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National Beef Quality Audit–2005: Survey of targeted cattle and carcass characteristics related to quality, quantity, and value of fed steers and heifers[1]

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ABSTRACT: The National Beef Quality Audit–2005 assessed the current status of quality and consistency of US fed steers and heifers. Hide colors or breed type were black (56.3%), red (18.6%), Holstein (7.9%), gray (6.0%), yellow (4.9%), brown (3.0%), white (2.3%), and brindle (1.0%). Identification method and frequency were lot visual tags (63.2%), individual visual tags (38.7%), metal-clip tags (11.8%), electronic tags (3.5%), bar-coded tags (0.3%), by other means (2.5%), and without identification (9.7%). Brand frequencies were no (61.3%), 1 (35.1%), and 2 or more (3.6%), and brands were located on the butt (26.5%), side (7.4%), and shoulder (1.2%). There were 22.3% of cattle without horns, and the majority of those with horns (52.2%) were between 2.54 and 12.7 cm in length. Percentages of animals with mud or manure on specific body locations were none (25.8%), legs (61.4%), belly (55.9%), side (22.6%), and top-line (10.0%). Permanent incisor number and occurrence were zero (82.2%), 1 (5.2%), 2 (9.9%), 3 (0.4%), 4 (1.2%), 5 (0.1%), 6 (0.3%), 7 (0.0%), and 8 (0.7%). Most carcasses (64.8%) were not bruised, 25.8% had one bruise, and 9.4% had multiple bruises. Bruise location and incidence were round (10.6%), loin (32.6%), rib (19.5%), chuck (27.0%), and brisket, flank, and plate (10.3%). Condemnation item and incidence were liver (24.7%), lungs (11.5%), tripe (11.6%), heads (6.0%), tongues (9.7%), and carcasses (0.0%). Carcass evaluation revealed these traits and frequencies: steer (63.7%), heifer (36.2%), bullock (0.05%), and cow (0.04%) sex classes; dark-cutters (1.9%); A (97.1%), B (1.7%), and C or older (1.2%) overall maturities; and native (90.9%), dairy-type (8.3%), and *Bos indicus* (0.8%) estimated breed types. Mean USDA yield grade (YG) traits were USDA YG (2.9), HCW (359.9 kg), adjusted fat thickness (1.3 cm), LM area (86.4 cm^2), and KPH (2.3%). The USDA YG were YG 1 (16.5%), YG 2 (36.3%), YG 3 (33.1%), YG 4 (11.8%), and YG 5 (2.3%). Mean USDA quality grade traits were USDA quality grade ($Select^{90}$), marbling score ($Small^{32}$), overall maturity (A^{64}), lean maturity (A^{57}), and skeletal maturity (A^{68}). Marbling score distribution was Slightly Abundant or greater (2.7%), Moderate (4.3%), Modest (14.4%), Small (34.5%), Slight (41.2%), and Traces or less (2.9%). This information helps the beef industry measure progress and provides a benchmark for future educational and research activities.

Key words: beef quality, carcass, market survey, meat grade

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INTRODUCTION

The National Beef Quality Audit (**NBQA**) has been an important vehicle to measure and report certain producer-related cattle and carcass traits in the US beef industry. Many of these findings are used as teaching tools for producer education programs, as benchmarks for research programs, and as an overall assessment of problems and opportunities for the carcasses and by-products from cattle.

The 3 previous audits conducted in the United States include the NBQA–1991 (Lorenzen et al., 1993), NBQA–1995 (Boleman et al., 1998), and NBQA–2000 (McKenna et al., 2002). Canada also has conducted

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Table 1. Company and location of surveyed plants

Company	Location
Brawley Beef Company	Brawley, CA
Cargill Meat Solutions	Dodge City, KS
Cargill Meat Solutions	Plainview, TX
Cargill Meat Solutions	Schuyler, NE
Greater Omaha Beef Company	Omaha, NE
Harris Ranch Beef Company	Selma, CA
Sam Kane Beef Processors	Corpus Christi, TX
Smithfield Beef Group–Green Bay	Green Bay, WI
Smithfield Beef Group–Souderton	Souderton, PA
Swift & Company	Grand Island, NE
Swift & Company	Greeley, CO
Swift & Company	Hyrum, UT
Tyson Fresh Meats	Amarillo, TX
Tyson Fresh Meats	Boise, ID
Tyson Fresh Meats	Joslin, IL
Washington Beef Company	Toppenish, WA

2 beef quality audits: the Canadian Beef Quality Audit–1995–96 (Van Donkersgoed et al., 1997) and the Canadian Beef Quality Audit–1998–99 (Van Donkersgoed et al., 2001). Information has shown where improvements in genetics and management have been made and where they may still be needed.

With each NBQA conducted, certain policies and practices may change traits that need to be measured or may influence certain occurrences of previously measured traits. Some of the events that have occurred since the last audit (McKenna et al., 2002) include, but are not limited to, 1) the finding of an animal with bovine spongiform encephalopathy in the United States in late 2003, which led to the need to identify the age of animals at slaughter through dentition if no other age-determining method was used (referred to as the "over 30-mo rule"), 2) the need to segregate carcasses equal to or younger than A^{40} overall maturity for the Japanese beef market, 3) condemnations of certain offal items if they originate from animals 30 mo of age or older, 4) more attention to individual animal identification as a means of documenting where animals originated, and 5) increased auditing of animal-handling processes by third-party entities, which may have caused changes in animal welfare practices. The NBQA–2005 was conducted to report the quality and consistency of US beef and to identify current issues and improvements from 1991 to the present.

MATERIALS AND METHODS

Animal Care and Use Committee approval was not obtained for this study because no live animals were involved.

General Overview

We conducted 32 in-plant audits—2 visits each to 16 beef-packing plants throughout the United States (Table 1)—in June through September 2005 and March through June 2006. A practice and correlation session was held before data collection was initiated to help ensure uniformity and consistency of observations and measurements.

