ULTRASOUND FAT AND MUSCLE MEASUREMENTS OF LIVE LAMBS AS A PREDICTOR OF CARCASS FAT AND MUSCLE MEASUREMENTS AND CHANGES IN ULTRASOUND RIB EYE AREA AND FAT THICKNESS AS LAMBS GROW

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Muscular and lean market lambs grow more efficiently and produce a meat product more preferred by the consumer compared to poorly muscled and fat lambs. Therefore, a case can be made for selection of breeding stock, especially within the terminal sire breeds like Suffolk and Hampshire, for desired carcass composition. Since breeding stock cannot be slaughtered in order to obtain carcass measurements, carcass traits must be estimated indirectly. Some well-trained livestock evaluators can do a reasonably accurate job of estimating carcass traits from a visual inspection of an animal. However, an objective measurement of carcass traits in live animals would be of great benefit to the entire sheep industry. Ultrasound technology has been used quite effectively in the swine industry and to a lesser extent in the beef cattle industry for measurement of carcass traits in live animals. Relatively little use has been made of ultrasound technology in the sheep industry.

The Wisconsin Sheep Breeders Cooperative received funding from the USDA National Sheep Industry Improvement Center, and the University of Wisconsin-Madison, Department of Animal Sciences received funding from the Agricultural Development and Diversification Program, Wisconsin Department of Agriculture, Trade and Consumer Protection for a joint project on the evaluation of ultrasound technology in the sheep industry. Following are the results of two components of this project.

Evaluation of ultrasound measurements to predict carcass ribeye area, loin depth, and fat thickness.

Procedures: Lambs were measured once with an Aloka 500 ultrasound machine with a 3.5 mHz linear probe set over the loin between the 12th and 13th ribs. Lambs were in 8 different groups (n = 174, 6 to 89/group) spread over a 13 mo period. Digital ultrasound images were saved to a PC and measured with ImageTool (www.ddsdx.uthscsa.edu/dig/itdesc.html). Carcass measurements on 89 lambs were obtained using a ribeye area (REA) grid and ruler on the carcass. Measurements on 85 lambs were obtained by tracing the cross section of the loin and the subcutaneous fat layer onto acetate paper. Carcass REA was measured with a compensating polar planimeter, and carcass fat thickness (FT) and loin depth were measured with a ruler from the trace. All ultrasound measurements were collected by one operator who was a novice at the start of the study.

Results: Correlations between ultrasound and carcass measurements by date of ultrasound measurement and for the entire group of 174 lambs is presented in Table 1. Statistically significant correlations between ultrasound and carcass measurements of all lambs were found for REA (.70), FT (.77), and loin depth (.53). For both REA and loin depth, the correlations increased with later groups of lambs as the operator obtained more experience. Fat thickness correlations did not follow a similar pattern.

Table 1. Correlations between ultrasound measurements on live lambs and measurements on their carcasses

		Trait		
Date	No. lambs	Ribeye area	Fat thickness	Loin depth
1/9/03	6	.40	.59	-
4/28/03	12	.20	**.59**	.02
6/2/03	15	.48	**.82**	.31
6/7/03	89	**.64**	**.80**	-
9/25/03	11	**.63**	.34	.32
10/6/03	13	**.80**	.47	.21
10/27/03	18	**.86**	**.78**	**.57**
2/18/04	10	**.93**	**.96**	**.68**
All lambs	174	**.70**	**.77**	**.53**

Correlations in bold type are statistically different from zero, $P < .05$.

A stepwise regression procedure was used to determine the best predictors of carcass REA and FT. Independent variables considered were ultrasound REA, ultrasound FT, and carcass weight. An independent variable was included in the equation if it was a significant source of variation at the $P < .15$ level.

The prediction equation for carcass REA used only ultrasound REA:
Carcass REA, cm^2 = 3.66 + .85(ultrasound REA), (R^2=.49).

The prediction equation for carcass FT used both ultrasound FT and carcass weight, but ultrasound FT was much more important than carcass weight in predicting carcass FT:
Carcass FT, cm = .071 + .88(ultrasound FT), (R^2=.60)
Carcass FT, cm = -.203 + .82(ultrasound FT) + .01(carcass wt, kg), (R^2=.62).

These data indicate that ultrasound measurements on live lambs can be good predictors of carcass measurements, but an experienced ultrasound operator is a necessity.

