Cattle Breeding and Genetics
&
Purebred Cattle Marketing

Coordinators: Dr. Joe Paschal
Dr. Andy Herring

70th Annual
Texas A&M
Beef Cattle Short Course
August 5-7, 2024

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The Road to Becoming a Master Breeder of Seedstock Cattle

Tommy Perkins, Ph.D., PAS
West Texas A&M University

What designates one as a registered cattle breeder? Is it the fact that you have paid membership dues into a breed association? Does ownership of pedigreed cattle make someone a breeder? Or does purchasing multiple descendants of famous bull make you a seedstock breeder? Perhaps ownership or rental of a lot of acreage with pasture makes one a seedstock breeder. Many people think that a paid association membership, owner of pedigreed cattle and purchase of a ranch qualify them for the designation of a seedstock breeder. However, this merely entitles one to be a multiplier of registered cattle. In contrast, a master breeder of quality purebred genetics is one hundred percent committed to producing elite seedstock cattle that will contribute to the overall genetic improvement of the selected breed as well as the commercial cattle industry.

I am often asked what kind of information should seedstock cattle breeders collect and submit to the association in order to maximize their herds genetic improvement. Several issues must be discussed before one can accurately describe every trait that should be measured to improve the breed. The importance of contemporary grouping, proper nutrition levels to display true genetic merit, accurate recordkeeping and a shortened breeding season will be addressed before the above-mentioned question can be answered accurately.

Animals born and reared in the exact same environment within the same season and year make up a proper contemporary group. Proper contemporary grouping allows the breeder to easily measure and identify individuals that excel for various traits on an equal playing field. Breed association genetic evaluations (sire summaries) need a breeder to perform proper contemporary grouping for accurate generation of ratios to adequately perform the analysis. Deception in contemporary grouping negatively impacts proper calculation of expected progeny differences (EPDs). All data, on all animals, should be reported to the association. This can be done through participation in the Total Herd Reporting (THR) program or Whole Herd Reporting (WHR).

It is very important that all animals in a contemporary group be in adequate condition to account for true genetic differences. Current research overwhelmingly shows that proper early nutrition can positively impact an animal's overall health, growth, fertility and marbling ability in later stages of life. Proper gain from weaning to yearling will have a positive impact on your heifer breed-up as well as your yearling ultrasound measurements for both heifers and bulls.

Try not to over feed bulls or heifers as it can lead to feet and leg problems, poor milking ability and even lack of fertility. Poor performing individuals should be culled at the end of their performance test. However, submission of all the collected data is very important to the genetic evaluation of their contemporary mates.

Accurate record keeping is also very important to a master seedstock breeder. Proper birthdates, birthweights, calving ease scores, breeding dates, breeding sires, and birthing dams are just a few to make note of. Don't count on your memory to recall these very important events as your lack of memory may be an embarrassment later on in the animal breeding process (e.g. wrong parent).

I prefer you use a 60 to 90-day breeding season which allows all females to have a minimum of three estrous cycles during a breeding season if necessary. All females should be pregnancy checked 45-60 days after bull removal (or artificial insemination date). Any open female should be culled from the herd. Giving them a second chance propagates inferior fertility in the long run. Strict adherence to culling open females (assuming they are managed appropriately to become pregnant) will lead to a highly fertile herd of cattle. Fertility happens to be a very important and economically relevant trait to all commercial cattlemen.

Breeders should provide adequate "bull power" during the shortened breeding season in order to have a successful pregnancy rate. It is generally recommended that a bull can breed 25-30 cows in a breeding season. This assumes the bulls are mature, have passed a breeding soundness evaluation (BSE) and have been tested negative to the various reproductive disorders (e.g. Trichomoniasis). I recommend young bulls breed the number of cows as they are in number of months of age (e.g. 18-month-old bull should be able to breed eighteen cows per season).

Use of artificial insemination (AI) and embryo transfer (ET) are excellent options for using the best genetics available to improve EPDs and overall genetic worth of your operation. Cows must be increasing in body condition or at least maintaining themselves in order to get maximum pregnancy results. Consult your veterinarian or breeding specialist for the best estrus synchronization protocols for your management. I am a firm believer that use of high accuracy, proven AI sires can tell you a lot about your current cattle population.

I am also a big proponent of ultrasound use for improving carcass merit in your breeding cattle. In general, cattle should be ultrasounded as close to one year of age as possible.

It is important that breeders record the correct disposal code (e.g. dead at birth, culled – bad udder) for all dead or culled animals. This is required in most THR and WHR reporting.

DNA collection is a must for master seedstock breeders. The DNA is generally used for parent verification. I would expect every animal produced on your operation to be both sire and dam verified via DNA. As a master breeder, you should collect a 50K (or higher) genomics test for calculation of genomic enhanced EPDs (GE-EPDs). Genomic technology has decreased in price over the years and DNA sample collection is relatively easy to perform using the Tissue Sampling Unit (TSU). Lastly, DNA sampling can also be used to validate animals for genetic defects found in the breed.

Everything mentioned above, if completed properly, will lead to the most accurate and precise EPDs and selection index (SI) values possible. Some prefer to use EPDs which generally leads to accurate directional changes in the genetic makeup. Others prefer the use of economic SI which may be more practical for increased profit levels for commercial breeders buying your genetics. Terminal SI's (e.g. $B, TI, $T), maternal SI's (e.g. FERT) and General Purpose SI's (e.g. $M, API, $M) should be utilized for the appropriate breeding objectives. For example, no breeding females should be kept from a Terminal SI breeding objective.

Below is a summary table for some of the traits that need to be measured or recorded by a "Master Seedstock Breeder".

Trait	Optimum Score	Optimum Collection Date	Range
Breeding Date		Immediately after Service	
Body Condition	5-6	3 months pre-calving	1.0 - 9.0
Calving Ease	1	At birth	1.0 5.0
Birthweight – Heifers	60-70 lbs.	Within 24 hours of birth	30 - 100
Birthweight - Cows	70-85 lbs.	Within 24 hours of birth	40 - 130
Udder and Teat	7, 7	Within 24 hours of Calving	1-9, 1-9
Gestation Length	<280 days	Calving date - breeding date	265-300 days
Calving Interval	<365 days	At birth	330-400 days
Weaning Age	205 days	Largest CG within 60 days	140-270 days
Weaning Wt.	>600 lbs.	Weaning day	400-900 lbs.
Hair Score	1 or 2	6-wks after last freeze	1.0 to 5.0
Cow Weight	2 times Calf WWT	Calf weaning day	1.5 to 3.0
Yearling Wt.	>900	365 Days of Age (DOA)	320-430 days
Frame Score	5-6	365 DOA (320-550 DOA)	1-10
Pelvic Measure	>150 cm^2	365 DOA (320-720 DOA)	120-250 cm^2
Scrotal Circumference	>32 cm	365 DOA (320-550 DOA)	30-40 cm
Docility Score	1 (Docile)	365 DOA (320-550 DOA)	1-6
Ultrasound – Rib Fat	0.20 to 0.50 in.	365 DOA (320-550 DOA)	0.10 - 1.0 in
Ultrasound – Ribeye	10.0 to 14.0 in^2	365 DOA (320-550 DOA)	5.0 - 18.0 in^2
Ultrasound – % Fat	3.0 to 5.0 %	365 DOA (320-550 DOA)	0.5 - 9.0 %
Ultrasound – Rump Fat	2 times Rib Fat	365 DOA (320-550 DOA)	0.10 – 1.0 in

In general, becoming a "Master Seedstock Breeder" can be quite simple. You must collect all relevant data at the optimum time, only keep replacements that excel in performance (based on your good record keeping), and cull ruthlessly for low performance (independent of pedigree), infertility, poor udder and teat quality, bad temperament, feet/leg problems, and others. Master breeders choose to market all cull animals at the sale barn and not to fellow seedstock breeders. The true master breeder works tirelessly to produce superior seedstock that can improve most animals of the particular breed of cattle they are producing.

Tell me again why you aren't using crossbreeding?

Bailey Engle
US Meat Animal Research Center, Clay Center, NE

2024 TAM Beef Cattle Short Course
Aug 5-7, 2024

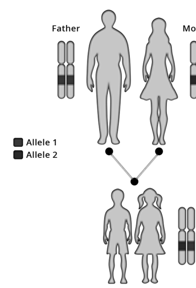
Let's talk about heterosis!

What is heterosis?

The advantage of crossbred progeny relative to the average performance of their purebred parents.

- Hybrid vigor
- Crossbreeding
- Heterozygosity

What is heterosis?



What is heterosis?

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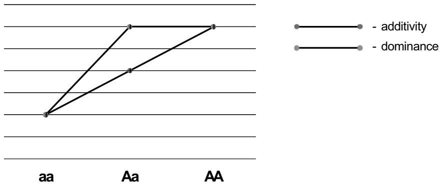

What is heterosis?

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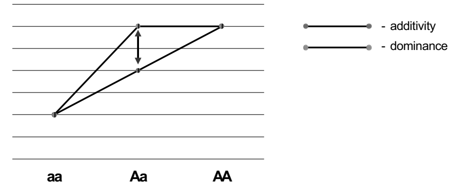
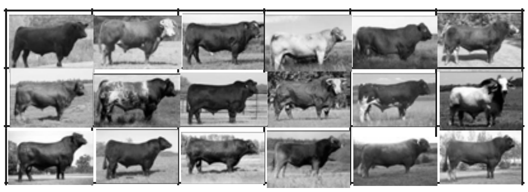


What is heterosis?

- Additive genetics = EPDs
- Less heritable traits will benefit more from heterosis
  - ↑ additivity = ↓ dominance
  - ↑ heritability = ↓ heterosis
- Notable low heritability phenotypes: health & fertility

GPE Breeds

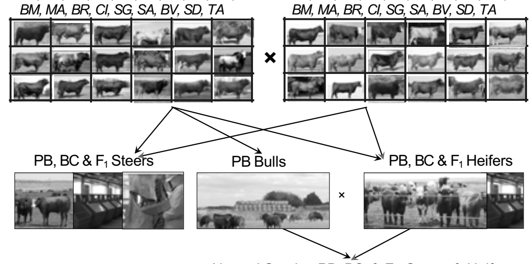


- Angus
- Red Angus
- Hereford
- South Devon
- Shorthorn
- Beefmaster
- Brangus
- Brahman
- Santa Gertrudis
- Braunvieh
- ChiAngus
- Charolais
- Gelbvieh
- Limousin
- Maine-Anjou
- Salers
- Simmental
- Tarentaise

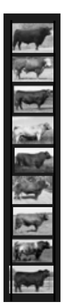
GPE Population Structure

AI Sires:
AN, HH, SM, CH, AR, LM, GV, SH, BN, BM, MA, BR, CI, SG, SA, BV, SD, TA

Dams:
AN, HH, SM, CH, AR, LM, GV, SH, BN, BM, MA, BR, CI, SG, SA, BV, SD, TA



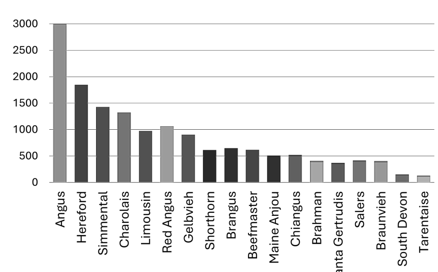
AI Sires Sampled Since 2006



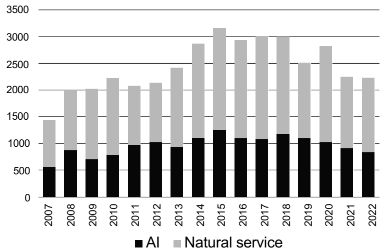
167 Angus
119 Hereford
99 Simmental
73 Charolais
75 Red Angus
74 Limousin
64 Gelbvieh
53 Shorthorn
52 Brangus

49 Beefmaster
45 Maine-Anjou
40 Brahman
34 Santa Gertrudis
36 ChiAngus
36 Salers
33 Braunvieh
18 South Devon
18 Tarentaise
1085 Total

AI-sired Calves Produced Since 2007



Calves born per year



39,090 calves born!

Phenotypes

- BWT – birth weight - *kg*
- AWWT – adjusted weaning weight - *kg*
- PWG – post weaning gain - *kg*
- MARB – marbling score - *units*
- REA – rib eye area – *cm*^{2}
- FAT – fat thickness - *cm*
- CWT – carcass weight – *kg*

- Maternal – birth weight & weaning weight

Biological-type heterosis

- Breeds were assigned to type's
  - British x British
  - British x Brahman
  - British x Continental
  - Continental x Brahman
  - Continental x Continental

Average breed heterosis

Expected merit of a breed randomly mated in a population comprised of all 18 breeds represented in GPE.

This project was *only* made possible by the unique features of GPE

Heterosis for other traits

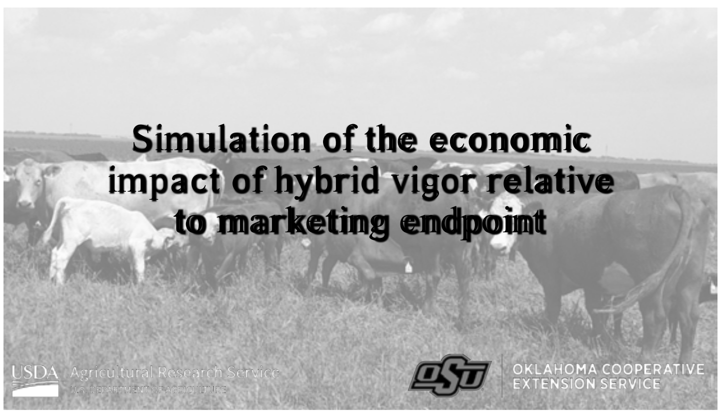
- Mature cow weight
  - Direct heterosis: 47.5 lb (Ribeiro, 2022)
  - Maternal heterosis: *negative* (Zimmerman, 2021)
- Reproductive longevity (Cundiff, 1992)
  - 1 extra year of production = 1 extra calf
  - 25-30% increase in cumulative calf weight weaned
    - 500-600 lb difference from purebred cows
- Feed efficiency (Retallick, 2017)

Brahman heterosis

1. *Bos indicus* x *Bos taurus crosses* will always have largest heterosis effects
   - Especially for maternal ability and fertility
2. Potentially large reciprocal differences exist and should be considered
   - Especially for birth weight
3. Breed complementarity for environmental adaptation

Why this is research important

- Highlights ongoing advantages of crossbreeding
- Provides information for producers using crossbreeding
  - iGenDec
- Informs genetic evaluations
- Significant advantages during national herd rebuilding



The Challenge

- How to incorporate genetic estimates into a comparative economic framework
- 3 Genetic Bases:
  - Straightbred Angus
  - Angus/Hereford cow base
  - Angus/Brahman cow base
- Marketing Endpoints
  - Cow/calf – Weaning
  - Stocker – Feeder
  - Feedlot
    - Live
    - Carcass Merit

Market Conditions

Modeled by Derrell Peel - OSU

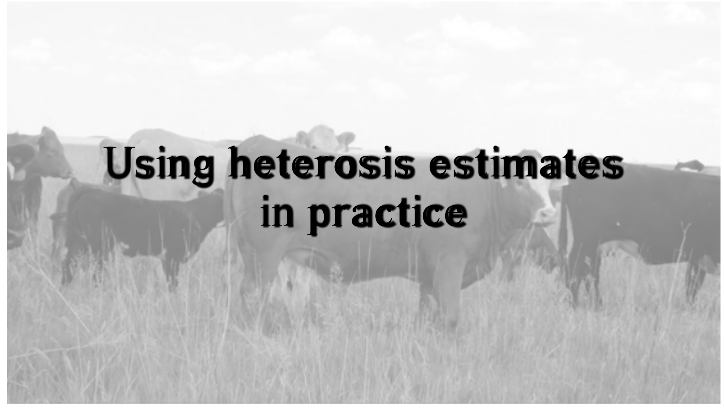
- Feeder cattle market
- Fed cattle price
- Dressed price
- Quality/yield factors
  - Prime
  - Upper Choice
  - Low Choice
  - Select
  - YG 4/5
  - YG 1/2

Preliminary relative value differences

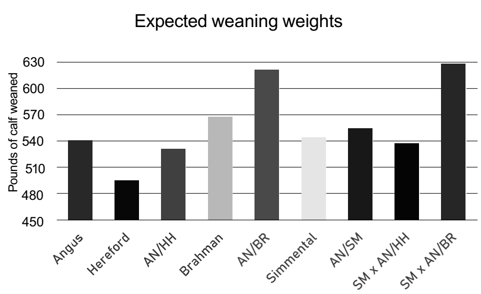
Considerations for national herd rebuild

- Crossbred replacement heifers
  - Significant heterosis advantages
    - Reproductive longevity, cow productivity, calf growth and productivity
  - Advantages of breed complementarity
  - Easy to make your own high-quality replacements in one generation
    - Will require a strategy for the subsequent years

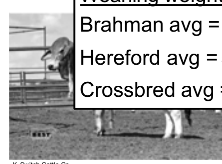
Crossbred cows will give you a more productive cow herd with slower turnover rate, producing more productive calves and requiring fewer expensive replacements

