Meat quality and thermotolerance in *Bos Indicus* influenced cattle

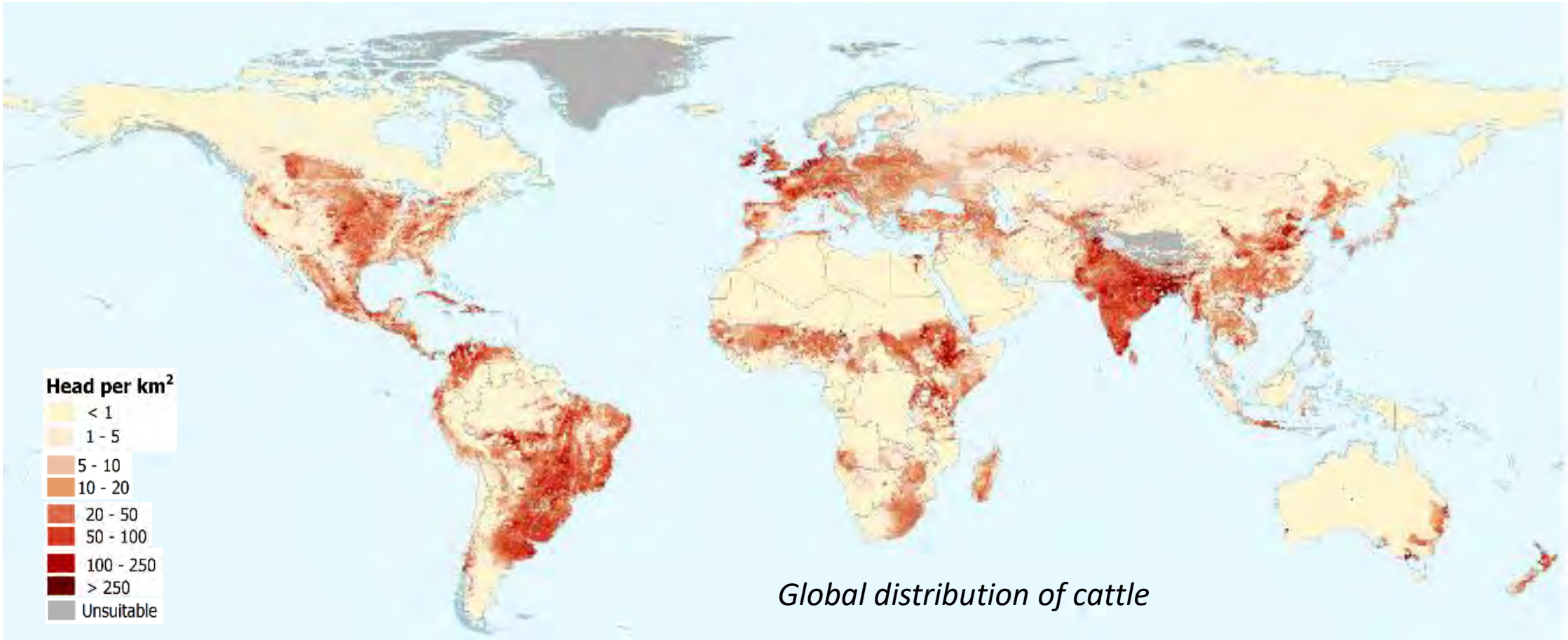
Raluca Mateescu | Associate Professor
Animal Genomics

Department of
Animal Sciences

UF | UNIVERSITY of FLORIDA

Beef cattle in the world

- > **50%** cattle in the world – maintained in hot and humid environments
  - including ~ 40% of beef cows in US



Global distribution of cattle

Bos Indicus cattle

- Approximately **80%** of global beef production is *Bos Indicus* based.

***Bos indicus* germplasm:**

- Critical role in US and worldwide beef production
- Particularly when used as part of a well-structured crossbreeding program

- **Adapted to heat and humidity**
- **Resistant (or at least tolerant) to internal and external parasites**
- **In crossbreeding systems produce improved cattle:**
  - Fertile
  - Gain well
  - Long lived

Two areas of interest

Meat Quality

- Top priority for beef industry
  - Great power to influence demand
  - Can be improved
- V. important for *B. indicus* crosses
  - Routinely penalized for relatively low marbling score.
  - Routinely penalized for perceived inadequate tenderness

Thermotolerance

- Climatic stress - major limiting factor of production efficiency
- Genomic tools can help select
  - Animals with superior ability for both thermal adaptation and food production
  - Energy-efficient, sustainable approach to meet the challenge of global climate change.

Meat quality

Meat Quality

USDA grading system

Based on marbling and maturity

Limited in predicting eating quality

Tenderness

Genomic Tests

Developed on *B. Taurus* data

Limited prediction in *B. Indicus* -influenced

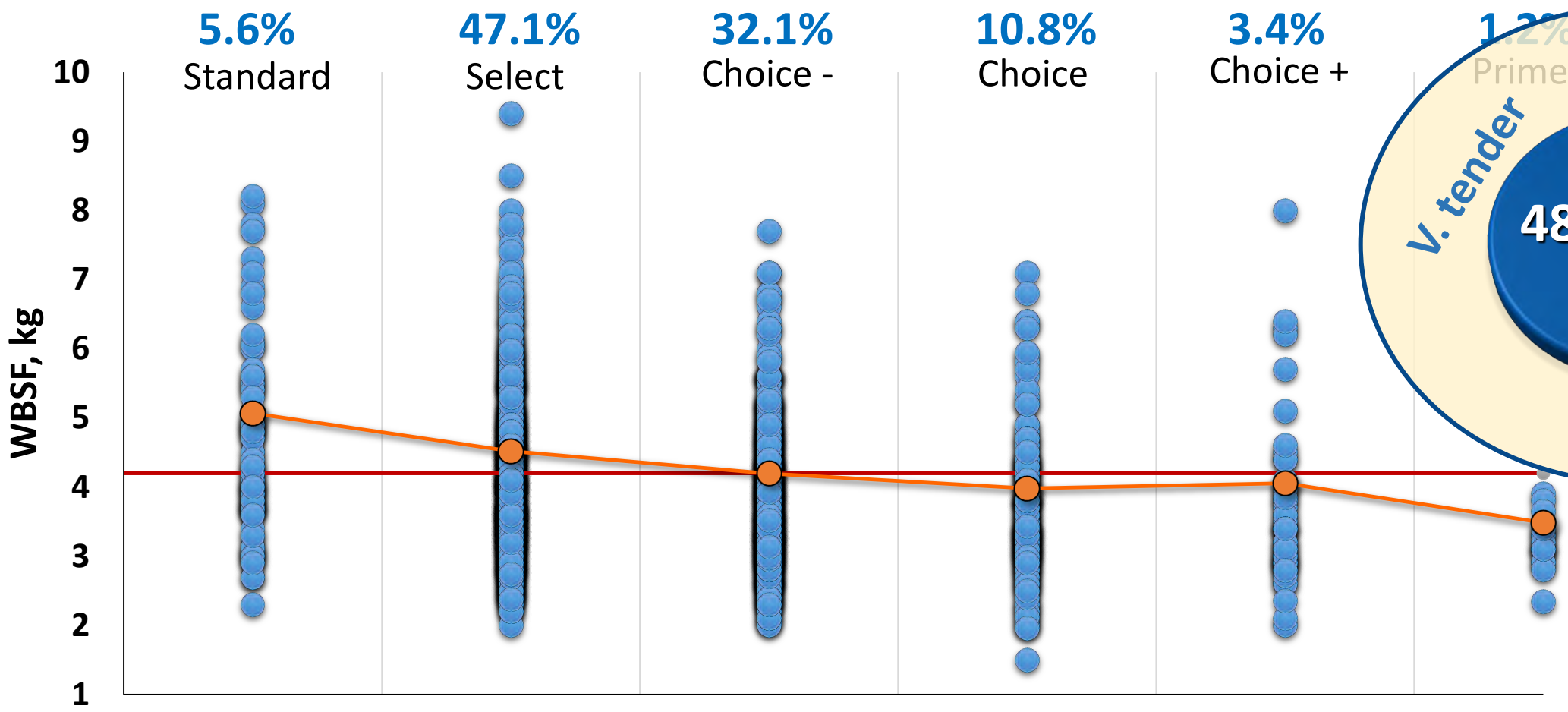
Need to be breed specific

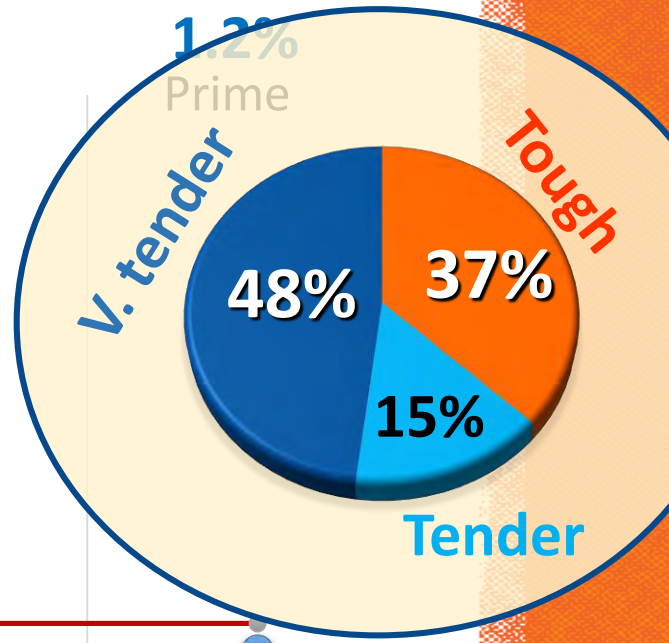
Tenderness by USDA Quality Grade

5.6% Standard	47.1% Select	32.1% Choice -	10.8% Choice	3.4% Choice +	1.2% Prime

UF MAB
(N = 1,366)

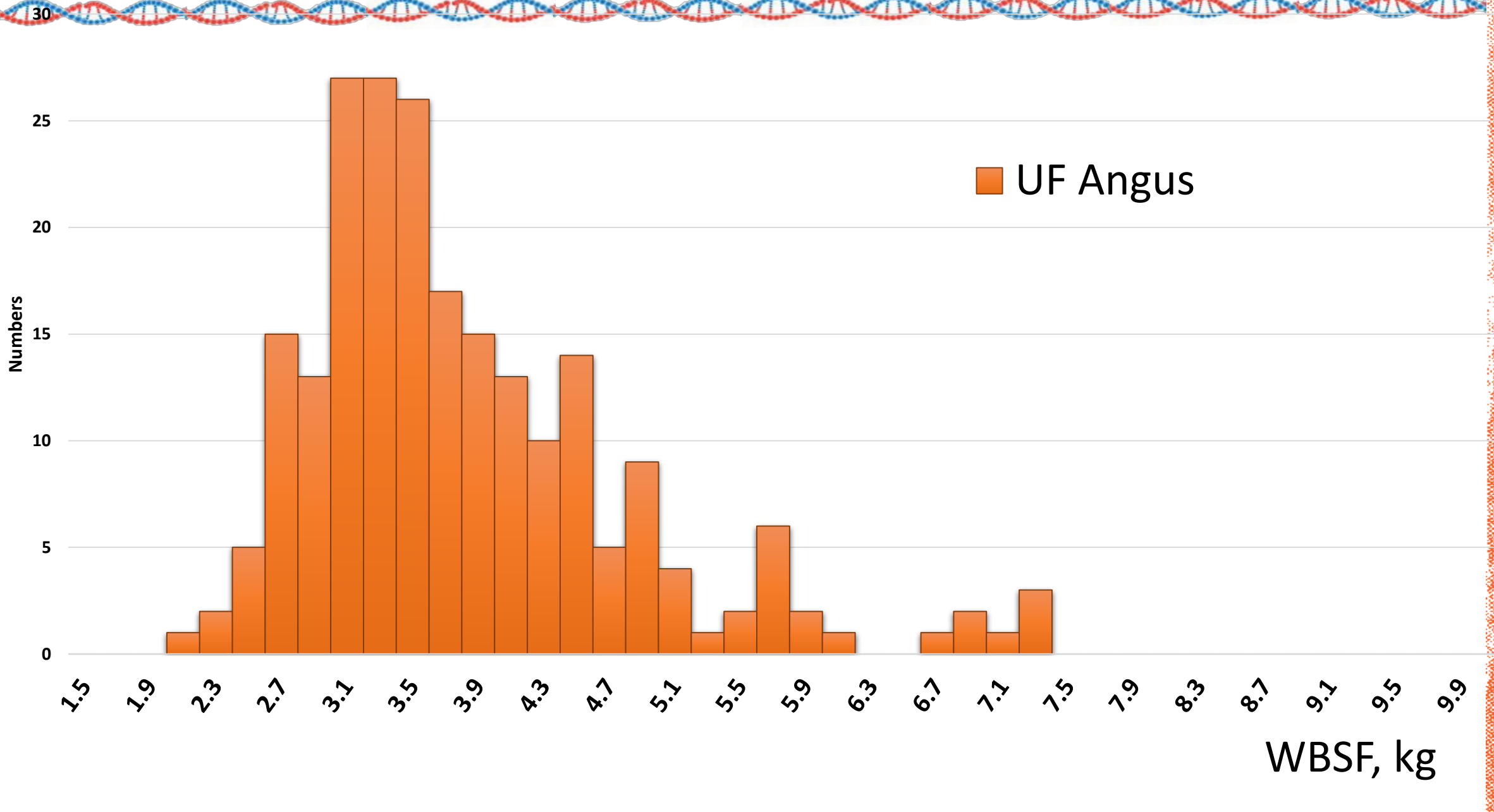
Tenderness by USDA Quality Grade



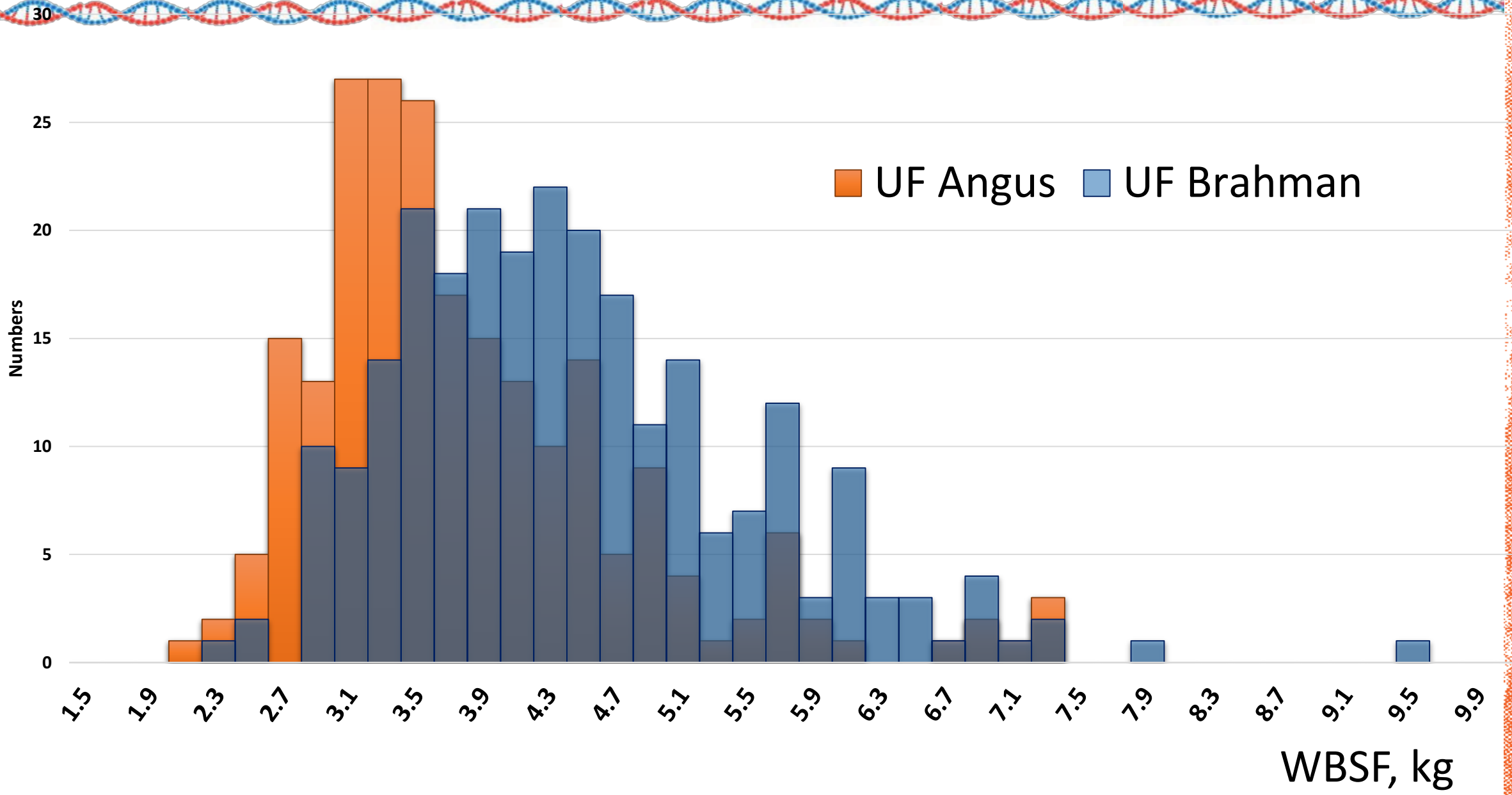


UF MAB
(N = 1,366)

