Translational Animal Science, 2024, **8**, txae098
https://doi.org/10.1093/tas/txae098
Advance access publication 15 June 2024
Meat Science

National Beef Quality Audit—2022: in-plant assessments of quality and yield determining carcass characteristics of fed steers and heifers

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Abstract

The National Beef Quality Audit – 2022 serves as a benchmark of the current fed steer and heifer population of the U.S. beef industry and allows comparison to previous audits as a method of monitoring industry progress. In-plant cooler assessments and collections of beef carcass data took place from July 2021 to November 2022. During in-plant evaluations, 10% of 1-d production was surveyed for quality and yield indicating characteristics of fed beef carcasses (n = 9,746 beef carcasses). Distributions of sex classes among sampled carcasses were steer (65.0%) and heifer (35.0%), whereas distributions of breed type were native (87.7%), dairy (11.3%), and *Bos indicus* (0.9%). Mean values were observed for USDA Yield Grades (**YG**; 3.3), USDA Quality Grade (**QG**; Choice^{16}), marbling score (Small^{98}), ribeye area (91.0 cm^2), adjusted fat thickness (1.49 cm), hot carcass weight (401.9 kg), and KPH (2.5%). Mean overall maturity was A^{66}, with a mean lean maturity of A^{56} and mean skeletal maturity of A^{72}. There were 28.1% of carcasses identified for use in a USDA-certified beef G-Schedule Program. Defects, such as dark cutting and blood splash, were observed at 1.8% and 0.5%, respectively. Distributions of USDA YG were YG 1 (8.2%), YG 2 (30.7%), YG 3 (40.2%), YG 4 (16.6%), and YG 5 (4.3%). USDA QGs were observed at 7.5% Prime, 69.2% Choice, 16.4% Select, and 6.8% other. The results of this study provide an updated look at the current grading trends of beef carcasses in the United States to drive progress in the fed beef industry.

Lay Summary

This phase of the National Beef Quality Audit – 2022 gathered quality- and yield-indicating characteristics of fed beef carcasses (n = 9,746 beef carcasses) representing 10% of 1-d production from 35 beef processing facilities from July 2021 to November 22, 2022. Distributions of sex classes among sampled carcasses were steer (65.0%) and heifer (35.0%), whereas distributions of breed type were native (87.7%), dairy (11.3%), and *Bos indicus* (0.9%). Mean values were observed for USDA YG (3.3), USDA QG (Choice^{16}), marbling score (Small^{98}), ribeye area (91.0 cm^2), AFT (1.49 cm), HCW (401.9 kg), and KPH (2.5%). There were 28.1% of carcasses identified for use in a USDA-certified beef G-Schedule Program. Defects, such as dark cutting and blood splash, were observed at 1.8% and 0.5%, respectively. Distributions of USDA YG were YG 1 (8.2%), YG 2 (30.7%), YG 3 (40.2%), YG 4 (16.6%), and YG 5 (4.3%). USDA QGs were observed at 7.5% Prime, 69.2% Choice, 16.4% Select, and 6.8% other. Results of this study provide an updated look at the current grading trends of beef carcasses in the United States.

Key words: audit, beef carcass, beef grading, quality grading, survey, yield grading

Received April 17, 2024 Accepted June 14, 2024.

Introduction

The National Beef Quality Audit (**NBQA**) focuses on analyzing the trends, strengths, and weaknesses of the fed cattle industry within the United States. The audit recurs approximately every 5 yr and is used to monitor the changes within the industry. This research evaluates all aspects of beef processing facilities, from arrival of cattle at a facility to the grading of carcasses. Specific to beef carcass characteristics, there have been six previous NBQAs conducted: NBQA-1991 (Lorenzen et al., 1993), NBQA-1995 (Boleman et al., 1998), NBQA-2000 (McKenna et al., 2002), NBQA-2005 (Garcia et al., 2008), NBQA-2011 (Moore et al., 2012), and NBQA-2016 (Boykin et al., 2017).

Conducting the audit at regular intervals has created a historical outlook on the progress made in the beef industry and continues with NBQA-2022. As in past surveys, carcass data collection including USDA beef quality and yield grade (**YG**) along with their individual components offers those interested in this information a way to evaluate trends in the industry. In addition, beef processors and other individuals can use the findings and data collected in NBQA-2022 to identify further research needs and develop educational programs to drive progress in the beef industry.

Materials and Methods

Institutional Animal Care and Use Committee approval was not required because the study was mostly observational, and no live animals were involved.

General Overview

Before data collection, a coordination meeting was held to emphasize the clarity and consistency of data to be collected by collaborating institutions. In-plant cooler data collection of the NBQA-2022 occurred from July 2021 to November 2022. For the fed cattle portion of the audit, data were collected from 35 beef processing plants (Table 1) by 14 different collaborating universities. Of the 35 processors surveyed, 24 operated solely for fed cattle harvest, and the other 11 harvested a combination of fed cattle and market cows/bulls (data not included here). Participating universities conducted the plant audits throughout the project timeline to provide observations from different times of the year. Additionally, staggering of plant observations allowed some of the facilities to return to full operations following workforce and livestock supply issues created by the COVID-19 pandemic (Ciotti et al., 2020; Padhan and Prabheesh, 2021).

Carcass Assessments

During in-plant assessments, participating universities recorded information on 10% of all carcasses processed/graded during one full day of operation at each beef processing facility for in-plant cooler assessments, for a total of 9,746 carcasses. Data were captured on 10% of the carcasses within each lot to accurately represent the variation of cattle harvested at each facility. For facilities that operated multiple shifts, universities ensured each was represented within the audit.

Trained personnel measured, evaluated, and/or documented from each carcass hot carcass weight (**HCW**), ribeye area (**REA**; M. longissimus thoracis at the 12th to 13th rib interface measured by dot grid or estimated by video image analysis instrument), apparent breed type (native, dairy, or *Bos indicus*), sex classification, carcass quality defects (dark cutter, blood splash, calloused eye, yellow fat), any USDA certified (U.S. Department of Agriculture, 2016, 2023) or other marketing program, and whether the animal was 30 mo or older as determined by dentition (Savell and Smith, 2021) as indicated on the carcass following in-plant protocols. The U.S. Department of Agriculture (2017) standards were used for evaluating sex classification (steer, heifer, bullock, and cow). Apparent breed type was determined using the procedures defined by Lorenzen et al. (1993): *B. indicus* type cattle were those with dorsal thoracic hump (M. rhomboideus, overlying muscles, and subcutaneous fat) with a height greater than 10.2 cm, dairy-type cattle were identified as those with thin muscling in relation to skeletal size, and all other cattle were classified as native. Lean maturity, skeletal maturity, preliminary yield grade (**PYG**), percentage of kidney, pelvic, and heart (**KPH**) fat, and marbling score were evaluated by United States Department of Agriculture, Agricultural Marketing Service (**AMS**), Quality Assessment Division personnel (U.S. Department of Agriculture, 2017). The PYG was converted to adjusted fat thickness (**AFT**) by subtracting 2.0 to convert to centimeters (e.g., PYG of 3.0 – 2.0 = 1.0 cm). This conversion was based on the Short-Cut Method for Beef Carcass Yield Grading (Savell and Smith, 2021) where AFT at 0 is a PYG of 2.0, and with each additional increase in AFT of 0.10 inches, the PYG increases by 0.25. The PYG becomes a de facto measure of AFT in centimeters (0.10 inches = 0.25 cm) by subtracting the starting point of 2.0 for 0 AFT to convert USDA grader-assessed PYG to AFT.

