AN EVALUATION OF FEEDER CATTLE GRADING STANDARDS

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Responding to the needs of the feeder cattle industry, the USDA (1979) implemented a new feeder cattle grading system which broke from the traditional method of using consistent grade terminology throughout the marketing process. The terms Prime, Choice, Good, etc. were replaced by three frame sizes (large, medium, and small) and three thickness scores (1, 2, and 3). The change from carcass quality terms to production-oriented terminology was deemed necessary because the product characteristics desired by cattle feeders differ from those desired at slaughter by the slaughterer-packer. Breimyer accurately stated the case when he said:

> "We need a grading system that has consistency all the way from the feeder calf to the beef in the retail show case; yet the criteria that determine value are not the same at all successive stages. Value in a feeder calf is governed in part by the animal's capacity to put on economical weight gain. Value in the fed steer. . . reflects chiefly the quantity and kind of carcass that will be produced from slaughter...."

The new feeder cattle grading system was not implemented without disagreements. Despite general agreement that a change was needed, conflict arose over which attribute should be used to define thickness scores. The USDA identified thickness as a feeder animal's muscle thickness and defined it as an indicator of a feeder animal's potential carcass yield grade (USDA 1979). An alternative method introduced but not used to identify thickness was fatness or degree of finish (Anderson, USDA 1979). Additional conflict occurred when the new standards failed to include an indicator of an animal's feed efficiency.

A study was undertaken to determine which feeder cattle attributes should be included in the feeder cattle grading system. Alternate methods of determining frame size and thickness scores were analyzed.

USDA FEEDER GRADES

The USDA (1979) introduced a new feeder cattle grading system consisting of three frame sizes and three thickness categories. The objective of the frame size categories was to predict the slaughter weight at which a feeder animal would reach a specific carcass quality grade. For example, USDA Low Choice carcass grade would be reached by large-frame steers at a slaughter weight in excess of 1,200 pounds, by medium-frame steers at slaughter weights between 1,000 and 1,200 pounds, and by small-frame steers at less than 1,000 pounds. Thickness score, which is determined by the muscle thickness, was chosen to indicate the carcass yield grade at slaughter. Though the 1979 feeder cattle standards are designed to improve marketing efficiency for buying and selling feeder cattle, the grades do not address the question of feed efficiency.

SURVEY OF FEEDLOT MANAGERS

In an effort to determine which feeder cattle attributes are important to cattle feeders, 100 feedlot managers in Oklahoma, Texas, Kansas, and Nebraska were surveyed. The questionnaire (which consisted of a short explanatory letter and a self-addressed postcard with the feeder steer attributes listed on the back) asked cattle feeders to specify which live cattle attributes were essential to know, convenient to know, or unnecessary to know when purchasing feeder cattle. The list of attributes included (1) sex, (2) weight, (3) age, (4) frame size, (5) degree of muscling, (6) degree of finish or fatness, (7) conformation, (8) breed, and (9) origin. Sixty-one percent of the feedlot managers responded to the questionnaire (Table 1).

Sex and weight were labeled essential information by 95 and 92 percent of the respondents, respectively. The remaining 5 and 8 percent of the respondents considered sex and weight convenient information to know when purchasing feeder cattle. Eighty percent of the

TABLE 1. SURVEY RESPONSE FROM FEEDLOT MANAGERS[a]

Variable	Essential (Percent)	Convenient (Percent)	Not Necessary (Percent)
Sex	95	5	--
Weight	92	8	---
Frame Size	80	20	--
Degree of Finish or Fatness	80	20	---
Conformation	53	44	3
Age	48	47	5
Breed	46	39	15
Origin	44	41	15
Degree of Muscling	32	61	7

[a]Sixty-one responses were received from 100 surveys mailed.

respondents said both frame size and degree of finish or fatness were essential characteristics to know when purchasing feeder cattle. The remaining 20 percent felt that frame and fatness were convenient information. The high response to the importance of fatness may be attributed to the relationship of fatness to compensatory gain and feed efficiency (Fox et al. 1972).

The feedlot managers ranked conformation, age, breed, and origin above muscle thickness as essential information to know when purchasing feeder cattle. Only 32 percent of the cattle feeders ranked muscle thickness as essential information. According to the survey, buyers of feeder cattle rely most heavily on information pertaining to sex, weight, frame size, and degree of finish in making purchasing decisions.