Variation in WBSF – by breed



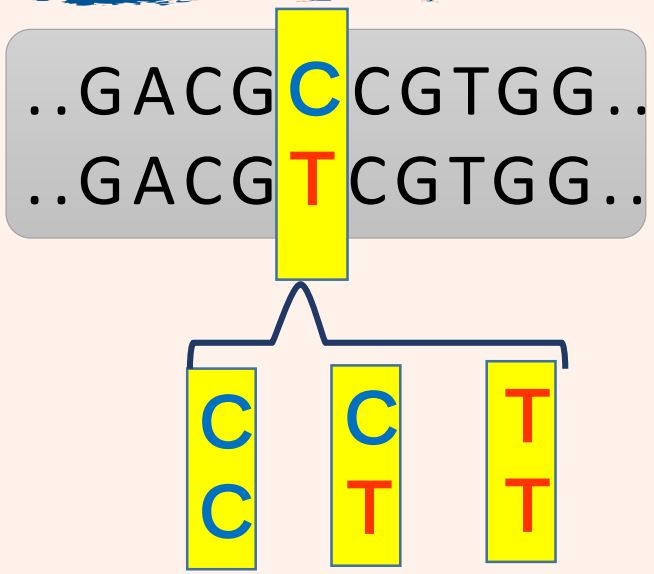
Variation in WBSF – by breed



Genetic tests Tenderness

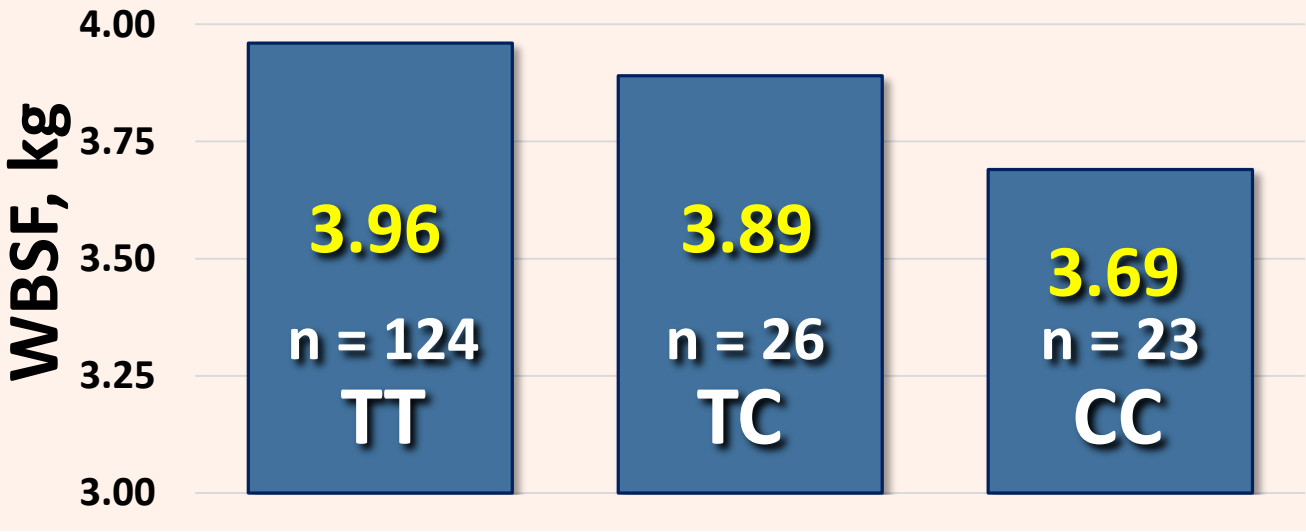
Genomics Tests

SNP – genetic marker

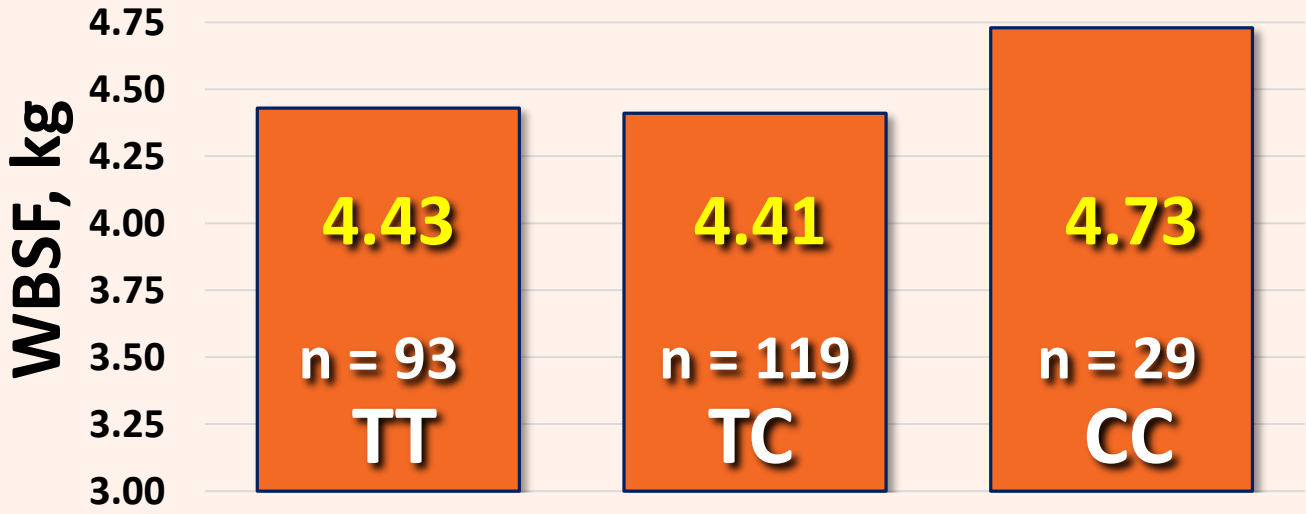


3 possible genotypes

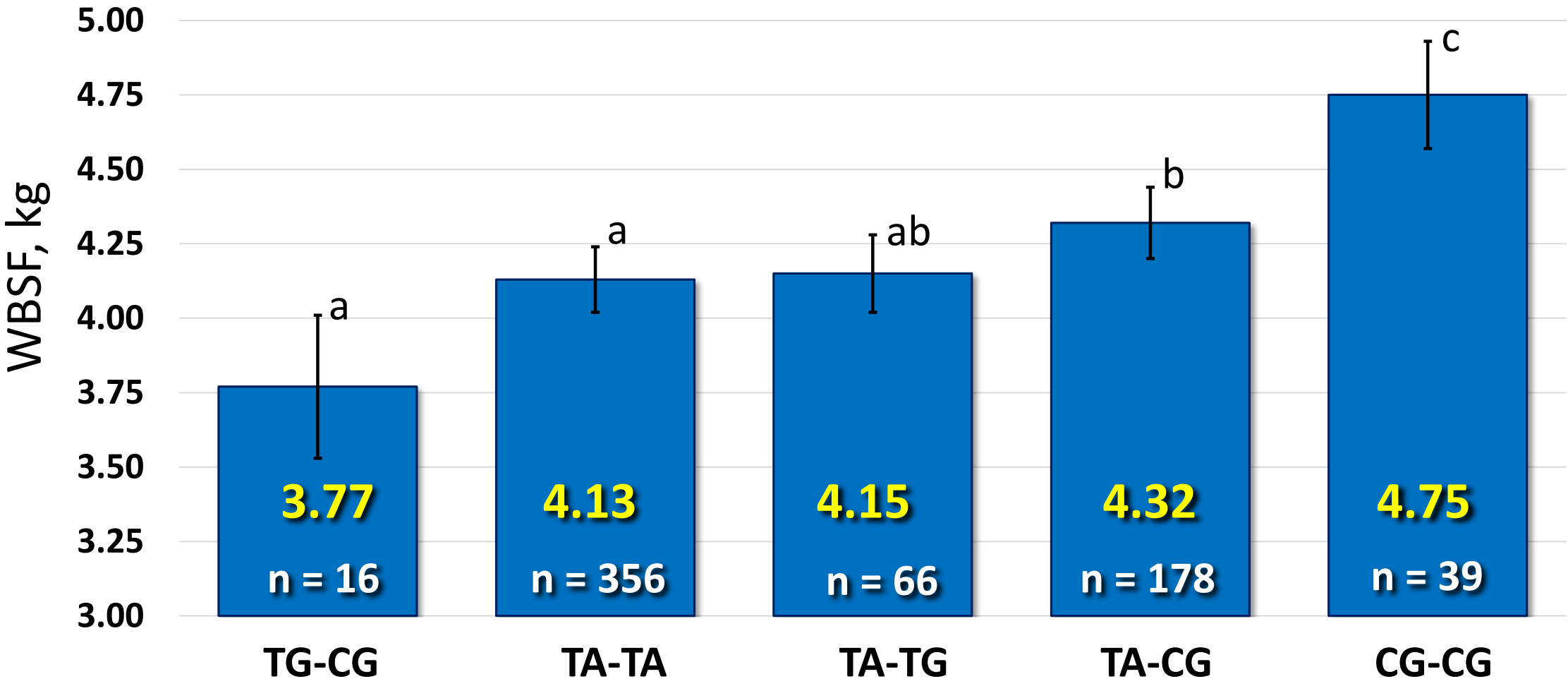
UF Angus, n = 153



UF Brahman, n = 241



Combination of markers in calpastatin



Thermo-tolerance

In response to heat stress, cattle will regulate:

Heat Production

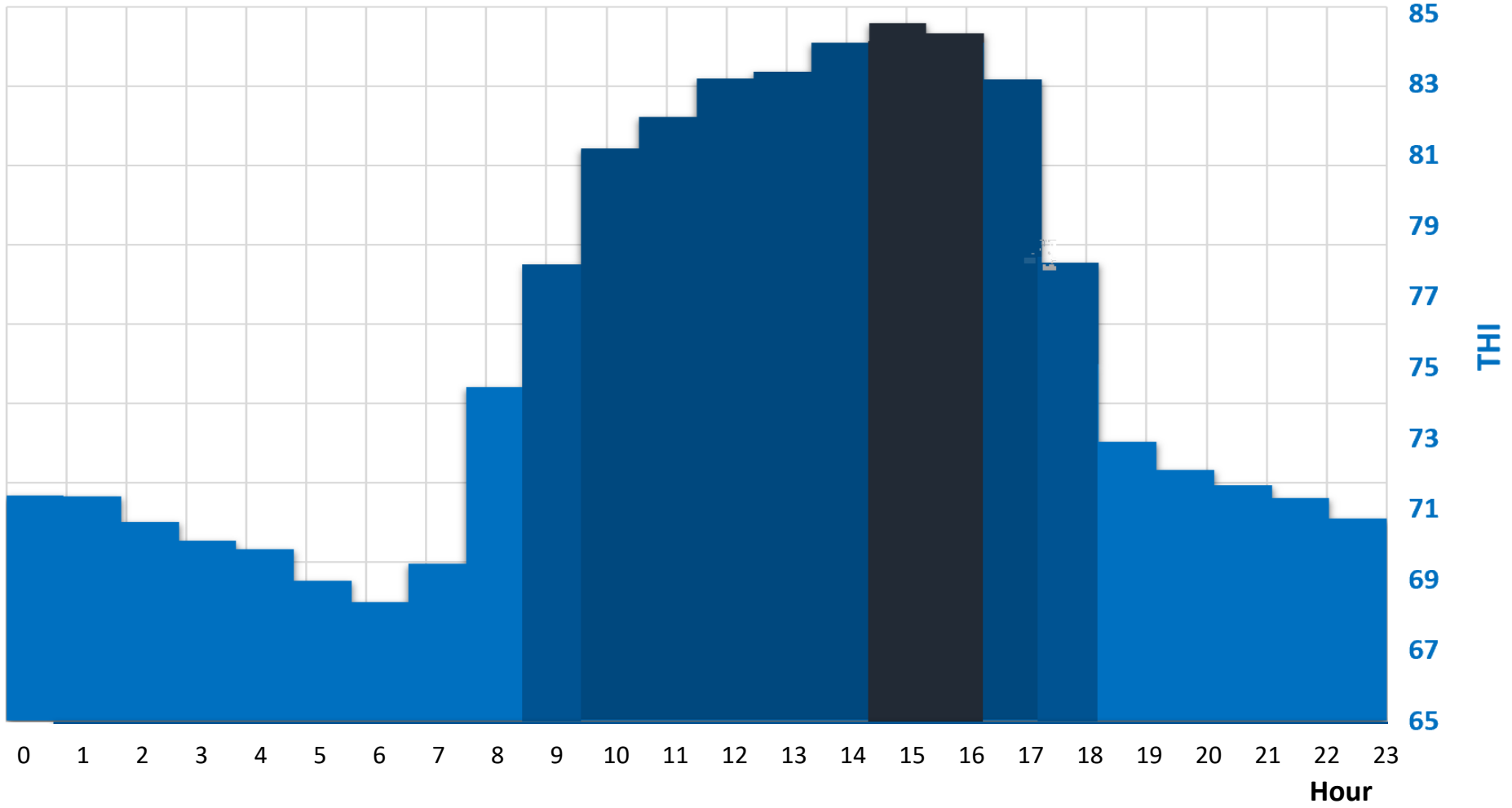
- Modulating basal metabolic rate
- Changing: feed intake, growth, lactation, activity

