EVALUATION OF REAL-TIME ULTRASOUND FOR PREDICTING CARCASS TRAITS OF FEEDLOT STEERS

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Story in Brief

One hundred thirty-seven yearling crossbred steers were ultrasonically measured for fat thickness and ribeye area. Additionally, a trained livestock evaluator visually estimated these same parameters prior to slaughter. Live animal ultrasound measurements and visual estimates were then compared to actual carcass values to determine the accuracy of each method. Overall, ultrasound measurements were more accurate than visual estimates for predicting carcass fat thickness (within .1 inch 62% of the time) and ribeye area (within 1 inch^2 58% of the time), versus 56 and 42% for subjective estimates, respectively. Both visual and ultrasonic estimates were more accurate in predicting fat thickness on thinner cattle. Subjective estimates of ribeye area were more accurate than ultrasound measurements on heavier muscled steers. These results suggest that ultrasonic measurements of fat thickness are accurate in determining carcass fat thickness, but ribeye area estimates are inconsistent and warrant further investigation.

(Key Words: Ultrasound, Visual Appraisal, Carcass Measurements, Feedlot Steers.)

Introduction

Live animal estimation of carcass parameters and the ultimate determination of composition of livestock remains an important research goal in animal agriculture. Methodology for obtaining carcass estimates are as varied in scope and complexity as the results which they produce. They range from relatively inexpensive and readily obtainable linear measurements to complex, and often costly, imaging technologies currently employed in the field of human medicine. Ultrasound is an imaging technology which holds great promise for elucidating compositional differences in animals. Presently, both the Australian

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and U.S. beef industries have assigned high priority to the development of an objective instrument grading system utilizing ultrasound. The ability to accurately identify individuals with superior carcass traits will enable the beef industry to abandon the current practice of trading cattle "on the average" and adopt a new value-based marketing system.

Ultrasound involves the transmission of high frequency sound waves through the hide of the animal. The interaction of these soundwaves with varying tissue structures of different densities enables a cross-sectional image to be produced. From these images, the dimensions and nature of the structural makeup of deep tissue can be quantified. The reported accuracy with which ultrasound predicts carcass parameters in live animals has varied. Initial studies at Oklahoma State University (Smith et al., 1989) indicated that ultrasound could accurately determine carcass fat thickness in live animals; however, estimates of carcass ribeye area were imprecise. Research has shown that accuracy is highly technician dependent and improves with experience (Henderson-Perry et al., 1989). Therefore, the objective of this study was to reevaluate live animal ultrasonic measurements for predicting actual carcass values and to compare these results with subjective visual estimates of the same carcass traits. An additional component of the study involved comparing ribeye area estimates of two technicians' interpretation of the same ultrasound image.

Materials and Methods

The one-hundred-thirty-seven yearling crossbred steers used in this study were part of a trial conducted to determine the effect of anabolic implants, both estrogenic and androgenic, on performance and carcass characteristics of feedlot steers (Foutz et al., 1990). Steers were slaughtered in two groups (one week apart) to facilitate ease of data collection. Steers in the first group (Kill 1) were fed a total of 119 days and those in the second group (Kill 2) were fed 126 days. Five days prior to slaughter, steers were scanned using a real-time, diagnostic ultrasound unit (Aloka 210DX)[5] equipped with a linear array, 3 megahertz transducer. Scanning site, as determined by physical palpation, was located between the twelfth and thirteenth ribs on the left side of each animal. The ultrasound images produced were recorded on video tape and later viewed on a large display monitor[6] to determine carcass ribeye area estimates. Fat thickness (USFT) was determined at the time of scanning by internal electronic calipers. Recorded ultrasound images were interpreted independently by two technicians for the determination of ribeye area values. Using the same images, tracings

[5]Distributed by Corometrics Medical System Inc, Wallingford, CT
[6]Sony 12 inch PVM 122

were made of each technicians' interpretation of muscle configuration. Area was determined from these tracings using an electronic digitizing board. Technician A (USREA1) was responsible for the generation and recording of ultrasonic images and had more ultrasound experience than Technician B (USREA2). In addition to ultrasonic measurements, ribeye area was also predicted as a function of shrunk final live weight (BWREA).