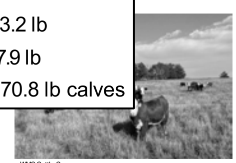


Estimated heterosis from USMARC



Example #1





<u>Weaning weight:</u>
Brahman avg = 563.2 lb
Hereford avg = 517.9 lb
Crossbred avg = 670.8 lb calves

BWT	WWT	MILK	CWT	REA	MARB	FAT
2.7	28	3	28	0.39	3.88	0.01

TABLE 2: BREED OF SIRE MEANS FOR 2021 BORN ANIMALS UNDER CONDITIONS SIMILAR TO USMARC

Breed	Birth Wt. (lb)	Weaning Wt. (lb)	Yearling Wt. (lb)	Maternal Milk (lb)	Marbling Score*	Ribeye Area (in²)	Fat (in)	Carcass Wt. (lb)
Angus	84.7	540.9	[illegible]	520.5	6.25	13.72	0.662	921.7
Hereford	87.1	517.9	[illegible]	509.8	5.34	13.47	0.600	871.7
Red Angus	83.8	520.1	[illegible]	[illegible]	[illegible]	[illegible]	0.633	884.9
Shorthorn	89.1	499.7	[illegible]	517.0	5.42	13.67	0.531	864.8
South Devon	87.9	503.5	[illegible]	[illegible]	5.42	13.69	0.511	853.9
Beefmaster	86.9	527.8	[illegible]	510.3				
Brahman	94.3	554.2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	853.7
Brangus	86.8	527.0	[illegible]	[illegible]				
Santa Gertrudis	88.4	528.7	[illegible]	514.4	5.12	13.27	0.579	870.6
Braunvieh	87.8	508.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	846.3
Charolais	89.6	541.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	899.5
Chiangus	87.7	506.4	[illegible]	[illegible]	[illegible]	[illegible]	0.523	874.0
Gelbvieh	86.4	536.9	[illegible]	522.6	5.29	14.32	0.525	884.6
Limousin	86.1	535.6	[illegible]	512.8	5.41	14.53	0.534	891.7
Maine-Anjou	86.2	494.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	849.5
Salers	85.3	519.9	[illegible]	521.9	5.32	[illegible]	[illegible]	866.2
Simmental	86.8	542.6	[illegible]	517.4	5.52	14.40	0.511	896.3
Tarentaise	86.3	520.1	[illegible]	509.2				

*Marbling score units: 4.00 = Sl[00]; 5.00 = Sm[00]

ABBA WWT avg EPD: 19
28 - 19 = +9 lb

9 lb WWT + 554.2 = 563.2 lb

563.2 + 517.9 / 2 = 540.55 lb
540.55 * 0.45 = 243.25 kg

243.25 + 49.9 + 8.7 = 301.9 kg or 670.8 lb calves

Breed	AWWT
AN	-
AR	8.2 ± 3.2
HH	8.7 ± 3.1
SH	9.6 ± 3.7
BM	52.9 ± 12.7
BR	49.9 ± 7.3
BV	-
CH	7.0 ± 3.2
GV	-
LM	-
MA	14.4 ± 4.0
SM	-
TA	-

Example #2

TABLE 2: BREED OF SIRE MEANS FOR 2021 BORN ANIMALS UNDER CONDITIONS SIMILAR TO USMARC

Breed	Birth Wt. (lb)	Weaning Wt. (lb)	Yearling Wt. (lb)	Maternal Milk (lb)	Marbling Score*	Ribeye Area (in²)	Fat (in)	Carcass Wt. (lb)
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Hereford	87.1	517.9	917.5	509.8	5.34	13.47	0.600	871.7
Red Angus	83.8	520.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Shorthorn	89.1	499.7	900.7	517.0	5.42	13.67	0.531	864.8
South Devon	87.9	503.5	[illegible]	[illegible]	[illegible]	[illegible]	0.511	853.9
Beefmaster	86.9	527.8	[illegible]	[illegible]				
Brahman	94.3	554.2	[illegible]	[illegible]	[illegible]	[illegible]	0.507	853.7
Brangus	86.8	527.0	933.3	519.8				
Santa Gertrudis	88.4	528.7	919.3	514.4	5.12	13.27	0.579	870.6
Braunvieh	87.8	508.8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Charolais	89.6	541.0	949.7	515.7	5.32	14.51	0.472	899.5
Chiangus	87.7	506.4	906.0	515.9	5.43	13.99	0.523	874.0
Gelbvieh	86.4	536.9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Limousin	86.1	535.6	938.2	512.8	5.41	14.53	0.534	891.7
Maine-Anjou	86.2	494.9	874.0	506.5	5.18	14.29	0.458	849.5
Salers	85.3	519.9	924.0	521.9	5.32	14.19	0.510	866.2
Simmental	86.8	542.6	961.2	517.4	5.52	14.40	0.511	896.3
Tarentaise	86.3	520.1	888.4	509.2				

*Marbling score units: 4.00 = Sl[00]; 5.00 = Sm[00]

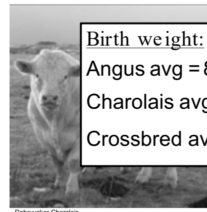
84.7 lb * 0.45 = 38.4 kg
89.6 lb * 0.45 = 40.6 kg

38.4 + 40.6 / 2 = 39.5 kg parental avg

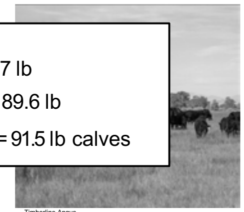
39.5 + 1.67 = 41.17 kg or 91.5 lb calves

Breed	BWT
AN	-
AR	-
HH	-
SH	-
BM	-
BR	3.73 ± 1.41
BV	-
CH	1.67 ± 0.67
GV	-
LM	-
MA	2.34 ± 0.84
SM	-
TA	-

Example



Debruycker Charolais



Timberline Angus

Birth weight:
Angus avg = 84.7 lb
Charolais avg = 89.6 lb
Crossbred avg = 91.5 lb calves

Summary

- Heterosis has been estimated to impact nearly all production traits
  - In particular:
    - Lowly heritable traits such as fertility or health
    - Brahman crosses
- Heterosis is one of the biggest benefits of crossbreeding
  - Only 1generation to see results
  - Plus, advantages from breed complementarity
- Ongoing collaborations and projects at USMARC on heterosis
  - Resource for breeders, may be integrated into iGenDec

Acknowledgements

- Mark Thallman, Larry Kuehn, Warren Snelling
- Derrell Peel and Mark Johnson - *OSU*
- Steven Shackelford, Andy King, Tommy Wheeler - *USMARC*
- USMARC Cattle Operations
- All breeds and producers involved in supporting the GPE program

USDA Agricultural Research Service
U.S. DEPARTMENT OF AGRICULTURE

CARCASS TRAITS AND TENDERNESS OF CATTLE WITH VARYING % *BOS INDICUS* BREEDING

TODD THRIFT

UNIVERSITY OF FLORIDA

DEPARTMENT OF ANIMAL SCIENCE

BACKGROUND

- 1950S-1980S FLORIDA HAD AN ACTIVE FEEDING INDUSTRY
- RECENT RE-INTEREST IN LOCAL FEEDING AVENUES
- FLORIDA BEEF VIEWED AS LOWER QUALITY
  - BRAHMAN PERCENTAGE
  - MARBLING ABILITY
  - TENDERNESS

FED BEEF CHALLENGE (5 YEARS)

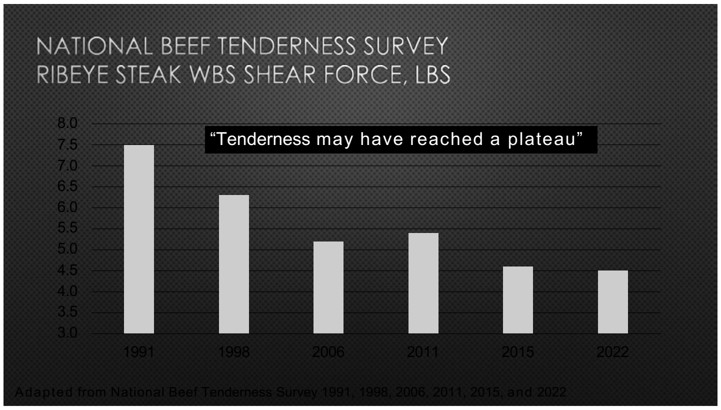
- 19 RANCHES
- 62 PENS/GROUPS OF 10 HEAD
- BREED OF SIRE
  - CHAROLAIS
  - ANGUS
  - BRAHMAN
  - BRANGUS
  - RED ANGUS
  - SIM ANGUS
  - HEREFORD
  - SHORTHORN

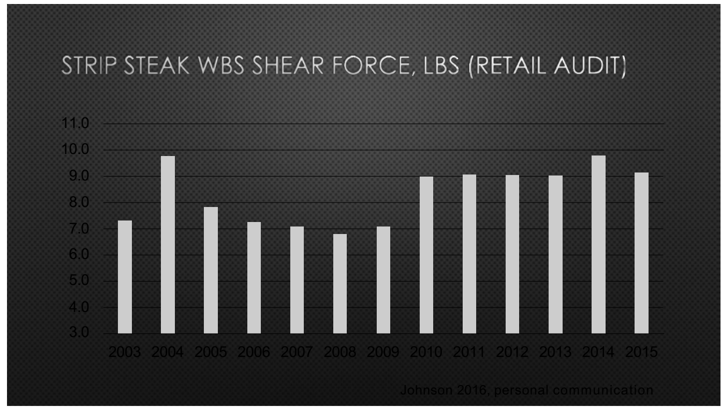
FED BEEF CHALLENGE

- DATA COLLECTED
  - FINAL LIVE WT
  - DAYS ON FEED
  - AVERAGE DAILY GAIN
  - HCW
  - USDA QUALITY GRADE
  - USDA YIELD GRADE
  - UF QUALITY GRADE (MARBLING SCORE)
  - FAT THICKNESS
  - RIBEYE AREA
  - LEAN MATURITY
  - BONE MATURITY
  - USDA CALCULATED YIELD GRADE
  - TENDERNESS (SLICE SHEAR FORCE)

TENDERNESS ANALYSIS

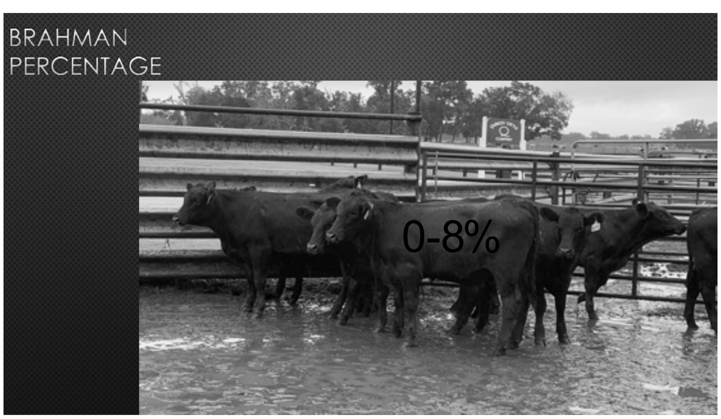
WHAT DO WE REALLY KNOW AND WHERE DID WE LEARN IT?

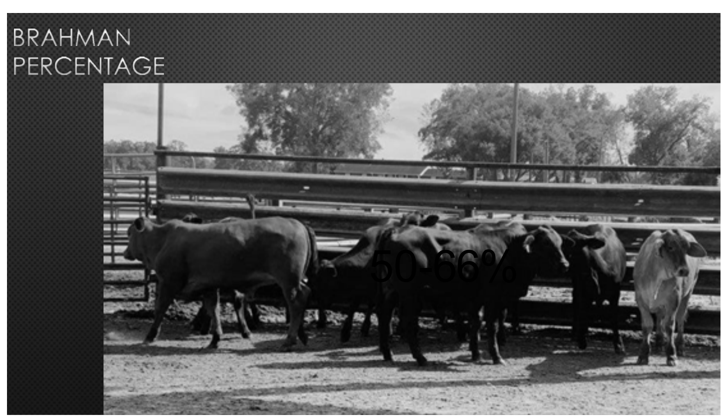

NATIONAL BEEF TENDERNESS SURVEY
RIBEYE STEAK WBS SHEAR FORCE, LBS
"Tenderness may have reached a plateau"
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
1991
1998
2006
2011
2015
2022
Adapted from National Beef Tenderness Survey 1991, 1998, 2006, 2011, 2015, and 2022


STRIP STEAK WBS SHEAR FORCE, LBS (RETAIL AUDIT)
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Johnson 2016, personal communication


BRAHMAN OR
% BOS INDICUS
IS OFTEN TO
BLAME?


FED BEEF CHALLENGE
• Brahman percentage was estimated by Neogen using DNA
• Range from 0 100%
• Average for the entire 615 hd was 20%
6%
26%


BRAHMAN
PERCENTAGE
0-8%


BRAHMAN
PERCENTAGE
50-66%

SUMMARY FLORIDA FED BEEF CHALLENGE (PERFORMANCE-5 YEAR SUMMARY)

	Mean	Range
Number head	615	
In Weight	683 lbs	438-945 lbs
Out Weight	1313 lbs	994-1633 lbs
ADG	3.22 lb/d	1.36-4.97 lb/d
DOF	198 d	162-246 d
Brahman %	20.0 %	0-100%

SUMMARY FLORIDA FED BEEF CHALLENGE (CARCASS-5 YEAR SUMMARY)

	Mean	Range
HCW	817 lbs	583-1048 lbs
MS	387	120-690
% CH	50 %	30-80%
YG	3.0	0.62-6.0
REA	13.6 sq in	10-21 sq in
FOE	.51 in	0.2-1.2 in
SSF	21.8 kg	11.7-44.2 kg

QUALITY GRADE DISTRIBUTION FLORIDA FED BEEF CHALLENGE (5 YEAR SUMMARY)

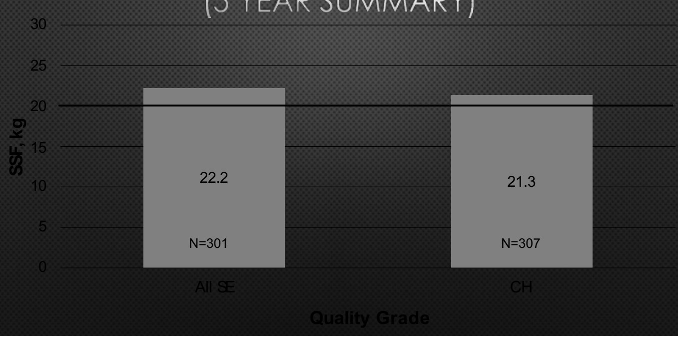
	hd
Upper 2/3 CH	11
CH -	297
SL+	170
SL -	131
STD	7

WHAT IS THE RELATIONSHIP BETWEEN MARBLING AND TENDERNESS? 5-10%

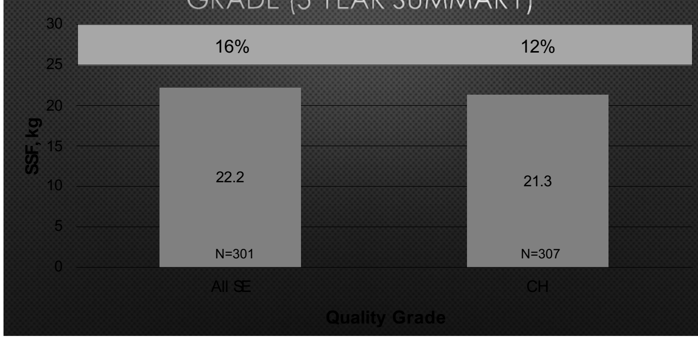
TENDERNESS CLASSIFICATION

- VERY TENDER <15 KG SSF "CERTIFIED VERY TENDER"
- TENDER 15-20 KG SSF "CERTIFIED TENDER"
- TOUGH 25-30 KG SSF
- VERY TOUGH >30 KG SSF

SSF BY QUALITY GRADE (5 YEAR SUMMARY)



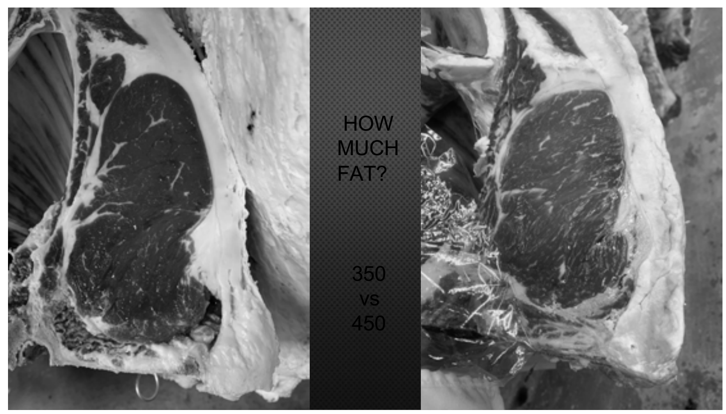
% OF CATTLE 25-30 KG (TOUGH) SSF BY QUALITY GRADE (5 YEAR SUMMARY)

