BEEF YIELD GRADING:
History, Issues, and Opportunities

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June 2016

Beef Grading History

- 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

AMSA, 2016; Murphey et al. (1960)

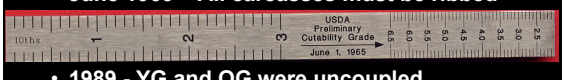
- 1960 ASAP meetings
  - Murphey, Hallett, Tyler, and Pierce reported a yield study of 162 beef carcasses
    - Chicago (boning establishment and major packer)
    - Steers, heifers, and cows
    - Prime, Choice, Good, Stand., Comm., Util., Cutt./Can.
    - 350-900 pound carcasses
    - Bone-in and boneless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

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 = >52.3 %BCTRLCR
    - 2 = 50.0 – 52.3 %BCTRLCR
    - 3 = 47.7 – 50.0 %BCTRLCR
    - 4 = 45.4 – 47.7 %BCTRLCR
    - 5 = <45.4 %BCTRLCR

Murphey et al. (1960)

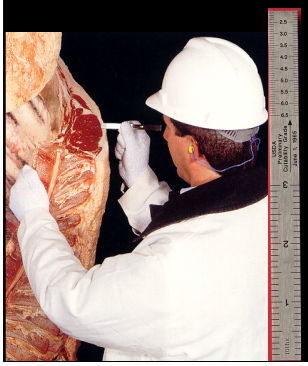
- YG equation was developed to estimate %BCTRLCR
  - Yield Grade = 2.5 + (2.5 * Fat)+ (0.2 * KPH%) + (0.0038 * HCW) - (0.32 * REA)
- 1962 – Dual (QG/YG) grading concept
  - Proposed April
  - Began 01July1962 – one year trial
- June 1965 – All carcasses must be ribbed



- 1989 - YG and QG were uncoupled

AMSA, 2016; Murphey et al. (1960); USDA (1997)

12th Rib SQ Fat Depth

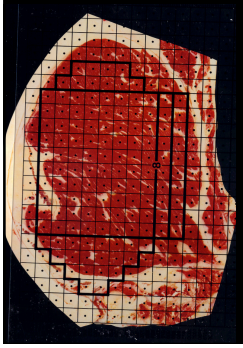


Correlation of fat to % boneless yield	
Abraham et al. (1968)	r = -0.66
Abraham et al. (1980)	r = -0.68
Reiling et al. (1992)	r = -0.53
Farrow et al. (2009)	r = -0.59

% Kidney-Pelvic-Heart fat

Correlation of KPH to % boneless yield	
Abraham et al. (1968)	r = -0.66
Abraham et al. (1980)	r = -0.35
Reiling et al. (1992)	r = -0.18
Farrow et al. (2009)	r = -0.44

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

Woerner & Belk, 2008

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 (Shackleford 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)

Woerner & Belk, 2008

USDA approval of VIA

- 26Feb2001
  - CVS/RMS approved for ribeye area
- 16Dec2003
  - VBG2000/E+V approved for ribeye area
- 16Aug2005
  - VBG2000/E+V approved for yield grade
- 02Nov2006
  - VBG2000/E+V and CVS/RMS approved for marbling score
- 09Mar2007
  - CVS/RMS approved for fat thickness
- 14Mar2007
  - VBG2000/E+V approved for fat thickness

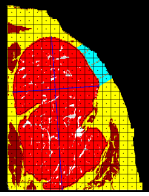
Woerner & Belk, 2008

Current U.S. Status

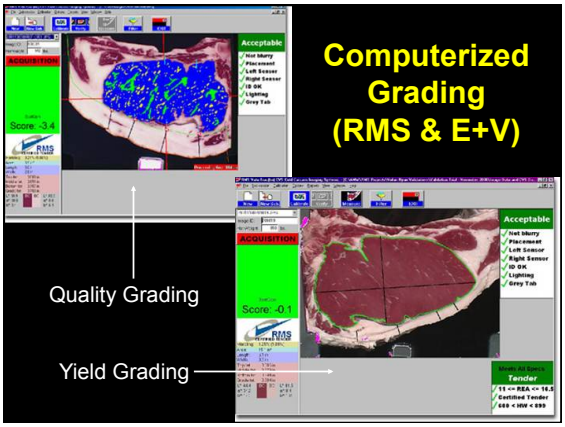
- Wide range since 2007
  - Not used
  - In-house use only
  - Sole determinant of YG
  - Used for both QG and YG w/ inspector approving each carcass

