Accuracy of Ultrasound Measures Relative to Carcass Measures of Body Composition in Sheep.

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Summary and Implications

Real-time ultrasound measures of body composition were collected on 85 head of market sheep by 3 ultrasound technicians and subsequent measures were collected on the carcasses of these sheep. This study may help to establish reasonable expectations for ultrasound certification statistics within the sheep industry. Based on these data, it appears that reasonable standards for a sheep ultrasound certification program would be: UFAT - bias <= 0.10 in., SEP <= 0.10 in., SER <= 0.10 in., correlation >= 0.60; UREA - bias <= 0.50 in.^{2}, SEP <= 0.50 in.^{2}, SER <= 0.50 in.^{2}, and correlation >= 0.50. If an ultrasound certification program were started within the sheep industry it may be possible for sheep breeders to more effectively work toward meeting consumer demands in terms of product composition.

Introduction

Real-time ultrasound has become an efficient, cost effective tool for genetic evaluation of body composition within the beef and swine industries. One of the procedures used by both of these industries to establish and monitor the accuracy of ultrasound measures being submitted to breed associations is through ultrasound technician certification programs. Certification generally indicates that a technician has reached some minimum set of standards established by a governing body who is interested in developing the protocols necessary for collecting good information to be used in genetic evaluations. The primary objective of this investigation is to look at what standards would seem relevant for establishing a sheep industry certification program.

Materials and Methods

Eighty-five (85) market sheep participating in the 2003 National Lamb Show (Cedar Rapids, IA) were each ultrasounded by three technicians (A, B, and C). Ultrasound measures were made by each technician for 12th- 13th rib fat thickness (UFAT) and 12th-13th rib ribeye area (UREA). Ultrasound images were collected with Aloka 500 with attached 12 cm 3.5 MHz transducer (technicians A and C) or Classic Scanner 200 with attached 18 cm 3.5 MHz transducer (technician B) technologies.

Within 24 hours after scanning these sheep were harvested at a commercial packing facility (Iowa Lamb Corporation, Hawarden, IA) following standard industry protocols. 24 hours post-mortem the carcasses were split between the 12th and 13th ribs and subcutaneous fat thickness at 1/2 the lateral distance of the *longissimus dorsi* (CFAT) and cross sectional area of the *longissimus dorsi* (CREA) were collected by experienced personnel.

Results and Discussion

Means, standard deviations, and ranges for carcass data and all three ultrasound technicians' data are given in Table 1. Some ultrasound to carcass measure studies have shown a reduction in the standard deviation of the ultrasound measures in comparison to carcass measures. However, this does not appear to be the case in these data.

There are three primary statistics involved in the evaluation of an ultrasound technician's abilities in the beef and swine industries (BIF, 2002; NSIF, 1994). These include TB = technician bias, SEP = standard error of prediction (or standard deviation of prediction), and SER = standard error of repeatability (or standard deviation of the difference) (calculations shown below).

$$TB = \{\sum_i \sum_j (u_{ij} - c_i)\} / n$$

$$SEP = \sqrt{\{\sum_i \sum_j (u_{ij} - c_i - TB)^2\}/\{n-1\}}$$

$$SER = \sqrt{\{\sum_i (u_{i2} - u_{i1})^2\} / n_2}$$

Where,

c_i = carcass measurement on the ith animal
u_{ij} = jth ultrasound measurement on the ith animal
n_1 = number of animals scanned
n_2 = number of animals repeat scanned, and
$n = n_1 + n_2$

In this study repeat measures were not collected on individual animals, so SER could not be calculated in this data set. The standards for ultrasound technician certification used by BIF and NSIF are given in Table 2.

Cattle and swine body composition measures generally have a higher mean and more variation than that observed in sheep. Swine populations would generally have much higher and more variable levels of subcutaneous fat thickness. Cattle have much larger and more variable measures of muscling than sheep. The swine measures of muscling and the cattle measures of subcutaneous fat would be more similar (but still larger) to those measures observed within the general market sheep population.

