Instrument Grading –
A Report Card

2012 Cattlemen’s College
February 1, 2012
Instrument Augmentation of USDA’s Beef Grading and Certification Programs

- USDA-approved, camera-based grading systems
  - VBG 2000 – e+v Technology GmbH

- Approved for official determination of
  - Ribeye area (2003)
  - Yield Grade (2005)
  - Marbling (2006)
Timeline for Industry Adoption of Instrument Quality Grading

- **2005** – regional grading differences provided strong impetus for transition to a more objective approach for marbling assessment.

- **June 2006** – 2 camera grading systems (E+V & CVS) were approved for use in assigning official USDA QG. Instruments were calibrated to predict marbling scores & QG assigned by a panel of 5 USDA grading experts.
Timeline for Actual Industry Adoption of Instrument Grading

• **2006-2007** – Post-approval testing conducted by commercial beef processors revealed great enough disparity between camera-based QG and grades assigned by USDA field graders that camera grading was not implemented.

• **2007-2008** – USDA conducted extensive evaluation of grade lines involving grade comparisons among more than 400,000 carcasses.

• **February 2009** – USDA aligned camera lines with QG lines of **USDA field graders**, resulting in industry implementation of camera-based quality grading.

• **September 2009** – Industry began using instruments for official USDA quality grade determination.
Current Use of Instrument Grading in the US Beef Industry

- 7 companies (18 plants) currently are approved to use instruments for assigning official USDA grades.
  - Cargill Meat Solutions
  - Greater Omaha Packing Co.
  - JBS USA
  - National Beef
  - Nebraska Beef
  - Tyson Fresh Meats
  - Washington Beef

- 5 companies (10 plants) are actively using instruments for official grading.
  - Cargill Meat Solutions
  - Greater Omaha Packing Co.
  - National Beef
  - Nebraska Beef
  - Washington Beef

Source: Larry Meadows, USDA-AMS, 1/11/2012
### Adjustment of Camera Grade Lines to Match USDA Field Graders’ Calls

<table>
<thead>
<tr>
<th>USDA Grade line</th>
<th>Current camera MS</th>
<th>Change from expert panel MS</th>
</tr>
</thead>
<tbody>
<tr>
<td>PR/CH+</td>
<td>695 (700)</td>
<td>-57 units</td>
</tr>
<tr>
<td>CH-/CHº</td>
<td>495 (500)</td>
<td>-28 units</td>
</tr>
<tr>
<td>CH-/SE</td>
<td>395 (400)</td>
<td>-14 units</td>
</tr>
<tr>
<td>SE/ST</td>
<td>295 (300)</td>
<td>-12 units</td>
</tr>
</tbody>
</table>

- Alignment of grading instruments with the grades of field graders, though necessary to facilitate industry adoption of camera-based quality grading, was viewed by some as a reduction in US beef quality standards.

- To address these concerns, the NCBA commissioned a study to quantify relationships of camera-based QG to sensory attributes of fed steer and heifer beef.
2011 Beef Checkoff Study
Conducted by Colorado State University

- **Objective**: Determine relationships between camera-based USDA quality grades and sensory attributes of fed beef.

- **718 A-maturity carcasses selected**
  - From commercial plants in CO, KS, NE, TX
  - To represent 7 camera marbling scores: MA, SA, MD, MT, SM, SL, TR
  - No dark cutters, < 1% *Bos indicus*, < 1% Dairy, 54% heifers/46% steers

- **Strip loin samples from both sides of each carcass aged 14 days**
7 Camera Marbling Scores Evaluated in the Study

MA PR°
SA PR-
MD CH+
MT CH°
SM CH-
SL SE
TR ST+
Percentage of Heifer & Steer Carcasses Selected Within Each Marbling Degree

<table>
<thead>
<tr>
<th>Marbling Degree</th>
<th>Heifer</th>
<th>Steer</th>
</tr>
</thead>
<tbody>
<tr>
<td>TR</td>
<td>51%</td>
<td>50%</td>
</tr>
<tr>
<td>SL</td>
<td>48%</td>
<td>46%</td>
</tr>
<tr>
<td>SM</td>
<td>54%</td>
<td>48%</td>
</tr>
<tr>
<td>MT</td>
<td>52%</td>
<td>52%</td>
</tr>
<tr>
<td>MD</td>
<td>63%</td>
<td>37%</td>
</tr>
<tr>
<td>SA</td>
<td>61%</td>
<td>39%</td>
</tr>
<tr>
<td>MA</td>
<td>67%</td>
<td>33%</td>
</tr>
</tbody>
</table>
Percentage of Carcasses in Each Marbling Degree Identified with an A-Stamp

