs to be used in the proper context. Reproductive performance, structural correctness, mature size, etc. are all important components that need proper consideration

2) Although marbling has received a considerable amount of attention, it shouldn't receive all of our attention. Most marbling premiums will generate moderate grid premiums when cattle are marketed individually on a grid pricing system. However it is common for up to 500 lbs of growth to be added during the finishing phase, where performance and feed efficiency can result in $.30 to $.35/lb differences in profitability.

3) Always remember that environment and management play a major role in the ability of cattle to perform in the feedlot, as well as achieve acceptable quality grades. Paying attention to management details may result in similar improvements and reduced variability in feedlot and carcass attributes.

4) Selection of females that have the best opportunity to succeed in your production environment should be the first priority.

Using ultrasound to improve carcass traits, both by removing the lightly muscled cattle which can potentially lead to USDA Yield Grade 4's and 5's, while also making positive selection decisions for marbling, can make rapid changes in the carcass attributes of your herd, but these selection decisions need to be made in the proper context.

LIT CITED

Bergen, R. D., McKinnon, J. J., Christensen, D. A., Kohle, N., Belanger, A. Use of real-time ultrasound to evaluate live animal carcass traits in young performance-tested beef bulls. J. Anim Sci. 1997 75: 2300-2307

Greinera, S. P[a]., Rouse, G. H., Wilson, D. E., Cundiff, L. V., Wheeler, T. L. Accuracy of predicting weight and percentage of beef carcass retail product using ultrasound and live animal measures. J. Anim Sci. 2003 81: 466-473

Greiner, S. P[b]., Rouse, G. H., Wilson, D. E., Cundiff, L. V., Wheeler, T. L. Prediction of retail product weight and percentage using ultrasound and carcass measurements in beef cattle. J. Anim Sci. 2003 81: 1736-1742

Greiner, S. P[c]., Rouse, G. H., Wilson, D. E., Cundiff, L. V., Wheeler, T. L. The relationship between ultrasound measurements and carcass fat thickness and longissimus muscle area in beef cattle. J. Anim Sci. 2003 81: 676-682

Hassen, A., Wilson, D. E., Rouse, G. H. Evaluation of carcass, live, and real-time ultrasound measures in feedlot cattle: II. Effects of different age end points on the accuracy of predicting the percentage of retail product, retail product weight, and hot carcass weight. J. Anim Sci. 1999 77: 283-290

Johnson, M. Z., Schalles, R. R., Dikeman, M. E., Golden, B. L. Genetic parameter estimates of ultrasound-measured longissimus muscle area and 12th rib fat thickness in Brangus cattle. J. Anim Sci. 1993 71: 2623-2630

May, S. G., Mies, W. L., Edwards, J. W., Harris, J. J., Morgan, J. B., Garrett, R. P., Williams, F. L., Wise, J. W., Cross, H. R., Savell, J. W. Using live estimates and ultrasound measurements to predict beef carcass cutability. J. Anim Sci. 2000 78: 1255-1261

Tait, R. G., Jr., Wilson, D. E., Rouse, G. H. Prediction of retail product and trimmable fat yields from the four primal cuts in beef cattle using ultrasound or carcass data. J. Anim Sci. 2005 83: 1353-1360

Williams, A. R. Ultrasound applications in beef cattle carcass research and management. J. Anim Sci. 2002 80: E183-188

Williams, R. E., Bertrand, J. K., Williams, S. E., Benyshek, L. L. Biceps femoris and rump fat as additional ultrasound measurements for predicting retail product and trimmable fat in beef carcasses. J. Anim Sci. 1997 75: 7-13

Wilson, D. E. Application of ultrasound for genetic improvement. J. Anim Sci. 1992 70: 973-983