Carcass Grading: Today and Tomorrow

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FEEDING QUALITY FORUM

Beef Grading

- The meat grading program is administered by the U.S. Department of Agriculture (USDA). Beef quality grades indicate palatability characteristics such as tenderness, juiciness and flavor
- Inspection
  - By law, all meat must be inspected and passed for wholesomeness by the USDA
- Grading
  - Quality grading is voluntary. Prime, Choice and Select are the most common quality grades consumers see

FEEDING QUALITY FORUM

Beef Grading

- Beef carcass, not individual cuts are graded
- Grade carries forward to all wholesale/primal and portion cuts derived from graded carcass
- Roughly 95% of all federally inspected slaughter gets a grade

FEEDING QUALITY FORUM

USDA Quality Grades for Beef*

Grades for Youthful Cattle

- Prime
- Choice
  - Premium Choice (CH°/CH+)
  - Commodity Choice (CH-)
- Select
- Standard

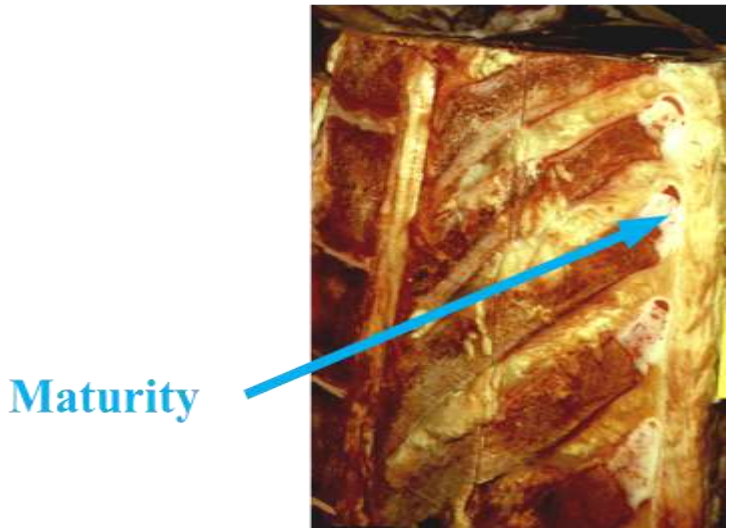
Grades for Mature cattle

- Commercial
- Utility
  - Breaking (< 80% lean)
  - Boning (≥ 80% lean)
- Cutter
- Canner

*Mature bulls are not eligible for quality grading.

USDA Quality Grade Factors

- **Maturity**
  - Skeletal Ossification (evaluated in split vertebrae)
  - Shape and Color of Ribs
  - Lean Color (longissimus)
  - Lean Texture (longissimus)
- **Degree of Marbling**
  - Amount and Distribution of Intramuscular Fat (longissimus)



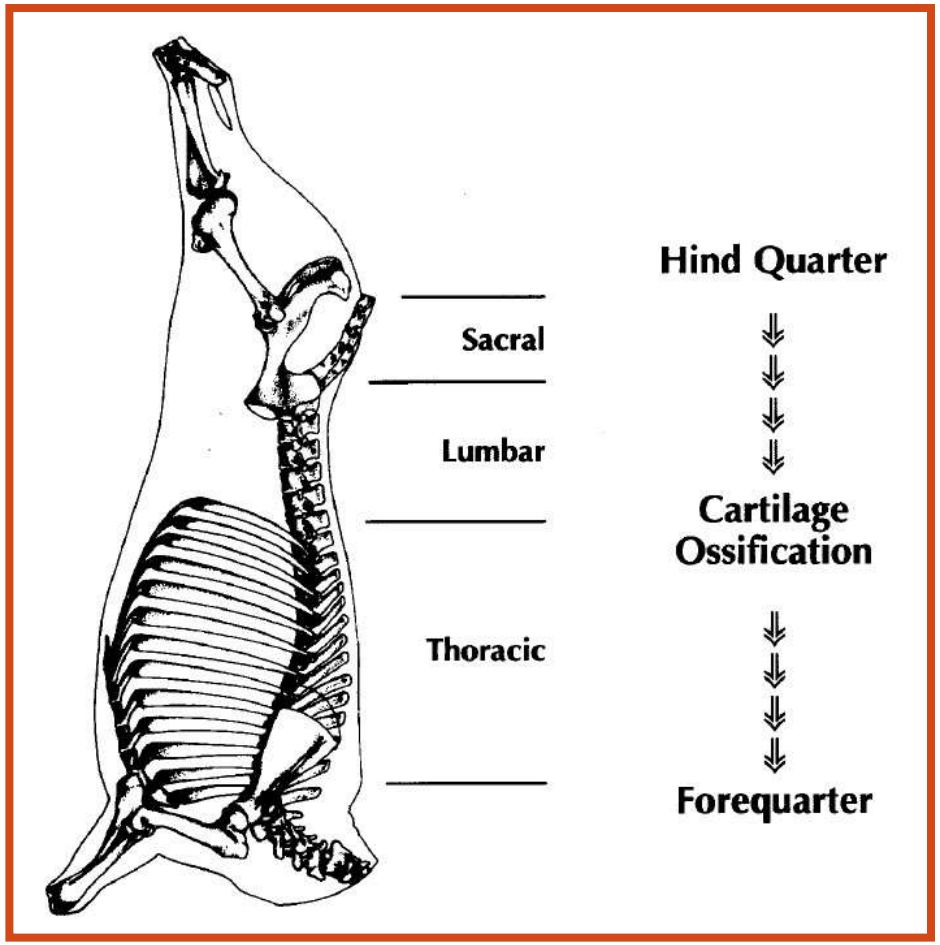
Beef Carcass Maturity

Maturity Group	Approximate Chronological Age	
A	9 to 30 months	Youthful
B	30 to 42 months	
C	42 to 72 months	
D	72 to 96 months	Mature
E	More than 96 months	

Carcass Maturity

- **Physiological Indicators**
  - **Skeletal Ossification**
  - **Lean Color and Texture**