Heat Exchange

- Blood flow to the skin
- Evaporative heat loss through sweating & panting

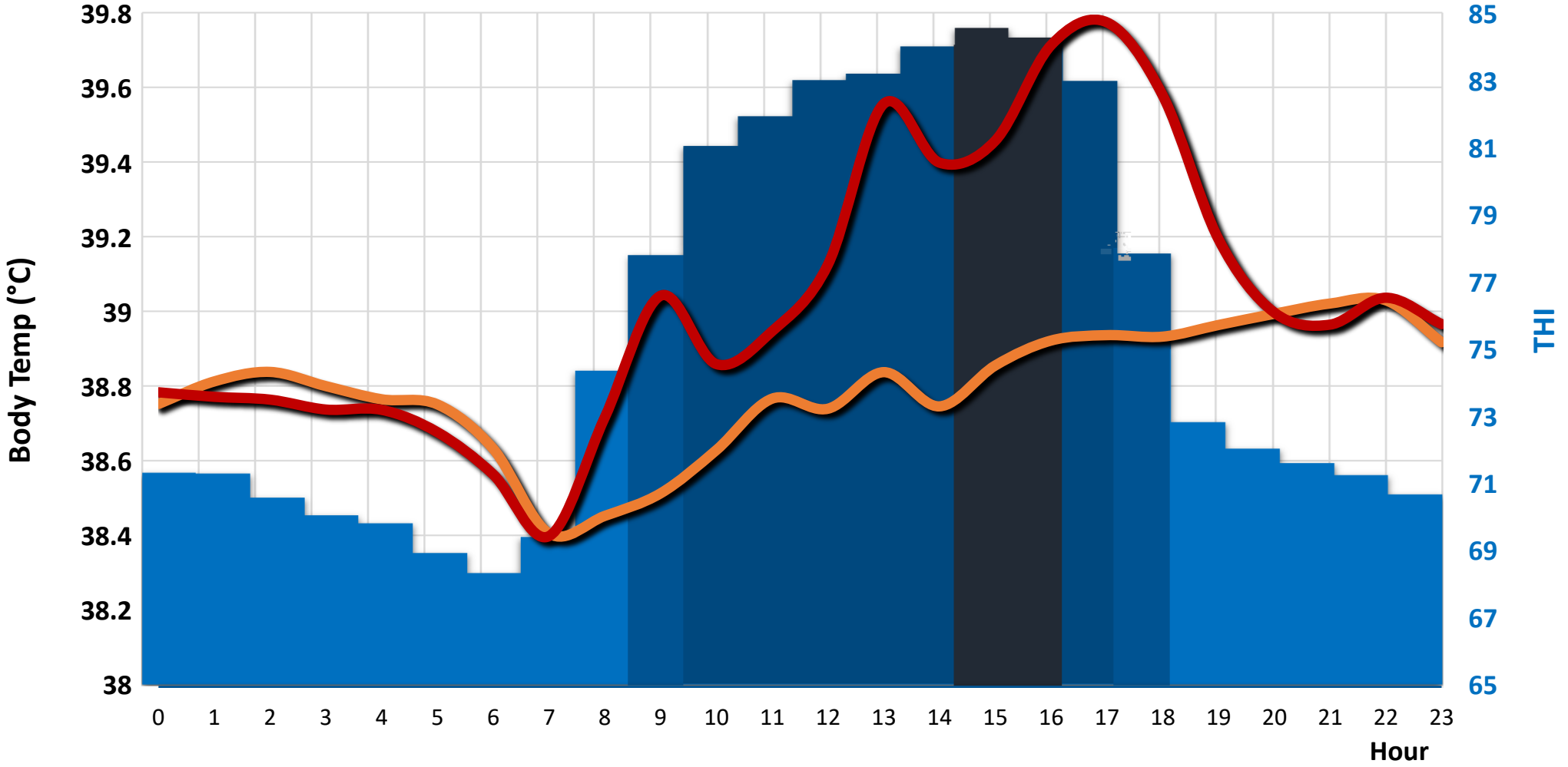
Goal: **Develop genomic tools to select for superior ability for both thermal adaptation and food production.**

Breed effect on body temperature



≥ 84	Critical heat stress
79 - 83	Major heat stress
75 - 78	Moderate heat stress
≤ 75	Minimal heat stress

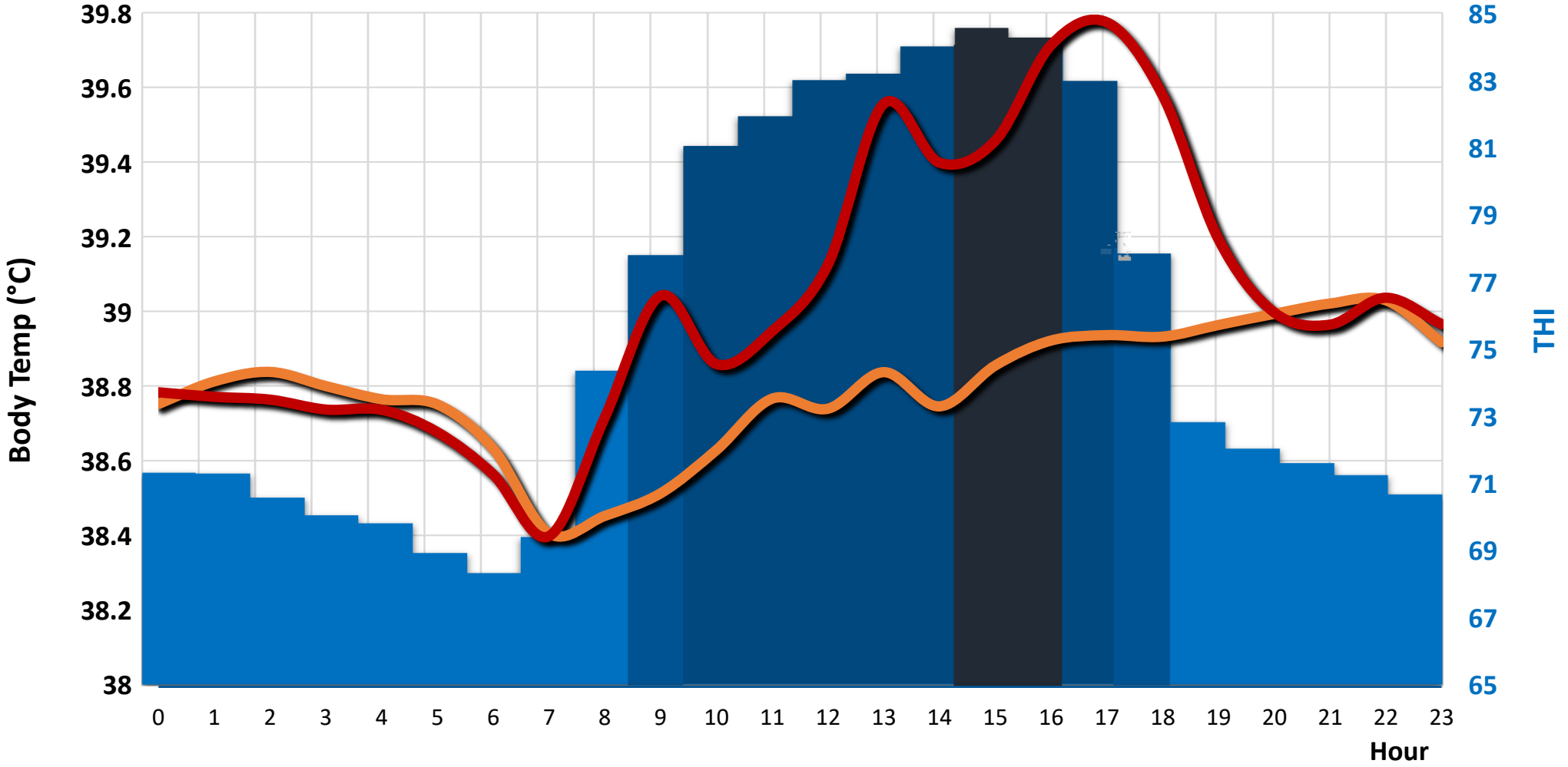
Breed effect on body temperature



vagtmp every 15 min by day - REPEATED with cov structure type = ARH(1)

≥ 84	Critical heat stress
79 - 83	Major heat stress
75 - 78	Moderate heat stress
≤ 75	Minimal heat stress

Breed effect on body temperature



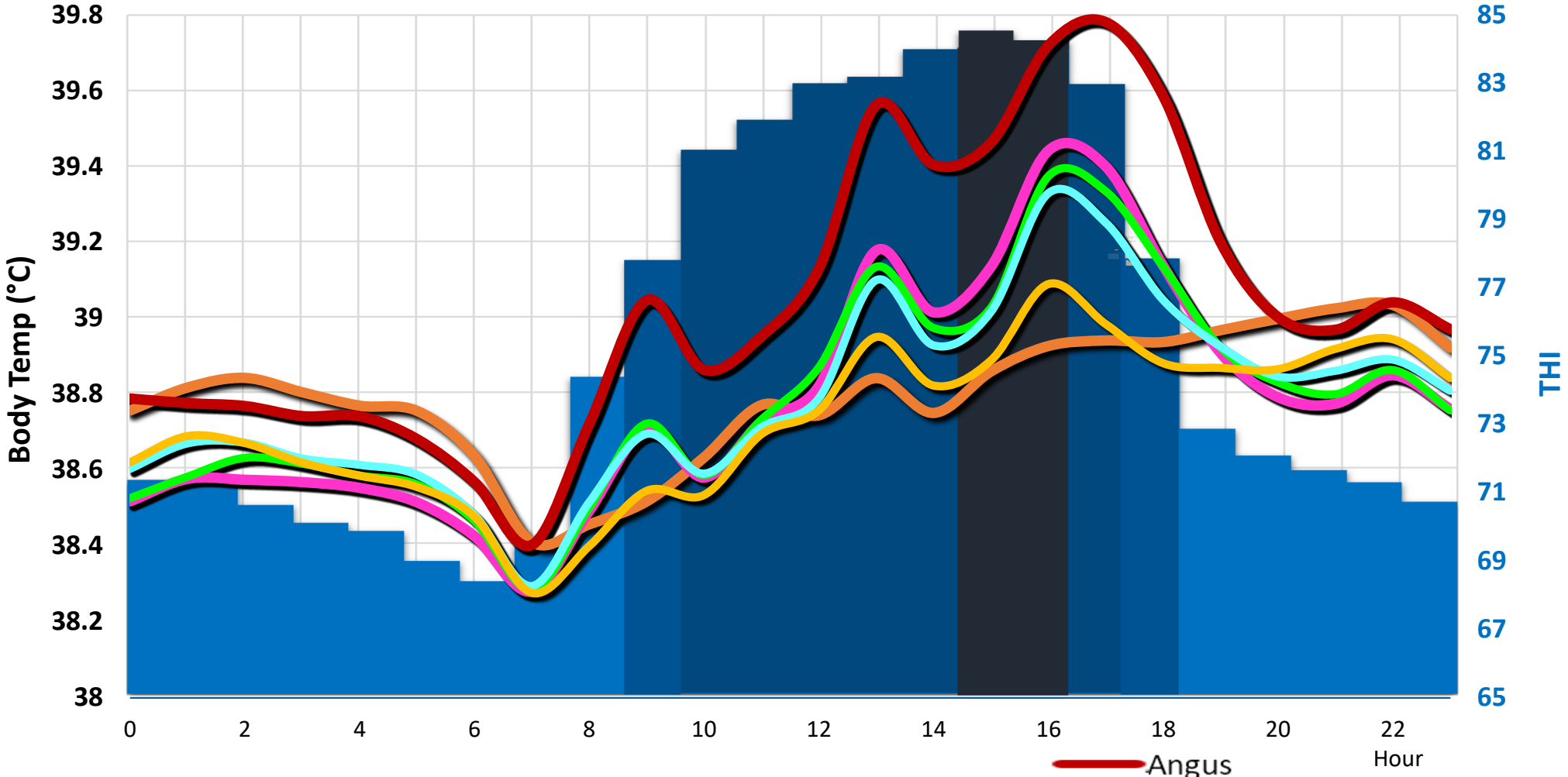
vagtmp every 15 min by day - REPEATED with
cov structure type = ARH(1)

≥ 84	Critical heat stress
79 - 83	Major heat stress
75 - 78	Moderate heat stress
≤ 75	Minimal heat stress

Brahman

Angus

Breed effect on body temperature



vagtmp every 15 min by day - REPEATED with
cov structure type = ARH(1)

Factors important in thermotolerance

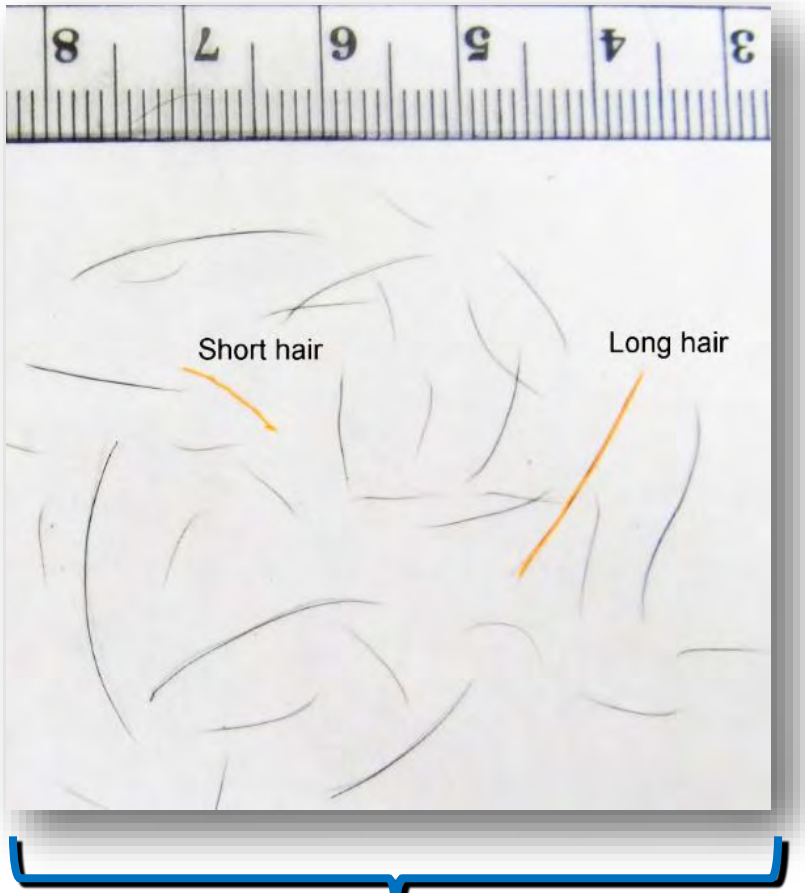
- Coat Hair
- Sweat Glands
- Other Skin Prop.

Factors important in thermotolerance

Coat Hair

Sweat Glands

Other Skin Prop.