Video Image Analysis (VIA)

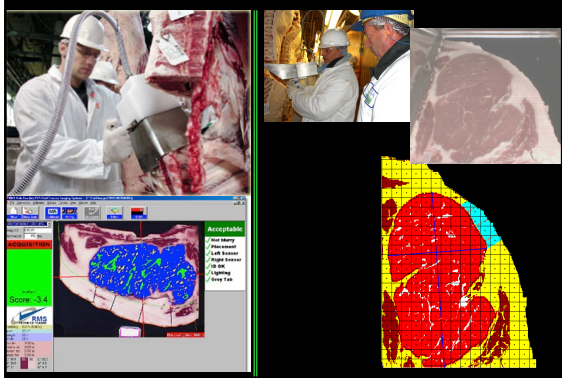
- Computer Instrument Use
- Increased Accuracy of Measures
- Repeatability Across Beef Processors



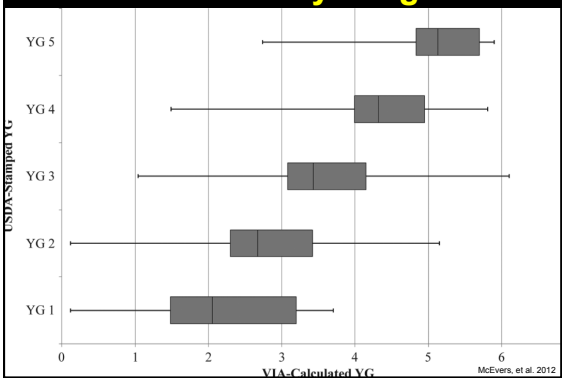
Computerized Grading (RMS & E+V)



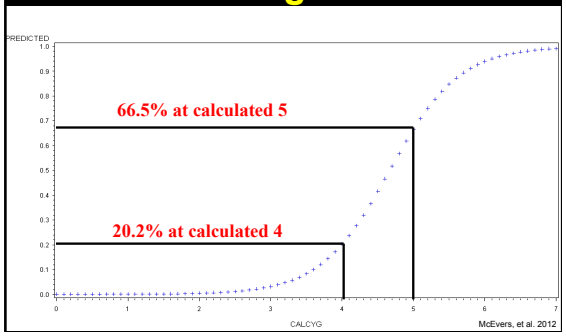
CVS/RMS or VBG2000/E+V??



Human vs VIA yield grade



Probability of YG4 stamp from USDA grader



Economics of yield grading

Carcass Value "Grid"

Maximum values for 06June2016

Hot carcass weight		Quality Grade		Yield Grade		Additional adjustments	
400-500	(-40)			1.0-2.0	(+8)	Dairy	(-10)
501-550	(-40)	Prime	(+24)	2.1-2.5	(+5)	+ 30 months	(-44)
551-600	(-20)	Prem Ch	(+8)	2.6-3.0	(+5)	Bullock	(-55)
601-900	**(0.00)**	**Low Ch**	**(0.00)**	**3.1-3.9**	**(0.00)**	C+ maturity	(-55)
901-1000	(-15)	Select	(-24)	4.0-4.9	(-15)	Dark cutter	(-55)
1000-1050	(-25)	Standard	(-43)	>5.0	(-20)		
>1050	(-50)						

USDA (2016a)

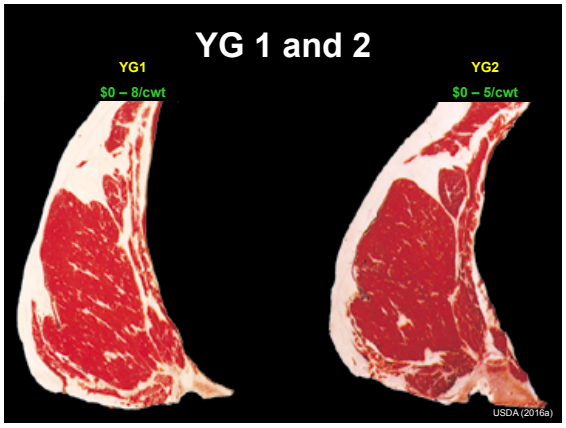
Carcass Value "Grid"