Skeletal Ossification

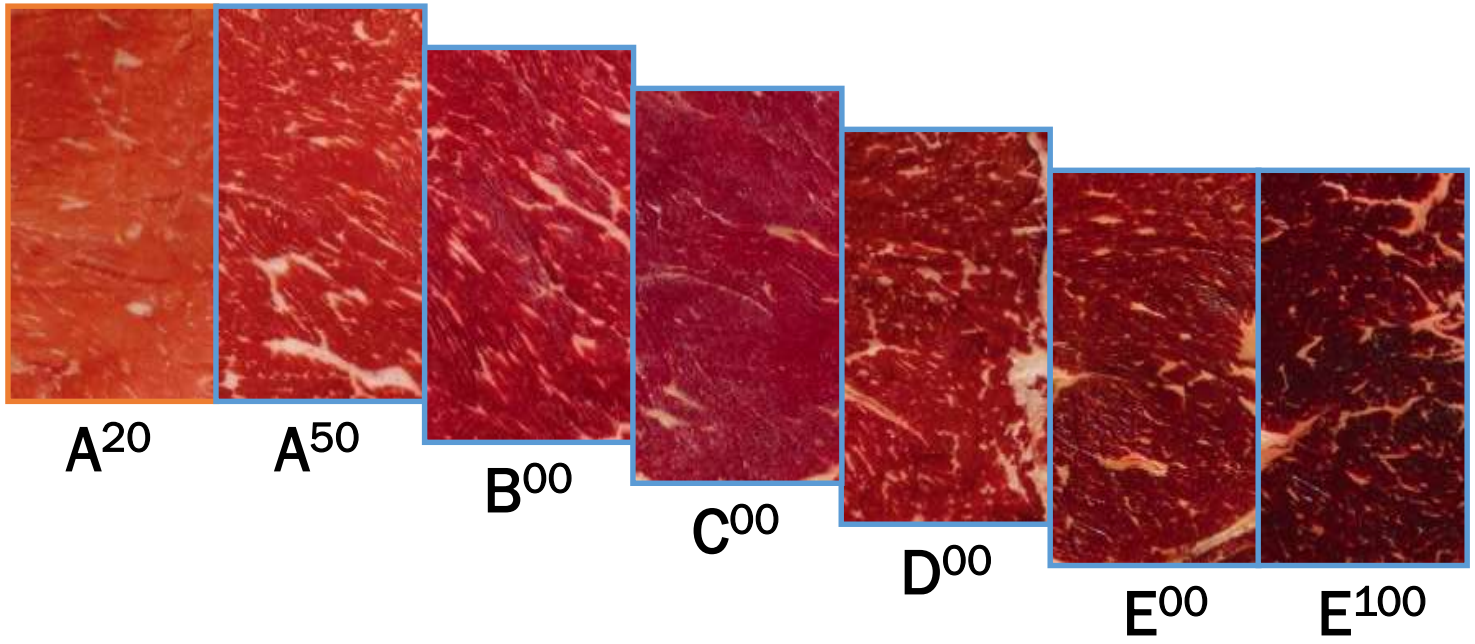


Lean Maturity

Lean maturity is based on the color of the lean in the Ribeye

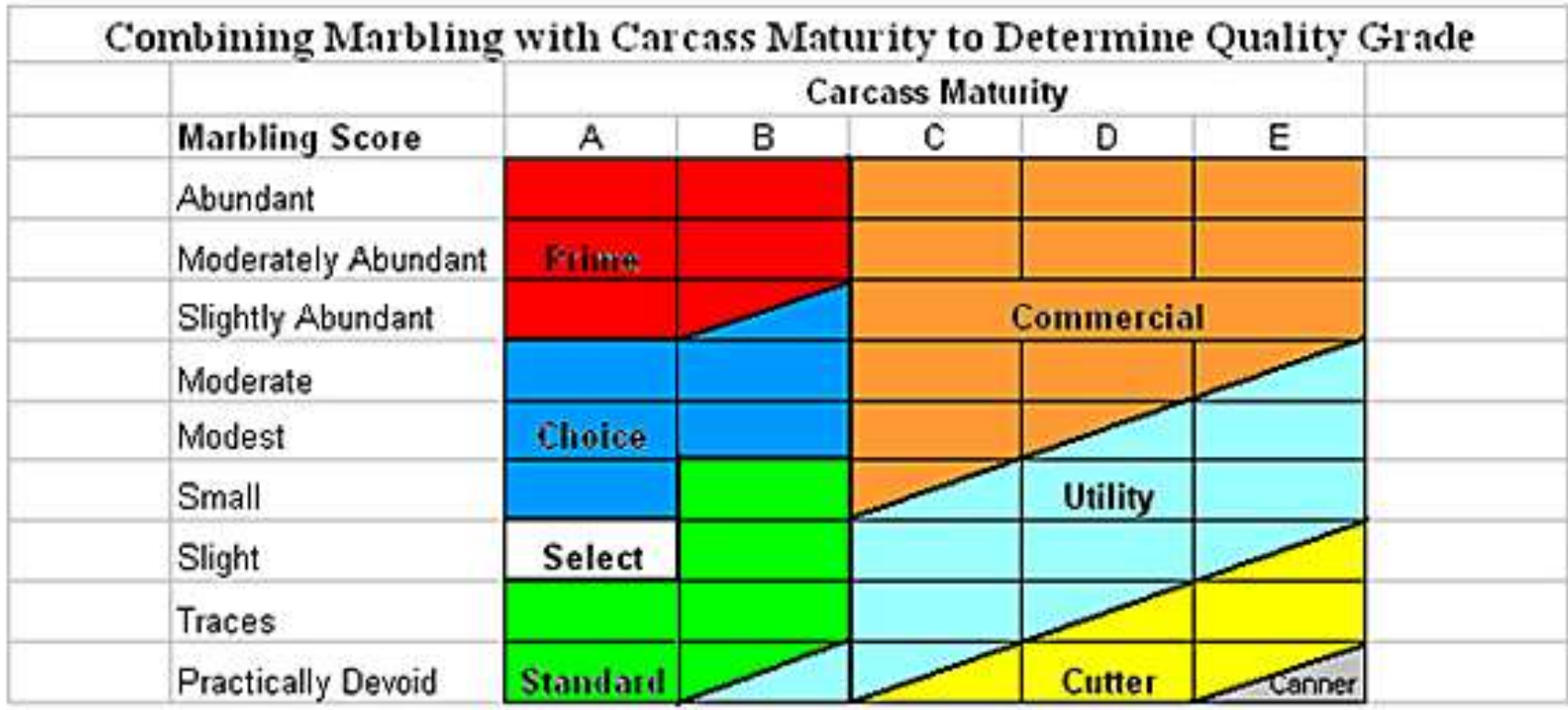
"A" Color Lean

"B" Color Lean



FEEDING QUALITY FORUM

Combining Marbling with Carcass Maturity to Determine Quality Grade



First pair permanent incisors present, greater than 24 months but less than 30 months

Three permanent incisors present, greater than 30 months

As of December of 2017, USDA Grade Standards ensure that:

Cattle 30 months old, or less, are included in the youngest maturity group recognized as "beef" (A maturity).

Skeletal and muscular evidence will still be used to determine maturity for those animals over 30 months of age.