Data were collected between Tuesday and Thursday of a given week. Packing plants that processed cattle during 2 daily shifts were audited during both of those shifts. Mondays were avoided to prevent biases caused by carcasses receiving extended chilling because of being held over a weekend (Calkins et al., 1980).

Harvest Floor Assessments—Before Hide Removal

We sampled 50% of the cattle from each production lot, for a maximum total of 49,330 animals for the harvest floor assessments. Hide color was classified based on primary visual color or breed type (black, white, yellow, brindle, red, brown, gray, and Holstein). Animal identification was recorded as follows: none, electronic tag, bar-code tag, individual visual tag, lot visual tag, metal-clip tag, or other. Incidence of hide brands was recorded based on location and approximate size. "Butt" brands were those located on the rump and round region, "side" brands were those located on the loin or rib-plate region or both, and "shoulder" brands were located on the shoulder (chuck) or neck region or both. Cattle were assessed visually for the presence of mud or manure based on body location (not visible, legs, belly, side, and top-line) and amount or severity (none, small, moderate, large, and extreme). Horns, if present, were evaluated visually for approximate length (none, <2.54 cm, 2.54 to 12.7 cm, and >12.7 cm).

Table 2. Characteristics of branded hides[1]

Brand location	Percentage of sample	Brand size			
		Mean, cm^2	SD	Minimum, cm^2	Maximum, cm^2
Butt	26.5	610.1	197.8	6.5	3,226.0
Side	7.4	222.0	864.8	6.5	7,742.4
Shoulder	1.2	292.4	246.8	6.5	3,716.4

[1]61.3% of hides had no brands, and 3.6% of hides had multiple brands (≥2).

Table 3. Means, SD, and minimum and maximum values for USDA carcass grade traits

Trait	Mean	SD	Minimum	Maximum
USDA yield grade	2.9	0.9	−1.1	8.9
USDA quality grade[1]	690	61	347	866
Adjusted fat thickness, cm	1.3	0.5	0.4	2.2
HCW, kg	359.9	47.6	155.0	561.3
LM area, cm^2	86.4	11.8	45.2	158.4
KPH, %	2.3	0.8	0.0	5.5
Marbling score[2]	432	101	110	900
Lean maturity[3]	157	18	110	370
Skeletal maturity[3]	168	30	110	490
Overall maturity[3]	164	25	120	380

[1]100 = Canner^{00}, 400 = Commercial^{00}, 600 = Select^{00}, and 800 = Prime^{00}.
[2]100 = Practically Devoid^{00}, 300 Slight^{00}, 500 = Modest^{00}, 700 = Slightly Abundant^{00}, and 900 = Abundant^{00}.
[3]100 = A^{00} and 500 = E^{00}.

Harvest Floor Assessments—After Hide Removal

Offal (liver, lung, tripe, and whole intestinal tract), head, tongue, and whole carcasses were evaluated for wholesomeness by USDA Food Safety and Inspection Service personnel, and we recorded the number of condemnations and their reasons for condemnation. Numbers of females carrying fetuses were evaluated at the viscera table. Cattle age was estimated through dentition by determining the number of permanent incisors present. Carcass bruises were assessed based on the number (0, 1, 2, 3, 4, and 5), location (round, loin, rib, chuck, and flank plate or brisket), and severity (minor, major, and critical or extreme). Grubs and injection sites, when visible, were noted.

Carcass Assessments

Beef carcasses (n = 9,475) representing 10% of each production lot were selected randomly for determination of USDA (1997) quality grade (**QG**) and yield grade (**YG**) factors. Trained university personnel evaluated beef carcasses for sex class (steer, heifer, cow, and bullock), estimated breed type (native, dairy, or *Bos indicus*), fat color (noted if yellow), LM area (measured by dot grid, blotting paper, or beef camera), and HCW. For the estimated breed type assessment, dairy-type carcasses were those in which the conformation and overall muscling were angular and thin in relation to the carcass size, *B. indicus*-type carcasses had dorsal thoracic humps (musculus rhomboideus and overlying muscles and s.c. fat) >10.2 cm, and native were those that remained with no readily distinguishable characteristics that would classify them as dairy-type or *B. indicus*-type carcasses. United States Department of Agriculture, Agricultural Marketing Service, Meat Grading and Certification Branch personnel evaluated beef carcasses for lean maturity, skeletal maturity, marbling score, adjusted fat thickness, and KPH percentage.

Statistical Analysis

All analyses were performed by using SAS (SAS Inst. Inc., Cary, NC). Mean, SD, and minimum and maximum values for each trait were generated by using PROC MEANS. Frequency distributions were analyzed

Table 4. Occurrence[1] of marbling scores within USDA quality grades[2]

Marbling score, %	Overall[3]	Prime	Choice	Select	Standard
Abundant	0.05	0.60			
Moderately Abundant	0.33	13.53			
Slightly Abundant	2.31	85.87	0.03		
Moderate	4.29		7.95	0.07	
Modest	14.39		27.22	0.07	
Small	34.54		64.80	0.27	13.99
Slight+	24.67			59.88	12.95
Slight−	16.55			39.71	12.44
Traces	2.50				59.84
Practically Devoid	0.41				0.78

[1]Rounding error prevents all categories from adding to 100.0.
[2]USDA quality grade was affected by maturity and dark-cutting beef.
[3]Overall category represents USDA quality grades of Prime, Choice, Select, Standard, Commercial, and Utility.