DATA

Primary data were a composite derived from four independent but coordinated studies sponsored by the Southern Regional Research Project, S-116. A total of 801 observations were collected on steers purchased as feeders by Mississippi State University, New Mexico State University, and the University of Illinois.

Oklahoma State University weighed and tagged 157 calves at birth with USDA Carcass Data Service ear tags, then maintained records on each steer through slaughter. The calves were from three privately owned herds. Selected attributes were scored subjectively and actual measurements of height, length, and weight were obtained before the steers were placed on a finishing ration. In the subjective scoring, (1) muscle thickness was scored very

thick plus = 1 to thin minus = 15, (2) frame size was scored framey plus = 1 to compact minus = 9, (3) age was reported in months, (4) degree of finish was scored extremely thin = 1 to extremely fat = 10, and (5) 1964 USDA feeder cattle grade was scored USDA Prime plus = 1 to USDA Low Utility = 15.

Individual live weights were obtained at slaughter and each carcass was graded by a USDA grader. The carcass attributes scored were (1) USDA carcass quality grade scored USDA High Prime = 17 to USDA Standard = 6, (2) calculated carcass yield grade to nearest tenth, and (3) packer's hot carcass weight in pounds.

EVALUATION OF FEEDER CATTLE GRADE STANDARDS

Anderson and Baquet demonstrated that the coordinative efficiency[1] of feeder cattle grading standards could be compared by determining each system's ability to explain a feeder animal's weight deviation from the hot carcass weight at which the animal would reach a specific carcass grade. Their method was based on three main assumptions: (1) inefficient feeder cattle grades cause a wide variation of carcass quality grades, (2) final weight is directly related to carcass grade, and (3) net return is maximized at some target quality and yield grade. The first assumption was supported by empirical observation. The other two were supported by research results from Nelson who developed a mathematical model to show that the net return for feeder animals was a function of final weight. The final weight which maximized net return was a function of various feeder cattle attributes and price relationships.

In the USDA feeder cattle grading system, feeder cattle attributes were used to identify the slaughter weight at which an animal would reach a specified carcass grade (USDA 1979). Muscle thickness was used to indicate the yield grade at slaughter and should indicate carcass yield grade at a specified carcass quality grade.

In the following analysis, the ability of various feeder attributes to explain the standard deviation of slaughter weight on carcass yield grade was determined by means of ordinary least squares procedure. Hot carcass weight was used as a measure of final weight because past research has shown hot weight to be a more accurate measure than live slaughter weight (Meyer et al.)

To develop a measure of the most efficient grading system, a "benchmark" grading system was devised. This system represents

[1]Coordinative efficiency was defined as the ability of a market, through an accurate matching of supply and demand, to identify and evaluate the quality characteristics of a product necessary to achieve maximum output relative to input.

the perfect information system because it was derived from actual carcass data. The results from the alternative grading systems can be compared with the results from the benchmark system.

Benchmark Grading System

A discountinuous variable, e.g. frame size, cannot explain all the standard deviation of a continuous variable, e.g. hot carcass weight. Therefore, to determine the maximum amount of the hot weight standard deviation that can be explained by three frame sizes, a "benchmark" grading system was developed. If a steer graded Low Choice and weighed more than 1,200 pounds at slaughter, the steer was classified large frame; if the slaughter weight at Low Choice was between 1,000 and 1,200 pounds, the steer was classified as medium; if the slaughter weight was less than 1,000 pounds the frame size was classified as small.

Hot carcass weight was regressed on the benchmark frame scores for USDA Low Choice steers with large frame = 1, medium frame = 2, and small frame = 3. The resulting equation was

$$\text{HOTWEIGHT} = 936 - 116 \, \text{BMFRAME}$$
$$(0.0001)$$
$$R^2 = 0.80$$
$$\text{STD DEV} = 47$$

with significance level in parentheses and

$$\text{HOTWEIGHT} = \text{actual carcass hot weight in pounds}$$
$$\text{BMFRAME} = \text{benchmark frame size.}$$

The actual standard deviation of hot weight was 104 pounds. Therefore, the maximum the hot carcass weight standard deviation could be reduced was 65 percent $[1 - (47 \div 104) = 0.65]$.