For beef processors that removed KPH before grading, only those that determined KPH based on before and after carcass weights were included. USDA YG were calculated only for those carcasses that had all four factors available. All collaborating universities returned data collected to Texas A&M University for data entry and analysis.

Statistical Analysis

For statistical analyses, data were entered into or received in Microsoft Excel Spreadsheets. Excel and JMP Software (JMP Pro, Version 16. SAS Institute Inc. Cary, NC, 1989-2021) were used for analyses. Fit Y by X functions were used for analysis of variance, and a Student's *t* test was used to conduct least-squares means comparisons. Distributions, frequencies, means, standard deviations, minimums, and maximums were calculated in JMP using the distribution function. Finally, correlations were determined using the multivariate functions in JMP.

Results and Discussion

Carcass Assessment

Mean marbling score for this study was Small^{98} (Table 2). This value represents a 6% point increase from the previous audits and corresponds to a relatively constant trend of improvements in marbling scores since the 1995 audit (Table 3). The NBQA-1991 (Lorenzen et al., 1993) reported a mean marbling score of Small^{24}, followed by Small^{06} for NBQA-1995 (Boleman et al., 1998), Small^{23} for NBQA-2000 (McKenna et al., 2002), Small^{32} for NBQA-2005 (Garcia et al., 2008), Small^{40} for NBQA-2011 (Moore et al., 2012), and Small^{70} for NBQA-2016 (Boykin et al., 2017). A marbling score of

Table 1. National Beef Quality Audit – 2022: company name and location of surveyed plants

Company	Location
AgriBeef Foods	Toppenish, WA
American Foods Group	Green Bay, WI
Cargill Protein Group	Dodge City, KS
Cargill Protein Group	Fort Morgan, CO
Cargill Protein Group	Friona, TX
Cargill Protein Group	Schuyler, NE
Cargill Taylor Beef	Wyalusing, PA
Caviness Beef Packers	Hereford, TX
Central Valley Meat Company	Hanford, CA
Creekstone Farms	Arkansas City, KS
CS Beef Packers	Kuna, ID
Demkota Ranch Beef	Aberdeen, SD
FPL Foods LLC	Augusta, GA
Greater Omaha Packing Company	Omaha, NE
Harris Ranch Beef Company	Selma, CA
JBS Foods, Cactus	Cactus, TX
JBS Foods, Grand Island	Grand Island, NE
JBS Foods, Greeley	Greeley, CO
JBS Foods, Green Bay	Green Bay, WI
JBS Foods, Hyrum	Hyrum, UT
JBS Foods, Omaha	Omaha, NE
JBS Foods, Plainwell	Plainwell, MI
JBS Foods, Souderton	Souderton, PA
JBS Foods, Tolleson	Tolleson, AZ
National Beef Packing Company	Dodge City, KS
National Beef Packing Company	Liberal, KS
National Beef Packing Company	Tama, IA
Nebraska Beef	Omaha, NE
OWB Packers	Brawley, CA
STX Beef	Corpus Christi, TX
Tyson Fresh Meats	Amarillo, TX
Tyson Fresh Meats	Dakota City, NE
Tyson Fresh Meats	Finney County (Holcomb), KS
Tyson Fresh Meats	Joslin, IL
Tyson Fresh Meats	Lexington, NE
Tyson Fresh Meats	Pasco, WA

Small^{98} exceeds all values for audits before NBQA-2022 and is approaching Modest marbling scores. Furthermore, the linear trend since the 1995 audit indicates that beef industry marbling improvement advanced by approximately 0.03 of a marbling score (e.g., Small^{50} to Small^{53}) year over year. As expected with the increase in marbling score, the mean USDA Quality Grade (**QG**) increased to Choice^{16} from Select^{96} reported for NBQA-2016 (Boykin et al., 2017), which is the greatest differential in USDA QG between two subsequent NBQAs.

Mean marbling score differs from USDA QG because of the influence of skeletal and lean maturity and the dark-cutting carcass defects. Overall carcass maturity is determined from combinations of lean and skeletal maturity. Of those, mean lean maturity was A^{58}, and skeletal maturity was A^{72}, contributing to a mean overall carcass maturity was A^{66}. This value is the highest overall maturity score since NBQA-2000 when McKenna et al. (2002) documented an identical mean of A^{66}. "A" maturity carcasses accounted for 93.2% of audited carcasses, followed by 5.12%, B maturity, 1.62%, C maturity, and 0.05%, D maturity. These values represent a −1.2% point numerical reduction in "A" maturity carcasses and a +1.27% point increase in B maturity carcasses.

Through evaluation of dentition, 2.6% of carcasses were 30 mo of age or older. As shown in Table 4, carcasses ≥30 mo had greater ($P < 0.05$) marbling scores (Modest^{23} vs. Small^{97}), but lower ($P < 0.05$) USDA QG (Select^{68} vs. Choice^{15}) scores. Additionally, these carcasses exhibited greater ($P < 0.05$) skeletal (B^{16} vs. A^{71}) and overall (A^{98} vs. A^{66}) maturity scores ($P < 0.05$), but lean maturity scores did not differ ($P > 0.05$).

Overall USDA QG distribution of carcasses sampled were 7.5% Prime, 69.2% Choice, 16.4% Select, and 6.8% other. Other USDA QG represents carcasses graded as Standard, Commercial, Utility, or were dark cutter or had blood splash or calloused ribeye. As compared to NBQA-2016, the percentage of Prime (+3.7% point), Choice (+1.9% point), and other (+0.2% point) all increased, whereas the rate of Select carcasses decreased drastically (−6.8% point). Table 5 displays the occurrence of specific marbling scores within each of these grades. In previous audits (Moore et al., 2012; Boykin et al., 2017), the majority of Prime and Choice carcasses had the lowest marbling score category for both grades (Slightly Abundant and Small, respectively), and the majority of Select carcasses were part of the upper half (Slight^{50} to Slight^{99}) of the grade. However, compared to NBQA-2016 (Boykin et al., 2017), there have been increases in the percentage of Prime carcasses with marbling scores in the upper two-thirds of the grade, as well as an increase in the percentage of Choice carcasses with Moderate marbling. Carcasses classified as other saw a numerical increase in the percentage of carcasses with marbling scores of Slight or greater.