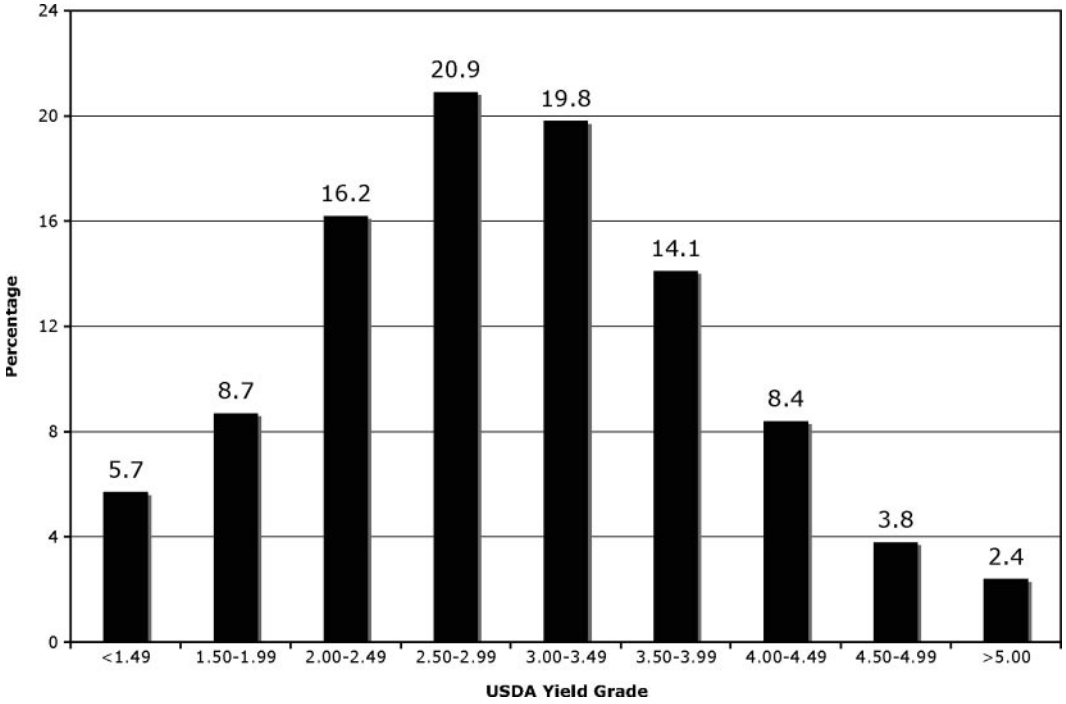

Figure 1. Frequency distribution of carcasses by one-half yield grade increments from the National Beef Quality Audit–2005.

by using PROC FREQ. Comparisons of traits across sex classes, YG, QG, weight groups, and fat thickness groups were made by using PROC MIXED. When main effects were significant ($P < 0.05$), least squares means were separated by using the PDIFF option.

RESULTS AND DISCUSSION

Hide Color Assessment

Hide color assessment as part of these audits was first performed, as described by McKenna et al. (2002), to provide an indication of breed-type predominance within the steer and heifer population and because hide color is used in many of the USDA-certified beef programs. In data not presented in tabular form, we found 56.3% of the cattle to be predominantly black (on at least 51% of the hide surface) and 18.6% to be red. Other classifications were the black-and-white characteristic of Holstein (7.9%), gray (6.0%), yellow (4.9%), brown (3.0%), white (2.3%), and brindle (1.0%). Clearly, black-hided cattle were found in greater numerical frequency compared with the 45.1% reported by McKenna et al. (2002). In the United States, the number of branded beef programs that emphasize Angus genetics, black-hided cattle, or both has increased dramatically over the years, which helps to explain why we found so many black-hided cattle in this audit.

Animal Identification Method

A new feature to this audit was to evaluate how individual animals were identified. Method of identification and frequency were electronic tags (3.5%), bar-coded tags (0.3%), individual visual tags (38.7%), lot visual tags (63.2%), metal-clip tags (11.8%), and by other

Table 5. Percentage distribution[1] of carcasses stratified by USDA quality[2] and yield grades

USDA yield grade	USDA quality grade, %					
	Prime	Choice	Select	Standard	Commercial	Utility
1	0.03	3.19	9.59	2.30	0.06	0.07
2	0.53	18.20	18.27	1.37	0.24	0.17
3	1.48	21.19	9.52	0.55	0.19	0.06
4	0.44	7.84	2.34	0.08	0.11	0.00
5	0.12	1.48	0.43	0.06	0.08	0.00

[1]Carcasses with missing values for USDA quality or yield grades are not included.
[2]USDA quality grade was affected by maturity and dark-cutting beef, and there were no Cutter and Canner carcasses observed in the audit.

Table 6. Characteristics of overall maturity[1]

Overall maturity	n	Percentage of sample	Mean	SD	Minimum	Maximum
A	9,051	97.05	156.8	16.9	100	190
B	149	1.72	231.7	24.0	200	290
C	98	1.16	334.9	25.5	300	380
D	6	0.08	455.0	27.4	400	480

[1]100 = A[00], 200 = B[00], 300 = C[00], 400 = D[00], and 500 = E[00].

means (2.5%), with some cattle having multiple forms of identification. There were 9.7% of cattle without any identification.

Hide Brand Assessment

Characteristics of branded hides are reported in Table 2. We found that 61.3% of hides were unbranded, which is greater numerically than was reported in the previous audits. The remaining numbers of branded hides (data not reported in tabular form) were one brand (35.1%), 2 brands (3.5%), and 3 or more brands (0.1%). Brands were located on the butt (26.5%), side (7.4%), and shoulder (1.2%). Mean hot iron brand sizes (cm × cm) were 24.7 × 24.7 for side brands, 14.9 × 14.9 for butt brands, and 17.1 × 17.1 for shoulder brands.

Mud or Manure Evaluation

Mud or manure is of great concern regarding contamination of the carcass, especially when present on the legs and belly of the animal, where a hide opening may introduce this contamination to the carcass inadvertently. Percentages of animals without (not visible, 25.8%) or with mud or manure on specific body locations were legs (61.4%), belly (55.9%), side (22.6%), and top-line (10.0%). Percentages of cattle with mud or manure were at 1 (43.6%), 2 (30.8%), 3 (17.7%), 4 (5.0%), and 5 (2.9%) body locations. Finally, percentages of hide-on cattle with various amounts or severity scores of mud or manure were none (25.9%), small (56.1%), moderate (14.8%), large (3.0%), and extreme (0.2%).