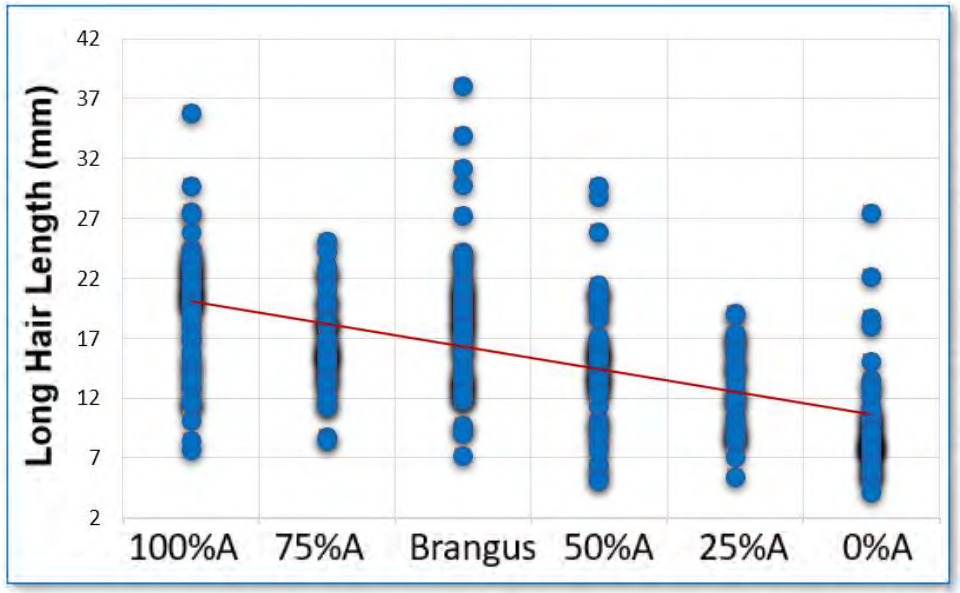
Long Hair Length
Long Hair Diameter
Short Hair Length
Short Hair Diameter

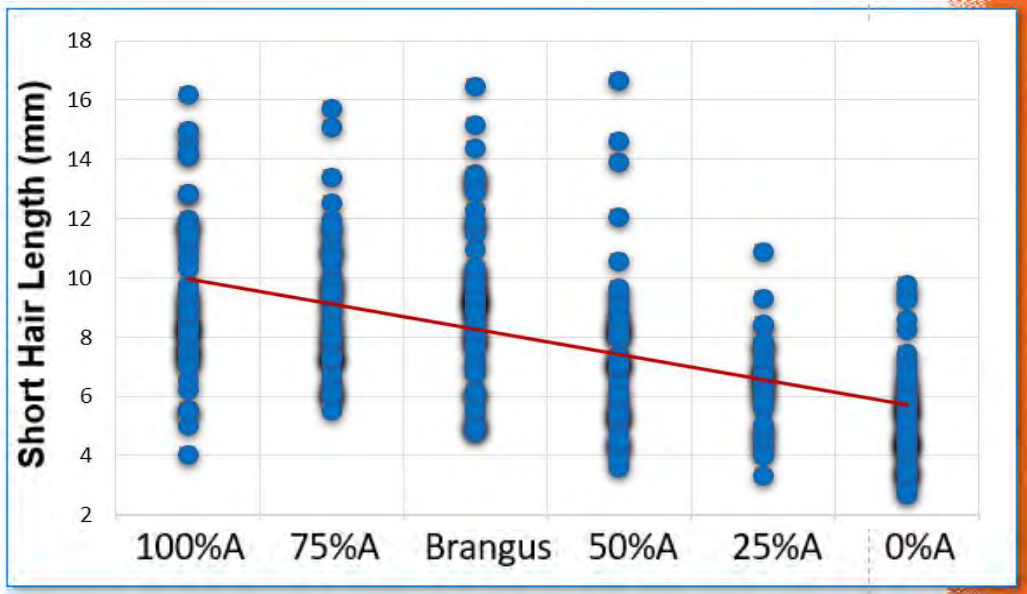
Factors important in thermotolerance

Coat Hair

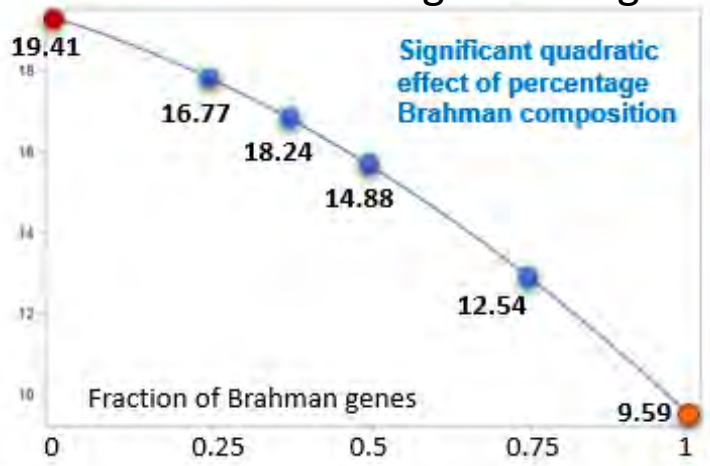
Sweat Glands

Other Skin Prop.

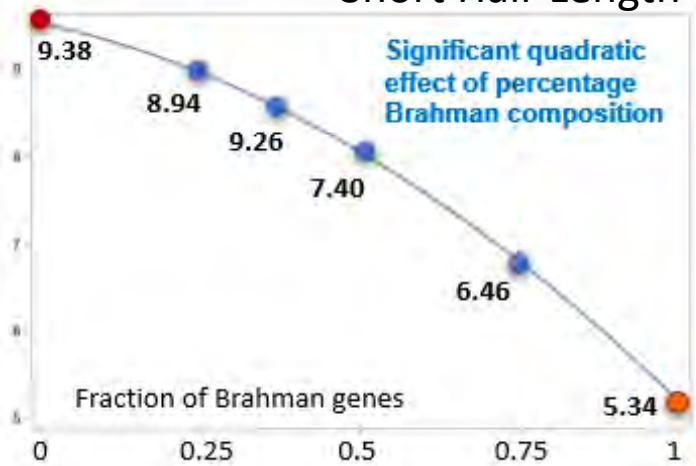




Long Hair Length



Short Hair Length



Angus

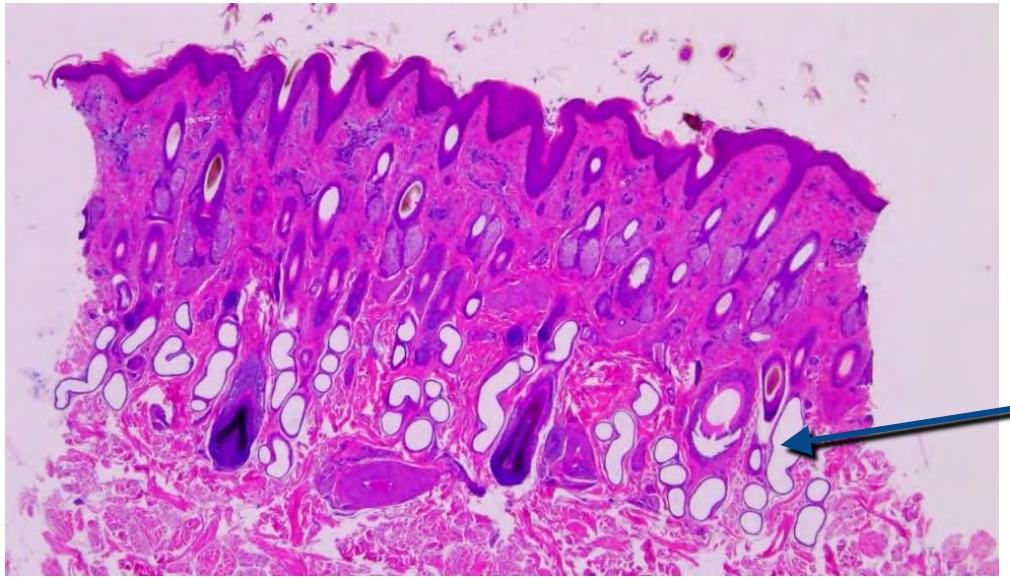
Brahman

Factors important in thermotolerance

Coat Score

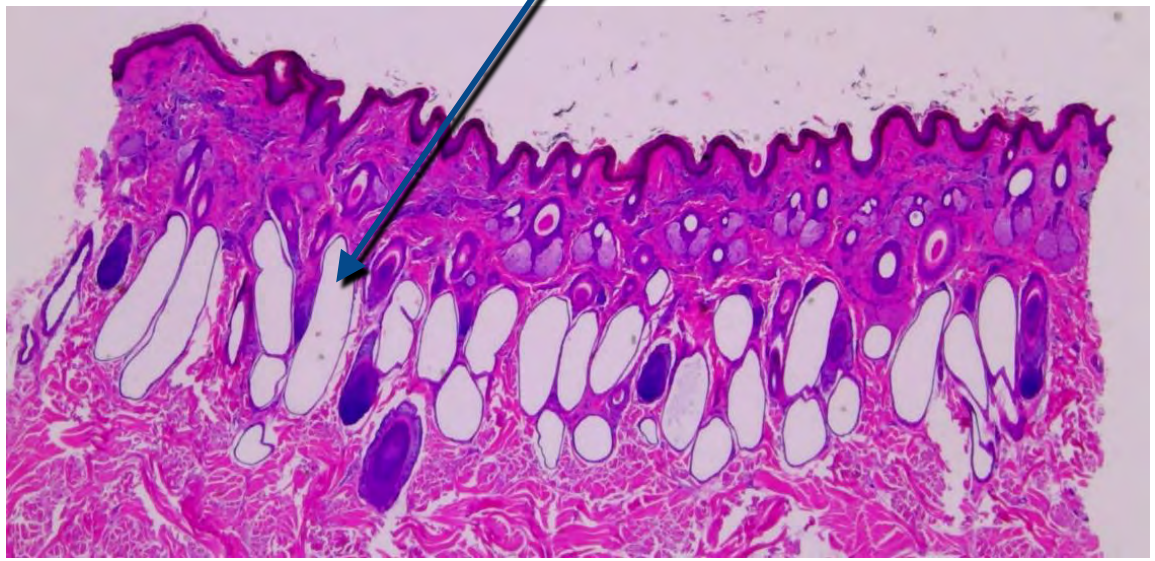
Sweat Glands

Other Skin Prop.



Angus

Sweat Glands



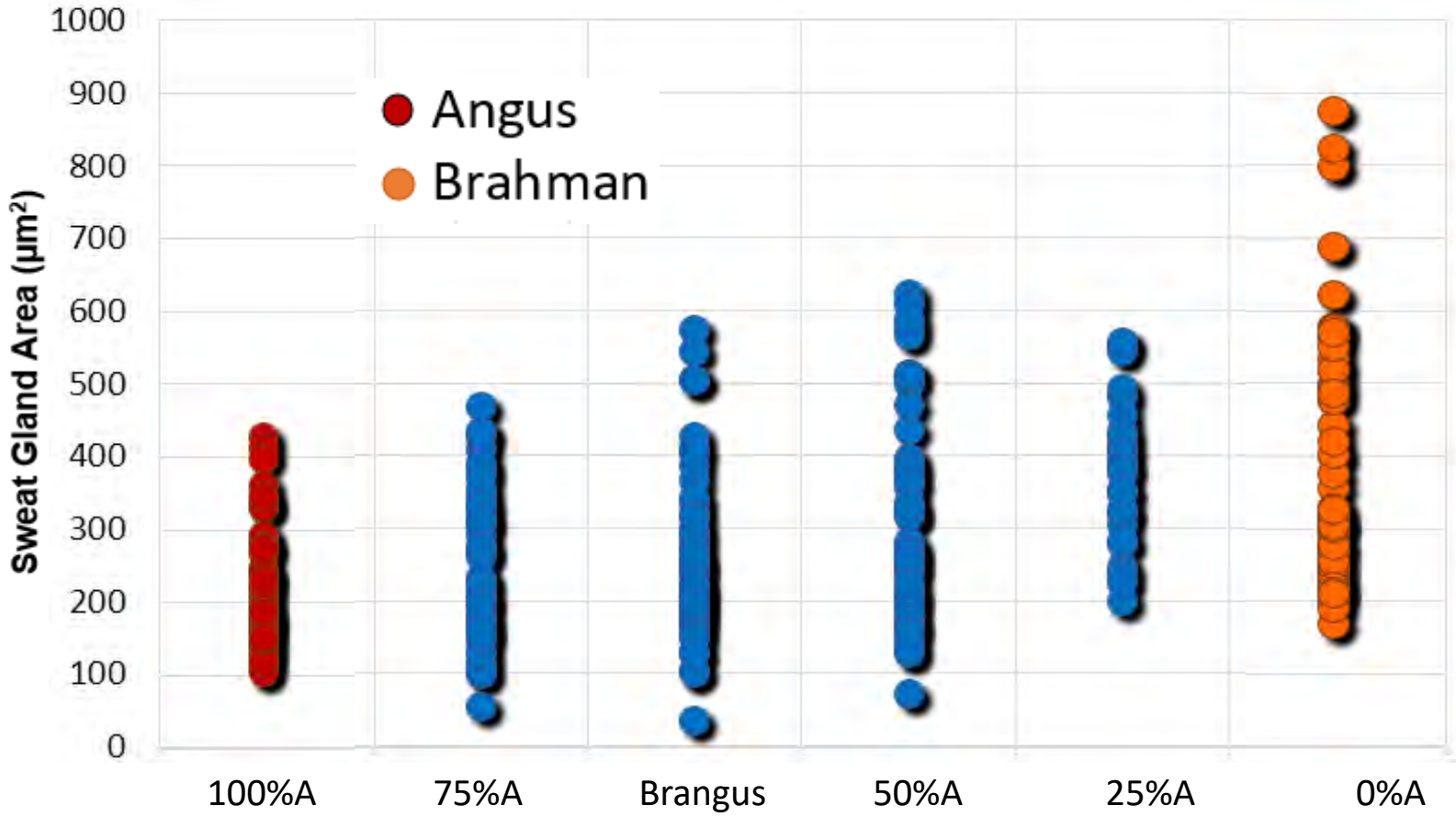
Brahman

Factors important in thermotolerance

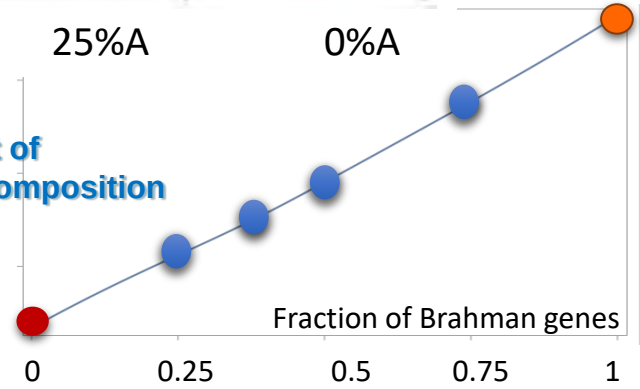
Coat Score

Sweat Glands

Other Skin Prop.



Significant linear effect of percentage Brahman composition

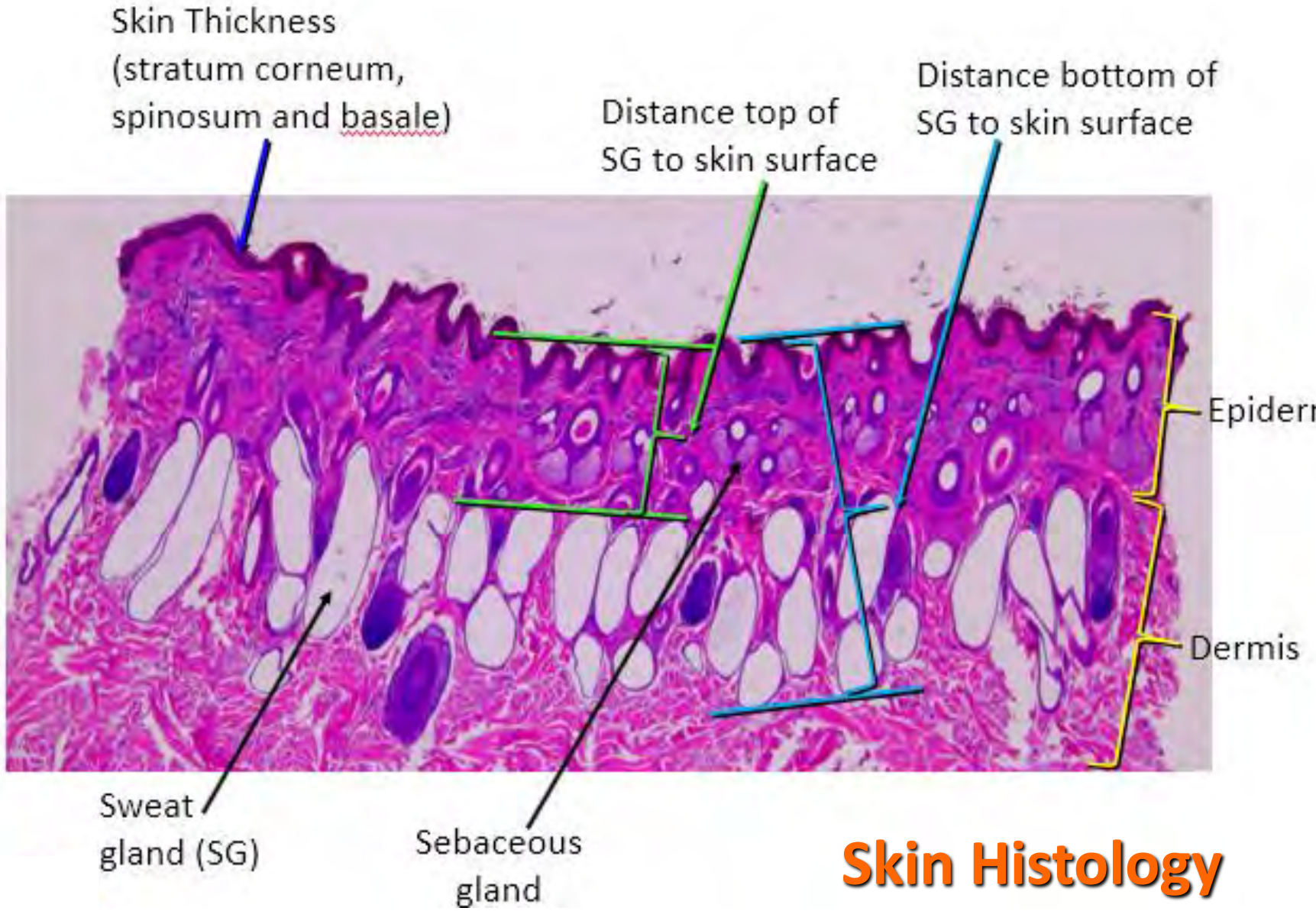


Factors important in thermotolerance

Coat Score

Sweat Glands

Other Skin Prop.



