PREDICTION OF RETAIL BEEF YIELD: PREDICTION MODELS

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***Abstract*—A total of 13,389 records of carcas and beef cut yield were collected from 30 abattoirs and butcheries in Korea from 2008 to 2009 to develop prediction models for retail cut percentage wtih higher accuracy. Models fit breed, sex, interaction of abattoir by butcherer for all breeds and sexes and interaction of abattoir by butcherer for each bree and sex. Because of future possible changes in back fat control, we suggest to take log transformation of back fat thickness. Our new models fit better than currenlty used model.**

***Index Terms*—breed, carcass, Hanwoo, retail cur percentage, sex, yield index**

I. INTRODUCTION

Beef carcass grading system in Korea has been put to practice since 1993. The system determines beef carcass grades in two categories. One is yield grade and the other is quality grade. Qaulity grade is assigned by combination of visual degrees in intramuscular fat deposition, muscle color, fat color, texture and maturity. Yield grade predicts the amount of saleable beef cuts and the grade of which is assigned by the index combining measures of cold carcass weight, eye muscle area and back fat thickness. Cattle breeds in Korea that are used for beef production consists of Hanwoo (Korean Native Cattle), Holstein steers and some cross products of these two major breeds. Holstein cattle widely grew as dairy cattle and their male progeny are byproducts. Therefore, breeding objective of Holstein breed is majorily milk production, yield and quality. On the other hand, Hanwoo cattle are mostly bred for their beef production. And the national breeding objectives also focus on their beef yield and quality. As consumers' growing concern on more tasteful beef products, Hanwoo breeding goals now focus more on quality rather than to yield. And this shift in genetic change affect other economically important characteristics such as back fat or retail cut yield, which is directly related to profitability from respect of beef salers.

The objective of this study was, therefore, to develop models to predict saleable retail cuts with higher accuracy than the index used currently as a national standard.

II. MATERIALS AND METHODS

A total of 14,389 records of beef cut yield by parts were collected from 30 abattoirs and butcheries in Korea for two years from September, 2008 to April, 2009. Breed and sex of the data were Hanwoo cows & heifers (940 heads, 6.5%), Hanwoo bulls (1,383 heads, 9.6%), Hanwoo steers (12,066 heads, 65.3%) and steers of mixed breeds other than Hanwoo (14,389 heads, 18.6%). The records consist of body weight (**BW**, kg) upon unloading from shipping trucks, cold carcass weight (**CWT**, kg), retail cut yield (**Retail cut,** kg) and percentage (**%Retail cut**, of carcass weight), total body fat (**Body** fat, kg), bones (**Bone**, kg), back fat thickness (**BF**, mm) and longissimus muscle area (**EMA**, cm^2). The latter two measures (**BF, EMA**) were estimated by a beef carcass grading specialist from Animal Products Grading Service (APGS), Korea.

Parameters of generalized regression coefficients were estimated by GLM procedures of SAS (2004) fitting models with fixed class effects of breed, sex, and an interaction term between abattoirs and butcheries and three covariate terms(CWT, EMA, BF). Prediction error was calculated as deviation of predicted value from measured values and its mean and variances (prediction error variance, PEV) were estimated with MEANS procedure.

III. RESULTS AND DISCUSSION

Lee et al. (2008) and Park et al. (2002) reported that sex of Hanwoo cattle is a significant source of variation determining retail cut percentages. And Dikeman et al. (1998)'s report also revealed significance of sex effect in other breeds as well. Reverter et al. (1999) had observed the retail cut percentage by breeds of different origins. Effect of sex can be understood as differences in feeding program. And breed difference can be understood as differences in market ages, especially when Hanwoo and Holstein breeds are combined into consideration together. Table 1 describe the difference in measures by sex and by breed. Generally other breeds (mostly Holstein) grow faster than Hanwoo cattle and can be slaughter in younger ages. Therefore, carcass weight and retail cut yields of other breeds are greater with thinner back fat thickness than those of Hanwoo cattle. But size of eye muscle is much smaller which support the evidence of much younger age at slaughter.

Table 1. Means and standard deviation of the carcass and beef cut measures by sex and by breed

breed	sex	N	CWT kg	Retail cut Kg	Retail cut %	Bone %	BF mm	EMA cm^2
Hanwoo	Steers	9391	405.6±39.8	254.1±26.3	62.7±3.0	12.1±1.0	12.4±4.5	88.4±9.3
	Female	940	335.5±35.2	208.1±22.9	62.1±2.8	11.7±1.1	10.4±4.0	76.4±8.9
	Bulls	1383	376.2±44.0	251.6±31.1	66.9±3.7	13.4±1.2	5.6±2.8	86.2±9.8
Other	Steers	2675	410.2±35.5	259.9±23.0	63.4±3.0	14.5±1.4	7.0±3.0	44.2±7.7

*BW : body weight before slaughter, CWT : cold carcass weight, BF : back fat thickness, EMA : eye muscle area

Table 2 and Table 3 show the regression coefficients of the three covariates to predict retail cut percentages by breeds and sexes. Error mean square was chosen as a criteria to selection of the best model. Table 2 fit models with back fat thickness as a direct linear variable while Table 3 fit models with back fat thickness as a logarithmic transformed variable to make it normalized.