Presence of A-stamp

<table>
<thead>
<tr>
<th>Marbling Degree</th>
<th>Presence</th>
</tr>
</thead>
<tbody>
<tr>
<td>TR</td>
<td>49%</td>
</tr>
<tr>
<td>SL</td>
<td>54%</td>
</tr>
<tr>
<td>SM</td>
<td>66%</td>
</tr>
<tr>
<td>MT</td>
<td>71%</td>
</tr>
<tr>
<td>MD</td>
<td>81%</td>
</tr>
<tr>
<td>SA</td>
<td>84%</td>
</tr>
<tr>
<td>MA</td>
<td>92%</td>
</tr>
</tbody>
</table>
2011 Beef Checkoff Study  
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- **Objective**: Determine relationships between camera-based USDA quality grades and sensory attributes of fed beef.
- **718 A-maturity carcasses selected**
  - From commercial plants in CO, KS, NE, TX
  - To represent 7 camera marbling scores: MA, SA, MD, MT, SM, SL, TR
  - No dark cutters, < 1% *Bos indicus*, < 1% Dairy, 54% heifers/46% steers
- **Strip loin samples from each carcass aged 14 days**

- **Measurements**:
  - Shear force
  - Sensory analysis by an 8 to 10 member panel
    - Juiciness
    - Tenderness
    - Flavor profile
  - Sensory experience based on overall performance (Positive/Negative)

Minimum score = 0  
Maximum score = 15
Beef Flavor Lexicon

• **Meaty/Brothy Flavor** (basic flavor & aroma of grilled or roasted beef; simulated by flavor of beef broth)

• **Buttery/Beef Fat Flavor** (flavor & aroma associated with cooked fat from grain-finished beef; often described as “buttery”)

• **Bloody/Serumy Flavor** (flavor & aroma of blood in beef cooked to a rare degree of doneness)

• **Livery/Organy Flavor** (flavor & aroma of cooked beef liver or kidney)

• **Grassy Flavor** (flavor & aroma of beef produced by grass-finished or short-fed cattle; described as green or hay-like)
Variation in Beef Sensory Attributes Explained by Differences in Visual Marbling Assessments

<table>
<thead>
<tr>
<th>Study</th>
<th>Juiciness</th>
<th>Tenderness</th>
<th>Flavor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kropf &amp; Graf, 1959</td>
<td>14%</td>
<td>38%</td>
<td>7%</td>
</tr>
<tr>
<td>Goll et al., 1965</td>
<td>2%</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>Breidenstein et al., 1968</td>
<td>38%</td>
<td>9%</td>
<td>38%</td>
</tr>
<tr>
<td>Campion et al., 1975</td>
<td>10%</td>
<td>8%</td>
<td>4%</td>
</tr>
<tr>
<td>Crouse et al., 1978</td>
<td>6%</td>
<td>5%</td>
<td>10%</td>
</tr>
<tr>
<td>Tatum et al., 1982</td>
<td>5%</td>
<td>5%</td>
<td>15%</td>
</tr>
<tr>
<td>Smith et al., 1984</td>
<td>24%</td>
<td>27%</td>
<td>30%</td>
</tr>
<tr>
<td><strong>Average across studies</strong></td>
<td><strong>14%</strong></td>
<td><strong>14%</strong></td>
<td><strong>15%</strong></td>
</tr>
</tbody>
</table>
Variation in Beef Sensory Attributes Explained by Differences in Camera Marbling

% Variation Explained by Marbling

- Juiciness: 45%
- Tenderness: 40%
- Meaty/Brothy: 32%
- Buttery/Beef Fat: 71%
- Sensory Experience: 61%
Effect of Marbling Shear Force and Panel Tenderness Ratings

**W-B Shear Force, kg**

- TR: 4.1<sup>a</sup>
- SL: 3.8<sup>b</sup>
- SM: 3.6<sup>c</sup>
- MT: 3.3<sup>d</sup>
- MD: 3.2<sup>de</sup>
- SA: 3.0<sup>e</sup>
- MA: 2.7<sup>f</sup>

**Tenderness Rating**

- TR: 7.0<sup>f</sup>
- SL: 7.7<sup>e</sup>
- SM: 8.6<sup>d</sup>
- MT: 9.5<sup>c</sup>
- MD: 9.7<sup>c</sup>
- SA: 10.7<sup>b</sup>
- MA: 11.2<sup>a</sup>
Sensory Ratings for Juiciness and Buttery/Beef Fat Flavor Intensity

Juiciness

- TR: 7.4f
- SL: 7.5f
- SM: 8.5e
- MT: 9.0d
- MD: 9.5c
- SA: 10.4b
- MA: 10.9a

Buttery/Beef Fat Flavor

- TR: 1.6g
- SL: 2.1f
- SM: 2.9e
- MT: 4.0d
- MD: 4.9c
- SA: 6.3b
- MA: 7.5a
Sensory Ratings for Intensity of Meaty/Brothy & Bloody/Serumy Flavors

Meaty/Brothy Flavor

Bloody/Serumy Flavor

<table>
<thead>
<tr>
<th></th>
<th>TR</th>
<th>SL</th>
<th>SM</th>
<th>MT</th>
<th>MD</th>
<th>SA</th>
<th>MA</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.0</td>
<td>7.4</td>
<td>7.9</td>
<td>8.5</td>
<td>8.7</td>
<td>9.2</td>
<td>9.4</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>TR</th>
<th>SL</th>
<th>SM</th>
<th>MT</th>
<th>MD</th>
<th>SA</th>
<th>MA</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.3</td>
<td>3.3</td>
<td>3.0</td>
<td>2.5</td>
<td>2.3</td>
<td>1.9</td>
<td>1.5</td>
<td></td>
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</tbody>
</table>
Sensory Ratings for Intensity of Livery/Organy & Grassy Flavors

