Under the Hide

A white paper on genetic evaluation of Angus cattle for carcass traits using real-time ultrasound scanning of yearling bulls and developing heifers

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The genetic-evaluation process for carcass compositional traits is in transition. The American Angus Association is moving from traditional progeny-testing programs to ultrasounding live seedstock animals at 1 year of age. Within a two-year time period, almost as many yearling bulls and heifers were scanned as currently exist in the totality of the Angus steer-progeny (some heifers) database, which has been gathered during more than two decades of carcass testing. As this new source of data is being researched and investigated, all of the results to date indicate that the information is not only descriptive from a genetic standpoint, but the ultrasound data offers significant advantages over carcass data.

■ Heritability estimates

From the genetic-information standpoint, the heritability (h^2) estimates for each of the component compositional traits are significantly higher than their corresponding carcass traits. The one exception is the heritability for percent intramuscular fat (%IMF) in yearling bulls [0.31 for %IMF in bulls vs. 0.36 for marbling in steers (see Table 1)]. However, this is a modest difference. The higher ultrasound heritability estimates indicate there is likely more accuracy associated with measuring compositional traits in live animals than in collecting the measures from carcasses. Several reasons could account for this.

There is a tight contemporary grouping of the animals from an age standpoint in the live scans (most animals are within 30 days of the measuring end point of 365 days for bulls and 390 days for heifers). This allows good age adjustments to be made in contrast to much wider age ranges in the steer progeny. There are two major age divisions in the carcass data because some animals are fed as calves and others are fed as yearlings. This results in trying to adjust animals in widely different age groups (437±26 days and 525±43 days) to a single end point halfway between the two (480 days).

Hide pullers distort fat in carcasses; and carcasses are no longer shrouded, which in the past helped in making external fat measurements. Some carcasses may not be ribbed accurately, and, perhaps more important, measurement accuracy is lost when the traits have to be measured at chain speed. Determination of marbling score is a subjective visual call by the grader. Sometimes the carcasses are graded after a 24-hour chill; at other times the carcasses are graded after a 48-hour chill. These factors will result in decreased measuring accuracy for fat thickness, ribeye area and degree of marbling.

Table 1. Heritability estimates for ultrasound-measured carcass traits and carcass-measured traits

Trait	Bull-only data	Heifer-only data	Carcass data
12th-13th rib fat	0.38	0.48	0.23
Rump fat	0.39	0.56	NA
Ribeye area	0.37	0.40	0.27
%IMF	0.31	0.42	0.36

■ Marbling and %IMF

It has been stated that marbling in a steer and %IMF in his sibling yearling bull are not the same trait. The %IMF trait is an objective prediction of percentage of intramuscular fat between the 12th and 13th ribs of a live animal. Marbling is subjectively scored by a grader from the ribbed carcass and takes into account several factors, including ribeye muscle color and distribution and texture of marbling flecks. However, at the age when most of the steers in the Angus database are graded, the predominate factor is the amount of marbling fat flecks. This is exactly the %IMF trait.

■ Bull vs. steer carcass traits

A more important question would be whether there exists a sire-by-sex interaction for the carcass traits. That is, do sires rank differently when evaluated with bull-ultrasound measures than they do when evaluated with steer-carcass measures? There are two ways to address this issue.

The first is to estimate the genetic correlation between ultrasound-measured traits on bulls and carcass-measured traits on steers. This has been done using the existing Angus carcass database and yearling-bull ultrasound database with the results presented in the following table. There were 19,095 ultrasound records and 42,353 carcass records included in the analysis. Heritabilities of the traits are listed on the diagonal. The genetic correlations are presented below the diagonal.

Variance-component estimates were developed using an average information-restricted maximum likelihood algorithm. The analysis was conducted both pair-wise and multiple-trait (four traits), with consistent variance-component estimates from both methods. There were three results of significance:

(1) heritability estimates in this joint analysis are consistent with and almost identical to previously developed estimates using the ultrasound data alone and using the carcass data alone;

(2) genetic-correlation estimates within ultrasound traits and within carcass traits are almost identical to estimates previously determined; and

(3) genetic correlations among the three basic traits of marbling (or %IMF), ribeye area and external fat thickness as measured in either yearling bulls or in steer carcasses are all greater than 0.70. Genetic correlations of this magnitude would suggest the traits are identical, and breeders can use ultrasound EPDs to make the same genetic progress in these three traits as they do using carcass EPDs.

These results also suggest that sires are going to rank similarly under both systems.

Table 2. Heritability and genetic-correlation estimates for yearling Angus bull ultrasound-measured traits (U) and carcass traits (C) measured in steer carcasses from a combined analysis

	Bulls			Steers		
Trait	**U %IMF**	**U REA**	**U fat**	**C marb.**	**C REA**	**C fat**
U %IMF	0.30[a]					
U REA	-0.18[b]	0.37				
U fat	0.11	0.24	0.33			
C marb.	0.77	-0.14	-0.02	0.37		
C REA	-0.15	0.71	0.01	-0.07	0.28	
C fat	0.04	0.00	0.75	0.01	-0.18	0.24

[a]Heritability estimates on the diagonal. • [b]Genetic correlations in the off-diagonals.