The statistics for each ultrasound technician are reported in Table 3. It would seem that all three of these ultrasound technicians would easily pass a sheep ultrasound certification program if the levels of statistical accuracy were established as: UFAT - bias <= 0.10 in., SEP <= 0.10

in., SER unknown (but <= 0.10 in. like SEP would seem reasonable); UREA - bias <= 0.50 in.^{2}, SEP <= 0.50 in.^{2}, SER unknown (but <= 0.50in.^{2} like SEP would seem reasonable). Correlation could also be considered in a sheep ultrasound certification program (taking into consideration the variation exhibited within the testing population) and it would appear that based on these data, UFAT r >= 0.60 and UREA r >= 0.50 would be reasonable standards for correlation in a sheep ultrasound certification program. In the context of ultrasound being applied to evaluate potential breeding stock for selection purposes the individual technician bias would become the least significant factor among these statistics. The technician bias would be included as part of the contemporary group effect and the selection of the most desirable genetics within each contemporary group would still occur regardless of technician bias if the other statistics were sufficiently accurate.

These ultrasound measures were taken with ultrasound equipment that is being currently utilized throughout the beef and swine seedstock industries to evaluate potential breeding stock for body composition traits. Therefore there are probably some limitations inherent to the equipment as it is being applied to sheep body composition evaluation. More specific equipment for application to sheep ultrasound measures of body composition could improve the accuracy of measurements collected through ultrasound on sheep. Some examples of these equipment refinements could include a higher frequency transducer to help differentiate smaller differences in fat thickness measures, without the concern of inability to penetrate the full ribeye depth on sheep because of the relative size of the sheep ribeye area. A smaller length transducer could also aid in application of ultrasound technology to the sheep industry as a smaller transducer would show a more expanded view of the tissues on the screen and may make interpretations more accurate to determine the differences among animals.

Implications

This study shows that ultrasound applied by experienced technicians can accurately evaluate sheep for the body composition traits of subcutaneous fat thickness over the 12th rib and ribeye area at the 12th rib. This study has also helped to evaluate reasonable standards for an ultrasound certification program in sheep. Based on these data, it appears that reasonable standards for a sheep ultrasound certification program would be: UFAT - bias <= 0.10 in., SEP <= 0.10 in., SER <= 0.10 in., correlation >= 0.60; UREA - bias <= 0.50 in.^{2}, SEP <= 0.50 in.^{2}, SER <= 0.50 in.^{2}, and correlation >= 0.50. Ultrasound can provide real potential for the sheep industry to make genetic progress through evaluation of live breeding stock. This will be especially true if sheep have similar heritability values as have been observed within the swine and beef industries.

References

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NSIF. 1994. The National Swine Improvement Federation Guidelines for Ultrasonic Certification Programs. Available at: http://www.nsif.com/Factsheets%5CNSIF-FS16_files/NSIF-FS16.html. Accessed: March 30, 2004.

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Table 1. Means and ranges of data for carcass and ultrasound measures.

	Carcass		Ultrasound A		Ultrasound B		Ultrasound C	
	CFAT in.	CREA $in.^2$	UFAT in.	UREA $in.^2$	UFAT in.	UREA $in.^2$	UFAT in.	UREA $in.^2$
Average	0.183	3.014	0.171	2.780	0.195	3.047	0.234	2.785
Std Dev	0.067	0.317	0.047	0.319	0.055	0.358	0.081	0.384
Minimum	0.050	2.250	0.079	1.836	0.090	2.050	0.104	2.036
Maximum	0.350	3.800	0.296	3.529	0.360	3.900	0.437	4.013

Table 2. Accuracy statistics standards required for certification in the swine and beef industries.

	BIF (2002)		**NSIF (1994)**	
	12th Rib Fat	12th Rib Ribeye Area	10th Rib Fat	10th Rib Loineye Area
Bias	<= 0.10	<= 1.20	<= 0.15	<= 0.50
Std. Error of Prediction	<= 0.10	<= 1.20	<= 0.15	<= 0.50
Std. Error of Repeatability	<= 0.10	<= 1.20	<= 0.10	<= 0.40

Table 3. Individual accuracy statistics for prediction of carcass measures with ultrasound.

	Ultrasound Tech A	Ultrasound Tech B	Ultrasound Tech C
12th Rib Fat Thickness			
Bias, in.	-0.012	0.012	0.052
Std. Error of Pred., in.	0.049	0.050	0.052
Correlation	0.690	0.680	0.774
12th Rib Ribeye Area			
Bias, $in.^2$	-0.233	0.033	-0.229
Std. Error of Pred., $in.^2$	0.297	0.338	0.321
Correlation	0.565	0.506	0.595