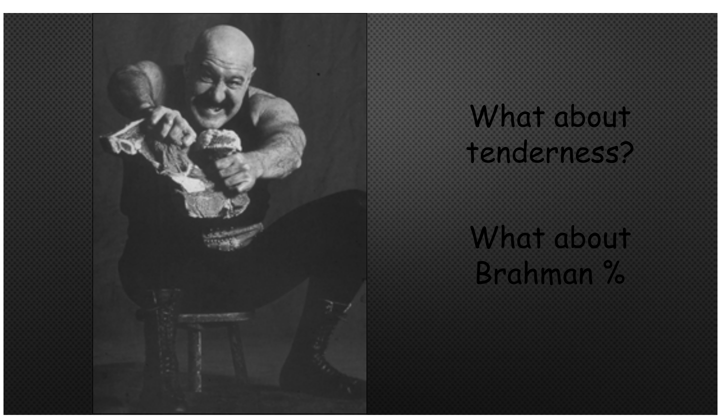


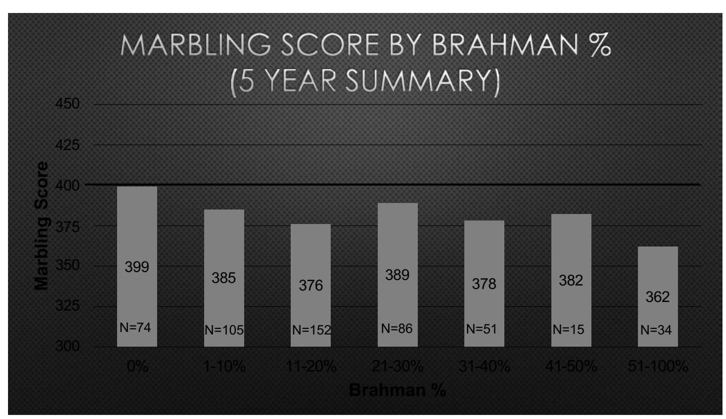

% OF CATTLE OVER 30 KG (VERY TOUGH) SSF BY QUALITY GRADE (5 YEAR SUMMARY)
SSF, kg
30
25
20
15
10
5
0
6%
7%
22.2
21.3
N=301
N=307
All SE
CH
Quality Grade

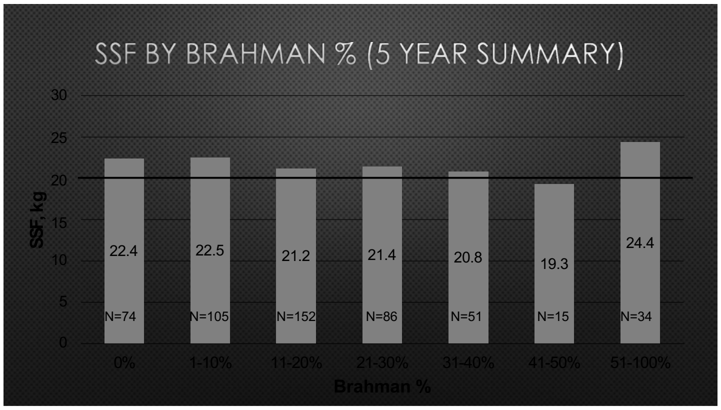

% OF CATTLE 15-20 KG (TENDER) SSF BY QUALITY GRADE (5 YEAR SUMMARY)
SSF, kg
30
25
20
15
10
5
0
30%
42%
22.2
21.3
N=301
N=307
All SE
CH
Quality Grade


% OF CATTLE UNDER 15 KG (VERY TENDER) SSF BY QUALITY GRADE (5 YEAR SUMMARY)
SSF, kg
30
25
20
15
10
5
0
6%
4%
22.2
21.3
N=301
N=307
All SE
CH
Quality Grade


HOW MUCH FAT?
350 vs 450

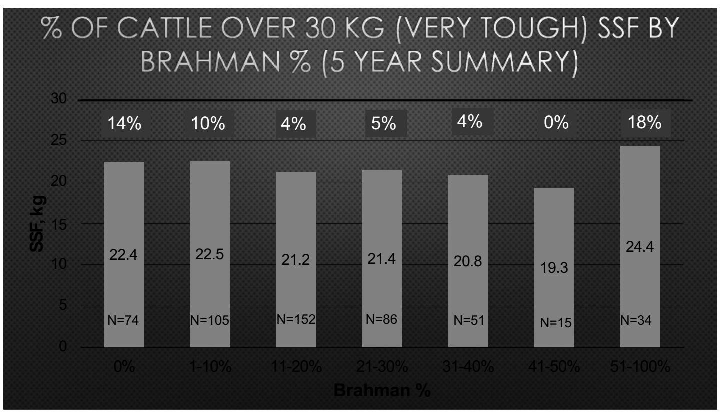

What about tenderness?
What about Brahman %


MARBLING SCORE BY BRAHMAN % (5 YEAR SUMMARY)
Marbling Score
450
425
400
375
350
325
300
399
385
376
389
378
382
362
N=74
N=105
N=152
N=86
N=51
N=15
N=34
0%
1-10%
11-20%
21-30%
31-40%
41-50%
51-100%
Brahman %



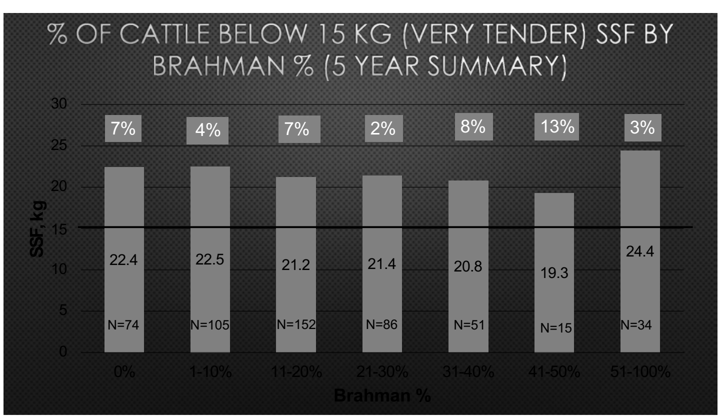
SSF BY BRAHMAN % (5 YEAR SUMMARY)
SSF, kg
Brahman %
0% 1-10% 11-20% 21-30% 31-40% 41-50% 51-100%
22.4 22.5 21.2 21.4 20.8 19.3 24.4
N=74 N=105 N=152 N=86 N=51 N=15 N=34

% OF CATTLE 25-30 KG (TOUGH) SSF BY BRAHMAN % (5 YEAR SUMMARY)
12% 14% 14% 9% 14% 13% 21%
SSF, kg
Brahman %
0% 1-10% 11-20% 21-30% 31-40% 41-50% 51-100%
22.4 22.5 21.2 21.4 20.8 19.3 24.4
N=74 N=105 N=152 N=86 N=51 N=15 N=34

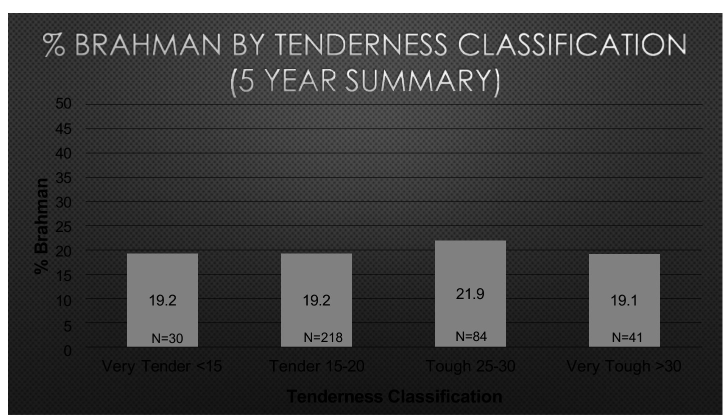


% OF CATTLE OVER 30 KG (VERY TOUGH) SSF BY BRAHMAN % (5 YEAR SUMMARY)
14% 10% 4% 5% 4% 0% 18%
SSF, kg
Brahman %
0% 1-10% 11-20% 21-30% 31-40% 41-50% 51-100%
22.4 22.5 21.2 21.4 20.8 19.3 24.4
N=74 N=105 N=152 N=86 N=51 N=15 N=34

% OF CATTLE 15-20 KG (TENDER) SSF BY BRAHMAN % (5 YEAR SUMMARY)
30% 35% 38% 36% 43% 53% 24%
SSF, kg
Brahman %
0% 1-10% 11-20% 21-30% 31-40% 41-50% 51-100%
22.4 22.5 21.2 21.4 20.8 19.3 24.4
N=74 N=105 N=152 N=86 N=51 N=15 N=34

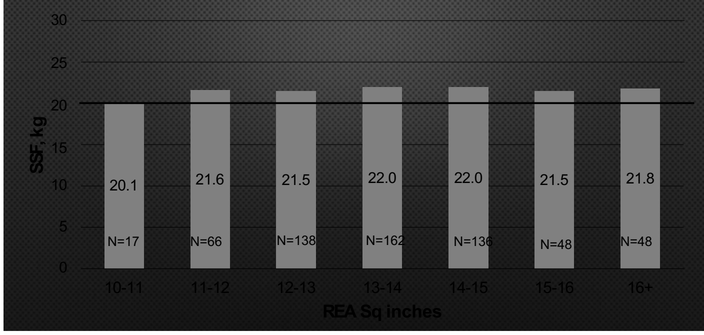


% OF CATTLE BELOW 15 KG (VERY TENDER) SSF BY BRAHMAN % (5 YEAR SUMMARY)
7% 4% 7% 2% 8% 13% 3%
SSF, kg
Brahman %
0% 1-10% 11-20% 21-30% 31-40% 41-50% 51-100%
22.4 22.5 21.2 21.4 20.8 19.3 24.4
N=74 N=105 N=152 N=86 N=51 N=15 N=34

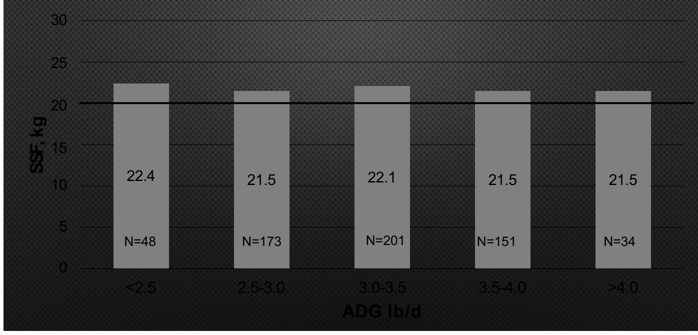


% BRAHMAN BY TENDERNESS CLASSIFICATION (5 YEAR SUMMARY)
% Brahman
Tenderness Classification
Very Tender <15 Tender 15-20 Tough 25-30 Very Tough >30
19.2 19.2 21.9 19.1
N=30 N=218 N=84 N=41

Effect of REA on SSF (5 Year Summary)



Effect of ADG on SSF (5 Year Summary)



Ranches with the Highest (Toughest) Slice Shear Force

Ranch	SSF	Brahman %	Range SSF
1	27.7 kg	60%	18.4 – 35.9 kg
2*	25.9 kg	15%	17.5 – 31.5 kg
3	25.4 kg	10%	17.5 – 31.5 kg
4	25.3 kg	100%	19.0 – 36.2 kg
5*	25.0 kg	15%	19.3 – 29.3 kg

Ranches with the Lowest (Tender) Slice Shear Force

Ranch	SSF	Brahman %	Range SSF
1*	16.3 kg	31%	14.2 – 21.1 kg
2*	17.0 kg	27%	11.9 – 21.9 kg
3**	18.3 kg	28%	13.5 – 24.4 kg
4**	18.4 kg	16%	12.3 – 32.1 kg
5**	18.5 kg	29%	13.6 – 22.4 kg

Conclusions from 5 Years of Fed Beef Challenge Tough Verses Tender

- 23/62 (37%) pens had at least one very tender calf (<15 kg)
- 61/62 (98%) pens had at least one tender calf (15–20 kg)
- 53/62 (85%) pens had at least one tough calf (25–30 kg)
- 28/62 (45%) pens had at least one very tough calf (>30 kg)
- 9/62 (15%) pens did not have a tough or Very Tough calf (>25 kg)

ALL RANCHES HAD BOTH TENDER AND TOUGH CATTLE IN THE SAME GROUP/PEN POTENTIALLY BY THE SAME SIRE!!!

Conclusions from 5 Years of Fed Beef Challenge

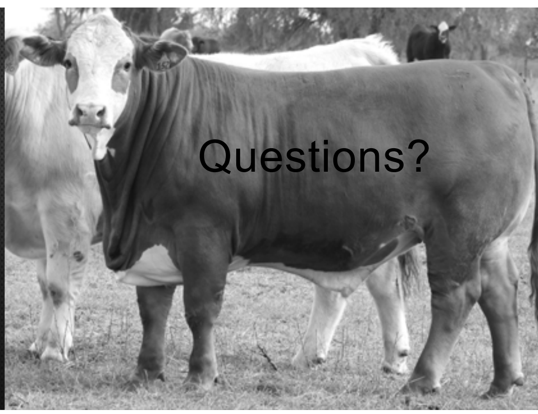
- As Brahman percentage increased marbling score trends down very slightly (But crosses the line from CH to SL)
- Brahman percentage up to 50% did not adversely affect tenderness
- Cattle with 0% Brahman were not more tender
- Cattle with larger REA or Higher ADG were not Tougher
- All Ranches Had Tough and Tender Cattle
- Choice cattle were similar in tenderness to Select cattle
- Approximately 3/4 of cattle fell in a Narrow window from mid select to mid choice

Overall Implications

- Based upon DNA analysis of Brahman percentage it is unlikely that the higher slice shear force values are a result of Brahman influence in this population
- Utilization of genomic Brahman percentage to sort cattle based upon potential SSF and marbling score is not warranted
  - In cattle <50% *Bos indicus*

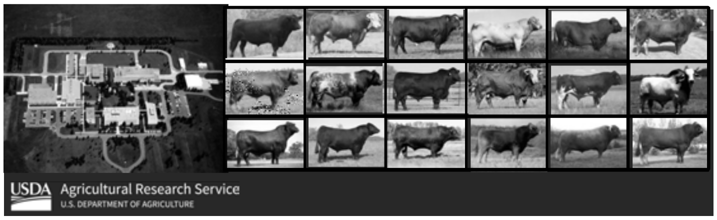
How do FL cattle compare?

	Fed Beef Challenge 5 years	Major Retail Outlet Spring 2024
Number hd	615	240
Marb Score	387	464
% CH	50%	100%
Brahman %	20 %	???
SSF	21.75 kg	20.76 kg
SSF range	11.7 – 44.2 kg	11.2 - 41.1 kg
% Very Tender <15 kg	5%	4%
% Tender 15-20 kg	35%	43%
% Tough 25-30 kg	14%	11%
% Very Tough >30 kg	7%	3%



Terminal Crossbreeding: A Missed Opportunity for the Beef Industry

R. Mark Thallman
U.S. Meat Animal Research Center
Clay Center, NE



Main Take-Home Message

- If the genetic potential for growth is the same in commercial cows as it is in the bulls they are bred to, some profit potential is probably left on the table.

Overview

- Terminal crossbreeding systems
- Practicality of raising replacement heifers in one-bull herds
- Need for producers to specialize in producing young bred cows with maternal genetics
  - How to make such a system sustainable and profitable
  - Genetic characteristics of such a population
- Obstacles to implementation
- Advantages to the entire beef industry
- Breeding Maternal Cattle

Terminal Crossbreeding Systems

- Breeding cows strong in maternal traits to bulls that are strong for terminal traits
- Was used extensively in the 1970s when exotic continental European breed bulls were commonly bred to British breed cows
  - Calving difficulty can be a challenge
  - Producing a sufficient number of replacements can be a challenge

The Traditional Replacement Rate Challenge

- Almost all cows in system are maternal
- About half of cows in the system need to be bred to maternal bulls to produce enough replacements to maintain a population of maternal cows
- This means only about half of steers and 2/3 of fed cattle are sired by terminal bulls
  - The remainder are straight maternal steers of substantially less value

Terminal Sire Breeding Goals

- Early growth rate
- Calving ease as a trait of the calf
- Feed efficiency
- Meat quality
- Carcass composition
- Disease resistance
- Calf survival and vigor
- Male fertility

Maternal Breeding Goals

- Female fertility
- Maternal calving ease
- Low maintenance requirements (small size)
- Longevity
- Milk production (but is more better?)
- Disease resistance
- Temperament
- Maternal instinct
- Adapted to the production environment

Fundamental Principles of Animal Breeding

- Focus on fewer traits allows faster progress per trait
- More traits are important in an extensive and variable production environment
- Terminal crossbreeding is much easier with higher female fecundity
  - The pork and poultry industries are not leaving this opportunity on the table

Practicality of Raising Replacement Heifers in One-Bull Herds

- There are generally not enough replacements in one year to be practical to manage as a separate group.
- It is not a very efficient use of time to night calve 3-5 heifers.
- The one bull that females of all ages must be bred to will likely either be too hard-calving for the heifers or have insufficient growth to optimize production from the cows.
- Unless the bull is changed every two years, he will breed his daughters.