Skin Histology

Take-home points

Meat Quality

- The USDA grading system (marbling and maturity) - limited in predicting eating quality (**tenderness**).
- Existing genomic tests, developed mostly on *Bos Taurus* data, are not predictive in our **Brahman** influenced cattle populations.

Thermotolerance

- Selection for production ignoring **adaptability** = animals more sensitive to heat stress
- Variation in **coat** and **skin** properties = allows selection for increased thermotolerance without affecting production.

Population Specific Genomic Tools

Acknowledgments

University of Florida

- Dr. Pete Hansen
- Dr. Mauricio Elzo
- Dr. Dwain Johnson
- Dr. Tracy Scheffler
- Dr. Jason Schaffler
- Dr. Serdal Dikmen
- Danny Driver
- Michelle Driver
- Joel Leal, Heather Hamblen, Sarah Flowers, Kaitlyn Sarlo, Mesfin Gobena, Eduardo Rodriquez, Zaira Estrada
- Adriana Zolini, William Ortiz, Samantha Eifert, Lauren Peacock, Alexa Chiroussot

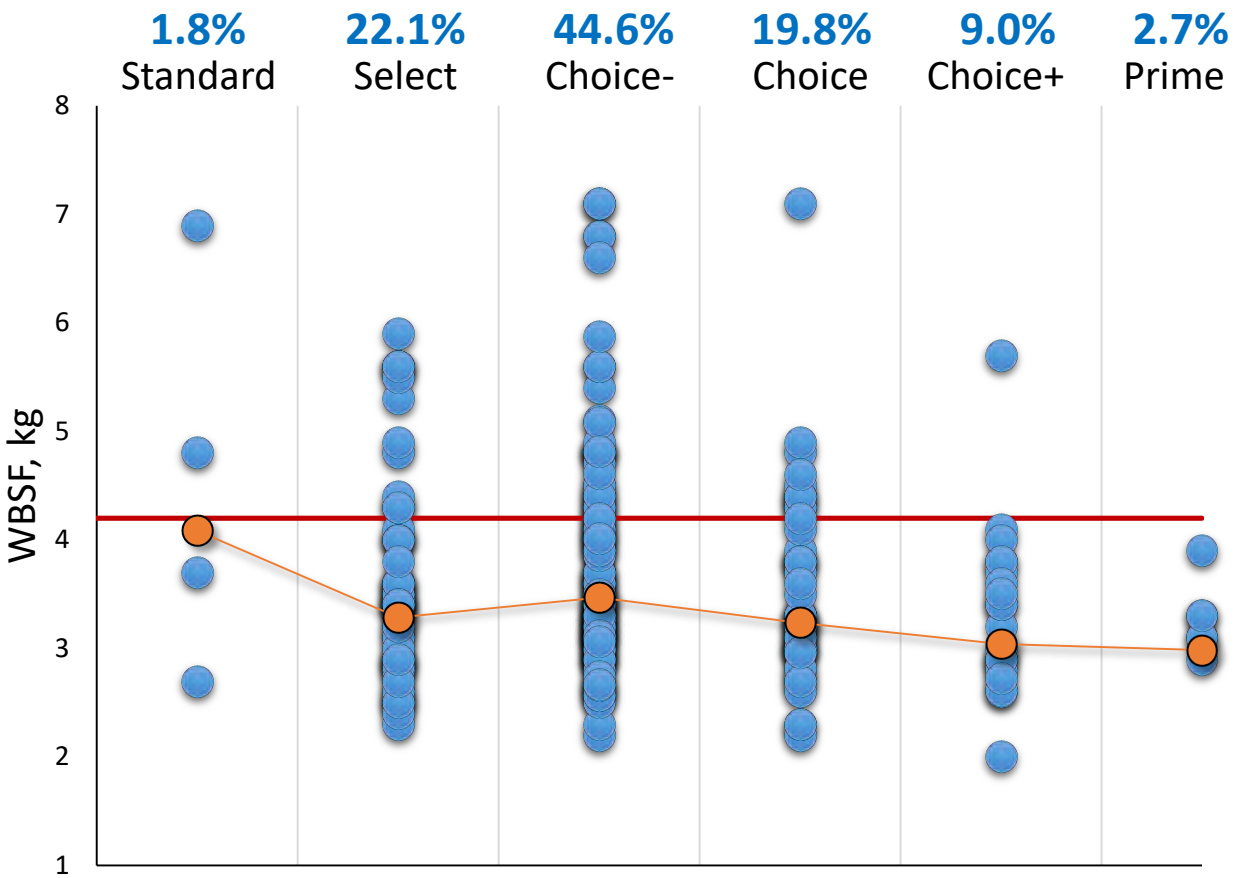
Seminole Tribe of Florida

- Alex Johns
- Phillip Clark
- Sheri Holmes
- Bobby Yates
- Mike Ciorocco
- Dayne Johns, etc.

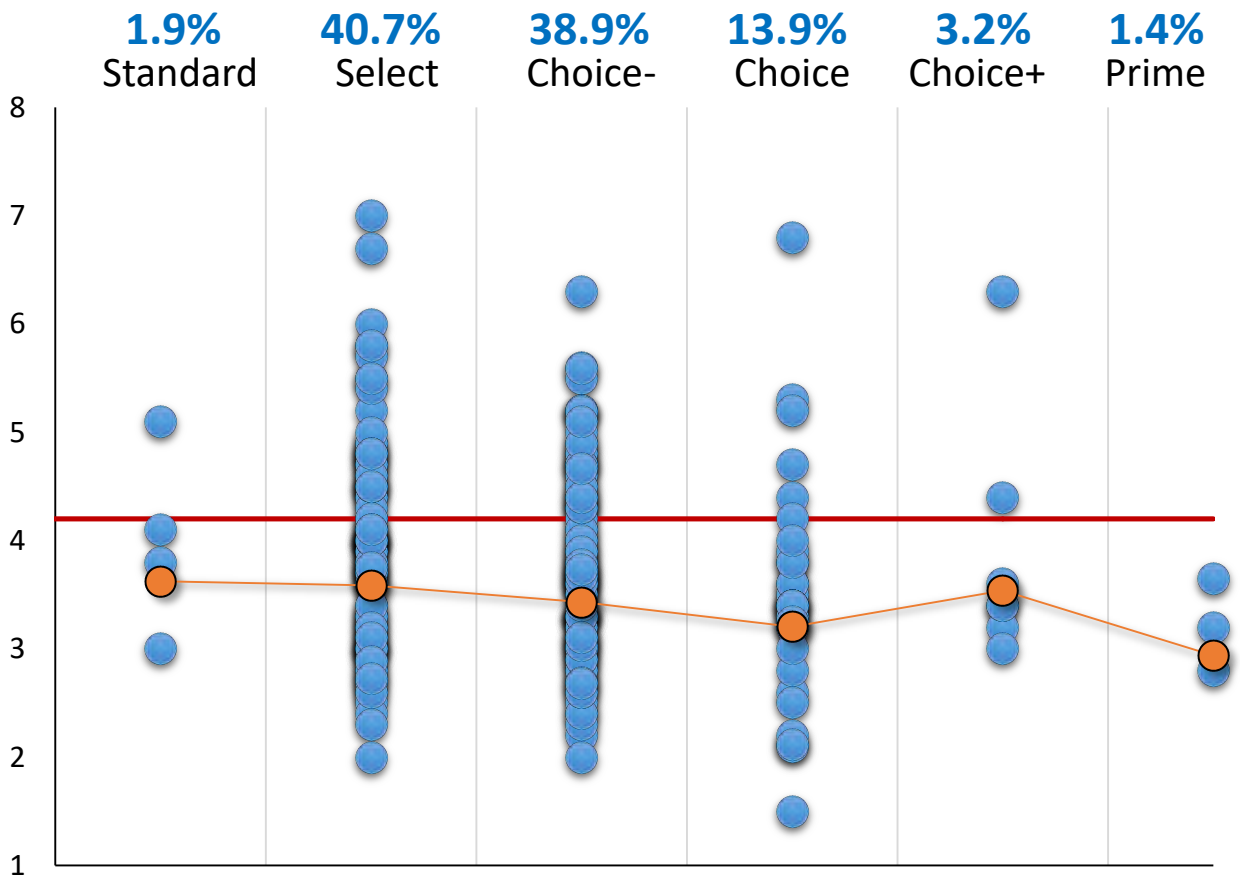
Financial Support

- USDA-NIFA Grant 2017-67007-26143
- UF Agricultural Experim. Station
- UF ANS Hatch Project
- Seminole Tribe of Florida
- Brangus Breeders Association
- Florida Beef Council
- Florida Cattlemen's Association

UF Angus vs Brangus tenderness/quality grade

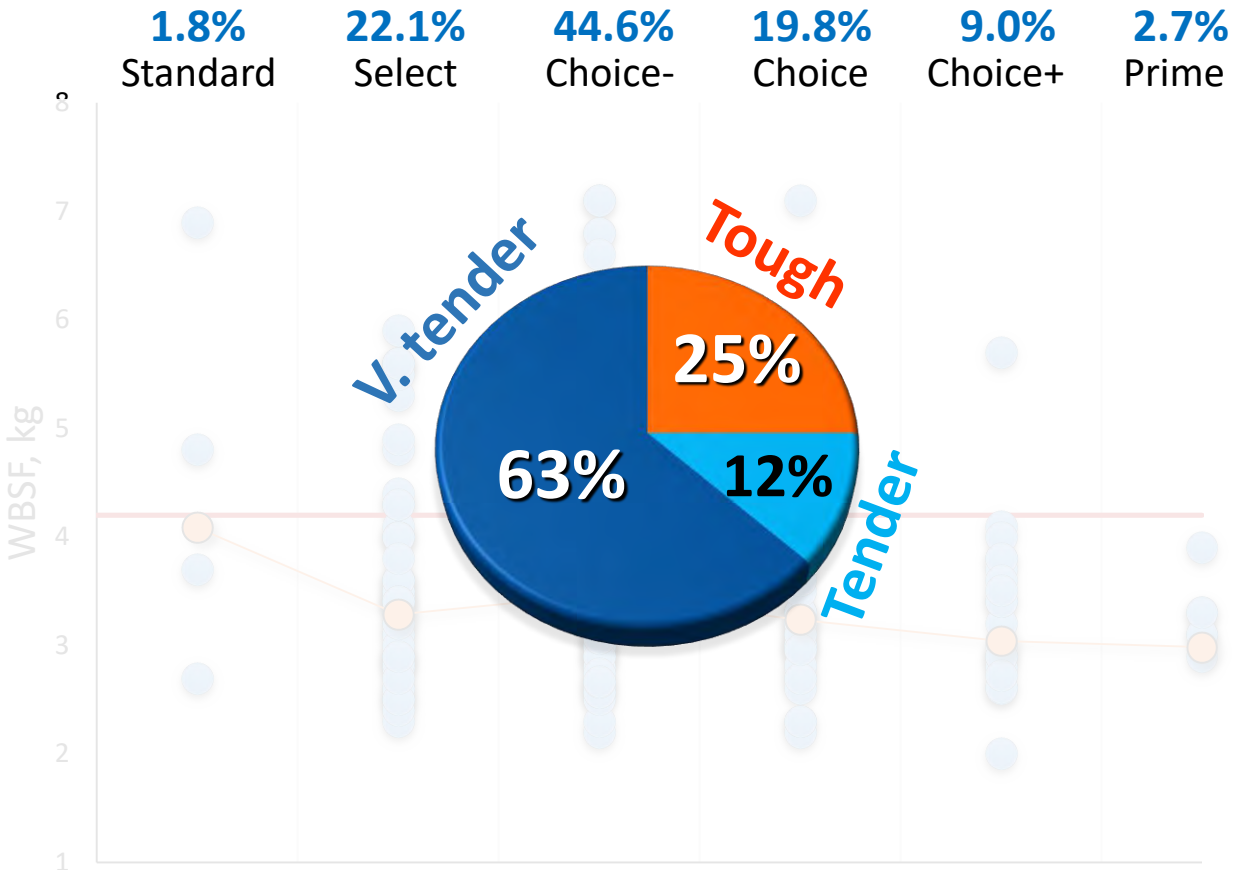


UF Angus
(N = 222)

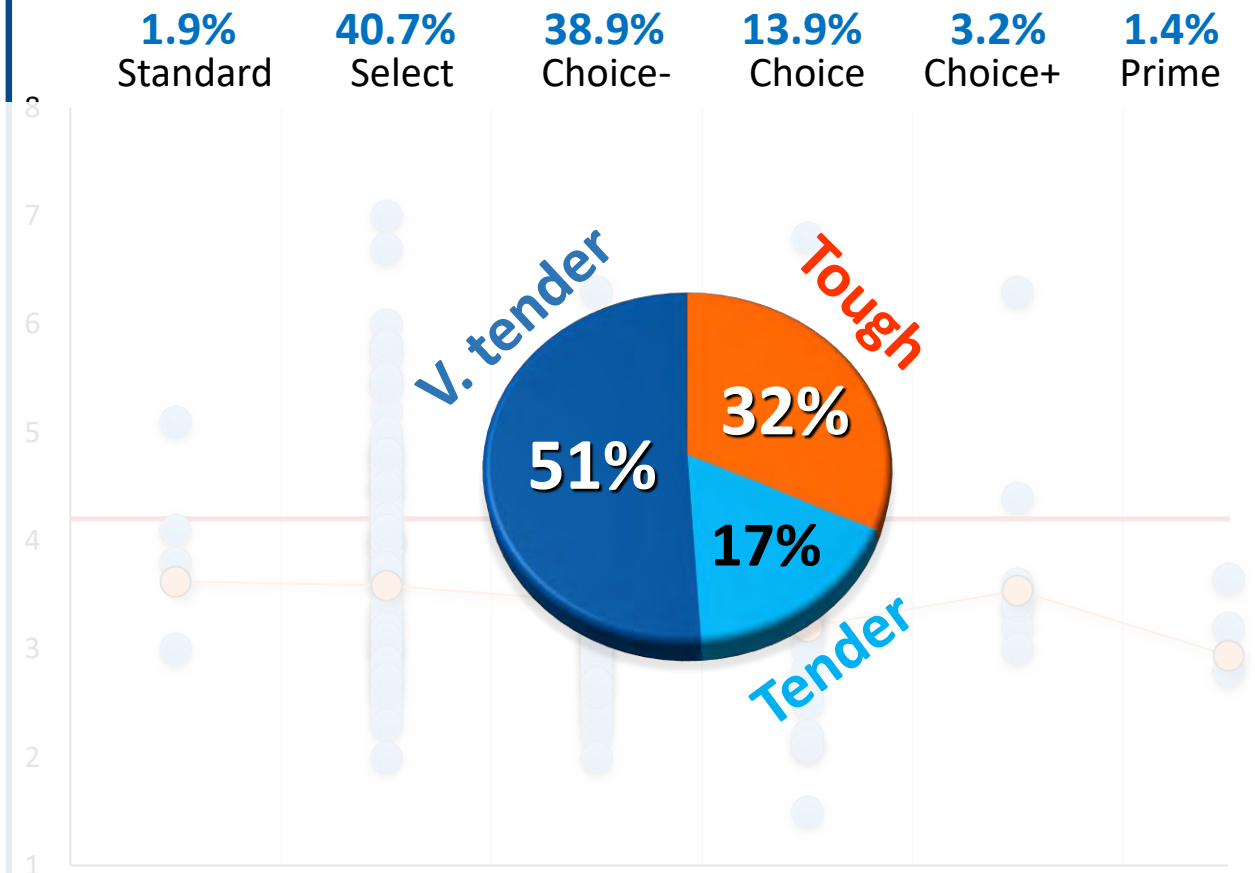


UF Brangus
(N = 216)

