ABSTRACT: The instrument grading assessments for the 2011 National Beef Quality Audit evaluated seasonal trends of beef carcass quality and yield attributes over the course of the year. One week of instrument grading data, HCW, gender, USDA quality grade (QG), and yield grade (YG) factors, were collected every other month (n = 2,427,074 carcasses) over a 13-mo period (November 2010 through November 2011) from 4 beef processing corporations, encompassing 17 federally inspected beef processing facilities, to create a “snapshot” of carcass quality and yield attributes and trends from carcasses representing approximately 8.5% of the U.S. fed steer and heifer population. Mean yield traits were YG (2.86), HCW (371.3 kg), fat thickness (1.19 cm.), and LM area (88.39 cm²). The YG distribution was YG 1, 15.7%; YG 2, 41.0%; YG 3, 33.8%; YG 4, 8.5%; and YG 5, 0.9%. Distribution of HCW was <272.2 kg, 1.6%; 272.2 to 453.6 kg, 95.1%; and ≥453.6 kg, 3.3%. Monthly HCW means were November 2010, 381.3 kg; January 2011, 375.9 kg; March 2011, 366.2 kg; May 2011, 357.9 kg; July 2011, 372.54 kg; September 2011, 376.1 kg; and November 2011, 373.5 kg. The mean fat thickness for each month was November 2010, 1.30 cm; January 2011, 1.22 cm; March 2011, 1.17 cm; May 2011, 1.12 cm; July 2011, 1.19 cm; September 2011, 1.22 cm; and November 2011, 1.22 cm. The overall average marbling score was Small49. The USDA QG distribution was Prime, 2.7%; Top Choice, 22.9%; Commodity Choice, 38.6%; and Select, 31.5%. Interestingly, from November to May, seasonal decreases (P < 0.001) in HCW and fat thicknesses were accompanied by increases (P < 0.001) in marbling. These data present the opportunity to further investigate the entire array of factors that determine the value of beef. Data sets using the online collection of electronic data will likely be more commonly used when evaluating the U.S. fed steer and heifer population in future studies.

INTRODUCTION

Over the last 20 yr, 4 National Beef Quality Audits (NBQA) have been conducted (Lorenzen et al., 1993; Boleman et al., 1998; McKenna et al., 2002; Garcia et al., 2008), and each has served as a reference to the industry in the areas of research, education, and business activities. Continuing to follow the recommendation to survey the beef quality attributes of the U.S. fed beef.
supply every 4 to 5 yr (Smith et al., 1992), the 2011 National Beef Quality Audit (NBQA-2011) was conducted to assess the current status of the quality and consistency of fed steers and heifers. With the recent implementation of instrument grading, the opportunity to measure quality attributes and trends seasonally and over the course of the year was feasible for the first time as part of the NBQA.

The need for the implementation of instrument grading was listed as a key message of the 2005 National Beef Quality Audit (NBQA-2005) reported by Smith et al. (2006). This technology has been 30 yr in development since the U.S. General Accounting Office (Comptroller General of the United States, 1978) reported to the U.S. Congress that the accuracy and the uniformity of the USDA beef grading needed to be improved. Greater accuracy and consistency, improved producer and packer confidence in the grades, and increased efficiency has been reported from the use of instruments in grading carcasses (Belk et al., 1998; Steiner et al., 2003a,b; Lorenzen, 2008). In the last 10 yr, the USDA has released the procedures for instrument approval and official use of instrument assessment for LM measurement (USDA, 2003), yield grade (YG) measurement (USDA, 2005), and marbling score assessment (USDA, 2006a,b). For this phase of the NBQA-2011, instrument grading data were used to compile the carcass information from multiple companies and facilities. In addition, seasonal changes were examined in the beef carcass characteristics over the course of the year.