USDA Marbling Scores

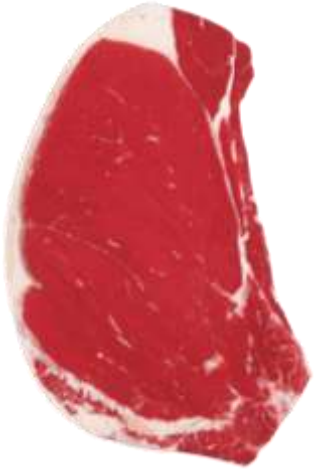
Moderately Abundant - Prime

Slightly Abundant - Prime

Moderate – High Choice

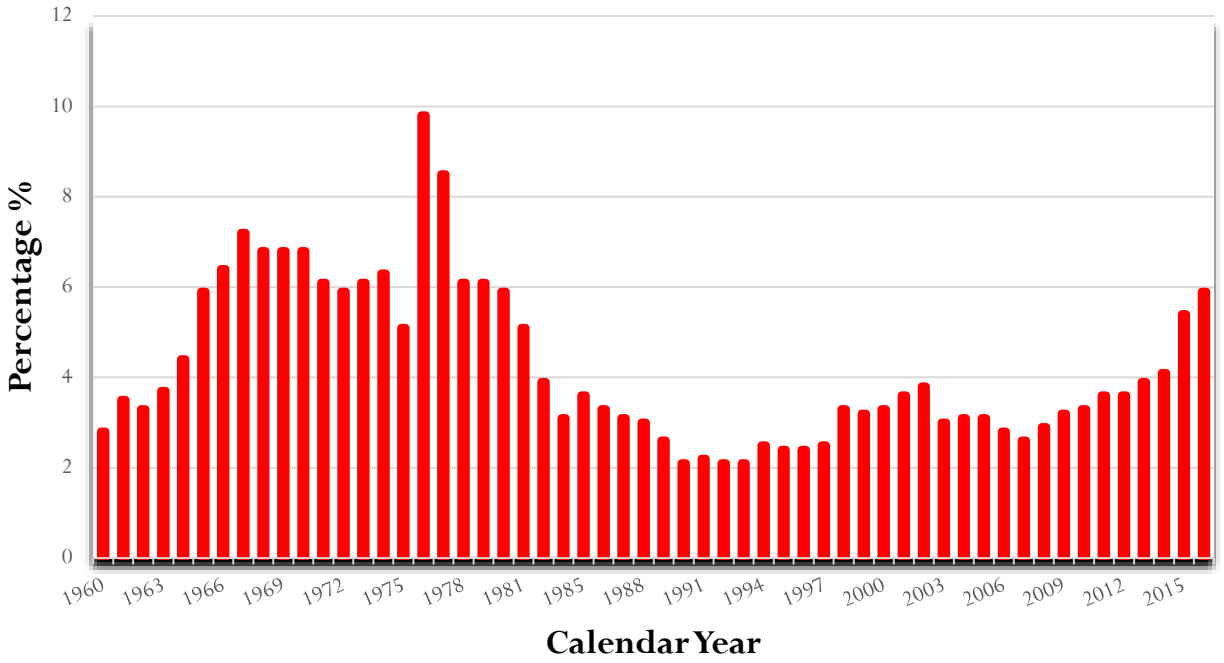
Modest – Average Choice

Small – Low Choice

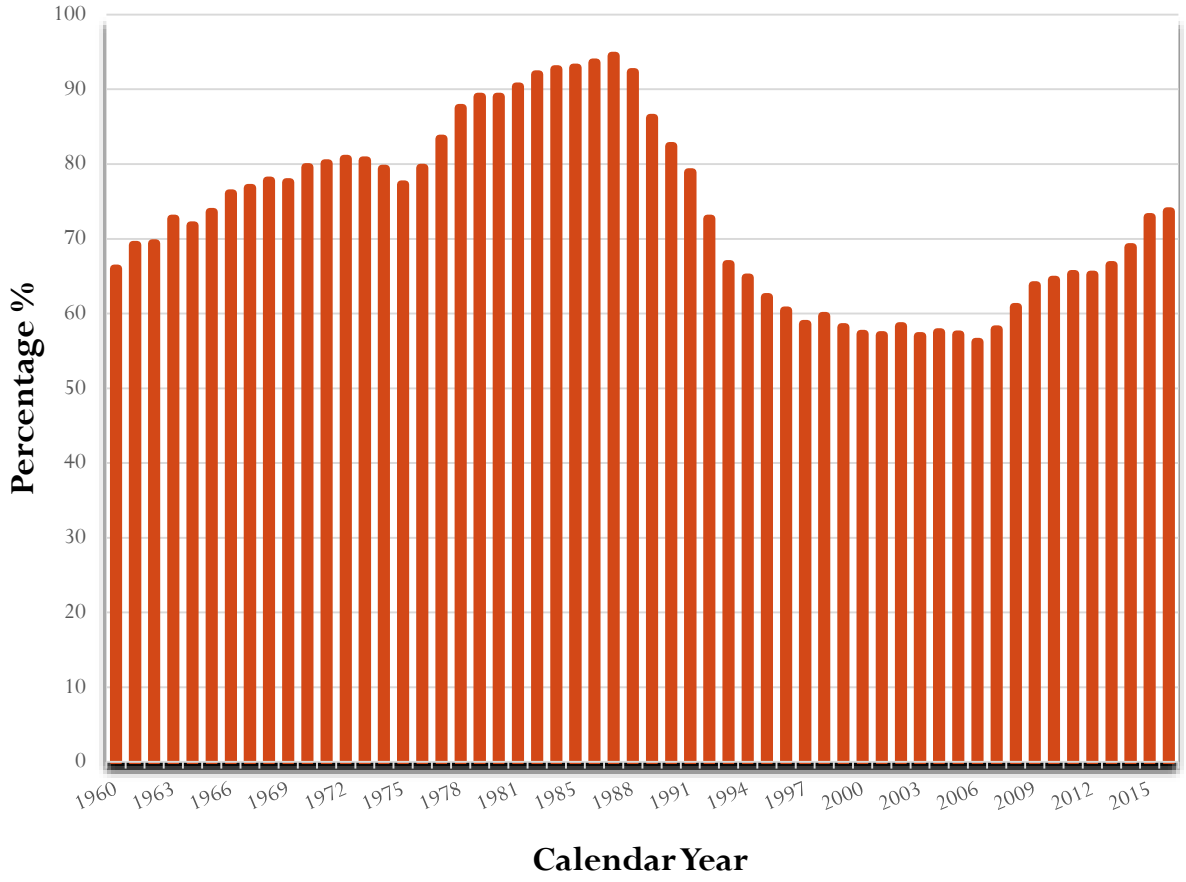


Slight - Select

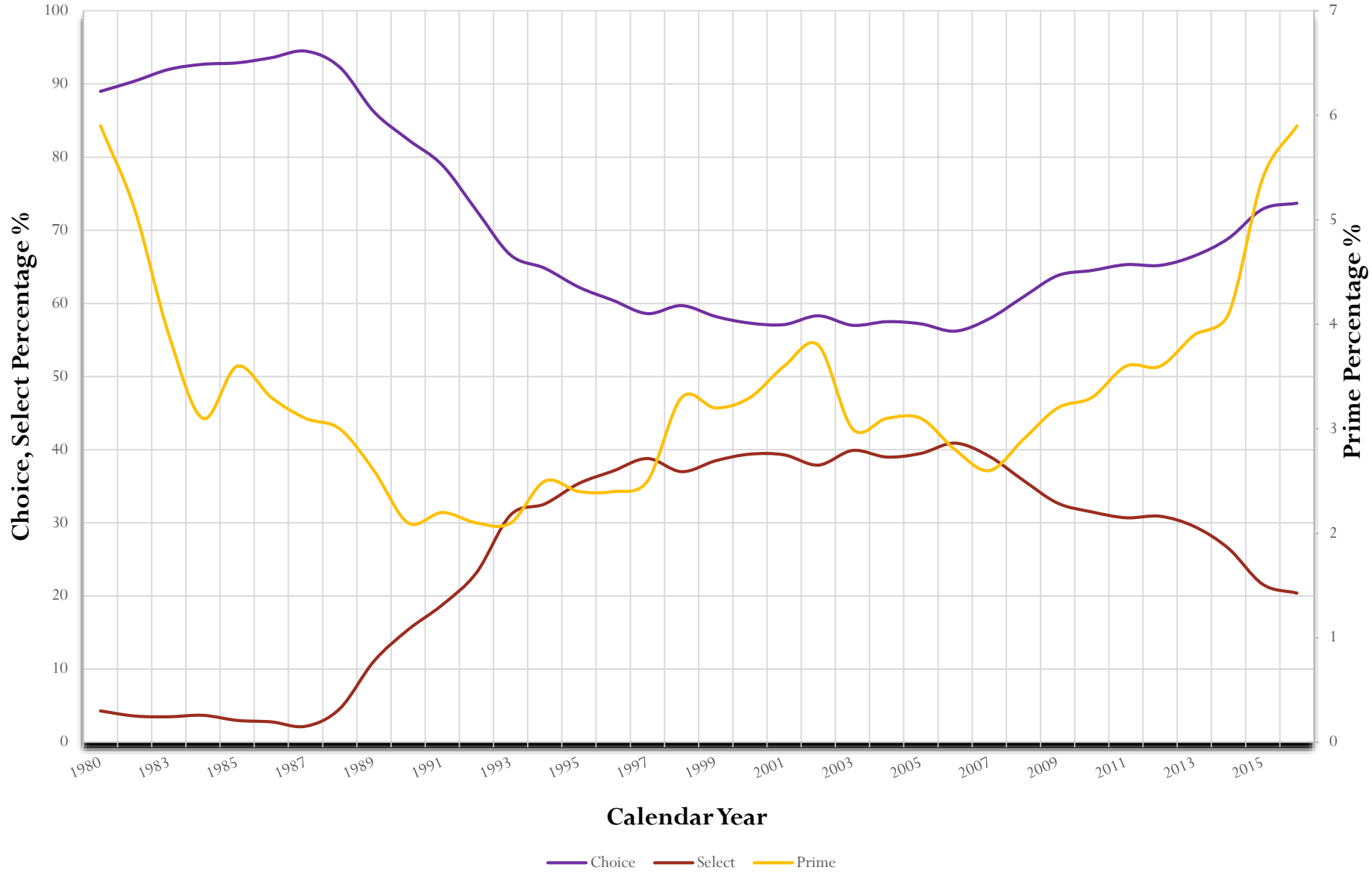
Prime Beef - 1960 to 2016

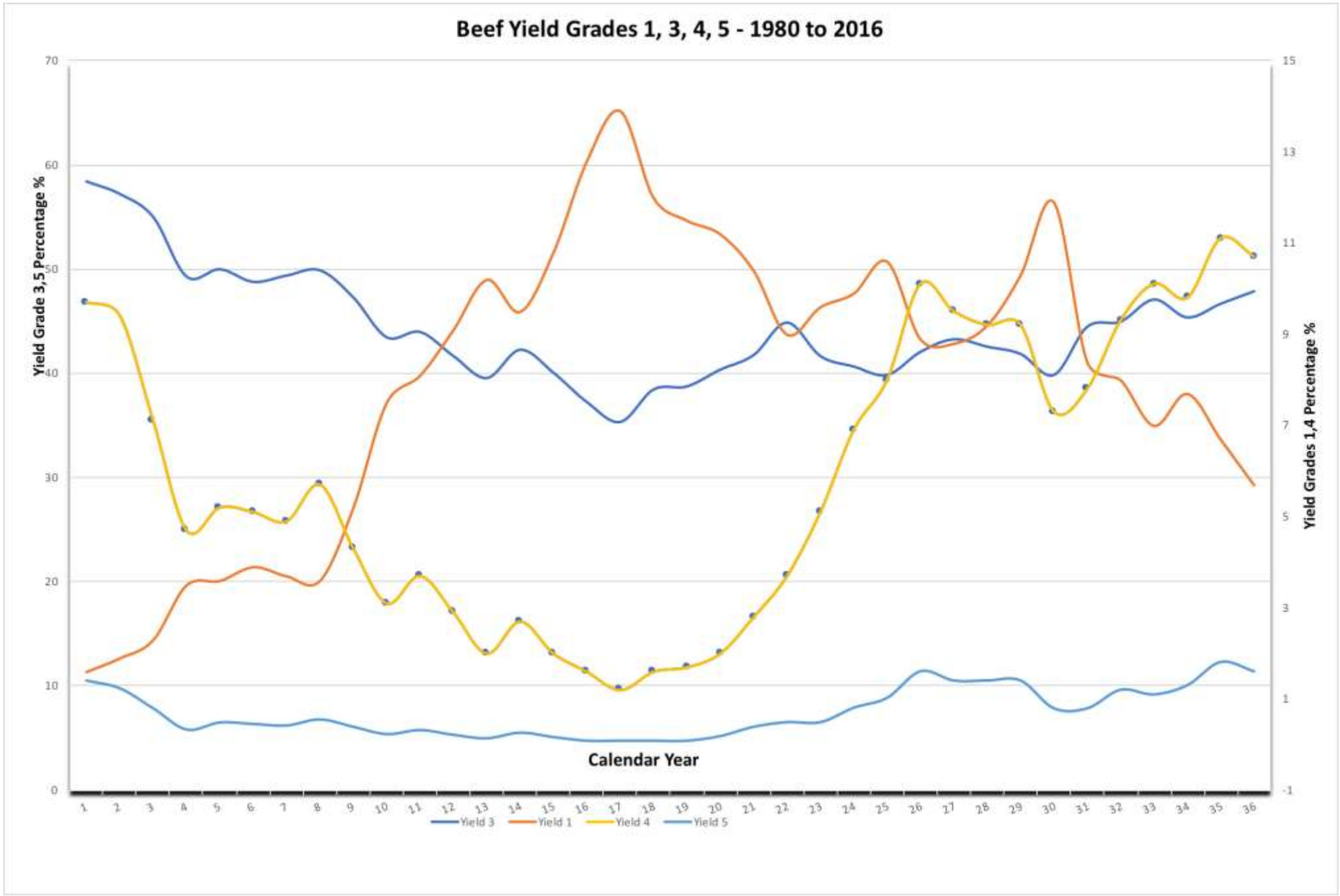


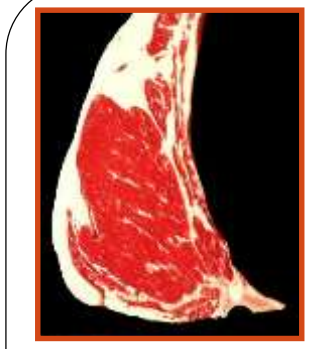
Choice Beef -1960 to 2016



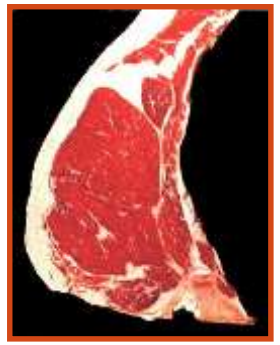
Beef Grades - 1980 to 2016



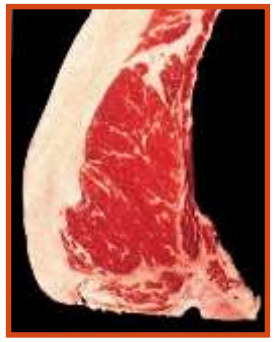

Beef Yield Grades 1, 3, 4, 5 - 1980 to 2016
Yield Grade 3,5 Percentage %
Yield Grades 1,4 Percentage %
Calendar Year
70
60
50
40
30
20
10
0
15
13
11
9
7
5
3
1
-1
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36
Yield 3
Yield 1
Yield 4
Yield 5



YG-1



YG-3



YG-5

USDA Yield Grades

Yield Grades:

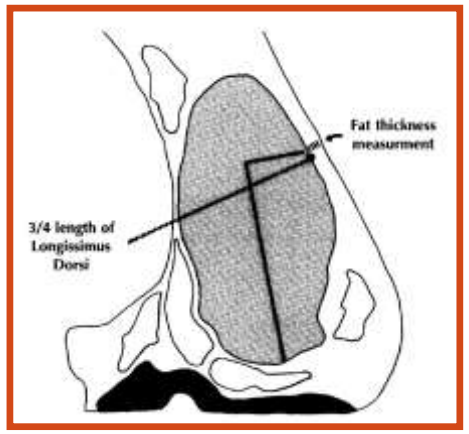
Reflect differences in yield of closely trimmed, boneless retail cuts from the round, loin, rib, and chuck.