Horn Evaluation

In data not reported in tabular form, we found that 22.3% of cattle had no horns, which is similar to the frequency found in the NBQA–2000 (22.7%) reported by McKenna et al. (2002). Both of these frequencies were numerically less than those reported for the NBQA–1991 (Lorenzen et al., 1993) and NBQA–1995 (Bole-

Table 7. Least squares means for carcass traits (SEM[1]) within USDA quality grades

	USDA quality grade			
Trait	Prime (n = 278)	Choice (n = 5,058)	Select (n = 3,472)	Standard (n = 385)
USDA yield grade	3.5[a]	3.2[b]	2.6[c]	2.0[d]
	(0.06)	(0.01)	(0.01)	(0.04)
USDA quality grade[2]	813[a]	725[b]	651[c]	547[d]
	(2.01)	(0.45)	(0.51)	(1.41)
Adjusted fat thickness, cm	1.47[a]	1.43[ab]	1.14[b]	0.98[c]
	(0.04)	(0.01)	(0.01)	(0.02)
HCW, kg	367.7[a]	363.7[a]	353.2[b]	343.8[c]
	(6.83)	(1.53)	(1.74)	(4.78)
LM area, cm^2	77.8[d]	84.5[c]	89.3[b]	92.4[a]
	(0.13)	(0.02)	(0.03)	(0.09)
KPH, %	1.7[c]	2.2[ab]	2.2[ab]	2.1[b]
	(0.05)	(0.01)	(0.14)	(0.04)
Marbling score[3]	741[a]	477[b]	352[c]	335[d]
	(4.1)	(0.9)	(1.1)	(2.9)
Lean maturity[4]	151[c]	153[c]	156[b]	166[a]
	(1.3)	(0.3)	(0.3)	(0.9)
Skeletal maturity[4]	162[bc]	160[c]	162[bc]	186[a]
	(2.2)	(0.5)	(0.6)	(1.5)
Overall maturity[4]	159[bc]	159[c]	160[b]	186[a]
	(2.1)	(0.5)	(0.5)	(1.5)

[a–d]Means within a row lacking a common superscript letter differ ($P < 0.05$).
[1]SEM is the SE of the least squares means.
[2]100 = Canner[00], 400 = Commercial[00], 600 = Select[00], and 800 = Prime[00].
[3]100 = Practically Devoid[00], 300 = Slight[00], 500 = Modest[00], and 700 = Slightly Abundant[00].
[4]100 = A[00] and 500 = E[00].

Table 8. Least squares means for carcass traits (SEM[1]) within USDA yield grades

	USDA yield grade				
Trait	1 (n = 1,330)	2 (n = 3,440)	3 (n = 3,137)	4 (n = 1,121)	5 (n = 214)
USDA yield grade	1.4[e]	2.5[d]	3.4[c]	4.3[b]	5.5[a]
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
USDA quality grade[2]	646[c]	683[b]	706[a]	713[a]	707[a]
	(1.72)	(1.07)	(1.14)	(1.98)	(4.38)
Adjusted fat thickness, cm	0.73[e]	1.05[d]	1.50[c]	2.06[b]	2.59[a]
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
HCW, kg	341.8[e]	350.5[d]	364.9[c]	382.3[b]	388.8[a]
	(2.87)	(1.78)	(1.90)	(3.30)	(7.30)
LM area, cm^2	100.5[a]	88.0[b]	82.1[c]	78.5[d]	69.2[e]
	(0.04)	(0.02)	(0.03)	(0.05)	(0.12)
KPH, %	1.9[e]	2.1[d]	2.3[c]	2.6[b]	2.8[a]
	(0.02)	(0.01)	(0.01)	(0.02)	(0.06)
Marbling score[3]	356[d]	414[c]	457[b]	472[ab]	485[a]
	(2.9)	(1.8)	(1.9)	(3.4)	(7.4)
Lean maturity[4]	155[b]	155[b]	154[b]	155[b]	158[a]
	(0.6)	(0.4)	(0.4)	(0.7)	(1.5)
Skeletal maturity[4]	162[b]	162[b]	162[b]	163[b]	167[a]
	(1.0)	(0.6)	(0.6)	(1.1)	(2.4)
Overall maturity[4]	160	160	160	162	165
	(0.9)	(0.6)	(0.6)	(1.1)	(2.4)

[a–e]Means within a row lacking a common superscript letter differ ($P < 0.05$).
[1]SEM is the SE of the least squares means.
[2]100 = Canner[00], 400 = Commercial[00], 600 = Select[00], and 800 = Prime[00].
[3]100 = Practically Devoid[00], 300 = Slight[00], 500 = Modest[00], and 700 = Slightly Abundant[00].
[4]100 = A[00] and 500 = E[00].

man et al., 1998), which were 31.1 and 32.2%, respectively. We also found that 17.0% had horns <2.54 cm in length, 52.2% had horns between 2.54 and 12.7 cm in length, and 30.8% had horns >12.7 cm in length.

Dentition

Permanent incisor numbers and occurrences were zero (82.2%), 1 (5.2%), 2 (9.9%), 3 (0.4%), 4 (1.2%), 5 (0.1%), 6 (0.3%), 7 (0.0%), and 8 (0.7%).