UF Angus vs Brangus tenderness/quality grade



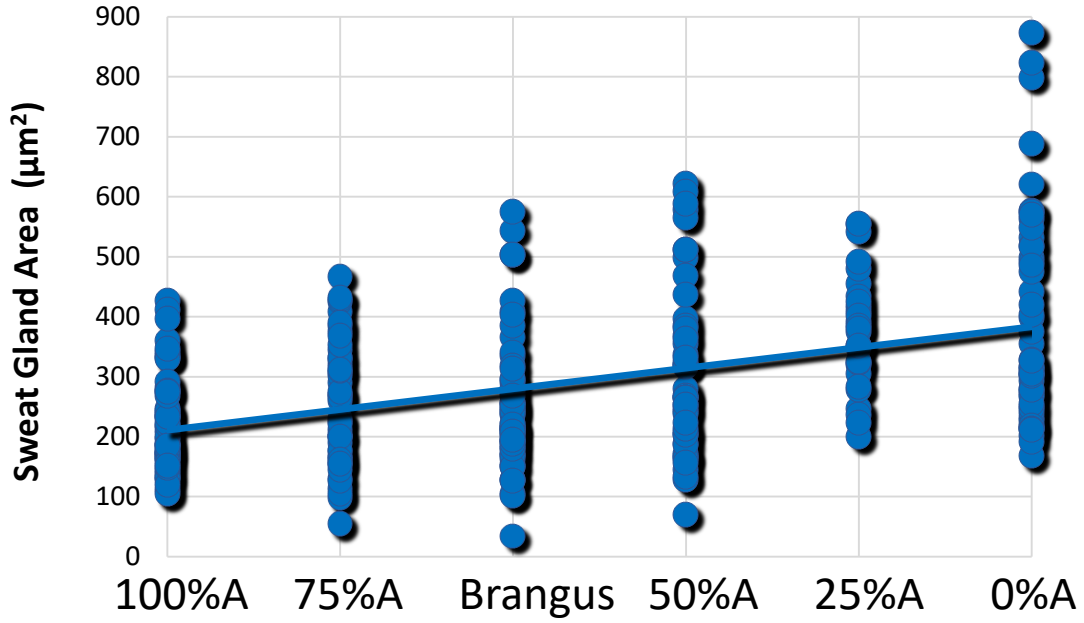
UF Angus
(N = 222)

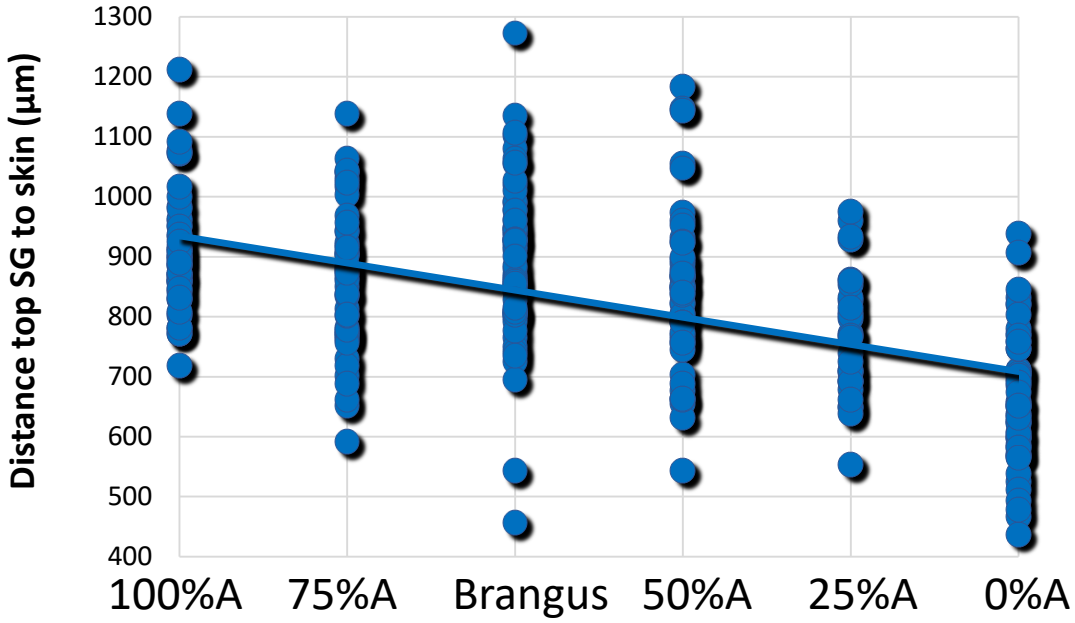


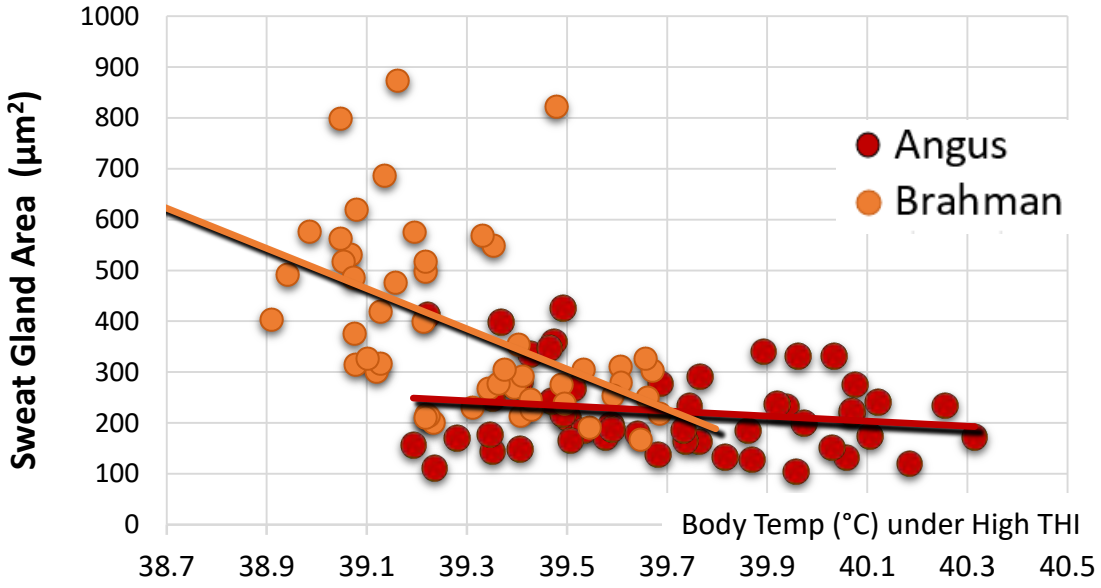
UF Brangus
(N = 216)

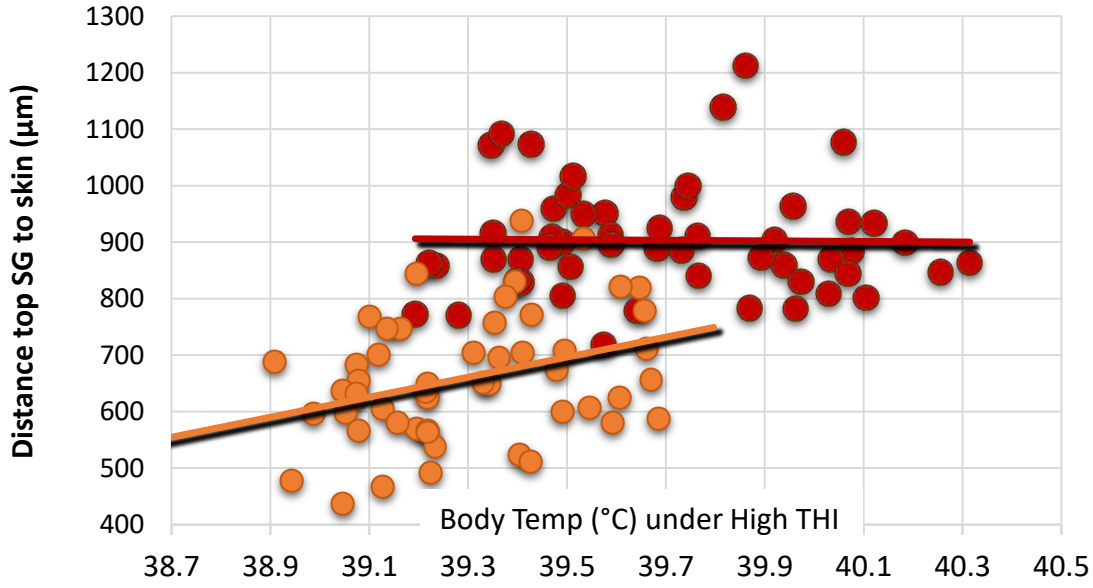
Sweat glands

Source	DF	F Value	Pr > F
Breed	5	13.42	<.0001
SweatGlandArea	1	18.40	<.0001









Factors important in thermotolerance

Coat Hair

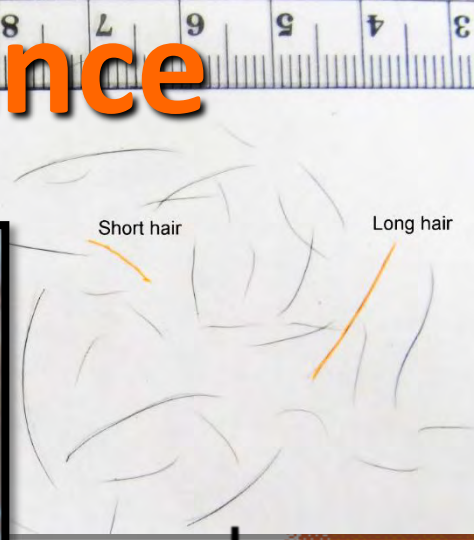
Sweat Glands

Other Skin Prop.