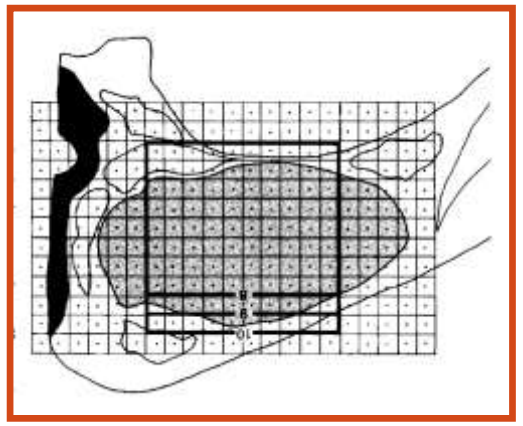
YG-1 more than 52.3%
YG-2 50.1 to 52.3%
YG-3 47.8 to 50.0%
YG-4 45.5 to 47.7%
YG-5 45.4% or less

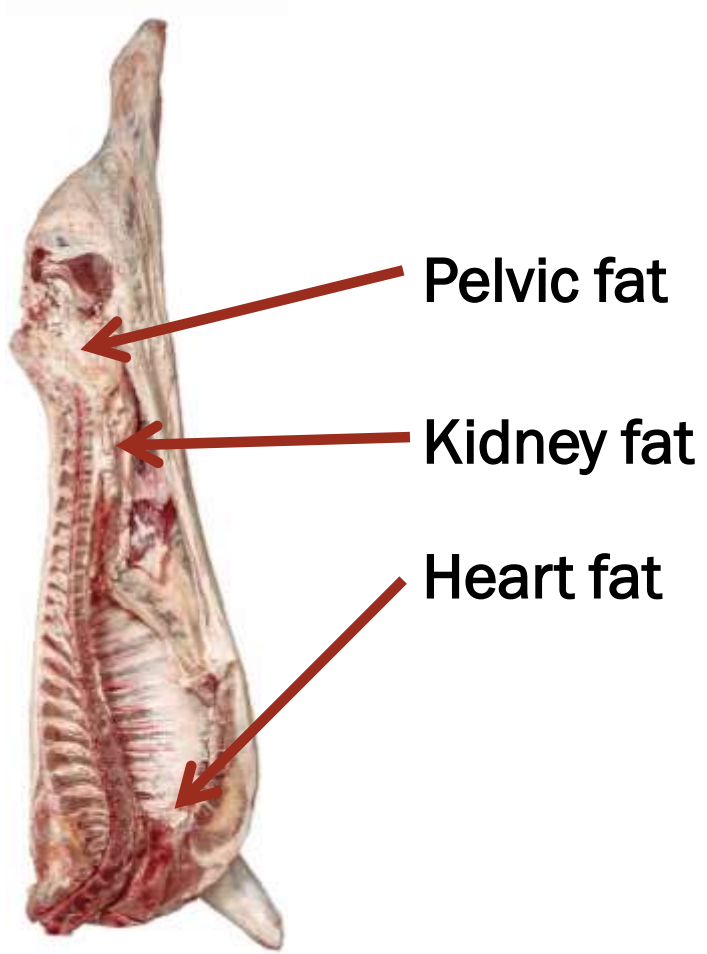
USDA Yield Grade Factors

- **Thickness of Fat over the ribeye (adjusted)**
- **Ribeye area**
- **Estimated % kidney, pelvic and heart (KPH) fat**
- **Hot carcass weight**

YG = 2.5 +(2.5*FT) – (.32*REA) + (.2*KPH) + (.0038*HCW)