MATERIALS AND METHODS

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

Overview

Instrument grading data (n = 2,427,074) were collected over a 13-mo period (November 2010 through November 2011) from 4 beef processing corporations, encompassing 17 federally inspected beef processing facilities, to assess the quality attributes and trends from carcasses representing approximately 8.5% of the U.S. fed steer and heifer population. Data for HCW, sex classification, USDA quality grade (QG), and YG groups were obtained from the production for 1 wk, every other month, beginning in November of 2010. Carcass data collection included measurements of subcutaneous fat thickness (FT), LM area, HCW, marbling score, genetic type, and sex condition. From this information, USDA (1997) YG and QG were calculated. In addition, the frequencies of the quality defects and combinations of these categories were determined.

The following describes how instrument grading is conducted: An in-plant employee aligns the calibrated camera onto the LM between the 12th and 13th ribs for each side. After the image is captured, it is stored and displayed for the USDA grader to verify that the objective assessments for USDA QG and YG were made correctly. The USDA grader can make adjustments to the grade or, if necessary, reject the instrumental assessment altogether. Adjustments are entered manually for maturity or any other defects (blood splash, calloused rib eye, dark cutter, etc.) that a carcass might possess. Factors that would not be ascertained from the camera, such as sex class, breed classification, and HCW, would have been entered into the computer system and follow each individual carcass using the trolley tracking system and their individual identification number.

Data were received from each of the 4 beef processing corporations in a Microsoft Excel spreadsheet (Microsoft Corporation, Redmond, WA). The spreadsheets were harmonized and consolidated, and corporate identifiers were removed to protect the identity of individual processors. Analyses were performed using JMP Software (JMP Pro, SAS Inst., Inc., Cary, NC). The Fit Y by X function was used for analysis of variance, and least squares means comparisons were performed using Student’s t test. Frequency distributions, means, standard deviations, and minimum and maximum values were determined using the distribution function. Correlations were determined using the multivariate function.

RESULTS AND DISCUSSION

Means for instrumentally assessed YG traits and marbling scores are shown in Table 1. The mean YG was 2.86, and the mean marbling score was Small⁴⁹. The YG distributions (Figure 1) were YG 1, 15.7%; YG 2, 41.0%; YG 3, 33.8%; YG 4, 8.5%; and YG 5, 0.9%. Distributions of carcasses and combinations of USDA QG and YG are shown in Table 2. Instrumental assess-

Table 1. Means, standard deviations, and minimum and maximum values for USDA carcass grade traits (n = 2,427,074)

<table>
<thead>
<tr>
<th>Trait</th>
<th>Mean</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield grade</td>
<td>2.86</td>
<td>0.8</td>
<td>−0.04</td>
<td>7.4</td>
</tr>
<tr>
<td>Fat thickness, cm</td>
<td>1.20</td>
<td>0.48</td>
<td>−0.98¹</td>
<td>6.32</td>
</tr>
<tr>
<td>LM area, cm²</td>
<td>88.45</td>
<td>11.08</td>
<td>28.67</td>
<td>181.94</td>
</tr>
<tr>
<td>HCW, kg</td>
<td>371.28</td>
<td>44.05</td>
<td>136.08</td>
<td>615.98</td>
</tr>
<tr>
<td>Marbling score²</td>
<td>449</td>
<td>94.8</td>
<td>100</td>
<td>1000</td>
</tr>
</tbody>
</table>

¹Minimum value is less than zero because of converting data from a preliminary YG of less than 2.0.

²Scores are as follows: 100 = Practically Devoid00, 300 = Slight00, 500 = Modest00, 700 = Slightly Abundant00, and 900 = Abundant00.
ment indicated that 70.5% of the carcasses were Choice (Ch) or Select (Se), YG 2 or 3. Carcasses classified as other consisted of no roll, Standard, Commercial, Utility, heiferette, dark cutter, blood splash, hard bone, and calloused rib eye. The carcasses classified as other comprised 4.3% of the instrumentally surveyed carcasses.

