National Beef Quality Audit–2000: 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–2000 was conducted to assess the current status of the quality and consistency of U.S. fed steers and heifers. Between May and November 2000, survey teams assessed hide condition (n = 43,415 cattle for color, brands, mud/manure), bruises (n = 43,595 carcasses), offal and carcass condemnation (n = 8,588 cattle), and carcass quality and yield information (n = 9,396 carcasses) in 30 U.S. beef packing plants. Hide colors were black (45.1%), red (31.0%), yellow (8.0%), Holstein (5.7%), gray (4.0%), white (3.2%), brown (1.7%), and brindle (1.3%). Brand frequencies were no (49.3%), one (46.2%), and two or more (4.4%), and brands were located on the butt (36.3%), side (13.7%), and shoulder (3.6%). Most cattle had no (18.0%) or a small amount (55.8%) of mud/manure on their hides, and they had no (77.3%) horns. Most carcasses (53.3%) were not bruised, 30.9% had one bruise, and 15.8% had multiple bruises. Bruise location and incidence were round (14.9%), loin (25.9%), rib (19.4%), chuck (28.2%), and brisket, flank, and plate (11.6%). Condemnation item and incidence were liver (30.3%), lungs (13.8%), tripe (11.6%), heads (6.2%), tongues (7.0%), and carcasses (0.1%). Carcass evaluation revealed these traits and frequencies: steer (67.9%), heifer (31.8%), and bullock (0.3%) sex-classes; dark-cutters (2.3%); A (96.6%), B (2.5%), and C or older (0.9%) overall maturities; and native (90.1%), dairy-type (6.9%), and *Bos indicus* (3.0%) breed-types. Mean USDA yield grade traits were USDA yield grade (3.0), carcass weight (356.9 kg), adjusted fat thickness (1.2 cm), longissimus muscle area (84.5 cm^2), and kidney, pelvic, and heart fat (2.4%). USDA yield grades were Yield Grade 1 (12.2%), Yield Grade 2 (37.4%), Yield Grade 3 (38.6%), Yield Grade 4 (10.4%), and Yield Grade 5 (1.3%). Mean USDA quality grade traits were USDA quality grade ($Select^{85}$), marbling score ($Small^{23}$), overall maturity (A^{66}), lean maturity (A^{65}), and skeletal maturity (A^{67}). Marbling score distribution was Slightly Abundant or higher (2.3%), Moderate (4.8%), Modest (13.1%), Small (33.3%), Slight (43.3%), and Traces (3.4%). USDA quality grades were Prime (2.0%), Choice (49.1%), Select (42.3%), Standard (5.6%), and Commercial, Utility, Cutter, and Canner (0.9%). This information will help the beef industry measure progress compared to the past two surveys and will provide a benchmark for future educational and research activities.

Key Words: Beef Quality, Market Surveys, Meat Grades

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Introduction

The National Beef Quality Audit–1991 (**NBQA–1991**; Lorenzen et al., 1993) established the first major benchmark that identified what the U.S. beef industry was producing. The National Beef Quality Audit–1995 (**NBQA–1995**; Boleman et al., 1998) measured progress regarding the quality, consistency, and competitiveness of beef. These audits have been used extensively in a variety of research, education, and business activities as references to what the beef industry was producing. Information gathered and disseminated

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from previous audits has focused on production practices (branding and dehorning), animal handling (mud/manure on hides and carcass bruising), condemnation (offal and carcass), and carcass quality and quantity factors, and a recommendation was made to update this information every 4 to 5 years (Smith et al., 1992).

Since the completion of the NBQA-1995, a number of management and marketing changes may have influenced the type of beef being produced. Most notably, a resurgence in demand for beef (NCBA, 2001), an increased number of USDA certified branded beef programs (USDA, 2001a), an affordable, abundant supply of grain (USDA, 2001b,c,d), and improved management and awareness facilitated through Beef Quality Assurance and other producer education programs. These factors may have impacted the quality and consistency of cattle and resulting carcass and by-product characteristics.

The National Beef Quality Audit–2000 (**NBQA–2000**) was conducted to assess the current status of the quality and consistency of the U.S. fed steer and heifer population, pinpoint inadequacies and shortfalls that the industry needs to improve upon, and track progress made since previous audits. This phase of the audit encompassed in-plant surveys of targeted qualitative and quantitative attributes of cattle, carcasses, and by-products.

Table 1. Company and location of plants audited

ConAgra Beef, Inc.	Cactus, TX
ConAgra Beef, Inc.	Garden City, KS
ConAgra Beef, Inc.	Grand Island, NE
ConAgra Beef, Inc.	Greeley, CO
E.A. Miller	Hyrum, UT
Excel, Inc.	Dodge City, KS
Excel, Inc.	Fort Morgan, CO
Excel, Inc.	Friona, TX
Excel, Inc.	Plainview, TX
Harris Ranch	Selma, CA
IBP, Inc.	Amarillo, TX
IBP, Inc.	Boise, ID
IBP, Inc.	Dakota City, NE
IBP, Inc.	Denison, IA
IBP, Inc.	Emporia, KS
IBP, Inc.	Garden City, KS
IBP, Inc.	Joslin, IL
IBP, Inc.	Lexington, NE
IBP, Inc.	Pasco, WA
IBP, Inc.	West Point, NE
Moyer Packing, Inc.	Souderton, PA
Murco	Plainwell, MI
Nebraska Beef	Omaha, NE
Packerland	Green Bay, WI
PM Beef, Inc.	Windom, MN
Sam Kane Beef Processors	Corpus Christi, TX
Shamrock	Vernon, CA
Sun Land Beef Co.	Tolleson, AZ
Taylor Packing, Inc.	Wyalusing, PA
Washington Beef	Sunnyside, WA

Materials and Methods

General Overview. The four universities involved with this study surveyed federally inspected fed-beef packing plants (n = 30; Table 1) selected to represent various geographical regions of the United States and comprise approximately 80% of fed steer and heifer slaughter capacity. Plants were audited within a 7-mo period (May through November 2000), and each team surveyed seven or eight plants based on a plan that maximized travel and time efficiency and optimized proportions of calf vs yearling slaughter cattle. To standardize assessments, team leaders participated in a 3-d training and correlation session at a beef packing plant before the start of the study.

