PREDICTING CARCASS MEAT YIELD AND MEAT QUALITY OF HANWOO(KOREAN NATIVE CATTLE) STEERS USING ULTRASOUND TECHNOLOGY

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Background.
Real-time ultrasound instruments have been widely used in the field for estimating live animal BFT, LMA and IF *(Song et al., 2002)*. Recently, several institutions and organizations have developed software systems, that can predict percentage of intramuscular fat or marbling from real time ultrasound images. However, limited information has been published on the accuracy or precision of these systems *(Brethour, 1994; Herring et al., 1998)*. Since 1993, the Korean Animal Products Grading Service has provided a beef grading system for quantifying meat yield and quality factors by subjective evaluation. The ability to use ultrasound to precisely and accurately estimate carcass measurements in live animals should be of benefit to the beef industry, allowing it to move away from the current practice of pricing cattle on pen averages to a value-based marketing system. Smith et al. (1992) found that correlation coefficients between live animal ultrasound and carcass measurements of BFT and LMA varied form 0.81 to 0.82 and from 0.43 to 0.63, respectively. Ultrasonic speckle deposits were related to the degree of marbling. Skilled sonographers can visually interpret an echogram and estimate marbling in a live animal with fair accuracy.

Objective.
The objective of this study was to compare and evaluate ultrasound measurements of BFT, LMA and IF before slaughter for improving prediction of yield grade and marbling score. In this study, scanning data were evaluated for increasing prediction accuracy rate by the yield grade index, fat depth, regression and decision methods.

Methods.
Six hundred seven progeny testing of Hanwoo steers were ultrasonically scanned by Super-eye Meat (FHK Co. Ltd., Japan) with the electric linear probe (2 MHz frequency: 27 X 147 mm) between the 13th rib and lumber vertebrae on the left side of 13th rib nearly one week before slaughter for estimating BFT, LMA and IF. Scanned images were obtained using double frame display capabilities of the equipment, and a transducer guide was used to minimize error that might occur due to produce one complete image of the longissimus muscle. The resulting ultrasound images were recorded on MO diskette and later viewed on a display monitor to estimate both ultrasound BFT and ultrasound LMA. Internal machine calipers of known length relative to the scanned image were used to draw a line that was then measured on the screen. Carcass fat thickness was measured at two-thirds the length of the longissimus muscle from the chine bone end, and longissimus muscle area was measured at the 13th rib end. A complete image was obtained by hard copy to estimate marbling score, another image recorded on videotape was viewed to estimate both BFT and LMA using computer software (SCD-150F, FHK, Japan). In this study, ultrasonic estimate was compared to carcass value for increased prediction accuracy by four prediction methods: yield grade index, fat depth alone, regression and decision tree.

Results and Discussion.
Table 1 presents correlations between predicted (BFTU, LMAU) and observed carcass measurements (BFTC, LMAC). Significant relationships ($p<0.01$) were found 0.78, between BFTU and BFTC; and 0.69, LMAU and LMAC. Fat thickness has the largest influence on yield grade(YG) of any of the factors involved in the YG equation. These correlations were large and positive. Figure 1 presents the relationship between YG and BFT. In appearance of cattle carcasses, yield grade A included 95.4% of carcasses with less than 6mm of BFT and yield grade B was 91% at greater than 8mm of BFT. In ultrasonic measurements, yield grade A was 85.4% at less than 5mm and yield grade B was 71.4% at largest than 9mm. Table 3 presents a comparison of the four methods used to analyze prediction accuracy between ultrasonic and carcass measurements. Firstly, prediction accuracy of the yield grade index was 79.2% at yield grade A and 69.5% at yield grade B. The fat depth alone method predicted 83.2% of carcasses less than 5 mm at grade A. and 72.3% of carcasses more than 9 mm at grade B. The regression method used YGI=70.69***-0.00239*** BW-0.34787*** BFTU+0.02808***LMAU (*** $p<0.001$). Finally, prediction accuracy by the decision tree method was 83% at grade A, 74.2% at grade B. The prediction accuracy of quality grade according to four Korean grade levels is presented in table 3. Meat quality level prediction accuracy was 44.9% at the third grade, 82.8% at second, 73.2% at first and 69% at prime. These results suggest that the decision tree method showed best accuracy among the four methods. Also, if live weight is unknown (as on the small-scale farm), the decision tree method enables prediction using only ultrasonic measurements (BFT and LMA). As we collect more data, prediction accuracy will increase giving satisfactory. Placement of the transducer for near and far image registration, and interpretation of the image produced by the technician may cause error between ultrasound and actual carcass measurements of BFT and LMA

Conclusions.
The results of the presents study show that the decision trees method for meat yield grade predicted at 79.9% accuracy. Also, scanned images for meat quality grade predicted 71% accuracy. Ultrasonic measurements made before slaughter are useful for estimating carcass BFT, LMA, and IF.

