ASSOCIATION OF BEEF CARCASS YIELD ATTRIBUTES TO THE PROBABILITY OF GRADING AAA OR BETTER

T.C. Tennant and T.E. Lawrence

Department of Agricultural Sciences, West Texas A&M University, Canyon, TX, United States, 79016

Abstract – Logistic regression was used to quantify the binomial probability of AAA or better quality grade as influenced by changes in subcutaneous fat class (1-10), muscle score (1-4), and percentage lean meat yield (45-65%) on 2,548 beef carcasses. Muscle score was linearly (*P* < 0.01) related to carcasses grading AAA or better, yet the relationship was poor (c statistic = 0.57; R^2 = 0.02). Carcasses with a muscle score of 1 had a 59% probability of AAA or better, whereas those with a muscle score of 4 only had a 40% probability of that grading threshold. The probability of achieving AAA or better by subcutaneous fat class was represented by a positive sigmoidal curve (*P* < 0.01; c statistic = 0.72; R^2 = 0.15); as fat class increased from 1 to 10, probability of AAA or better increased from 21% to 91%. In contrast, the predicted probability of AAA or better carcasses by percentage lean meat yield was a negative sigmoidal curve (*P* < 0.01; c statistic = 0.72; R^2 = 0.14); probability of grading AAA or better declined from 97% to 18% as lean meat yield increased from 45% to 65%. Fat class and lean meat yield estimates can be valuable predictors of carcass grading ability.

Key Words – finish, logistic regression, quality grade

I. INTRODUCTION

Objective methods are needed to quantify the optimum point at which beef carcass quality is maximized without detrimental losses in red meat yield. Cattle feeding operations typically use parameters such as of days on feed, dry matter intake, and body weight to estimate penwise harvest endpoints. Boleman *et al.* [1] indicated that a substantial proportion of concentrate fed cattle are overfinished, resulting in 25% of beef carcasses with more than 1.5 cm of subcutaneous fat. Likewise, the proportion of cattle with low quality grades and lightweight carcasses suggest that another 25% were marketed too early or not fed long enough.

Few live cattle production scenarios utilize carcass quality and yield estimates as harvest determinants. Knowledge and understanding of animal growth patterns, particularly the accretion rate of muscle and fat tissue is paramount to establishing the relation between carcass quality and yield attributes. Bruns *et al.* [2] stated that carcass composition is largely affected by sex, age, genetic background, plane of nutrition, and body weight.

Previously literature has documented the antagonist relationship between muscle and fat. Reinhardt *et al.* [3] reported that lighter muscled cattle had greater marbling scores, higher quality grades, and poorer yield grades when compared with heavier muscled cattle. Owens *et al.* [4] illustrated that increased carcass weight resulted in a quadratic increase in fat mass and a linear increase in protein mass. Furthermore, Brethour [5] reported that intramuscular fat was deposited at a slow rate best described as a modified power function; conversely subcutaneous fat accrued at an exponential rate.

The objective of this study was to quantify the relationship between carcass quality and yield attributes. This information can be used to provide the beef industry with greater insight into factors affecting performance and carcass value.

II. MATERIALS AND METHODS

Cattle Population

Data used for this analysis were contained in the West Texas A&M University - Beef Carcass Research Center database. Carcass (n = 2,548) data included subcutaneous fat class (1-10), ribeye area ($cm^{2)}$, ribeye length (1-3) and width (1-3), muscle score (1-4), quality grade (PRIME, AAA, AA, A, B1, B4, D1), marbling score and hot carcass weight. Lean meat yield was calculated from the official CBGA yield equation: lean yield = 63.65 + (1.05 x muscle score) - (0.76 x fat class). Canadian quality and yield grades were determined for each carcass using the Canadian Beef Grading Agency standards.

Statistical Analysis

Analyses were conducted to examine the association of carcass yield attributes on the binary response variable of Canada AAA or higher (yes or no) using logistic regression equations calculated with the LOGISTIC procedure of SAS (SAS Inst., Inc., Cary, NC). Models included the response variable of AAA or better quality grading and the explanatory variables of SCFAT, MS, and LMY. Generalized coefficients of determination were calculated for each model using the RSQUARE option. Predicted probability values and 95% confidence limits were calculated for each logistic regression model. Descriptive statistics were summarized via the UNIVARIATE and FREQ procedures.

