

Quantifiable Differences to Inform Breed Selection and Use

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USMARC Germplasm Evaluation Program

- Long standing resource for current differences of US breeds
 - ABEPD adjustment factors
 - Yearly update – current differences for growth and carcass traits
- Several other trait complexes are biologically or economically important
 - Few or no breeds with EPDs

Objectives

- Review GPE program and yearling ABEPD updates
- Share results from (relatively) recent analyses for novel traits
- Share project analysis plans and updates

Germplasm Evaluation Project

Population Structure

All Sires:

All Dams:

About 3500 cows are allocated to this project

DM, MA, BK, CI, CC, CA, BV, CD, TA

DM, MA, BK, CI, CC, CA, BV, CD, TA



×



PB, BC & F₁ Steers

PB Bulls

PB, BC & F₁ Heifers



×



Natural Service PB, BC, & F₁ Steers & Heifers

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

**TABLE 1: JANUARY 2023 ADJUSTMENT FACTORS TO ADD TO EPDs OF EIGHTEEN
DIFFERENT BREEDS TO ESTIMATE ACROSS BREED EPDs**

Breed	Birth Wt. (lb)	Weaning Wt. (lb)	Yearling Wt. (lb)	Maternal Milk (lb)	Marbling Score ^a	Ribeye Area (in ²)	Fat (in)	Carcass Wt.(lb)
Angus	0.0	0.0	0.0	0.0	0.00	0.00	0.000	0.0
Hereford	0.8	-14.4	-39.3	-10.6	-0.31	0.01	-0.068	-68.3
Red Angus	2.2	-17.9	-24.8	1.4	-0.09	0.24	-0.035	-10.0
Shorthorn	3.8	-24.2	-38.6	0.5	-0.13	0.27	-0.040	-10.9
South Devon	3.5	-37.5	-63.4	10.6	-0.07	0.28	-0.068	-17.9
Beefmaster	3.4	26.8	7.4	6.1				
Brahman	9.0	57.6	15.5	14.9	-0.68	0.09	-0.154	-38.7
Brangus	2.7	20.9	11.6	17.8				
Santa Gertrudis	4.8	40.4	37.2	20.4	-0.45	0.18	-0.071	-0.5
Braunvieh	3.4	-23.1	-48.0	25.6	-0.15	0.90	-0.038	-23.3
Charolais	6.4	6.4	-22.7	-1.4	-0.33	0.76	-0.188	6.9
Chiangus	2.3	-22.5	-41.3	6.4	-0.42	0.52	-0.108	-23.7
Gelbvieh	3.3	-10.0	-20.0	7.1	-0.57	0.73	-0.116	-20.0
Limousin	1.8	-9.3	-32.1	-2.7	-0.29	0.63	-0.067	-11.0
Maine-Anjou	1.9	-27.3	-55.5	-7.0	-0.51	0.92	-0.166	-38.0
Salers	2.0	-17.6	-30.0	10.8	-0.19	0.47	-0.078	-20.6
Simmental	1.8	-13.3	-24.3	-0.6	-0.16	0.45	-0.056	-4.5
Tarentaise	2.4	28.0	-5.6	13.3				

