Grading Cows—Impact of the New USDA Grades

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Introduction

Merchandising of cull cows and bulls is a significant part of the beef cattle industry accounting for 19% of the cattle slaughtered in 1995 (USDA, 1995). For beef cattle producers, marketing of cull cows and bulls makes up between 15 and 25% of their gross income in a given year (NCA, 1994). Even though this is a significant source of income for cow–calf producers, the beef industry lacks a common price discovery mechanism for cull cows. In fact, live and carcass reporting systems differ from region to region and from packer to packer.

The major reason for the lack of uniformity in price discovery of cull cows and bulls is that the current value determining mechanism (USDA Yield and Quality grades) is not used by the non-fed beef industry. Although yield and quality grades do a good job of sorting young, fed cattle into value groups, they are ineffective for non-fed cows. This is because the predicted USDA Yield grade endpoint of boneless, closely trimmed retail cuts has little meaning to non-fed packers who primarily produce boneless manufacturing beef of a specified fat content. Therefore, the non-fed industry incorrectly uses USDA Quality grade nomenclature to describe cutability endpoints. To further complicate market reporting, nomenclature and carcass value endpoints differ between regions and packers. Often the demand for certain types of non-fed animals is confusing to producers due to the lack of a universal language flowing down the marketing chain. In turn, producers may find it difficult to develop long-term merchandising strategies for this critical quarter of their income.

The lack of an effective live and carcass price discovery mechanism was identified as a contributor to quality shortfalls in the National Non-Fed Beef Quality Audit (NNFBQA) conducted by Colorado State University in 1994. Excessive external fat and inferior muscling cost the non-fed industry $32.17 per head and made up 46% of the total potential loss to the non-fed industry (NCA, 1994). As a potential strategy to improve these quality shortfalls, the NNFBQA workshop participants recommended development of effective *live* and carcass grading standards for non-fed cattle (NCA, 1994). Therefore, the objectives of the ensuing discussion are to report results of a study specifically aimed at evaluating live and carcass prediction equations for determining the yield of boneless manufacturing beef of a specified fat content and to evaluate their use as a potential value discovery/classification system for market reporting.

Design and Methods

In order to obtain a test sample representative of the current slaughter cow population, 120 cows were selected to represent 4 breed types (British, straightbreds or crosses showing predominantly British breeding; Continental, straightbreds or crosses showing predominantly Continental breeding; *Bos indicus*, straightbreds or crosses showing at least 25% *Bos indicus* breeding; and Dairy) and 3 body condition classes based on a 9-point body condition score (Richards et al., 1986) (thin = scores 1, 2, 3; moderate = scores 4, 5, 6; fat = scores 7, 8, 9). Each breed type–body condition subclass contained 10 slaughter cows.

Selected cows were individually identified, weighed and evaluated alive by 3 experienced evaluators for USDA Yield and Quality grade factors (USDA, 1989) and other live traits specified in Table 1. After live evaluation, cows were slaughtered at a commercial packing facility, hot carcass weight was recorded, and carcasses were chilled for 24 hours. Twenty-four hours after slaughter, carcasses were ribbed and evaluated for current USDA Yield and Quality grade factors (USDA, 1989) and other carcass traits specified in Table 1 by a USDA grader. Table 1 defines selected live and carcass traits measured in the study.

One side of each carcass was fabricated into boneless subprimals (trimmed to .25 inch external fat), lean trimmings (unadjusted for fat content), fat trim and bone (includes heavy connective tissue) within 6 days of slaughter. The top butt, top round, outside round, eye of round and sirloin tip were further trimmed to 0 inches external fat. Fat and moisture content were determined on the ribeye roll, strip loin and 5 denuded subprimals. The remaining subprimals and trimmings were combined, mixed and tested for fat and moisture content. The following composition endpoints were calculated:

Table 1. Live and carcass traits measured

Acronym	Definition
COND	Body condition score (1=thin , 9=fat)
DRESS	Dressing (%)
FMAT	Final carcass maturity (A=100, E=500)
FRAME	Frame score (1=small$^-$, 9=large$^+$)
HCW	Hot carcass weight (lb)
KPHADJ	Live kidney, pelvic, heart fat adjustment
KPHC	Carcass kidney, pelvic, and heart fat (%)
LWT	Live weight prior to slaughter (lb)
MARB	Carcass marbling score (devoid=000, abundant=900)
MUSC	Carcass muscle score (1=thin$^-$, 9=thick$^+$)
MUSCL	Live muscle score (1=thin$^-$, 9=thick$^+$)
PYGA	Carcass adjusted preliminary yield grade
PYGL	Live preliminary yield grade
PYGM	Carcass measured preliminary yield grade
REA	Actual carcass ribeye area (in^2)
READJ	Live ribeye area adjustment

- Total fat percentage (TFP) = total fat weight (trimmed and chemical) ÷ side weight.
- Tissue lean percentage (TLP) = total boneless, fat-free lean ÷ total soft tissue weight ([side weight]-[bone, kidney, pelvic and heart fat, kidney, and hanging tender weight]).
- Muscle-to-bone ratio (M:B) = total boneless, fat-free lean ÷ total bone weight.
- Total boneless percentage (TBP) = total boneless, trimmed subprimals and lean trimmings ÷ side weight.

