SOURCES OF ERROR FOR ULTRASONIC MEASUREMENTS

OF STEER COMPOSITIONAL TRAITS IN GRAZING STUDIES[1]

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Abbreviations: AB, Angus x Brahman; SAB, Simmental x Angus x Brahman; SBH, Simmental x

Brahman x Hereford; EF, external fat; LDA, *longissimus dorsi* area; ADG, average daily gain.

Abstract

Real-time ultrasound technology has potential use for measuring compositional traits in

grazing studies. Sources of error with this application must be identified for designing experiments

with adequate precision to determine treatment effects. A study was conducted to evaluate breed

type (Angus x Brahman, AB; Simmental x [Angus x Brahman], SAB; Simmental x [Brahman x

Hereford], SBH), initial body weight, and initial ultrasonic measures as sources of experimental

error in the analyses of external fat (EF) depths and *longissimus dorsi* (ribeye) areas (LDA). Steers were ultrasonically scanned at the initiation and conclusion of a grazing study that examined stocking rate effects on average daily gain (ADG) and body condition of steers grazing a mixture of rye (*Secale cereale* L.) and ryegrass (*Lolium multiflorum* L.). Breed type did not affect ($P > 0.10$) final or increases in EF, and curvilinear trends of increased EF with increasing ADG ($P > 0.10$) among the breed types over the range of ADG (0.03 kg d^{-1} to 1.62 kg d^{-1}). The three breed types showed curvilinear increases in LDA as ADG increased, but the trends were different ($P < 0.05$) for SBH than for the other two types. Final LDA and magnitude of increases in EF and LDA over the experimental period were influenced ($P < 0.05$) by initial body weight. Results indicated that allotting cattle to pastures based on a combination of breed type and body weight should improve precision in detecting treatment effects.

Introduction

Potential for real-time ultrasound technology to measure live cattle compositional traits has been reported (Stouffer, et al., 1961; Perkins et al., 1992; Griffin et al., 1999). Ultrasound instruments have been used to predict carcass traits of feedlot cattle and to make genetic selection decisions (Wilson et al., 1997). Based upon a review of the literature, Wilson (1997) determined that correlation coefficients between carcass and live animal ultrasonic measures of EF and LDA averaged 0.86 and 0.74, respectively.

Real-time ultrasound technology also has application for studying growth and development

in grazing research. Many cattle producers have vertically integrated their operations by retaining ownership of their calves through the feedlot. Furthermore, cattle marketing is becoming more value-based. Awareness of body condition and composition response with forage and grazing systems could assist in making management decisions and strategies. Ultrasound technology holds promise for determining treatment effects on compositional traits and subsequent evaluations of feedlot performance and carcass traits; however, sources of error in using ultrasound for these applications must be identified to design experiments that minimize experimental error. The objective of this research was to evaluate breed type, initial body weight, and initial ultrasonic measures as possible sources of inflated error in compositional measurements taken in grazing studies.

Material and Methods

Ultrasound scan data were collected from yearling steers grazed at the Texas A&M University Research and Extension Center at Overton, in northeast Texas. The study determined effects of stocking rate (3.7, 5.2, and 6.7 steers ha^{-1}) on steer ADG for a mixture of >Maton= rye and >TAM-90' ryegrass. Stocking rates were assigned to pastures in a randomized block design with two replications. Steers were stratified by breed type and weight into groups and these groups were randomly allocated to pastures. Three breed types were used: Angus x Brahman, 50:50, n = 41; Simmental x (Angus x Brahman), 50:25:25, n = 25, and Simmental x (Brahman x Hereford), 50:25:25, n = 32. Stocking rates were assigned to pastures in a randomized complete block design. Cattle were weighed unshrunk and placed on pastures on 24 November, 1998 (initial body weights: AB = 234 ∀ 11 kg; SAB = 302 ∀ 12 kg; SBH = 263 ∀ 14 kg) and weighed at 28-d intervals, and

terminated on 12 May, 1999.