Carcasses with observed defects were categorized into the "other" USDA QG category. The defects were identified by a USDA AMS grader and recorded by a member of the research team. Data not reported in tabular form, 1.8% of surveyed carcasses exhibited dark-cutting characteristics, which is a slight numerical decrease from the 1.9% observed by Boykin et al. (2017) during NBQA-2016. Dark cutters were classified into four categories based on level of dark cutting and percentages of each of the four categories are as follows: 33% (35.4%), 50% (12.4%), 66% (34.3%), 100% (18.0%). Based on the data, dark-cutting carcasses exhibited lower USDA YG, AFT, HCW, and marbling score ($P < 0.05$) than non-dark-cutting carcasses. No differences ($P > 0.05$) were found in REA between dark-cutting and non-dark-cutting carcasses. Of the data pertaining to defects (not reported in tabular form), 0.5% of surveyed carcasses were identified as blood splash, 0.07% exhibited calloused ribeyes, and 0.38% exhibited yellow fat. Incidence of blood splash increased numerically (+0.3% point) from NBQA-2016 (Boykin et al., 2017).

Least squares means for carcass characteristics across USDA quality grades are shown in Table 6. As USDA QG increased from USDA Select to Prime, numerical USDA YG and HCW increased ($P < 0.05$). Select carcasses exhibited lower mean values for skeletal and overall maturity ($P < 0.05$) when compared to both Prime and Choice. Additionally, as the grade increased from Select to Prime, the mean REA decreased ($P < 0.05$). These outcomes support the conclusions

Table 2. National Beef Quality Audit – 2022: means, SD, and minimum and maximum values for USDA carcass grade traits

Trait	*n*	Mean	SD	Minimum	Maximum
USDA Quality Grade and components					
USDA Quality Grade[1]	9,657	716	70.29	240	897
Marbling Score[2]	8,688	498	119.26	160	1,000
Lean maturity[3]	9,581	157.6	25.35	100	580
Skeletal maturity[3]	9,707	172.1	36.16	100	590
Overall maturity[3]	9,575	166.3	27.05	100	490
USDA Yield Grade and components					
USDA Yield Grade	8,114	3.28	0.95	−0.7	7.2
Adjusted fat thickness, cm	9,692	1.49	0.61	0.0	4.6
HCW, kg	9,713	401.9	50.13	136.4	650.5
Ribeye area, cm²	9,721	91.0	11.38	41.9	148.4
KPH, %	8,182	2.5	0.79	0	7.43

[1]200 = Cutter^{00}, 300 = Utility^{00}, 400 = Commercial^{00}, 500 = Standard^{00}, 600 = Select^{00}, 700 = Choice^{00}, and 800 = Prime^{00} (U.S. Department of Agriculture, 2017).
[2]100 = Practically Devoid^{00}, 200 = Traces^{00}, 300 = Slight^{00}, 400 = Small^{00}, 500 = Modest^{00}, 600 = Moderate^{00}, 700 = Slightly Abundant^{00}, 800 = Moderately Abundant^{00}, and 900 = Abundant^{00} (U.S. Department of Agriculture, 2017).
[3]100 = A^{00}, 200 = B^{00}, 300 = C^{00}, 400 = D^{00}, and 500 = E^{00} (U.S. Department of Agriculture, 2017).

Table 3. National Beef Quality Audit – 2022: means for USDA carcass grade traits for NBQA-1991, NBQA-1995, NBQA-2000, NBQA-2005, NBQA-2011, NBQA-2016, and NBQA-2022[1]

Trait	NBQA-1991 (*n* = 7,375)	NBQA-1995 (*n* = 11,799)	NBQA-2000 (*n* = 9,396)	NBQA-2005 (*n* = 9,475)	NBQA-2011 (*n* = 9,802)	NBQA-2016 (*n* = 9,106)	NBQA-2022 (*n* = 9,746)
USDA Quality Grade and components							
USDA Quality Grade[2]	686	679	685	690	693	696	716
Marbling Score[3]	424	406	423	432	440	470	498
Lean maturity[4]	163	154	165	157	154	155	158
Skeletal maturity[4]	175	163	167	168	162	169	172
Overall maturity[4]	169	160	166	164	159	164	166
USDA Yield Grade and components							
USDA Yield Grade	3.2	2.8	3.0	2.9	2.9	3.1	3.3
Adjusted fat thickness, cm	1.5	1.2	1.2	1.3	1.3	1.42	1.49
HCW, kg	345.0	339.2	356.9	359.9	374.0	390.3	401.9
Ribeye area, cm²	83.4	82.6	84.5	86.4	88.8	89.5	91.0
KPH, %	2.2	2.1	2.4	2.3	2.3	1.9	2.5

[1]NBQA-1991 (Lorenzen et al., 1993); NBQA-1995 (Boleman et al., 1998); NBQA-2000 (McKenna et al., 2002); NBQA-2005 (Garcia et al., 2008); NBQA-2011 (Moore et al., 2012); NBQA-2016 (Boykin et al., 2017); and NBQA-2022, present study.
[2]600 = Select^{00}, 700 = Choice^{00}, 800 = Prime^{00} (U.S. Department of Agriculture, 2017).
[3]300 = Slight^{00}, 400 = Small^{00}, 500 = Modest^{00}, 600 = Moderate^{00} (U.S. Department of Agriculture, 2017).
[4]100 = A^{00} and 200 = B^{00} (U.S. Department of Agriculture, 2017).

by Boykin et al. (2017) illustrating the antagonistic relationship between quality and muscling. The correlation coefficient between marbling scores and REA was a weak negative correlation ($r = -0.18$; $P < 0.001$), supporting the claim of a negative correlation between the factors but failing to prove any strength to said correlation.

Mean USDA YG was 3.3 (Table 3), and the increase follows the steady trend in USDA YG compared to more recent NBQAs. For example, USDA YG for NBQA-2011 (Moore et al., 2012) and NBQA-2016 (Boykin et al., 2017) were 2.9 and 3.1, respectively. Frequency distribution of USDA YG was YG 1 (8.2%), YG 2 (30.7%), YG 3 (40.2%), YG 4 (16.6%), and YG 5 (4.3%). This distribution is a noteworthy shift toward decreased cutability as compared to the 2016 audit reported by Boykin et al. (2017), which were YG 1 (9.6%), YG 2 (36.7%), YG 3 (39.2%), YG 4 (12.0%), and YG 5 (2.5%). Increases in YG 4 and 5 carcasses were noted in NBQA-2022 and NBQA-2016. However, the magnitude of increase was much greater in the current study. Because of this, the percentages of YG 1 and 2 carcasses are also decreasing, with very little change in percentage of YG 3 carcasses. For a further breakdown of USDA YG, Fig. 1 segregates carcasses by one-half USDA YG increments.