Data were analyzed by maximum R^2 regression procedures using compositional endpoints as dependent variables and live and carcass physical traits as predictors (SAS, 1989). Rank correlation analysis and general linear fixed effect model procedures were used to compare potential grade classifications to a currently used system for price discovery in cull cows (SAS, 1989). Grade and genotype were included in the model as main effects.

Discussion

Predicting Composition

One of the critical steps in developing prediction models for carcass composition is to ensure that your test sample is representative of the entire population you would like the equations to represent. This was achieved in the test population as evidenced by the large range in weight, fat, muscle and cutability traits shown in Table 2. The means and ranges are very similar to those reported in the NNFBQA (NCA, 1994), indicating the test population was representative of the current slaughter cow population. Of interest is the large variability found in tissue lean percentage (a measure of the lean content of the boneless manufacturing beef yielded from a cow carcass) which ranged from almost 50% to more than 98% lean. This is a significant source of value differences to the beef industry because 90%

lean trimmings sell for $40/cwt more than 50% lean trimmings (USDA, 1996).

For most of the non-fed beef industry, boneless manufacturing beef is the dominant product. The value of that product is dependent on its lean or fat content, as illustrated above. Therefore, it is important that the composition endpoint of a potential grading scheme is (1) accurately predicted in both live animals and their carcasses, and (2) able to reflect the lean or fat content of the boneless manufacturing beef derived from the carcass.

The two composition endpoints, in the current study, combining the greatest degree of prediction accuracy and most application as a potential cutability endpoint for value discovery in the non-fed industry, were total fat percentage and tissue lean percentage. The other composition endpoints, listed in the design section, were not as accurately predicted in the present study. Composition endpoints of total fat and tissue lean percentage estimate the fat content of the carcass and the lean content of the boneless manufacturing beef. These endpoints were accurately predicted in the live animal (Table 3). Using all available live animal traits as predictors, the best prediction models had 4 variables and accounted for 83 and 82% (the R^2 values in Tables 3 and 4 represent the percentage of the variation accounted for in the predicted endpoint by the predictor variables in the equation, and the closer the R^2 is to 1 the more accurate the equation) of the variation in total fat percentage and tissue lean percentage, respectively. The variables included in the most accurate prediction equations represent all known influences of composition: fatness (measured as condition score and preliminary yield grade, where fat thickness of the animal is converted to a preliminary yield grade ranging from 2 to 6 with 2.0 = 0 inches of fat thickness and increasing one tenth of a preliminary yield grade for each quarter inch increase in fat thickness), muscling (live muscle score) and live weight. Furthermore, the predictors were live physical traits that were easy to obtain, and would be extremely effective in a live value reporting system.

However, the most accurate models did include two measures of fatness, live preliminary yield grade and condition score, which seems redundant to include in a practical grading equation. Therefore, we investigated using only 1 fat indicator in the model to see if acceptable accuracy could be maintained. The fat variable selected was live preliminary yield grade instead of condition score, because it entered the model first and

Table 2. Means for traits measured in the test population

Trait	Mean	Min[a]	Max[b]	SD
LWT (lb)	1125.25	575.00	1850.00	243.09
COND	5.03	1.00	9.00	2.38
PYGL	2.77	1.80	5.30	0.88
READJ	0.53	–0.30	1.63	0.41
KPHADJ	–0.48	–0.60	–0.10	0.13
MUSCL	3.72	1.00	8.50	1.67
FRAME	6.03	1.67	9.00	1.98
DRESS	51.34	42.58	59.69	3.90
HCW (lb)	586.93	257.00	1030.00	150.47
PYGM	2.71	2.00	7.50	0.95
PYGA	2.90	2.00	6.80	1.00
REA (in^2)	9.07	4.00	14.80	2.24
KPHC	1.45	0.00	4.50	0.99
MUSC	4.71	1.00	9.00	2.43
FMAT	403.55	175.00	580.00	83.50
MARB	344.67	110.00	830.00	153.56
Total fat %[c]	16.22	1.03	42.65	9.01
Tissue lean %[d]	81.36	52.06	98.38	9.82
Total boneless %[e]	72.06	62.33	78.47	2.70
Muscle-to-bone[f]	3.11	1.73	4.92	0.51

[a] Min = minimum

[b] Max = maximum

[c] Total fat (trimmed and chemical)/side weight.