Ultrasound scans were taken for each steer using an Aloka SSD-500V (Tokyo, Japan) instrument. Cross-sections of the *longissimus dorsi* muscle were scanned between the 12th and 13th ribs. Ultrasound scans were taken 1 day prior to initial weights and 1 day following obtaining terminal weights. A well-trained technician measured EF depth and LDA using the Beef Information Manager Program of Critical Visions, Inc (Atlanta, GA). Final measurements of EF and LDA were analyzed for effects of breed and ADG in a statistical model that evaluated breed as a discreet variable and ADG as a continuous variable (Littel et al., 1991). Correlation analyses were performed to determine associations of final measures and increases in EF depth and LDA (final minus initial) with intial body weight and initial ultrasonic measures.

Results and Discussion

Final EF thickness among breed types showed similar ($P > 0.10$) curvilinear increases as ADG increased (Fig. 1). The overall relationship (EF thidkness $= 0.03 + 0.06 \, ADG + 0.14 \, ADG^2$; $R^2 = 0.51$) indicated that EF depth increased ($P < 0.05$) at an increasing rate with ADG. For the specific breed types used in this experiment, there was no interference in EF measures associated with breed types which ranged from 25 to 50% Brahman, 0 to 50% Simmental, 25 to 50% Angus, and 0 to 25% Hereford.

Final LDA exhibited curvilinear increases as ADG increased, but there was a difference among the breed types in the linear ($p = 0.08$) and quadratic ($p < 0.05$) terms. Longissimus dorsi areas for BA (Final REA $= 38.6 - 0.9 \, ADG + 12.6 \, ADG^2$; $R^2 = 0.65$) and SBH (Final REA $= 39.3 + 9.3 \, ADG + 6.2 \, ADG^2$; $R^2 = 0.74$) increased at a declining rate with increases of ADG (negative

quadratic term), but SAB (Final LDA = 37.3 + 32.3 - 10.4 ADG^2; R^2 = 0.710) increased at an increasing rate (positive quadratic term) with higher ADG. These differences suggest that breed type should be considered when designing grazing experiments. Numbers of calves for each breed type were too low to make valid conclusions regarding breed type responses to ADG. The intent of this study was to analyze the effect with a number of calves for each breed type that represents what would be used in a typical experiment; thereby using the effect as an indicator of error if breeding is assumed similar.   Researchers routinely block by breed type when designing experiments with distinctive breed types; however, careful attention should be made for experiments that take ultrasound measurements with diverse mixtures of breed. Characteristics should be identified (e.g., distinctive color patterns of hair coat, body frame and size, and *Bos indicus* characters) and, if possible, randomly allotted across all experimental pastures.

Final EF and LDA were correlated with initial body weight (Table 1). These data suggest that initial ultrasound measurements should be used in allocating animals to pastures; however, initial body weight was also highly correlated with initial EF (0.58; $p < 0.001$) and initial LDA (0.61; $p < 0.001$). Therefore, blocking by body weight for allocation to pastures should sufficiently reduce extraneous error.

Ultrasound scan results from this experiment indicate that breed type and initial body weights may inflate experimental error associated with ultrasonic measures. Cattle should therefore be allocated to pastures based on breed type and body weight. Although it was not a part of the study, scan interpretations will certainly influence the accuracy and precision of the measures. Obtaining quality ultrasound scans and their interpretation by trained technicians will also help to reduce errors.

References

Griffin, D.B., Savell J.W., Recio R.P., Garrett R.P. and Cross H.R. (1999). Predicting carcass composition of beef cattle using ultrasound technology. J. Anim. Sci. **77**:889-892.

Littel, R.C., Freund R.J. and Spector P.C. (1991). SAS System for Linear Models. SAS Institute, Inc. Cary, NC.

Perkins, T.L., Green R.D. and Hamlin K.E. (1992). Evaluation of ultrasonic estimates of carcass fat thickness and longissimus muscle area in beef cattle. J. Anim. Sci. **70**:1002-1010.

Stouffer, J.R., Wallentine M.V., Wellington G.H. and Diekmann A. (1961). Development and application of ultrasonic methods for measuring fat thickness and rib-eye area in cattle and hogs. J. Anim. Sci. **20**:759-767.