Determine changes in ultrasound rib eye area and fat thickness in lambs as they grow and determine if the changes differ among breeds and sexes

Procedures: Approximately monthly ultrasound measurements were taken on 160 lambs of the Hampshire (n = 52), Polypay (n = 42), Rambouillet (n = 48), and Targhee (n = 18) breeds at the University of Wisconsin-Madison, Arlington Agricultural Research Station. Lambs were born between 9/23/02 and 5/26/03. Measurements began postweaning, and two to five measurements were obtained on each lamb. Lambs weighed 45 to 240 lb. at the time of measurement with the majority of the measurements taken when the lambs weighed 75 to 155 lb. Distribution of lambs among sex types was: 108 ewes and 52 rams. Data were analyzed with a random regression mixed model that included the effects of lamb, sex, breed, weight, (weight)^2, and age. Depending upon the trait, final models also included one or more of the following interactions: sex x weight, breed x weight, and breed x (weight)^2.

Results: **Fat Thickness** – Ultrasound fat thickness (FT) increased linearly (quadratic component was not significant) in all breeds as weight increased. The linear regression of FT on weight was greater ($P < .05$) for Hampshire and Polypay than for Rambouillet and Targhee (Table 2 and Figure 1) and 60% greater ($P < .05$) for ewe lambs than for ram lambs (Table 2).

Table 2. Regression (in./lb.) of ultrasound fat thickness on weight for lambs of different breeds and sex.

	Sex		Breed average
Breed	Ewe	Ram	across sex
Hampshire	.0020	.0013	.0016
Polypay	.0018	.0011	.0014
Rambouillet	.0016	.0009	.0012
Targhee	.0013	.0006	.0009
Sex average – across breed	.0016	.0010	

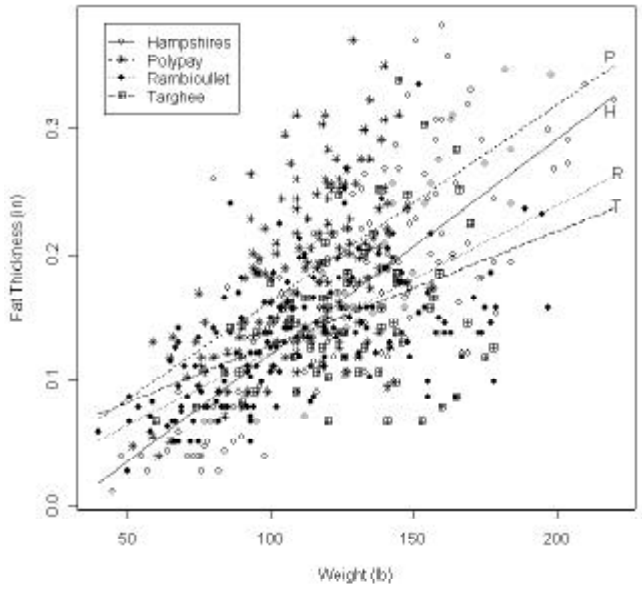

Figure 1. Fat thickness vs. weight for lambs of different breeds.

Rib eye area – Unlike FT, rib eye area generally showed a quadratic relationship with weight. Linear and quadratic regression coefficients were similar for ram and ewe lambs. Targhees showed only a linear increase in rib eye area as weight increased while the other three breeds had a linear and quadratic response (Table 3 and Figure 2). As weight increased, rib eye area increased at a slower rate in both Hampshire and Rambouillet. However, rib eye area increased at an increasing rate at heavier weights in Polypay. The positive quadratic coefficient for Polypay was due to a very few heavy lambs with large rib eye areas, and it is questionable if it would exist with more observations on heavy Polypay lambs.

Table 3. Linear (in.^{2}/lb.) and quadratic (in.^{2}/lb.^{2}) regressions of rib eye area on weight for lambs of different breeds.