Offal and Carcass Condemnations

Incidence rates for USDA Food Safety and Inspection Service viscera and carcass condemnations were livers (24.7%), lungs (11.5%), tripe (11.6%), head (6.0%), tongue (9.7%), and whole carcass (0%). Liver condemnations were for abscesses (54.2%), flukes (18.5%), animals greater than 30 mo of age (0.3%), contamination (6.7%), and other reasons (20.3%). Lung condemnations causes and percentages were pneumonia (40.6%), contamination (20.5%), abscesses (2.9%), animal greater than 30 mo (0.4%), and other reasons (35.6%). Tripe condemnation causes and percentages were abscesses (28.5%), contamination (23.9%), ulcers (2.8%), animals greater than 30 mo of age (0.8%), and other reasons (43.9%). Head condemnation causes and percentages were inflamed lymph nodes (19.3%), contamination (9.0%), animal greater than 30 mo of age (3.2%), abscesses (0.4%), and other reasons (68.1%). Tongue condemnation causes and percentages were "hair sore" (27.8%), "cactus tongue" (22.5%), inflamed lymph nodes (12.3%), contamination (2.5%), animal greater than 30 mo of age (0.3%), and other reasons (34.6%). "Hair sores" are lesions in the surface of the tongue that contain feed and hair particles (Gill et al., 1996), and "cactus tongue" appears when cactus spines have penetrated the tongue in cattle that have consumed cacti, especially prickly pear (Migaki et al., 1969). In general, condemnation rates for livers and lungs were numerically less than in NBQA–2000 (McKenna et al., 2002). However, incidence rates for tripe, head, and tongue condemnations were similar numerically to the NBQA–2000 (McKenna et al., 2002), but definitely greater than for the NBQA–1991 (Lorenzen et al., 1993) and NBQA–1995 (Boleman et al., 1998).

The number of cattle that had fetuses was 0.6%. This is the least reported incidence (numerically) of the 4 audits.

Carcass Bruises

We found that 64.8% of the carcasses had no bruises, 25.8% had 1 bruise, 7.4% had 2 bruises, 1.6% had 3 bruises, 0.4% had 4 bruises, and 0% had more than 4 bruises. Compared with the NBQA–1995 and NBQA–2000, there was a numerical reduction in bruising incidence: Boleman et al. (1998) reported 51.6% of carcasses without bruises, and McKenna et al. (2002) reported 53.3% without bruises. Attention to animal handling by the livestock and meat industry in recent years may have led to the reduced bruising we found in the current audit.

Table 9. Least squares means for carcass traits (SEM[1]) within fat thickness groups

	Fat thickness, cm									
Trait	<0.51 (n = 519)	0.51 to 0.75 (n = 910)	0.76 to 1.01 (n = 1,975)	1.02 to 1.26 (n = 1,172)	1.27 to 1.51 (n = 2,052)	1.52 to 1.77 (n = 1,024)	1.78 to 2.02 (n = 912)	2.03 to 2.28 (n = 331)	2.29 to 2.53 (n = 352)	>2.54 (n = 214)
USDA yield grade	1.6^{j}	2.0^{i}	2.3^{h}	2.7^{g}	3.1^{f}	3.5^{e}	3.8^{d}	4.2^{c}	4.5^{b}	5.1^{a}
	(0.02)	(0.16)	(0.08)	(0.01)	(0.04)	(0.06)	(0.03)	(0.03)	(0.03)	(0.04)
USDA quality grade[2]	645^{g}	660^{f}	680^{e}	688^{d}	695^{c}	706^{b}	707^{ab}	705^{b}	715^{a}	708^{ab}
	(2.8)	(2.0)	(1.4)	(1.8)	(1.4)	(2.0)	(2.2)	(3.8)	(3.6)	(4.6)
Adjusted fat thickness, cm	0.30^{j}	0.61^{i}	0.81^{h}	1.12^{g}	1.32^{f}	1.62^{e}	1.83^{d}	2.13^{c}	2.34^{b}	2.84^{a}
	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)
HCW, kg	339.6^{f}	346.5^{e}	352.7^{d}	358.0^{c}	360.2^{c}	367.4^{b}	366.2^{b}	376.7^{a}	377.6^{a}	381.7^{a}
	(4.65)	(3.37)	(2.32)	(3.07)	(2.35)	(3.32)	(3.62)	(6.38)	(5.93)	(7.69)
LM area, cm^2	89.6^{a}	89.6^{a}	88.4^{a}	88.4^{a}	85.8^{b}	84.5^{c}	83.2^{d}	82.5^{de}	80.6^{e}	78.1^{f}
	(0.09)	(0.06)	(0.04)	(0.06)	(0.04)	(0.06)	(0.07)	(0.12)	(0.11)	(0.15)
KPH, %	1.8^{f}	1.9^{f}	2.1^{e}	2.2^{d}	2.2^{d}	2.4^{bc}	2.3^{c}	2.4^{bc}	2.5^{b}	2.7^{a}
	(0.3)	(0.2)	(0.01)	(0.02)	(0.01)	(0.02)	(0.03)	(0.05)	(0.05)	(0.06)
Marbling score[3]	357^{g}	381^{f}	407^{e}	422^{d}	438^{c}	457^{b}	459^{ab}	463^{ab}	475^{a}	476^{a}
	(4.7)	(3.4)	(2.3)	(3.1)	(2.3)	(3.3)	(3.6)	(6.4)	(6.0)	(7.7)
Lean maturity[4]	157^{ab}	155^{bc}	155^{bc}	155^{bc}	154^{c}	153^{c}	155^{bc}	159^{a}	156^{ab}	156^{ab}
	(0.9)	(0.6)	(0.4)	(0.6)	(0.4)	(0.6)	(0.7)	(1.2)	(1.1)	(1.5)
Skeletal maturity[4]	160^{c}	160^{c}	160^{c}	162^{c}	163^{c}	164^{b}	166^{ab}	171^{a}	163^{b}	166^{ab}
	(1.5)	(1.1)	(0.7)	(1.0)	(0.7)	(1.1)	(1.2)	(2.1)	(1.9)	(2.5)
Overall maturity[4]	160^{cde}	158^{e}	159de	160^{cde}	160^{cd}	162^{bc}	163^{bc}	168^{a}	162^{bc}	166^{a}
	(1.4)	(1.1)	(0.7)	(0.9)	(0.7)	(1.0)	(1.1)	(2.0)	(1.9)	(2.4)

[a–j]Means within a row lacking a common superscript letter differ ($P < 0.05$).
[1]SEM is the SE of the least squares means.
[2]100 = Canner^{00}, 400 = Commercial^{00}, 600 = Select^{00}, and 800 = Prime^{00}.
[3]100 = Practically Devoid^{00}, 300 = Slight^{00}, 500 = Modest^{00}, and 700 = Slightly Abundant^{00}.
[4]100 = A^{00} and 500 = E^{00}.