Maximum values for 06June2016

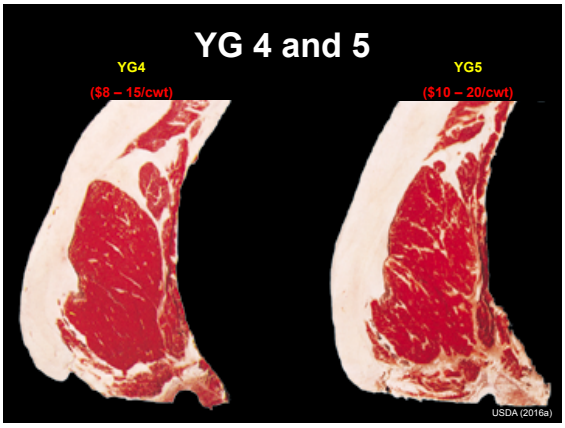
		Yield Grade	
		1.0-2.0	(+8)
		2.1-2.5	(+5)
		2.6-3.0	(+5)
		3.1-3.9	**(0.00)**
		4.0-4.9	(-15)
		>5.0	(-20)

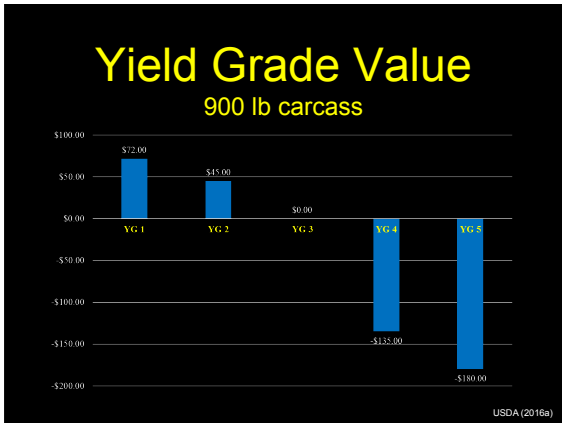
USDA (2016a)