Efficiency of USDA's Frame Size

To estimate the efficiency of USDA's frame sizes in determining the hot carcass weight at which a steer will reach a specific USDA carcass grade, the hot carcass weight of 888 steers was regressed on the grader frame scores. The grader frame scores were determined by a grader subjectively scoring the feeder steers for frame size based on the USDA's frame size definition (height and length adjusted for age). Only steers with USDA carcass grades

between High Standard and Choice were included in the analysis.[2] The High Standard carcass grade and medium frame size were omitted to avoid a singular matrix. Dummy variables were used rather than continuous variables to represent better the discontinuous aspect of grade standards. The derived equation was

$$\text{HOTWEIGHT} = 586 + 40 \, \text{LGOOD} +$$
$$(0.001) \quad (0.002)$$

$$39 \, \text{GOOD} + 44 \, \text{HGOOD} +$$
$$(0.0001) \quad (0.0001)$$

$$73 \, \text{LCHOICE} +$$
$$(0.0001)$$

$$58 \, \text{CHOICE} - 56 \, \text{SFRAME}$$
$$(0.0001) \quad (0.0001)$$

$$+ 59 \, \text{LFRAME}$$
$$(0.0001)$$
$$R^2 = 0.18$$
$$\text{STD DEV} = 79.6$$

with the significance levels in parentheses and

$$\text{LGOOD} = \text{zero-one dummy variable for USDA Low Good carcass grade}$$
$$\text{GOOD} = \text{zero-one dummy variable for USDA Good carcass grade}$$
$$\text{HGOOD} = \text{zero-one dummy variable for USDA High Good carcass grade}$$
$$\text{LCHOICE} = \text{zero-one dummy variable for USDA Low Choice carcass grade}$$
$$\text{CHOICE} = \text{zero-one dummy variable for USDA Choice carcass grade}$$
$$\text{SMFRAME} = \text{zero-one dummy variable for grader-specified small frame and}$$
$$\text{LFRAME} = \text{zero-one dummy variable for grader-specified large frame.}$$

Grader frame score was a significant variable in predicting hot weight for a given USDA carcass grade ($P < 0.0001$). The standard deviation of hot weight, after it was regressed on USDA carcass grade and grader frame score, was 79.6 pounds. Actual standard deviation of hot weight was 87.5 pounds. Therefore, only 9 percent of the hot weight standard deviation

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[2]Carcass quality grades were included in the equations to remove the variance in hot weight that can be attributed to carcass quality grade. This adjustment was consistent with USDA's definition of frame size.

was explained [1 − (79.6 ÷ 87.5) = 0.09]. Comparison of the 9 percent with the 65 percent explained by the benchmark system shows that only 14 percent of the explainable standard deviation was explained.

As determined by an F-test, there was no significant difference among the coefficients of USDA Low Good, USDA Good, and USDA High Good or between USDA Low Choice and USDA Choice. There was a significant difference between the coefficients of the USDA Good and USDA Choice grades. No statistical difference between USDA one-third carcass grades but statistical difference between USDA whole grades was consistent with USDA carcass grade standards. The USDA does not officially break carcass grades into one-third grade classifications. The purpose of the equation was to test the efficiency of frame size classifications at a constant carcass grade; inclusion of the quality grades allows this test to be conducted.

Efficiency of an Alternate Frame Size Definition

Research reported by Brungardt indicated that feeder cattle weight adjusted for age was a more efficient indicator of weight at which a feeder would reach a specified carcass grade than was height and length adjusted for age.

To derive a comparison with USDA's frame size, three frame size categories were developed by dividing the feeder steer's actual weight by the natural log of the steer's estimated age in months. The steers were then placed into one of the three frame size categories based on the index value. Steers with index values less than 241.1 were classified as small frame, those with index values between 244.1 and 299.1 were classified as medium frame, and steers with indices greater than 299.1 were classified as large frame. The values of 244.1 and 299.1 were selected so that the number of animals in each frame size category would be consistent with the USDA's objective of frame size.