[d] Fat-free lean/soft tissue weight.

[e] Total boneless subprimals (trimmed to .64 cm) and trim/side weight.

[f] Fat-free muscle-to-bone ratio.

accounted for more than 70% of the variation in both total fat and tissue lean percentage. Table 3 illustrates that little prediction accuracy was lost in predicting total fat or tissue lean percentage when condition score was dropped from the equation (for example .83 versus .80 R^2 for the 4-variable versus the 3-variable model predicting tissue lean percentage). These data indicate predicting total fat and tissue lean percentage in live slaughter cows using fat thickness, muscle score and live weight would be simple and accurate, and would enable producers or market reporters to sort live cows into value groups.

Similar to using live traits to predict total fat and tissue lean percentage, carcass traits accurately predicted those composition endpoints. Both composition endpoints were more accurately predicted using carcass traits (higher R^2) than live traits as shown in Table 4. The variables that entered the best carcass models were different from those found in the live models, but they still represented fat and weight. Interestingly, neither muscle score nor ribeye area entered into the prediction models for both composition endpoints when using carcass traits. The carcass traits of internal fat (KPH adjustment) and marbling entered the models because they account for a significant amount of fat in the carcass that is not accounted for by fat thickness alone. The reason these two traits did not enter the live models is most likely because they can be more accurately determined in carcasses than in live animals. In addition, dressing percentage replaced hot carcass weight in the tissue lean percentage prediction model.

Again, we wanted to investigate if a simpler model could be used to accurately predict the 2 composition endpoints. Using the easy to obtain traits of carcass fatness (adjusted preliminary yield grade), hot carcass weight and muscle score, both total fat and tissue lean percentage could be accurately predicted, R^2 of .84 or greater. It should be pointed out that muscling added little to the prediction accuracy of either composition endpoint and was not even a significant variable in either equation (Table 4). In short, carcasses could easily and accurately be sorted into value classes using the simple predictors of preliminary yield grade, hot carcass weight and muscle score.

Potential Grading System

Findings from this study indicate we should be able to accurately predict meaningful compo-

Table 3. Regression equations for predicting cutability using live animal traits

					Partial Regression Coefficients[a]				
Equations	**Dependent Variable**	**Cp**	**R^2**	**Intercept**	**PYGL**	**COND**	**MUSCL**	**LWT**	***P*-value[b]**
Best-4 Variable	Total fat %[c]	8.27	0.83	−8.14	4.50	1.70	−0.79	0.01	.0026
	Tissue lean %[d]	5.66	0.82	107.15	−5.01	−1.84	0.78	−0.01	.0182

					Partial Regression Coefficients[a]			
Equations	**Dependent Variable**	**Cp**	**R^2**	**Intercept**	**PYGL**	**LWT**	**MUSCL**	***P*-value[b]**
PYGL, LWT, and MUSCL[e]	Total fat %[c]	4.00	0.80	−13.97	8.10	0.02	−0.37	.1337
	Tissue lean %[d]	4.00	0.79	113.45	−8.90	−0.02	0.33	.2420

[a] Coefficients in metric values.
[b] *P*-value of last variable to enter the model.
[c] Total fat (trimmed and chemical)/side weight.
[d] Fat-free lean/soft tissue weight.
[e] Using only PYGL, LWT, and MUSCL as predictors.

sition endpoints for both live cows and their carcasses using easily obtained predictors. The obvious question arises: ***Will the predicted endpoints be able to more accurately sort slaughter cows into value groups than classification systems currently used?*** With this in mind, the second part of this study was to evaluate if a potential grading system would sort slaughter cows into value groups better than systems commonly used in today's marketing environment.

The most common market reporting grade system currently used for slaughter cows is based on quality grade nomenclature and dressing percentage, and includes the following: low dressing cutter/canners (very thin cows), high dressing cutter/canners, low dressing boning utility (cows with less than .25 inch fat), high dressing boning utility, low dressing breaking utility (cows with greater than .25 inch fat), high dressing breaking utility, low dressing commercial (fat cows) and high dressing commercial. Using slaughter cows in the present study, the current system was compared to a potential value classification system based on boneless manufacturing beef lean content consisting of 5 value classes. The *lean grades* were assigned to correspond with value price breaks for boneless manufacturing beef (USDA, 1996). Grade 1 consisted of cows yielding boneless manufacturing beef of greater than 90% lean; grade 2, 85–89.9%; grade 3, 80–84.9%; grade 4, 75–79.9%; and grade 5, less than 75% lean.

