Genetic improvement of carcass traits in *Bos Indicus* influenced cattle

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What do consumers want?

- The **National Beef Quality Audit**
  - Seedstock Producers, Cow-Calf Producers, Stockers/ Backgrounders, Feedlot Operators, Packers, Purveyors, Retailers, & Restauranteurs
  - "**Eating satisfaction**" - only quality category for which the packers, food service buyers, and retailers are willing to pay a premium
- NBQA Strategy Workshop
  - Discuss the implications of research for the U.S. beef industry, provides the beef industry with a blueprint for the next five years
  - **Top 10** Quality Challenges:
    1. Low overall uniformity & consistency of cattle, carcasses, cuts
    2. Inappropriate carcass size & weight
    3. Inadequate **tenderness** of beef
    4. Insufficient marbling

National Beef Quality Audit

Quality Challenges

Ranked according to priority, 1991 to 2011

1991	1995	2000	2005	2011
External Fat	Overall Uniformity	Overall Uniformity	Traceability	Food Safety
Seam Fat	Overall Palatability	Carcass Weights	Overall Uniformity	Eating Satisfaction
Overall Palatability	Marbling	Tenderness	Instrument grading	How and where cattle were raised
Tenderness	Tenderness	Marbling	Market Signals	Weight and Size
Overall Cutability	External and Seam Fat	Reduced quality due to implants	Segmentation	Lean, Fat and Bone
Marbling	Cut weights	External Fat	Carcass Weights	Cattle Genetics

2011 NBQA

Beef Industry Future Outlook

- Strong "**high-quality**" branded beef programs
  - Consumers are willing to pay for assured quality
- Important to maintain and increase current consumers brand loyalty (meeting and exceeding quality expectations)
- Important to **expand** consumer base
- Improving quality – critical for beef industry
- **Tenderness** – the most important sensory attribute

Tenderness
Juiciness
Flavor

Improving Beef Tenderness

- Beef **tenderness**
  - Measured by Warner-Bratzler shear force (kg)
  - Trait measured after **slaughter** & **expensive**
  - **15 - 40%** of the variation – due to **genetics**
- Sustainable strategy to deliver a **consistently superior** quality product:
  - Develop effective selection and management **genomic** tools
  - Assist producers to produce cattle that **fit** customer expectations

How do we communicate quality level?

- Currently USDA grading system (**marbling** and **maturity**) is used to predict **eating quality** of beef

*The U.S. Department of Agriculture (USDA) has established Standards for Grades of Slaughter Cattle and Standards for Grades of Carcass Beef (USDA, 1996), which are designed to **facilitate beef marketing** by separating a highly variable population of live cattle and/or beef carcasses into groups which are **more uniform in quality and composition**.*

*Beef quality refers to the **expected** eating characteristics (tenderness, juiciness and flavor) of the cooked product. USDA Quality Grades are used to reflect differences in expected eating quality among slaughter cattle and their carcasses.*

How do we communicate quality level?

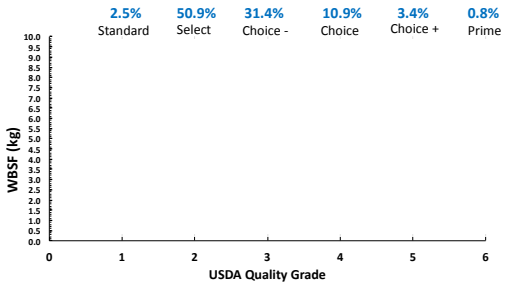
- Currently USDA grading system (**marbling** and **maturity**) is used to predict **eating quality** of beef
  - Limitation in the ability to predict eating quality
  - Limited consumer understanding of the system

Populations

- *Bos Indicus* influenced cattle: UF Angus x Brahman Herd
  - **6,870** animals: from 100%Angus to 100% Brahman
  - ~ **780** animals with **250K** genotypes
  - **1,941** with carcass traits: **marbling score,** hot carcass weight, dressing %, ribeye area, back fat thickness, yield grade, quality grade, KPH.
  - **1,253** with meat quality phenotypes
    - Warner-Bratzler Shear Force (**WBSF**)
  - **640** with sensory panels (**Tenderness**, **Juiciness**, **Connective** tissue, **Flavor**: beef, painty/fishy, livery/metallic)

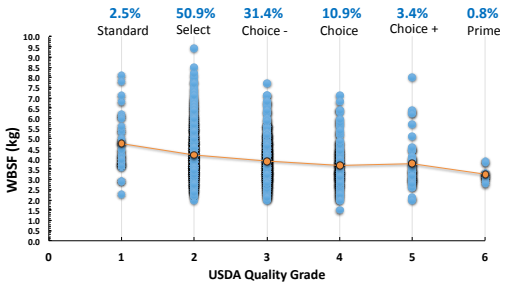
Breed Group	Angus %	Brahman %	Angus %	Brahman %
1	100	0	100-80	0-20
2	75	25	79-60	21-40
3	62.5	37.5	62.5	37.5
4	50	50	59-40	41-60
5	25	75	39-20	61-80
6	0	100	19-0	81-100