Each team audited plants that were assigned to them once during the prescribed month. Plants were audited to achieve the equivalent of one day's production; plants operating only a single production shift each day were audited on a single day, and those operating two production shifts each day were audited over the course of 2 d (e.g., d 1, evening shift; d 2, morning shift). Plants were eligible to be audited on any day of the week; however, 14% of the audits were conducted on Mondays. Because additional postmortem chilling may influence USDA quality grade factors (Calkins et al., 1980), we did not want to over- or under-sample carcasses that would be chilled over the weekend from animals slaughtered on Fridays or Saturdays.

Cattle Assessment. These characteristics were assessed for samples of cattle from each production lot during the slaughter process in each packing facility: before hide removal (n = 43,415), hide color, hide branding, mud/manure, and horns; after hide removal (n = 43,595), carcass bruising; and carcass and offal condemnation (n = 8,588) upon pathological evaluation. For the characteristics evaluated before and after hide removal, approximately 50% of each production lot was sampled, and about 10% of each lot was sampled for carcass and offal condemnation.

These assessments were made at the beginning of the slaughter process near the exsanguination area of each packing plant. Hide color was classified according to primary color (black, red, yellow, gray, white, brown, brindle, or Holstein) and percentage saturation (100%, 99 to 85%, 84 to 51%, or roan). Cattle classified as Holstein were given a saturation value of 100%. Hide brands, if present, were evaluated for location and approximate size. "Butt" brands were those located on the rump and round region, "side" brands were those located on the loin and(or) rib-plate regions, and "shoulder" brands were located on the shoulder (chuck) and(or) neck regions. Cattle were evaluated for the presence of horns. If horns were present, approximate length (of a single horn) was estimated (< 2.54 cm, 2.54 to 12.7 cm, or > 12.7 cm). Mud/manure on the hides was evaluated visually as to its amount (no, small, moderate, large or extreme) and location (no, mud/manure on legs, mud/manure on

belly, mud/manure on side, mud/manure on topline, or any combination). In addition, cattle were assessed for the presence of mud/manure in an area around the tail region (10 cm radius around the anus).

Bruise information (frequency, location, and severity) was collected after hide removal and before splitting as described by Boleman et al. (1998) with the following modifications: brisket evaluations also included the flank and plate regions, and an extreme category (trim loss > 2.28 kg to remove bruise) was added to bruise severity scores of minor, major, and critical (because of small numbers of bruises in these categories, critical and extreme were combined for analysis purposes). Bruises were assessed according to the primal area on the carcass at which each occurred (chuck, rib, loin, round, and brisket, flank, and plate).

Condemnation incidence and reason for whole carcasses and for offal (livers, lungs, tripe, heads, and tongues) were obtained in the USDA Food Safety and Inspection Service (**USDA-FSIS**) pathological assessment areas (evisceration and final inspection) of each plant. Number of fetuses was evaluated at the evisceration area.

Carcass Assessment. Carcasses (n = 9,396), representing approximately 10% of each production lot, were evaluated for USDA yield and quality grade factors (USDA, 1997), sex class (steer, heifer, bullock, or cow), breed type (native, dairy or *Bos indicus* [dorsal thoracic hump height > 10 cm]), and quality defects (blood splash, yellow fat, and dark cutters). Carcass information was obtained by each team as outlined in Lorenzen et al. (1993) and Boleman et al. (1998) except that area supervisors from the USDA, Agricultural Marketing Service, Meat Grading and Certification Branch determined marbling score, identified and evaluated dark-cutting carcasses (a one-half grade deduction category was added), and determined adjusted fat thickness.

Statistical Analysis. Means, standard deviations, minimum and maximum values, and frequency distributions were generated. The effects of yield grade, quality grade, sex-class, breed-type, carcass weight, and fat thickness on quality and yield grade factors were determined using the GLM procedure of SAS (SAS Inst. Inc., Cary, NC). When main effects were significant ($P < 0.05$), least squares means were generated and separated by the P-DIFF procedure.

Results and Discussion

Hide Color Assessment. We evaluated hide color in this audit to provide some indication of breed-type predominance within the fed steer and heifer population. Many of the USDA (2001a) certified beef programs include hide color, and our information may be useful to those who market beef based on breed-type or hide color characteristics.

In data not presented in tabular form, we found 45.1% of the cattle to be predominately black (at least 51%) with solid black representing 32.0% of the sample and an additional 11.7% were predominantly black with white facial markings (e.g., black baldy). We found 31.0% of the cattle to be predominantly red (at least 51% red); solid red comprised 16.6% of the sample and 12.5% were predominantly red with white facial markings (e.g., Hereford breed characteristics). Other hide color classifications included yellow (8.0%), Holstein (5.7%), gray (4.0%), white (3.2%), brown (1.7%), and brindle (1.3%).

Hide Brand Assessment. Brand sizes and locations are reported in Table 2. We found that 49.3% of the cattle were not branded. Lorenzen et al. (1993) and Boleman et al. (1998) reported 55.0% and 47.7%, respectively, of the cattle in the previous audits were not branded. Multiple brands occurred on 4.4% of the cattle surveyed. Boleman et al. (1998) reported 6.1% of the cattle surveyed in the NBQA–1995 had multiple brands, and Lorenzen et al. (1993) reported 2.1% in NBQA–1991 had multiple brands.

Horn Evaluation. We found that 22.7% of the cattle had horns (data not reported in tabular form), which is numerically lower than Lorenzen et al. (1993) reported in NBQA–1991 (31.1%) and than Boleman et al. (1998) reported in NBQA–1995 (32.2%). Horns are a concern for the industry because they may cause bruising during transportation and handling, which would adversely affect dressing percentage and, if severe enough, product value.

Of the cattle with horns (data not reported in tabular form), 10.1% had horns < 2.54 cm in length, 75.5% were between 2.54 cm and 12.7 cm, and 14.4% had horns that were > 12.7 cm. We evaluated horn length for the first time so that not only presence but length could be determined and tracked in future audits.

