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# USING LIVE ANIMAL ULTRASOUND MEASURES OF RIBEYE AREA AND FAT THICKNESS IN YEARLING HEREFORD BULLS[1]

J. W. Turner[2], Lorna S. Pelton[3] and H. R. Cross[4]

Texas Agricultural Experiment Station,
Texas A&M University
College Station 77843-2471

## ABSTRACT

Ultrasonic measurements of fat thickness (FAT) and ribeye area (REA) were analyzed together with weight (WT), scrotal circumference (SC) and age data from 385 yearling Hereford bulls representing 45 sires. Additional variables created were 100*REA/WT (REACWT) and 365-d adjusted REA (AREA). Multiplicative age adjustment for AREA was calculated from linear regression of REA on age. Heritabilities were .45 ± .17 for REACWT, .36 ± .16 for WT, .12 ± .13 for REA, .11 ± .13 for AREA, .04 ± .13 for FAT and .18 ± .14 for SC. Phenotypic and genetic correlations were strongly negative for WT with REACWT. Neither AREA nor REACWT alone were considered suitable muscling variables due to their association with age, WT and FAT. Ultrasound REA measurements should be adjusted for the linear effects of age and WT and quadratic effects of FAT before being used for selection. Measurement of SC indicated a strong association with WT (r = .55) and a moderate positive genetic correlation with REA (.49 ± .58).
(Key Words: Beef Cattle, Ultrasound, Longissimus, Fat Thickness, Selection.)

## Introduction

Recently, the beef cattle industry has directed more attention to product evaluation and consumer attitudes toward beef (Cross et al., 1986). This emphasis has led to an increased awareness by breeders of carcass merit and selection of breeding cattle for carcass traits. Cross et al. (1988) reviewed objective methods to evaluate the composition of cattle and swine; ultrasound was considered acceptable for measuring ribeye area and various fat thickness measures. Thereby, breeders could select young breeding cattle for less fat thickness, larger ribeye size and larger ribeye size in relation to weight, rather than rely upon progeny testing that costs time and money. The objectives of this research were to describe ultrasound measures of ribeye area and fat thickness over the ribeye in yearling Hereford bulls characterizing variation and associated effects with age and weight. Scrotal circumference was included to establish its relationship with ultrasound traits. Heritabilities and genetic correlations were estimated.

## Materials and Methods

Ultrasound fat thickness (FAT) and ribeye area (REA) were measured on 385 yearling Hereford bulls owned by B and B Cattle Company, Connell, Washington. The American Hereford Association in a cooperative agreement with Texas A&M University sup-

3502

ported this collection of the data through the Livestock and Carcass Evaluation Service, Texas Agricultural Extension Service. The bulls were developed under common management as a single contemporary group and averaged 350 ± 27 d of age at the time of ultrasound data collection in March 1988. All bulls were identified by sire (n = 45), birth date, weighed full (WT) and measured for scrotal circumference (SC) simultaneously when ultrasound data were collected. A single technician utilized an Aloka 210 DXII real time linear array ultrasound unit equipped with a 3.0 MHz probe. FAT was directly recorded from the image on the ultrasound screen at data collection; REA was later estimated by a split-image video tape recording interpreted at Texas A&M University.

Response variables analyzed were WT, FAT, REA and calculated variables of 365-d REA (AREA) and 100*REA/WT (REACWT). To develop the AREA variable, REA was adjusted to a 365-d basis by determining the prediction equation for the linear regression of REA on age and calculating a multiplicative age adjustment factor as: correction factor = predicted REA at 365 d/ predicted REA using the actual animal age. The correction factor × REA for each animal yielded AREA. Cattlemen are concerned with comparing REA on an age-adjusted basis or on a relative body weight basis. Therefore, AREA and REACWT were considered important response variables.

Analyses were done with Mixed Model Least Squares and Maximum Likelihood Computer Program PC-1 (Harvey, 1987). Model 1 was a simple sire effect (n = 45) with linear regression on age. Model 2 included covariates of WT, FAT and age with quadratic terms for analysis of REA, REACWT, AREA and SC.

Estimates of genetic parameters, heritability and genetic correlations were obtained for the response variables under both analyses as well as phenotypic correlations between these response variables.

## Results

Table 1 contains descriptive statistics for the response variables and the linear regression coefficients on age. All variables had comparable age variation except FAT and AREA; FAT did not reveal any age regression effect ($P > .10$). Sires were not an important source of variation for REA, AREA or FAT ($P > .10$), but they were ($P < .10$) for WT, SC and REACWT.

Genetic parameter estimates and phenotypic correlations between response variables are given in Table 2. The heritability for WT (.36 ± .16) is comparable to literature values (Koch, 1980). Estimates for FAT (.04 ± .13), REA (.12 ± .13), AREA (.11 ± .13) and SC (.18 ± .14) were lower than most reported values. The calculated REACWT had a higher heritability, .45 ± .17, which compares more favorably to published heritability estimates for carcass traits (Koch, 1980). Evidently REACWT, because of its association with WT, is influenced so that sire effects become more important. The k value or average number of progeny per sire for the between-sire variance component was 8.3 with progeny numbers from 1 to 45.