One day prior to shipping steers to the slaughter facility, a trained evaluator visually estimated carcass fat thickness (SFT) and ribeye area (SREA) for each animal. Off-test weights for each steer were made available to the evaluator. Carcass fat thickness (FT), adjusted fat thickness (AFT) and ribeye area (REA) were measured at the 12th and 13th rib interface 24 h postmortem. Adjusted fat thickness is a subjective adjustment made by the grader in response to irregular fat distribution in other carcass locales. Means and standard deviations for parameters of interest in this study are presented in Table 1.

Results and Discussion

Simple correlations (r) between predicted (USFT, SFT) and observed fat thickness (FT, AFT) are presented in Table 2. Ultrasonic fat thickness measurements were highly correlated with actual values (r=.82, FT; r=.81, AFT). Similar results were observed in a previous study (Smith et al., 1989), thus indicating that ultrasound can accurately predict carcass fat thickness.

Table 1. Description of data used for analysis[a].

Parameter	Mean	Standard deviation
Final weight, lb	1185.0	98.63
Carcass weight, lb	758.2	56.78
FT, in	.54	.19
AFT, in	.57	.18
REA, in^2	13.40	1.49
USFT, in	.51	.15
SFT, in	.52	.14
USREA1, in^2	12.96	1.30
USREA2, in^2	12.90	1.29
SREA, in^2	14.40	1.50
BWREA, in^{2b}	12.78	.96

[a] See text for explanation of symbols.
[b] BWREA=((final weight*.96)/100)*1.1.

Table 2. Correlations of predicted and observed fat thickness[a].

	AFT	SFT	USFT
FT	.96	.56	.82
AFT		.60	.81
SFT			.52

[a] See text for explanation of symbols.

Subjective estimates were less closely associated with actual (r=.56) and adjusted (r=.60) carcass fat thickness (r=.56). When visually estimating fat thickness the evaluator uses indicators of overall fat cover, therefore, one would expect higher correlation coefficients between subjective and adjusted fat thickness due to the adjustments made by the grader.

Table 3 contains simple correlations (r) between predicted (USREA1, USREA2, SREA, BWREA) and observed ribeye area (REA). Ultrasonic ribeye area measurements were moderately correlated with actual values and did not differ between technicians (r=.63). It is apparent that there were interpretational differences of ultrasonic images, as the relationship between technician estimates was not perfect (r=.71). Subjective estimates of ribeye area were also moderately correlated with actual values (r=.61), thus indicating that the evaluator was able to identify differences in muscularity between animals. Ribeye area predicted from final shrunk live weight showed the weakest relationship (r=.48) between predicted and observed values in this study.

Perhaps a more useful measure of the predictive capacity of a given technique is an evaluation of the residual, the difference between the predicted and actual parameter values. In this study, the relative frequency with which estimates are within a given range of actual carcass values was determined.

Table 3. Correlations of predicted and observed ribeye area[a].

	SREA	USREA1	USREA2	BWREA
REA	.61	.63	.63	.48
SREA		.37	.33	.63
USREA1			.71	.22
USREA2				.32

[a] See text for explanation of symbols.

Ultrasonic estimates of carcass fat thickness were within .1 inch 62% of the time and within .2 inch 95% of the time (Table 4). Steers which produced carcasses with less than .5 inch fat thickness were estimated within .1 inch 76% of the time compared to 51% for those with actual carcass fat thickness greater than .5 inch. The same general trend was noted for subjective estimates of carcass adjusted fat thickness, with 56 and 83% of all steers estimated within .1 and .2 inch of actual values, respectively. The evaluator was more accurate in assessing adjusted carcass fat thickness with thinner steers (<.5 inch actual fat thickness) as evident by a greater proportion of those cattle being estimated within .1 inch of actual values (63% vs 49%).