Mud/Manure Evaluation. In data not reported in tabular form, we found that 18.0% of the cattle had no visible mud/manure, 55.8% had a small amount, 23.0% had a moderate amount, 3.6% had a large amount, and 0.2% had an extreme amount. Location of mud/manure on the hide was highly variable; 18.8% of the cattle had mud/manure coverage over their entire hide, 8.5% had mud/manure concurrently on their legs, belly, and side, 25.3% had mud/manure on both their legs and belly, 8.9% had mud/manure on their legs only, and 8.1% had mud/manure on their belly only.

Visible mud/manure along the legs and belly of cattle is a concern during hide removal; heavy coverage can increase the risk of carcass contamination and can decrease dressing percentage. Mud/manure also was present in the tail region of 33.3% of the cattle; presence of fecal material in this region is a concern because of increased risk of contamination during bunging, evisceration, and hide removal.

Carcass Bruises. Bruise data (not shown in tabular form) showed that 53.3% of the carcasses were not bruised, 30.9% had one bruise, 11.4% had two bruises, 3.5% had three bruises, and 0.9% had four or more

Table 2. Characteristics of branded hides

Brand size	% of Sample[a]	Brand size			
		Mean, cm^2	SD	Minimum, cm^2	Maximum, cm^2
Shoulder	3.6	210.1	228.5	19.4	2,580.6
Side	13.7	456.8	478.1	6.5	5,806.4
Butt	36.3	154.6	138.8	12.9	2,580.6

[a]49.3% hides had no brands and 4.4% of hides had multiple brands (≥ 2).

bruises. Bruising incidence has not changed since the last audit; Boleman et al. (1998) in the NBQA–1995 reported the following occurrences of bruises: none (51.6%), one (30.9%), two (12.8%), three (3.7%), and four or more bruises (1.0%). Location of bruises were chuck (28.2%), loin (25.9%), rib (19.4%), round (14.9%), and brisket, flank, and plate (11.6%). We found fewer bruises in the loin region compared to the 41.1% incidence rate reported in the NBQA–1995 (Boleman et al., 1998). In contrast, there were higher percentages of bruises reported in the round and brisket, flank, and plate (the evaluation of the flank and plate was not included in previous audits).

Bruises, however, appeared to be less severe than those found in NBQA–1995. For NQBA–2000, we found minor, major, and critical/extreme bruises, respectively, for the round (83.0%, 14.3%, 2.6%), loin (70.0%, 24.9%, 5.1%), rib (73.6%, 19.6%, 6.7%), chuck (76.6%, 19.7%, 3.9%), and brisket, plate, and flank (71.1%, 24.9%, 4.0%). For NBQA–1995, Boleman et al. (1998) found these minor, major and critical bruises, respectively, for the round (51.3%, 39.7%, 9.0%), loin (48.1%, 41.4%, 10.5%), rib (39.0%, 45.7%, 15.4%), chuck (43.6%, 45.5%, 11.0%), and brisket (50.0%, 50.0%, 0.0%).

Offal and Carcass Condemnations. In data not reported in tabular form, incidence rates for USDA-FSIS viscera condemnations were livers (30.3%), lungs (13.8%), and tripe (11.6%). Liver condemnations were for abscesses (44.8%), flukes (21.7%), and miscellaneous reasons such as contamination, cirrhosis, and carotenosis (33.6%). Lung condemnations were for pneumonia (27.0%) and miscellaneous reasons such as contamination and abscesses (73.0%). Additional USDA-FSIS condemnations were for heads (6.2%), tongues (7.0%), and carcasses (0.1%). Heads were condemned for problems with lymph nodes (17.0%) and for miscellaneous reasons (83.0%). Tongues were condemned for hair sores (34.8%), cactus tongue (17.6%), abscesses (14.7%), and miscellaneous reasons (34.5%). Of the heifers in the audit, 3.8% had fetuses.

Condemnation rates of liver, lungs, tripe, heads, and tongues were higher than rates reported in NBQA–1991 (Lorenzen et al., 1993) and NBQA–1995 (Boleman et al., 1998). This may be explained partially by the inclusion of contamination data in the miscellaneous category. In our previous audits, contamination was considered a packer-related issue and was not included as a cause of condemnation. We included contamination in this survey because this information better represents total condemnation of offal products. Even if contamination is not included, it appears that condemnation rates for offal were higher than in our past surveys.

Carcass Assessment. Mean USDA quality and yield grade traits are shown in Table 3. The mean USDA quality grade was Select[85], and mean yield grade was 3.0. Boleman et al. (1998) reported a mean quality grade of Select[79] and a mean yield grade of 2.8, and Lorenzen et al. (1993) reported a mean USDA quality grade of Select[87] and a mean USDA yield grade of 3.2. Frequency distribution of USDA yield grades by half

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

Trait	Mean	SD	Minimum	Maximum
USDA yield grade	3.0	0.9	–0.3	7.6
USDA quality grade[a]	685	60	180	890
Adjusted fat thickness, cm	1.2	0.5	–0.2	4.4
Hot carcass weight, kg	356.9	42.7	189.5	540.6
Longissimus muscle area, cm^2	84.5	10.8	50.3	149.7
Kidney, pelvic, and heart fat, %	2.4	0.8	0	9.0
Marbling score[b]	423	101	170	990
Lean maturity[c]	165	20	110	430
Skeletal maturity[c]	167	31	120	590
Overall maturity[c]	166	24	120	590

[a]100 = Canner[00], 400 = Commercial[00], 600 = Select[00], and 800 = Prime[00].
[b]100 = Practically devoid[00], 300 = Slight[00], 500 = Modest[00], 700 = Slightly Abundant[00], and 900 = Abundant[00].
[c]100 = A^{00} and 500 = E^{00}.