Figures 1 and 2 present least squares means for live (PYGL) and carcass (PYGA) fat thickness, muscle-to-bone ratio, actual and predicted tissue lean percentage and boneless yield for the current classification system. No slaughter cows in the current study fell within the high dressing boning utility class, therefore this grade is not reported. As grade increased, fat thickness and muscle-to-bone ratio tended to increase (Figure 1). However, fat thickness was similar ($P > .05$) for grades 1, 2, 3 and 5, which were less ($P < .05$) than grades 6, 7 and 8. Muscle-to-bone ratio showed a similar pattern, with grades 1, 3 and 5 being lower ($P < .05$) than the higher grades. Tissue lean percentage was lower ($P < .05$) for grades 1–5 compared to grades 6–8 (Figure 2). Most important, boneless yields in grades 2–8 were higher ($P < .05$) than grade 1, with boneless yields being similar ($P > .05$) for grades 28 (Figure 2).

In contrast to the current classification system, fat thickness increased ($P < .05$) with increasing grade in the proposed grade classification system

Table 4. Regression equations for predicting cutability using carcass traits

					Partial Regression Coefficients[a]					
Equations	**Dependent Variable**	**Cp**	**R^2**	**Intercept**	**PYGA**	**KADJ**	**MARB**	**HCW**	**DRESS**	***P*-value[b]**
Best-4 Variable	Total fat %[c]	10.32	0.92	–4.16	5.59	9.32	0.01	0.01	—	.0008
	Tissue lean %[d]	13.82	0.90	114.89	–6.20	–8.08	–0.01	—	–0.27	.0025
					Partial Regression Coefficients[a]					
Equations	**Dependent Variable**	**Cp**	**R^2**	**Intercept**	**PYGA**		**HCW**		**MUSC**	***P*-value[b]**
PYGL, LWT, and MUSCL[e]	Total fat %[c]	4.00	0.85	–12.43	6.77		0.02		–0.06	.7773
	Tissue lean %[d]	4.00	0.84	112.01	–7.59		–0.02		0.07	.7680

[a] Coefficients in metric values.
[b] *P*-value of last variable to enter the model.[b] Total fat (trimmed and chemical)/side weight.
[c] Total fat (trimmed and chemical)/side weight.
[c] Fat-free lean/soft tissue weight.
[d] Using only PYGL, LWT, and MUSCL as predictors.

(Figure 3). In addition, muscle-to-bone ratio was greater ($P < .05$) for grade 1 than 5, with grades 2, 3 and 4 being intermediate (Figure 3). The two most interesting findings were (1) the value endpoint tissue lean percentage decreased linearly ($P < .05$) as grade increased, and (2) boneless yield was similar ($P > .05$) for all grades, except grade 1 which was lower ($P < .05$) than the other grade classes (Figure 4).

These findings point to several advantages the proposed classification system has over one of the prominent value classification systems used currently in market reporting. First, the proposed 5-category lean grade system did a much better job of sorting slaughter cows based on a meaningful value endpoint (tissue lean percentage) into grade classes, due to statistical differences between each grade for tissue lean percentage in the proposed system versus the current system. This was primarily due to the lower variation in measured traits (lower standard errors) in each grade class of the proposed versus the current system. Similarly, fat and muscle traits were more discretely separated in the proposed system (Figures 1 and 3).

Second, contradictory prices exist between current live and carcass grade classifications. Live prices paid for cows classified as breaking utility and higher grades are greater than those paid for cows classified as boning utility and cutter/canner (USDA, 1996). In contrast, cutter/canner carcasses are worth more than boning utility carcasses, which are priced higher than the fatter breaking utility carcasses (USDA, 1996). The live pricing relationship is primarily due to higher dressed and boneless yields for fatter slaughter cows. Conversely, carcass price is reflected in the greater value of the leaner boneless manufacturing beef derived from cutter/canner carcasses. This contradictory pricing system could be potentially eliminated using a grading system in which the live slaughter cow and her carcass is priced the same as shown in the proposed system.

Finally, classifying and reporting live animals in the current grade system is difficult because marbling, maturity and dressing percentage are difficult to estimate in live cows. In fact, most live reporting in the current system is really based on fatness and not what the quality grade infers, marbling and maturity. However, in the proposed system, the meaningful value endpoint of tissue lean percentage could be accurately estimated using the easy to estimate factors of fat thickness, muscle score and live weight (Table 3). This would potentially allow for more accurate reporting of value differences in slaughter cows. In order for a price discovery system to send the correct signals down the marketing chain, live cows and their carcasses should have the same relative value and be easy to classify into value groups.