Score 1
Excessively Smooth

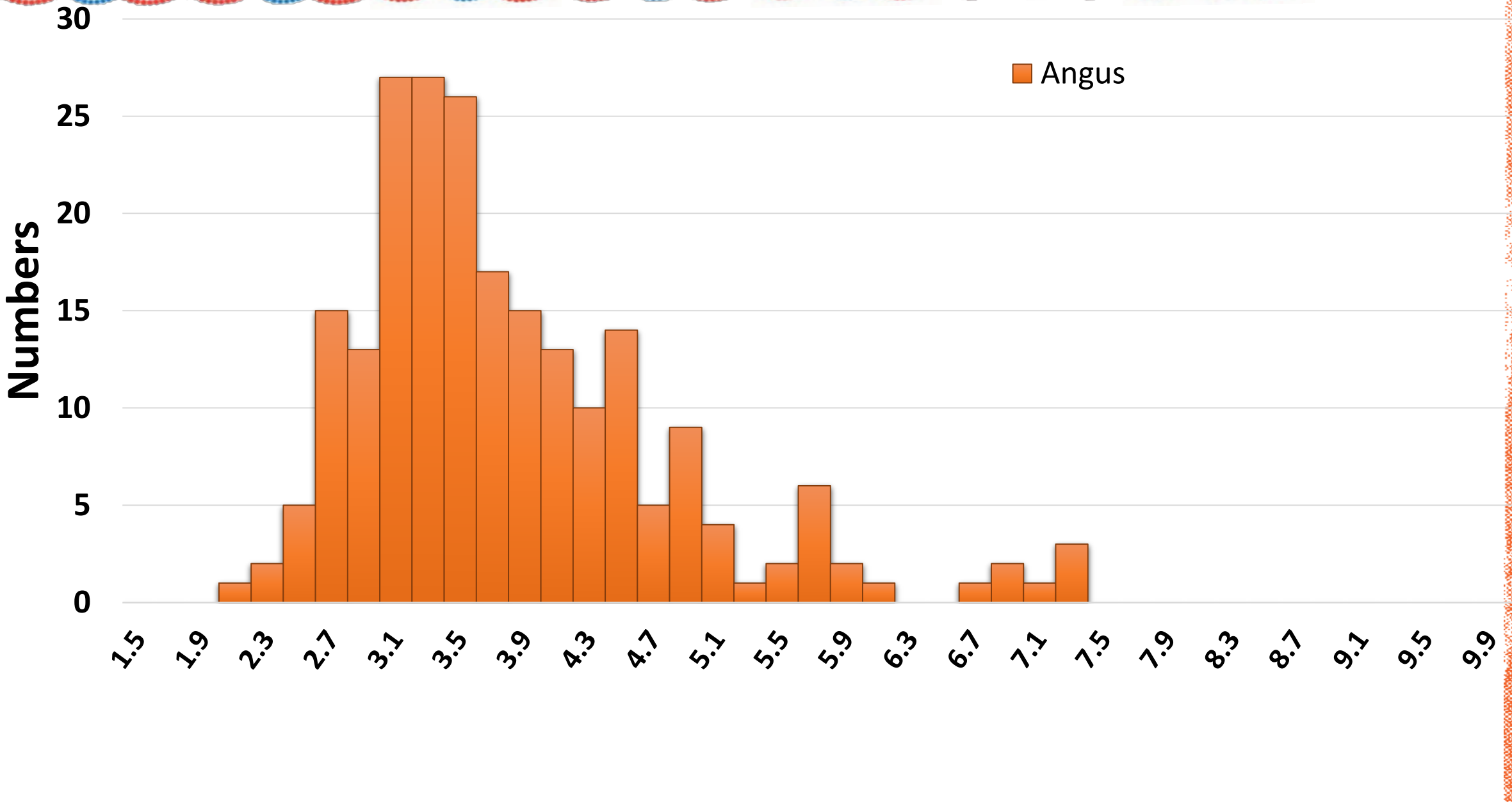
Score 2
Fairly Smooth

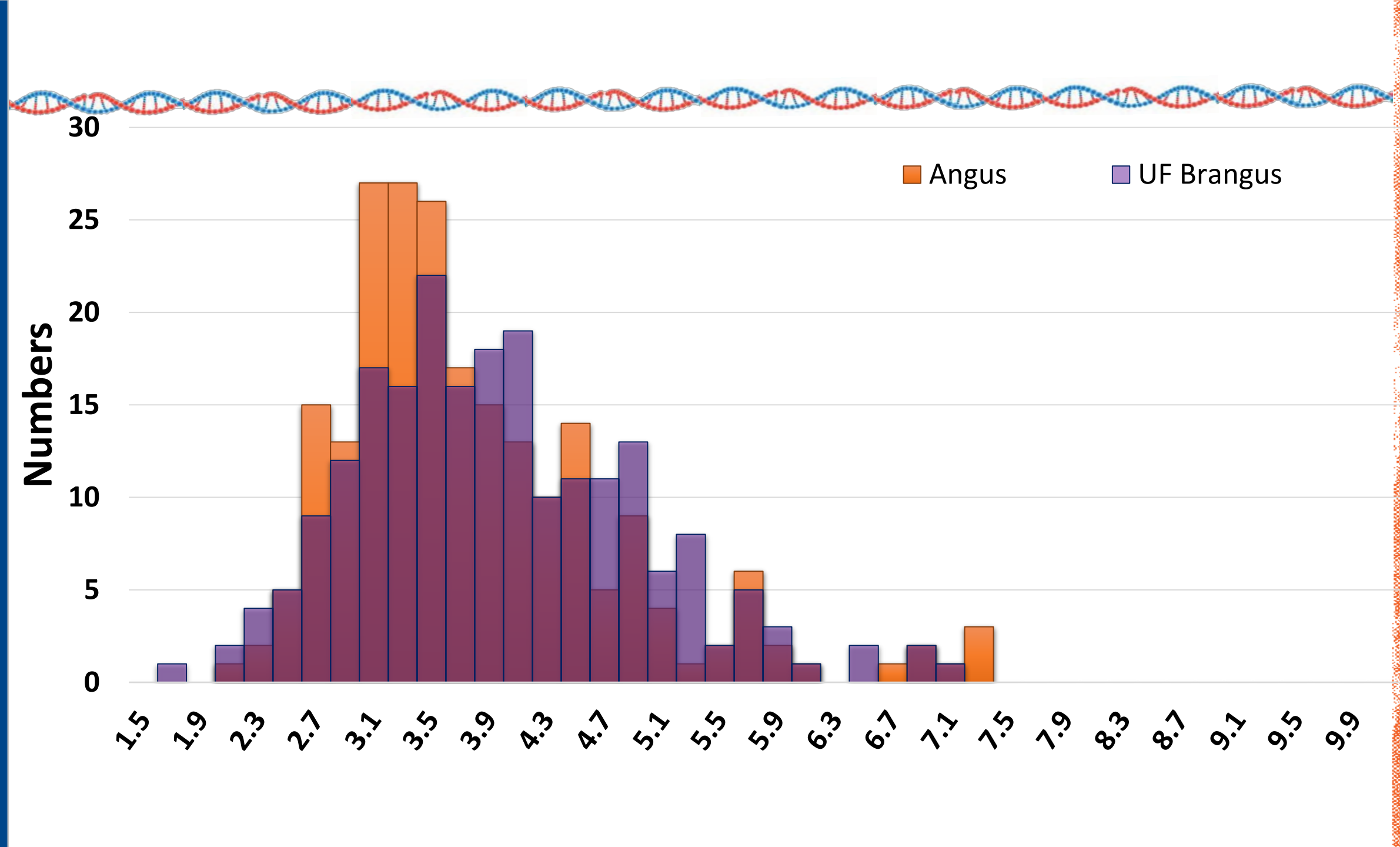
Coat score
1. excessively smooth
2. fairly smooth
3. long coat
4. woolly
5. excessively woolly coat



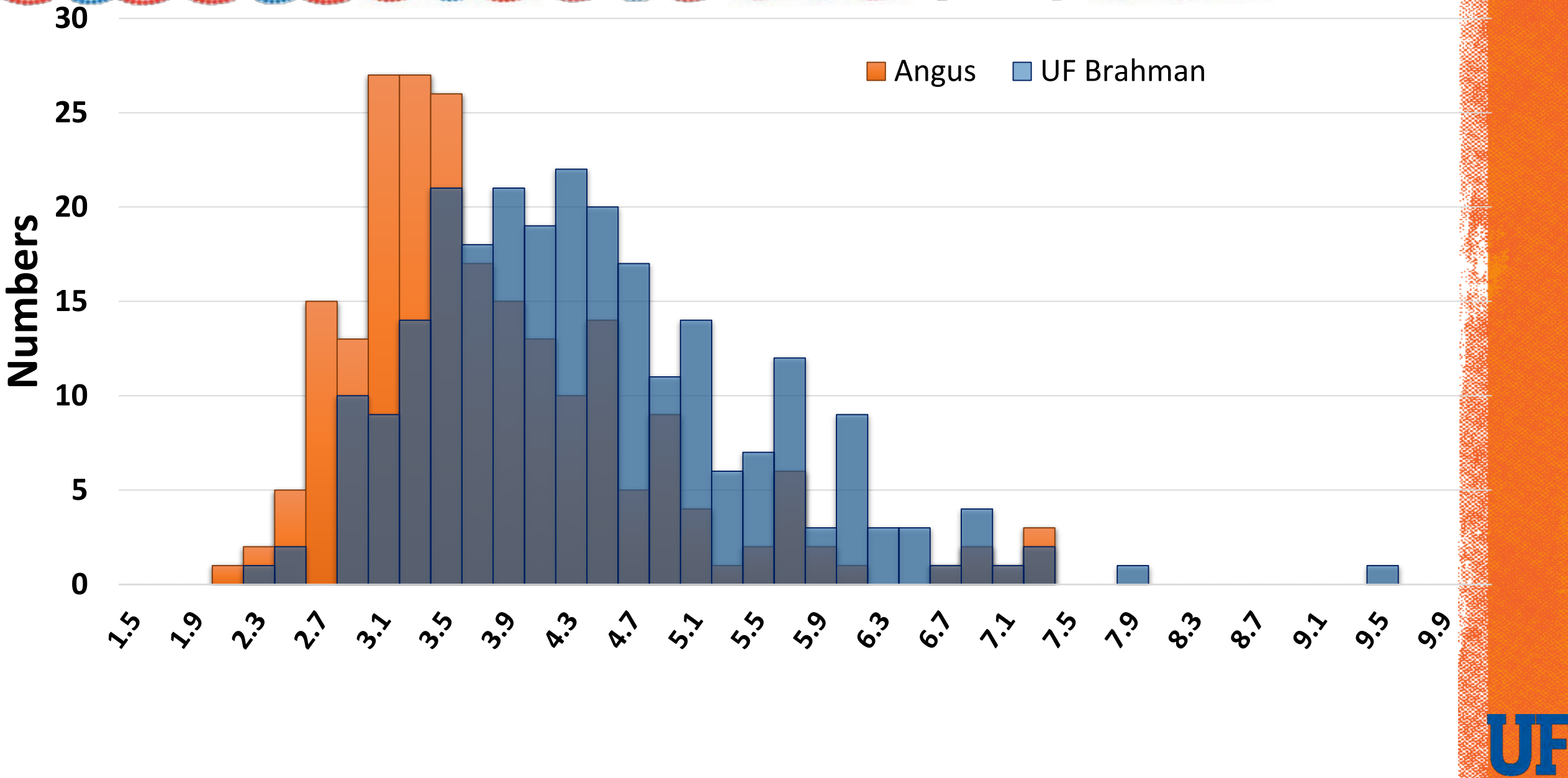
Long Hair Length
Long Hair Diameter
Short Hair Length
Short Hair Diameter

WBSF

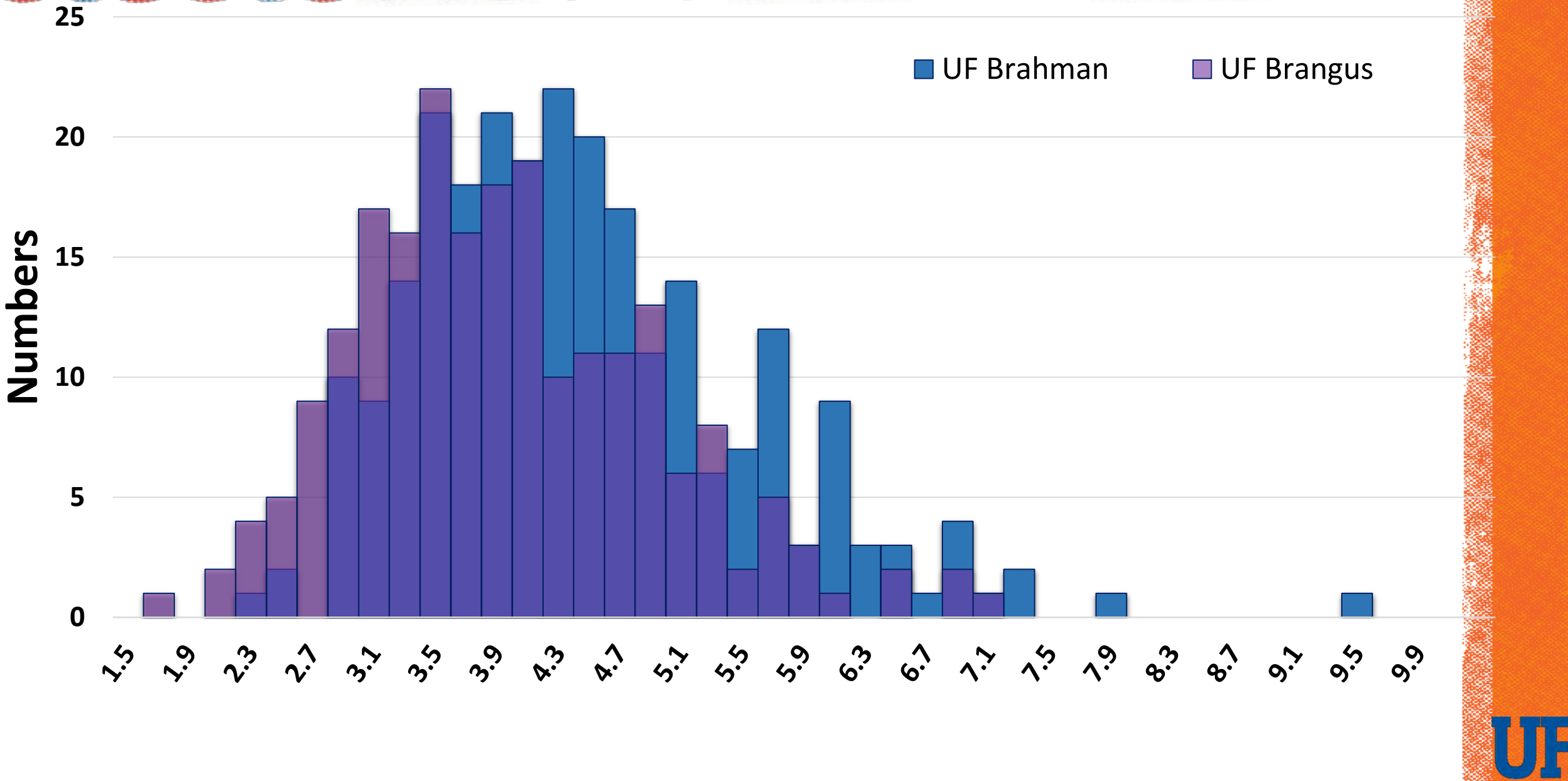

Angus
Numbers
30
25
20
15
10
5
0
1.5
1.9
2.3
2.7
3.1
3.5
3.9
4.3
4.7
5.1
5.5
5.9
6.3
6.7
7.1
7.5
7.9
8.3
8.7
9.1
9.5
9.9


Angus
UF Brangus
Numbers
30
25
20
15
10
5
0
1.5
1.9
2.3
2.7
3.1
3.5
3.9
4.3
4.7
5.1
5.5
5.9
6.3
6.7
7.1
7.5
7.9
8.3
8.7
9.1
9.5
9.9

WBSF

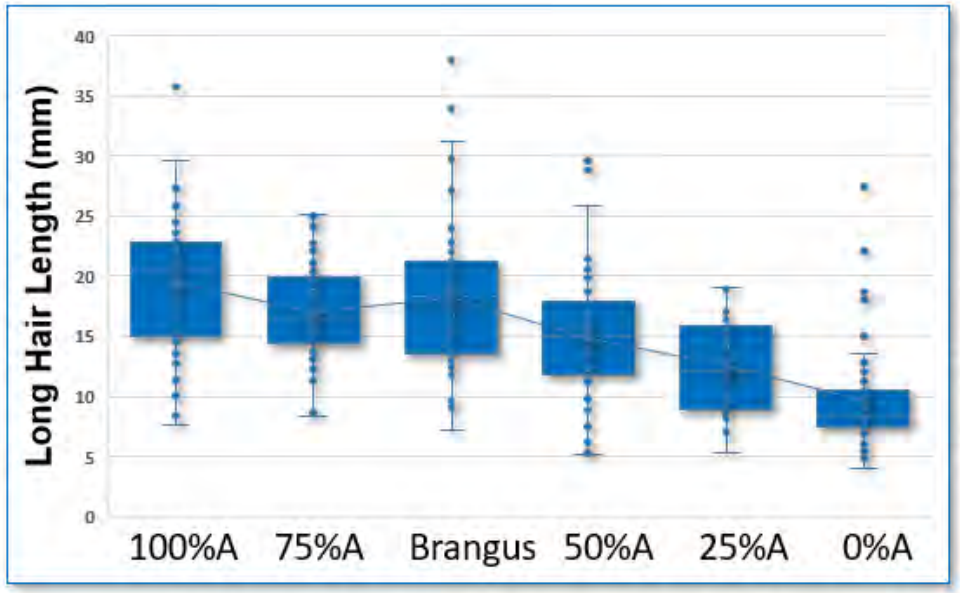

Angus
UF Brahman
Numbers
30
25
20
15
10
5
0
1.5
1.9
2.3
2.7
3.1
3.5
3.9
4.3
4.7
5.1
5.5
5.9
6.3
6.7
7.1
7.5
7.9
8.3
8.7
9.1
9.5
9.9

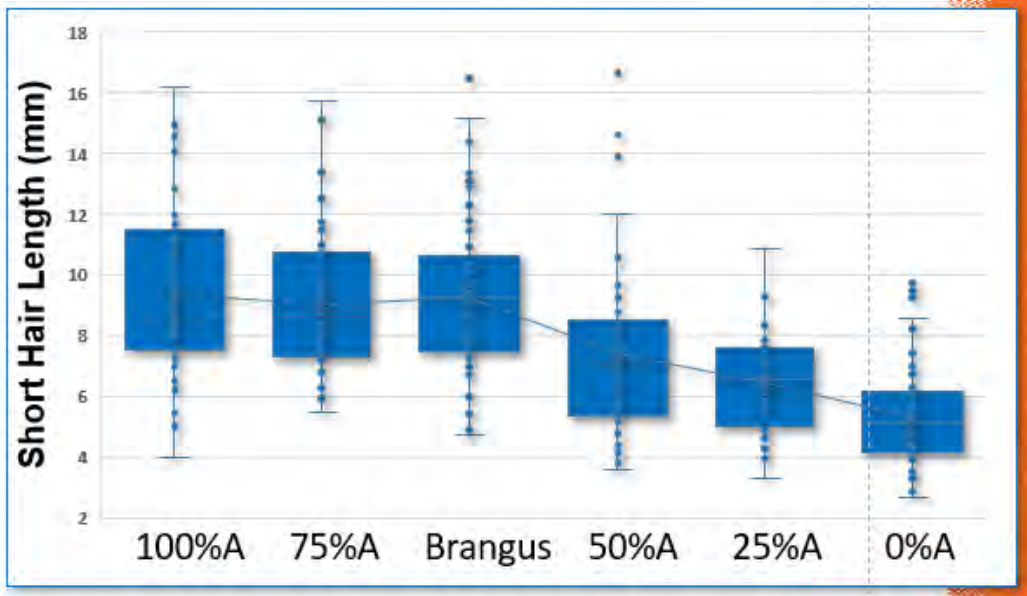
WBSF


UF Brahman
UF Brangus
Numbers
25
20
15
10
5
0
1.5
1.9
2.3
2.7
3.1
3.5
3.9
4.3
4.7
5.1
5.5
5.9
6.3
6.7
7.1
7.5
7.9
8.3
8.7
9.1
9.5
9.9

