51st International Congress of Meat Science and Technology
August 7-12, 2005 – Baltimore, Maryland USA

EVALUATION OF CURRENT UNITED STATES PORK INDUSTRY CARCASS GRADING EQUIPMENT[a]

Newman, D.J.[1,*], E.L. Walker[2], T.B. Schmidt[1], D.L. Meyer[1], C.A. Stahl[1], G.K. Rentfrow[1], V.L. Pierce[3], M.R. Ellerseick[4], and E.P. Berg[1]

[1]University of Missouri – Columbia; Division of Animal Science, [2]Missouri State University, [3]University of Missouri – Columbia; Division of Agricultural Economics, [4]University of Missouri Agriculture Experiment Station – Division of Statistics
[a]Project funded in part by the United States Department of Agriculture Agricultural Marketing Service.

Key Words: Pork, Carcass, Yield, Instrument

Introduction

Mandatory Price Reporting (MPR) was developed as an information system to enable the United States Department of Agriculture (USDA) to implement the intent of the 1999 Livestock Mandatory Reporting Act. One component of MPR requires reporting of pork pricing data based on pork carcass compositional yield. In accordance with MPR, market data must be reported in an accurate and timely fashion to the public. Existing pork carcass grading equipment could be used to report an industry standard that could be commonly evaluated and reported on a daily basis. Reporting a common endpoint of pork carcass yield and (or) primal and subprimal cuts manufactured and sold in the U.S., would be well received and readily understood by packers, further processors, and producers.

Objectives

The objective of this project was to provide the USDA Agricultural Marketing Service (AMS) a means of standardizing data across different pork carcass composition assessment equipment to a common end point. This would create a base of consistency for reporting national pork pricing information.

Methodology

The numbers of barrow and gilt carcasses used in the trial to meet the average backfat and carcass weight for each of the nine selection cells were selected over an eight week span (Table 1). Carcasses were pre-selected based on visual composition appraisal for inclusion within the selection grid below. Each cell included carcasses selected over the eight week period, to represent multiple days of plant operation and no one cell was filled on a single day's operation. Final evaluation of the carcass condition was conducted prior to the grading station. Carcasses with skin removed, possessing lean tissue or bone removal, and (or) a poor carcass split were not considered for inclusion.

Table 1. Final carcass selection grid

Fat Thickness (mm)		Carcass Weight Range (kg) 79.4 – 87.1 Barrows	Gilts	87.5 – 93.9 Barrows	Gilts	94.3 – 104.3 Barrows	Gilts
< 20.3	No.	17	18	17	17	17	19
	Hot Carc. wt (kg)	83	83	90.2	90.6	97.0	96.9
	Last rib FT (mm)	17.0	17.0	18.0	18.0	17.8	18.3
20.3-27.9	No.	17	20	17	18	17	15
	Hot Carc. wt (kg)	82.4	82.4	91.7	90.9	98.5	98.3
	Last rib FT (mm)	23.9	23.9	23.9	23.4	23.4	23.6
> 28.0	No.	17	14	17	17	17	20
	Hot Carc. wt (kg)	82.5	82.4	90.8	90.3	100.3	99.8
	Last rib FT (mm)	30.5	29.0	30.0	30.0	32.5	30.5

Carcass weight and last-rib backfat thickness were obtained on the warm, pre-rigor carcasses railed off-line at the carcass grading station. Carcasses were included in the study based on the gender, hot carcass weight, and last rib backfat thickness. Carcasses not fitting the grid were returned to normal plant processing. Carcasses fitting the grid were measured with the following equipment; Animal Ultrasound Services (AUS; Ithaca, NY) Carcass Value Technology instrument 1 (CVT1; 17cm long 5049 ultrasonic transducer head) and CVT2 (12.5cm long 5011 ultrasonic transducer head), Hennessy Optical Grading Probe (Auckland, NZ), and SFK (Peosta, IA) Fat-O-Meater (FOM) optical grading probe, Ultrasonic FOM, and the Automatic FOM (AutoFOM). Data collection personnel operated the same pieces of equipment throughout the trial and were properly trained for operation. Right carcass sides were removed from the processing line after an overnight chill, wrapped, and transported via refrigerated truck to the University of Missouri Meat Science Laboratory. The weekly schedule is outlined in Figure 1.

Figure 1. Weekly schedule of carcass selection, cutout, and data collection

Monday	Tuesday	Wednesday	Thursday	Friday
AM: Carcass selection and equipment data collection **PM**: Carcass identification labeling in the cooler.	**AM**: Pork sides removed from processing line & wrapped **PM**: Sides transported to UMC via refrigerated truck.	Carcass cutout & data collection.	Continued cutout (if necessary).	Data entry.

Carcass cutout data sheets were designed to obtain the weight of all primal and subprimal cuts reported in the USDA National Carlot Pork Report. Cutout sheets and cut specifications were supervised then approved by USDA Market News personnel. After collection of cutout data, all boneless soft tissue was collected for each side, mixed, and ground, then re-mixed and subsampled for analysis of total ether extractable lipid and moisture. Fat-free carcass lean (**FFL**) was determined according to Schinckel et al. (2001) whereby; **FFL=dissected soft tissue (ST) wt – [ST lipid weight / %lipid of pure fat sample]** and lipid-free lean (LFL) calculated as **LFL=dissected soft tissue (ST) wt – (ST weight*%lipid of ST)**.