Both the USDA one-third carcass quality grades and the three frame categories were converted to zero-one dummy variables. The medium frame and USDA High Standard dummies were dropped to avoid creating a singular matrix. The resulting equation was

$$HOTWEIGHT = 617 + 33\ LGOOD +$$
$$(0.0018)$$

$$37\ Good + 35\ HGOOD +$$
$$(0.0001) \quad (0.0002)$$

$$53\ LCHOICE +$$
$$(0.0001)$$

$$47\ CHOICE -$$
$$(0.0001)$$

$$74\ SWFRAME +$$
$$(0.0001)$$

$$113\ LWFRAME$$
$$(0.0001)$$
$$R^2 = 0.39$$
$$STD\ DEV = 68.5$$

with the standard errors in parentheses and

SWFRAME = zero-one dummy variable for small frame size determined by the index actual feeder weight divided by the log (age) < 244

LWFRAME = zero-one dummy variable for large frame size determined by the index feeder weight divided by the log (age) > 299.

All variables were significant at $P < .002$ or better. The standard deviation of hot weight was reduced from 87.5 to 68.5 pounds when hot weight was regressed on the feeder weight ÷ log (age) index. Thus, 22 percent of the hot weight standard deviation was explained [1 − (68.5 ÷ 87.5) = 0.22]. This was 46 percent of the amount explained by the benchmark system.

Interpretations of the index frame sizes follow. If the index of the steer was greater than 299, the frame classification was large. On the average, a large-frame steer graded Low Choice when it reached a slaughter weight of 1,284 pounds. Eighty percent of the large-frame steers reached Low Choice between 1,139 and 1,429 pounds. If the index frame score was between 244 and 299, the steer was classified as medium frame. The average medium-frame steer reached Low Choice of 1,098 pounds. Eighty percent of these steers weighed between 953 and 1,243 pounds. Steers with index values less than 244 were classified as small frame. Small-frame steers averaged 977 pounds at slaughter. The slaughter weights ranged from 832 to 1,112 pounds for 80 percent of the steers.

Summary of Frame Definitions

The results indicated that USDA's definition of frame size was statistically significant and explained approximately 9 percent of the hot carcass weight standard deviation. Of alternative methods of defining frame size, the

FIGURE 1. FRAME SIZE DETERMINA-
TION BASED ON FEEDER
STEER WEIGHT AND THE
LOGARITHM OF FEEDER
STEER AGE.
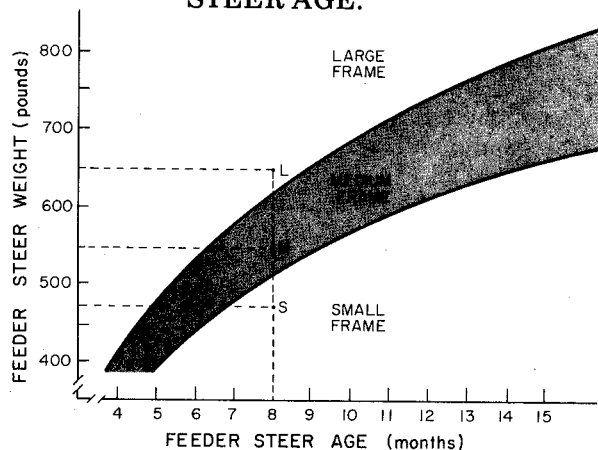
most efficient was feeder weight divided by the log of estimated age. This variable explained 22 percent of the hot weight standard deviation or 46 percent of the standard deviation that could be explained by a three-group grading standard.

The relationship of feeder steer weight as a function of age and frame size is depicted in Figure 1. The equation used to derive the break points for small-, medium-, and large-frame steers was

$$\text{Frame Index} = \text{Feeder Weight} \div \text{Log (Age)}.$$

Frame index was set at 244.1 and 299.1 for the small-medium and medium-large frame breaks, respectively. Feeder steers in areas L, M, or S were classified small-, medium-, or large-frame, respectively.

Logic dictates that there is more to explaining or predicting the slaughter weight at which a steer reaches Low Choice than weight and age. Although two animals with the same weight and age may appear to have the same frame size, they actually may not because of environmental factors, breed, or some unmeasured attribute. However, research results indicate that the index of weight divided by the log of age may be the most efficient method available to estimate frame.