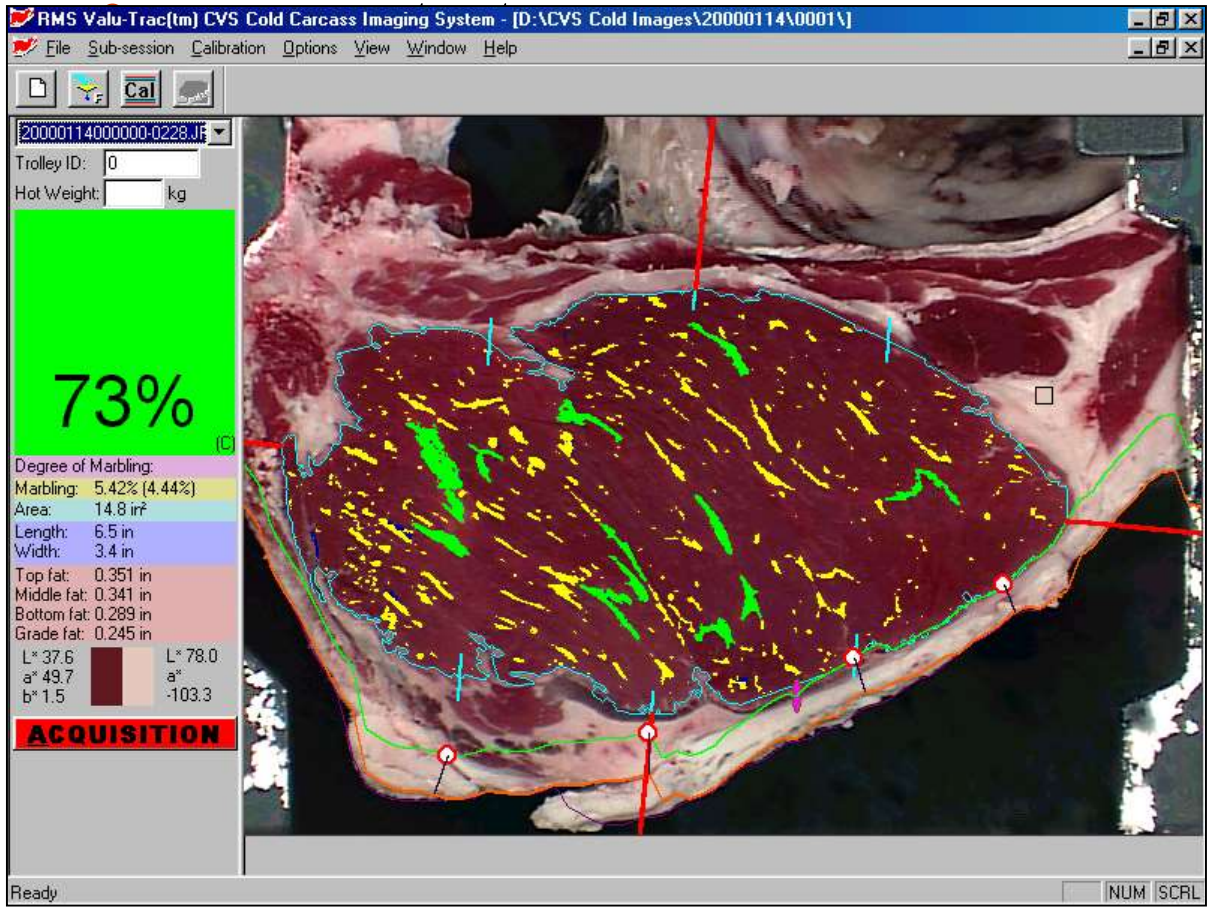






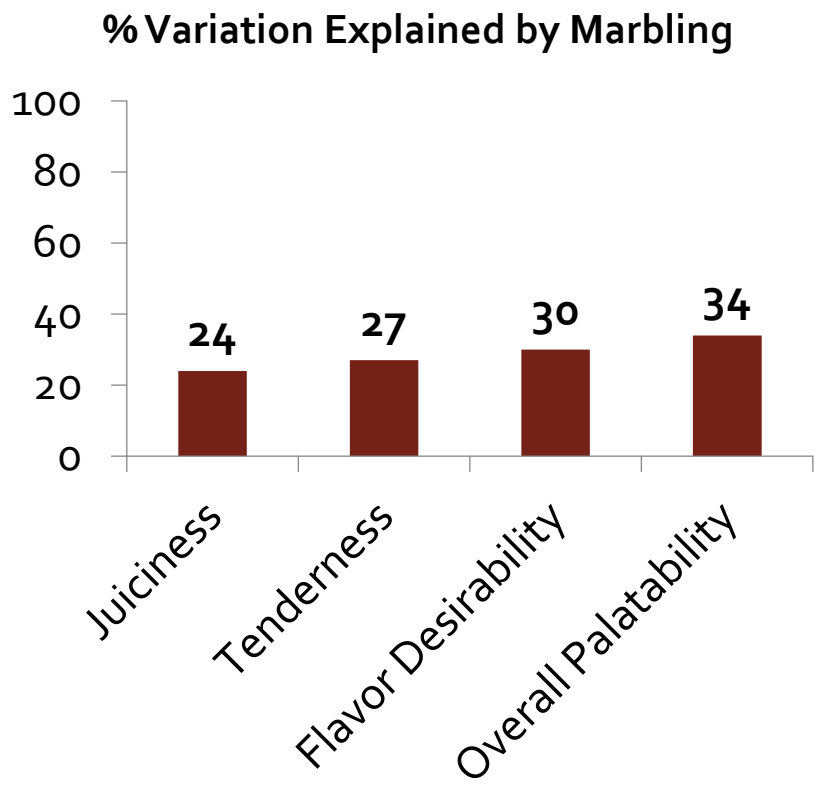
Camera Grading Systems

Augmentation of USDA Grade Application

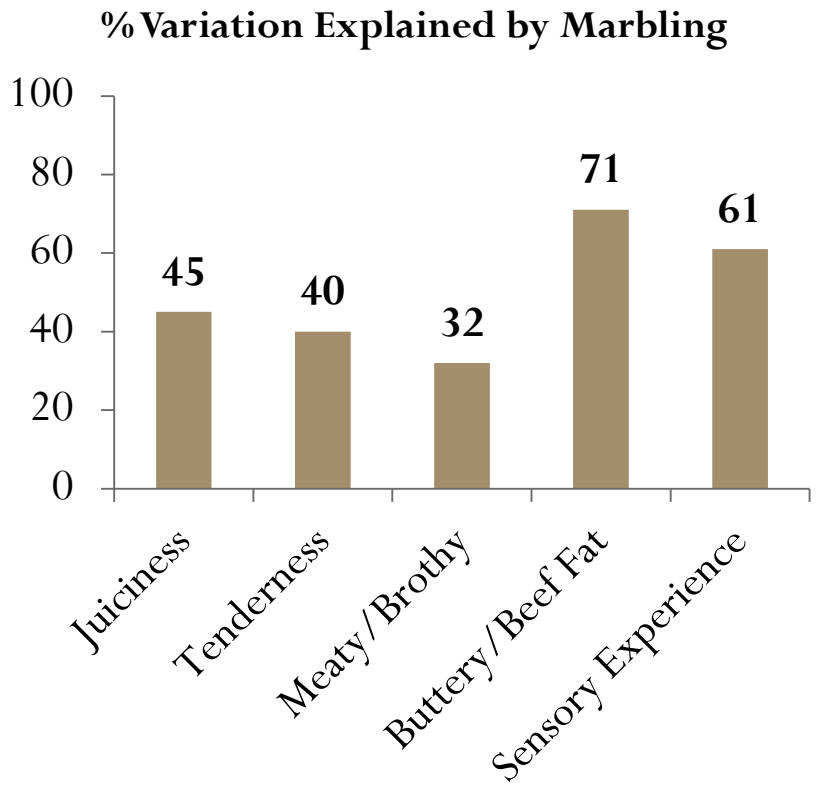


Variation in Beef Sensory Attributes Explained by Differences in Marbling

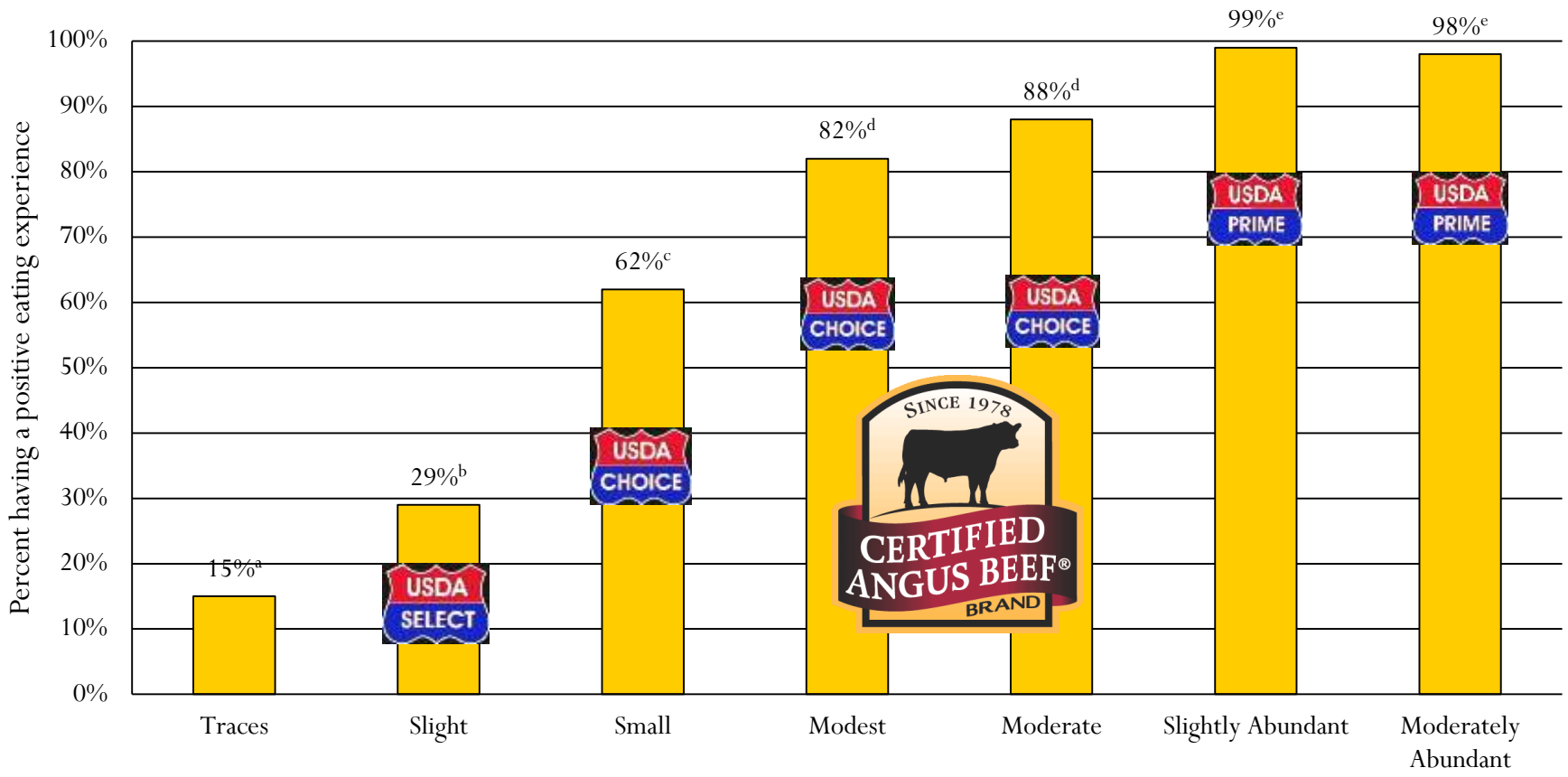
TAMU "1005-Head Study" Smith et al. (1980)



Camera study



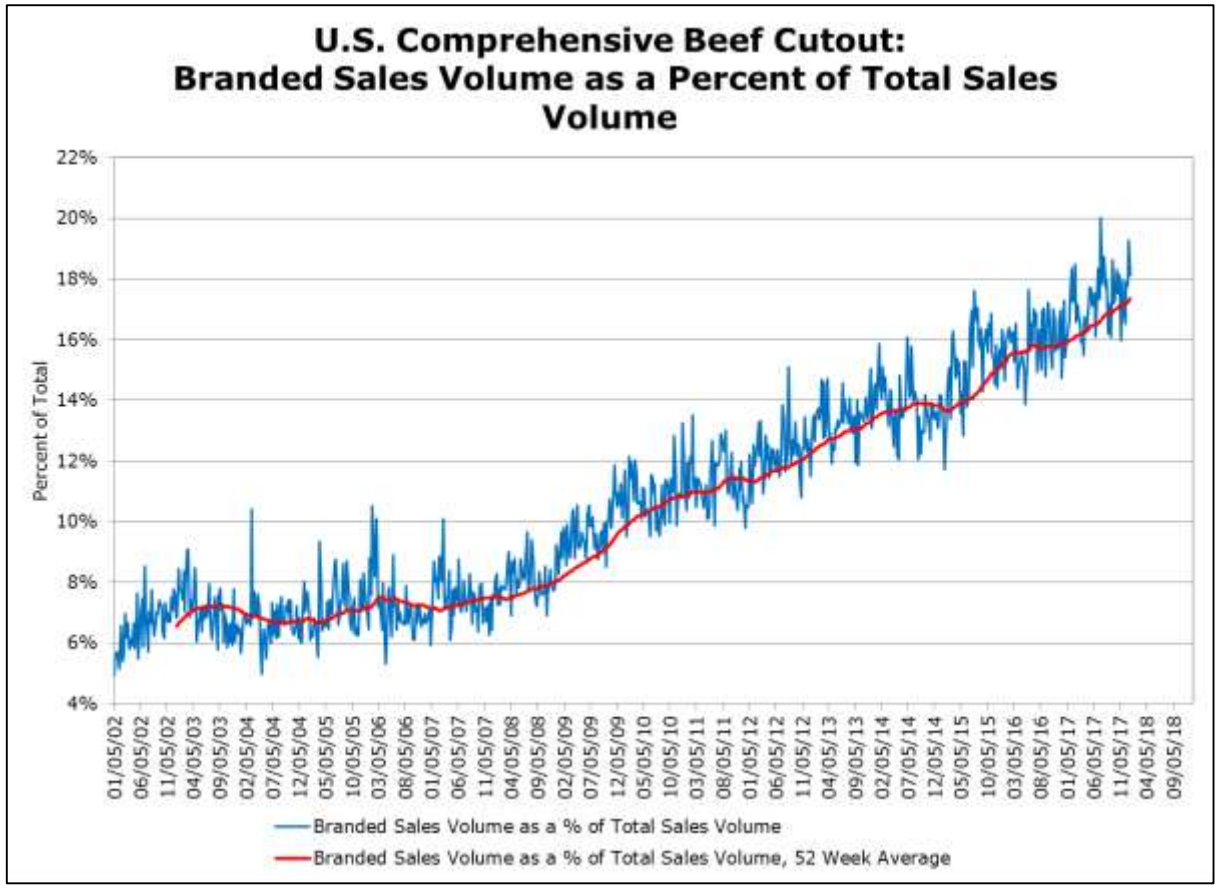
Effect of Marbling Degree on Probability of a Positive Sensory Experience



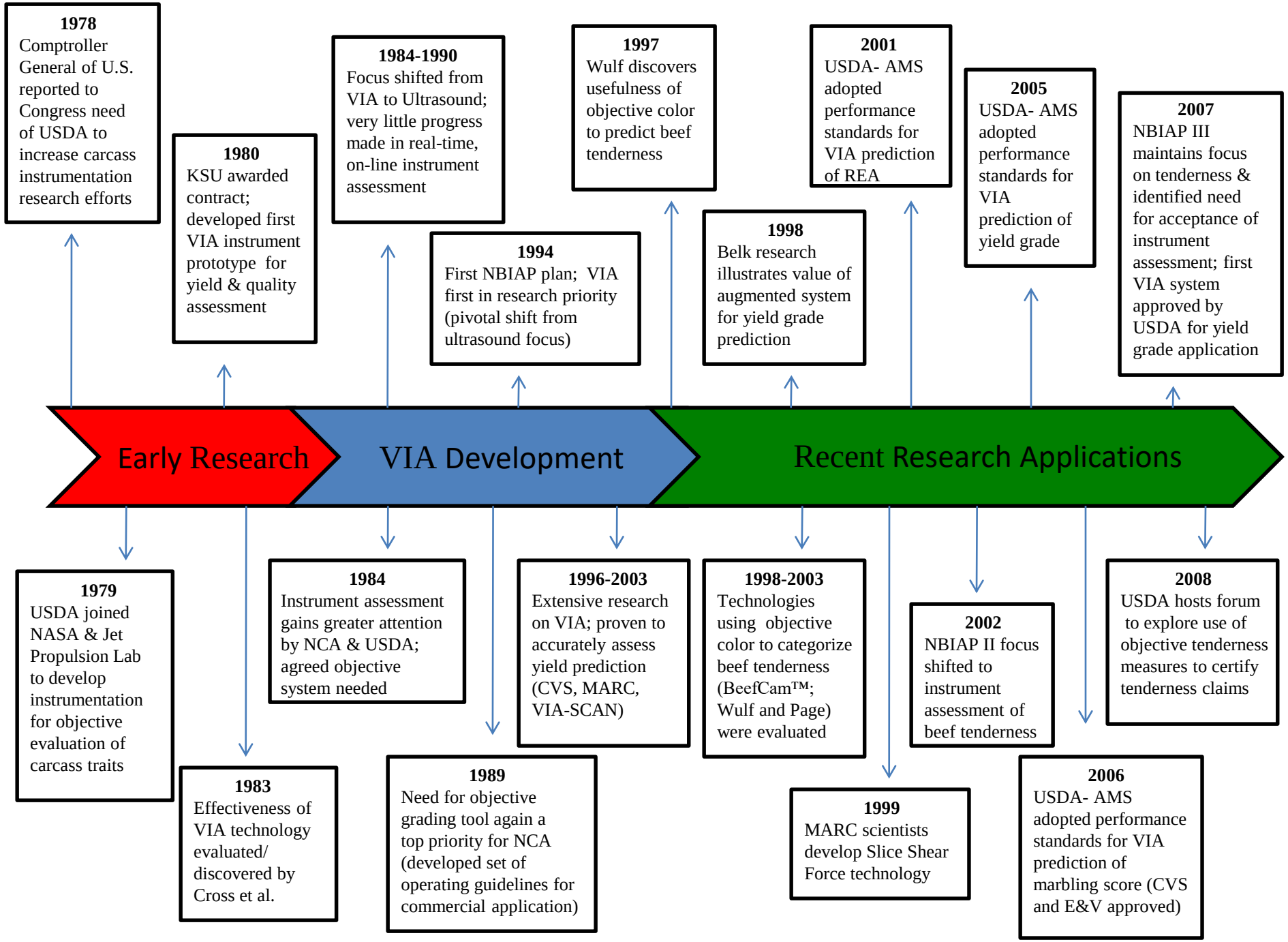
Colorado State University M.S. Thesis: M. R. Emerson (2011)

"This is one of the food business's biggest new battlefields, as meat packers make a bold bid to turn their anonymous product into coveted national brand names."