Statistics. Linear regression analysis was conducted using the representative fat and lean tissue depths (or loin muscle area as output by the AutoFOM) obtained from each electronic grading instrument. Tissue measurements and hot carcass weight were used as independent variables to predict pork carcass yield to various trim levels, bone-in/boneless, and fat-free status (Table 2). Final prediction equations were determined using the STEPWISE procedure of SAS (Raleigh, NC). Independent variables were selected for inclusion in the final regression equation at a level of $P < 0.10$.

Results & Discussion

The precision and accuracy of each instrument are similar, but for the Ultrasonic Fat-O-Meater Table 2. The CVT probes (also ultrasonic equipment) recorded the highest R^2 and lowest RMSE statistics. Therefore, it appears that ultrasonic attenuation due to carcass external fat cooling was not a problem. When the new equations (developed from these data) were applied to predict compositional yield, no differences were observed across instrument for predicted carcass yield. This suggests that the equations generated from this project can be used as an industry standard.

Table 2. Accuracy (coefficient of determination; R^2) and precision (residual standard deviation; RSD) of pork carcass grading instruments to predict proportional carcass yield.

		Pork carcass grading equipment[a]						
% carcass yield[b]		**Ruler**	**AFOM**	**CVT1**	**CVT2**	**FOM**	**HGP**	**UFOM**
BI-6FLC	R^2	0.568	0.682	0.704	0.708	0.649	0.664	0.355
	(RSD)	(1.67)	(1.44)	(1.38)	(1.37)	(1.51)	(1.47)	(2.04)
BI-3FLC		0.592	0.708	0.734	0.728	0.678	0.692	0.363
		(1.73)	(1.47)	(1.39)	(1.42)	(1.55)	(1.50)	(2.16)
BI-0FLC		0.664	0.754	0.791	0.784	0.726	0.729	0.392
		(2.07)	(1.78)	(1.62)	(1.66)	(1.88)	(1.86)	(2.78)
BL-0FLC		0.472	0.639	0.688	0.672	0.593	0.599	0.313
		(2.29)	(1.91)	(1.76)	(1.81)	(2.03)	(2.00)	(2.62)
FFL		0.282	0.387	0.454	0.416	0.366	0.368	0.225
		(4.55)	(4.24)	(4.00)	(4.12)	(4.30)	(4.27)	(4.72)
LFL		0.479	0.600	0.678	0.662	0.554	0.561	0.321
		(2.99)	(2.64)	(2.35)	(2.42)	(2.78)	(2.75)	(3.41)

[a]**Ruler**: lastrib fat thickness measured with a stainless steel ruler. **AFOM**: Automatic Fat-O-Meater, SFK, Industries, Inc. Peosta, IA. **CVT1**: Carcass Value Technology system 1, Animal Ultrasound Services (AUS), Ithaca, NY (17 cm, 5049 transducer). **CVT2**: Carcass Value Technology system 2, AUS 12.5 cm 5011 transducer and *tailhook*). **FOM**, Fat-O-Meater, SFK. **HGP**: Hennessy Grading Probe, Hennessy Grading Systems, Inc., Auckland, NZ. **UFOM**: Ultra-Fat-O-Meater, SFK.

[b]**BI-6FLC**: Bone-in, four lean cuts (Ham, loin, picnic shoulder, Boston butt) trimmed to 6.35 mm external fat depth. **BI-3FLC**: Bone-in, four lean cuts trimmed to 3.18 mm external fat depth. **BI-0FLC**: Bone-in, four lean cuts trimmed to 0.0 mm external fat depth. **BL-0FLC**: Boneless four lean cuts (five piece ham, full-length loin, strap on, picnic shoulder, and Boston butt) trimmed to 0 mm external fat. **FFL**: Fat-free lean = carcass soft tissue wt – (soft tissue lipid / %lipid of pure fat tissue). **LFL**: Lipid-free lean = carcass soft tissue wt – (carcass soft tissue wt * %lipid soft tissue)

Hot carcass weight (HCWT) was not significantly correlated (Pearson Coefficient of Correlation) with any proportional carcass yield variable. The fat depth as recorded by the CVT1 possessed the highest correlation with all carcass yield variables, followed closely by CVT2 and FOM derived fat depth. The highest correlations between fat depth and proportional product yield were seen for three yield estimates of bone-in closely trimmed four lean cuts. Of the two definitions of fat-free mass, LFL possessed higher correlation with subcutaneous fat measurements. All subcutaneous fat measurements were significantly ($P < 0.0001$) correlated to one another. The highest correlations were seen between the FOM and HGP ($r = 0.94$), CVT1 and CVT2 ($r = 0.93$), and last rib fat thickness and AFOM last rib fat thickness ($r = 0.915$). Correlations between muscle depth measurements from the various pieces of equipment were significant, yet not as highly correlated to one another as were the fat depth measures.

Conclusions

The different yield endpoints predicted by carcass grading equipment will possess different meanings and levels of importance to the individual utilizing them. Packers and wholesalers may find the estimate of trimmed or boneless yield to the be the most beneficial while swine producers using the National Research Council's nutrition management software will use and appreciate the fat-free lean estimate and researchers may obtain the most information from lipid-free lean. The data and results generated from the completion of this project will benefit all segments of the pork production chain.