Table 4. Occurrence[a] of marbling scores within USDA quality grades[b]

Marbling score	Overall[c]	Prime	Choice	Select	Standard
	%				
Abundant	0.16	6.32	—	—	—
Moderately abundant	0.46	21.58	—	—	—
Slightly abundant	1.56	72.11	0.17	—	—
Moderate	4.78	—	9.49	—	—
Modest	13.07	—	25.98	0.20	0.19
Small	33.28	—	64.36	1.41	14.53
Slight+	25.34	—	—	57.93	10.90
Slight–	17.97	—	—	40.44	13.96
Traces	3.36	—	—	—	60.04
Practically devoid	0.02	—	—	—	0.38

[a]Rounding error prevents all categories from summing to 100.0.
[b]USDA Quality grade was affected by maturity and dark cutting.
[c]Overall category represents USDA quality grades of Prime, Choice, Select, Standard, Commercial, Utility, Cutter, and Canner.

grade increments is shown in Figure 1. Distribution of USDA yield grades were as follows: Yield Grade 1 (12.2%), Yield Grade 2 (37.4%), Yield Grade 3 (38.6%), Yield Grade 4 (10.4%), and Yield Grade 5 (1.3%). Distribution of USDA quality grades was Prime, (2.0%), Choice (49.1%), Select (42.3%), Standard (5.6%), and Commercial, Utility, Cutter, and Canner (0.9%).

Table 4 presents the distribution of marbling scores within USDA quality grades. Within Prime, 72.11% had a marbling score that corresponded to Low Prime. Of Choice carcasses, 35.47% had marbling scores that would qualify for Premium Choice branded beef programs (i.e., Modest and Moderate amounts of marbling). Some USDA (2001a) certified beef programs segment Small into an upper (≥ Small^{50}) and lower (< Small^{50}) grouping. Of the carcasses that graded Low Choice, 36.6% had marbling scores that were greater than or equal to Small^{50} (data not shown in tabular form). Boleman et al. (1998) reported lower percentages of carcasses that graded Prime and Choice than

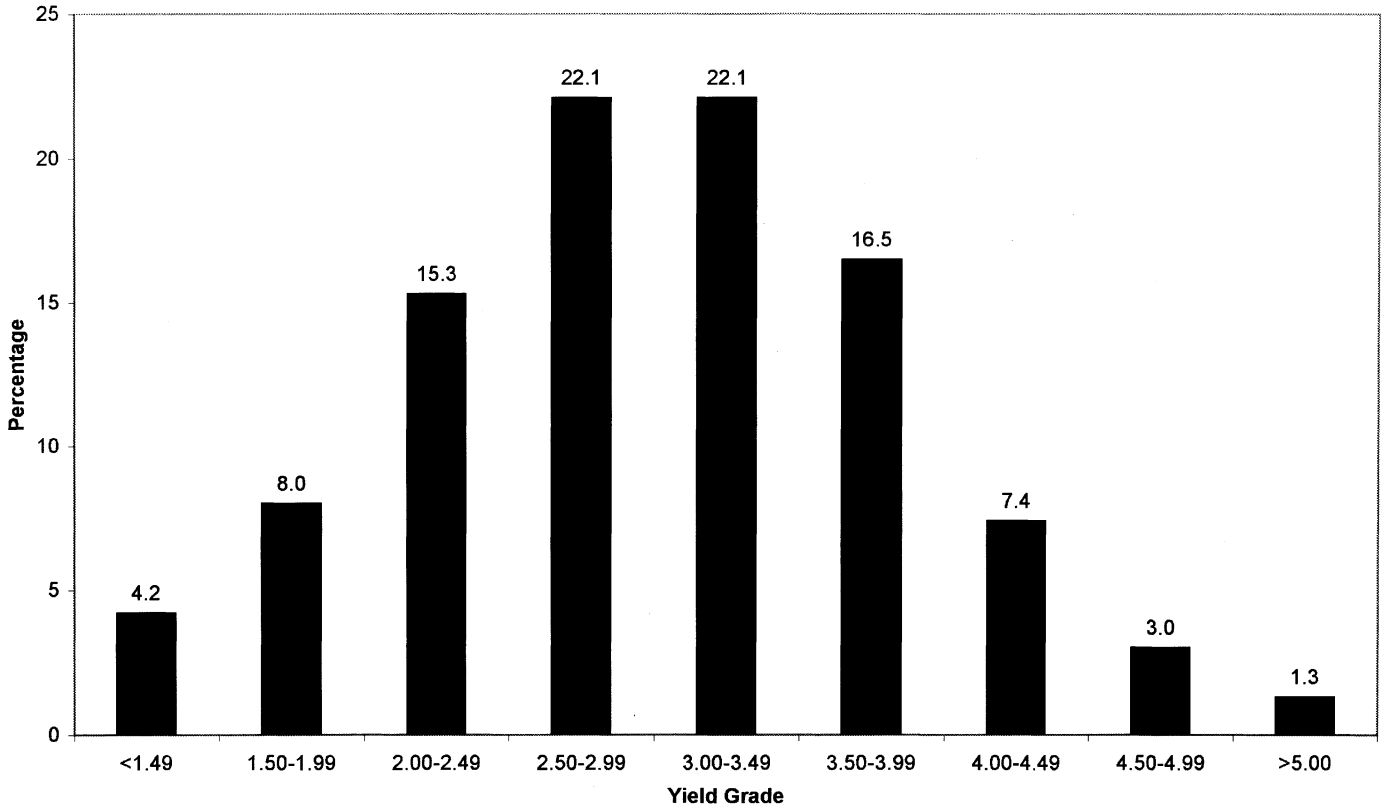

Figure 1. Frequency distribution of carcasses by one-half yield grade increments from the National Beef Quality Audit–2000.

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

Yield grade	Prime	Choice	Select	Standard	Commercial	Utility	Cutter	Canner
	%							
1	0.02	2.69	7.62	1.89	0.01	0.03	0.02	0.00
2	0.23	16.22	18.37	2.28	0.17	0.14	0.00	0.01
3	1.10	22.69	13.24	1.17	0.22	0.22	0.00	0.00
4	0.57	6.62	2.85	0.19	0.07	0.05	0.00	0.00
5	0.10	0.89	0.21	0.03	0.03	0.01	0.00	0.00

[a]Rounding error prevents all from summing to 100.0.
[b]USDA quality grade was affected by maturity and dark cutting.

were found in this survey. However, the increase in percentages of carcasses grading Prime or Choice since NBQA–1995 did not achieve the desired mixture of 6% Prime, 27% Premium Choice, and 32% Low Choice described by Roeber et al. (2001).