Wilson, D.E. (1997). Using real-time ultrasound to improve body composition traits in beef cattle. Intermountain Cow Symp. Twin Falls, Idaho.

Wilson, D.E., Rouse G., Steinkamp K. and Greiner S. (1997). Real-time ultrasound measurements for body composition traits in Iowa Cattlemen=s Association test station bulls. A.S. Leaflet R1436. 1997 Beef Research Rep. Iowa State University.

Table 1 - Correlation coefficients between initial measures of external fat (EF) depth, *longissimus dorsi* area (LDA), and body weight and final measures of EF, LDA and increases in EF and LDA (n = 91).†

| | Final | | Increases ‡ | |
	EF	LDA	EF	LDA
Initial EF	0.16	0.25*	-0.39***	0.06
Initial LDA	0.02	0.24*	-0.27**	-0.34***
Initial body weight	0.27**	0.35***	-.06	-.01

† External fat and LDA measurements were taken using real-time ultrasound.
‡ Increases of EF and LDA over the duration of the grazing trial.
*, **, *** Significant at P < 0.05, P < 0.01, and P < 0.001 levels of significance, respectively.
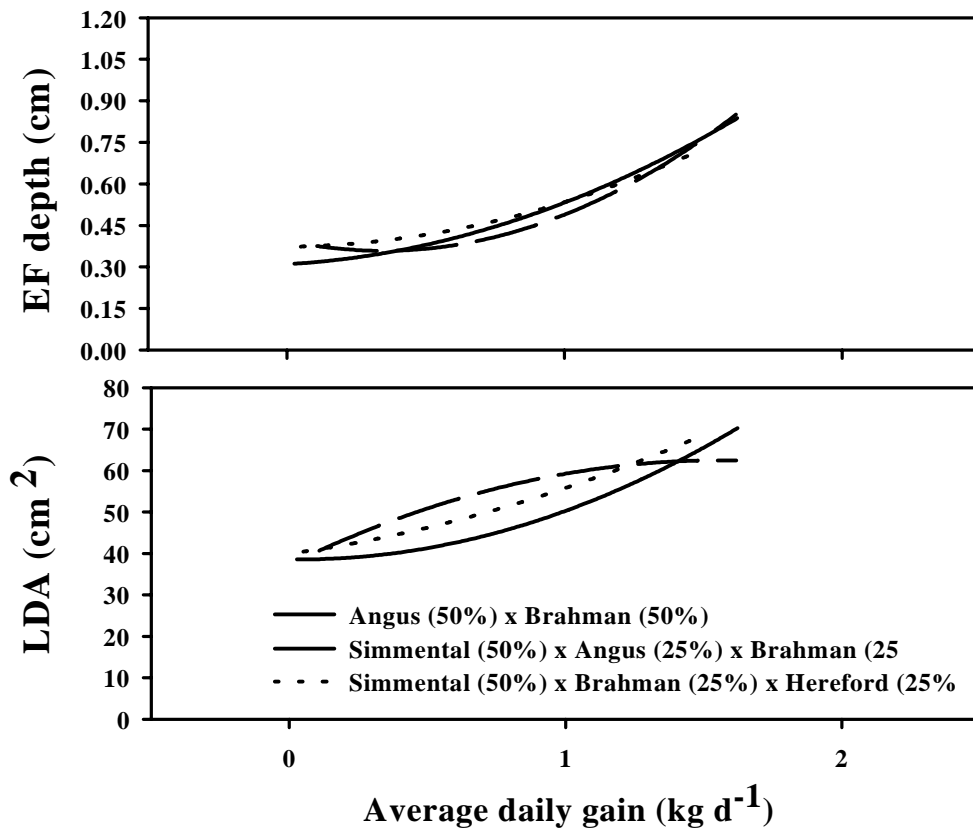
Figure 1 – Relationships of final external fat (EF) depth and *longissimus dorsi* area (LDA) with average daily weight gain for steers grazing rye-ryegrass pasture.