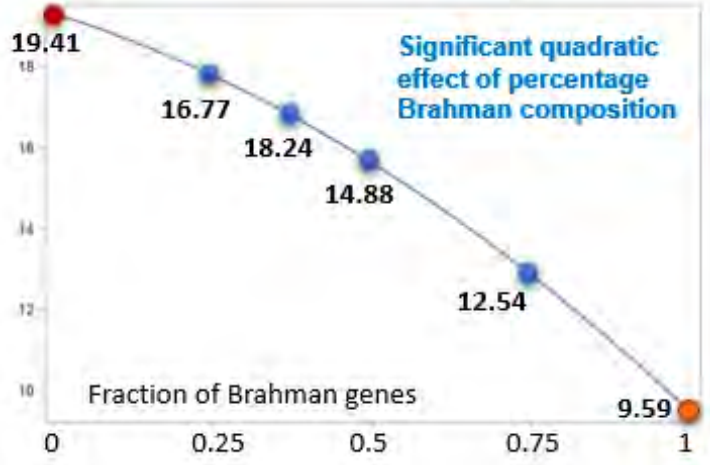
Factors important in thermotolerance

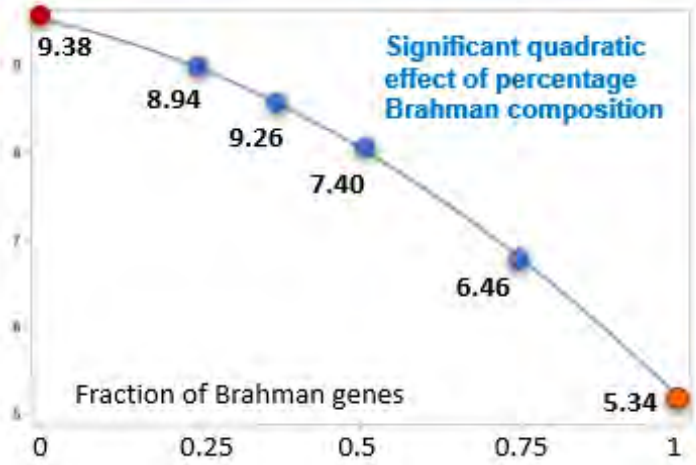
Coat Score





Sweat Glands





Angus
Brahman

Other Skin Prop.

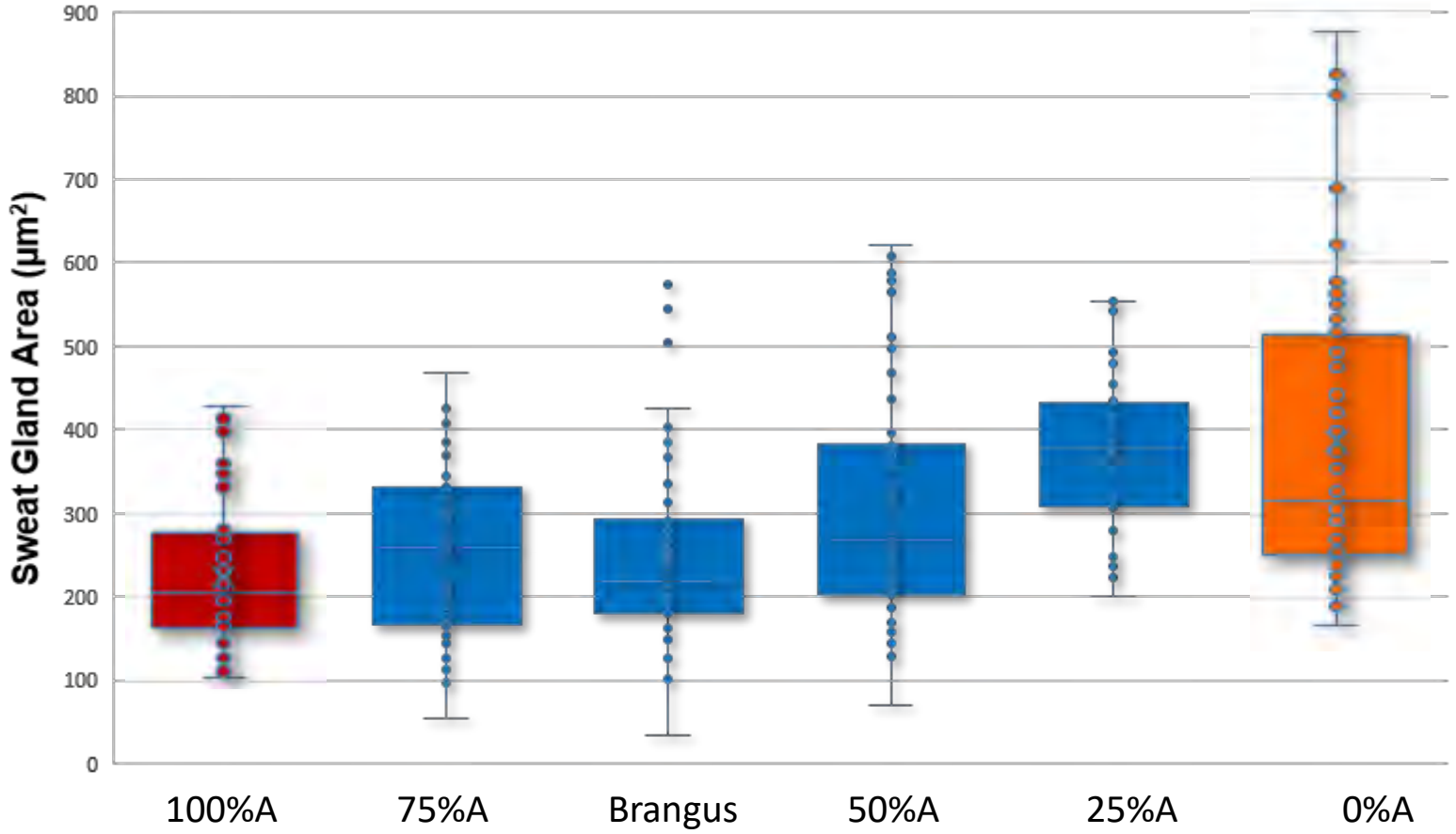
Factors important in thermotole

Source	DF	F Value	Pr > F
Breed	5	13.42	<.0001
SweatGlandArea	1	18.40	<.0001

Coat Score

Sweat Glands

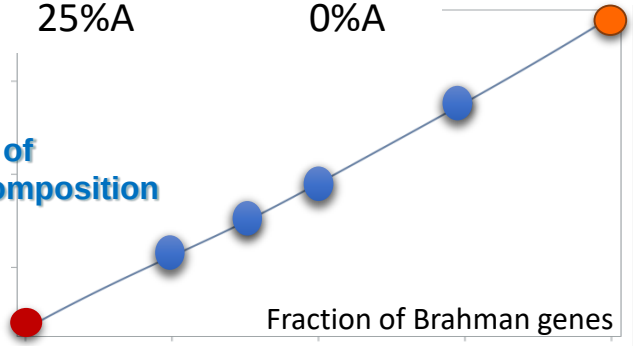
Other Skin Prop.



Angus

Brahman

Significant linear effect of percentage Brahman composition

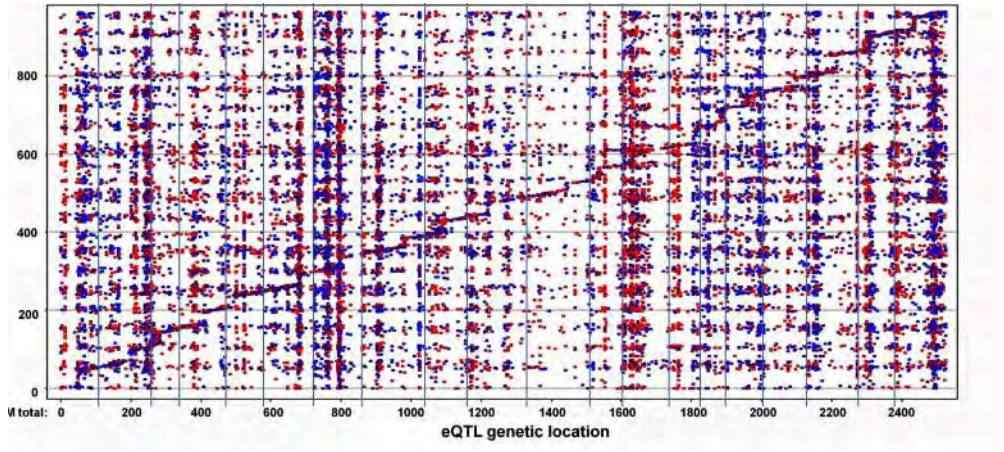


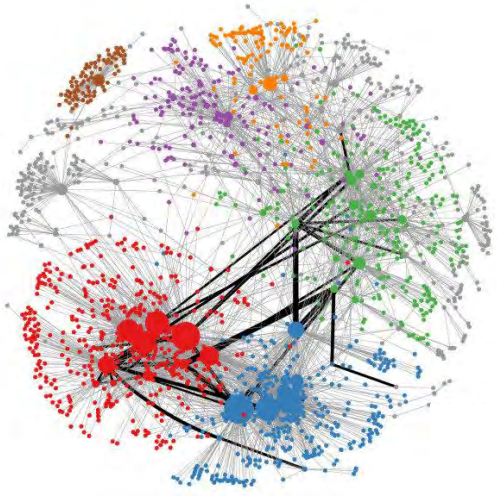
Thermotolerance measurements

- Vaginal **temperature** 15 min over 5 days
- Environmental data: temperature, humidity, **THI**
- **Sweating** rate
- **Coat**: color, coat score, hair length & diameter
- **Temperament**: chute and exit score
- Body **condition** score
- **Skin** biopsies: for histology & gene expression
- **Weight gain** over the summer/fall
- Rump fat and rib fat ultrasound
- Subsequent **pregnancy** status
- **250K** genotypes

Conclusion and future work

- Critical to identify genes and gene **pathways** for thermotolerance independent of production traits.
- Ultimate goal: cattle with high productivity and resistant to heat stress
  - Genomic **selection** within indicine-influenced breeds.
  - **Gene editing** for rapid incorporation into non-adapted breeds.
- Approach: **GWAS** for all traits (gene networks) combined with **gene expression**.

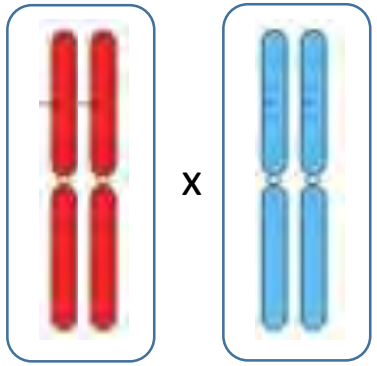




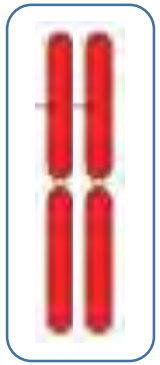
Conclusion and future work

- **Reaction norm** – good approach to describe **phenotypic plasticity** of core body temperature in response to environmental heat stress.
- Cattle with different **Brahman** percentage vary in their phenotypic plasticity.
- The **phenotypic plasticity** has a genetic component (h^2~.24)

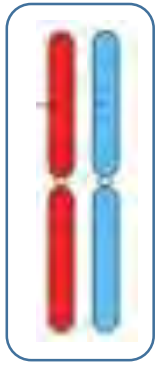
Programs to utilize the genetic component to improve **phenotypic plasticity** can be implemented.

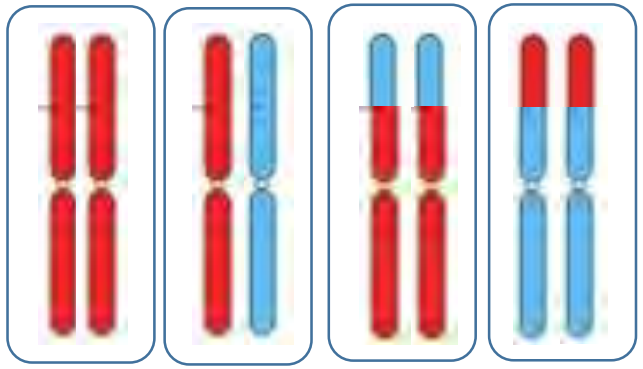


x

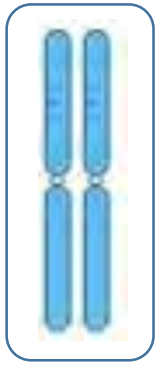


x

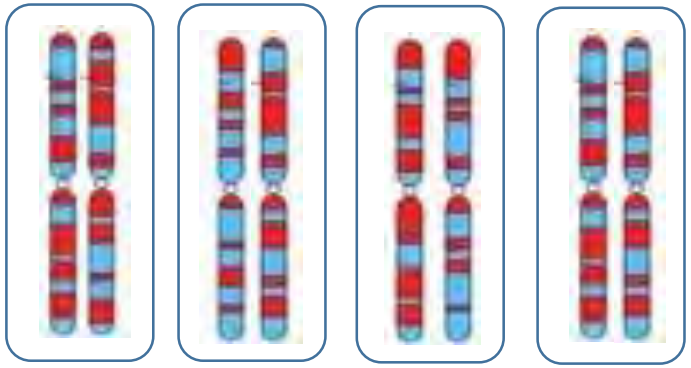




x



.....



Take-home points

- **Brahman** cattle – critical role in US and worldwide beef production.
- Genetics of **thermotolerance** – will allow for improved adaptability in Brahman crosses.
- **Meat quality** – great improvements in tenderness
- Need **breed specific genomic** tool for accurate prediction.

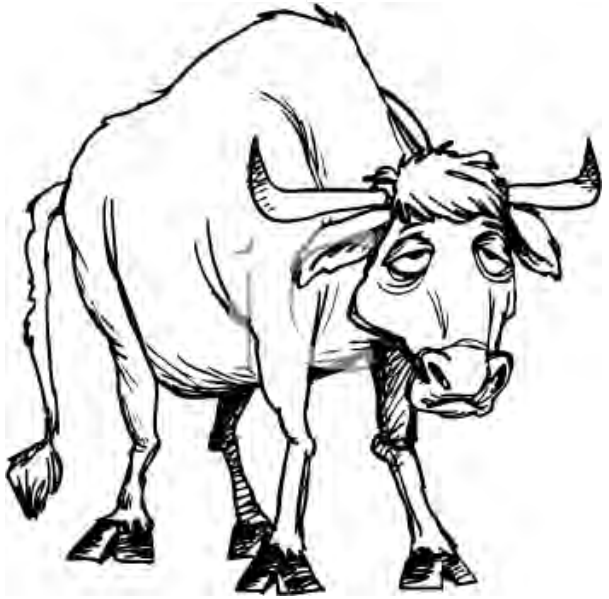
Breed-specific genomic tools

- To meet consumer expectation, the average **tenderness** needs to be **improved** and the **variation** in meat tenderness must be **controlled/managed**

- To be effective - genomic tools need to be developed in the **target** populations

Large resource populations with phenotypes are required for discovery and estimation.

Thermotolerance

- **Heat stress** - negative impact on US and global livestock productivity.
- > **50%** cattle in the world – maintained in hot and humid environments
- When cattle experience heat stress:

Feed intake
Milk production
Growth
Reproduction