In data not reported in tabular form, frequencies of carcass maturities were A maturity (96.6%), B maturity (2.5%), and C maturity or older (0.9%). We found 2.3% dark cutter carcasses with these partial or full grade discounts: one-third grade (1.0%), one-half grade (0.6%), two-thirds grade (0.4%), and full grade (0.3%). Quality grade discounts due to B maturity and(or) dark cutters contributed to the 39.6% of the carcasses that graded Standard.

Quality and yield grade distribution of carcasses is reported in Table 5. We found 70.5% of the carcasses to be Choice and Select, Yield Grade 2 and 3; comparable percentages were 67.2% for NBQA–1991 (Lorenzen et al., 1993) and 75.0% for NBQA–1995 (Boleman et al., 1998). Non-conforming carcasses, such as Yield Grade 4 or 5, and Standard carcasses comprised 17.8% of the carcasses evaluated.

Table 6 shows least squares means for carcass traits within each USDA quality grade group. As USDA quality grade increased, numerical yield grade, carcass weight, and percentage kidney, pelvic, and heart fat (**KPH**) increased ($P < 0.05$). Longissimus muscle area decreased with increasing quality grade ($P < 0.05$). Because a greater range of marbling scores within B-maturity now qualify for U.S. Standard (USDA, 1997), it is not surprising to find more advanced maturity scores for Standard carcasses compared to the other USDA quality grades.

Carcass trait means within each USDA yield grade are displayed in Table 7. Average yield grade within each yield grade group was near the center of the

Table 6. Least squares means for carcass traits (SEM[a]) within quality grades

	USDA quality grade			
Trait	Prime	Choice	Select	Standard
USDA yield grade	3.7^{h}	3.2^{g}	2.8^{f}	2.4^{e}
	(0.06)	(0.01)	(0.01)	(0.04)
USDA quality grade[b]	821^{h}	726^{g}	651^{f}	584^{e}
	(1.8)	(0.4)	(0.4)	(1.1)
Adjusted fat thickness, cm	1.4^{g}	1.4^{g}	1.1^{f}	0.9^{e}
	(0.04)	(0.01)	(0.01)	(0.02)
Hot carcass weight, kg	370.1^{h}	359.2^{g}	354.6^{f}	347.9^{e}
	(3.08)	(0.63)	(0.68)	(1.86)
Longissimus muscle area, cm^2	78.0^{e}	82.7^{f}	86.3^{g}	88.6^{h}
	(0.77)	(0.13)	(0.13)	(0.45)
Kidney, pelvic, and heart fat, %	3.1^{h}	2.4^{g}	2.2^{f}	2.1^{e}
	(0.05)	(0.01)	(0.01)	(0.03)
Marbling score[c]	764^{h}	479^{g}	352^{g}	312^{e}
	(4.2)	(0.9)	(0.9)	(2.5)
Lean maturity[d]	161^{e}	161^{e}	164^{f}	185^{g}
	(1.3)	(0.3)	(0.3)	(0.9)
Skeletal maturity[d]	169^{g}	164^{f}	163^{e}	186^{h}
	(1.5)	(0.3)	(0.3)	(0.9)
Overall maturity[d]	166^{f}	163^{e}	164^{f}	186^{g}
	(1.1)	(0.2)	(0.3)	(0.7)

[a]SEM is the standard error of the least squares means.
[b]$100 = Canner^{00}$, $400 = Commercial^{00}$, $600 = Select^{00}$, and $800 = Prime^{00}$.
[c]$100 = Practically\ devoid^{00}$, $300 = Slight^{00}$, $500 = Modest^{00}$, $700 = Slightly\ Abundant^{00}$, and $900 = Abundant^{00}$.
[d]$100 = A^{00}$ and $500 = E^{00}$.
[e,f,g,h,i,j,k,l,m,n]Means within a row lacking a common superscript letter differ ($P < 0.05$).

Table 7. Least squares means for carcass traits (SEM[a]) within yield grades

	USDA yield grade				
Trait	1	2	3	4	5
USDA yield grade	1.6[e]	2.6[f]	3.5[g]	4.4[h]	5.4[i]
	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)
USDA quality grade[b]	649[e]	677[f]	698[g]	709[h]	712[h]
	(1.7)	(1.0)	(1.0)	(1.9)	(5.3)
Adjusted fat thickness, cm	0.6[e]	1.0[f]	1.5[g]	2.0[h]	2.7[i]
	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)
Hot carcass weight, kg	341.9[e]	350.2[f]	362.4[g]	374.6[h]	390.1[i]
	(1.22)	(0.70)	(0.69)	(1.33)	(3.78)
Longissimus muscle area, cm^2	97.6[i]	86.8[h]	80.7[g]	76.2[f]	72.7[e]
	(0.26)	(0.13)	(0.13)	(0.26)	(0.77)
Kidney, pelvic, and heart fat, %	2.0[e]	2.2[f]	2.5[g]	2.7[h]	2.8[i]
	(0.02)	(0.01)	(0.01)	(0.02)	(0.07)
Marbling score[c]	360[e]	404[f]	445[g]	471[h]	493[i]
	(2.8)	(1.6)	(1.6)	(3.1)	(8.7)
Lean maturity[d]	167[g]	166[f]	163[e]	162[e]	164[efg]
	(0.6)	(0.3)	(0.3)	(0.6)	(1.8)
Skeletal maturity[d]	167[e]	166[e]	167[e]	167[e]	176[f]
	(0.9)	(0.5)	(0.5)	(1.0)	(2.8)
Overall maturity[d]	167[f]	166[ef]	165[e]	165[e]	170[f]
	(0.7)	(0.4)	(0.4)	(0.8)	(2.2)

[a]SEM is the standard error of the least squares means.
[b]100 = Canner[00], 400 = Commercial[00], 600 = Select[00], and 800 = Prime[00].
[c]100 = Practically devoid[00], 300 = Slight[00], 500 = Modest[00], 700 = Slightly Abundant[00], and 900 = Abundant[00].
[d]100 = A[00] and 500 = E[00].
[e,f,g,h,i]Means within a row lacking a common superscript letter differ ($P < 0.05$).

grade, with mean Yield Grade 4 carcasses deviating the furthest from the center of the grade. As USDA yield grade decreased (numerically), quality grade, adjusted fat thickness, hot carcass weight, and percentage KPH decreased, whereas longissimus muscle area increased ($P < 0.05$).