Practicality of Raising Replacement Heifers in One-Bull Herds

- Nonetheless, these herds produce a substantial fraction of the calves in the beef industry and that seems unlikely to change.
- These herds would be more productive, profitable, and enjoyable for their owners if they purchased replacement females that were bred for their 2nd or later calf and sold their entire calf crops to be fed for harvest.
- Ideally, the bulls would be selected for terminal traits and the cows for maternal traits.

Practicality of Raising Replacement Heifers in One-Bull Herds

- The advantages of changing to this structure are not limited to one-bull herds.
- The educational, cultural, and marketing challenges to getting this approach adopted should not be underestimated.
- Furthermore, the current lack of a substantial supply of maternal-oriented young bred cows in the marketplace would make it very challenging to try to convince conventional all-purpose producers to specialize in terminal calf production.

Producers of Young Bred Cows with Maternal Genetics

- There is a need for specialized producers of these
- They would probably tend to be larger than average producers, but not necessarily.
- Large ranches could have both maternal and terminal herds in the same operation.
- The ideal product would be young maternal cows bred to terminal bulls to have their 2nd calf.
- However, there is currently a market for replacement heifers that are either open or bred for their 1st calf.
  - Producers of specialized maternal genetics should not miss the opportunity to supply that market.

Producing Young Bred Cows: Sex Ratio and Replacement Rate

- On average, each cow needs to produce a heifer calf to replace herself in order to maintain herd size.
  - Sex ratio, pregnancy, and culling rates determine the required replacement rate. With 50% female calves:
    - First-calf heifers in the maternal herd should be bred to maternal sires and should generate roughly half of the needed maternal females.
    - Assuming the product is maternal heifers bred to terminal sires for their second calf, the other half of the needed maternal females has to come from maternal females that are third parity and older.
    - Minimizing the replacement rate in these mature females is important for the efficiency of the system.

Producing Young Bred Cows: Sex Ratio and Replacement Rate

- With use of sexed semen in the maternal herd:
  - First-calf heifers in the maternal herd should be bred to maternal sires and should generate more than half of the needed maternal females.
  - Depending on the sex ratio achieved, the required number of mature maternal females could be reduced substantially.
  - This could make the production of maternal females far more efficient.

Lessons from the Dairy Industry

- It was only a few decades ago that the dairy industry faced a replacement rate crisis
- It was solved by:
  - Genetic evaluation of fertility
  - Use of sexed semen
- Sexed semen is fundamentally responsible for the beef-on-dairy phenomenon

Sexed Semen

- Sexed semen is rapidly becoming a feasible technology that should be a game-changer for consideration of terminal crossbreeding

Producing Young Bred Cows: Sex Ratio

- Altering sex ratio would also:
  - Reduce the incidence of calving difficulty (by reducing the number of heavier bull calves).
  - Reduce the number of maternal line steers that need to be marketed, likely at a discount and lower weight.

Marketing Young Bred Cows: Sex Ratio of the Pregnacies

- It might be profitable to breed cows designated for sale with male-sexed terminal semen, but it would be necessary to capture added value from the improved sex ratio
  - Best if early ultrasound pregnancy detection could be used to identify AI-sired calves and/or determine sex of calves
  - A lower cost strategy could be to sell based on a guaranteed sex ratio and pay a rebate if not realized.

Selection for Maternal Traits

- Genetic improvement for maternal traits should primarily come from bull selection
- It would benefit greatly from better maternal trait EPDs based on data from all parities.

Selection for Maternal Traits

- Culling should be minimal and based almost solely on immediate effect on profitability.
- Don't cull cows in the hope of improving genetics of the herd.
  - Attempting to use culling to achieve genetic progress would make the system unsustainable.
  - But, keeping daughters of the best cows for use in nucleus herds would be beneficial.

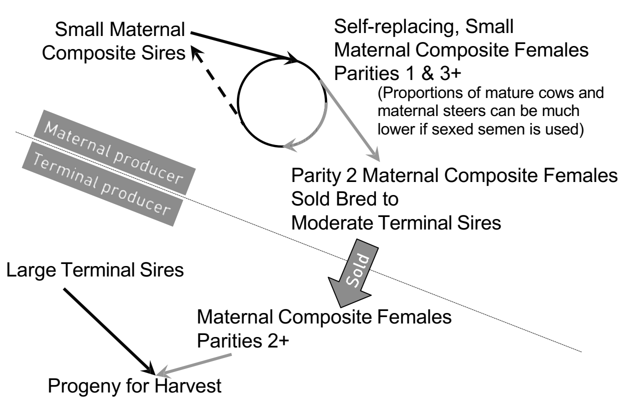
Length of Breeding Season

- Short breeding seasons:
  - Reduce pregnancy rate
  - Increase replacement rate
  - Are reasonable if justified by immediate profitability
  - Are not justified by the idea that they will improve breeding value for fertility

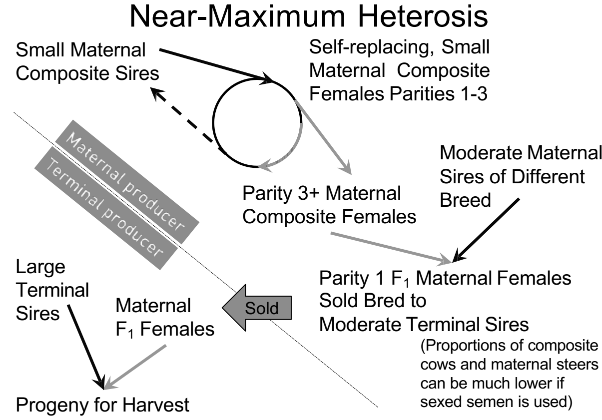
Mating Systems for Terminal Crossbreeding

- It is probably simplest for maternal females to be a composite, but other crossbreeding systems would also work.
- But we should not miss the opportunity to take advantage of heterosis in the primary cow herds that produce commercial calves for the beef industry

Maternal Composite System



System with F_1 Cows for Near-Maximum Heterosis



Size Disparity Between Cows and Bulls

- This is the essence of complementarity as Dr. Tom Cartwright used the term.
- It is the greatest opportunity to improve efficiency of cow-calf production
- The primary constraint is dystocia
- It can be mitigated by breeding to maternal sires (female semen) in early parities and to terminal sires (male semen) in later parities

Obstacles to Implementation

- Tradition
- It may be difficult to establish a market for maternal females until a group of dedicated terminal producers develops
  - It would take years to breed cattle best suited for this purpose
  - It may be difficult to convince all-purpose producers to shift to terminal production until a reliable supply of maternal cows develops
- Need to balance growth with calving ease

Advantages of Terminal Crossbreeding to the Beef Industry

- Natural efficiency of heavier calves and carcasses from smaller cows (terminal producers)
- Less calving difficulty in heifers (maternal producers)
- More uniform stream of calves with better carcass characteristics going into feedlots
- Smaller producers can focus on doing one thing well

Effect of Cow Size on Efficiency and Profitability

- Smaller cows may or may not be inherently more efficient, but they are almost certainly more profitable if they can be bred to bulls of greater genetic potential for growth
- Maternal breeds should generally be selected for lower mature size and maternal calving ease
- Terminal breeds should generally be selected for greater early growth and greater direct calving ease

What Size Cows are Most Efficient?

- I don’t think we really have a good answer
- Perhaps larger cows are more efficient where nutrients are abundant and smaller cows where they are sparse.
- It’s really hard to measure.
- There are numerical artifacts that can mislead people into thinking small cows are more efficient than they really are.
- We would need to know how much cows of various sizes eat to answer it adequately

Beef Breeds Have Become Far Too Similar

- Breeds that used to have some of the smallest cows now have the biggest cows
- Selection objectives vary only minimally among beef breeds
- Almost all beef breeds have general purpose breeding objectives
- This presents a challenge for the industry moving to a more efficient mating system.

Conclusions

- Most breeds should decide whether they are a maternal or terminal breed.
- The notion that beef breeds should be all-purpose is pervasive, but counterproductive
- Beef breeds have become far too similar in mature size and most other characteristics
- Heterosis is important and underutilized, but it is not a “free lunch”
  - Greater production comes at the partial expense of higher inputs

Conclusions

- Complementarity and terminal crossbreeding systems are underutilized
- A change in industry structure with regard to replacement females could benefit the entire industry
  - Specialized production of young replacement females with maternal genetics
- An economically feasible sexed semen technology could make terminal crossbreeding much more practical

For More Information:

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The highs and lows of selecting for carcass quality

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2024 TAM Beef Cattle Short Course
Aug. 5-7, 2024

USDA Agricultural Research Service
U.S. DEPARTMENT OF AGRICULTURE

Genetics of carcass quality

- Heritabilities
- Trait definitions

Where to begin…

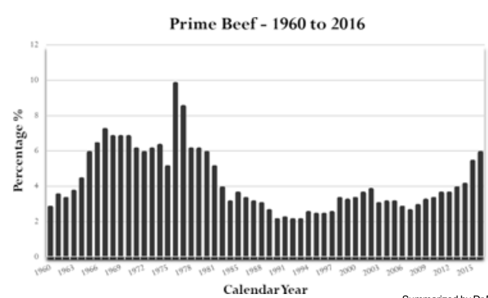
- Timeline of a couple major events…
  - Setting of standards
  - Collection of data
  - Genetic evaluations
  - Market trends and incentives

The timeline

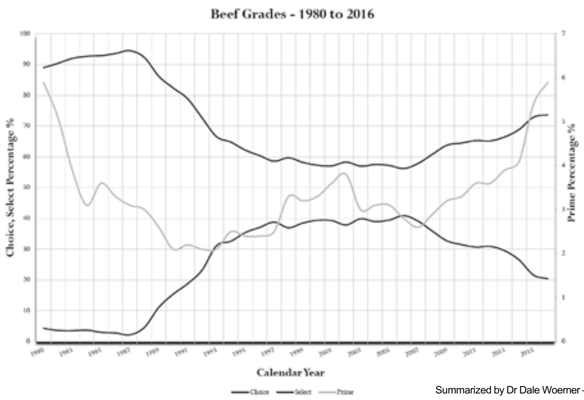
Trends for carcass quality

Summarized by Dr Dale Woerner – TTU, 2019

Trends for carcass quality



Summarized by Dr Dale Woerner – TTU, 2019



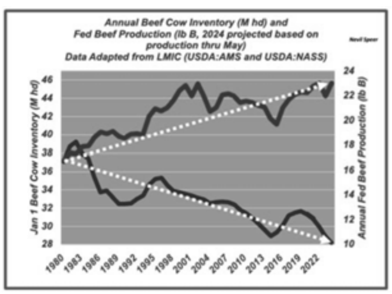
Summarized by Dr Dale Woerner – TTU, 2019

Trends for carcass quality

National Beef Quality Audit Carcass Trends Data Sourced from NBQA						
Year	# of Carcasses Sampled	Hot Carcass Weight (lb)	Adjusted Fat Thickness (in)	Ribeye Area (in^2)	USDA Yield Grade	Marbling Score*
1991	7,375	761	.59	12.9	3.2	424
1995	11,799	748	.47	12.8	2.8	406
2000	9,396	769	.47	13.1	3.0	423
2005	9,475	793	.51	13.4	2.9	432
2011	9,802	825	.51	13.8	2.9	440
2016	9,106	861	.56	13.9	3.1	470
2022	9,746	886	.59	14.1	3.3	498

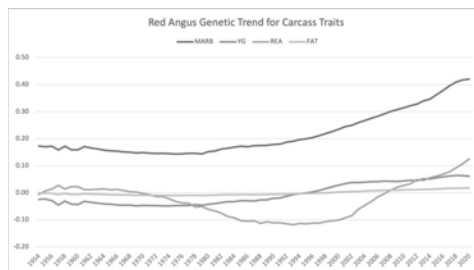
*400 = Small (low Choice), 500 = Modest (middle Choice)

Nevil Speer, https://www.drovers.com/opinion/speer-more-better-beef, accessed 7/12/24



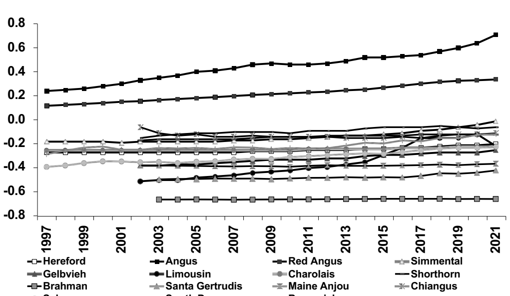
Nevil Speer, https://www.drovers.com/opinion/speer-more-better-beef, accessed 7/12/24

Genetic trends

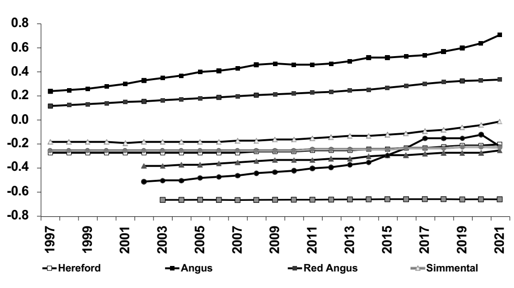


Published by the RAAA, accessed 7/12/24

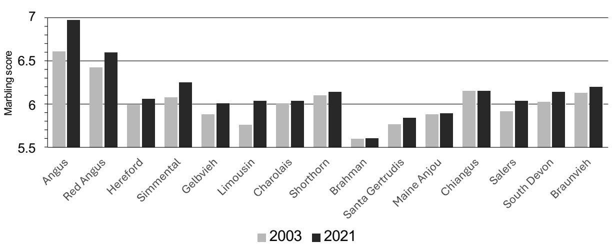
Genetic Trends for Marbling Score



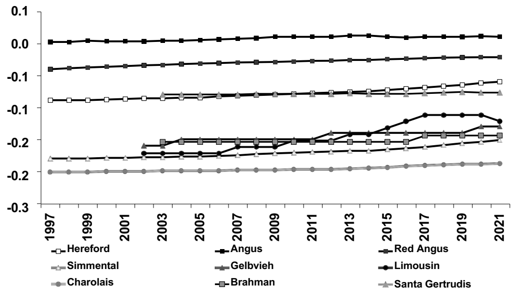
Genetic Trends for Marbling Score



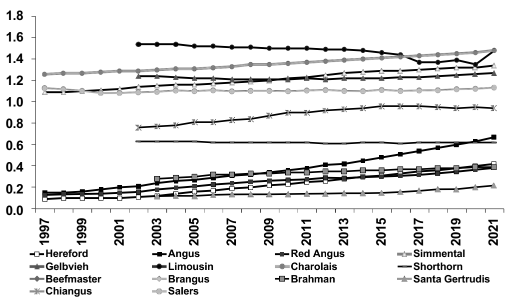
Genetic Trends for Marbling Score



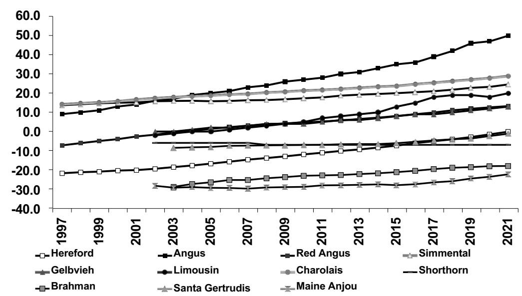
Genetic Trends for Backfat Depth, In



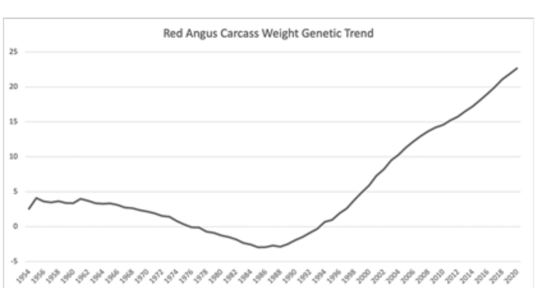
Genetic Trends for Ribeye Area, sq in



Genetic Trends for Carcass Weight, lb



Genetic trends



Published by RAAA, accessed 7/12/24

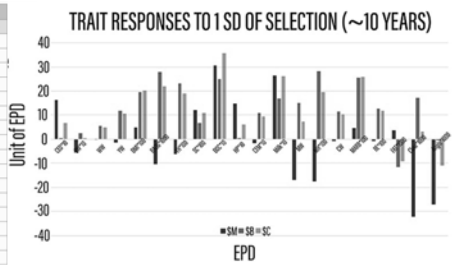
Selection for carcass quality

- EPDs
- Selection indices
- SNP based genetic tests for large effect genes

Angus $Values

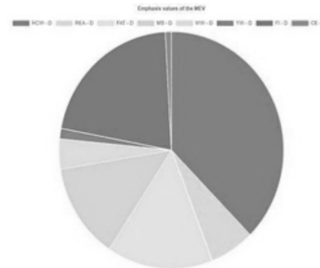
EPDs Influencing $Values							
Trait	$M	$W	$EN	$F	$G	$B	$C
CED	X						X
BW		X					
WW	X	X					X
*PG (YW-WW)				X		X	X
CEM	X						X
MILK	X	X	X				X
MW	X	X	X				X
DOC	X						X
HP	X						X
CLAW	X						X
ANGLE	X						X
DMI				X		X	X
CW				X	X	X	X
RE					X	X	X
MARB					X	X	X
FAT					X	X	X

*PG, Post-Weaning Gain assess the gain differences from weaning to yearling.