A potential problem with the lean grade system using lean content of boneless manufacturing beef as its cutability endpoint is that no consideration is given to boneless carcass yield, which is known to have an impact on value. However, for the population used in this study there were no differences ($P > .05$) in boneless yields across lean grades, except for the extremely emaciated cows in the number 1 grade (Figure 4). Since this grade possessed the most valuable end product (90% lean trimmings) it could be priced at a premium and a minimum muscle score could be used in live animals to insure acceptable boning yields. On the other hand, inferior muscled slaughter cows falling in the number 1 grade could be discounted to make up the difference in lowered boneless yields. It should also be pointed out that dressing percentage did increase ($P < .05$) with increased lean grades due to the increase in fatness. Dressing percentage means for each lean grade were 1=48.8, 2=49.8, 3=51.0, 4=52.9, and 5=54.1. In any account, these results indicate the lean grade classification system would not significantly sacrifice carcass boneless yields across grades.

In essence, the true test of any grade or value reporting system is not necessarily its ability to perfectly estimate the final value of an individual slaughter cow, but more importantly its ability to correctly rank a population of slaughter cows for value. To test this in the current study, Spearman rank correlations were calculated between the 2 grading systems for several composition traits, including tissue lean percentage. The closer a rank correlation within a grading system is to 1 or –1, the more accurately the grading system is ranking that specific trait. As shown in Table 5, the proposed lean grade did a much better job of ranking slaughter cows based on boneless manufacturing beef value (tissue lean percentage) than did the current system (–.98 versus –.78). Similarly, the lean grade system more accurately ranked fatness in the test population (higher correlations for total fat percentage and live and carcass preliminary yield grade) than the current grading system. However, neither system ranked slaughter cows for boneless yields very well (low rank correlations). Interestingly, this is most likely due to the lack of variation in boneless yields across the various grade classes (Figures 2 and 4).

Conclusions

These data suggest an effective market reporting system could be developed that more accurately reflects differences in value for the cow slaughter industry. It is apparent that a more pertinent value endpoint for slaughter cow value, tissue lean percentage, can be accurately predicted in both live slaughter cows and their carcasses than the current yield grade estimates provide. Furthermore, a classification system (or grading system) designed to determine a more applicable compositional endpoint appears to do a much better job of sorting live cows and their carcasses into value groups. If a system using common classification terminology, such as this one, were to be universally adopted for market reporting (and it appears it may be), it would provide producers with an essential tool to develop more effective marketing plans for their cull cows. Since the merchandising of cull cows accounts for more than 25% of a producers revenue, such a reporting system would give producers a greater understanding of how their cull cows are priced. This in turn would allow producers to develop effective marketing strategies for their cull cows to hopefully increase income and profits.

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Table 5. Spearman rank correlations between classification systems and composition indicators and endpoints

	Lean Grade	Quality Grade/DRESS
Tissue lean[a]	–.98***	–.74***
Total fat[b]	.97***	.75***
Total boneless[c]	.06	.16
Muscle-to-bone[d]	.48***	.51***
PYGL	.83***	.71***
PYGA	.90***	.72***