Thickness Versus Fatness as Indicators of Yield Grade

On the basis of USDA's description of the relationship between muscle thickness and the 1964 USDA feeder grades, muscle scores 1 through 6 were designated as thickness No. 1, muscle scores 7 through 12 were identified as

thickness No. 2, and muscle scores 13 through 15 were labled thickness No. 3 (USDA 1979). In the 957 observations collected by the four state universities no steers had muscle thickness scores between 13 and 15. Therefore, the following analyses include only thickness No. 1 and thickness No. 2 steers. According to USDA's feeder grading standards, thickness scores should explain differences in USDA carcass yield grades (USDA 1979).

Simple correlations were used to indicate which attributes should be used to predict carcass yield grade. Carcass yield grade was most highly correlated with carcass quality grade, 0.43 (Table 2). Hot weight had a 37 percent

TABLE 2. SIMPLE CORRELATIONS OF
YIELD GRADE AND RELE-
VANT VARIABLES

Variable	Yield Grade	Carcass Quality Grade	Carcass Hot Weight	Feeder Finish Score	Feeder Thickness Score
Yield Grade	1.00	0.43	0.37	0.28	0.03
Quality Grade	0.43	1.00	0.18	0.29	-0.01
Hot Weight	0.37	0.18	1.00	0.10	-0.09
Finish	0.28	0.29	0.10	1.00	-0.05
Thickness	0.03	-0.01	-0.09	-0.05	1.00

correlation with yield grade. However, thickness had only a 3 percent correlation with yield grade. The simple correlation indicated that carcass quality grade and hot weight could be used to estimate potential carcass yield grade.

There appears to be a problem when carcass grade and hot weight are used as independent variables to predict carcass yield grade. Until the animal is slaughtered, both variables are unknowns. However, frame size should indicate the final weight at a specified target carcass grade. Thus, if the frame size categories were accurate and the target grade were known, carcass grade and carcass hot weight would be known at slaughter. Inclusion of carcass grade and hot weight was equivalent to using perfect estimators of frame size and target grade. This approach allowed the error created by using imperfect estimators to be removed and the influence of muscle and degree of finish to be measured more accurately.

Thickness as an Indicator of Yield Grade

To determine the ability of carcass quality, carcass hot weight, and thickness scores to predict carcass yield grade, yield grade was regressed on the three independent variables. The resulting equation was

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$$YIELD\ GRADE = 0.91 + 0.22\ LGOOD +$$
$$(0.0001)\quad(0.017)$$

$$0.29\ GOOD + 0.51\ HGOOD$$
$$(0.0003)\qquad(0.0001)$$

$$+ 0.58\ LCHOICE +$$
$$(0.0001)$$

$$0.76\ CHOICE +$$
$$(0.0001)$$

$$0.002\ HOTWT -$$
$$(0.0001)$$

$$0.10\ MUSC1$$
$$(0.016)$$
$$R^2 = 0.23$$
$$STD\ DEV = 0.587$$

with observed significance levels in parentheses and

HOTWT = hot carcass weight in pounds
MUSC1 = zero-one dummy variable for muscle thickness scores from 1 through 6.

The coefficient on the thickness dummy variable was significant (P < 0.016). Standard deviation of carcass yield grade was reduced from 0.695 to 0.587 or by 15.5 percent. If muscle thickness were not included in the equation, the standard deviation would be reduced to 15.4 percent or only 0.1 percent less. Also, the magnitude of the coefficient implies that the difference in the yield grade between thickness No. 1 and thickness No. 2 steers was one-tenth of a yield grade. Except for borderline cases, thickness would not affect the USDA yield grade—reported as integers—of a steer.

The coefficients on the carcass grade and hot weight were all significant (P < −0.17 or better). There was three-fourths of a yield grade difference between USDA Choice and USDA Standard carcass grades and approximately one-half of a yield grade difference between USDA Choice and USDA Good carcass grades.