As shown in Figure 2, the percentage of Prime (Pr) and Ch carcasses was greatest in January 2011 (67.7%) and March 2011 (67.8%). Because of fewer carcasses classified as other, May 2011 exhibited the greatest percentage of Pr, Ch, and Se carcasses (96.5%). The YG (Figure 1) and QG (Figure 3) frequency distributions and QG and YG trait means (Table 3) within the instrument grading data set were found to be similar to the frequency distributions and means from the NBQA in-plant chilled carcass assessment data set (Moore et al., 2012). The surprisingly similar results of the LM area, FT, YG, and marbling scores (Table 4) between the traditional in-plant carcass assessment and the instrument grading data set adds credibility to the current as well as the previously conducted surveys that the sample sizes have been adequate to obtain a representative snapshot of the industry.

Carcasses in March 2011 had the greatest mean marbling score (Small60), followed by a decrease for the month of May 2011 (Figure 4). Of the dairy-type carcasses, January 2011 had the greatest percentage of Pr, Ch, and Se (95.08%), whereas May had the greatest percentage of Ch (68.43%). The Choice-Select spread (Ch-Se) reflects the daily average price differential between these 2 grades in the marketplace (McCully, 2010; Suther, 2010). McCully (2010) reported on the negative relationship between the Ch-Se spread and the percentage of cattle that graded Ch. The 2011 archived copies of the “National Daily Boxed Beef Cutout and Boxed Beef Cuts” report from USDA Agricultural Marketing Service (AMS) were accessed to obtain Ch-Se spreads, which were plotted against the percentage of Ch carcasses for the same time period as the instrumental grading data collected for this study. The correlation coefficient value for the Ch-Se spread (Figure 5) in the present study was −0.88. McCully (2010) also reported a strong correlation (−0.86) when examining the relationship between the Ch-Se spread and percentage of USDA Ch carcasses using 2002 to 2009 data. The Ch-Se spread is calculated

**Table 2.** Distribution (%) of carcasses (n = 2,427,074) stratified by USDA quality and yield grades.1,2

<table>
<thead>
<tr>
<th>Yield grade</th>
<th>USDA quality grade</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Prime</td>
</tr>
<tr>
<td>1</td>
<td>0.03</td>
</tr>
<tr>
<td>2</td>
<td>0.47</td>
</tr>
<tr>
<td>3</td>
<td>1.30</td>
</tr>
<tr>
<td>4</td>
<td>0.72</td>
</tr>
<tr>
<td>5</td>
<td>0.13</td>
</tr>
</tbody>
</table>

1Carcasses with missing values for USDA quality or yield grades were not included.
2Other includes no roll, Standard, Commercial, Utility, heiferette, dark cutter, blood splash, hard bone, and calloused rib eye.
3Top Choice = USDA quality grade Choice and marbling score ≥500, and Commodity = USDA quality grades Choice and marbling score <500.

**Figure 1.** Frequency distribution of yield grade comparing the instrument grading data set and the 2011 National Beef Quality Audit in-plant chilled carcass assessment data set (Moore et al., 2012).

**Figure 2.** Frequency distribution of quality grade by month.

**Figure 3.** Frequency distribution of USDA quality grade comparing the instrument grading data set and the 2011 National Beef Quality Audit in-plant chilled carcass assessment data set (Moore et al., 2012).
using Commodity Ch and does not take into account the price for Ch product that is marketed through a carcass program and thereby demanding a premium price. As the number of branded carcass programs continues to increase and profit margins decrease, it is important that carcasses are sorted to use the optimal marketing and fabrication method. Through the increased accuracy of the camera grading system, up to $115.00 per animal increase in carcass value can be obtained through the utilization and augmentation of YG placement with instrumentation (Lorenzen, 2008).

Carcass weight distributions are presented in Figure 6. As the carcass trait ranges that are important to various carcass programs evolve, it is pertinent for the industry to also adapt to meet the demand of these programs. The majority of the carcass programs that are currently on the list of USDA Certified Programs with a HCW provision use the range of 272.2 to 453.6 kg. Of the instrumentally assessed carcasses, 95.1% of the carcasses were between 272.2 and 453.6 kg. The May 2011 HCW (Figure 7) was the lightest HCW month average observed (357.9 kg), which was 13.4 kg less than the average HCW for the study (371.3 kg).