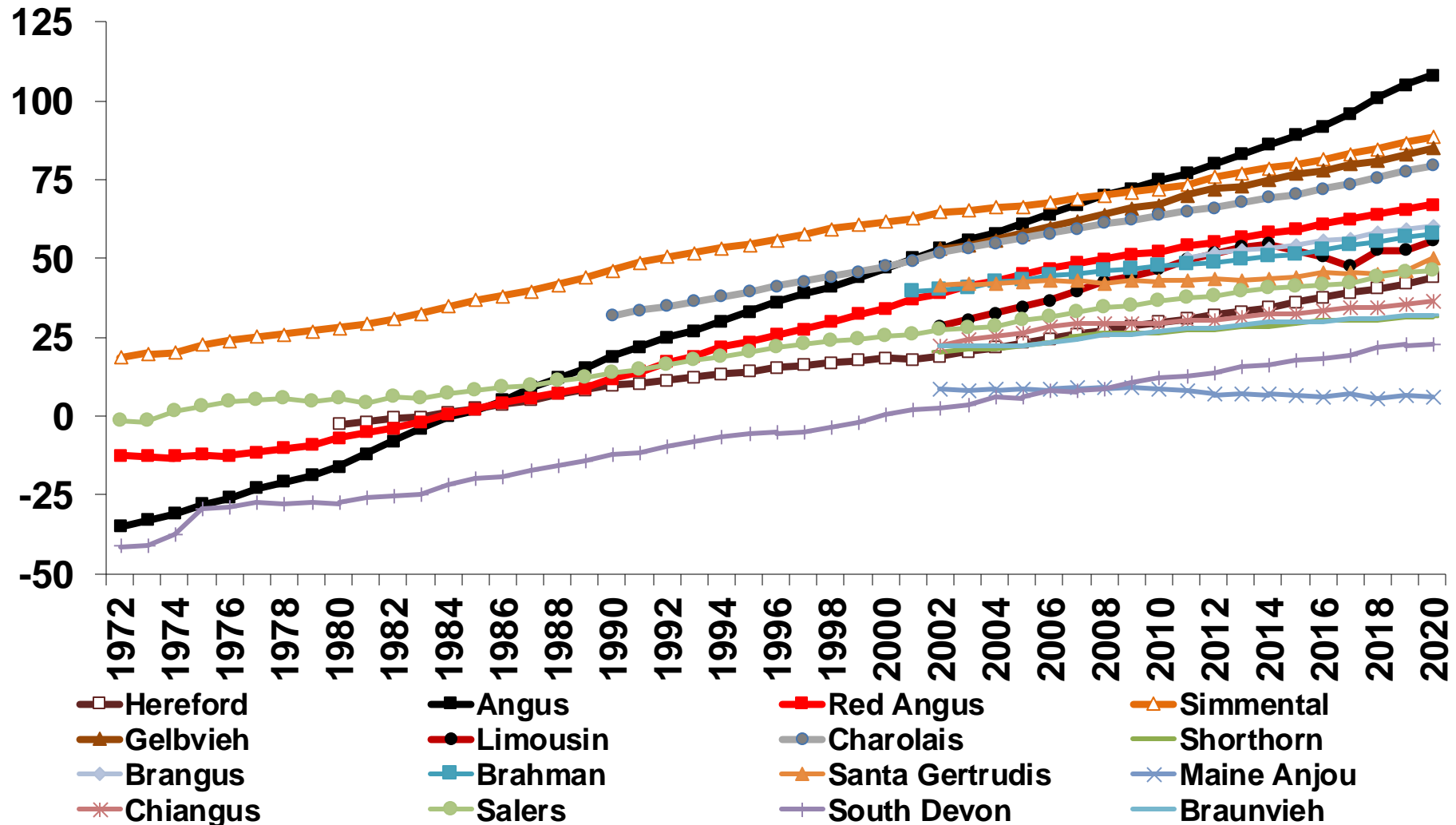
^aMarbling score units: 4.00 = S1⁰⁰; 5.00 = S5⁰⁰. Note that Brahman EPDs for marbling are reported on a scale where 400 = S1⁰⁰ and 500 = S5⁰⁰. When converting sires from other breeds to a Brahman basis, the adjusted EPD should be multiplied by 100. Likewise, when Brahman EPDs are adjusted to other breeds, the EPD should be divided by 100 before adding the adjustment factor.

**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 ^a	Ribeye Area (in ²)	Fat (in)	Carcass Wt.(lb)
Angus	84.7	540.9	981.3	520.5	6.25	13.72	0.662	921.7
Hereford	87.1	517.9	917.5	509.8	5.34	13.47	0.600	871.7
Red Angus	83.8	520.1	940.6	521.4	5.87	13.44	0.633	884.9
Shorthorn	89.1	499.7	900.7	517.0	5.42	13.67	0.531	864.8
South Devon	87.9	503.5	899.0	521.3	5.42	13.69	0.511	853.9
Beefmaster	86.9	527.8	916.4	510.3				
Brahman	94.3	554.2	918.7	515.3	4.88	13.44	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	897.3	532.1	5.47	14.36	0.493	846.3
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	954.3	522.6	5.29	14.32	0.525	884.6
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				