Of the methods used to predict carcass ribeye area (Table 5), ultrasonic estimates of Technician A (USREA1) correctly identified the greatest proportion of steers within 1 in^2 of actual carcass values (58%). Predicting ribeye area as a function of live weight (BWREA) was almost as accurate (57% within 1 in^2) as ultrasound estimates of Technician A and better than those of Technician B (52%). Subjective visual estimates (SREA) correctly identified the lowest proportion of steers within 1 in^2 of actual values (42%) even though the correlation coefficient was similar to that of ultrasonic measurements (.61 vs .63). This points to the fallacy of utilizing correlation coefficients (measures of precision) as indicators of accuracy.

Ultrasonic estimates were least accurate in determining ribeye area for steers having carcass ribeyes greater than 14 in^2, with 38 and 36% of those

Table 4. Cumulative frequency distribution (%) of carcass fat thickness measurement error[a].

Range of absolute residual, inches	All data	Actual fat thickness, inches <.5	>.5
USFT			
+/- .10	62	76	51
+/- .20	95	95	87
+/- .30	99	100	99
SAFT			
+/- .10	56	63	49
+/- .20	83	92	75
+/- .30	94	98	89

[a] See text for explanation of symbols.

Table 5. Cumulative frequency distribution (%) of carcass ribeye area measurement error[a].

Absolute residual	All data	Actual ribeye area, in^2		
		<13	13-14	>14
USREA1				
+/- 1.0	58	67	63	38
+/- 2.0	86	91	85	74
+/- 3.0	99	100	100	95
USREA2				
+/- 1.0	52	60	53	36
+/- 2.0	88	93	98	69
+/- 3.0	99	100	100	95
SREA				
+/- 1.0	42	29	50	51
+/- 2.0	80	79	85	79
+/- 3.0	96	93	100	95
BWREA				
+/- 1.0	57	84	60	26
+/- 2.0	88	95	95	59
+/- 3.0	96	100	100	79

[a] See text for explanation of symbols.

estimates within 1 in^2 for Technicians A and B, respectively. In contrast, the live evaluator was most accurate within this range, correctly estimating carcass ribeye area for 51% of the steers within 1 in^2. Predicting ribeye area as a function of live weight was most accurate for steers with carcass ribeye areas of less than 13 in^2 and least accurate for those in excess of 14 in^2.

To illustrate the accuracy of subjective and ultrasonic estimates, residuals (predicted minus observed values) were plotted against measurements of carcass fat thickness and ribeye area. As shown in Figure 1, ultrasound estimates tended to overpredict fat thickness on steers with less than .4 in actual carcass fat thickness and underpredict fat thickness for steers with greater than .6 in carcass measured fat thickness. A similar trend is noted with subjective visual estimates (Figure 2) as all carcass with greater than .8 in adjusted fat thickness were underestimated. Ultrasonic estimates of ribeye area generally underpredicted heavier muscled steers (Figures 3 and 4), with both technicians

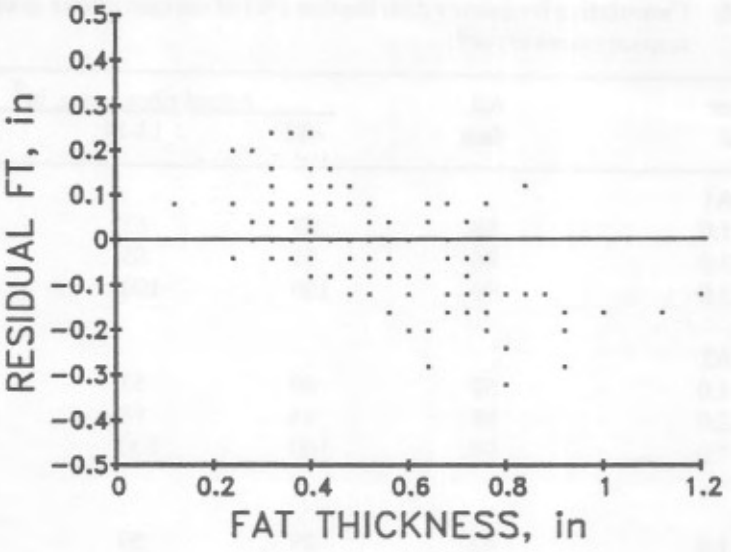

Figure 1. The relationship of residual (ultrasonically predicted minus observed) fat thickness and carcass measured fat thickness (FT) of feedlot steers.