Of the carcasses with bruises, 10.6% were located on the round, 32.6% were on the loin, 19.5% were on the rib, 27.0% were on the chuck, and 10.3% were on the flank, plate, or brisket. There were greater numerical differences in bruise frequencies in the round and loin in the NBQA–2005 compared with the NBQA–2000. McKenna et al. (2002) reported that 14.9% of the bruises were located on the round, 25.9% were located on the loin, 19.4% were located on the rib, 28.2% located on the chuck, and 11.6% were located on the flank, plate, or brisket.

Carcass Assessment

Means for USDA QG and USDA YG traits are shown in Table 3. The mean USDA QG for the current study was Select^{90} and the mean USDA YG was 2.9. Means for USDA QG and USDA YG from the previous audits were Select^{79} and 3.2 for NBQA–1991 (Lorenzen et al., 1993), Select^{79} and 2.8 for NBQA–1995 (Boleman et al., 1998), and Select^{90} and 3.0 for NBQA–2000 (McKenna et al., 2002). Frequency distributions of USDA YG by half-grade increments are shown in Figure 1. The USDA YG distributions were YG 1 (15.3%), YG 2 (38.8%), YG 3 (32.9%), YG 4 (10.8%), and YG 5 (2.2%). The USDA QG distributions were Prime (2.6%), Choice (51.9%), Select (40.2%), Standard (4.4%), Commercial (0.7%), and Utility (0.3%).

Marbling scores across and within USDA QG are shown in Table 4. The vast majority of the marbling scores are in the lower parts of the grades (e.g., low Prime = 85.87%, low Choice = 64.21%, etc.). McKenna et al. (2002) reported the need to determine the number of carcasses that was Small^{50} or greater because some of the certified beef programs include such carcasses. We found that 23.6% of the carcasses had marbling scores greater than or equal to Small^{50}, which is numerically less than that reported (36.6%) by McKenna et al. (2002) in NBQA–2000.

Distributions of carcasses in various combinations of USDA QG and YG are reported in Table 5. We found 67.2% of the carcasses to be Choice and Select, YG 2 and 3; comparable percentages were 67.2% for NBQA–1991 (Lorenzen et al., 1993), 75% for NBQA–1995 (Boleman et al., 1998), 70.5% for NBQA–2000 (McKenna et al., 2002). Nonconforming carcasses—QG of Standard or lower and YG 4 and 5—represented 18.3% of the carcasses surveyed. McKenna et al. (2002) reported 17.8% of the carcasses in NBQA–2000 to be nonconforming.

Frequencies of carcass maturities are reported in Table 6. More than 97% of the carcasses were of A maturity. The Beef Export Verification program for Japan requires that beef carcasses from cattle of unknown chronological ages must be A^{40} or more youthful in overall maturity. For A-maturity carcasses, 19.4% met this qualification, whereas 80.6% of the carcasses were A^{50} or older.

In data not reported in tabular form, 1.9% of the carcasses were dark cutters. The partial-or full-grade discounts for dark cutters were one-third grade (0.7%),

Table 10. Least squares means for carcass traits (SEM[1]) within carcass weight groups

	Carcass weight group, kg						
Trait	<227.0 (n = 14)	227.0 to 272.3 (n = 35)	272.4 to 317.7 (n = 143)	317.8 to 363.1 (n = 8,013)	363.2 to 408.5 (n = 768)	408.6 to 453.9 (n = 334)	>454.0 (n = 134)
USDA yield grade	1.8[e]	1.9[e]	2.3[d]	2.8[c]	3.3[b]	3.6[a]	3.6[a]
	(0.27)	(0.16)	(0.08)	(0.01)	(0.04)	(0.06)	(0.09)
USDA quality grade[2]	612[d]	639[d]	656[c]	688[b]	694[a]	695[a]	706[a]
	(17.0)	(10.57)	(5.37)	(0.74)	(2.59)	(3.96)	(5.92)
Adjusted fat thickness, cm	0.8[d]	0.7[d]	0.9[d]	1.2[c]	1.4[b]	1.6[a]	1.5[a]
	(0.15)	(0.09)	(0.04)	(0.01)	(0.02)	(0.03)	(0.05)
HCW, kg	202.9[g]	240.6[f]	282.8[d]	351.7[e]	405.5[c]	440.4[b]	469.3[a]
	(19.68)	(12.24)	(6.23)	(0.86)	(3.01)	(4.58)	(6.85)
LM area, cm^2	72.4[d]	75.2[d]	75.8[d]	89.3[c]	91.8[b]	92.6[b]	96.1[a]
	(0.52)	(0.32)	(0.16)	(0.02)	(0.08)	(0.12)	(0.18)
KPH, %	2.1[ab]	2.1[ab]	2.1[ab]	2.2[ab]	2.2[ab]	2.3[a]	2.1[ab]
	(0.23)	(0.14)	(0.07)	(0.01)	(0.03)	(0.05)	(0.08)
Marbling score[3]	342[d]	353[d]	372[d]	424[c]	438[b]	450[ab]	472[a]
	(28.4)	(17.7)	(9.0)	(1.2)	(4.3)	(6.6)	(9.89)
Lean maturity[4]	170[a]	160[b]	155[b]	154[b]	156[b]	156[b]	162[ab]
	(5.3)	(3.3)	(1.7)	(0.2)	(0.8)	(1.2)	(1.84)
Skeletal maturity[4]	175[ab]	157[b]	159[b]	162[b]	164[b]	169[b]	178[a]
	(8.9)	(5.5)	(2.8)	(0.4)	(1.4)	(2.1)	(3.10)
Overall maturity[4]	175[a]	160[b]	158[b]	162[b]	164[b]	166[b]	172[a]
	(8.6)	(5.4)	(2.7)	(0.4)	(1.3)	(2.0)	(2.99)