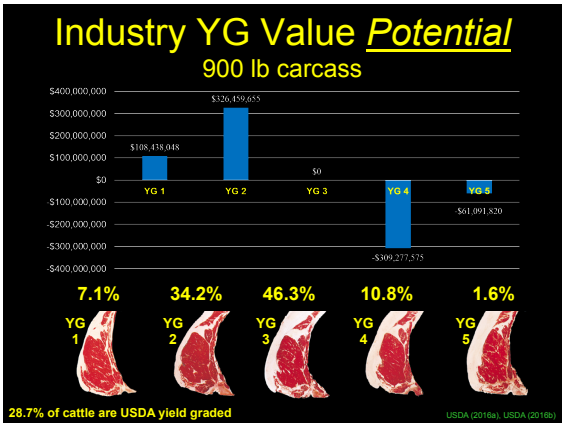
YG 1 and 2



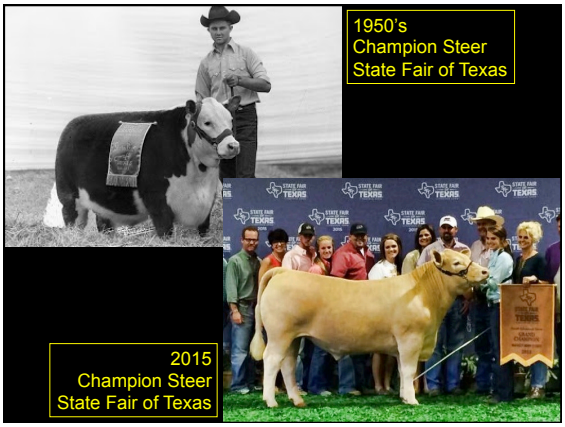
YG 4 and 5

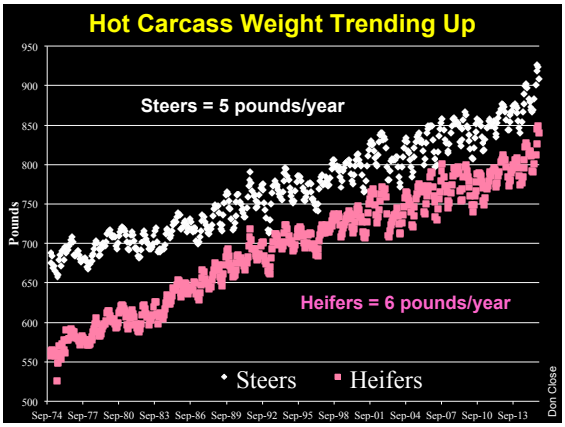


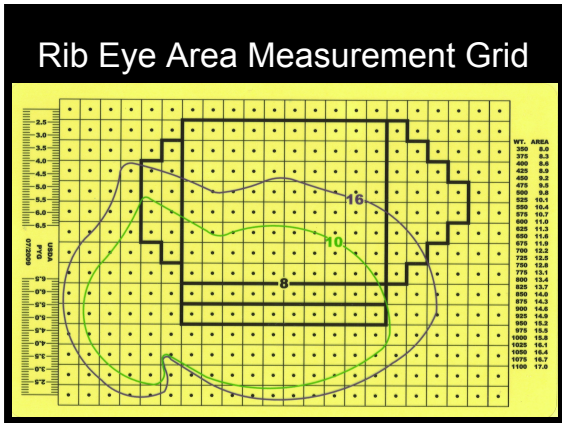


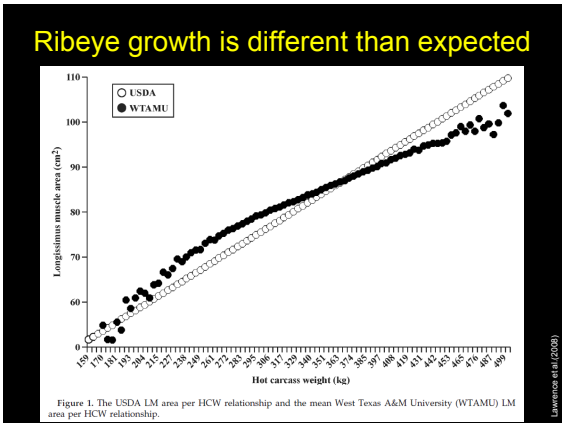


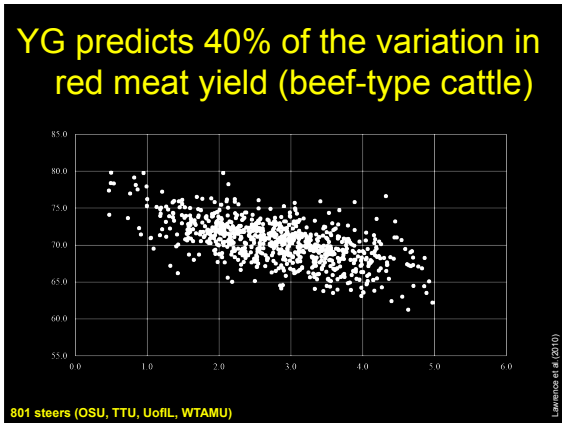
Inconsistencies and challenges

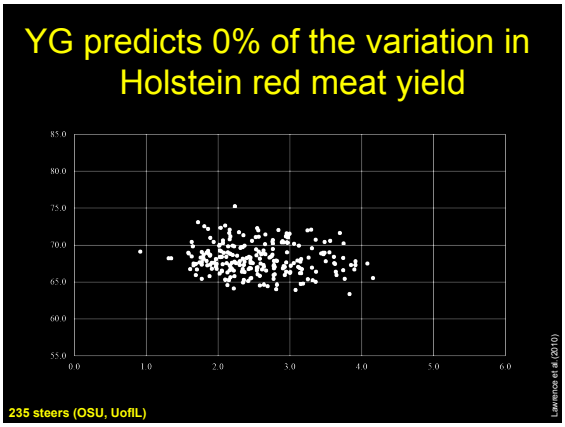


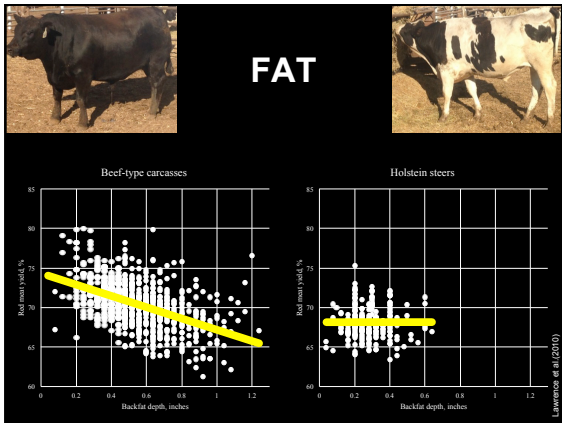


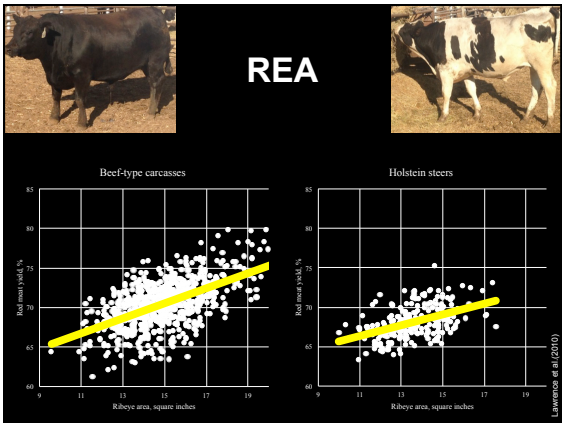

Rib Eye Area Measurement Grid
16
10
8

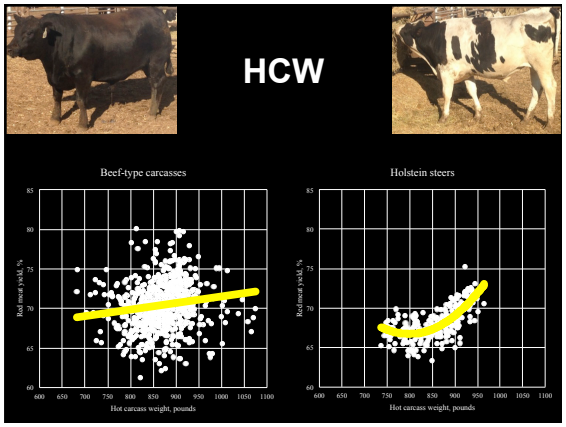

Ribeye growth is different than expected
USDA
WTAMU
Longissimus muscle area (cm²)
Hot carcass weight (kg)
Figure 1. The USDA LM area per HCW relationship and the mean West Texas A&M University (WTAMU) LM area per HCW relationship.
Lawrence et al (2009)