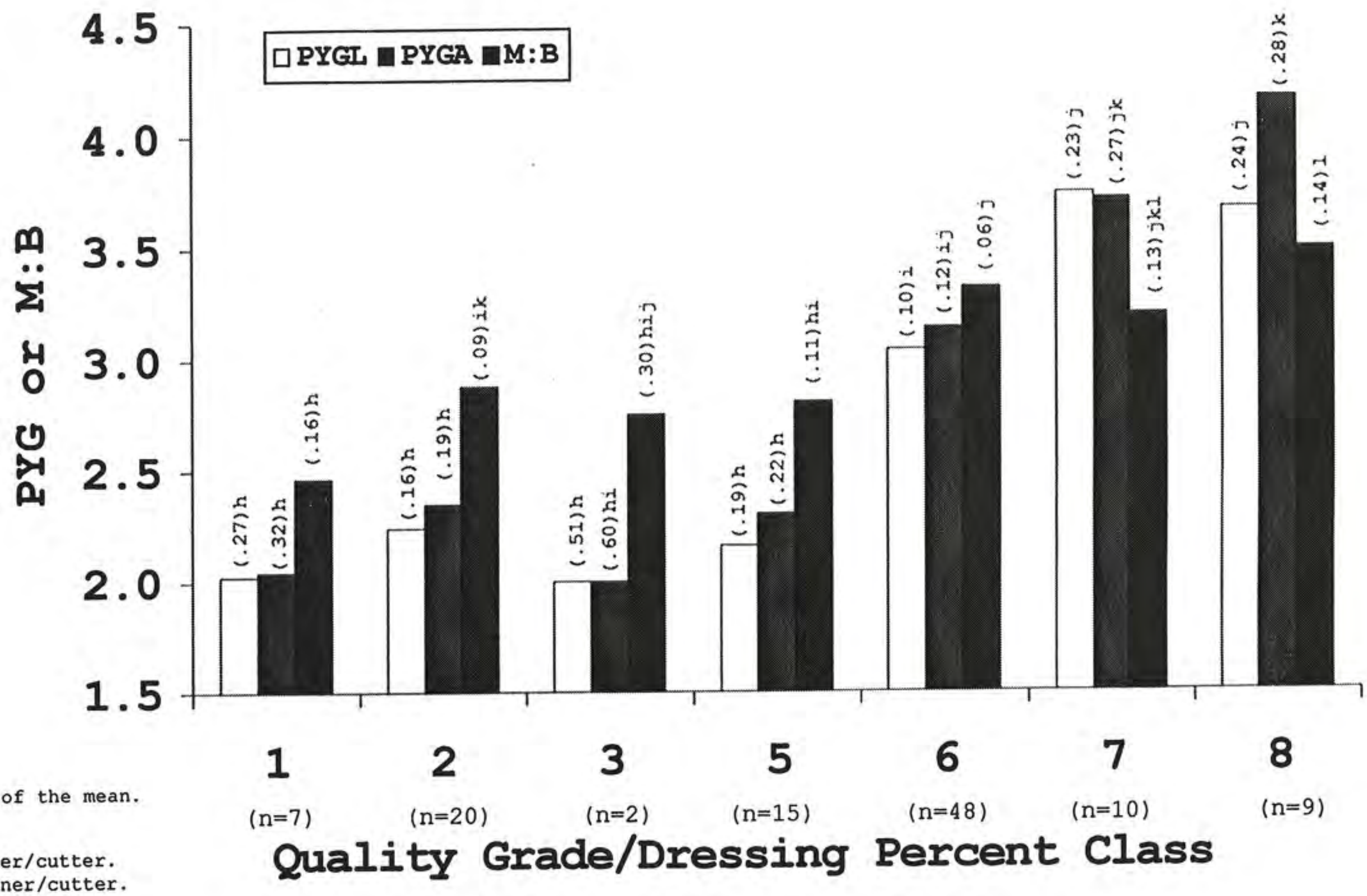
[a] Fat-free lean/soft tissue weight, %.

[b] Total fat (trimmed and chemical)/side weight, %.

[c] Total boneless subprimals (trimmed to .64 cm) and trim/side weight, %.

[d] Fat-free muscle to bone ratio.