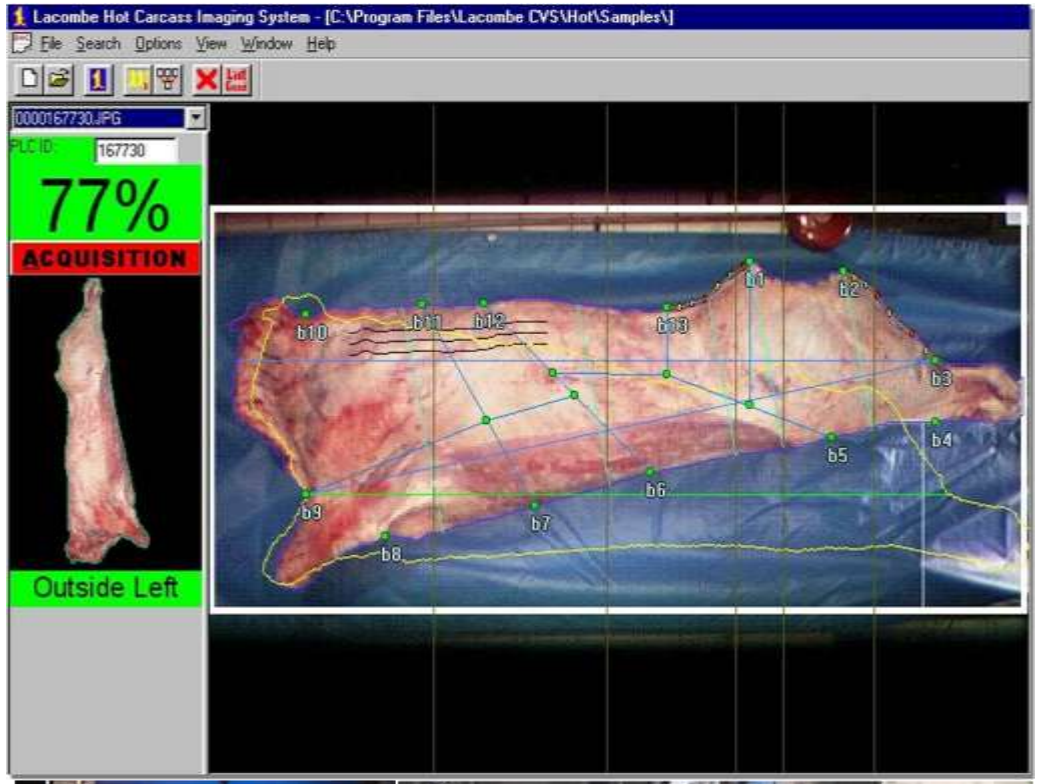
Branded Beef Demand

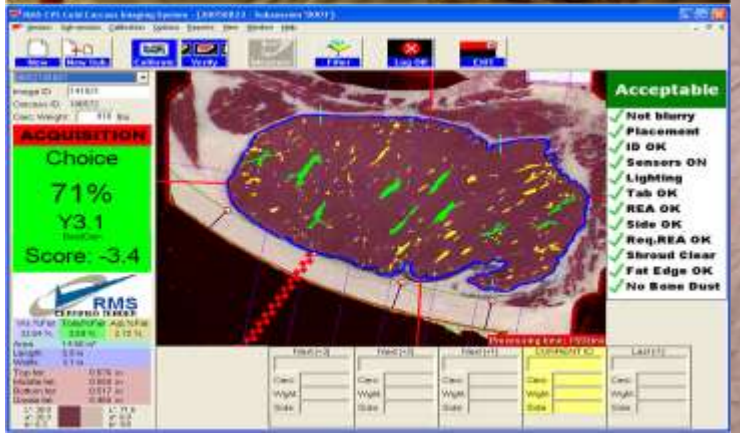


www.beefresearch.org


1978
Comptroller General of U.S. reported to Congress need of USDA to increase carcass instrumentation research efforts
1980
KSU awarded contract; developed first VIA instrument prototype for yield & quality assessment
1984-1990
Focus shifted from VIA to Ultrasound; very little progress made in real-time, on-line instrument assessment
1994
First NBIAP plan; VIA first in research priority (pivotal shift from ultrasound focus)
1997
Wulf discovers usefulness of objective color to predict beef tenderness
1998
Belk research illustrates value of augmented system for yield grade prediction
2001
USDA- AMS adopted performance standards for VIA prediction of REA
2005
USDA- AMS adopted performance standards for VIA prediction of yield grade
2007
NBIAP III maintains focus on tenderness & identified need for acceptance of instrument assessment; first VIA system approved by USDA for yield grade application
Early Research
VIA Development
Recent Research Applications
1979
USDA joined NASA & Jet Propulsion Lab to develop instrumentation for objective evaluation of carcass traits
1983
Effectiveness of VIA technology evaluated/ discovered by Cross et al.
1984
Instrument assessment gains greater attention by NCA & USDA; agreed objective system needed
1989
Need for objective grading tool again a top priority for NCA (developed set of operating guidelines for commercial application)
1996-2003
Extensive research on VIA; proven to accurately assess yield prediction (CVS, MARC, VIA-SCAN)
1998-2003
Technologies using objective color to categorize beef tenderness (BeefCam™; Wulf and Page) were evaluated
1999
MARC scientists develop Slice Shear Force technology
2002
NBIAP II focus shifted to instrument assessment of beef tenderness
2006
USDA- AMS adopted performance standards for VIA prediction of marbling score (CVS and E&V approved)
2008
USDA hosts forum to explore use of objective tenderness measures to certify tenderness claims

Hot Camera Systems

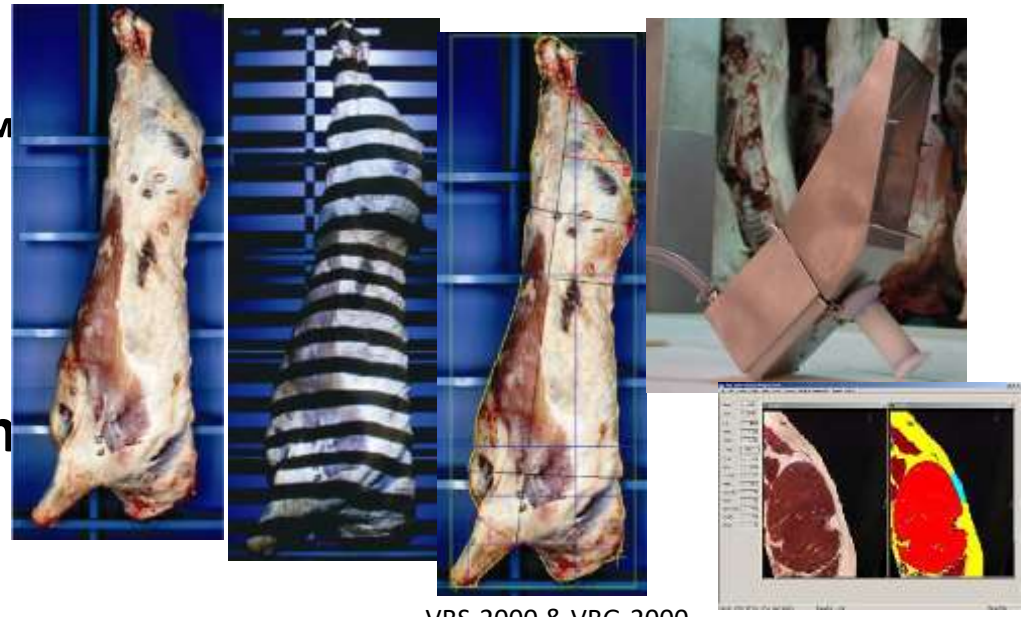




Cold Camera Systems

Beef Carcass Instrumentation

- **Australian VIAScan™**
- **Computer Vision System™ (CVS™)**
  - **RMS Research Management Systems (Canada/USA)**
- **Beef Carcass Classification Center II™ (BCC-II™)**
  - **SFK (Denmark)**
- **VBS-2000 & VBG-2000**
  - **E+V (Germany)**
- **QualitySpec BT Spectrometer**
  - **Analytical Spectral Devices, Inc.**



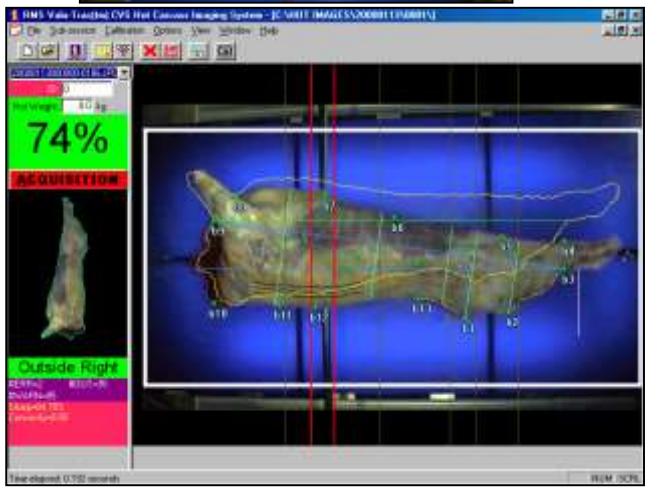
VBS-2000 & VBG-2000
e+v Technology GmbH

Computer Vision System
RMS Research Management Systems, Inc.