Frequency distribution of carcasses by weight group is displayed in Figure 2. Traditionally, packers discount prices paid for carcasses outside the hot carcass weight range of 249 to 431 kg. We found that 4.6% of carcasses had hot carcass weights outside of the 249 to 431 kg range, with 85% (3.9% of total sample) of those carcasses weighing in excess of 431 kg. Lorenzen et al. (1993) and Boleman et al. (1998) reported that 2.7% and 1.7%, respectively, of carcasses weighed in excess of 431 kg.

Mean carcass traits within carcass weight groups are shown in Table 8. As carcass weight increased, numerical yield grade, adjusted fat thickness, longissimus muscle area, and percentage KPH increased ($P < 0.05$). Quality grade increased with increasing carcass weight ($P < 0.05$), but at carcass weights greater than 364 kg and up to 454 kg, little additional increase in quality grade was observed.

Table 9 displays means of carcass traits within fat thickness groups. In general, as fat thickness increased, numerical USDA yield grade and hot carcass weight increased and longissimus muscle area decreased ($P < 0.05$). Quality grade increased with increasing fat thickness up to 1.77 cm ($P < 0.05$) but did not increase thereafter with additional increased fat thickness.

In data not reported in tabular form, sex-class distribution of carcasses was steers (67.9%), heifers (31.4%), and bullocks (0.3%), which was nearly identical to those reported by Boleman (1995). Carcass traits for heifers and steers are presented in Table 10. Heifer carcasses had a slightly lower (numerically) average yield grade than steer carcasses even though heifer carcasses had slightly higher mean adjusted fat thickness values ($P < 0.05$). Carcass weights for steers were approximately 30 kg heavier than those for heifers ($P < 0.05$). Heifer carcasses had slightly higher marbling scores ($P < 0.05$), but the difference in quality grade between sex classes was of no practical significance. There was no difference in percentage KPH and the difference in mean longissimus muscle area between heifer and steer carcasses was small though statistically significant. Boleman et al. (1998) reported similar findings relative to steer vs heifer carcasses.

Carcass estimated breed types were predominantly native-type (90.1%), but 6.9% of carcasses were classified as dairy-type, and 3.0% were classified as *Bos indicus* (data not reported in tabular form). The percentage of dairy-type carcasses was similar to the percentage of Holstein cattle reported in the hide color assessment phase. We found less than half as many *Bos indicus* carcasses in this survey compared to 6.5% reported by Boleman (1995).

Average carcass traits among the estimated breed types are reported in Table 11. Dairy-type carcasses

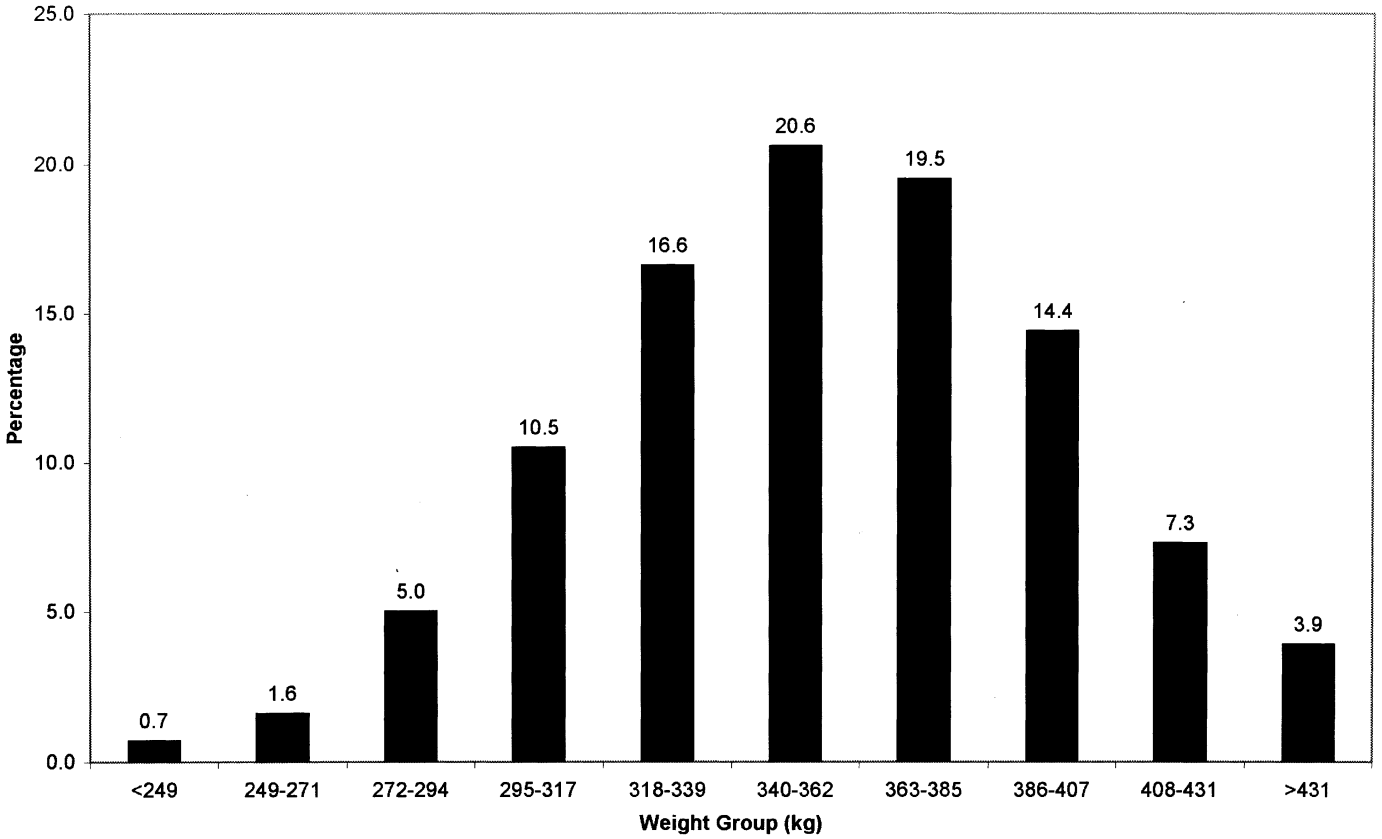

Figure 2. Frequency distribution of carcasses by weight groups from the National Beef Quality Audit–2000.