Demonstrated in Table 3, all factors associated with the calculation of USDA YG increased, correlating to the increase in overall USDA YG. Current means of YG factors are AFT of 1.49 cm, HCW of 401.9 kg, and REA of 91.0 cm². These values are all increases from NBQA-2016, as Boykin et al. (2017) reported a mean AFT of 1.42 cm, HCW of 390.3 kg, and REA of 90.6 cm². Table 7 displays the least squares means for carcass characteristics by USDA YG. As numerical USDA YG increased from 1 to 5, mean AFT, HCW, and marbling score increased ($P < 0.05$) by 0.48 cm, 19.1 kg, and about 0.40 of a marbling score, respectively, per unit change in YG, whereas REA also decreased from USDA YG 1 to 5 ($P < 0.05$). Inversely, USDA QG increased from USDA YG 1 to 4, with no significant difference in QG between 4 and 5 ($P > 0.05$). The lack of significance between quality grading among yield grade 4/5 carcasses could represent data from older cattle fed past their optimal endpoint, depositing subcutaneous fat at a rate greater than deposition of intramuscular fat. Table 8 summarizes least squares means for carcass traits between fat thickness categories.

Table 4. National Beef Quality Audit – 2022: least squares means for carcass traits (SEM) of carcasses by dental age classification

Trait	<30 mo	≥30 mo
	(n = 9,502)	(n = 244)
USDA Quality Grade and components		
USDA Quality Grade[1]	714.7[a]	667.9[b]
	(0.82)	(5.11)
Marbling Score[2]	496.9[b]	523.1[a]
	(1.23)	(7.65)
Lean maturity[3]	157.6[a]	159.5[a]
	(0.26)	(1.64)
Skeletal maturity[3]	170.6[b]	215.7[a]
	(0.36)	(2.28)
Overall maturity[3]	165.5[b]	197.7[a]
	(0.28)	(1.72)
USDA Yield Grade and components		
USDA Yield Grade	3.3[a]	3.2[a]
	(0.01)	(0.07)
Adjusted fat thickness, cm	1.49[a]	1.32[b]
	(0.01)	(0.04)
HCW, kg	401.9[a]	404.5[a]
	(0.52)	(3.23)
Ribeye area, cm²	91.0[a]	89.6[a]
	(0.12)	(0.73)
KPH, %	2.5[b]	2.7[a]
	(0.01)	(0.08)

[a,b]Means within a row with different superscripts differ ($P < 0.05$).
[1]600 = Select[00], 700 = Choice[00], 800 = Prime[00] (U.S. Department of Agriculture, 2017).
[2]300 = Slight[00], 400 = Small[00], 500 = Modest[00], 600 = Moderate[00](U.S. Department of Agriculture, 2017).
[3]100 = A[00] and 200 = B[00] (U.S. Department of Agriculture, 2017).

Of characteristics used in calculating USDA YG, HCW has been a prevailing concern year to year as weights continue to rise. From data in previous NBQAs, growth of HCW values remains relatively steady, demonstrated by a HCW of 354.0 kg for NBQA-1991 (Lorenzen et al., 1993), 339.2 kg for NBQA-1995 (Boleman et al., 1998), 356.9 kg for NBQA-2000 (McKenna et al., 2002), 359.9 kg for NBQA-2005 (Garcia et al., 2008), 374.0 kg for NBQA-2011 (Moore et al., 2012), 390.3 kg for NBQA-2016 (Boykin et al., 2017), and 401.9 kg for the present study in NBQA-2022. Before the first NBQA, Lambert (1991) outlined the upper threshold for carcass size as 408.2 kg. Thirty years later, this study resulted in 43.7% of surveyed carcasses surpassing that threshold (Figure 2). Due to the sustained 2.3 kg annual increase in HCW, the range of weights that receive discounts has shifted and reports by U.S. Department of Agriculture (2024) show carcass discounts beginning at the value Lambert (1991) identified as too high (approximately 408 kg). Boykin et al. (2017) documented the increase in the upper carcass weight threshold reported by USDA Market News to 477.2 kg, which was the same upper carcass weight threshold observed during this audit. The current audit resulted in 6.7% of sampled carcasses exceeding that threshold, an increase from the 5.0% observed in NBQA-2016 (Boykin et al., 2017). Table 9 displays the least squares means for carcass characteristics by HCW intervals. For every 100 kg increase in HCW, USDA YG increased ($P < 0.05$) by 0.78 units, AFT increased by 0.38 cm, REA increased by 8.6 cm², and marbling scores increased by 0.29 of a marbling score.

Table 5. National Beef Quality Audit – 2022: Occurrence (%)[1] of marbling scores within USDA quality grades[2]

Marbling score[3]	Overall[4]	Prime	Choice	Select	Other[5]
Abundant	0.37	4.64			0.32
Moderately Abundant	1.52	19.37			0.79
Slightly Abundant	6.12	75.99	0.09		4.59
Moderate	11.97		16.56		7.28
Modest	22.74		31.03		18.35
Small	39.29		52.31		45.57
Slight+	12.31			69.99	11.85
Slight−	5.28			30.01	5.08
Traces	0.38				5.85
Practically Devoid	0.02				0.32

[1]Rounding error prevents all categories from adding to 100.00.
[2]U.S. Department of Agriculture (2017) Quality Grade was affected by maturity and dark cutting.
[3]U.S. Department of Agriculture (2017).
[4]Category represents U.S. Department of Agriculture (2017) Quality Grades of Prime, Choice, Select, Standard, Commercial, Utility, and Cutter.
[5]Includes U.S. Department of Agriculture (2017) Quality Grades of Standard, Commercial, and Utility, as well as dark cutter, blood splash, hard bone, and calloused ribeye.

Table 6. National Beef Quality Audit – 2022: in-plant least squares means (SEM) for carcass traits within USDA Quality Grades

Trait	USDA Quality Grade			
	Prime	Choice	Select	Other[1]
	(n = 733)	(n = 6,719)	(n = 1,596)	(n = 663)
USDA Quality Grade and components				
USDA Quality Grade[2]	821.0[a]	734.0[b]	657.1[c]	510.2[d]
	(1.67)	(0.55)	(1.13)	(1.81)
Marbling Score[3]	765[a]	505[b]	357[d]	469[c]
	(2.74)	(0.90)	(1.85)	(2.96)
Lean maturity[4]	158[b]	156[c]	157[bc]	184[a]
	(0.91)	(0.30)	(0.61)	(1.07)
Skeletal maturity[4]	167[b]	168[b]	163[c]	238[a]
	(1.16)	(0.38)	(0.79)	(1.23)
Overall maturity[4]	163[b]	163[b]	160[c]	233[a]
	(0.81)	(0.27)	(0.55)	(0.96)
USDA Yield Grade and components				
USDA Yield Grade	3.9[a]	3.4[b]	2.7[d]	3.0[c]
	(0.04)	(0.01)	(0.03)	(0.04)
Adjusted fat thickness, cm	1.8[a]	1.5[b]	1.2[d]	1.3[c]
	(0.02)	(0.01)	(0.01)	(0.02)
HCW, kg	413.5[a]	404.2[b]	390.6[c]	394.8[c]
	(1.84)	(0.61)	(1.25)	(1.94)
Ribeye area, cm^2	87.2[d]	90.7[c]	93.7[a]	92.2[b]
	(0.42)	(0.14)	(0.28)	(0.44)
KPH, %	2.5[a]	2.5[a]	2.3[c]	2.4[b]
	(0.04)	(0.01)	(0.02)	(0.04)

[a,b,c,d]Means within a row lacking a common superscript letter differ ($P < 0.05$).
[1]Other includes Standard, Commercial, Utility, dark cutter, blood splash, hard bone, and calloused ribeye.
[2]500 = Standard^{00}, 600 = Select^{00}, 700 = Choice^{00}, 800 = Prime^{00} (U.S. Department of Agriculture, 2017).
[3]300 = Slight^{00}, 400 = Small^{00}, 500 = Modest^{00}, 600 = Moderate^{00}, 700 = Slightly Abundant^{00}, and 800 = Moderately Abundant^{00} (U.S. Department of Agriculture, 2017).
[4]100 = A^{00} and 200 = B^{00} (U.S. Department of Agriculture, 2017).