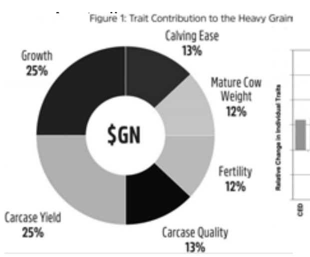
Published by AAA, accessed 7/12/24

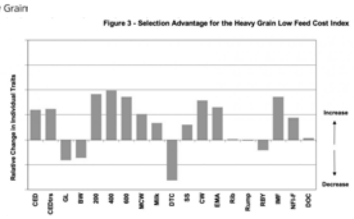
Limousin's new terminal index



Published by NALF, accessed 7/12/24

Australian Angus

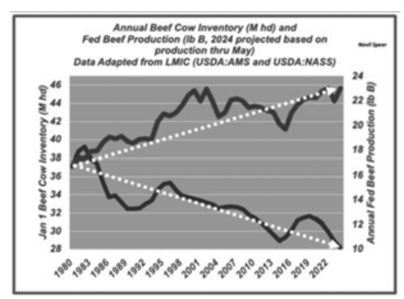




CED	+4.0
CEDtrs	+3.4
GL	-1.1
BW	-0.7
WW	+9
YW	+17
FW	+20
MCW	+15
Milk	+2
DTC	-1.5
SS	+0.4
CW	+14
EMA	+2.6
Rib	+0.0
Rump	-0.0
RBY	-0.2
IMF	+1.5
NFI-F	+0.17
DOC	+0

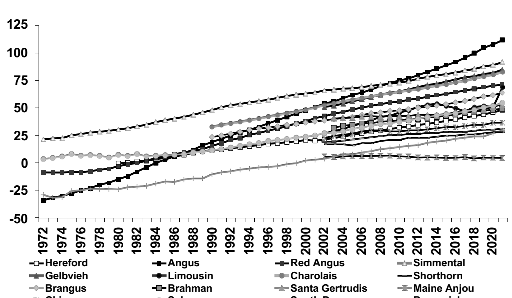
Published by Australian Angus Association, accessed 7/12/24

The correlated response



Nevil Speer, 6/24/24, https://www.drovers.com/opinion/speer-more-better-beef

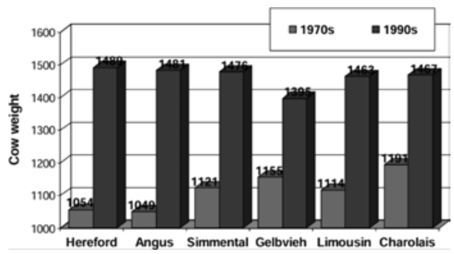
Genetic Trends for Yearling Weight, lb



The trade off

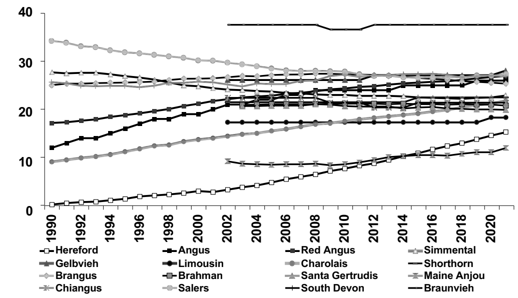
- Large mature cow size, potentially at expense of cow efficiency
- Flat genetic trends for other important traits
  - Such as fertility

Mature cow weight (5 yrs of age)

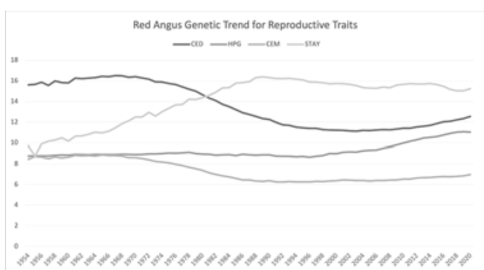


Adapted from Cundiff 2007, summarized by Herring 2010

Genetic Trends for Maternal Milk, lb

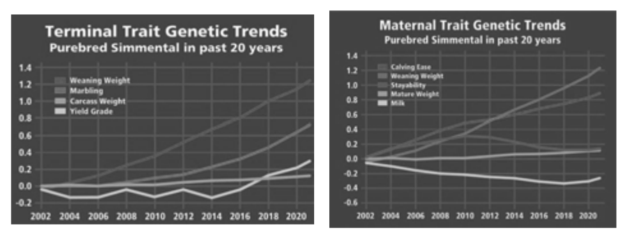


Red Angus



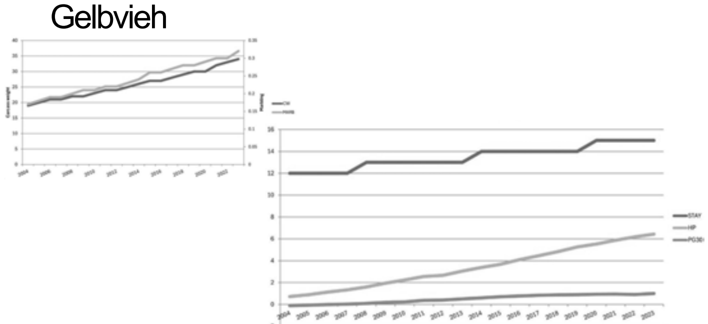
Published by the RAAA, accessed 7/12/24

Simmental



Published by ASA, accessed 7/12/24

Gelbvieh



Published by AGA (Gelbvieh Journal July 2024)

Where do we go from here

- Demand suggests that there is still opportunity and so it makes economic sense to continue selecting for carcass quality/marbling
- Carcass evaluation programs and returning commercial data for genetic evaluations
- Balanced selection
  - Increase index emphasis on fertility traits
- Terminal crossbreeding

In summary

The beef industry has done extremely well to meet market demands over the last 30+ years, and genetics played a role in this success

- Genetic selection for carcass quality is effective and a long-term solution
- Selection trade-offs are inevitable, but can be balanced
- There is more opportunity for improvement!

Acknowledgements

- **Larry Kuehn, Steven Shackelford**
- Mark Thallman, Warren Snelling, Andy King, Tommy Wheeler - *USMARC*
- USMARC Cattle Operations
- All breeds and producers involved in supporting the GPE program

USDA Agricultural Research Service
U.S. DEPARTMENT OF AGRICULTURE

Genetic Merit Pricing Task Force – The Time is Now!

By Tom Brink, CEO, Red Angus Association of America

Purpose. The Genetic Merit Pricing Task Force (GMP) is an industry-based, voluntary group, temporarily assembled and charged with identifying ways to increase the use of objectively determined genetic merit in pricing feeder cattle and calves. GMP's purpose will therefore be to identify ways to bring about significant change in how feeder cattle are priced, favoring objective genetic attributes over pricing on averages and subjective, appearance-based assessments.

Background. Today's feeder cattle market regularly uses appearance as a proxy for genetic merit. Hide color is communicated in many auction market reports as the only would-be quality indicator. Eared cattle are often discounted based on how they look, without any real consideration of their genetics. Reliance upon appearance has become ubiquitous in the price discovery process. Yet dissatisfaction with this approach is apparent among cattle feeders and other industry participants. Predictability from one group to the next is poor under the current system, in which over 95% of all feeder cattle and calves trade without objective genetic information. Said another way, a high majority of feeder cattle and calves enter the marketplace as genetic 'mystery' cattle, because very little or nothing is known about their genetics.

For a brighter future, cattle feeders and industry experts feel strongly the time has come to change how the feeder cattle market operates, shifting its emphasis from subjective value assessments to quantified genetic merit and other objectively determined attributes.

Moving to objectively determined genetic/genomic information as a key influencer in valuing feeder cattle will increase the percentage of rational pricing outcomes, while encouraging more rapid genetic progress over time. Once genetics become influential in feeder cattle pricing, the incentive to produce genetically superior calves and feeder cattle will increase. This change will make the beef cattle industry more competitive and prosperous**.**

The primary goal of the GMP Task Force, therefore, is to identify methods, practices, educational initiatives (etc.) that will increase the use of genetic merit in pricing U.S. feeder cattle and calves. The GMP Task Force has met three times and is making significant progress toward its goal.

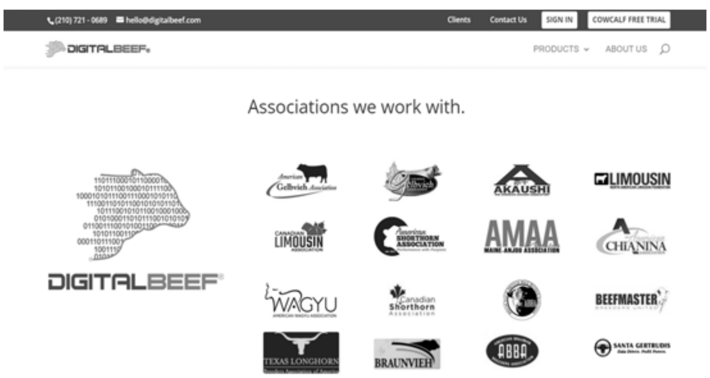
Supporting Cattle Organizations. The GMP Task Force has on-record support from 20 industry-leading organizations at the present time. Numerous conversations with additional organizations are in process, so that number is expected to grow during 2024.

The time is now to bring objective genetic information into the price discovery process for U.S. feeder cattle and calves. We can all have a part in making this happen and moving the industry forward for the future.

Tracking Cattle Performance in DigitalBeef Registry Program
JOSEPH MASSEY
digitalbeef.com
San Antonio, Texas

DigitalBeef

- DigitalBeef is an information tracking and data banking company for the cattle industry
- The Goal is simple – to track data from birth to slaughter (Performance Data)
- Provide analyzed data in a meaningful way to all stake holder

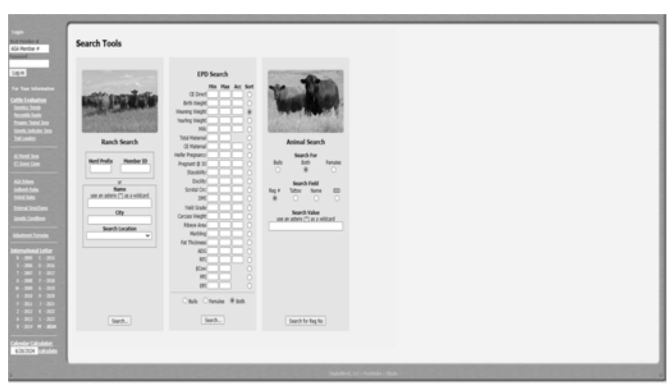


DigitalBeef

- Quantitative Genetic has been successfully implemented and absolutely worked in the cattle industry over the past 25 years
- We produce the same amount of beef today with 15 million less beef cows

DigitalBeef

- Over the next 25 years DATA, DATA and DATA will drive our advancements in beef production
- Success will depend on your ability to identify those animals that produce and those that don’t



International Cattle Evaluation - Run Date: 061824

Genetic Trends

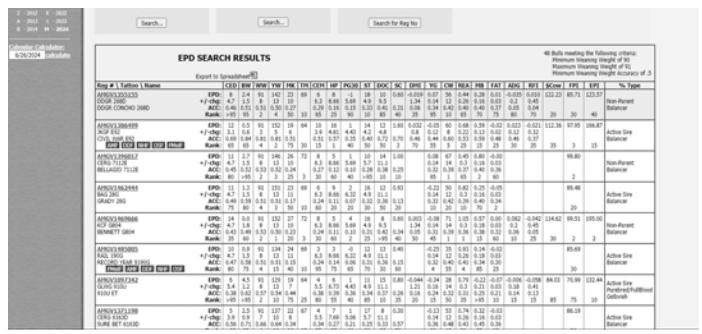
Year	# Head	CED	BW	WW	YW	Milk	TM	CEM	HP	PG30	STAY	DOC	SC	DMI	YG	CW	CREA	MARB	CFAT	ADG	RFI	$Cow	FPI	EPI
		Expected Progeny Differences: Growth and Maternal												Intake and Carcass								Index Values		
2004	44902	11	1.0	54	75	19	46	5	0.70	-0.07	12	9	0.20	0.002	-0.22	19	0.51	0.16	-0.04	-0.050	0.000	85.47	63.09	46.34
2005	45534	11	0.9	55	76	19	46	5	0.90	-0.04	12	9	0.21	0.001	-0.21	20	0.50	0.18	-0.04	-0.047	-0.000	86.07	64.00	49.45
2006	45689	11	0.8	56	78	19	47	6	1.11	0.02	12	10	0.23	0.002	-0.20	21	0.49	0.19	-0.04	-0.046	-0.000	86.35	64.98	52.50
2007	42733	11	0.7	56	80	19	47	6	1.32	0.06	12	10	0.25	0.001	-0.19	21	0.49	0.19	-0.04	-0.043	-0.000	87.71	65.75	56.70
2008	39260	11	0.6	57	82	20	48	6	1.59	0.13	13	10	0.27	0.001	-0.19	22	0.49	0.20	-0.03	-0.040	0.000	88.15	66.56	59.77
2009	37465	11	0.5	58	84	20	49	6	1.88	0.22	13	10	0.28	0.002	-0.17	22	0.48	0.21	-0.03	-0.038	0.001	89.86	67.55	62.76
2010	36916	11	0.5	59	85	20	49	6	2.15	0.24	13	10	0.30	-0.001	-0.18	23	0.48	0.21	-0.03	-0.039	-0.001	90.63	68.04	63.99
2011	33977	12	0.5	60	87	20	50	6	2.47	0.40	13	11	0.31	0.002	-0.17	24	0.50	0.22	-0.03	-0.037	-0.002	90.81	69.00	66.94
2012	34326	12	0.4	61	89	20	51	6	2.64	0.42	13	11	0.34	0.001	-0.17	25	0.49	0.23	-0.03	-0.034	-0.002	91.27	69.91	70.00
2013	33819	12	0.3	62	90	21	51	6	3.00	0.53	13	11	0.36	0.006	-0.17	25	0.50	0.23	-0.03	-0.031	-0.002	93.02	70.63	73.70
2014	32454	12	0.3	63	93	21	52	6	3.43	0.61	13	11	0.41	0.004	-0.15	26	0.49	0.25	-0.03	-0.028	-0.003	93.73	71.97	78.61
2015	32721	12	0.2	64	94	21	53	6	3.64	0.72	14	11	0.40	0.002	-0.15	27	0.49	0.26	-0.03	-0.027	-0.004	93.91	72.85	80.32
2016	33117	12	0.1	64	96	21	53	6	4.08	0.79	14	12	0.43	0.003	-0.14	27	0.50	0.26	-0.03	-0.024	-0.003	96.53	73.65	83.66
2017	32529	12	0.1	65	98	21	54	6	4.44	0.86	14	12	0.45	0.005	-0.14	28	0.50	0.27	-0.02	-0.023	-0.003	98.08	74.44	85.79
2018	31412	12	0.0	66	99	22	55	6	4.82	0.88	14	12	0.47	0.006	-0.14	29	0.50	0.28	-0.02	-0.021	-0.004	100.17	75.29	88.93
2019	29918	13	-0.1	67	101	22	55	6	5.24	0.91	14	12	0.49	0.003	-0.14	30	0.52	0.28	-0.02	-0.019	-0.006	101.17	76.14	92.14
2020	29483	13	-0.1	68	103	22	56	7	5.51	0.91	14	12	0.52	0.009	-0.13	31	0.52	0.29	-0.02	-0.017	-0.006	101.90	76.92	94.78
2021	29037	13	-0.2	69	105	23	57	7	5.89	0.97	15	12	0.53	0.008	-0.13	32	0.54	0.30	-0.02	-0.018	-0.005	105.24	78.12	95.99
2022	27531	13	-0.2	70	107	23	58	7	6.24	0.93	15	12	0.56	0.008	-0.13	33	0.55	0.30	-0.02	-0.018	-0.008	106.68	79.06	98.06
2023	24831	13	-0.3	71	109	23	59	7	6.47	1.01	15	12	0.58	0.012	-0.12	34	0.56	0.32	-0.02	-0.015	-0.010	108.92	80.26	101.82