Tenderness by USDA Quality Grade



UF Angus x Brahman
(N = 1,253)

Tenderness by USDA Quality Grade



UF Angus x Brahman
(N = 1,253)

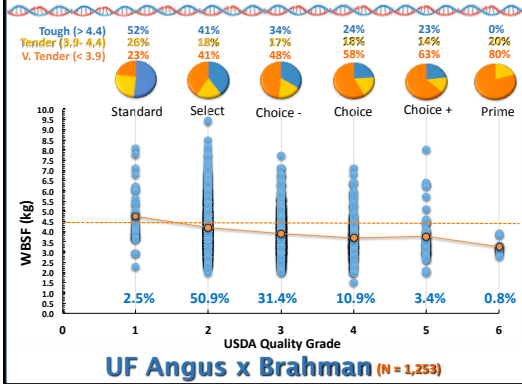
Certified Tender Program

- USDA-AMS – design a **tenderness standard** for beef
  - Facilitate corresponding marketing claims by the industry
  - Better align incentives for assuring tenderness.

- **Tender**
  4.4 kg of WBSF
  USDA CERTIFIED TENDER

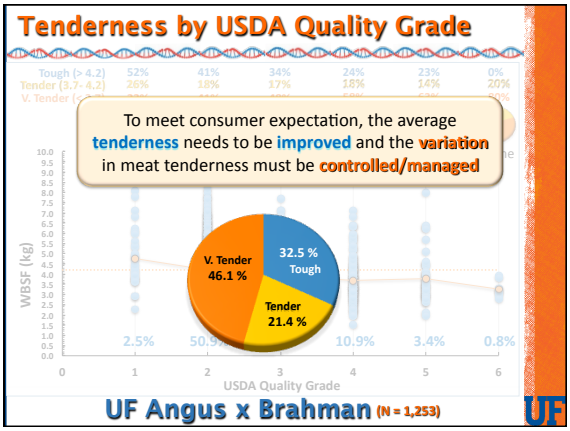
- **Very Tender**
  3.9 kg of WBSF
  USDA CERTIFIED VERY TENDER

Tenderness by USDA Quality Grade



UF Angus x Brahman (N = 1,253)

Tenderness by USDA Quality Grade



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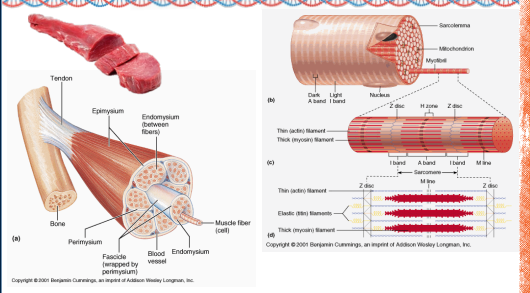
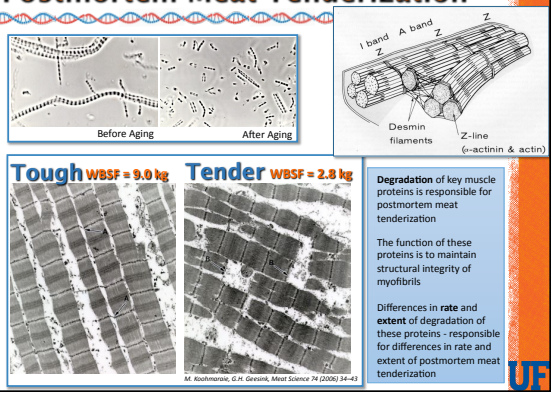
Biological Basis of Beef Tenderness



Meat **tenderness** is determined by the amount and solubility of **connective** tissue, sarcomere **shortening** during rigor development, and postmortem **proteolysis** of myofibrillar and myofibrillar-associated proteins (titin and desmin).

Postmortem Meat Tenderization

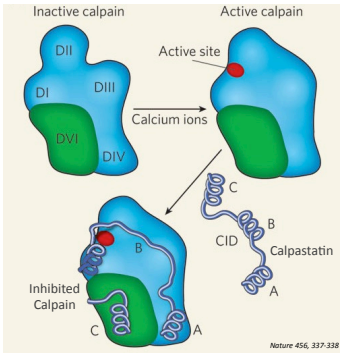


Degradation of key muscle proteins is responsible for postmortem meat tenderization

The function of these proteins is to maintain structural integrity of myofibrils

Differences in **rate** and **extent** of degradation of these proteins - responsible for differences in rate and extent of postmortem meat tenderization