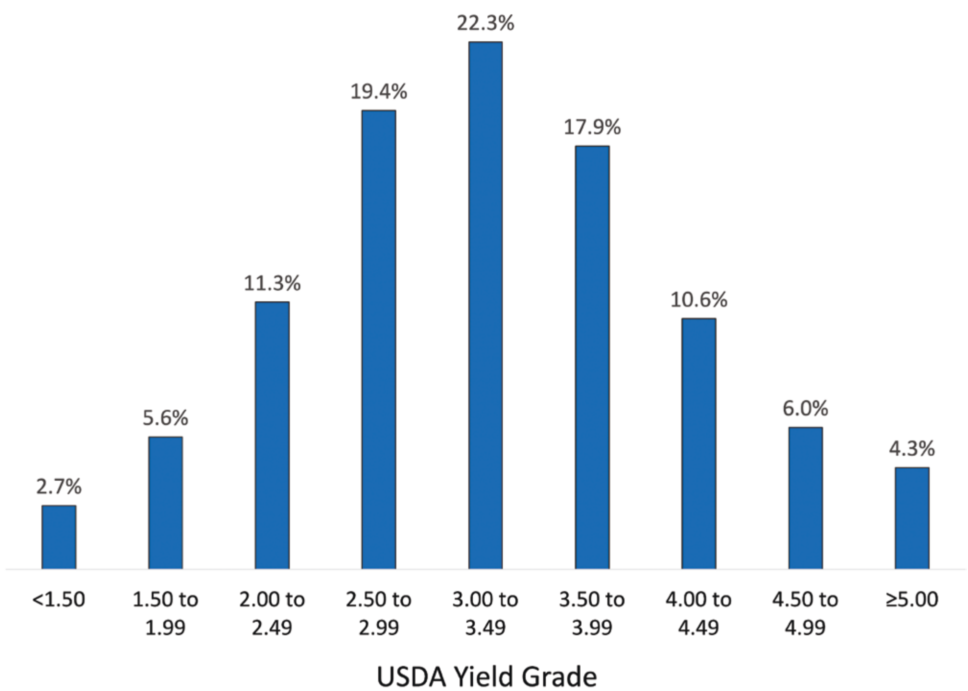

Figure 1. National Beef Quality Audit – 2022: frequency of carcasses by one-half yield grade increments

Table 7. National Beef Quality Audit – 2022: least squares means (SEM) for carcass traits within USDA Yield Grades

Trait	USDA Yield Grade				
	1	2	3	4	5
	(n = 754)	(n = 2,879)	(n = 3,910)	(n = 1,653)	(n = 550)
USDA Quality Grade and components					
USDA Quality Grade[1]	670.2[d]	701.0[c]	723.2[b]	735.9[a]	738.2[a]
	(2.49)	(1.27)	(1.09)	(1.67)	(2.92)
Marbling Score[2]	407.5[e]	464.8[d]	508.4[c]	546.8[b]	566.2[a]
	(4.10)	(2.10)	(1.79)	(2.76)	(4.82)
Lean maturity[3]	159.5[a]	159.1[a]	156.7[b]	156.2[b]	158.1[ab]
	(0.93)	(0.48)	(0.41)	(0.62)	(1.09)
Skeletal maturity[3]	171.6[b]	172.2[b]	171.0[b]	172.8[b]	177.7[a]
	(1.32)	(0.67)	(0.58)	(0.89)	(1.55)
Overall maturity[3]	166.6[bc]	167.0[b]	165.2[c]	166.1[bc]	170.1[a]
	(1.00)	(0.51)	(0.44)	(0.67)	(1.16)
USDA Yield Grade and components					
USDA Yield Grade	1.6[e]	2.6[d]	3.5[c]	4.4[b]	5.5[a]
	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)
Adjusted fat thickness, cm	0.7[e]	1.1[d]	1.5[c]	2.1[b]	2.6[a]
	(0.01)	(0.01)	(0.01)	(0.01)	(0.04)
HCW, kg	367.4[e]	384.6[d]	405.3[c]	427.0[b]	443.7[a]
	(1.68)	(0.86)	(0.74)	(1.13)	(2.03)
Ribeye area, cm^2	103.3[a]	94.9[b]	88.2[c]	85.2[d]	84.0[e]
	(0.37)	(0.19)	(0.16)	(0.25)	(0.44)
KPH, %	2.0[d]	2.3[c]	2.5[b]	2.7[a]	2.8[a]
	(0.02)	(0.01)	(0.01)	(0.03)	(0.05)

[a,b,c,d,e]Means within a row lacking a common superscript letter differ ($P < 0.05$).
[1]600 = Select[00], 700 = Choice[00], 800 = Prime[00] (U.S. Department of Agriculture, 2017).
[2]400 = Small[00], 500 = Modest[00], 600 = Moderate[00] (U.S. Department of Agriculture, 2017).
[3]100 = A[00] and 200 = B[00] (U.S. Department of Agriculture, 2017).

In this audit, REA increased (+ 1.5 cm^2) from the data presented by Boykin et al. (2017). The steady increase in both HCW and REA since NBQA-1995 has created concerns of the connection between the two factors. Primary concerns stem from possible issues associated with topics such as chilling heavier carcasses and excess portion sizes for the food service sector. Whereas increase in REA size is not typically a negative aspect of consumer preference (Sweeter et al., 2005; Maples et al., 2018), as REA increases, steaks must be cut thinner to maintain consistent weight targets. As a result, these thinner-cut steaks do negatively influence a consumer's purchasing trends (Maples et al., 2018), as do steaks that have been cut in half to meet requirements (Sweeter et al., 2005). Thus, the increasing size of carcasses and need to manipulate steak sizes has likely begun to create a less desirable steak for the average consumer (Maples et al., 2018). Data from the current audit indicate a positive correlation coefficient ($r = 0.40$; $P < 0.0001$) between REA and HCW. Therefore, concerns of increasing ribeye size along with HCW are substantiated, but the lower correlation values suggest some variability.