YG predicts 40% of the variation in red meat yield (beef-type cattle)
801 steers (OSU, TTU, UofIL, WTAMU)
Lawrence et al (2010)


YG predicts 0% of the variation in Holstein red meat yield
235 steers (OSU, UofIL)
Lawrence et al (2010)


FAT
Beef-type carcasses
Holstein steers
Red meat yield, %
Backfat depth, inches
Lawrence et al (2010)


REA
Beef-type carcasses
Holstein steers
Red meat yield, %
Ribeye area, square inches
Lawrence et al (2010)



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
- Develop estimate of intermuscular fat
- Value incremental yield changes
  - 60 to 80% red meat yield vs YG 1-5

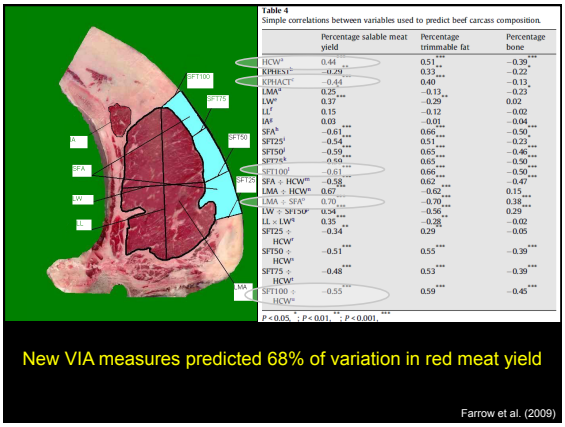


Table 4
Simple correlations between variables used to predict beef carcass composition.

