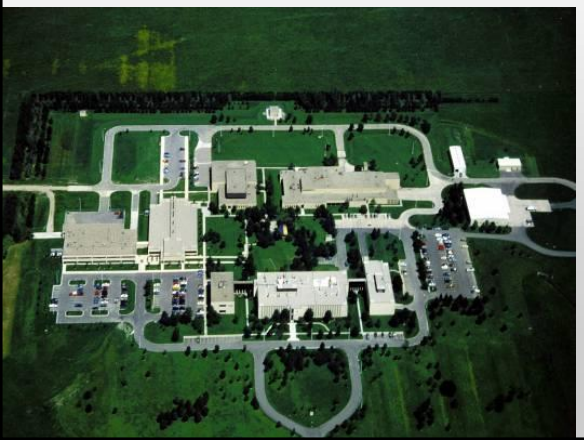
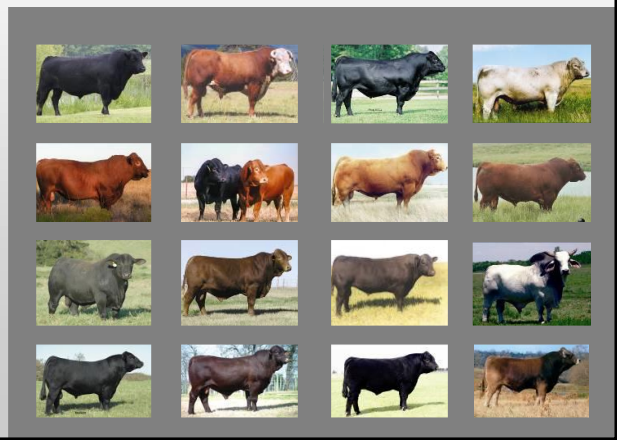
Proposed enhancements to the across-breed EPD system

Larry Kuehn and Mark Thallman
Research Geneticists

USDA, ARS, U.S. Meat Animal Research Center



The USDA is an equal opportunity employer.



Background - ABEPD

- Across-breed EPD adjustment factors have been computed for BIF since 1993
- Account for differences in EPD base in the genetic evaluations of each breed involved
- Uses USMARC Germplasm Evaluation (GPE) data to adjust for breed differences

SIRE BREEDS USED IN THE GERMPLASM EVALUATION PROGRAM AT THE USMARC

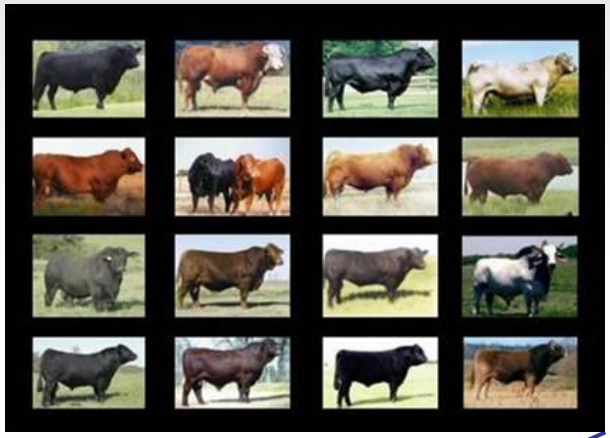
Cycle I 70-72	Cycle II 73-74	Cycle III 75-76	Cycle IV 86-90	Cycle V 92-94	Cycle VI 97-98	Cycle VII 99-00	Cycle VIII 01-02
F_1 Crosses (Hereford or Angus dams) [a]							
Hereford	Hereford	Hereford	Hereford	Hereford	Hereford	Hereford	Hereford
Angus	Angus	Angus	Angus	Angus	Angus	Angus	Angus
Jersey	Red Poll	Brahman	Longhorn	Tuli	Wagyu	Red Angus	Beefmaster
S. Devon	Braunvieh	Sahiwal	Salers	Boran	Norweg. Red	Limousin	Brangus
Limousin	Gelbvieh	Pinzgauer	Galloway	Belg. Blue	Sw. Red&Wh.	Charolais	Bonsmara
Simmental	Maine Anj.	Tarentaise	Nellore	Brahman	Friesian	Simmental	Romosinuano
Charolais	Chianina		Shorthorn	Piedmontese		Gelbvieh	
			Piedmontese				
3-way crosses			Charolais				
Hereford	Hereford		Gelbvieh				
Angus	Angus		Pinzgauer				
Brahman	Brangus						
Devon	Santa Gertrudis						
Holstein							

a
Sire breeds mated to Angus and Hereford females, and Composite MARC III (1/4 Angus, Hereford, Red Poll and Pinzgauer) cows in Cycles V, VI, VII and VIII.