Table 10 outlines the percentage distribution of carcasses by USDA YG and USDA QG. The highest percentage of carcasses were Choice, YG 3 (29.9%), and 61.6% of surveyed carcasses were either Choice or Select and USDA YG 2 or 3. Boykin et al. (2017) documented 70.7% of carcasses were of the same grade combination, preceded by 72.0% in NBQA-2011 (Moore et al., 2012). This significant shift in carcass grading can be attributed to the overall increase in Prime carcasses as well as those grading USDA YG 4 and 5. During NBQA-2005, Garcia et al. (2008) took note of nonconforming carcasses, which were those grading Standard or below and greater than USDA YG 3. NBQA-2005 (Garcia et al., 2008) documented 18.3% nonconforming, followed by 15.6% in NBQA-2011 (Moore et al., 2012), 18.2% in NBQA-2016 (Boykin et al., 2017), and 27.0% in the current study. Relationship between AFT and marbling scores was noted by Boykin et al. (2017) during NBQA-2016 ($r = 0.24$). In the current study, the correlation coefficient between marbling and AFT increased numerically and is $r = 0.28$ ($P < 0.0001$) but remains relatively low failing to demonstrate a strong relationship between the two factors.

Steers accounted for 65.0% of all carcasses sampled, followed by heifers at 35.0%. Except for the few bullock carcasses that appeared in the data, the distribution of sex class is comparable to the percentages seen by Boykin et al. (2017) during NBQA-2016, with slight decrease in steer numbers. Least squares means for carcass traits among sex classes are summarized in Table 11. Steer carcasses were trimmer but heavier resulting in higher mean USDA YG, concomitant with lower marbling scores, but younger lean, skeletal, and overall maturity that resulted in equivalent quality grades.

Estimated breed types and frequencies were Native, 87.7%; dairy, 11.3%; and *B. indicus,* 0.9%. Frequency of

Table 8. National Beef Quality Audit – 2022: least squares means (SEM) for carcass traits within adjusted fat thickness groups

Trait	Adjusted fat thickness, cm											
	<0.51	0.51 to 0.75	0.76 to 1.01	1.02 to 1.26	1.27 to 1.51	1.52 to 1.77	1.78 to 2.02	2.03 to 2.28	2.29 to 2.53	2.54 to 2.78	2.79 to 3.04	>3.05
	(*n* = 474)	(*n* = 539)	(*n* = 1,498)	(*n* = 982)	(*n* = 1,460)	(*n* = 1,996)	(*n* = 872)	(*n* = 919)	(*n* = 395)	(*n* = 303)	(*n* = 126)	(*n* = 129)
USDA Quality Grade and components												
USDA Quality Grade[1]	681.7^{g}	694.2^{f}	699.0^{f}	710.0^{e}	714.5^{e}	722.1^{d}	726.7^{cd}	730.6^{bc}	741.0^{a}	738.5^{ab}	729.4^{abcd}	745.9^{a}
	(3.19)	(2.97)	(1.78)	(2.19)	(1.80)	(1.54)	(2.33)	(2.27)	(3.46)	(3.96)	(6.11)	(6.06)
Marbling Score[2]	435.6^{g}	447.1^{g}	461.2^{f}	479.3^{e}	488.5^{e}	509.9^{d}	522.2^{c}	539.3^{b}	545.8^{b}	552.1^{ab}	574.3^{a}	574.6^{a}
	(5.28)	(5.92)	(2.97)	(3.65)	(2.99)	(2.56)	(3.88)	(3.77)	(5.75)	(6.56)	(10.17)	(10.09)
Lean maturity[3]	156.8^{bc}	156.3^{bc}	157.7^{b}	160.7^{a}	158.3^{b}	156.7^{bc}	156.3^{bc}	158.2^{b}	154.3^{c}	158.3^{ab}	159.5^{ab}	158.7^{abc}
	(1.91)	(1.11)	(0.66)	(0.81)	(0.66)	(0.57)	(0.86)	(0.84)	(1.28)	(1.46)	(2.26)	(2.25)
Skeletal maturity[3]	169.2^{cd}	166.1^{d}	170.9^{c}	170.3^{c}	172.7^{bc}	172.7^{bc}	172.2^{bc}	175.0^{b}	172.5^{bc}	175.8^{ab}	182.1^{a}	171.1^{bcd}
	(1.66)	(1.55)	(0.93)	(1.15)	(0.94)	(0.81)	(1.22)	(1.19)	(1.81)	(2.07)	(3.20)	(3.16)
Overall maturity[3]	164.5^{cd}	161.9^{d}	165.4^{c}	166.4^{bc}	167.0^{bc}	166.3^{bc}	166.2^{bc}	168.4^{b}	164.6^{cd}	168.1^{bc}	174.3^{a}	166.0^{bcd}
	(1.27)	(1.18)	(0.71)	(0.87)	(0.71)	(0.61)	(0.92)	(0.89)	(1.36)	(1.56)	(2.40)	(2.39)
USDA Yield Grade and components												
USDA Yield Grade	2.1^{l}	2.4^{k}	2.6^{j}	2.9^{i}	3.1^{h}	3.4^{g}	3.8^{f}	4.1^{e}	4.5^{d}	4.8^{c}	5.2^{b}	5.8^{a}
	(0.04)	(0.04)	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.02)	(0.03)	(0.04)	(0.06)	(0.06)
Adj. fat thickness, cm	0.4^{l}	0.7^{k}	0.9^{j}	1.2^{i}	1.4^{h}	1.6^{g}	1.9^{f}	2.1^{e}	2.4^{d}	2.6^{c}	2.9^{b}	3.4^{a}
	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.01)	(0.03)
HCW, kg	365.8^{j}	373.9^{i}	387.0^{h}	394.5^{g}	399.7^{f}	406.9^{e}	415.1^{d}	418.0^{d}	423.9^{c}	431.4^{b}	441.2^{ab}	448.7^{a}
	(2.17)	(2.03)	(1.22)	(1.51)	(1.24)	(1.06)	(1.60)	(1.56)	(2.38)	(2.72)	(4.20)	(4.17)
Ribeye area, cm^2	87.7^{fg}	89.6^{de}	91.8^{bc}	92.5^{ab}	92.8^{a}	91.4^{c}	90.4^{d}	90.2^{d}	88.8^{ef}	88.3^{efg}	88.4^{defg}	86.4^{g}
	(0.52)	(0.49)	(0.29)	(0.36)	(0.30)	(0.25)	(0.38)	(0.37)	(0.57)	(0.65)	(1.01)	(0.99)
KPH, %	2.6^{b}	2.7^{a}	2.5^{bc}	2.4^{def}	2.4^{ef}	2.4^{ef}	2.5^{cd}	2.4^{def}	2.4^{def}	2.3^{g}	2.5^{bcde}	2.6^{bcd}
	(0.06)	(0.06)	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.04)	(0.05)	(0.07)	(0.06)

[a,b,c,d,e,f,g,h,i,j,k,l]Means within a row lacking a common superscript letter differ ($P < 0.05$).
[1]600 = Select^{00}, 700 = Choice^{00}, 800 = Prime^{00} (U.S. Department of Agriculture, 2017).
[2]300 = Slight^{00}, 400 = Small^{00}, 500 = Modest^{00}, and 600 = Moderate^{00} (U.S. Department of Agriculture, 2017).
[3]100 = A^{00} and 200 = B^{00} (U.S. Department of Agriculture, 2017).