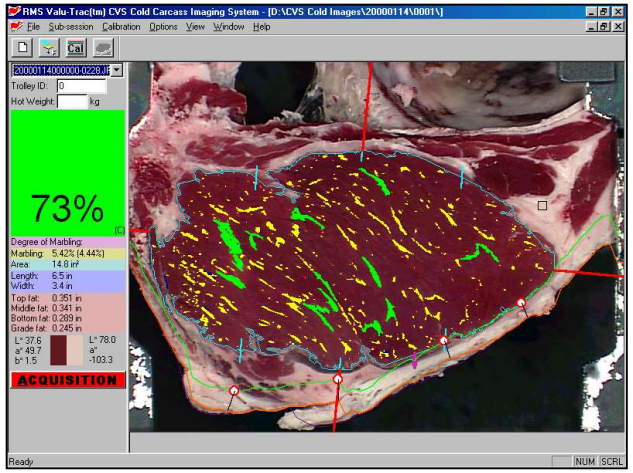
QualitySpec BT Spectrometer
Analytical Spectral Devices, Inc.

Dual Component VIA Systems & Output

Hot System Camera



Chilled Carcass System



DANISH MEAT
RESEARCH INSTITUTE

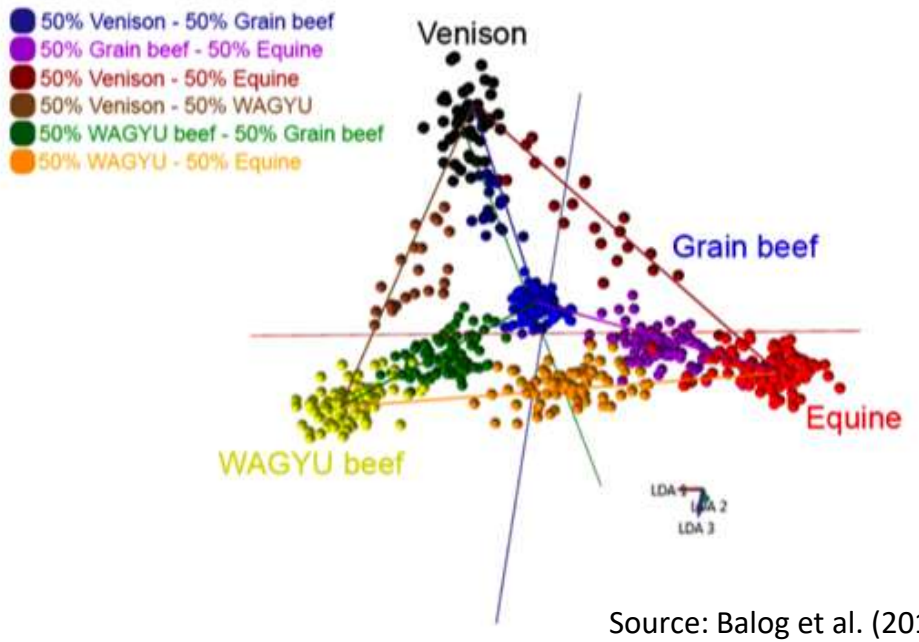
“The world’s first online CT scanner for food”

X-Ray Technologies

- Past technologies have been imaged based, but new technologies are x-ray based technologies
  - CT Scans
    - Danish Meat Institute
  - Dexa
    - Australian x-ray system
- X-ray technologies show the most promise for advancing accuracy of yield prediction
  - Use to predict % fat-free lean
  - Use to estimate trim/grind lean points in addition to %BCTRC

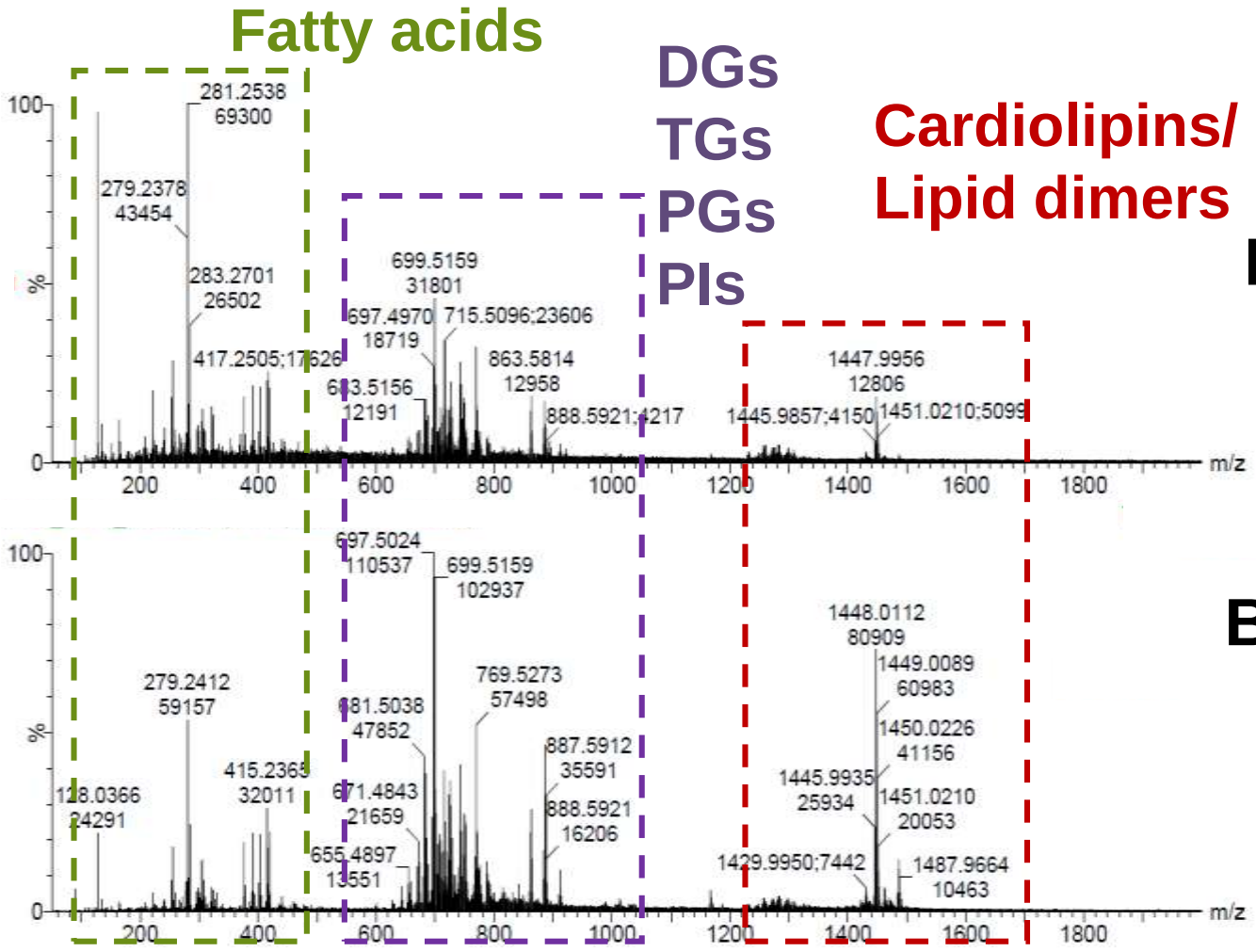
Rapid Evaporative Ionization Mass Spectrometry (REIMS)

- New technique allowing for characterization of biological tissues
- Provides molecular fingerprint
  - Real-time analysis (seconds)
  - No sample preparation
  - Hand-held sampling device
- Histological-based tissue identification with 90-98% accuracy (Balog et al., 2013)



Source: Balog et al. (2016)

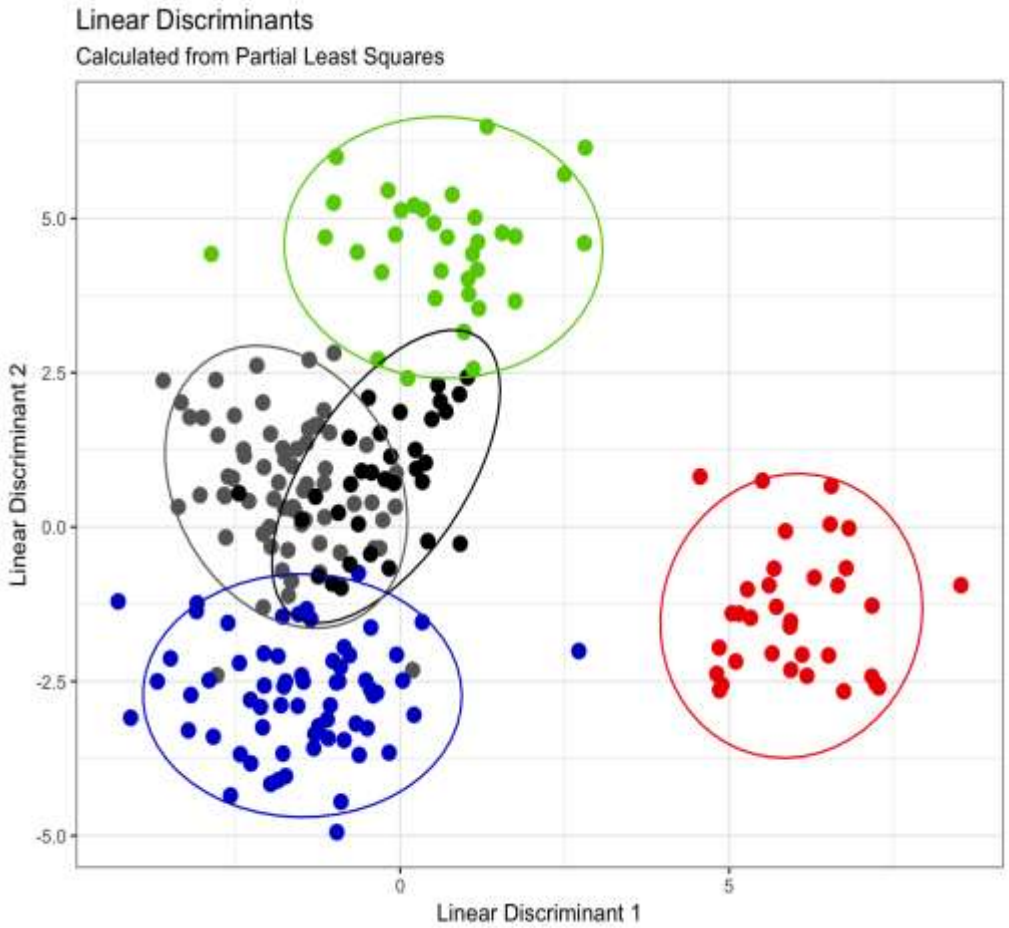
Rapid Evaporative Ionization (REIMS) Mass Spectrometry