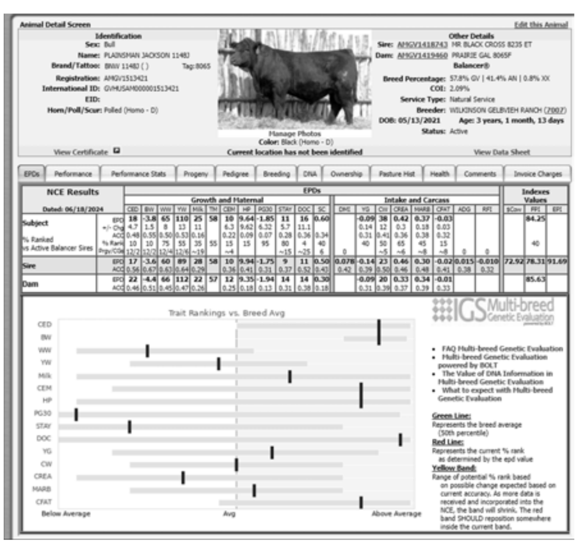
International Cattle Evaluation - Run Date: 061824

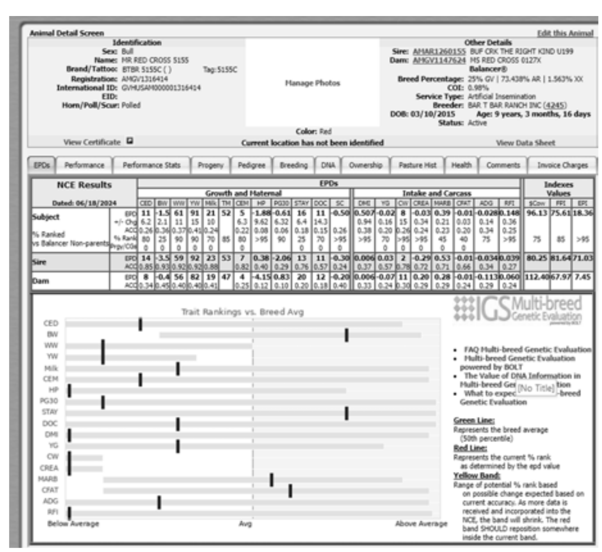
Statistical Breakdown

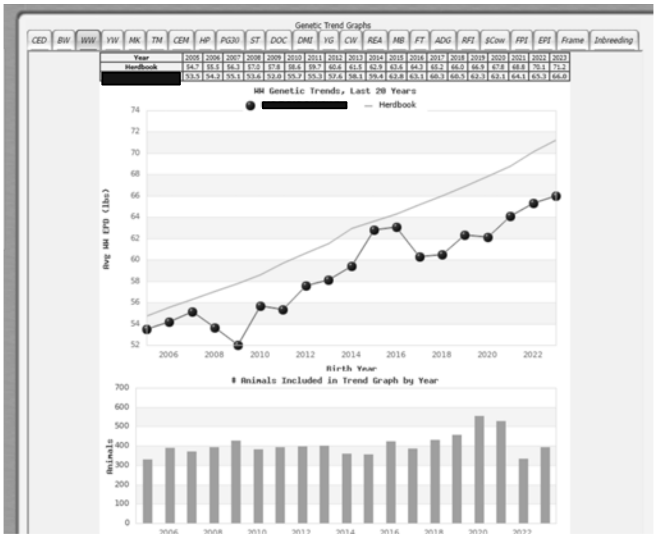
Gelbvieh Active Sires

	CED	BW	WW	YW	Milk	TM	CEM	HP	PG30	STAY	DOC	SC	DMI	YG	CW	CREA	MARB	CFAT	ADG	RFI	Cow	FPI	EPI
	Expected Progeny Differences: Growth and Maternal												Intake and Carcass								Index Values		
Num Animals	1463	1463	1463	1463	1463	1463	1463	1452	1452	1463	1463	1424	924	1463	1463	1463	1463	1463	924	924	935	1463	935
High	27	9.2	107	168	43	85	17	23	11	26	21	3.30	1.278	0.10	71	1.37	0.80	0.03	0.284	0.333	182.58	103.67	358.90
Average	13	0.1	69	102	23	57	6	7	1	15	12	0.60	0.007	-0.25	28	0.68	0.18	-0.04	-0.044	-0.006	109.54	75.44	74.77
Low	-7	-7.7	36	42	-2	28	-9	-9	-8	3	-2	-0.90	-1.486	-0.63	-23	-0.12	-0.40	-0.13	-0.222	-1.017	26.29	51.06	-66.20
1%	21	-4.3	94	145	34	75	13	18	6	24	18	1.90	-0.268	-0.47	57	1.23	0.62	-0.09	0.110	-0.330	167.34	93.63	189.90
2%	20	-3.8	91	141	33	73	12	16	5	23	17	1.70	-0.211	-0.45	54	1.15	0.56	-0.09	0.091	-0.199	162.40	92.09	171.10
3%	20	-3.5	90	138	32	72	12	15	5	22	17	1.60	-0.164	-0.43	51	1.10	0.54	-0.08	0.067	-0.154	159.14	90.68	153.39
4%	19	-3.2	88	135	32	71	11	15	5	21	16	1.50	-0.142	-0.41	49	1.07	0.50	-0.08	0.054	-0.133	155.72	89.60	148.38
5%	19	-3.1	87	133	31	70	11	14	4	21	16	1.50	-0.124	-0.40	48	1.05	0.49	-0.08	0.042	-0.114	151.98	88.63	138.45
10%	17	-2.2	83	126	29	67	10	12	4	20	15	1.30	-0.074	-0.37	44	0.98	0.42	-0.07	0.009	-0.064	142.68	85.38	124.05
15%	16	-1.7	80	121	28	66	9	11	3	19	15	1.10	-0.053	-0.34	41	0.91	0.37	-0.06	-0.006	-0.037	135.82	84.06	115.42
20%	16	-1.4	78	117	27	65	9	10	3	18	14	1.00	-0.035	-0.33	39	0.87	0.34	-0.06	-0.013	-0.027	131.04	82.58	107.04
25%	15	-1.0	76	114	26	63	8	10	2	18	14	0.90	-0.025	-0.31	36	0.83	0.30	-0.06	-0.020	-0.020	126.29	80.95	101.84
30%	15	-0.8	75	112	26	62	8	9	2	17	13	0.90	-0.015	-0.30	34	0.80	0.27	-0.05	-0.025	-0.017	123.35	79.65	95.47
35%	14	-0.5	73	109	25	61	7	8	2	17	13	0.80	-0.009	-0.28	32	0.77	0.25	-0.05	-0.031	-0.011	120.17	78.55	90.05
40%	14	-0.3	72	107	24	60	7	8	1	16	13	0.70	-0.004	-0.27	31	0.74	0.23	-0.05	-0.037	-0.007	116.66	77.47	83.13
45%	13	-0.1	71	105	24	59	7	7	1	16	12	0.70	0.000	-0.26	29	0.70	0.20	-0.05	-0.041	-0.004	113.40	76.55	78.05
50%	13	0.1	70	102	23	57	6	7	1	15	12	0.60	0.003	-0.25	28	0.68	0.17	-0.04	-0.046	-0.001	110.10	75.38	72.66
55%	13	0.4	68	100	22	56	6	6	1	15	12	0.60	0.007	-0.23	26	0.65	0.15	-0.04	-0.052	0.003	106.65	74.31	68.90
60%	12	0.6	67	98	21	55	6	6	0	14	11	0.50	0.010	-0.22	24	0.62	0.13	-0.04	-0.056	0.006	103.36	73.14	64.61
65%	12	0.8	66	96	21	54	5	5	0	14	11	0.40	0.013	-0.21	23	0.58	0.11	-0.04	-0.061	0.011	99.19	71.99	59.10
70%	11	1.0	64	93	20	53	5	5	0	13	11	0.40	0.019	-0.20	21	0.56	0.08	-0.03	-0.067	0.015	96.15	71.15	53.00
75%	11	1.3	62	90	19	52	5	4	-1	13	10	0.30	0.025	-0.18	19	0.52	0.06	-0.03	-0.074	0.022	92.25	70.17	47.55
80%	10	1.7	60	87	18	51	4	3	-1	12	10	0.30	0.036	-0.16	18	0.48	0.03	-0.03	-0.080	0.029	86.76	68.58	41.54
85%	10	2.0	58	83	17	48	3	2	-1	11	9	0.20	0.053	-0.15	15	0.44	-0.01	-0.02	-0.090	0.038	81.22	66.74	33.27
90%	9	2.6	56	78	15	46	3	1	-2	11	8	0.10	0.077	-0.12	11	0.36	-0.05	-0.02	-0.100	0.050	76.47	65.09	22.49
95%	7	3.2	52	72	13	43	1	0	-3	9	7	-0.10	0.132	-0.08	7	0.28	-0.09	-0.01	-0.119	0.069	67.57	62.06	7.17

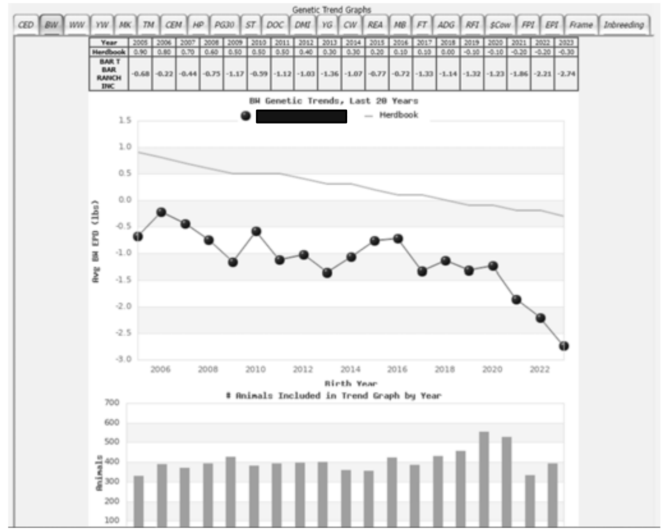




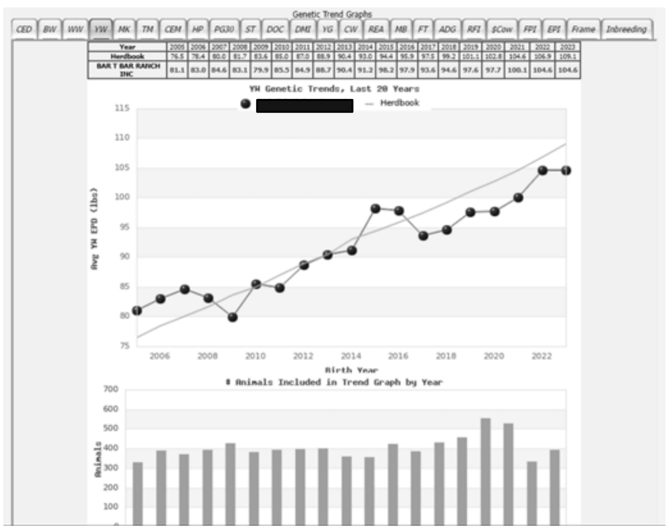




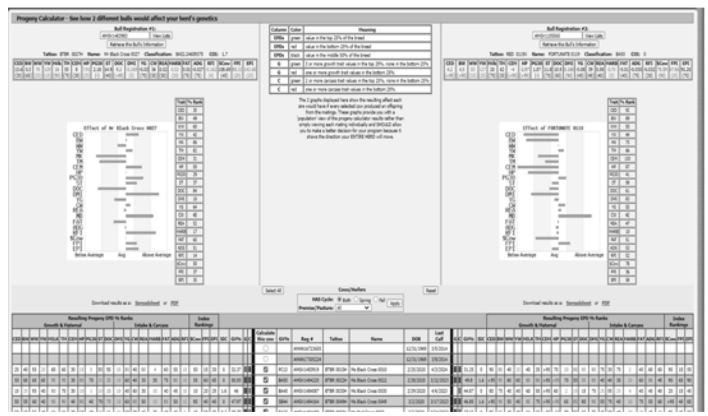
Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Herdbook	54.7	55.5	56.3	57.0	57.8	58.6	59.7	60.6	61.5	62.9	63.6	64.3	65.2	66.0	66.9	67.8	68.8	70.1	71.2
[redacted]	53.5	54.2	55.1	53.6	52.0	55.7	55.3	57.6	58.1	59.4	62.8	63.1	60.3	60.5	62.3	62.1	64.1	65.3	66.0

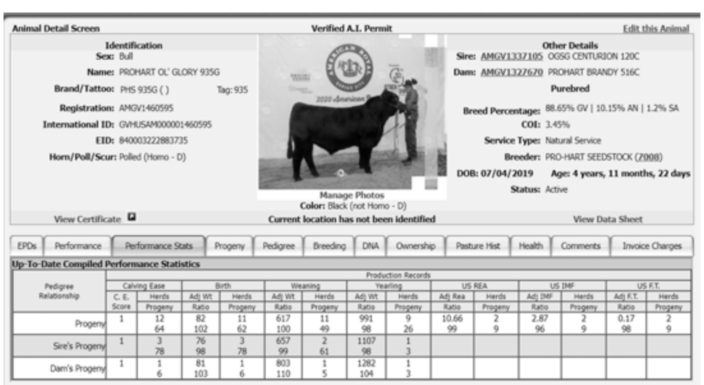


Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Herdbook	0.90	0.80	0.70	0.60	0.50	0.50	0.50	0.40	0.30	0.30	0.20	0.10	0.10	0.00	-0.10	-0.10	-0.20	-0.20	-0.30
BAR T BAR RANCH INC	-0.68	-0.22	-0.44	-0.75	-1.17	-0.59	-1.12	-1.03	-1.36	-1.07	-0.77	-0.72	-1.33	-1.14	-1.32	-1.23	-1.86	-2.21	-2.74



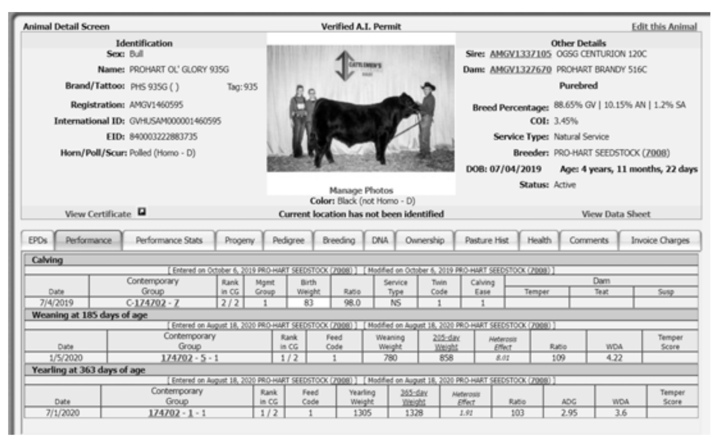
Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Herdbook	76.5	78.4	80.0	81.7	83.6	85.0	87.0	88.9	90.4	93.0	94.4	95.9	97.5	99.2	101.1	102.8	104.6	106.9	109.1
BAR T BAR RANCH INC	81.1	83.0	84.6	83.1	79.9	85.5	84.9	88.7	90.4	91.2	98.2	97.9	93.6	94.6	97.6	97.7	100.1	104.6	104.6





Up-To-Date Compiled Performance Statistics

Pedigree Relationship	Calving Ease: C. E. Score	Calving Ease: Herds / Progeny	Birth: Adj Wt / Ratio	Birth: Herds / Progeny	Weaning: Adj Wt / Ratio	Weaning: Herds / Progeny	Yearling: Adj Wt / Ratio	Yearling: Herds / Progeny	US REA: Adj Rea / Ratio	US REA: Herds / Progeny	US IMF: Adj IMF / Ratio	US IMF: Herds / Progeny	US F.T.: Adj F.T. / Ratio	US F.T.: Herds / Progeny
Progeny	1	12 / 64	82 / 102	11 / 62	617 / 100	11 / 49	991 / 98	9 / 26	10.66 / 99	2 / 9	2.87 / 96	2 / 9	0.17 / 98	2 / 9
Sire's Progeny	1	3 / 78	76 / 98	3 / 78	657 / 99	2 / 61	1107 / 98	1 / 3						
Dam's Progeny	1	1 / 6	81 / 103	1 / 6	803 / 110	1 / 5	1282 / 104	1 / 3						



Calving

[Entered on October 6, 2019 PRO-HART SEEDSTOCK (7008)] [Modified on October 6, 2019 PRO-HART SEEDSTOCK (7008)]

Date	Contemporary Group	Rank in CG	Mgmt Group	Birth Weight	Ratio	Service Type	Twin Code	Calving Ease	Dam: Temper	Dam: Teat	Dam: Susp
7/4/2019	C-174702 - 7	2 / 2	1	83	98.0	NS	1	1			

Weaning at 185 days of age

[Entered on August 18, 2020 PRO-HART SEEDSTOCK (7008)] [Modified on August 18, 2020 PRO-HART SEEDSTOCK (7008)]

Date	Contemporary Group	Rank in CG	Feed Code	Weaning Weight	205-day Weight	Heterosis Effect	Ratio	WDA	Temper Score
1/5/2020	174702 - 5 - 1	1 / 2	1	780	858	8.01	109	4.22	

Yearling at 363 days of age

[Entered on August 18, 2020 PRO-HART SEEDSTOCK (7008)] [Modified on August 18, 2020 PRO-HART SEEDSTOCK (7008)]

Date	Contemporary Group	Rank in CG	Feed Code	Yearling Weight	365-day Weight	Heterosis Effect	Ratio	ADG	WDA	Temper Score
7/1/2020	174702 - 1 - 1	1 / 2	1	1305	1328	1.91	103	2.95	3.6	

Why DigitalBeef

- For the first time the rancher can collect data & obtain simple to use reports with little to no effort
- This process is now available to all producers no matter the size

Why DigitalBeef

- In the past cost, time and resources have prevented most producers from consistently obtain the records and data needed for good management decisions.