Table 2. Estimates for prediction of % retail cut by breeds and sexes

breed	sex	N	R^2	$\sqrt{MSE}$	Intercept	CWT	BF	EMA
1	1	925	0.429	2.087	62.9785	-0.0112	-0.1871	0.0979
1	2	1344	0.535	2.541	70.1382	-0.0091	-0.4196	0.0652
1	3	9259	0.540	2.034	68.0800	-0.0179	-0.1902	0.0933
2	3	2647	0.154	2.759	68.1082	-0.0216	-0.2084	0.0679

*Prediction Model: [%retail cut] = β_0+[house*butcherer]+β_1[CWT]+β_2[BF)]+β_3[EMA]+ε
breed : 1=Hanwoo, 2=Other, sex: 1=female, 2=bull, 3=steer
$\sqrt{MSE}$: square root of MSE(error mean square)

Model fitness as determined by either R^2 or $\sqrt{MSE}$ became a little better by taking log value of BF but not quite considerably.

Table 3. Estimates for prediction of % retailcut by breeds and sexes

breed	sex	N	R^2	$\sqrt{MSE}$	Intercept	CWT	log(BF)	EMA
1	1	925	0.436	2.075	65.3304	-0.0108	-1.9752	0.0974
1	2	1344	0.542	2.522	71.9158	-0.0085	-2.6833	0.0659
1	3	9259	0.538	2.040	71.1873	-0.0180	-2.1900	0.0939
2	3	2647	0.157	2.755	69.5805	-0.0212	-1.9378	0.0972

*Model: [%retail cut] = β_0+[house*butcherer]+β_1[CWT]+β_2[log(BF)]+β_3[EMA]+ε
breed : 1=Hanwoo, 2=Other, sex: 1=female, 2=bull, 3=steer
$\sqrt{MSE}$: square root of MSE(error mean square)

However, prediction error variance of our new models were much smaller than the model used as a current national standard (penow in Table 4). Indices i1_3 and i2_3 are the index models fit by a subset of data used in this study (N=12,247) without or with log transformation of BF, respectively. And indices i1_4 and i2_4 are the index models fit by full set of data (N=14,389) without or with log transformation, respectively. All of these four models predict retail cut percentage regardless of the effect of breed and sex.

Table 4. Prediction error variances (PEV) from indices for all breeds and sexes

Variable	N	PEV
penow	14389	11.75251
pe1_3	14389	8.81203
pe2_3	14389	8.544518
pe1_4	14389	8.767299
pe2_4	14389	8.535938

inow=**68.184-0.024***cwt-**0.625***bf+**0.130***ema (currrent yield index) & penow=p_retailcut-inow
i1_3=**68.2802-0.0174***cwt-**0.1916***bf+**0.0882***ema & pe1_3=p_retailcut-i1_3
i2_3=**70.9531-0.0168***cwt-**2.1101***logbf+**0.0887***ema & pe2_3=p_retailcut-i2_3
i1_4= **68.3368-0.0171***cwt-**0.2036***bf+**0.0879***ema & pe1_4=p_retailcut-i1_4
i2_4=**70.9917-0.0168***cwt-**2.1338***logbf+**0.0886***ema & pe2_4=p_retailcut-i2_4
* breed : 1=Hanwoo, 2=Other, sex: 1=female, 2=bull, 3=steer

IV. CONCLUSION

Covariance models were developed to increase predictability of beef carcass yield index. Breed specific indices were compared with or without normalization of back fat thickness. And prediction error variances were compared between currently used model and newly developed models independent of breed and sex. We suggest to use new prediction models, preferably the model with log transformation of back fat thickness because this might be more powerful statistically to accommodate future changes in back fat control.

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REFERENCES

Dikeman, M. E., Cundiff, L. V., Gregory, K. E., Kemp, K. E., & Koch, R. M. (1998). Relative contribution of subcutaneous and intermuscular fat to yields and predictability of retail product, fat trim, and bone in beef carcasses. *J. Anim. Science*, 76, 1604-1612.

Lee, J. M., Hah, K. H., Kim, J. H., Cho, S. H., Seong, P. N., Jung, M. O., Cho, Y. M., Park, B. Y., Kim, D. H., & Ahn, J. N. (2008). Study on the carcass yield grade traits and predictin of retail product weight in Hanwoo beef. *Korean J. Food Sci. Anl. Resour.*, 28, 604-609.

Park, G. B., Moon, S. S., Ko, Y. D., Ha, J. K., Lee, J. K., Chang, H. H., & Joo, S. T. (2002). Influence of sluaghter weight and sex on yield and quality grades of Hanwoo (Korean native cattle) carcasses. *J. Anim. Science*, 80, 129-136.

Reverter, A., Johnston, D. J., Stephens, E., & Perry, D. (1999). Development of a prediction equation for retail beef yield precent to be used in national genetic evaluation schemes. In *Proc. Assoc. Advmnt. Anim. Bree. Genet.* Vol. 13, 381-384.

SAS/STAT® 9.1 User's Guide (2004). SAS Institute Inc. Cary, NC, USA, ISBN 1-59047-243-8.