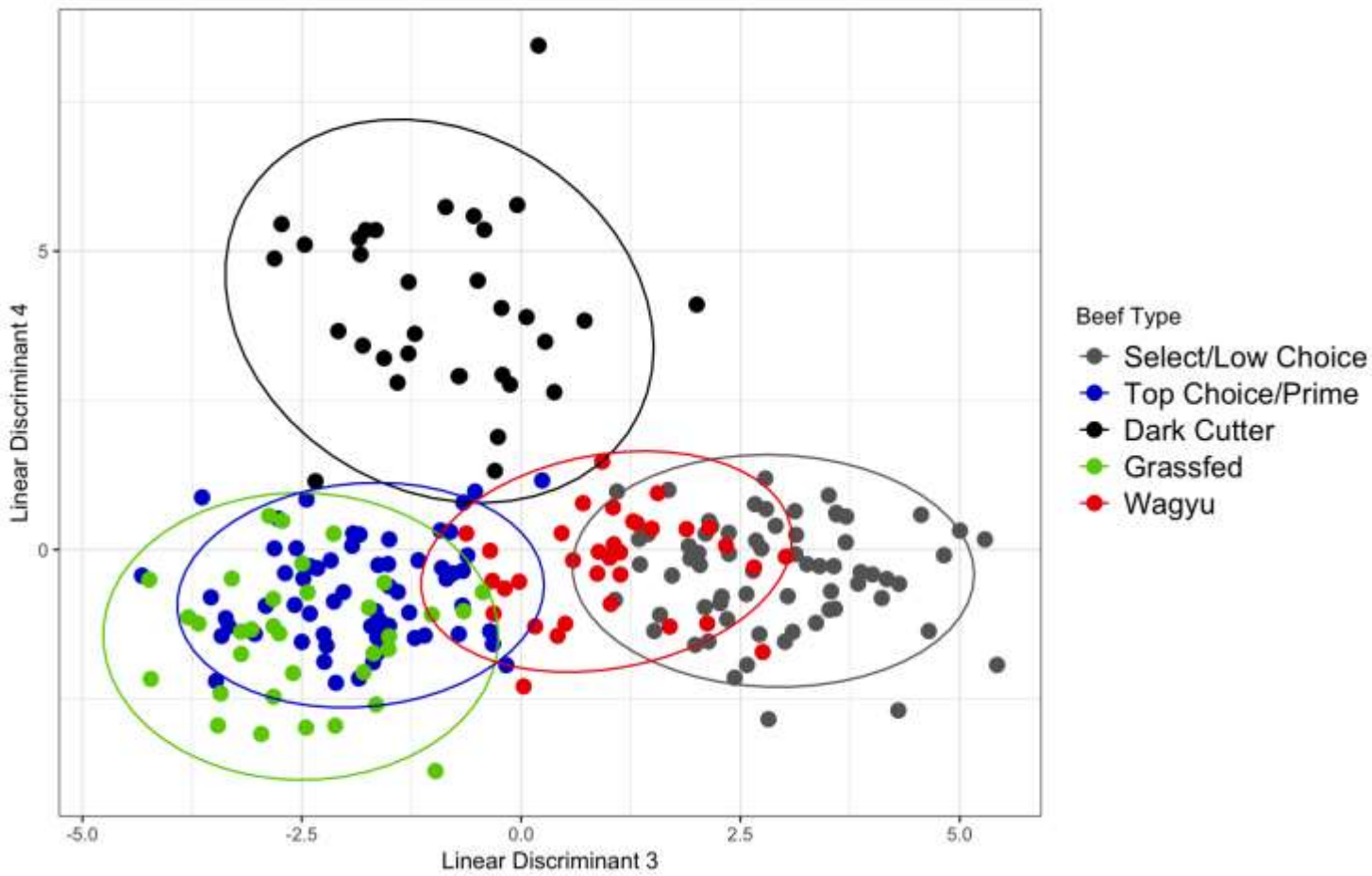


MILD (-)

BOLD (-)

Beef Type Classification



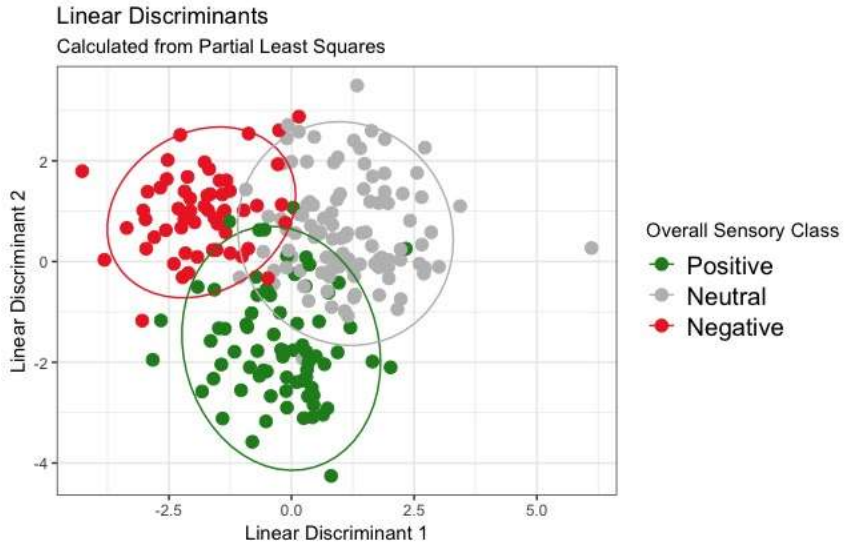


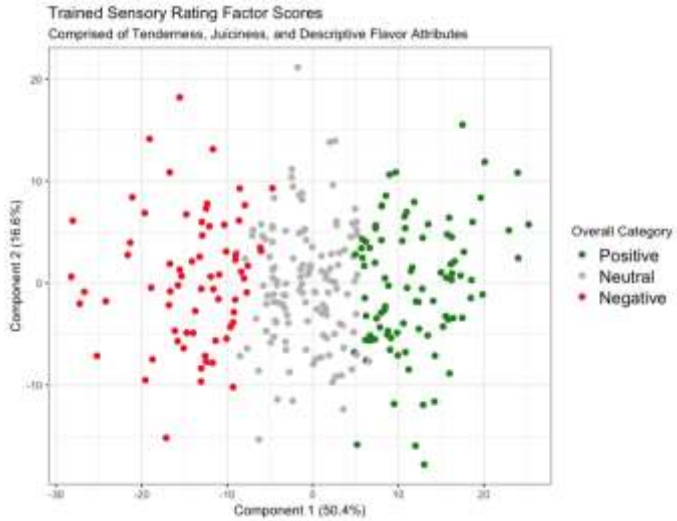
Sensory Prediction with REIMS

Overall

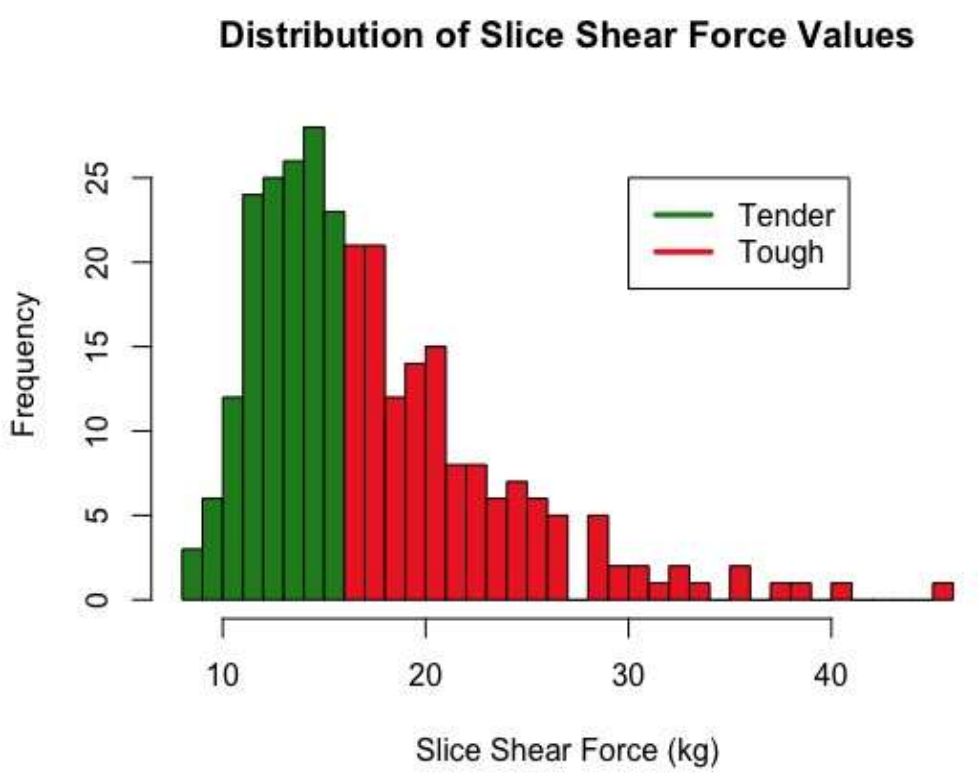
	Predicted Class				
Reference Class	Positive	Negative	Total	Sensitivity	Precision
Positive	11	7	18	61.1%	73.3%
Negative	4	35	39	89.7%	83.3%
Total	15	42	57		

Overall Prediction Accuracy	80.7%
Balanced Prediction Accuracy	75.4%





SSF Tenderness Classification



	Predicted Class				
Reference Class	Tender	Tough	Total	Sensitivity	Precision
Tender	18	9	27	66.7%	78.3%
Tough	5	25	30	83.3%	73.5%
Total	23	34	57		

Overall Prediction Accuracy	75.44%
Balanced Prediction Accuracy	75.00%

Questions, please.
Thank you!

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