Why DigitalBeef

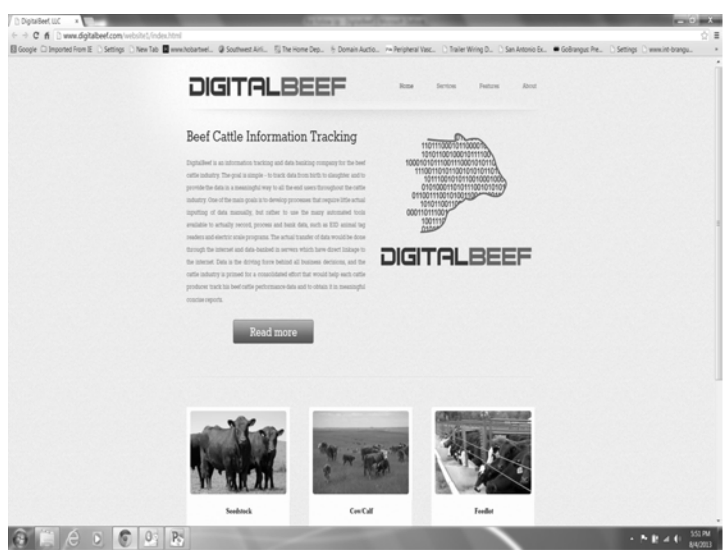
- Performance data is absolutely essential in all decision-making processes required to produce cattle, feed cattle and to market them efficiently.

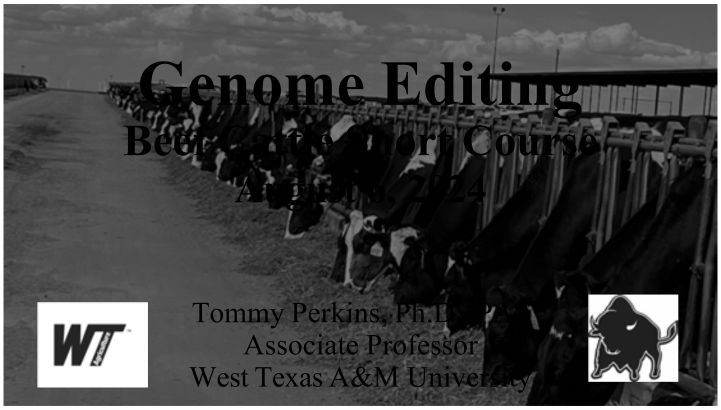
Why DigitalBeef

- DigitalBeef is developing the platforms to manage cattle performance databases and to perform genetic analysis within herds and across herds cost effectively

Why DigitalBeef

- DATA, DATA AND DATA WILL DEFIND YOUR ABILITY TO BE SUCCESSFUL AS PRODUCERS



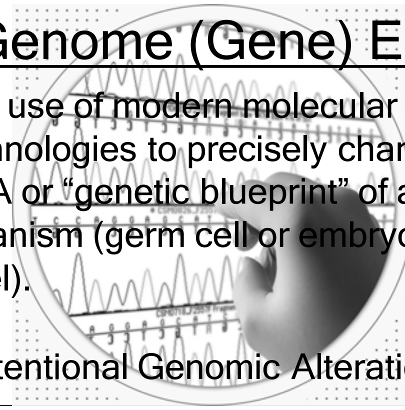


Genome Editing

Beef Cattle Short Course

August 6, 2024

Tommy Perkins, Ph.D., PAS
Associate Professor
West Texas A&M University



Genome (Gene) Editing

The use of modern molecular biological technologies to precisely change the DNA or "genetic blueprint" of an organism (germ cell or embryonic level).

Intentional Genomic Alteration (IGA)

Gene Editing

Cas9: CRISPR associated protein 9

CRISPR: Clustered regularly interspaced short palindromic repeats

GMO: Genetically modified organism

KO: Knock-out

MSTN: Myostatin gene

IGA: Intentional Genomic Alteration

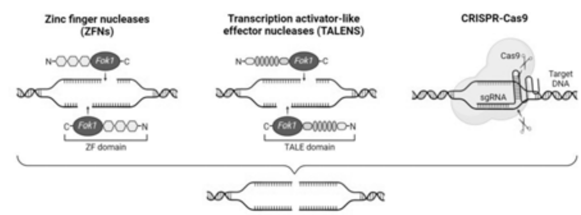
SCNT: Somatic cell nuclear transfer

sgRNA: Single guide RNA

TALEN: Transcription activator-like effector nucleases

ZFN: Zinc-finger nuclease

Genome-Editing Technologies



The presence of DSBs in a cell initiate a response from the cell's own repair mechanisms to assist in performing the edit

BioRender

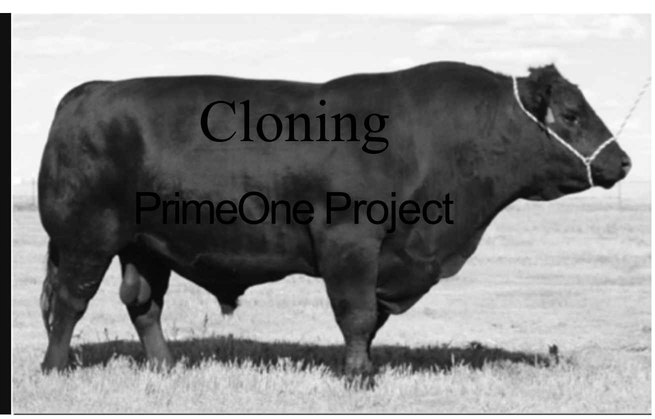
Gene Editing and Assisted Reproductive Technologies (ARTs)

Somatic Cell Editing (e.g. Fibroblasts)

1. In Vitro culture of cells during editing.
2. Allows preselection of the edit prior to producing live offspring.
3. Requires somatic cell nuclear transfer (SCNT) or cloning to produce a living edited animal.

Gamete, Embryo or Embryonic Stem Cell (ESC) Editing

1. Higher "success" rate than SCNT produced animals
2. Little Opportunity to select specific edits (some embryos/animals will not have edits).
3. Potential for production of chimeric animals (embryos).



Cloning

PrimeOne Project

Background and Justification

Global focus on feeding the world…..while conserving resources.

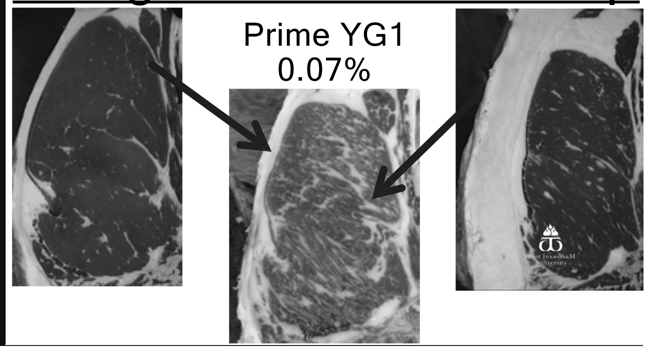
Increased interest in efficient protein production

Demand for beef that is high quality and lean

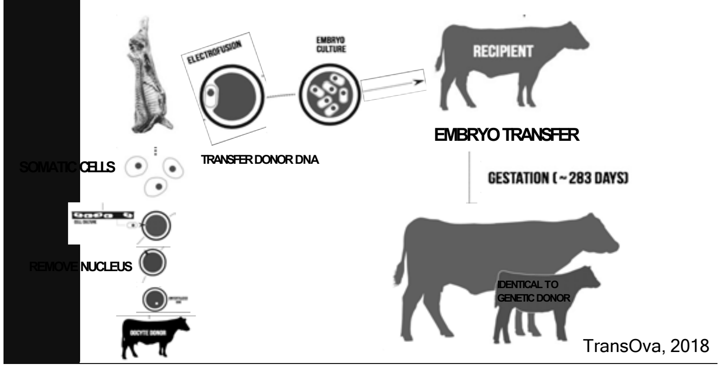
Role of technology in addressing challenges?

Antagonistic Relationship

Prime YG1
0.07%



SOMATIC CELL NUCLEAR TRANSFER



TransOva, 2018

SOMATIC CELL NUCLEAR TRANSFER

Cloning as a Tool

Available and feasible

Valuable option for preserving rare genetics

Potential for producing new lines

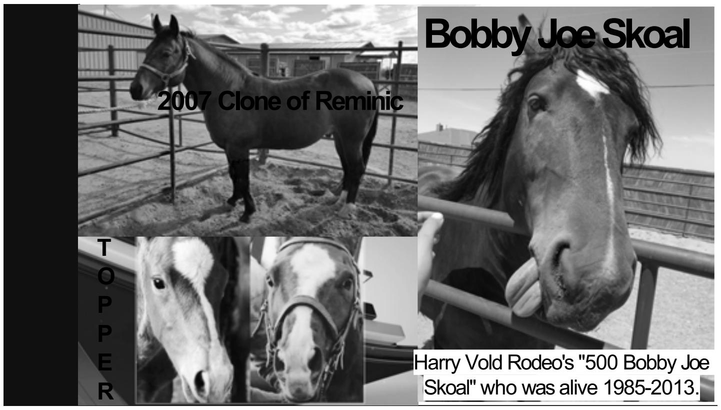
Limitations with cloning

Przewalski's horses are "critically endangered" animals found in Mongolia

Equus przewalskii

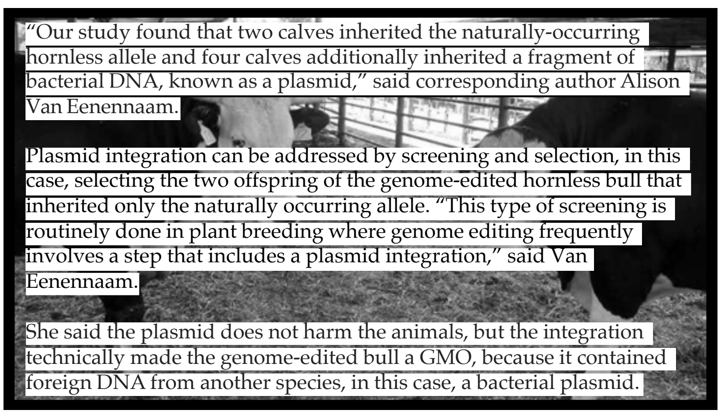
San Diego Frozen Zoo

Critically Endangered



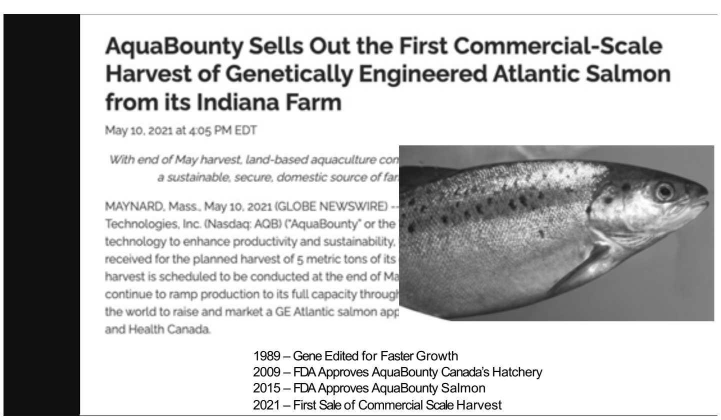
Bobby Joe Skoal
2007 Clone of Reminic
TOPPER
Harry Vold Rodeo's "500 Bobby Joe Skoal" who was alive 1985-2013.

Somatic cell genome editing
NORMAL
SICKLE CELL
MUTATION
DNA
RNA
PROTEIN
NORMAL PROTEIN
MUTANT PROTEIN
PERSPECTIVES
Science (2015)
A prudent path forward for genomic engineering and germline gene modification

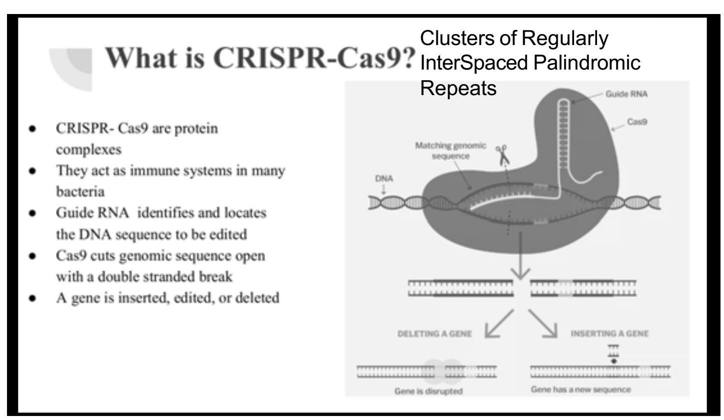


"Our study found that two calves inherited the naturally-occurring hornless allele and four calves additionally inherited a fragment of bacterial DNA, known as a plasmid," said corresponding author Alison Van Eenennaam.
Plasmid integration can be addressed by screening and selection, in this case, selecting the two offspring of the genome-edited hornless bull that inherited only the naturally occurring allele. "This type of screening is routinely done in plant breeding where genome editing frequently involves a step that includes a plasmid integration," said Van Eenennaam.
She said the plasmid does not harm the animals, but the integration technically made the genome-edited bull a GMO, because it contained foreign DNA from another species, in this case, a bacterial plasmid.

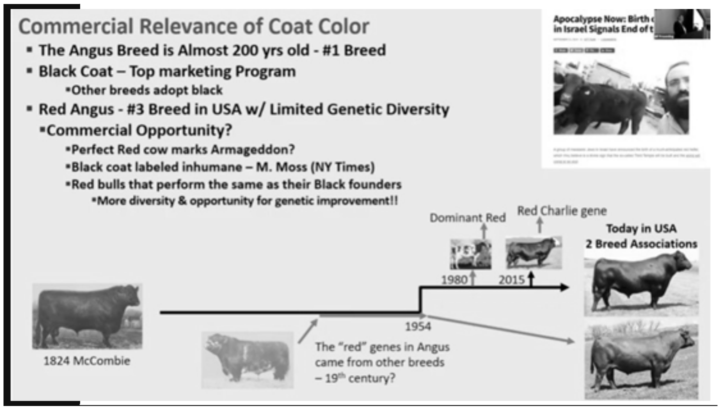
Agriculture:
Improving crop qualities
Agriculture:
Enhancing crop yields
Cell
Bypassing Negative Epistasis on Yield in Tomato Imposed by a Domesticatio
What Is a Genetically Modified Crop? A European Ruling Sows Confusion
In Europe, plants created with gene-editing technologies will be stringently regulated as G.M.O.'s. But older crops whose DNA has been altered will be left alone.
Into the Future with CRISPR Technology with Jenn

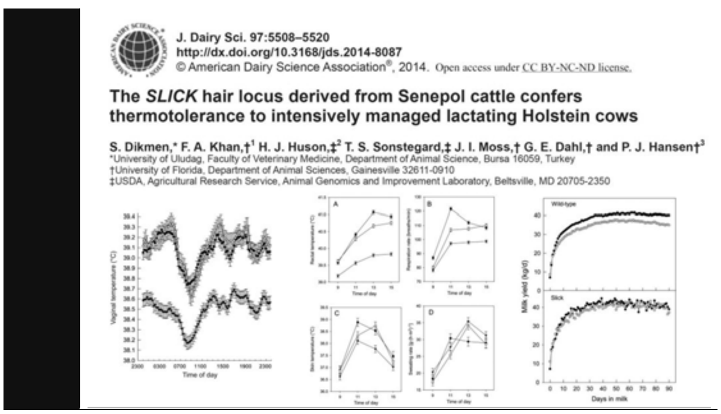


AquaBounty Sells Out the First Commercial-Scale Harvest of Genetically Engineered Atlantic Salmon from its Indiana Farm
May 10, 2021 at 4:05 PM EDT
With end of May harvest, land-based aquaculture con
a sustainable, secure, domestic source of far
MAYNARD, Mass., May 10, 2021 (GLOBE NEWSWIRE) --
Technologies, Inc. (Nasdaq: AQB) ("AquaBounty" or the
technology to enhance productivity and sustainability,
received for the planned harvest of 5 metric tons of its
harvest is scheduled to be conducted at the end of Ma
continue to ramp production to its full capacity through
the world to raise and market a GE Atlantic salmon app
and Health Canada.
1989 – Gene Edited for Faster Growth
2009 – FDA Approves AquaBounty Canada's Hatchery
2015 – FDA Approves AquaBounty Salmon
2021 – First Sale of Commercial Scale Harvest