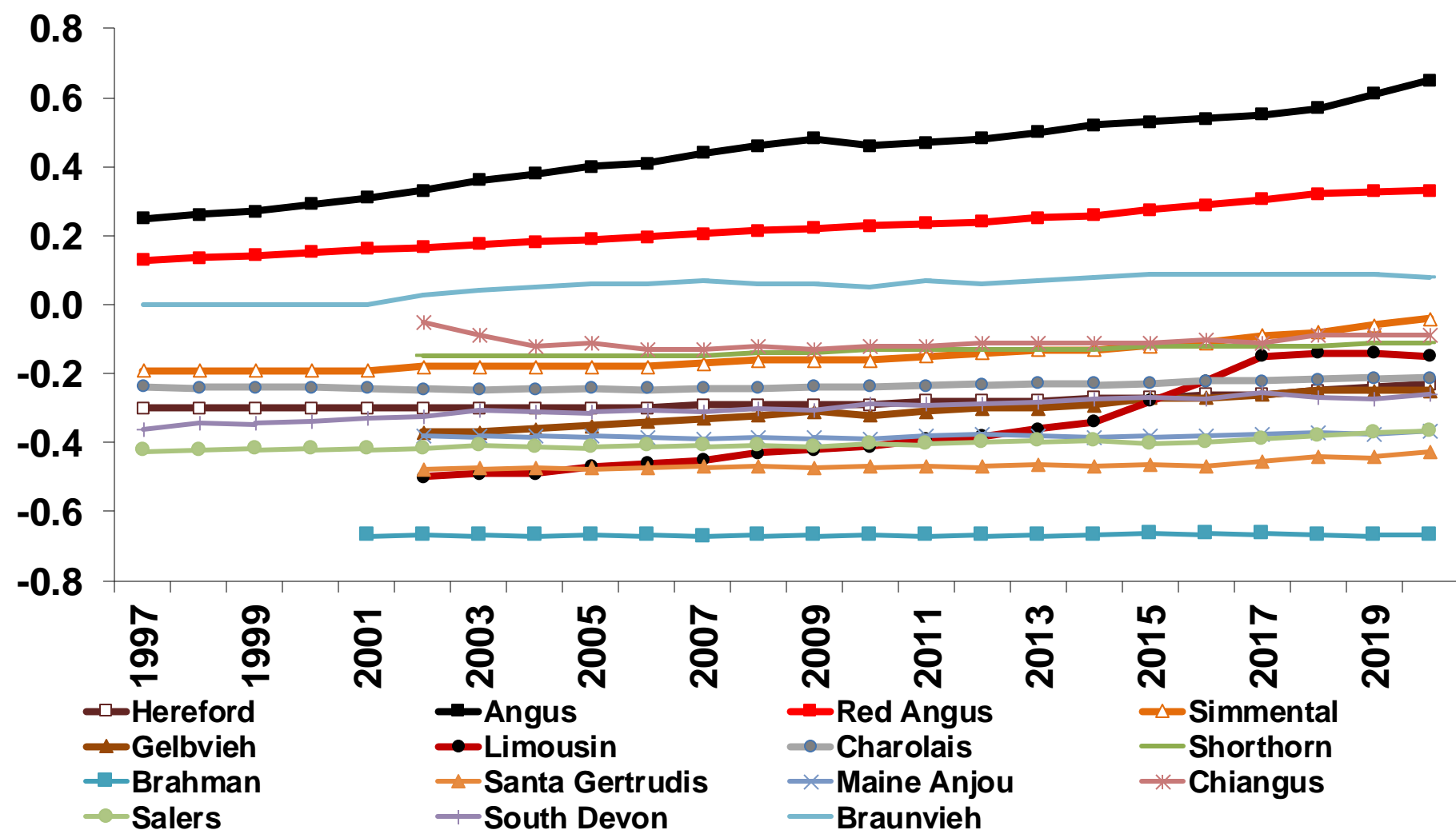
^aMarbling score units: 4.00 = S1⁰⁰; 5.00 = S^m0⁰

Genetic Trends (EPD) for Yearling Weight, lb



Adapted from Spring 2021 Genetic Trends from Breed Associations and 2021 AB-EPD factors

Genetic Trends (EPD) for Marbling Score



Adapted from Spring 2021 Genetic Trends from Breed Associations and 2021 AB-EPD factors

Traits Emphasized in GPE

Calving

- Dystocia
- Survival

Growth

Carcass & Meat

Quality

- Shear force
- Cutability
- Yield Grade factors

Reproduction

- Heifer age at puberty
- Heifer pregnancy rate

We try to evaluate as many economically important traits as is feasible

- Postweaning growth
- Mature weight, height, and condition

Maternal

- Birth Weight
- Dystocia
- Survival
- Weaning Weight
- Milk Production

Efficiency

- Feed utilization of finishing steers
- Feed utilization of pre-breeding heifers
- Mature cow maintenance requirements
- Rumen microbial composition

- Postpartum interval
- Male fertility

Longevity

Disease Resistance

Adaptation

... and many more.