[a–g]Means within a row lacking a common superscript letter differ ($P < 0.05$).
[1]SEM is the SE of the least squares means.
[2]100 = Canner[00], 400 = Commercial[00], 600 = Select[00], and 800 = Prime[00].
[3]100 = Practically Devoid[00], 300 = Slight[00], 500 = Modest[00], and 700 = Slightly Abundant[00].
[4]100 = A[00] and 500 = E[00].

one-half grade (0.3%), two-thirds grade (0.3%), and full grade (0.5%). McKenna et al. (2002) found that 2.3% of carcasses in NBQA–2000 were dark cutters.

Least squares means for carcass traits within each USDA QG are shown in Table 7. As QG increased from Standard to Prime, numerical YG, adjusted fat thickness, and HCW increased ($P < 0.05$). In contrast, LM area and KPH percentage decreased as QG increased from Standard to Prime. McKenna et al. (2002) stated that the USDA (1997) grade standards changed some

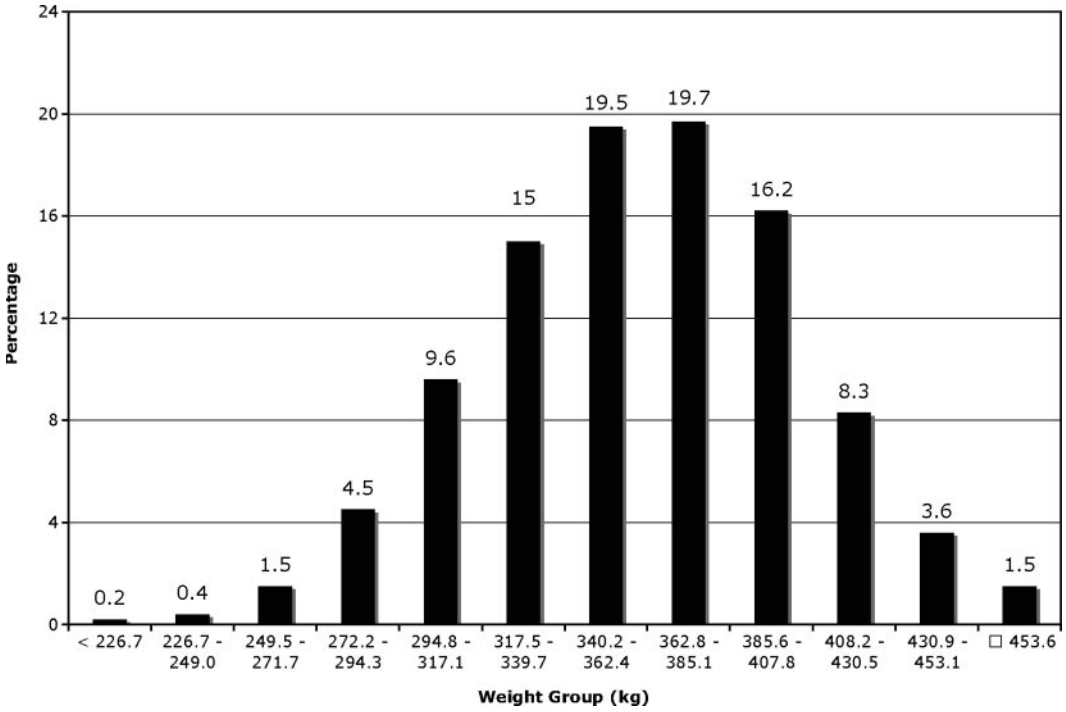

Figure 2. Frequency distribution of carcasses by weight groups from the National Beef Quality Audit–2005.

Table 11. Least squares means for carcass traits (SEM[1]) within sex class

Trait	Sex class			
	Steer (n = 6,007)	Heifer (n = 3,412)	Bullock (n = 5)	Cow (n = 4)
USDA yield grade	2.9	2.9	3.6	3.4
	(0.01)	(0.02)	(0.55)	(0.55)
USDA quality grade[2]	691	685	668	725
	(0.87)	(1.22)	(33.82)	(33.82)
Adjusted fat thickness, cm	1.31	1.34	1.72	1.48
	(0.01)	(0.01)	(0.31)	(0.31)
HCW, kg	366.9	342.1	382.3	367.9
	(1.36)	(1.91)	(52.99)	(52.99)
LM area, cm^2	86.7	85.7	89.2	82.1
	(0.02)	(0.03)	(1.08)	(1.08)
KPH, %	2.1[b]	2.3[b]	3.5[a]	2.8[ab]
	(0.01)	(0.01)	(0.46)	(0.46)
Marbling score[3]	430	424	373	490
	(1.5)	(2.1)	(57.6)	(57.6)
Lean maturity[4]	154[c]	156[b]	210[a]	176[b]
	(0.4)	(0.6)	(17.4)	(17.4)
Skeletal maturity[4]	159[c]	169[b]	166[bc]	300[a]
	(0.4)	(0.6)	(17.4)	(17.4)
Overall maturity[4]	157[d]	166[c]	233[b]	300[a]
	(0.4)	(0.6)	(16.7)	(16.7)

[a–d]Means within a row lacking a common superscript letter differ ($P < 0.05$).
[1]SEM is the SE of the least squares means.
[2]100 = Canner[00], 400 = Commercial[00], 600 = Select[00], and 800 = Prime[00].
[3]100 = Practically Devoid[00], 300 = Slight[00], 500 = Modest[00], and 700 = Slightly Abundant[00].
[4]100 = A[00] and 500 = E[00].

of the marbling-maturity-grade relationships, and the marbling and maturity scores for the Standard grade in our survey are similar to those in the NBQA–2000 (McKenna et al., 2002).