III. RESULTS AND DISCUSSION

Table 1 Descriptive carcass yield and quality measures

Trait	Mean	Stdev	Max	Min
HCW	369.7	36.9	478.5	254.9
Marbling Score[a]	41.2	7.9	92.0	27.0
Fat thickness class	4.3	2.2	10	1
REA length (REL)	2	.75	3	1
REA width (REW)	2.4	.65	3	1
Muscle Score	2.5	1.0	4	1
Lean Meat Yield	58.4	3.54	65	45

[a] Marbling score: 30 = slight^{00}, the minimum required for AA; 40 = small^{00}, the minimum required for AAA

Descriptive carcass measures are presented in Table 1. The most recent Canadian Beef Quality Audit conducted by VanDonkersgoed *et al.* [6] evaluated carcass quality and yield data on 0.6% of the annual Canadian slaughter cattle population; they reported an average HCW of 353 kg, average grade fat of 9 mm (score = 5), calculated LMY of 58.8, and 33% of the cattle in the sample population grading AAA or better. Comparatively, the cattle in our sample population exhibited greater HCW, lower mean fat thickness class score, similar calculated LMY, and a greater percentage of cattle grading AAA or better (49.7%).

Logistic regression equations were developed to quantify the association of carcass yield factors to the binomial probability of carcasses meeting the AAA or better threshold. Muscle score, which is determined via a matrix of ribeye length and ribeye width was linearly ($P < 0.01$), but weakly (c statistic = 0.57; $R^2 = 0.02$; Figure 1) related to carcasses meeting the AAA or better grading threshold. Carcasses with a muscle score of 1 (lightest muscled score) had a 59% probability of achieving AAA or better, whereas those with a muscle score of 4 (heaviest muscled score) only had a 40% probability of achieving AAA or better. The model for muscle score correctly classified only slightly better then random chance (percent correct = 52.5). These data illustrate the antagonistic relationship between muscle and fat accretion. Keane [7] supported this relationship and stated the proportion of muscle was opposite to fat proportion. Moreover, Brackebusch et al. [8] reported that muscle weights and the percentage that each muscle contributed to the carcass tended to decrease with an increase in marbling level.

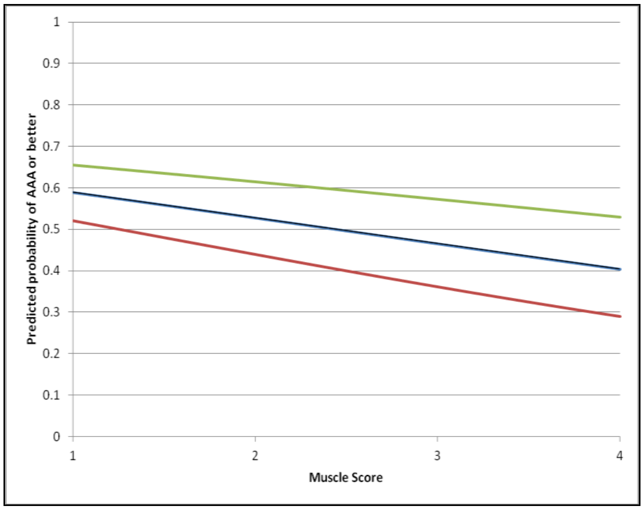

Figure 1. Predicted probability of a beef carcass grading AAA or better by CBGA muscle score

Calculated lean meat yield assimilates both muscle score and fat class information in a standardized equation; lean meat yield was a better predictor of the ability of a carcass to grade AAA or better than was muscle score. The predicted probability of a carcass meeting the AAA or better threshold by percentage lean meat yield was a negative sigmoidal curve ($P < 0.01$; c statistic = 0.72; $R^2 = 0.14$; Figure 2). The probability of a carcass grading AAA was 97% with the low lean meat yield of 45%; that probability declined to only 18% at the high lean meat yield of 65%. The model for lean meat yield correctly classified a larger percent of the population (percent correct = 57.6). Ramsey *et al.* [9] reported that carcass grade was negatively correlated (-0.70) with separable lean and bone. Moreover, Abraham *et al.* [10] reported a negative correlation between marbling score (-0.60) and the percentage of boneless, closely trimmed retail cuts from the round, loin, rib and chuck.