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The second method is to compute the rank correlation for sire EPDs for those sires evaluated under both systems. This analysis shows that as accuracy levels increase within each system, the rank correlation between the two systems increases. For example, looking at sires with carcass EPD accuracy levels of 0.85 and better and ultrasound EPD accuracy levels of 0.80 and better, the rank correlation for marbling, ribeye area and 12th-13th-rib fat thickness is 0.83, 0.91 and 0.84, respectively. These are high rank correlations, meaning that both systems rank the majority of the sires in the same order. The rank correlations are not perfect, but this would be unrealistic to expect because of the known inaccuracies that exist in both systems.

■ Physiological development of lean and fat tissues

It is scientifically accepted that bulls, steers and heifers have different rates and proportions of lean- and fat-tissue development due to hormonal differences. However, sex differences for composition are minor when comparisons are made at equal fat thickness. The total rate of fat deposition relative to muscle is similar for heifers and steers of the same genotype but lower for bulls. Bulls tend to have a lower percentage of subcutaneous fat and a higher percentage of intermuscular fat compared to steers and heifers. Leaner bulls will sire leaner calves at the same slaughter-weight end point, and bulls with larger ribeyes will sire calves with larger ribeyes at the same slaughter-weight end point.

■ Sexual development and %IMF

Whether bulls begin to lose intramuscular fat (marbling) as they sexually mature is not known. Research ongoing at Iowa State University (ISU) using serial scanning techniques will shed some light on this frequently debated issue. The genetic relationship between scrotal circumference and level of intramuscular fat in yearling bulls is another debated issue that is currently under investigation. ISU research in evaluating the genetic relationship between intramuscular fat (marbling) and scrotal circumference in yearling Angus bulls is preliminary at this point in time. However, the product-moment correlation between scrotal circumference EPD and percent intramuscular fat EPD is -0.03 in the Angus database. This is not a genetic correlation, but it is an indication that no strong genetic relationship exists between these two traits.

Second, as a part of the ISU beef breeding project in 1999, 74 intact yearling bulls were harvested from which scrotal circumference measures had been taken just prior to harvest. The product-moment correlations between scrotal circumference and marbling score and between scrotal circumference and percent ether extract were -0.009 and -0.02, respectively. The percent ether extract was a chemical fat extraction taken from a 12th-rib facing sample of the *longissimus dorsi* muscle. Again, these are not genetic-correlation values but evidence that no strong genetic relationship exists between scrotal circumference and percent intramuscular fat in yearling bulls.

■ Advantages of ultrasound scanning

The advantages of scanning yearling bulls and heifers vs. conducting progeny testing are numerous. First is the advantage of a much shorter generation interval associated with scanning for carcass traits directly in the animal being evaluated. Breeders will have carcass EPDs for individual animals in almost the same amount of time that they will have EPDs on the growth traits.

Second, the ultrasound-scan data represents some of the most unbiased and unselected data in all of the Angus database. Breeders will have the opportunity to scan upwards of 90% of any heifer calf crop and could have the same percentage of bulls scanned unless castration of culls would preclude this.

Breeders do not have the opportunity to decide, based upon chuteside or near-chuteside interpretation, what records get sent to the Association for processing. All of the records go for processing.

Another major advantage of the scanning data is that the genetic evaluation can be accomplished using the full-animal model as opposed to a sire-maternal grandsire model used with the carcass. The animal model accounts for both sides of an animal's pedigree (sire and dam), which will allow for EPDs on all animals being scanned along with both the sire and dam. The animal model also has the advantage of correcting for any preferential matings, which cannot be accounted for adequately in the sire model.

■ Combining carcass and ultrasound data?

Combing the two data sets is not advisable. Reasons include:

(1) The ultrasound database will soon overwhelm the carcass database in terms of numbers by literally thousands of animals.

(2) The ultrasound database allows for the use of the full-animal model. The carcass database does not, as most of the steers are produced from unknown dams (both sire and dam must be identified to take advantage of the animal model). If the dam is unknown, all you have is a sire model.

(3) The ultrasound database is much less biased and unselected. [Note: In scrutinizing the carcass data more thoroughly than has been done before to determine why the ultrasound and carcass EPDs were not ranking a few sires the same, it has been discovered that the carcass data appear truncated in some sire cases and nonrandomly selected carcasses with high marbling scores have been added to the database over time for other sires, making some of the data suspect and, perhaps, in need of much more stringent editing.]

(4) The animals are measured at physiologically different end points, which gives a different genetic relationship between ribeye area and backfat in steers (a negative value) in contrast to this relationship in bulls and heifers (a positive value). Thus the need for special modeling provisions.

From a scientific standpoint, there is no valid argument that can justify putting these two data sets together. And it can be further postulated that if this were to be done, the overall accuracy of the ultrasound evaluation would be severely compromised.

■ Industry targets

Angus sires need to be genetically evaluated for carcass traits at an end point consistent with current industry objectives. Today's target objectives penalize high yield grades. Yield Grade 1s and 2s are preferred over 3s, and 4s and 5s are severely discounted.

A genetic-evaluation objective should be to find sires that produce progeny feedlot steers that deposit intramuscular fat at a younger age and with external fat levels that will keep the cattle at a Yield Grade 1 or 2.

Evaluating sires on the existing steer carcass data will not allow these sires to be identified. The ultrasound data do allow for these sires to be identified, as both the yearling bulls and developing heifers are at a young age end point when scanned and at modest external fat levels.

Combining the carcass data with the ultrasound data would destroy this unique aspect of the ultrasound data. AJ