Table 8. Least squares means for carcass traits (SEM[a]) within carcass weight groups

	Carcass weight group, kg						
Trait	< 227.0	227.0–272.3	272.4–317.7	317.8–363.1	363.2–408.5	408.6–453.9	> 454.0
USDA yield grade	1.6^{e}	2.4^{f}	2.7^{g}	2.9^{h}	3.1^{i}	3.3^{j}	3.7^{k}
	(0.22)	(0.06)	(0.02)	(0.01)	(0.01)	(0.03)	(0.08)
USDA quality grade[b]	618^{e}	668^{f}	679^{g}	685^{h}	688^{h}	689^{h}	703^{i}
	(15.6)	(4.3)	(1.6)	(1.0)	(1.1)	(2.0)	(5.8)
Adjusted fat thickness, cm	0.4^{e}	1.0^{f}	1.1^{g}	1.2^{h}	1.3^{i}	1.4^{ij}	1.4^{j}
	(0.13)	(0.04)	(0.01)	(0.01)	(0.01)	(0.01)	(0.05)
Hot carcass weight, kg	213.7^{e}	257.9^{f}	300.1^{g}	341.3^{h}	383.1^{i}	423.5^{j}	471.7^{k}
	(3.28)	(0.90)	(0.34)	(0.21)	(0.23)	(0.41)	(1.21)
Longissimus muscle area, cm^2	68.7^{e}	72.6^{e}	78.7^{f}	82.8^{g}	87.4^{h}	91.7^{i}	94.9^{j}
	(2.52)	(0.71)	(0.26)	(0.19)	(0.19)	(0.32)	(0.90)
Kidney, pelvic, and heart fat, %	1.5^{e}	2.2^{f}	2.3^{g}	2.3^{h}	2.4^{i}	2.5^{j}	2.8^{k}
	(0.20)	(0.05)	(0.02)	(0.01)	(0.01)	(0.02)	(0.07)
Marbling score[c]	339^{e}	394^{f}	412^{g}	420^{h}	427^{i}	435^{j}	495^{k}
	(25.9)	(7.2)	(2.6)	(1.7)	(1.8)	(3.3)	(9.6)
Lean maturity[d]	174^{efgh}	168^{g}	165^{fg}	164^{ef}	164^{e}	165^{efg}	173^{h}
	(5.7)	(1.4)	(0.5)	(0.3)	(0.4)	(0.7)	(1.9)
Skeletal maturity[d]	169^{efg}	169^{ef}	167^{e}	166^{e}	166^{e}	170^{f}	183^{g}
	(7.9)	(2.2)	(0.8)	(0.5)	(0.5)	(1.0)	(2.9)
Overall maturity[d]	173^{efg}	169^{ef}	167^{ef}	165^{e}	165^{e}	168^{f}	180^{g}
	(6.1)	(1.7)	(0.6)	(0.4)	(0.4)	(0.8)	(2.3)

[a]SEM is the standard error of the least squares means.
[b]100 = Canner^{00}, 400 = Commercial^{00}, 600 = Select^{00}, and 800 = Prime^{00}.
[c]100 = Practically devoid^{00}, 300 = Slight^{00}, 500 = Modest^{00}, 700 = Slightly Abundant^{00}, and 900 = Abundant^{00}.
[d]100 = A^{00} and 500 = E^{00}.
[e,f,g,h,i,j,k]Means within a row lacking a common superscript letter differ ($P < 0.05$).

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

	Fat thickness, cm									
Trait	< 0.51	0.51–0.75	0.76–1.01	1.02–1.26	1.27–1.51	1.52–1.77	1.78–2.02	2.03–2.28	2.29–2.53	> 2.54
USDA yield grade	1.8^{e}	2.2^{f}	2.5^{g}	2.8^{h}	3.2^{i}	3.5^{j}	3.8^{k}	4.1^{l}	4.4^{m}	4.9^{n}
	(0.03)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.03)	(0.04)	(0.04)
USDA quality grade[b]	652^{e}	670^{f}	673^{f}	685^{g}	689^{g}	700^{h}	702^{h}	703^{h}	704^{h}	705^{h}
	(2.8)	(1.6)	(1.5)	(1.4)	(1.5)	(1.5)	(2.4)	(2.9)	(4.3)	(4.0)
Adjusted fat thickness, cm	0.3^{e}	0.6^{f}	0.9^{g}	1.1^{h}	1.4^{i}	1.6^{j}	1.9^{k}	2.1^{l}	2.4^{m}	2.8^{n}
	(0.004)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)	(0.007)	(0.006)
Hot carcass weight, kg	339.8^{e}	350.2^{f}	354.1^{g}	356.8^{gh}	358.3^{h}	362.1^{i}	362.9^{ij}	367.1^{j}	365.9^{ij}	364.8^{ij}
	(1.97)	(1.17)	(1.09)	(1.02)	(1.08)	(1.10)	(1.74)	(2.08)	(3.07)	(2.86)
Longissimus muscle area, cm^2	86.6^{k}	87.4^{k}	87.2^{k}	85.4^{j}	83.4^{i}	82.5^{h}	81.6^{gh}	81.0^{fg}	79.4^{ef}	77.6^{e}
	(0.49)	(0.29)	(0.27)	(0.25)	(0.26)	(0.27)	(0.43)	(0.51)	(0.77)	(0.71)
Kidney, pelvic, heart fat, %	2.4	2.4	2.3	2.4	2.3	2.3	2.3	2.4	2.3	2.5
	(0.04)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.04)	(0.06)	(0.05)
Marbling score[c]	374^{e}	398^{f}	401^{f}	419^{g}	426^{h}	449^{i}	456^{i}	454^{i}	455^{i}	463^{i}
	(4.6)	(2.7)	(2.5)	(2.4)	(2.5)	(2.6)	(4.0)	(4.8)	(7.1)	(6.7)
Lean maturity[d]	170^{h}	167^{g}	166^{g}	164^{f}	164^{ef}	163^{ef}	163^{ef}	161^{e}	161^{e}	162^{ef}
	(0.9)	(0.6)	(0.5)	(0.5)	(0.5)	(0.5)	(0.8)	(1.0)	(1.4)	(1.4)
Skeletal maturity[d]	168	166	165	167	167	168	169	167	168	170
	(1.4)	(0.8)	(0.8)	(0.7)	(0.8)	(0.8)	(1.3)	(1.5)	(2.2)	(2.1)
Overall maturity	169	167	166	166	166	166	166	165	165	167
	(1.1)	(0.7)	(0.6)	(0.6)	(0.6)	(0.6)	(1.0)	(1.2)	(1.7)	(1.6)