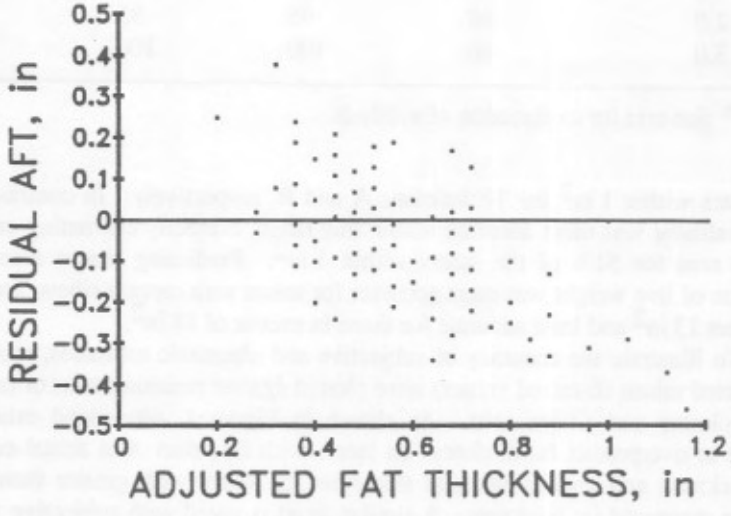

Figure 2. The relationship of residual (subjectively estimated minus observed) fat thickness and adjusted carcass fat thickness (AFT) of feedlot steers.

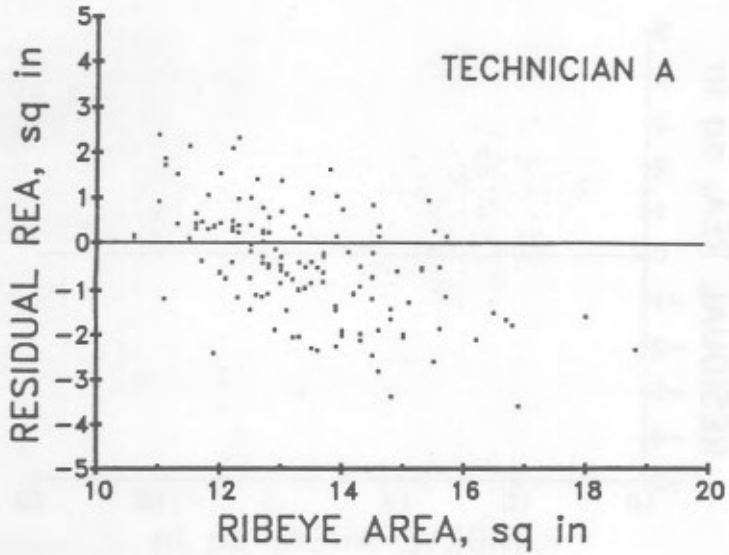

Figure 3. The relationship of residual (ultrasonically predicted minus observed) ribeye area and carcass measured ribeye area (REA) of feedlot steers for Technician A.

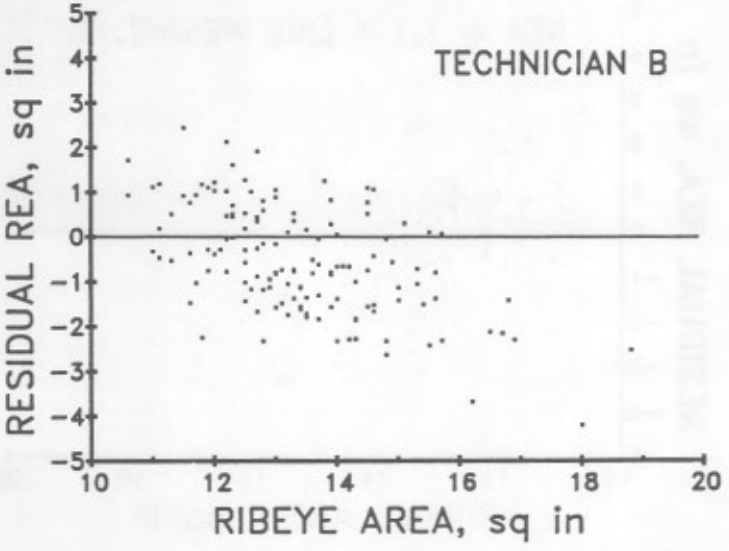

Figure 4. The relationship of residual (ultrasonically predicted minus observed) ribeye area and carcass measured ribeye area (REA) of feedlot steers for Technician B.