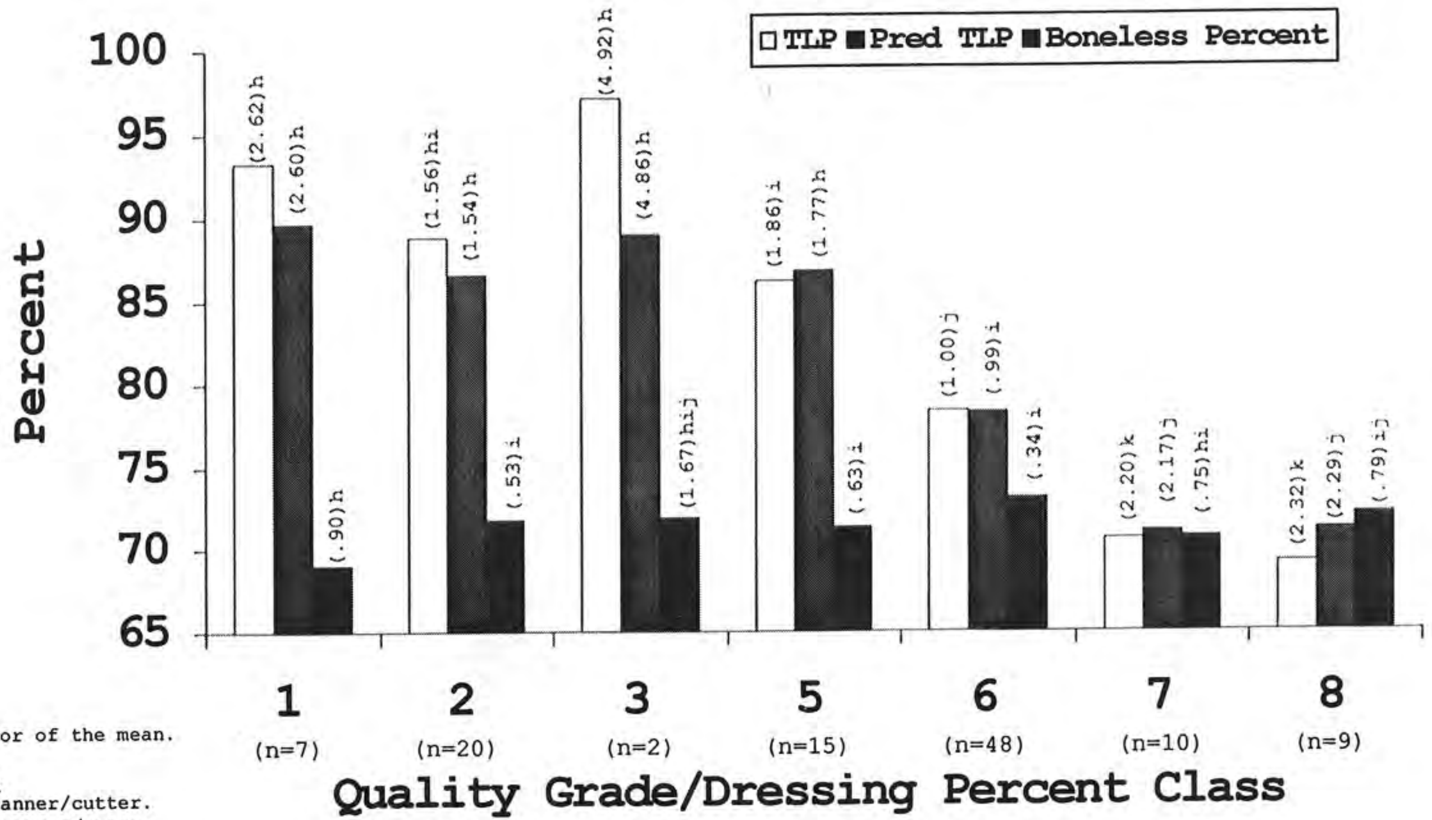
***P < .001



()- standard error of the mean.

Current Classes
1 - Low dress canner/cutter.
2 - High dress canner/cutter.
3 - Low dress boning utility.
5 - Low dress breaking utility.
6 - High dress breaking utility.
7 - Low dress commercial.
8 - High dress commercial.

Figure 1. Least squares means by the current classification system



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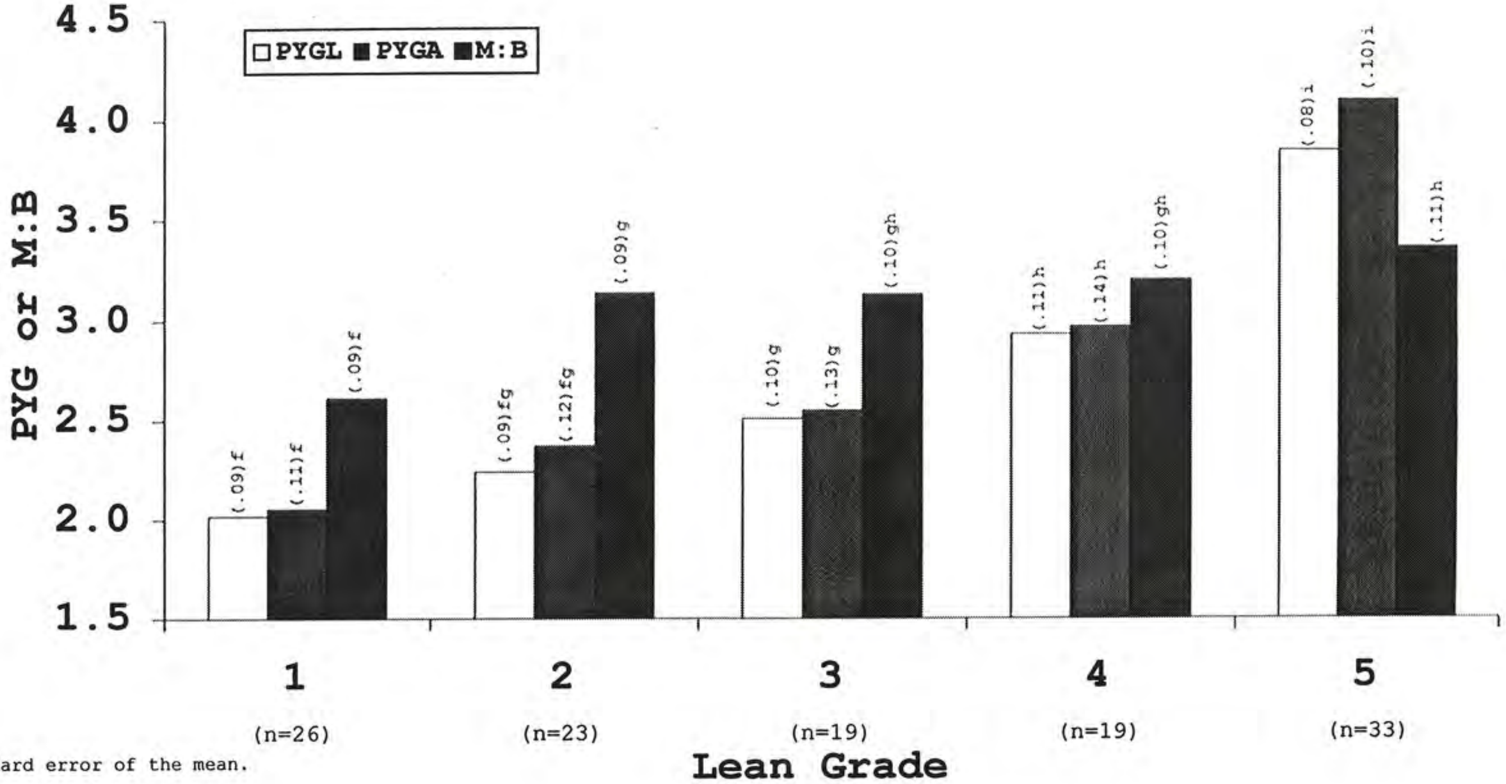
5 - Low dress breaking utility.
6 - High dress breaking utility.
7 - Low dress commercial.
8 - High dress commercial.