[a]SEM is the standard error of the least squares means.
[b]100 = Canner^{00}, 400 = Commercial^{00}, 600 = Select^{00}, and 800 = Prime^{00}.
[c]100 = Practically devoid^{00}, 300 = Slight^{00}, 500 = Modest^{00}, 700 = Slightly Abundant^{00}, and 900 = Abundant^{00}.
[d]100 = A^{00} and 500 = E^{00}.
[e,f,g,h,i,j,k,l,m,n]Means within a row lacking a common superscript letter differ ($P < 0.05$).

Table 10. Least squares means for carcass traits (SEM[a]) within sex class

Trait	Sex class	
	Heifer	Steer
USDA yield grade	2.9[e]	3.0[f]
	(0.02)	(0.01)
USDA quality grade[b]	688[f]	685[e]
	(1.1)	(0.7)
Adjusted fat thickness, cm	1.4[f]	1.2[e]
	(0.01)	(0.01)
Hot carcass weight, kg	336.3[e]	366.4[f]
	(0.74)	(0.50)
Longissimus muscle area, cm^2	84.1[e]	84.6[f]
	(0.19)	(0.13)
Kidney, pelvic, and heart fat, %	2.4	2.4
	(0.01)	(0.01)
Marbling score[c]	431[f]	418[e]
	(1.9)	(1.3)
Lean maturity[d]	166[f]	163[e]
	(0.4)	(0.2)
Skeletal maturity[d]	170[f]	164[e]
	(0.5)	(0.3)
Overall maturity[d]	169[f]	164[e]
	(0.4)	(0.3)

[a]SEM is the standard error of the least squares means.
[b]100 = Canner[00], 400 = Commercial[00], 600 = Select[00], and 800 = Prime[00].
[c]100 = Practically devoid[00], 300 = Slight[00], 500 = Modest[00], 700 = Slightly Abundant[00], and 900 = Abundant[00].
[d]100 = A[00] and 500 = E[00].
[e,f]Means within a row lacking a common superscript letter differ ($P < 0.05$).

Table 11. Least squares means for carcass traits (SEM[a]) within estimated breed types

Trait	Breed type		
	Native	*Bos indicus*	Dairy
USDA yield grade	3.0[e]	3.0[e]	3.4[f]
	(0.01)	(0.05)	(0.03)
USDA quality grade[b]	684[f]	662[e]	710[g]
	(0.7)	(3.6)	(2.4)
Adjusted fat thickness, cm	1.3[f]	1.3[f]	0.8[e]
	(0.01)	(0.03)	(0.02)
Hot carcass weight, kg	356.6[f]	349.0[e]	364.5[g]
	(0.46)	(2.54)	(1.67)
Longissimus muscle area, cm^2	85.2[g]	83.7[f]	75.7[e]
	(0.13)	(0.65)	(0.39)
Kidney, pelvic, and heart fat, %	2.3[e]	2.2[e]	3.6[f]
	(0.01)	(0.04)	(0.03)
Marbling score[c]	419[f]	381[e]	489[g]
	(1.1)	(5.9)	(3.9)
Lean maturity[d]	164	164	166
	(0.2)	(1.2)	(0.8)
Skeletal maturity[d]	167[e]	171[f]	168[ef]
	(0.3)	(1.8)	(1.2)
Overall maturity[d]	166	168	168
	(0.3)	(1.4)	(0.9)

[a]SEM is the standard error of the least squares means.
[b]100 = Canner[00], 400 = Commercial[00], 600 = Select[00], and 800 = Prime[00].
[c]100 = Practically devoid[00], 300 = Slight[00], 500 = Modest[00], 700 = Slightly Abundant[00], and 900 = Abundant[00].
[d]100 = A[00] and 500 = E[00].
[e,f,g]Means within a row lacking a common superscript letter differ ($P < 0.05$).

had a higher numerical yield grade than either native or *Bos indicus* carcasses due to heavier carcass weights, smaller longissimus muscle areas, and higher KPH percentages ($P < 0.05$). There were no differences in yield grade, adjusted fat thickness, or percentage KPH between native and *Bos indicus* type carcasses. Dairy-type carcasses had higher mean quality grades than either native or *Bos indicus* carcasses, and native carcasses had a higher average quality grade than *Bos indicus* carcasses ($P < 0.05$).

Implications

The NBQA–2000 continues the process of updating information on various factors that affect the value of live cattle and their carcasses and by-products. Compared to previous audits, number and location of bruises have remained consistent; however, bruise severity has decreased. The number and location of brands, especially side brands, have remained relatively constant. Quality as measured by marbling score and USDA quality grade appears to be back to the level observed in the early 1990s, but carcass weights continue to increase dramatically. This information adds to the existing knowledge base of beef quality and consistency factors and will be a useful reference for various educational and research endeavors as the beef industry addresses issues related to improving the value of beef.

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