What is CRISPR-Cas9?
Clusters of Regularly InterSpaced Palindromic Repeats
• CRISPR- Cas9 are protein complexes
• They act as immune systems in many bacteria
• Guide RNA identifies and locates the DNA sequence to be edited
• Cas9 cuts genomic sequence open with a double stranded break
• A gene is inserted, edited, or deleted
Guide RNA
Cas9
Matching genomic sequence
DNA
DELETING A GENE
INSERTING A GENE
Gene is disrupted
Gene has a new sequence




J. Dairy Sci. 97:5508–5520
http://dx.doi.org/10.3168/jds.2014-8087
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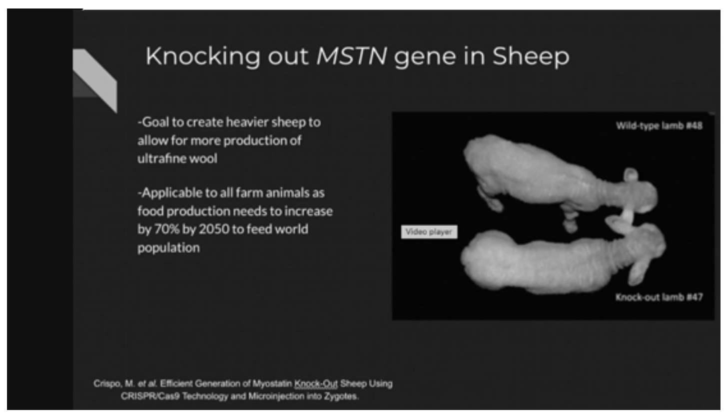
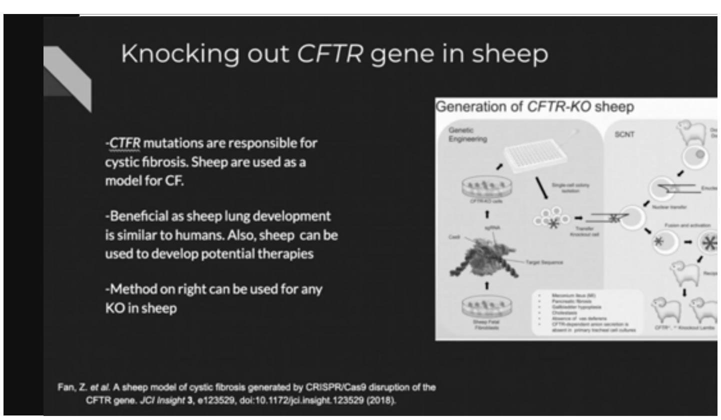
The *SLICK* hair locus derived from Senepol cattle confers thermotolerance to intensively managed lactating Holstein cows

S. Dikmen,* F. A. Khan,†[1] H. J. Huson,‡[2] T. S. Sonstegard,‡ J. I. Moss,† G. E. Dahl,† and P. J. Hansen†[3]
*University of Uludag, Faculty of Veterinary Medicine, Department of Animal Science, Bursa 16059, Turkey
†University of Florida, Department of Animal Sciences, Gainesville 32611-0910
‡USDA, Agricultural Research Service, Animal Genomics and Improvement Laboratory, Beltsville, MD 20705-2350





How is Genome Editing Different Than Other Biotechnology Tools?

Genome editing allows animal breeders to make very precise changes to DNA. Genome editing can be used to make changes to an animal or other organism by targeting at a specific location in a gene within the DNA. Genome editing can be used to add, remove, or alter DNA in the animal genome.

- The idea behind the project is to try to use the SRY gene , which results in maleness, as a way to create visually-appearing males from genotypic XX females. The development of all-male feedlot cattle using XSRYY bulls would improve the efficiency of beef production over the production of 50% male: 50% female offspring.

"BOYS ONLY CLUB"

Cosmo is expected to produce 75% male offspring: 50% of which will be XY males; 25% of which will be XX females; and 25% of which are expected to be XX individuals that appear male due to inheritance of chromosome 17 carrying the SRY gene.

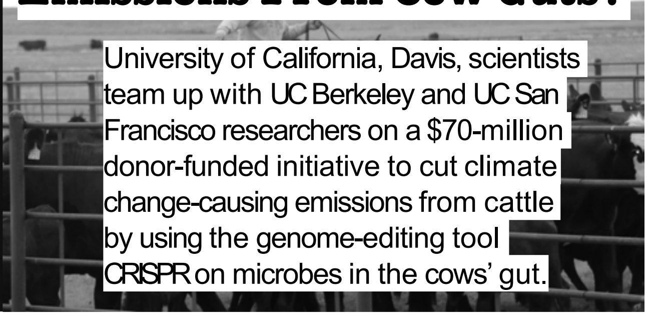
These XX males are not expected to produce viable sperm due to SRY on chromosome 17.

<u>College of Veterinary Medicine, Northwest A&F University in Shaanxi, China</u>

"We used a novel version of the CRISPR system called CRISPR/Cas9n to successfully insert a tuberculosis resistance gene, called *NRAMP1*, into the cow genome. We were then able to successfully develop live cows carrying increased resistance to tuberculosis. Importantly, our method produced no off-target effects on the cow genetics meaning that the CRISPR technology we employed may be better suited to producing transgenic livestock with purposefully manipulated genetics."

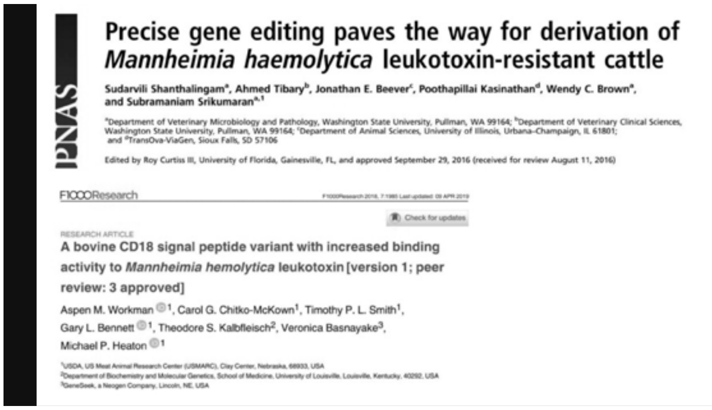
A team of scientists at Genus, a British animal genetics company with research facilities in Wisconsin and Tennessee, have developed a new generation of CRISPR-edited pigs that are resistant to porcine reproductive and respiratory syndrome (PRRS) virus, a disease that has had a widespread impact on porcine populations around the world for decades.

Can CRISPR Cut Methane Emissions From Cow Guts?



University of California, Davis, scientists team up with UC Berkeley and UC San Francisco researchers on a $70-million donor-funded initiative to cut climate change-causing emissions from cattle by using the genome-editing tool CRISPR on microbes in the cows' gut.

A *MSTN/PRNP* double gene edited beef cattle at current age (3-month-old). Red arrow = enlarged biceps femoris. **B** *MSTN/BLG* double gene edited dairy cattle (4-month-old).

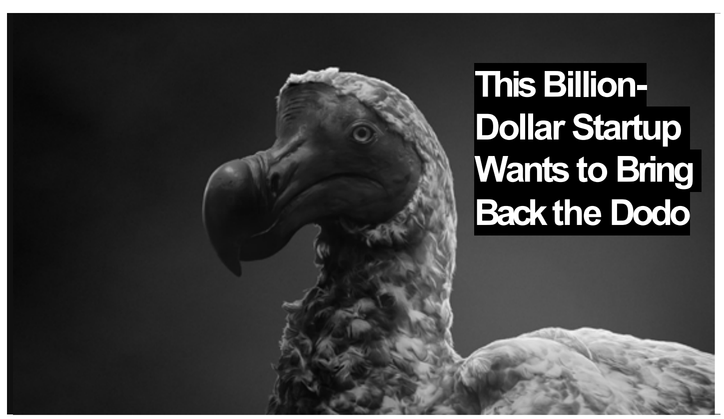

PNAS
Precise gene editing paves the way for derivation of *Mannheimia haemolytica* leukotoxin-resistant cattle
Sudarvili Shanthalingam[a], Ahmed Tibary[b], Jonathan E. Beever[c], Poothapillai Kasinathan[d], Wendy C. Brown[a], and Subramaniam Srikumaran[a,1]
[a]Department of Veterinary Microbiology and Pathology, Washington State University, Pullman, WA 99164; [b]Department of Veterinary Clinical Sciences, Washington State University, Pullman, WA 99164; [c]Department of Animal Sciences, University of Illinois, Urbana-Champaign, IL 61801; and [d]TransOva-ViaGen, Sioux Falls, SD 57106
Edited by Roy Curtiss III, University of Florida, Gainesville, FL, and approved September 29, 2016 (received for review August 11, 2016)
F1000Research
Check for updates
RESEARCH ARTICLE
A bovine CD18 signal peptide variant with increased binding activity to *Mannheimia hemolytica* leukotoxin [version 1; peer review: 3 approved]
Aspen M. Workman[1], Carol G. Chitko-McKown[1], Timothy P. L. Smith[1], Gary L. Bennett[1], Theodore S. Kalbfleisch[2], Veronica Basnayake[3], Michael P. Heaton[1]
[1]USDA, US Meat Animal Research Center (USMARC), Clay Center, Nebraska, 68933, USA
[2]Department of Biochemistry and Molecular Genetics, School of Medicine, University of Louisville, Louisville, Kentucky, 40292, USA
[3]GeneSeek, a Neogen Company, Lincoln, NE, USA


Scientists Use Gene-Editing Technology to Produce First Calf Resistant to Major Viral Disease
JOURNAL ARTICLE
First gene-edited calf with reduced susceptibility to a major viral pathogen
Aspen M Workman, Michael P Heaton, Brian L Vander Ley, Dennis A Webster, Luke Sherry, Jonathan R Bostrom, Sabreena Larson, Theodore S Kalbfleisch, Gregory P Harhay, Erin E Jobman ... Show more
Author Notes
PNAS Nexus, Volume 2, Issue 5, May 2023, pgad125,
https://doi.org/10.1093/pnasnexus/pgad125
Published: 09 May 2023 Article history
1st CD46 Gene-Edited Calf - Ginger


Endangered
GREAT PASSENGER PIGEON COMEBACK
BLACK-FOOTED FERRET RESCUE


Thylacinus Cynocephalus
THYLACINE
Vitals
EXTINCT


wants to create woolly mammoth hybrids by 2027


This Billion-Dollar Startup Wants to Bring Back the Dodo

<u>Feng Zang an MIT Neuroscientist</u>

1. Prokaryotic OMEGA systems and Fanzor proteins in eukaryotes.
2. Fanzor enzymes might also use an RNA-guided mechanism to target and cut DNA.

MOSAICS

occurs when there are two or more genetically different sets of cells in the body

Table 1. Publications using genome editing in cattle for agricultural applications. Modified from Mueller and Van Eenennaam (2022).

Trait category	Goal	Genome target and function	Reference
Animal health/ welfare	Prevent horn growth	Horn/Poll	Tan et al. (2013); Carlson et al. (2016)
	Disease resistance: mastitis	CSN2 (Beta-casein): milk protein gene	Liu et al. (2013)
			Liu et al. (2014)
	Disease resistance: tuberculosis	Intergenic region between SFTPA1 and MAT1A	Wu et al. (2015)
		Intergenic region between FSCN1 and ACTB	Gao et al. (2017)
	Disease resistance: bovine respiratory disease (BRD)	ITGB2 (integrin subunit beta 2): encodes the leukocyte signal peptide CD18	Shanthalingam et al. (2016)
	Disease resistance: bovine spongiform encephalopathy (BSE)	PRNP (prion protein): susceptibility to BSE	Bevacqua et al. (2016)
	Repair mutation: IARS syndrome	Isoleucyl-tRNA synthetase (IARS)	Ikeda et al. (2017); Ishino et al. (2018)
	Thermotolerance	PMEL (premelanosomal protein gene): coat color	Laible et al. (2020)
		PRLR (prolactin receptor): hair coat length	Rodriguez-Villamil et al. (2021)

		hair coat length	(2021)
Product yield or quality	Eliminate a milk allergen	PAEP (Beta-lactoglobulin): whey protein gene	Yu et al. (2011) Wei et al. (2015) Wei et al. (2018b)
		CSN2 (Beta-casein): milk protein gene	Su et al. (2018)
	Increase lean muscle yield	MSTN (myostatin): a negative regulator of muscle growth	Carlson et al. (2012) Luo et al. (2014) Proudfoot et al. (2015) Namula et al. (2019)
Reproduction and novel breeding schemes	Generate host for germ cell transfer	NANOS2 (Nanos C2HC-Type Zinc Finger 2): necessary for male germline development	Miao et al. (2019), Ciccarelli et al. (2020)
	All male offspring	Safe harbor loci, H11	Owen et al. (2021)

Genome editing research in cattle to date has focused primarily on monogenic (single gene) traits for animal health and welfare, or product yield and quality. There are also some applications that focus on reproduction and novel breeding schemes that may be of relevance to beef cattle breeding programs (Table 1).

recombinetics™

SARXION BIOLOGICS

Acceligen™

THERILLUME

colossal®

2021
First non-GMO decision for heavy muscled Nelore bull in Brazil

2019
Bred first commercial slick Angus in US using CRISPR/Cas9 in embryos

2018
Demonstrated heat tolerance of SLICK for Angus clone in Brazil (bred by TALENs)

2017
Demonstrated durability of polled trait bred by gene editing

2015
First polled dairy animal prototype bred by TALENs (first HDR edited bovine – first use of gene editing in cattle as validation of non-genic variation for polled trait)

2013
Bred heavy muscled Nelore bull by embryo treatment with TALENs (first bovine animal edit)

2024
SLICK Angus progeny are born and raised in US

2023
First validation of reduced disease susceptibility to BVD in cattle

2023
First polled Wagyu are born in US

2023
Acceligen's unique PRRSV resistance trait for swine is validated

2023
SLICK Holstein sire is determined non-GMO in Brazil

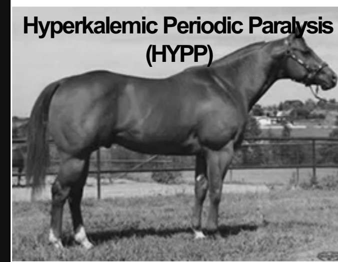
2022
FDA allows commercial use of first two SLICK Angus

2022
First Thamani Holstein is born derived from editing of multiple traits in bovine embryonic stem cells

Conclusions

Genome editing is a tool that is well-suited for modifying qualitative, single-gene traits at comparatively rapid rates and which could be used in conjunction with conventional selection approaches to address issues such as thermo tolerance, coat color, disease resistance, improved product yield or quality, and animal welfare traits.

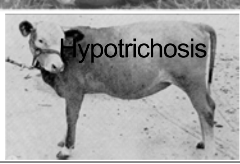
Horse Industry



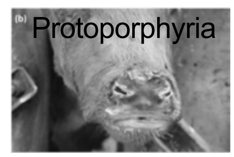
Lavender Foal Syndrome

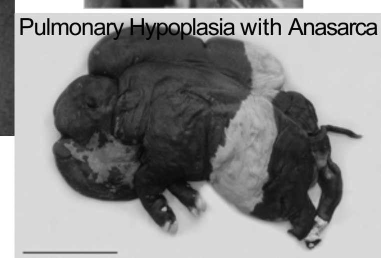
Glycogen Branching Enzyme Deficiency (GBED)

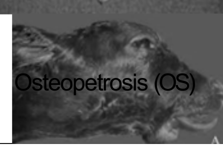
Neuropathic Hydrocephalus (NH)



DD (Devolpmental Duplication)





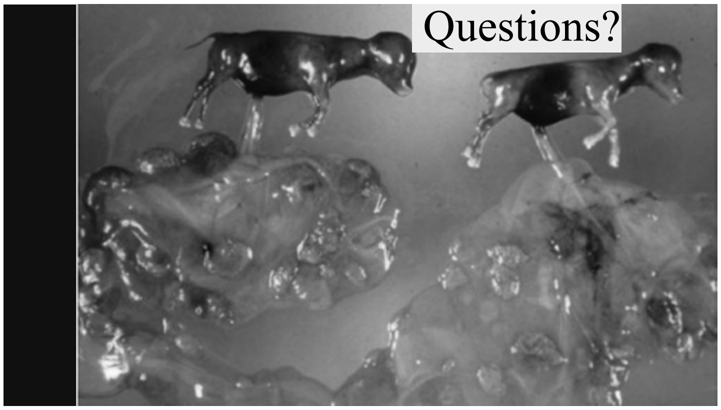


Callipyge Gene

Spider Leg Syndrome

Breed Association Food For Thought

1. Natural occurring mutation - single gene
2. Whole Genome Sequence - WGS each animal
3. Don't include data from the genome edited animal (IVF - Large calf syndrome). Genome Edited Founders (GEF).
4. Include all data from offspring of the genome edited animals. Genome Edited Descendants (GED).
5. Think of gene editing as "substitution" of a bad copy of the gene for a good copy of the gene.


Questions?