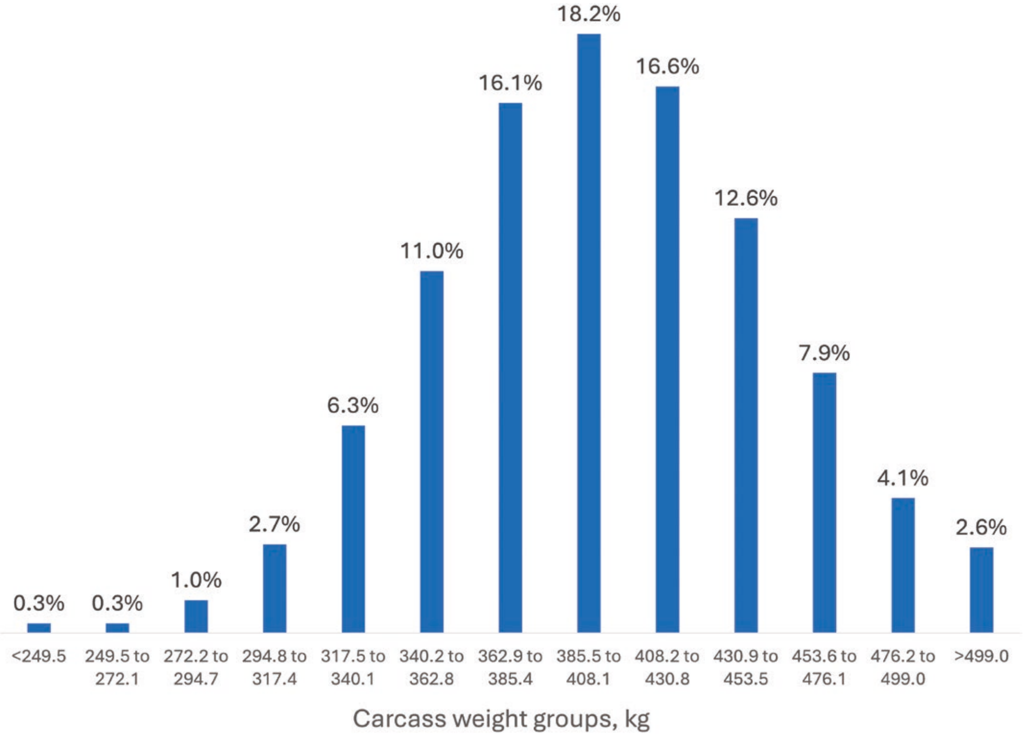

Figure 2. National Beef Quality Audit – 2022: frequency distribution of carcasses by HCW (kg) category

Table 9. National Beef Quality Audit – 2022: least squares means (SEM) for carcass traits within carcass weight groups

Trait	Carcass weight groups, kg						
	<272.2	272.2 to 317.4	317.5 to 362.8	362.9 to 408.1	408.2 to 453.5	453.6 to 498.9	>499
	(*n* = 51)	(*n* = 355)	(*n* = 1,669	(*n* = 3,308)	(*n* = 2,867)	(*n* = 1,194)	(*n* = 271)
USDA Quality Grade and components							
USDA Quality Grade[1]	690.2[cd]	685.2[d]	708.5[c]	716.0[b]	719.5[ab]	722.7[a]	724.7[ab]
	(9.98)	(3.74)	(1.72)	(1.22)	(1.31)	(2.03)	(4.25)
Marbling Score[2]	465.0[def]	447.2[f]	483.0[e]	494.4[d]	504.8[c]	515.5[b]	538.1[a]
	(16.89)	(6.30)	(2.90)	(2.06)	(2.21)	(3.43)	(7.19)
Lean maturity[3]	160.6[abc]	157.6[bc]	158.6[b]	157.7[bc]	156.8[c]	156.9[bc]	162.0[a]
	(3.62)	(1.37)	(0.63)	(0.45)	(0.48)	(0.74)	(1.54)
Skeletal maturity[3]	170.4[bcd]	171.0[cd]	169.9[d]	170.4[d]	172.8[c]	176.2[b]	181.9[a]
	(5.10)	(1.92)	(0.89)	(0.63)	(0.67)	(1.05)	(2.20)
Overall maturity[3]	166.1[abc]	166.4[bc]	165.4[c]	165.2[c]	166.3[c]	168.6[b]	174.3[a]
	(4.01)	(1.52)	(0.70)	(0.49)	(0.53)	(0.82)	(1.74)
USDA Yield Grade and components							
USDA Yield Grade	2.1[g]	2.5[f]	2.8[e]	3.1[d]	3.5[c]	3.9[b]	4.5[a]
	(0.15)	(0.04)	(0.02)	(0.02)	(0.02)	(0.03)	(0.07)
Adjusted fat thickness, cm	1.1[f]	1.0[f]	1.3[e]	1.4[d]	1.6[c]	1.8[b]	2.1[a]
	(0.12)	(0.03)	(0.01)	(0.01)	(0.01)	(0.02)	(0.04)
HCW, kg	238.2[g]	301.4[f]	344.5[e]	386.5[d]	428.7[c]	471.2[b]	519.5[a]
	(1.84)	(0.70)	(0.32)	(0.23)	(0.24)	(0.38)	(0.80)
Ribeye area, cm^2	77.7[f]	79.4[f]	86.1[e]	89.8[d]	93.4[c]	97.2[b]	99.8[a]
	(1.47)	(0.56)	(0.26)	(0.18)	(0.20)	(0.30)	(0.64)
KPH, %	2.2[c]	2.4[bcd]	2.4[bcd]	2.5[a]	2.5[a]	2.5[abc]	2.5[abc]
	(0.14)	(0.05)	(0.02)	(0.02)	(0.01)	(0.02)	(0.04)

[a,b,c,d,e,f,g]Means within a row lacking a common superscript letter differ ($P < 0.05$).
[1]600 = Select[00], 700 = Choice[00], 800 = Prime[00] (U.S. Department of Agriculture, 2017).
[2]400 = Small[00], 500 = Modest[00], 600 = Moderate[00] (U.S. Department of Agriculture, 2017).
[3]100 = A[00] and 200 = B[00] (U.S. Department of Agriculture, 2017).

Table 10. National Beef Quality Audit – 2022: percentage distribution of carcasses stratified by USDA Quality and Yield Grades[1,2]

	USDA Quality Grade, %			
USDA Yield Grade	Prime	Choice	Select	Other[3]
1	0.10	3.41	3.66	1.08
2	1.11	20.32	6.54	2.71
3	3.14	29.93	4.81	2.29
4	2.39	12.33	1.05	0.83
5	0.98	2.77	0.27	0.27

[1]U.S. Department of Agriculture (2017).
[2]Carcasses with missing values for U.S. Department of Agriculture (2017) Quality or Yield grades are not included.
[3]Other includes Standard, Commercial, Utility, dark cutter, blood splash, hard bone, and calloused ribeye.