Finish as an Indicator of Yield Grade

The USDA (1979) considered including finish as a factor for feeder cattle standards. However, finish was not included because (1) it would greatly increase the number of grade combinations, (2) using fatness in lieu of muscle thickness would result in feeders being so dissimilar in appearance that their marketability would be impaired, (3) using finish could necessitate placing a different feeder grade on

the same animal in different stages of its development, and (4) cattle from the same herd may be graded differently from year to year depending on the plan of nutrition and management. The USDA did conclude, however, that variations in finish may affect feeder cattle value.

On the basis of the data collected for the study, the simple correlation between carcass yield grade and finish scores (thin − 1, ..., fat 10) was 0.28 (Table 2). Thus, the R^2 of yield grade regressed on finish would be 0.08. However, to include finish in the grade standards, the steers were divided into two groups: thin and fat. Scores from 1 to 6 indicated thin steers whereas scores 7 to 10 indicated fat steers. The resulting equation was

$$YIELD\ GRADE = 1.19 + 0.22\ LGOOD +$$
$$(0.0001)\quad(0.0015)$$

$$0.26\ GOOD + 0.47\ HGOOD$$
$$(0.0015)\qquad(0.0001)$$

$$+ 0.51\ LCHOICE +$$
$$(0.0001)$$

$$0.65\ CHOICE +$$
$$(0.0001)$$

$$0.002\ HOTWT - 0.26\ THIN$$
$$(0.0001)\qquad\quad(0.0001)$$
$$R^2 = 0.25$$
$$STD\ DEV = 0.577$$

with standard errors in parentheses and

THIN = zero-one dummy variable for thin finish scores 1-5 where thin = 1, ..., fat = 10.

The coefficient on the thin finish zero-one dummy variable was highly significant (P < 0.0001) and the magnitude implied that there was 0.26 difference in the carcass yield grade between thin and fat steers. There was little change in the coefficient on the hot weight and USDA quality grade variables in comparison with the equation that included the thickness variable. The magnitude of the USDA Choice variable decreased from 0.76 to 0.65. However, the magnitude of the coefficients on USDA Low Good and hot weight remained the same.

The actual standard deviation of carcass yield grade was 0.695. Carcass quality grade, hot weight, and finish reduced the standard deviation to 0.577 or by 17 percent. Thus, adding finish explained an additional 1.6 percent or increased the explained yield grade standard deviation 10.4 percent in comparison with carcass quality grade and hot weight alone.

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Finish had only limited correlation with yield grade; consequently, the yield grade standard deviations were only slightly reduced when finish was included in the regression equations. On the basis of these analytical results, very little support can be derived for including finish. However, both the survey of feedlot managers and the literature support inclusion of finish in the feeder grade standards.

Finish and compensatory growth have been the subject of research studies since Osborne and Mendel (1916) found that growth continued at an accelerated rate after a long period of restriction. Osborne and Mendel (1916) suggested that increased feed intake during recovery was partially responsible for the compensatory gains. However, a study by Meyer et al. (1965) suggested that an increase in energy utilization independent of feed intake during compensatory growth was responsible. Fox et al. (1972) conducted research to determine which of the conclusions was correct. They concluded that increased efficiency in utilization of energy and protein during the full feeding period was responsible for compensatory growth and that there was only a slight increase in the total intake of metabolizable energy. Thus, feed efficiency was not independent of the cattle's previous nutritional treatment or their level of finish. Research also indicated that low nutritional levels hindered muscle development (Berg and Butterfield).

Other researchers have found that finish partially indicates the relative weight at which a steer will reach a carcass quality grade (Brungardt). Feeder cattle with a relatively heavier finish will reach grade at a lighter weight than feeder cattle with relative less finish.

CONCLUSIONS

Results from the study indicate that frame size could be more efficiently identified by using weight adjusted for age rather than to height adjusted for age. Furthermore, previous research indicates that frame size, as defined by the USDA, should be adjusted by the degree of finish. Animals with a relatively higher percentage of finish tend to reach grade at a relatively lighter weight.

Statistical results show that cattle feeders are correct in placing more emphasis on degree of finish than on muscle thickness. Only a trivial amount of the yield grade standard deviation is explained by muscle thickness or the degree of finish. However, finish is a more powerful indicator than muscle. The literature implies that the real value of finish is as an indicator of possible compensatory gains or feed efficiency. Moreover, the literature indicates that both muscle and finish development may be hindered by low nutritional levels.

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