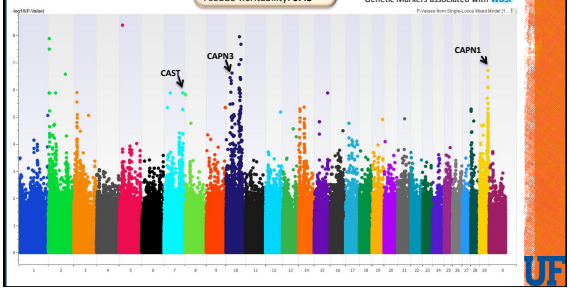
The Calpain Proteolytic System



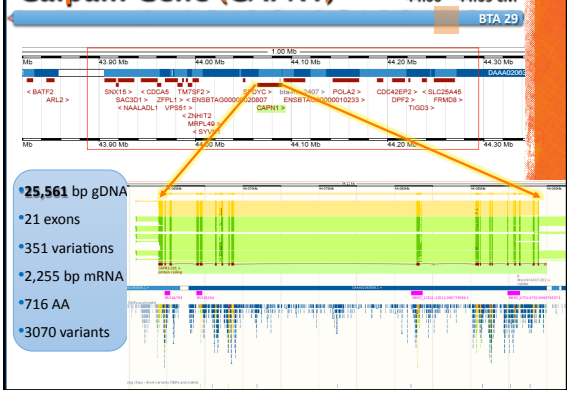
Genome-wide association, Angus

- Identify **SNPs** and chromosomal regions associated with tenderness.

Samples scanned: 1,012
Markers scanned: 708,461
Markers analyzed: 690,096
Pseudo-heritability: **0.45**



Calpain Gene (CAPN1)



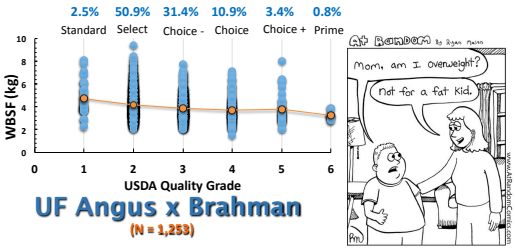
- **25,561** bp gDNA
- 21 exons
- 351 variations
- 2,255 bp mRNA
- 716 AA
- 3070 variants

Breed-specific genomic tools

- Genetic markers in CAPN/CAST system can be used in *B. Taurus* animals
- Analysis of ~ 800 *B. Indicus* influenced cattle for DNA markers in CAPN & CAPST (~40): no effect.
- To be effective - genomic tools need to be developed in the **target** populations
  - Large resource populations with phenotypes are required for discovery and estimation.

Challenge or Opportunity

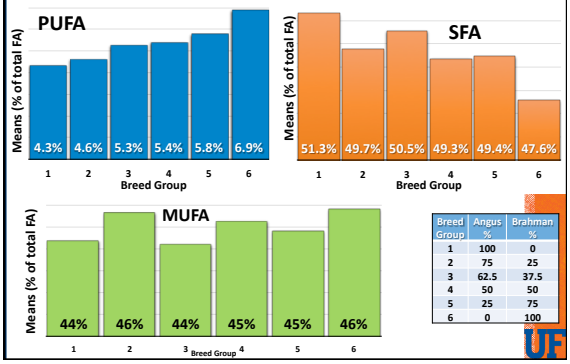
- Consumers today are increasingly interested in a **healthful** diet
- Beef nutritional and healthfulness value



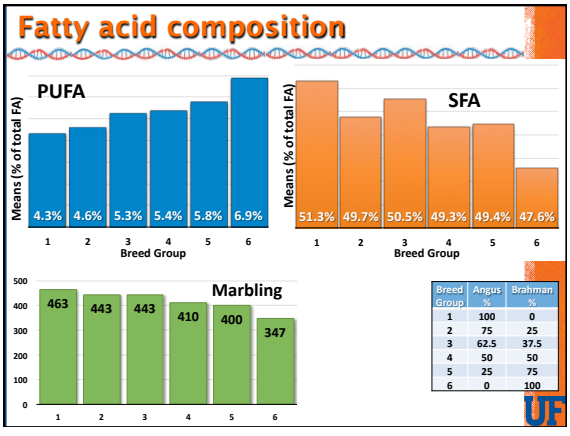
Challenge or Opportunity

- Consumers today are increasingly interested in a **healthful** diet
- Beef nutritional and healthfulness value
- UF Angus x Brahman Herd
  - **150** animals: 100%Angus - 100% Brahman
  - Fatty acid composition: 28 individual fatty acids grouped into saturated (**SFA**), mono (**MUFA**) and polyunsaturated (**PUFA**)
  - Mineral composition: **iron**, **zinc**, sodium, magnesium, manganese, phosphorus, potassium, calcium, copper

Fatty acid composition



Fatty acid composition



Beef Industry Prosperity

"The path to sustainable, profitable growth begins with creating more promoters [happy customers] and few detractors [unhappy customers]…
It's that simple and that profound."

Frederick Reichheld, Harvard Business Review, Dec., 2003

The cornerstone of **prosperity** for any industry depends on final **consumer demand**

Conclusions

- **Quality** of beef important to drive **demand**
- Brahman-influenced cattle – penalized for relatively **low marbling: could be an opportunity**
- Selection and management **genomic** tools – sustainable strategy
- To be effective - genomic tools need to be developed in the **target** populations
  - Large resource populations with phenotypes are required for discovery and validation.

Genomics - technology to accelerate genetic progress.

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Questions?