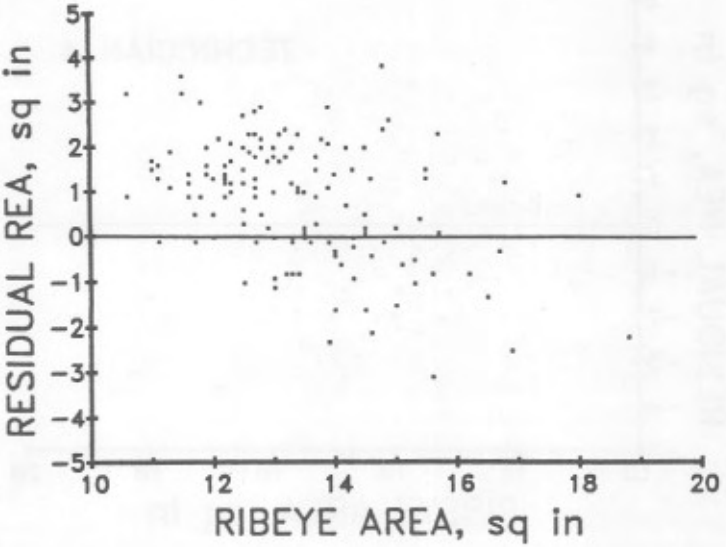

Figure 5. The relationship of residual (subjectively estimated minus observed) ribeye area and carcass measured ribeye (REA) of feedlot steers.

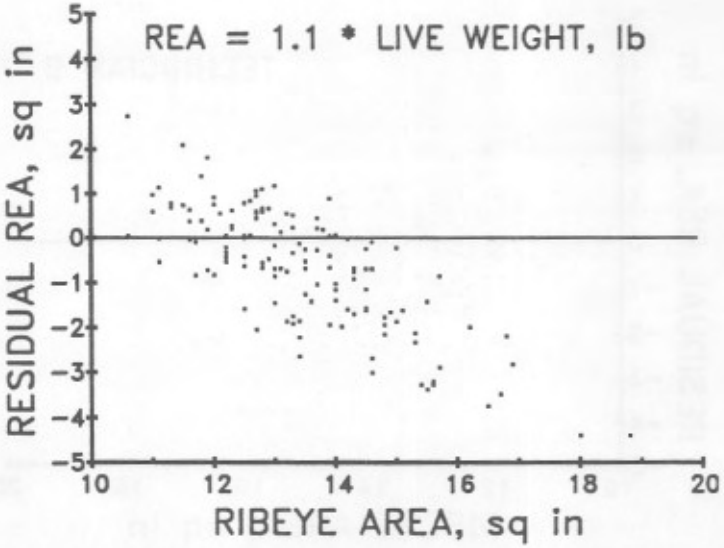

Figure 6. The relationship of residual (predicted ribeye area as a function of weight minus observed) ribeye area and carcass measured ribeye (REA) of feedlot steers.

underpredicting all animals with carcass measured ribeyes greater than 16 in^2. The residuals associated with subjective estimates of ribeye area (Figure 5) tended to be more variable; however, ribeye area was generally overpredicted for steers producing carcass ribeye areas of 13 in^2 or less. When using weight to predict carcass ribeye area, a systematic error is evident (Figure 6). As actual ribeye area increases, there is a corresponding increase in the error of prediction. These results suggest that the steers used in this study were heavier muscled than the general cattle population if one assumes that an average muscled steer will produce 1.1 in^2 of ribeye per hundred pounds of shrunk live weight.

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