BEEF YIELD GRADING: History, Issues, and Opportunities

Ty Lawrence
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• 1950’s
  – Interest in objective yield measurement

• 1952 RMC
  – Adopted “(1) length of body, (2) length of hind leg, (3) circumference of round, (4) depth of body, (5) length and width of ribeye, (6) area of ribeye, and (7) three thicknesses of fat over the ribeye” as yield estimation measures

• 1956 ASAP meetings
  – Pierce, Strong, Van Zandt, and Murphey reported a yield study of 459 beef carcasses

• 1960 ASAP meetings
  – Murphey, Hallett, Tyler, and Pierce reported a yield study of 162 beef carcasses
    • Chicago (boning establishment and major packer)
    • Steers, heifers, and cows
    • Prime, Choice, Good, Stand., Comm., Util., Cutt./Can.
    • 350-900 pound carcasses
    • Bone-in and boneless
    • ¼” fat trim on thick cuts, ½” fat trim on thinner cuts
    • 17 independent variables measured
      – %Boneless Closely Trimmed Round Loin Rib and Chuck
        \[ 51.34 = (5.78 \times \text{single fat thickness over rib eye, in.}) - (0.482 \times \text{percent kidney fat}) - (0.0093 \times \text{carcass wt., lbs.}) + (0.74 \times \text{area of rib eye, sq. in.}) \]

AMSA, 2016; Murphey et al. (1960)
• Initially %BCTRLRC converted to YG 1 to 10
  – 2.3% range of major boneless retail cut yield
  – Junction of YG1-2 was 53.1%
  – Junction of YG 9-10 was 34.7%

• Later, %BCTRLRC converted to YG 1 to 5
  – 2.3% range of major boneless retail cut yield
  – Range of outcomes narrowed toward lean
    – 1 = 50.3 %BCTRLRC
    – 2 = 51.8 - 52.3 %BCTRLRC
    – 3 = 47.7 - 50.0 %BCTRLRC
    – 4 = 44.4 - 47.7 %BCTRLRC
    – 5 = <44.4 %BCTRLRC

Murphey et al. (1960)

• YG equation was developed to estimate %BCTRLRC
  • Yield Grade = 2.5 + (2.5 * Fat) + (0.2 * KPH%) + (0.0038 * HCW) - (0.32 * REA)

• 1962 – Dual (QG/YG) grading concept
  – Proposed April
  – Began 01July1962 – one year trial

• June 1965 – All carcasses must be ribbed

Murphey et al. (1960); USDA (1997)

12th Rib SQ Fat Depth

Correlation of fat to % boneless yield

<table>
<thead>
<tr>
<th>Study</th>
<th>Correlation (r)</th>
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<tbody>
<tr>
<td>Abraham et al. (1988)</td>
<td>-0.66</td>
</tr>
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</tr>
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<td>Reiling et al. (1992)</td>
<td>-0.53</td>
</tr>
<tr>
<td>Farrow et al. (2009)</td>
<td>-0.59</td>
</tr>
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Abraham et al. (1968), Farrow et al. (2009), Reiling et al. (1992)

% Kidney-Pelvic-Heart fat

Correlation of KPH to % boneless yield

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<td>-0.35</td>
</tr>
<tr>
<td>Reiling et al. (1992)</td>
<td>-0.18</td>
</tr>
<tr>
<td>Farrow et al. (2009)</td>
<td>-0.44</td>
</tr>
</tbody>
</table>

Abraham et al. (1968), Farrow et al. (2009), Reiling et al. (1992)

AMSA, 2016; Murphey et al. (1960); USDA (1997)
**12th Rib - Rib Eye Area**

| Correlation of REA to % boneless yield | Abraham et al. (1968) | r = +0.18 |
|                                        | Abraham et al. (1980) | r = +0.35 |
|                                        | Reiling et al. (1992) | r = +0.51 |
|                                        | Farrow et al. (2009)  | r = +0.25 |

**Hot Carcass Weight**

| Correlation of HCW to % boneless yield | Abraham et al. (1968) | r = -0.50 |
|                                       | Abraham et al. (1980) | r = -0.17 |
|                                       | Reiling et al. (1992) | r = -0.03 |
|                                       | Farrow et al. (2009)  | r = -0.44 |

**Camera Grading History**

- **1978** – GAO reports to Congress that USDA needed to “increase research efforts to develop instruments to accurately measure beef carcass characteristics”
- **1979** – USDA asks NASA and JPL to develop an instrument
- **1980** – USDA-ARS begins developing an instrument
  - Kansas State University awarded contract to develop first VIA instrument
- **Remainder of 1980’s**
  - Industry seeks other alternatives including NMR, NIR, ultrasound, and CAT-scan – VIA progress stopped
- **1994**
  - Focus shifted from ultrasound back to VIA

**Camera Grading History**

- **1996-2004**
  - USMARC developed VIA system to predict retail weight and yield (Shackelford et al. 1998)
  - Dual component (hot side and ribbed image) VIASCAN and CVS systems evaluated for yield grading (Cannell et al. 1999; Cannell et al. 2002)
  - E+V VIA technology patented for determination of yield and quality parameters (Haagensen et al. 2001)
  - VIA technology evaluated at USMARC for yield grading and prediction of intramuscular fat (Shackelford et al. 2003)
  - VIA technology further investigated for USDA YG augmentation (Steiner et al. 2003)
  - E+V VIA technology patented for prediction of yield and quality parameters through calculation of pixel area (Eger et al. 2004)
USDA approval of VIA