Phenotypic relationships among the calculated AREA and REACWT variables are important as combination variables. Weight (WT) was negatively correlated with the ratio measure of REACWT (r = −.66). AREA was positively associated with WT (r = .37). FAT has no association with REA and AREA. Age

TABLE 1. MEANS, STANDARD DEVIATIONS, COEFFICIENT OF VARIATION (CV) AND AGE REGRESSION FOR ALL TRAITS

| Trait | Units | Mean | SD | CV, % | Linear regression |
|---|---|---|---|---|---|
| REACWT | $cm^2$/45.4kg | 8.98 | .93 | 10.36 | −.016257** |
| WT | kg | 437.8 | 49.8 | 11.38 | 1.181385** |
| REA | $cm^2$ | 86.0 | 7.5 | 8.14 | .079811** |
| AREA | $cm^2$ | 87.5 | 7.3 | 8.34 | −.012723 |
| FAT | cm | .63 | .17 | 26.14 | .000727 |
| SC | cm | 35.0 | 2.2 | 6.29 | .034684** |

\* $P < .05$.

\*\*$P < .01$.

TABLE 2. HERITABILITY, GENETIC AND PHENOTYPIC CORRELATIONS OF RESPONSE VARIABLES[ab]

| Trait | WT | FAT | SC | REA | AREA | REACWT |
|---|---|---|---|---|---|---|
| WT | .36 ± .16 | .45 ± .88 | .82 ± .27 | −.05 ± .53 | −.07 ± .53 | −.89 ± .43 |
| FAT | .40 | .04 ± .13 | −.89 ± 1.4 | <−1 ± .97 | <−1 ± .98 | <−1 ± .69 |
| SC | .55 | .29 | .18 ± .14 | .49 ± .58 | .48 ± .58 | −.52 ± .46 |
| REA | .53 | −.02 | .34 | .12 ± .13 | 1 ± .00 | .52 ± .39 |
| AREA | .37 | −.07 | .25 | .95 | .11 ± .13 | .54 ± .39 |
| REACWT | −.66 | −.48 | −.32 | .27 | .40 | .45 ± .17 |

[a]Upper diagonal $r_g$ values, lower diagonal $r_p$ values and $h^2$ on the diagonal.

[b]± SE.

was negatively correlated with REACWT (r = −.39).

Genetic correlations of REA and AREA with WT indicated independent genetic determination. However, REACWT had a large, negative correlation with WT. This reflects the automatic relationship with this calculated variable. Also, FAT was observed to be correlated negatively with all measures of muscling with extremely large standard errors. The FAT measure presumably was skewed because of the relatively low fat level observed in all bulls. Therefore, a power transformation using the square root function was used on the FAT observations. The resulting analysis using Model 1 showed the heritability of transformed FAT to be .14 ± .13 with the CV reduced to 10.63%. Genetic correlations of REA, AREA and REACWT with the transformed FAT values remained highly negative.

To clarify these associated effects, Model 2 analysis used covariates of age, WT and actual FAT plus quadratic terms for each for analyzing REA, AREA, REACWT and SC. Results in Table 3 indicated that sire effects were important ($P$ < .08) for REA, AREA and

REACWT. Variation in SC was best predicted by a linear regression on WT ($P$ < .01). Linear regressions on age and WT ($P$ < .01) were detected for REA and AREA; both linear and quadratic FAT regressions were found ($P$ < .01). REACWT was linearly related to age, but it was related linearly and quadratically to WT and FAT ($P$ < .01). Heritability estimates for REA, AREA and REACWT considering age, WT and FAT covariates should be equal. Estimates ranged from .17 ± .14 to .19 ± .14, and both genetic and phenotypic correlation coefficients among the measures were essentially 1.00. The heritability for SC from Model 2 was .09 ± .12. Also, the genetic correlations were about .50 ± .75 for SC with the REA-related variables. Collectively, these results suggest that AREA and REACWT are not suitable as singular traits for selection. REA should be used in combination with age, WT and FAT. It is important to note that WT was the principle factor predicting REA. The $R^2$ values for Model 2 analyses were .503 for REA, .635 for REACWT, .411 for SC and .463 for AREA. Comparable $R^2$ values for Model 1 analyses using only linear age

TABLE 3. ANOVA MEAN SQUARES FOR AREA, REA, REACWT
AND SC WITH COVARIATES OF AGE, WEIGHT AND FAT

| Sources | df | REA | REACWT | SC | AREA |
|---|---|---|---|---|---|
| Sire | 44 | 44.50* | .49* | 4.06 | 46.58* |
| Age-linear | 1 | 193.17** | 2.30** | 4.98 | 1,966.43** |
| Age-quadratic | 1 | .31 | .00 | .99 | 1.67 |
| Weight-linear | 1 | 6,095.82** | 24.77** | 188.93** | 6,383.83** |
| Weight-quad. | 1 | 1.60 | 3.23** | 2.70 | 9.28 |
| Fat-linear | 1 | 2,009.83** | 23.92** | .31 | 2,113.97** |
| Fat-quadratic | 1 | 1,114.95** | 13.21** | 3.81 | 1,169.80** |
| Remainder | 334 | 32.05 | .36 | 3.43 | 33.36 |
| $R^2$ | | .503 | .635 | .411 | .463 |

* $P$ < .08.