Table 11. National Beef Quality Audit – 2022: Least squares means (SEM) for carcass traits within sex class

Trait	Steer	Heifer
	(*n* = 6,045)	(*n* = 3,256)
USDA Quality Grade and components		
USDA Quality Grade[1]	716.4[a]	714.0[a]
	(0.91)	(1.24)
Marbling Score[2]	494.3[b]	504.4[a]
	(1.54)	(2.10)
Lean maturity[3]	156.1[b]	159.1[a]
	(0.32)	(0.44)
Skeletal maturity[3]	168.3[b]	180.5[a]
	(0.46)	(0.63)
Overall maturity[3]	163.4[b]	171.9[a]
	(0.35)	(0.48)
USDA Yield Grade and components		
USDA Yield Grade	3.3[a]	3.2[b]
	(0.01)	(0.02)
Adjusted fat thickness, cm	1.4[b]	1.6[a]
	(0.01)	(0.01)
HCW, kg	412.3[a]	382.7[b]
	(0.62)	(0.84)
Ribeye area, cm^2	91.1[a]	90.7[a]
	(0.15)	(0.20)
KPH, %	2.5[a]	2.3[b]
	(0.01)	(0.01)

[a,b]Means within a row lacking a common superscript letter differ ($P < 0.05$).
[1]600 = Select^{00}, 700 = Choice^{00}, 800 = Prime^{00} (U.S. Department of Agriculture, 2017).
[2]400 = Small^{00}, 500 = Modest^{00}, 600 = Moderate^{00} (U.S. Department of Agriculture, 2017).
[3]100 = A^{00} and 200 = B^{00} (U.S. Department of Agriculture, 2017).

Native cattle increased numerically (+6.1% points) from NBQA-2016, whereas dairy (−5.0% points) and *B. indicus* (−0.5% points) decreased numerically. These data reflect the first relative decrease in dairy carcasses between two corresponding NBQAs. Boykin et al. (2017) reported a frequency of 16.3% dairy breed type, which was the highest recorded value of any audit. The decline in frequency of dairy breed type is likely an outcome of the recent movement toward feeding beef × dairy cattle as opposed to straightbred dairy. Beef processors have stated that the number of beef × dairy cattle slaughtered in 2020 and 2021 drastically increased compared to years past (Foraker et al., 2022). Foraker et al. (2022) also equate a 200% increase in beef semen sells during 2018 to the movement of the dairy industry to increased production of beef × dairy crosses. Aside from dairy crosses, market trends of the past 5 yr could have decreased slaughter of dairy cattle in large-scale beef-packing facilities. Of least squares means of carcass traits between breed types (Table 12), dairy carcasses possessed the greatest USDA QG and marbling scores, the least AFT, the most KPH, and the smallest REA ($P < 0.05$).

Certification Programs

There were 28.1% of the carcasses that qualified for USDA Certified Beef Programs (U.S. Department of Agriculture, 2016, 2023), often referred to as "G-programs," where the prefix "G" is followed by a number that details the exact carcass requirements for that program (e.g., G-1 is Certified Angus Beef, G-2 is Cargill Meat Solutions Sterling Silver, and so on). Compared to NBQA-2016 (Boykin et al., 2017), carcasses qualifying for Certified Angus Beef (U.S. Department of Agriculture, n.d.) increased by 5.6% points. Other G Programs, excluding Certified Angus Beef, increased from 0.6% in NBQA-2016 (Boykin et al., 2017) to 14.7% in the current study. The increase in certified programs may be a reflection of an increase in market demand for premium beef programs and consumer's willingness to pay for these premium products. Tatum (2015) stated that consumers have become more accepting of higher-priced beef products that are quality driven.

Conclusions

During the past 5 yr, numerous changes have been observed in evaluation of carcass traits through in-plant assessments and instrument grading. NBQA-2022 is the first NBQA to report mean marbling scores close to Modest. With this, incidence of Prime and Choice carcasses increased, especially in those carcasses that graded USDA Prime. However, much like previous instances of the NBQA, USDA YG continues to increase as characteristics such as AFT, HCW, KPH, and REA all increase.

While quality grades have shown improvements, prevalence of USDA YG 4 and 5 carcasses also has increased, and carcasses continue to trend in the direction of exceeding carcass weight thresholds. As carcasses progressed from YG 1

Table 12. National Beef Quality Audit – 2022: least squares means (SEM) for carcass traits within estimated breed types

Trait	Estimated breed type		
	Native	Dairy	*Bos indicus*
	(n = 7,923)	(n = 1,023)	(n = 85)
USDA Quality Grade and components			
USDA Quality Grade[1]	713.0[b]	732.3[a]	682.4[c]
	(0.77)	(2.16)	(7.53)
Marbling Score[2]	491.4[b]	526.5[a]	413.1[c]
	(1.31)	(3.66)	(12.67)
Lean maturity[3]	158.9[a]	153.4[b]	150.1[b]
	(0.29)	(0.82)	(2.83)
Skeletal maturity[3]	173.5[a]	159.1[b]	165.7[b]
	(0.40)	(1.11)	(3.84)
Overall maturity[3]	167.6[a]	156.5[b]	158.9[b]
	(0.30)	(0.84)	(2.91)
USDA Yield Grade and components			
USDA Yield Grade	3.2[b]	3.3[a]	3.0[c]
	(0.01)	(0.03)	(0.13)
Adjusted fat thickness, cm	1.5[a]	0.9[c]	1.4[b]
	(0.01)	(0.02)	(0.07)
HCW, kg	402.3[a]	384.9[b]	395.1[ab]
	(0.55)	(1.53)	(5.32)
Ribeye area, cm^2	92.3[a]	79.5[b]	94.0[a]
	(0.12)	(0.33)	(1.15)
KPH, %	2.3[c]	3.2[a]	2.7[b]
	(0.01)	(0.04)	(0.05)

[a,b,c]Means within a row lacking a common superscript letter differ ($P < 0.05$).
[1]600 = Select[00], 700 = Choice[00], 800 = Prime[00] (U.S. Department of Agriculture, 2017).
[2]400 = Small[00], 500 = Modest[00], 600 = Moderate[00] (U.S. Department of Agriculture, 2017).
[3]100 = A[00] and 200 = B[00] (U.S. Department of Agriculture, 2017).

to YG 5, improvements were noted in marbling scores and quality grades until YG 4, but there was no statistical difference in the quality grading ability between YG 4 and 5 carcasses. NBQA-2022 reported lower percentages of dairy carcasses, which is likely an outcome of the progressive shift to increased production and feeding of beef × dairy cattle. The results of this research can be used in improving the value-determining carcass characteristics of the fed beef industry.

Acknowledgments

This study was funded, in part, by the Beef Checkoff. Appreciation is extended to the Agricultural Marketing Service, U.S. Department of Agriculture personnel for their help in collecting carcass data for this project.
Conflict of interest statement. There are no known conflicts of interest by any of the authors.

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