- 26 Feb 2001
  - CVS/RMS approved for ribeye area
- 16 Dec 2003
  - VBG2000/E+V approved for ribeye area
- 16 Aug 2005
  - VBG2000/E+V approved for yield grade
- 02 Nov 2006
  - VBG2000/E+V and CVS/RMS approved for marbling score
- 09 Mar 2007
  - CVS/RMS approved for fat thickness
- 14 Mar 2007
  - VBG2000/E+V approved for fat thickness

Current U.S. Status

- Formally implemented in Sept 2009
- Wide range of use
  - Not used
  - In-house use only
  - Sole determinant of YG
  - Used for both QG and YG w/ inspector approving each carcass

Video Image Analysis (VIA)

- Computer Instrument Use
- Increased Accuracy of Measures
- Repeatability Across Beef Processors

Computerized Grading
(RMS & E+V)
CVS/RMS or VBG2000/E+V??

Human vs VIA yield grade

Probability of USDA On-Line Classification of USDA YG 4

20.2% at calculated 4

56.5% at calculated 5

Probability of YG4 stamp from USDA grader

Economics of yield grading
## Carcass Value “Grid”

Maximum values for 15 August 2016

<table>
<thead>
<tr>
<th>Hot carcass weight</th>
<th>Quality Grade</th>
<th>Yield Grade</th>
<th>Additional adjustments</th>
</tr>
</thead>
<tbody>
<tr>
<td>400-500 (-40)</td>
<td>1.0-2.0 (+8)</td>
<td>Dairy</td>
<td>(-10)</td>
</tr>
<tr>
<td>501-550 (-40)</td>
<td>2.1-2.5 (+5)</td>
<td>+ 30 months</td>
<td>(-40)</td>
</tr>
<tr>
<td>551-600 (-20)</td>
<td>2.6-3.0 (+5)</td>
<td>Bullock</td>
<td>(-55)</td>
</tr>
<tr>
<td>601-900 (0.00)</td>
<td>3.1-3.9 (0.00)</td>
<td>C+ maturity</td>
<td>(-55)</td>
</tr>
<tr>
<td>901-1000 (-15)</td>
<td>4.0-4.9 (-15)</td>
<td>Dark cutter</td>
<td>(-55)</td>
</tr>
<tr>
<td>1000-1050 (-25)</td>
<td>&gt;5.0 (-20)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;1050 (-50)</td>
<td></td>
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USDA (2016a)

## Carcass Value “Grid”

Maximum values for 15 August 2016

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<tr>
<th>Yield Grade</th>
<th>YG 1 and 2</th>
<th>YG 2</th>
<th>YG 4 and 5</th>
<th>YG 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0-2.0</td>
<td>$0 – 8/cwt</td>
<td>$0 – 5/cwt</td>
<td>($8 – 15/cwt)</td>
<td>($10 – 20/cwt)</td>
</tr>
<tr>
<td>2.1-2.5</td>
<td>(-8)</td>
<td>(+5)</td>
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USDA (2016a)
Yield Grade Value
900 lb carcass

USDA (2016a)

Industry YG Value Potential
900 lb carcass

USDA (2016a), USDA (2016b)

28.7% of cattle are USDA yield graded

Inconsistencies and challenges

1950’s Champion Steer
State Fair of Texas

2015 Champion Steer
State Fair of Texas
Cattle Feeding Technology/Change

**Synovex S**
- Progesterone and melengestrol acetate
- Increased rate of weight gain and improved feed efficiency

*Lawrence et al. (2008)*

Rib Eye Area Measurement Grid

- Ribeye growth is different than expected

**Hot Carcass Weight Trending Up**

- Steers = 5 pounds/year
- Heifers = 6 pounds/year

*Don Close*

**Figure 1.** The USDA LM area per HCW relationship and the mean West Texas A&M University (WTAMU) LM area per HCW relationship.
YG predicts 40% of the variation in red meat yield (beef-type cattle)

801 steers (OSU, TTU, UofIL, WTAMU)

YG predicts 0% of the variation in Holstein red meat yield

235 steers (OSU, UofIL)
Potential modifications and other systems

Re-parameterization

- Separate beef-type and dairy-type cattle
  - Where do their crosses best fit?
- Represent entire carcass yield
- Represent current carcass weights
- Estimate KPH consistently or eliminate
- Value incremental yield changes
  - 60 to 80% red meat yield vs YG 1-5
New VIA measures predicted 68% of variation in red meat yield

**Canada - Yield Grading**

- **Fat Thickness**
  - Linear measure of backfat
- **Muscle Score**
  - Matrix of ribeye length and ribeye width

Lean % = $63.65 + (1.05 \times \text{muscle score}) - (0.76 \times \text{fat thickness, mm})$

**Japanese Yield Grading**

Yield Grades
- A – 72% and greater
- B – 69-72%
- C – Less than 69%

Measured between the 6th and 7th ribs

Japanese Yield % = $67.37 + (0.130 \times \text{REA, cm}^2) + (0.587 \times \text{Rib thickness, cm}) - (0.025 \times \text{Cold left side wt, kg}) - (0.896 \times \text{FAT, cm})$
• E – Excellent; all profiles convex to super convex; exceptional muscle development
• U – Very good; profiles on the whole straight; good muscle development
• R – Good; profiles straight to concave; good muscle development
• O – Fair; profiles straight to concave; average muscle development
• P – Poor; profiles straight to concave; poor muscle development

1 - indicative of carcass with little to no fat deposition across the loin and the round
5 - indicative of carcass with pronounced fat deposition across the loin and round

References


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