Historically, annual HCW trends typically reach the lightest HCW for the year in May, which is reflected by the 2007 to 2011 archived “5 Area Weekly Weighted Average Direct Slaughter Cattle” reports from the AMS-USDA, which were accessed to obtain the carcass weights, weighted for steer and heifer proportions, for historical comparisons. These seasonal differences in HCW could be a result of the type of cattle marketed at this period. Because these data were collected from carcasses and do not contain information on a live animal basis, it is not known whether the carcasses are from cattle from yearling-fed or calf-fed systems or from spring- or fall-calving herds.

Lighter average HCW and a greater percentage of YG 1 to 3 (92.5%) were observed for May 2011 compared with the average percentage of YG 1 to 3 (90.6%) for the entire survey (data not reported in tabular form). Native (non-dairy type) steers were heavier (*P* < 0.001)

### Table 3. Means for carcass traits between in-plant survey and instrument data

<table>
<thead>
<tr>
<th>Trait</th>
<th>In-plant chilled carcass assessment (n = 9,802)</th>
<th>Instrument assessment (n = 2,427,074)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield grade</td>
<td>2.95</td>
<td>2.86</td>
</tr>
<tr>
<td>Fat thickness, cm</td>
<td>1.30</td>
<td>1.20</td>
</tr>
<tr>
<td>HCW, kg</td>
<td>374.0</td>
<td>371.3</td>
</tr>
<tr>
<td>LM area, cm²</td>
<td>88.77</td>
<td>88.45</td>
</tr>
<tr>
<td>Marbling score²</td>
<td>440</td>
<td>450</td>
</tr>
</tbody>
</table>

1Moore et al. (2012).
2Scores are as follows: 100 = Practically Devoid00, 300 = Slight00, 500 = Modest00, 700 = Slightly Abundant00, and 900 = Abundant00.
than dairy steers for each month except May 2011. Native heifers were heavier ($P < 0.001$) than dairy heifers (n = 6,697) for every month observed except March 2011 (data not reported in tabular form). The change in the average HCW of steers and heifers had the same trend from across months ($P < 0.001$). Steers were heavier than heifers each month, with an average difference of 35.3 kg between steers and heifers (Figure 7). As shown in Table 4, Dairy steers (n = 116,410) had a lower numerical YG (2.81) compared to native (non-dairy type) steers (n = 1,317,287) and native heifers (n = 986,162), as well as a smaller FT (0.71 cm) and smaller LM area (78.61 cm$^2$). As shown in Table 4, native steers had the heaviest HCW (386.45 kg) and the native heifers had the greatest marbling score (465).

Frequency of dark cutters (data not reported in tabular form) was at the lowest points in January 2011 (0.43%) and March 2011 (0.38%), with an increase that peaked in September 2011 (1.94%) and a mean frequency of 0.85% for the study. These findings were consistent with the trend of an increased frequency of dark cutters from January to October and a decrease in November reported by Kreikemeier et al. (1998). Contrary to the results from Scanga et al. (1998), in the current study, steers (61.24%) accounted for a greater proportion of the dark cutters than heifers (38.76%). Dark cutters were leaner with a lower mean FT, HCW, and YG ($P < 0.001$) and a larger mean LM area ($P < 0.001$). Janloo et al. (1998) also found lower mean

<table>
<thead>
<tr>
<th>Trait</th>
<th>Native Steers (n = 1,317,287)</th>
<th>Native Heifers (n = 986,162)</th>
<th>Dairy Steers (n = 116,410)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield grade</td>
<td>2.85$^b$ (0.00076)</td>
<td>2.87$^a$ (0.0009)</td>
<td>2.81$^c$ (0.0019)</td>
</tr>
<tr>
<td>Fat thickness, cm</td>
<td>1.18$^b$ (0.00042)</td>
<td>1.29$^a$ (0.00052)</td>
<td>0.71$^c$ (0.00090)</td>
</tr>
<tr>
<td>LM area, cm$^2$</td>
<td>90.40$^a$ (0.01008)</td>
<td>87.09$^b$ (0.01175)</td>
<td>78.61$^c$ (0.02749)</td>
</tr>
<tr>
<td>HCW, kg</td>
<td>386.45$^a$ (0.03784)</td>
<td>350.98$^c$ (0.04227)</td>
<td>372.89$^b$ (0.11177)</td>
</tr>
<tr>
<td>Marbling score1</td>
<td>437$^a$ (0.08326)</td>
<td>464$^b$ (0.10547)</td>
<td>456$^c$ (0.31176)</td>
</tr>
</tbody>
</table>