Breed differences for novel traits

- So what differences have been reported?
- How can we use these results
- Note that generally, these summaries are analyzed with a similar model (animal model with pedigree) to ABEPD analysis
 - EPD adjustment where available

Retail Case Shelf Life

- Color stability is a primary biological trait that determines retail case shelf life
 - Longer color ‘stability’ leads to less discounting and product wastage
- Measurement (Texas A&M)
 - Hue – words we normally think of as describing color: red, purple, blue, etc.
 - Chroma – strength or dominance of the hue
 - L^* , a^* , b^* color space (pronounced “L-star, a-star, b-star”) for instrumental measurements (listed as a composite color change in summary)

Color Stability

- Changes in L^* , a^* and b^* , chroma, and a composite change in color
 - Table only summarizes the composite change as overall decreases in color are unfavorable. Also reported:
 - Chroma change
 - Decreases in intensity over time
 - Metmyoglobin (oxidated form of myoglobin)
 - Increases over time

Color Stability (King et al., 2009)

	AN	CH	GV	HH	LM	RA	SM
Chroma: Color							
Intensity decrease (6d)	-7.07 ^z	-2.11 ^y	-6.57 ^z	-7.41 ^z	-2.84 ^y	-8.95 ^z	-5.00 ^{yz}
	(1.98)	(2.08)	(2.12)	(2.17)	(1.98)	(0.86)	(0.05)
Composite color decrease (6d)	-7.65 ^z	-2.97 ^y	-7.26 ^z	-8.11 ^z	-3.77 ^y	-9.25 ^z	-6.19 ^{yz}
	(1.93)	(2.01)	(2.05)	(2.11)	(1.93)	(0.82)	(2.02)
Myoglobin, mg/ml	3.05 ^{yz}	2.77 ^{xy}	3.62 ^z	3.34 ^{yz}	2.72 ^x	3.43 ^z	3.71 ^z
	(0.36)	(0.37)	(0.37)	(0.39)	(0.36)	(0.15)	(0.38)

Feed intake and test gain

- Several breeds now offer EPDs although data is still very limited
- USMARC data based on measurements when animals were as young as 8 months and as old as 15 months.
 - Reported ADG are for test period only

Feed Intake and Gain (Retallick et al., 2017)

Breed	Steer ADFI (lb)	Steer ADG (lb)	Heifer ADFI (lb)	Heifer ADG (lb)
Angus	0	0	0	0
Hereford	-1.74 (0.63)	-0.08 (0.12)	-2.12 (0.59)	-0.05 (0.10)
Red Angus	-0.68 (0.61)	-0.15 (0.11)	-1.51 (0.56)	-0.19 (0.09)
Shorthorn	-2.20 (0.71)	-0.22 (0.13)	-2.25 (0.66)	-0.22 (0.11)
South Devon	-4.09 (1.47)	-0.60 (0.39)	-3.47 (1.41)	0.03 (0.24)
Beefmaster	-1.70 (0.76)	0.16 (0.15)	-3.43 (0.74)	-0.20 (0.12)
Brahman	-2.91 (0.77)	-0.27 (0.15)	-2.98 (0.70)	-0.41 (0.12)
Brangus	-0.38 (0.74)	-0.07 (0.14)	-1.29 (0.70)	-0.26 (0.12)
Santa Gertrudis	-1.25 (0.74)	0.05 (0.14)	-2.29 (0.67)	-0.25 (0.11)
Braunvieh	-3.28 (0.77)	-0.40 (0.15)	-4.06 (0.67)	-0.66 (0.11)
Charolais	-1.15 (0.64)	-0.04 (0.12)	-1.93 (0.60)	-0.17 (0.10)
Chiangus	-2.74 (0.74)	-0.18 (0.14)	-2.31 (0.65)	-0.26 (0.11)
Gelbvieh	-2.32 (0.61)	-0.16 (0.12)	-1.59 (0.56)	-0.25 (0.09)
Limousin	-2.73 (0.62)	-0.01 (0.12)	-3.24 (0.56)	-0.35 (0.09)
Maine Anjou	-3.63 (0.74)	-0.33 (0.14)	-2.43 (0.67)	-0.22 (0.11)
Salers	-2.67 (0.73)	-0.30 (0.14)	-2.59 (0.67)	-0.31 (0.11)
Simmental	-0.09 (0.63)	-0.04 (0.12)	-1.17 (0.61)	-0.15 (0.10)
Tarentaise	-2.60 (1.49)	-0.33 (0.30)	-4.25 (1.25)	-0.69 (0.21)