Pertinent literature.
Brethour, J. R. 1994. Estimating marbling score in live cattle form ultrasound images using pattern recognition and neural network procedures. J. Anim. Sci. 72:1425-1432.
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Table 1. Correlation coefficient between ultrasonic and carcass measures

	Live Weight	BFU	LMAU	Carcass Weight	BFT	LMAC	YGI
Live weight	.00						
BFU[1]	.40***	1.00					
LMAU[2]	.50***	0.39***	1.00				
CW	.94***	0.46***	0.56***	1.00			
BFC[3]	.41***	0.78***	0.35***	0.46***	1.00		
LMAC[4]	.56***	0.27***	0.69***	0.62***	0.22***	1.00	
YGI[5]	.20***	-0.60***	0.03	-0.22***	0.83***	0.33***	1.00

[1] Ultrasonic Back Fat Thickness, [2] Ultrasonic Longissimus Muscle Area, [3] Carcass Back Fat Thickness, [4] Carcass Longissimus Muscle Area, [5] Yield Grade Index, *** $p<0.001$

Table 2. Comparison of prediction accuracy by four methods on yield grade

YGIC	YGIU	Formula N[a]	Formula Accuracy	Fat depth alone N	Fat depth alone Accuracy	Regression N	Regression Accuracy	Decision tree N	Decision tree Accuracy
A	A	312[b]	79.2%[c]	328	83.2%	334	84.8%	327	83.0%
	B	82		66		60		67	
Subtotal		394[d]		394		394		394	
B	A	65		59		69		55	
	B	148[e]	69.5%	154	72.3%	144	67.6%	158	74.2%
Subtotal		213		213		213		213	
Total		607[f]	75.8%	607[g]	79.4%	607	78.8%	607	79.9%

[a] Number of carcasses. [c] $b/d\times100$. [g] $(b+e)/f\times100$

Table 3. Prediction accuracy between carcass marbling score and ultrasonic marbling score measurements

MSC	MSU 1+	MSU 1	MSU 2	MSU 3	Total	Accuracy
1+	29[a]	12	1		42	69.0
1	11	104[b]	25	2	142	73.2
2	1	34	236[c]	14	285	82.8
3		7	69	62[d]	138	44.9
Total	41	157	331	78	607[e]	71.0[f]

[f] $(a+b+c+d)/e\times100$

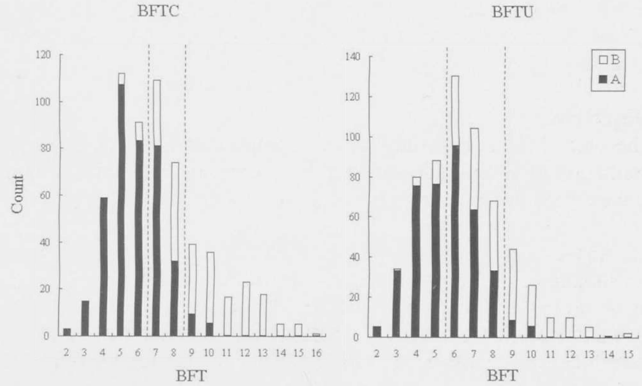

Fig 1. Frequency distributions between BFTU, BFTC and YG

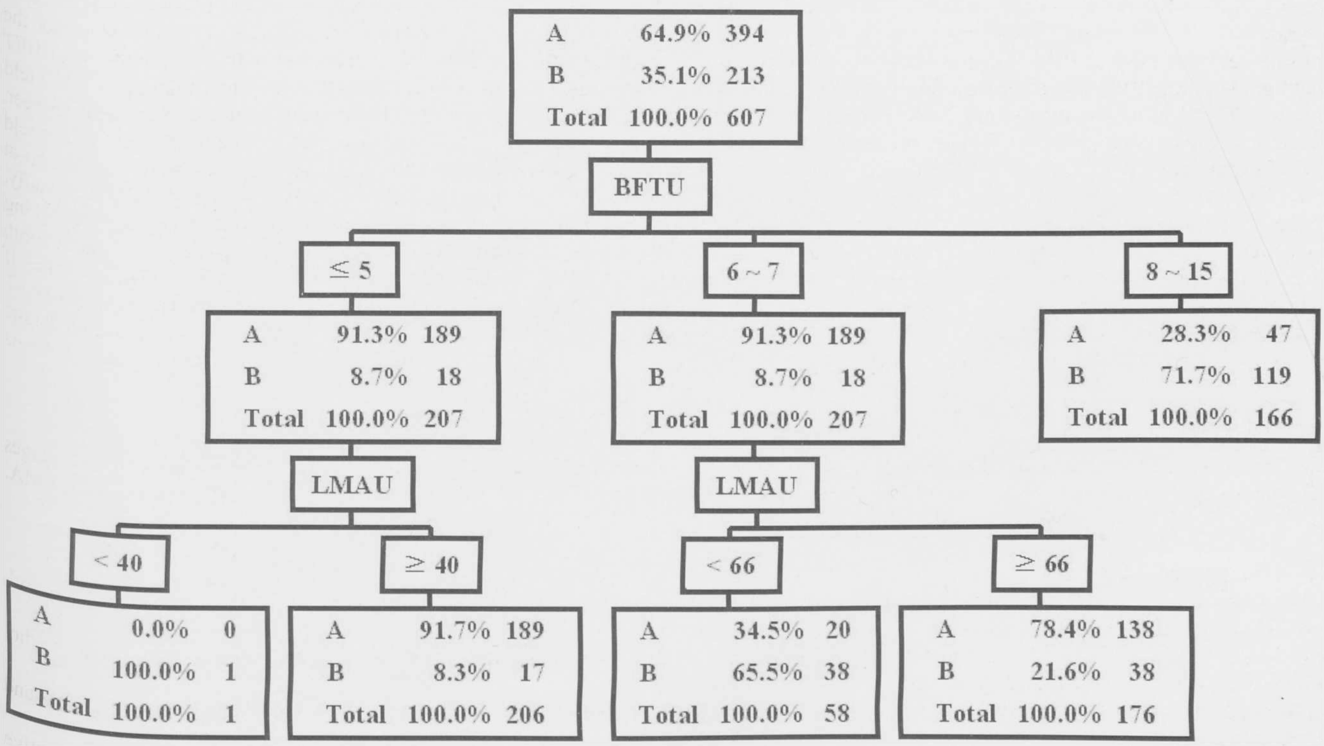

Fig 2. Distribution pattern of yield grade index by the decision tree method