### Livery/Organy Flavor

- TR: 0.75<sup>a</sup>
- SL: 0.65<sup>ab</sup>
- SM: 0.60<sup>b</sup>
- MT: 0.54<sup>b</sup>
- MD: 0.27<sup>c</sup>
- SA: 0.32<sup>c</sup>
- MA: 0.27<sup>c</sup>

### Grassy Flavor

- TR: 0.86<sup>a</sup>
- SL: 0.63<sup>b</sup>
- SM: 0.47<sup>c</sup>
- MT: 0.39<sup>cd</sup>
- MD: 0.35<sup>cd</sup>
- SA: 0.28<sup>de</sup>
- MA: 0.14<sup>e</sup>
Effect of Marbling Degree on Probability of a Positive Sensory Experience

Probability of a Positive Sensory Experience

<table>
<thead>
<tr>
<th>Marbling Degree</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>TR</td>
<td>0.15</td>
</tr>
<tr>
<td>SL</td>
<td>0.29</td>
</tr>
<tr>
<td>SM</td>
<td>0.62</td>
</tr>
<tr>
<td>MT</td>
<td>0.82</td>
</tr>
<tr>
<td>MD</td>
<td>0.88</td>
</tr>
<tr>
<td>SA</td>
<td>0.99</td>
</tr>
<tr>
<td>MA</td>
<td>0.98</td>
</tr>
</tbody>
</table>
Beef Sensory Properties Influencing Overall Sensory Experience Rating

% Explained Variation

- Tenderness: 91%
- Buttery/Beef Fat Flavor: 10%
- Grassy Flavor: 1%
- Meaty/Brothy Flavor: 1%
- Juiciness: 1%
- Livery Flavor: 1%
- Unexplained: 4%

Overall Sensory Experience Rating: 81%
Effect of Sex on Warner-Bratzler & Slice Shear Force

**W-B Shear Force, kg**

- Heifer: 3.5
- Steer: 3.3

*P = 0.015*

**Slice Shear Force, kg**

- Heifer: 16.0
- Steer: 14.8

*P = 0.012*
Comparison of Camera Grade Lines

5 Experts vs. Field Graders

Number of Carcasses in Each Quality Grade Category

- ST: 104 (5 Experts), 119 (Field Graders)
- SE: 101 (5 Experts), 112 (Field Graders)
- CH-: 104 (5 Experts), 119 (Field Graders)
- CH°/CH+: 228 (5 Experts), 22 (Field Graders)
- PR: 153 (5 Experts), 205 (Field Graders)
Comparison of Camera Grade Lines

5 Experts vs. Field Graders

**Juiciness**

<table>
<thead>
<tr>
<th>Grade</th>
<th>5 Experts</th>
<th>Field Graders</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST</td>
<td>d d</td>
<td>d d</td>
</tr>
<tr>
<td>SE</td>
<td>c c</td>
<td>c c</td>
</tr>
<tr>
<td>CH⁻</td>
<td>b b</td>
<td>b b</td>
</tr>
<tr>
<td>CH⁺/CH⁺</td>
<td>a a</td>
<td>a a</td>
</tr>
</tbody>
</table>

**Tenderness**

<table>
<thead>
<tr>
<th>Grade</th>
<th>5 Experts</th>
<th>Field Graders</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST</td>
<td>e e</td>
<td>d d</td>
</tr>
<tr>
<td>SE</td>
<td>d d</td>
<td>c c</td>
</tr>
<tr>
<td>CH⁻</td>
<td>c c</td>
<td>b b</td>
</tr>
<tr>
<td>CH⁺/CH⁺</td>
<td>a a</td>
<td>a a</td>
</tr>
</tbody>
</table>

Legend:
- 5 Experts
- Field Graders
Comparison of Camera Grade Lines

5 Experts vs. Field Graders

Meaty/Brothy Flavor

- ST
- SE
- CH-
- CH^/CH^+
- PR

Buttery/Beef Fat Flavor

- ST
- SE
- CH-
- CH^/CH^+
- PR

5 Experts vs. Field Graders
Comparison of Camera Grade Lines

5 Experts vs. Field Graders

Probability of a Positive Sensory Experience

0.15e 0.15e
0.29d 0.29d
0.67c 0.62c
0.89b 0.85b
0.99a 0.99a

ST SE CH- CH°/CH+ PR

5 Experts  Field Graders
Impacts of Instrument Grading

• Improved accuracy & precision of USDA beef grading system

• Reduced variation in assignment of grades
  o Within plants & between shifts
  o Between plants, areas & regions

• Assists in certification of carcasses for branded beef programs
  o Ribeye area specifications
  o Marbling/Quality Grade specifications
  o Yield Grade specification

• Data capture – feedback of carcass data to production sector