Feed Efficiency Indices (Retallick et al., 2017)

Breed	Steer Gain:Feed	Steer RADG	Heifer Gain:Feed	Heifer RADG
Angus	0.000	0.000	0.000	0.000
Hereford	0.099	0.004	0.094	0.075
Red Angus	-0.014	-0.051	-0.004	-0.018
Shorthorn	0.070	-0.050	0.025	0.005
South Devon	-0.041	-0.182	0.203	0.171
Beefmaster	0.203	0.110	0.096	0.065
Brahman	0.100	-0.058	-0.023	-0.050
Brangus	-0.002	-0.023	-0.049	-0.061
Santa Gertrudis	0.119	0.051	0.012	-0.009
Braunvieh	0.073	-0.105	-0.078	-0.115
Charolais	0.070	0.008	0.030	0.013
Chiangus	0.130	-0.019	0.008	-0.013
Gelbvieh	0.107	-0.019	-0.027	-0.042
Limousin	0.206	0.057	0.017	-0.013
Maine Anjou	0.130	-0.067	0.031	0.009
Salers	0.070	-0.075	0.002	-0.021
Simmental	0.027	0.022	-0.004	-0.015
Tarentaise	0.050	-0.091	-0.081	-0.119

Mature weight and condition

- Looked at both traits and their relationships
- Breed differences for both traits reported as well as mature weight adjusted for body condition via genetic regression.
- Weights taken at three time points for cows each year at USMARC

Mature Weight and Condition (Ribeiro et al., 2022)

Breed	Mature Weight (lb)	Adj Mature Weight (lb)	Condition Score
Angus	0	0	0
Red Angus	-47.8 (20.5)	-53.8 (18.1)	0.04 (0.08)
Beefmaster	-76.1 (25.8)	-56.9 (22.7)	-0.13 (0.10)
Brahman	20.9 (30.0)	9.3 (26.5)	0.08 (0.12)
Brangus	-45.0 (24.7)	-27.3 (21.8)	-0.12 (0.10)
Braunvieh	-194.7 (29.3)	-113.5 (26.0)	-0.55 (0.11)
Charolais	14.3 (20.3)	14.3 (17.9)	0.004 (0.08)
Chiangus	-33.1 (26.5)	-7.9 (23.4)	-0.17 (0.10)
Gelbvieh	-71.2 (20.5)	7.1 (18.1)	-0.53 (0.08)
Hereford	-30.4 (19.2)	-14.3 (16.8)	-0.11 (0.07)
Limousin	-76.3 (20.3)	-17.4 (17.9)	-0.40 (0.07)
Maine-Anjou	-62.6 (26.0)	-19.8 (22.9)	-0.29 (0.10)
Salers	-20.1 (28.0)	9.5 (24.7)	-0.20 (0.10)
Santa Gertrudis	-33.1 (27.6)	27.3 (24.5)	-0.41 (0.10)
Shorthorn	-49.8 (24.7)	24.0 (21.8)	-0.50 (0.09)
Simmental	-17.0 (19.6)	15.4 (17.2)	-0.22 (0.07)

Cow lifetime productivity

- Random regressions for cow weight and for cumulative weight weaned as a cow
 - Need to set an approximate 'breakeven' age for profit evaluation
- Right now, breed differences examined as representation in high/low cow weight and high/low cumulative weight weaned

Cow productivity

Charolais and Simmental overrepresented in the high CW/high WtW group

Angus, Simmental, Gelbvieh, Limousin, and Tarentaise overrepresented in low CW/high WtW

Hereford, Brahman, Shorthorn, Maine-Anjou and Salers overrepresented in high CW/low WtW

Angus, Hereford, Braunvieh, Red Angus, and Shorthorn were overrepresented in the low CW/low WtW group

weight weaned (additive+domin

0

Gelbvieh
Hereford
Indicus
Limousin
Minor

-200

-100

0

100

200

Cow weight effect (additive+dominance)

Implications and next steps

- iGENDEC uses these breed of sire/breed effects from this body of work and will update annually
 - Also factoring into IGS system
- We are working on solutions for updating these estimates more often
 - Similar to ABEPD adjustment factors
 - Also working to release EPDs for sampled bulls
- Other breeds?