Breed	Linear	Quadratic
Hampshire	.028	-.00005
Polypay	.003	.00004
Rambouillet	.022	-.00003
Targhee	.010	0

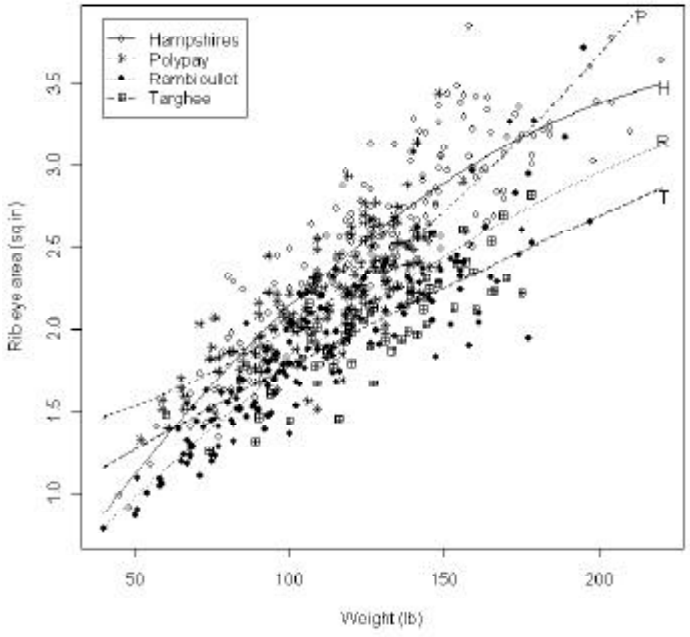

Figure 2. Rib eye area vs. weight for lambs of different breeds.

Rib eye depth – Rib eye depth showed a quadratic relationship with weight. Linear and quadratic regression coefficients were similar for ram and ewe lambs. Hampshire had greater ($P < .05$) linear regressions than Polypay or Targhee, but the Rambouillet curve was similar to that of Hampshire (Table 4 and Figure 3).

Table 4. Linear (in./lb.) and quadratic (in./lb.^{2}) regressions of rib eye depth on weight for lambs of different breeds.

Breed	Linear	Quadratic
Hampshire	.0089	-.00002
Polypay	.0074	-.00002
Rambouillet	.0088	-.00002
Targhee	.0066	-.00002

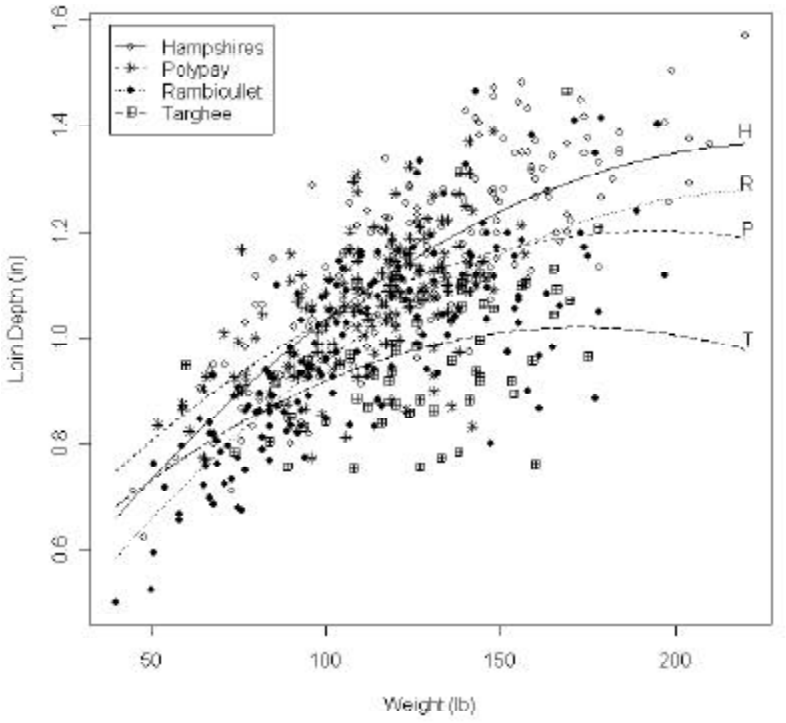

Figure 3. Rib eye area depth vs. weight for lambs of different breeds.

Application of results: The Wisconsin Ram Test Station currently adjusts ultrasound fat thickness, rib eye area, and rib eye depth measurements to 135 pounds using the following linear regression coefficients for all breeds:

Fat thickness - .00158 in./lb.
Rib eye area - .00993 in.^{2}/lb.
Rib eye depth - .0042 in./lb.

Weight adjusted ultrasound measurements using the above linear regressions or the linear (and quadratic) regressions generated from this study from the Hampshire breed do not differ greatly, especially if ram weights are 135 ± 25 lb. However, since it is well known that growth of tissues is not linear relative

to changes in body weight and that different breeds deposit fat and muscle at different rates relative to changes in body weight, it may be advisable to develop breed type-specific regressions from the results of this study to adjust ultrasound measurements to a common body weight.