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Predicting Wholesale Value of Beef Carcasses

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Summary

Electromagnetic scanning (EMS) has been studied as a method to determine the lean content of beef carcasses. In this study the capability of EMS to predict wholesale value of beef carcasses was examined. Yield grades, as assigned by a USDA grader (GRADER), and yield grades calculated to the nearest hundredth (CALC), were also examined to compare their predictive value. Beef hindquarters (n=219) were obtained from the U.S. Meat Animal Research Center's germ plasm evaluation project, Cycle V. Fat thickness ranged from .10 to .90 inches with calculated yield grades ranging from 1.26 to 5.46. When side value was determined from estimates of subprimal cut weight with 0.0 inches of fat trim, EMS had an R^2 of .91 (root mean square error [RMSE] of $9.92), CALC had an R^2 of .88 (RMSE of $11.03), and the GRADER method produced an R^2 of .85 (RMSE of $12.49). When side value was predicted from subprimal cuts with 0.3 inches of fat, differences between methods were reduced. Expressing the value on a percentage of carcass weight basis ($/cwt) revealed calculated yield grade to provide the most precise estimates (higher R^2), followed by EMS and GRADER estimates. Addition of fat thickness to the EMS model increased predictive accuracy (lower RMSE). Electromagnetic scanning appears to provide a more accurate estimate of total wholesale beef carcass value than the USDA yield grade system, as currently applied.

Introduction

The growing interest in value-based marketing elevates the importance of accurate assessment of individual carcass merit. Retailers, meat plants, and producers must find a way to reduce the production and marketing of fat. Instant feedback to producers, in the way of a higher dollar value for preferred cattle, gives a clear signal on what type of beef is desirable. Electromagnetic scanning (EMS) has the capability to accurately provide an assessment of lean content on a single carcass basis.

Previous research at the University of Nebraska has shown that EMS has the ability to predict lean composition of beef carcasses (1994 Nebraska Beef Report, pp. 61-64; 1993 Nebraska Beef Report, pp. 68-69). This project was conducted to evaluate the use of EMS to predict wholesale value of beef carcass sides. The relationships of grader-assigned and calculated USDA yield grades to carcass value were also compared.

Procedure

Hindquarters (n=219) were obtained from steers used for the U.S. Meat Animal Research Center's germ plasm evaluation project, Cycle V. These steers were slaughtered at a commercial midwest packing plant at four intervals. USDA yield grades were calculated from carcass data obtained at the slaughter plant following a 24-hour chill. The whole number yield grade assigned by a USDA grader was also recorded.

One carcass side from each animal was transported to the U.S. Meat Animal Research Center facilities at Clay Center, Nebraska for dissection. The right hindquarter from each side was scanned using a model MQI-Pork Carcass electromagnetic scanner at 2.5 MHz. Deep internal temperature and total length of each hindquarter were measured.

The hindquarters were scanned shank first, fat side down. The entire side was then dissected into bone, fat, lean trim, and subprimal cuts. The weight of each subprimal was recorded at 0.30 inches of fat trim and at 0.0 inches of fat trim.

Using the variables scan peak, hindquarter weight, and hindquarter length, weights of subprimal cuts were predicted using linear regression. Actual side values were calculated by summing the actual value of each subprimal cut. Subprimal prices from the USDA Agricultural Marketing Service in late 1994 were used. Calculated and whole number (GRADER) yield grades were used to create estimates of percentage of carcass weight represented by individual sub-primal cuts. These estimates were converted to weight (using actual carcass weight) and subsequently to value using reported prices. The R^2 statistic represents the proportion of the variation explained by the technology. A higher R^2 means a stronger relationship between predicted values and actual values. Root mean square error (RMSE) is the standard deviation of the predicted value, an indication of precision.

Results

Yield grades ranged from 1.26 to 5.46 with actual fat thicknesses ranging from 0.10 inches to 0.90 inches (Table 1). Hot carcass weights ranged from 471 lb to 990 lb. The cattle used in this study were genetically diverse. The wide range in weights and fat thicknesses represent the variation seen at commercial packing plants.