	Percentage salable meat yield	Percentage trimmable fat	Percentage bone
HCW[a]	0.44 ***	0.51 ***	−0.39 ***
KPHES[b]	−0.29 ***	0.33 ***	−0.22 ***
KPHACT[c]	−0.44 ***	0.40 ***	−0.13 *
LMA[d]	0.25 ***	−0.13 *	−0.23 ***
LW[e]	0.37 ***	−0.29 ***	0.02
LL[f]	0.15	−0.12 *	−0.02
IA[g]	0.03	−0.01	−0.04
SFA[h]	−0.61 ***	0.66 ***	−0.50 ***
SFT25[i]	−0.54 ***	0.51 ***	−0.23 ***
SFT50[j]	−0.59 ***	0.65 ***	−0.46 ***
SFT75[k]	−0.59 ***	0.65 ***	−0.50 ***
SFT100[l]	−0.61 ***	0.66 ***	−0.50 ***
SFA ÷ HCW[m]	−0.58 ***	0.62 ***	−0.47 ***
LMA ÷ HCW[n]	0.67 ***	−0.62 ***	0.15 ***
LMA ÷ SFA[o]	0.70 ***	−0.70 ***	0.38 ***
LW ÷ SFT50[p]	0.54 ***	−0.56 ***	0.29 ***
LL ÷ LW[q]	0.35 ***	−0.28 **	−0.02
SFT25 ÷ HCW[r]	−0.34 ***	0.29 ***	−0.05
SFT50 ÷ HCW[s]	−0.51 ***	0.55 ***	−0.39 ***
SFT75 ÷ HCW[t]	−0.48 ***	0.53 ***	−0.39 ***
SFT100 ÷ HCW[u]	−0.55 ***	0.59 ***	−0.45 ***

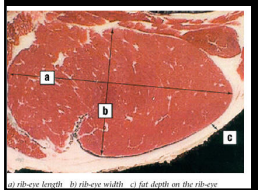
* P < 0.05, ** P < 0.01, *** P < 0.001.

New VIA measures predicted 68% of variation in red meat yield

Farrow et al. (2009)

Canada - Yield Grading

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



a) rib-eye length b) rib-eye width c) fat depth on the rib-eye

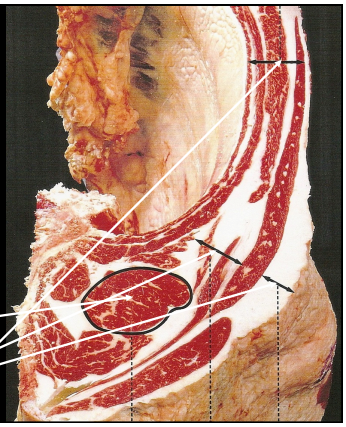
Lean % = 63.65
+ (1.05 x muscle score)
– (0.76 x fat thickness, mm)

Japanese Yield Grading

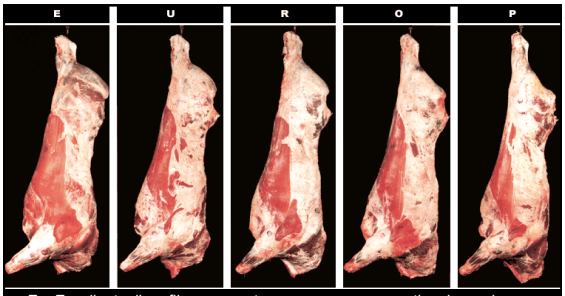
Yield Grades
A – 72% and greater
B – 69-72%
C – Less than 69%

Measured between the 6th and 7th ribs

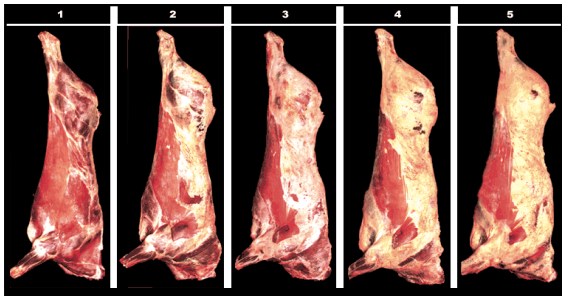
Japanese Yield % =
67.37
+ (0.130 x REA, cm2)
+ (0.667 x Rib thickness, cm)
– (0.025 x Cold left side wt, kg)
– (0.896 x FAT, cm)



Conformation Camera



- 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

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