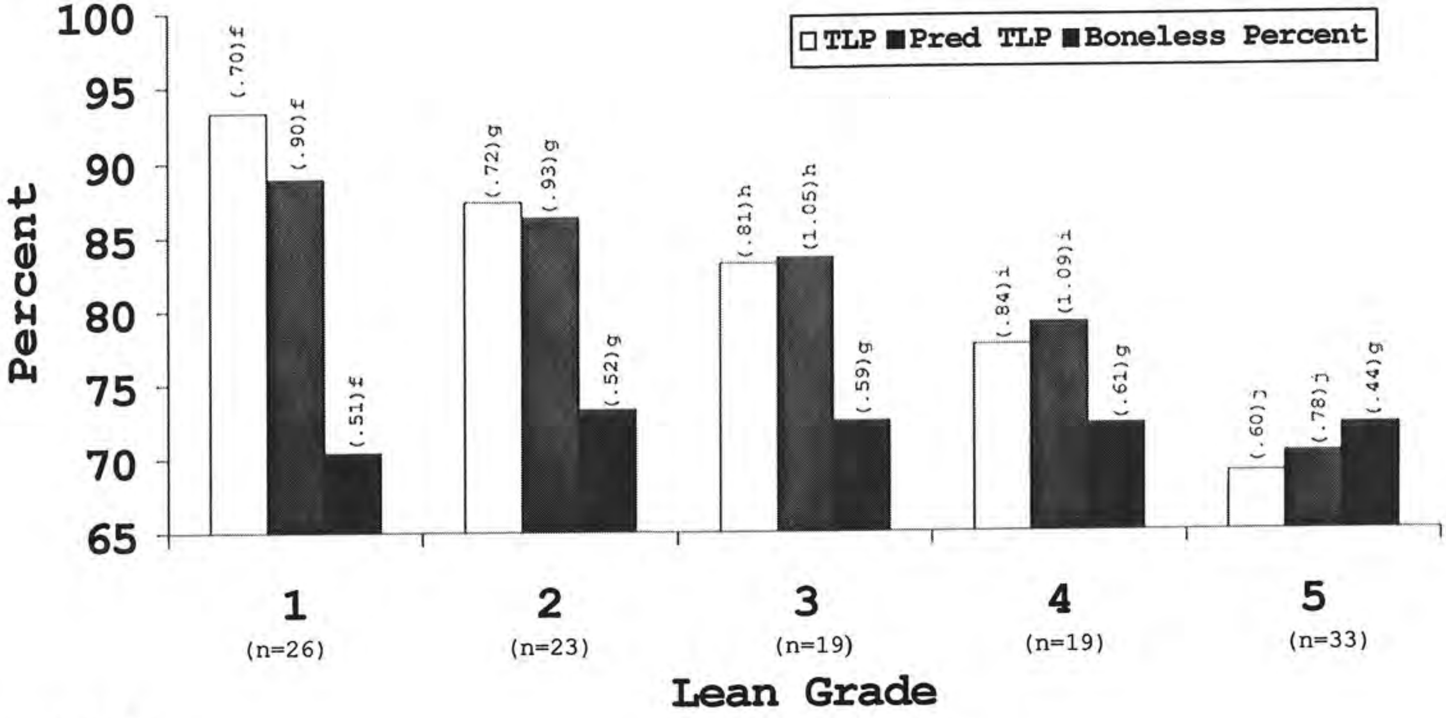
Figure 2. Least squares means by the current classification system



()-standard error of the mean.

Lean Grades
1 - Animals yielding at least 90/10.
2 - Animals yielding between 85/15 and 90/10.
3 - Animals yielding between 80/20 and 85/15.
4 - Animals yielding between 75/25 and 80/20.
5 - Animals yield less than 75/25.

Figure 3. Least squares means by lean grade



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