Table 2 shows the R^2 and RMSE for each method of determining total side value through estimates of weights for each subprimal cut. Electromagnetic scanning had the highest R^2 and the lowest RMSE at 0.30 inch level of fat trim, although calculated yield grade provided similar estimates.

Table 1. Mean carcass characteristics of beef steers[1].

Variable	Mean	SD[2]	Minimum	Maximum
Hot carcass weight, lb	717.7	86.0	471.4	989.8
Fat thickness, in	.38	.16	.10	.90
Ribeye area, in^2	11.6	1.19	9.0	15.0
Kidney, pelvic, and heart fat, %	2.7	.56	1.0	4.5
Calculated yield grade	3.00	.69	1.26	5.46

[1] n=219.
[2] Standard deviation.

Table 2. Prediction of total side value at 0.0 and 0.3 in of fat trim.

	0.3 in fat trim		0.0 in fat trim	
Prediction method	R^2	RMSE[1], $	R^2	RMSE[1], $
Electromagnetic scanning	.92	8.12	.91	9.92
Calculated yield grade	.91	8.34	.88	11.03
Grader yield grade	.89	9.17	.85	12.49
Electromagnetic scanning + fat thickness	.92	8.11	.92	9.50

[1]RMSE = Root mean square error.

Table 3. Prediction of value/cwt at 0.0 and 0.3 in of fat trim.

	0.3 in fat trim		0.0 in fat trim	
Prediction method	R^2	RMSE[1], $	R^2	RMSE[1], $
Electromagnetic scanning	.43	1.25	.57	1.66
Calculated yield grade	.53	1.13	.64	1.51
Grader yield grade	.41	1.26	.52	1.73
Electromagnetic scanning + fat thickness	.47	1.21	.64	1.52

[1]RMSE = Root mean square error.

At the 0.0 inch fat level, EMS estimates of total side value had RMSE below $10 per side, while either yield grade method had RMSE of $11 or more. These data imply that EMS is more precise than yield grade in predicting the overall side wholesale value. The increased accuracy of EMS at leaner levels also becomes important as more fat is trimmed at packing plants.

Addition of fat thickness to the EMS model (Table 2) did not improve accuracy (R^2) and had little beneficial effect on precision (RMSE) of total value estimates. This was expected as EMS measures lean content and most of the excess fat is removed in preparing trimmed subprimal cuts.

When value ($/cwt) was expressed as a percentage of carcass weight (total side value/side wt*100), then calculated yield grades provided more precise (lower RMSE) estimates of value (Table 3). The EMS estimates were intermediate between the calculated yield grade and the yield grade applied by the USDA grader. This suggests that EMS could provide objective estimates of value that are equal or superior to the yield grade system as currently applied. Such an approach to value determination would also be objective and less subject to biases or errors in human judgement of composition. The magnitude of the R^2 values for prediction of $/cwt (Table 3) is much lower than for prediction of total value (Table 2). Any time data are expressed on a percentage basis. This reduction in R^2 is noted because percentage yield varies due to both lean and fat and thus is more difficult to predict.

When carcass fat thickness was added to the EMS model at 0.0 in of fat trim, the R^2 for $/cwt improved to the level of calculated yield grade. The R^2 also improved at 0.3 in of fat, but not to the same extent. These results would be expected as a measure of fatness needs to be coupled with a measure of lean for prediction of percentage. Carcasses containing the same amount of lean, but different amounts of fat would have different percentages of lean.

Traditionally, packers and producers have defined carcass value on the basis of percentage yield of subprimal cuts. This might be the consequence of deriving value based on the cost of the raw material. With the pricing strategy enabled by the technology presented here, it is now possible to estimate value based on the weight and price of subprimal cuts. This approach reflects the amount of money an individual animal is worth on the wholesale, subprimal, beef market - regardless of initial carcass weight. Such a value-determining system should allow prompt, efficient transfer to producers of market demands for specific products.

The data from this study suggest EMS can provide more precise, objective estimates of value than the yield grading system as currently applied. Measurement of factors for, and calculation of, yield grade to the nearest hundredth of a grade appears equally effective, but would be more labor and time intensive. Selection of a value-determining system could be influenced by the objective nature of the technology and the potential to automate it. Electromagnetic scanning offers potential in this application.

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