EPDs of AI sires for novel traits

- USMARC is working to provide EPDs for bulls that contribute to GPE to bull owners and the beef industry
 - EPDs will be multibreed and genomically enhanced
 - Last calf crop needed to reach target progeny numbers was born in 2023
 - First EPDs expected at the end of 2024
 - Traits that are not part of NCE or not covered for most breeds
 - Feed intake, fertility, possible disease resistance, tenderness, color stability.

Genotype by Environment by Management Interactions

- We've long known that differences among breeds may not be consistent in all environments for all traits
 - Little has been done to account for differences in our genetic evaluation systems
 - Huge amounts of data would be required on a sire level
 - Breeds may give us a proxy for the importance of considering GxExM

ARS Beef Grand Challenge

Livestock and Range Research Laboratory

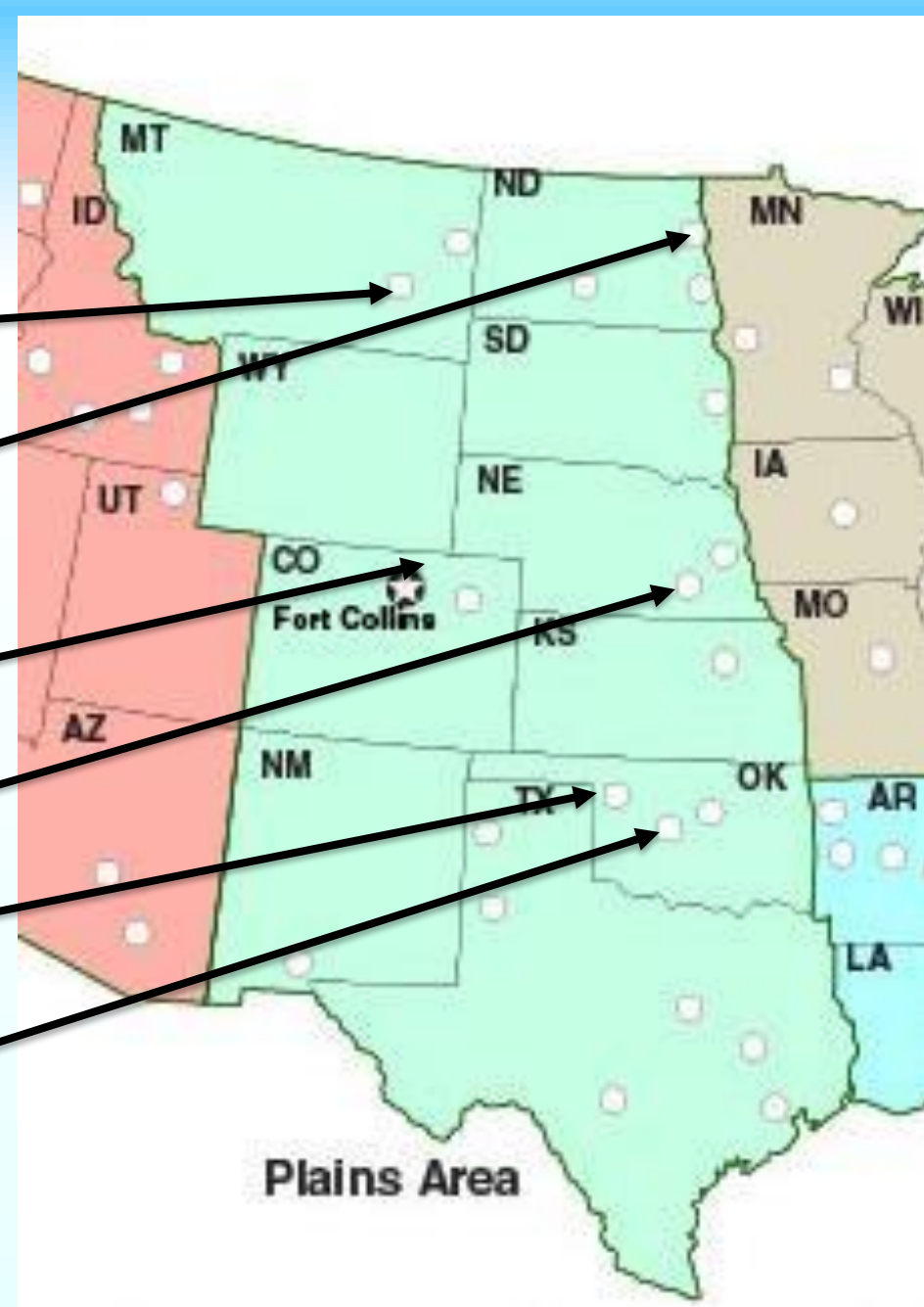
Grand Forks Human Nutrition Center