** $P$ < .01.

regression were .203 for REA, .330 for REACWT, .246 for SC and .140 for AREA.

### Discussion

Ultrasound equipment has been used since 1956 to evaluate live cattle (Temple, 1956). Stouffer et al. (1961) reviewed the development and early techniques used to estimate fat thickness and ribeye area. Wallace et al. (1977) documented the limitations of predicting whole-body composition with ultrasound measures on only small sections or portions of the body. However, the application of ultrasound affords a very useful approach and may have merit for singular traits. Gillis et al. (1973) reported that B-scan ultrasonic equipment yielded greater accuracy (correlation) between ultrasonic and carcass measurements than A-mode equipment. Correlations for actual and ultrasound fat thicknesses among operators ranged from $r = .67$ to $r = .83$. Similar correlations among operators for ultrasonic ribeye area to measured carcass ribeye area ranged from $r = .17$ to $r = .80$. Recently, Turner et al. (1989) reported that correlations of ultrasonic fat thickness to carcass fat thickness were $r = .81$ and $r = .94$ for two independent data sets utilizing the Aloka 210 DXII real time linear array ultrasound unit equipped with a 3.0 MHz probe. Corresponding correlations of ultrasonic ribeye area with measured carcass ribeye area were $r = .71$ and $r = .94$. Differences in measurement technique were cited as one obvious critical factor relating to accuracy as estimated by correlation. Comparisons of means $\pm$ SE for fat thickness and ribeye area were nearly identical.

Terry et al. (1989) reported that live animal ultrasound measures were adequate to predict the percentage of lean cuts from pork carcasses using fat thickness and estimated longissimus muscle area as independent variables ($R^2 = .63$). Early research (Miles et al., 1983) questioned the utility of Scanogram measurements due to their low accuracy and repeatability, but they indicated it could be used as a means to select lean (low-fat) cattle. Tong et al. (1981) observed that a single fat measure at the 11th and 12th rib was sufficient to improve prediction of beef carcass composition. Leymaster et al. (1985) used the Scanogram to predict carcass chemical composition of Suffolk rams and reported that ultrasonic area measurements did not improve precision rela-tive to linear measurements of fat thickness. Ultrasonic fat measurements lacked precision, so the Scanogram was not recommended for use in live sheep. Hamby et al. (1986) reported real time ultrasound measures overestimated cross-sectioned areas by 7 to 17%, and underestimated subcutaneous fat thickness by 19 to 35% relative to carcass measures in lambs. In cattle, ultrasonic estimates of FAT are presumed to be more accurate than REA estimates. Analysis of technician proficiency data (D. S. Hale, personal communication) for certification of real time ultrasound operators revealed that REA generally was overestimated and fat was underestimated, particularly for fatter cattle. Approved technicians all had correlations of >.7 between ultrasound and carcass measurements for both FAT and REA. Repeatability was very good by technicians (R > .95). Assuming that objective ultrasound measures are fundamentally accurate in ranking cattle, measurement of fat thickness over the ribeye, ribeye area between the 12th and 13th rib and weight at a known age comparable to 1 yr, 300 d to 430 d of age, represents three of the four variables used to predict yield grade.

Questions remain concerning the accuracy of ultrasound data, but trained technicians, better equipment and improved techniques warrant attention to ultrasound. Knowledge of WT, REA and FAT is useful to group feeder cattle for more uniform composition at slaughter. Ribeye size is recognized as important by cattle producers in predicting yield grade. However, because of the disadvantages associated with double muscling, there is concern about selecting for more heavily muscled cattle. Breeders must be warned not to stress size of REA as an absolute value. With better control of carcass size, fatness and age at slaughter, variation in REA should be reduced. If young breeding cattle are to be evaluated ultrasonically, selection should be based on REA adjusted for age, WT and FAT. Some breeds and herds will not need to consider selection for muscling because they already meet or exceed accepted industry values. With more research, alternative measures of muscling in live cattle may be found that have more value than REA. Finally, the relationship of REA considering associated age, WT and FAT effects in young breeding bulls needs further study relative to its association with carcass values of steer and heifer progeny.

What relative REA in yearling bulls relates most closely to acceptable retail lean yield in commercial progeny?

## Implications

To objectively determine beef carcass value, ultrasound measures in live cattle warrant consideration. Breeders must consider the value of early measurement carefully and select cattle with more muscling and less fat relative to body weight. The requirement for an acceptable USDA beef quality grade cannot be overlooked when seeking leaner slaughter cattle. Results of this study indicated that ultrasound measures of fat thickness and ribeye area in young Hereford bulls were less heritable than carcass data traits. Ultrasound ribeye area measurement should be adjusted for age, weight and fat thickness effects. The genetic correlation of scrotal circumference with ribeye area adjusted for age, weight and fat thickness effects was moderately positive.

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