$^a$–$^c$ Means within a row that do not have a common superscript letter differ ($P < 0.001$).

1Scores are as follows: 100 = Practically Devoid00, 300 = Slight00, 500 = Modest00, 700 = Slightly Abundant00, and 900 = Abundant00.
FT and YG and larger LM areas in dark cutters than in carcasses with brighter-colored lean. Moore et al. (2012) reported 57.5% of the dark cutters occurred between September and February. In the current study, 62.0% of the dark cutters were observed during the months of September through January, most likely reflecting environmental stress during this period.

The overall average LM area for the instrumental assessment was 88.45 cm². Many carcass programs that are currently on the list of USDA Certified Programs with a LM area stipulation use the range of 64.5 to 103.2 cm². Of the instrumentally assessed carcasses, March 2011 and May 2011 resulted in the greatest percentage of carcasses (90.7%) with LM areas between 64.5 and 103.2 cm² (Figure 8). May 2011 also had the least percentage of LM areas greater than 103.2 cm² (7.5%) for the year. May 2011 had the greatest percentage of dairy-type carcass with LM areas between 64.5 and 103.2 cm² (data not reported in tabular form). The LM areas between steers and heifers differed for each month ($P < 0.001$).

As shown in Figure 9, November 2010 had the greatest average FT (1.30 cm), which was greater than the total average for the study (1.19 cm). Conversely, May 2011 had the least average FT (1.12 cm). The distributions of steers and heifers for month are represented in Figure 10. Steers had less FT than heifers in each month observed ($P < 0.001$), and dairy-type carcasses had lower FT than native-type carcasses ($P < 0.001$). As the FT increased, the percentage of Pr and Ch QG increased, and the percent of Se and other carcasses decreased (Figure 11). Nonetheless, the premiums that would be gained from the increase in the percentage of USDA Pr and Ch carcasses might not offset the discounts that would be applied because of the loss in cutability.

We also were interested in examining the relationship between FT and marbling. Using data from this study as well as data from Moore et al. (2012), the correlation coefficients between FT and marbling for the instrument grading data set ($r = 0.35$) was similar to that of the in-plant chilled carcass assessment ($r = 0.34$). Brethour (2000) reported that the correlation of FT and carcass marbling score was $r = 0.26$ and $r = 0.40$, respectively, from 2 different groups of cattle. As has been previously reported, carcasses with less marbling also had less subcutaneous FT, whereas carcasses with a greater marbling scores had a greater subcutaneous FT (Jeremiah, 1996; Moore et al., 2012).

In conclusion, for the first time in the NBQA, sufficient information was available to allow QG and YG traits to be evaluated seasonally. The present data indicate that shifts in the magnitude of the mean of certain QG and YG traits occurred on a month-to-month basis. Seasonal variation could be a result of the various production systems used, which are necessary to continually supply the United States with a safe, high-quality product. The HCW decreased from the heaviest in November 2010 to the lightest mean HCW in May 2011. Mean FT followed the same trend line as mean HCW. Conversely, mean marbling score increased from November 2010 to the peak in March 2011 and then decreased for the remainder of the study period. This data set presented the opportunity to further investigate the whole array of value-determining factors that influence the viability and profitability of the beef industry, and now with the opportunity to use the method of online electronic collection of data, these data sets will allow a much greater array of information to be reported.

**LITERATURE CITED**


Comptroller General of the United States. 1978. Report to the Con-