Central Plains Experimental Range

US Meat Animal Research Center

Rangeland and Pasture Research

Grazinglands Research Laboratory



Next steps

- Looking at ways to connect our cow herd to other locations (Beeville, TX; El Reno, OK).
 - Sent 120 females and 7 bulls to Beeville
 - Sent 69 females and 4 bulls to El Reno
- We are open to other possible collaborations

Beeville, TX



El Reno, OK



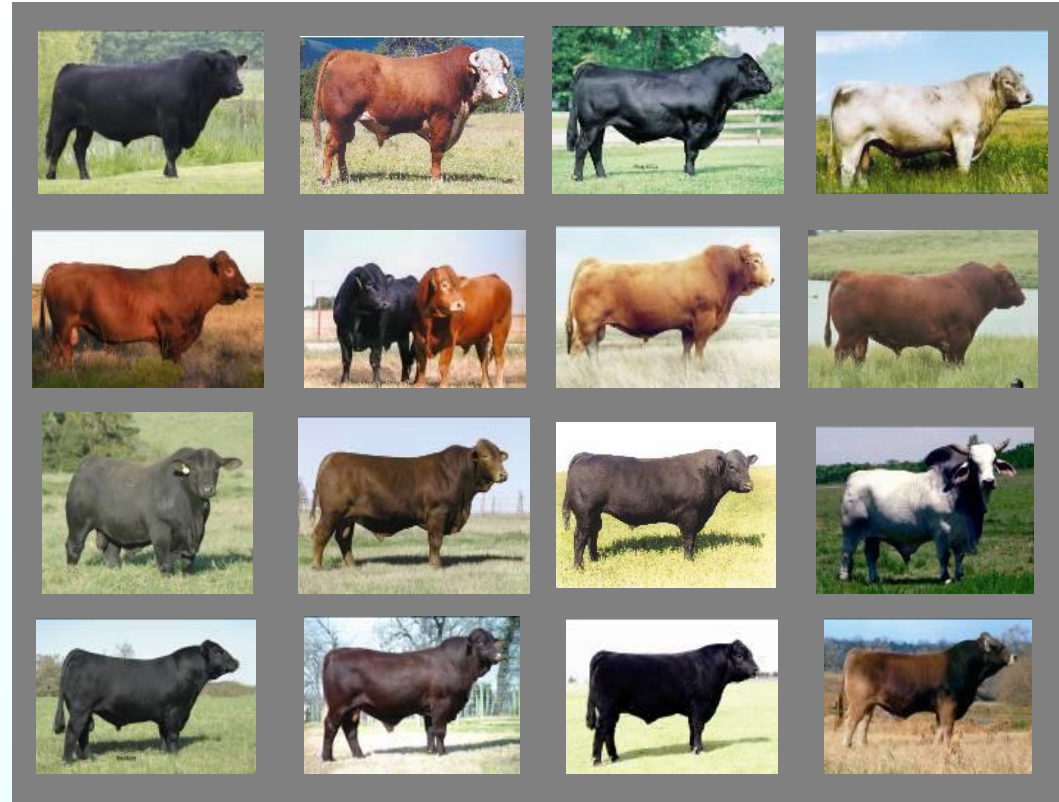
Future traits

- Sustainability (several meanings)
- Tenderness – already reported on earlier iterations but updates are needed
- Heifer fertility and cow fertility
- Continued analyses of disease resistance
 - Looking at aspects related to tolerance
- Calving ease/difficulty – prototyped and being updated

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- USMARC scientific collaborators
 - Collaboration across all units
- All breeds and producers involved in supporting the GPE program

Questions



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