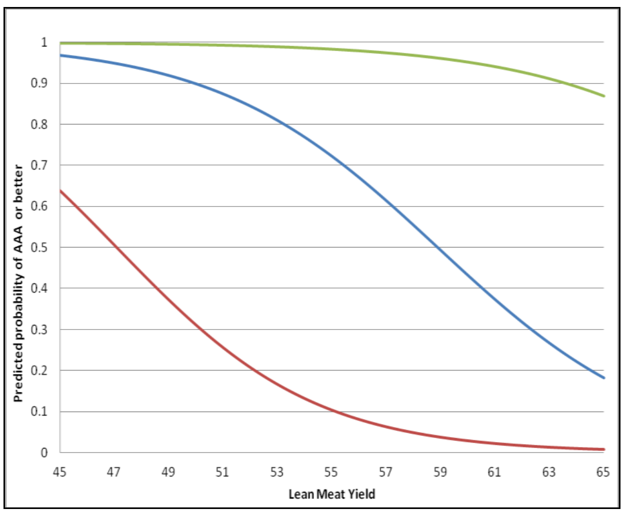

Figure 2. Predicted probability of a beef carcass grading AAA or better by CBGA lean meat yield.

Subcutaneous fat class had the strongest of relationship to the threshold of grading AAA or better and was exhibited by a positive sigmoidal curve ($P < 0.01$; c statistic = 0.72; $R^2 = 0.15$; Figure 3). As fat class increased from 1 to 10, probability of AAA or better increased from 21% to 91%; moreover, the fat class model correctly classified 58.3% of the population. Parret *et al.* [11] reported that percentage fat-free lean decreased with increasing subcutaneous fat-thickness endpoint; with increased fat the percentage lean and bone decreased correspondingly. Charles and Johnson [12] suggested that differences in percentage lean, fat and bone are most likely due to changes in fat level. Dikeman *et al.* [13] suggested that 12th-rib fat measurements may provide an alternative to the current USDA Quality-Grading System for predicting meat quality and could provide a management tool for the producer to identify optimum marketing time.

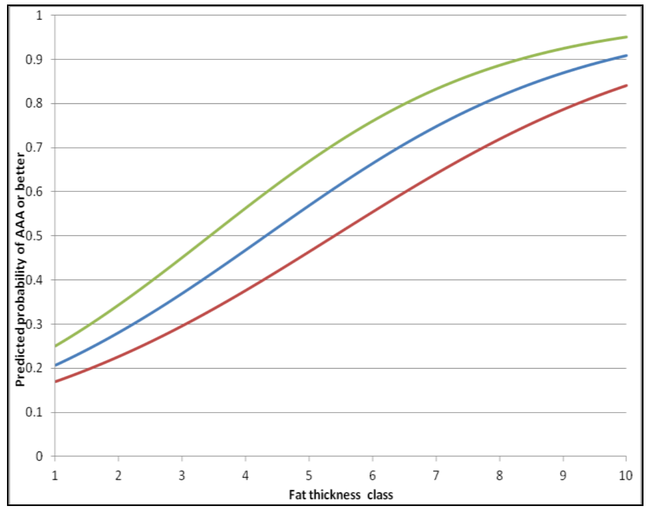

Figure 3. Predicted probability of a beef carcass grading AAA or better by CBGA fat class

Table 2 Diagnostic statistics of logistic regression

	R^2	C-stat	Percent Correct, %	Probability
Muscle Score	0.02	0.57	52.5%	exp(0.6106+(0.2497*MS))/(1+exp(0.6106+(0.2497*MS)))
Lean Meat Yield	0.14	0.72	57.6%	exp(14.481+(0.2459*LMY))/(1+EXP(14.481+(0.2459*LMY)))
Fat Thickness	0.15	0.72	58.3%	exp(1.75+(0.406*FAT))/(1+EXP(-1.75+(0.406*FAT)))

IV. CONCLUSION

The utilization of fat class and calculated lean meat yield estimates can be valuable predictors of carcass grading ability. Subcutaneous fat class and the probability of carcasses grading AAA or better share a synergistic relationship. The use of SCFAT class was the most accurate predictor associated with the probability of grading AAA or better. Calculated LMY and probability of grading AAA or better conversely share an antagonistic relationship; thus the use of lean meat yield was a viable secondary option compared to muscle score. Muscle and fat share an antagonist relationship with one another, as muscle increases the proportion of SCFAT generally decreases; contrariwise when SCFAT increases the proportion of lean muscle decreases. Therefore, SCFAT class and calculated LMY are the most accurate predictors of grading AAA or better as they represent a muscle component and fat component.

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