Carcass trait means within each USDA YG are displayed in Table 8. As USDA YG increased (from YG 1 to YG 5), marbling, QG, adjusted fat thickness, HCW, and KPH percentage also increased, whereas LM area decreased. These relationships between carcass traits and USDA YG are similar to those reported by Lorenzen et al. (1993), Boleman et al. (1998), and McKenna et al. (2002).

Least squares means for carcass traits within fat thickness categories are reported in Table 9. As fat thickness increased, numerical YG, QG, adjusted fat thickness, HCW, and KPH percentage also increased ($P < 0.05$). However, LM area decreased ($P < 0.05$) with increased fat thickness. These relationships between carcass traits and USDA YG are similar to those reported by Lorenzen et al. (1993), Boleman et al. (1998), and McKenna et al. (2002). In addition, McKenna et al. (2002) noted that QG increased ($P < 0.05$) with increasing fat thickness up to 1.77 cm but did not increase with additional increased fat thickness. We found that QG increased ($P < 0.05$) with increasing fat thickness up to 1.51 cm, but did not increase after that point. Both of these audits show that simply increasing fat thickness in cattle beyond a specific point will not ensure increased marbling or QG.

Carcass traits within HCW groups are displayed in Table 10. As HCW increased, numerical YG, adjusted fat thickness, marbling score, QG, and LM area increased ($P < 0.05$). These findings are similar to those of the NBQA–2000 (McKenna et al., 2002). Frequency distribution of carcasses by weight group is reported in Figure 2. McKenna et al. (2002) discussed discounts for carcasses that weighed in excess of 431 kg and reported 4.6% of carcasses in the NBQA–2000 exceeded this weight. We found that more than 5% of the carcasses in this audit weighed more than 431 kg; however, it is more common today for US beef packers to begin discounting carcasses only after they exceed 454 kg of HCW. This increase in the HCW at which discounts may apply has been the result of a trend toward increasing carcass weights and the reluctant acceptance of them by the industry.

In data not presented in tabular form, the sex-class distribution of carcasses was steers (63.7%), heifers (36.2%), bullocks (0.05%), and cows (0.05%). Percentage of steers was numerically less and percentage of heifers was numerically greater than in NBQA–1995 (Boleman, 1995) and NBQA–2000 (McKenna et al., 2002), but these percentages are close to those reported in the NBQA–1991 (Lorenzen et al., 1993). Carcass traits stratified by sex class are displayed in Table 11. Carcasses from steers and heifers had more youthful ($P < 0.05$) overall maturity scores than carcasses from bullocks and cows.

Table 12. Least squares means for carcass traits (SEM[1]) within estimated breed types

Trait	Estimated breed type		
	Native (n = 8,563)	*Bos indicus* (n = 80)	Dairy (n = 777)
USDA yield grade	2.9	2.8	2.9
	(0.01)	(0.12)	(0.03)
USDA quality grade[2]	687[b]	667[c]	696[a]
	(0.8)	(7.4)	(2.3)
Adjusted fat thickness, cm	1.3[a]	1.2[ab]	1.1[b]
	(0.01)	(0.06)	(0.02)
HCW, kg	357.7[b]	319.9[c]	370.7[a]
	(1.17)	(10.83)	(3.55)
LM area, cm^2	86.9[a]	81.1[c]	85.1[b]
	(0.02)	(0.22)	(0.07)
KPH, %	2.3[a]	2.1[ab]	2.0[b]
	(0.01)	(0.00)	(0.03)
Marbling score[3]	424[b]	388[c]	441[a]
	(1.3)	(12.6)	(3.9)
Lean maturity[4]	155	155	155
	(0.2)	(2.3)	(0.7)
Skeletal maturity[4]	163[a]	162[ab]	158[b]
	(0.4)	(3.9)	(1.2)
Overall maturity[4]	162[a]	162[a]	157[b]
	(0.4)	(3.7)	(1.2)

[a–c]Means within a row lacking a common superscript letter differ ($P < 0.05$).
[1]SEM is the SE of the least squares means.
[2]100 = Canner[00], 400 = Commercial[00], 600 = Select[00], and 800 = Prime[00].
[3]100 = Practically Devoid[00], 300 = Slight[00], 500 = Modest[00], and 700 = Slightly Abundant[00].
[4]100 = A[00] and 500 = E[00].

Carcass traits stratified by estimated breed type are reported in Table 12. Among breed types, marbling score, QG, skeletal and lean maturity, HCW, KPH, and LM area differed significantly. Dairy-type carcasses had greater ($P < 0.05$) QG and marbling scores and lower overall maturity scores than the other 2 breed types. Dairy-type carcasses have had the greatest ($P < 0.05$) marbling scores compared with the other breed types in all previous audits (Lorenzen et al., 1993; Boleman et al., 1998; McKenna et al., 2002).

In data not reported in tabular form, carcass estimated (visually apparent) breed types were native type (90.9%), dairy type (8.3%), and *B. indicus* (0.8%). The greatest trend over time in these audits was the declining number of carcasses classified as *B. indicus*. Corresponding percentages from previous audits were 7.3% for NBQA–1991 (Lorenzen et al., 1993), 6.5% for NBQA–1995 (Boleman, 1995), and 3.0% for NBQA–2000 (McKenna et al., 2002).

Conclusions

Without information from the NBQA, members of the beef industry would not know how various factors that affect the value of live cattle, carcasses, or by-products have changed over time. Some of the trends observed in NBQA–2005 include more black-hided cattle, fewer branded hides, fewer carcasses with bruises, fewer *B. indicus* carcasses, and increased carcass weights compared with previous audits. Without question, genetic and management decisions are being made that affect the types of cattle coming to market, including how they are being handled to minimize bruising. Information from this audit adds to the existing knowledge base of beef quality, which is used in numerous educational activities and research programs to measure whether progress is being made.

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