GPE Target 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



×

PB & F_1 Steers

PB & F_1 Bulls

×

PB & F_1 Heifers

Natural Service PB, F_1, & F_1^2 Steers & Heifers

Calculations

1) Solve for breed of sire solutions
   - USMARC GPE data
   - Sample of sires from participating breeds
   - AI sire and base female genetic groups
   - Animal model

2) Get EPD of GPE sires and of 2011 born animals from breed associations
   - Used to scale differences from GPE data to breed EPD reported in 2011

Calculations

3) Adjust USMARC solutions to year 2011

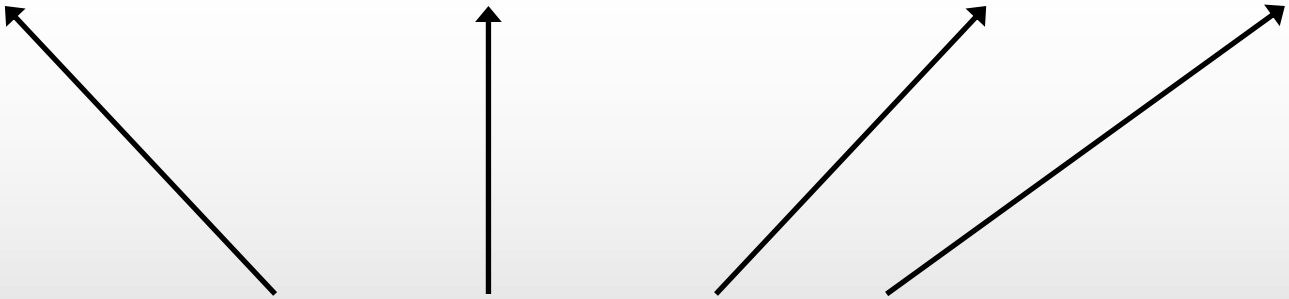
$$USMARC(ADJ)=USMARC/b + [\overline{EPD}_{11} - \overline{EPD}_{USMARC}]$$

- b is derived as the regression of progeny phenotypes on sire EPD (expect b = 1.00)
- Convert USMARC solutions to industry scale
- $\overline{EPD}_{USMARC}$ a weighted mean where weight is the sum of numerator relationships between sires and progeny with phenotypes

Calculations

4) Compute adjustment factor (breed Y) relative to breed X (Angus) bull base:

$$[USMARC(Adj, Y) - USMARC(Adj,X)] - [\overline{EPD}_{11Y} - \overline{EPD}_{11X}]$$



All on an industry scale

Calculations

5) Use adjustment factor to compare bulls from different breeds:

bull i, breed Y: Table Factor + EPD(Y,i)

bull j, breed Z: Table Factor + EPD(Z,j)

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

Breed	Birth Wt.	Weaning Wt.	Yearling Wt.	Maternal Milk	Marbling Score[a]	Ribeye Area	Fat Thickness
Angus	0.0	0.0	0.0	0.0	0.00	0.00	0.000
Hereford	2.7	-3.5	-23.6	-17.1	-0.32	-0.09	-0.050
Red Angus	3.4	-23.2	-27.9	-3.9	-0.30	-0.08	-0.029
Shorthorn	5.8	11.3	38.8	20.2	-0.16	0.21	-0.142
South Devon	3.2	-4.8	-6.6	-0.3	0.08	0.16	-0.111
Beefmaster	6.3	35.7	29.5	9.9			
Brahman	11.0	42.8	5.9	23.2			
Brangus	4.5	14.6	6.0	5.8			
Santa Gertrudis	6.6	36.2	48.3	12.4	-0.66	-0.05	-0.116
Braunvieh	1.9	-21.6	-42.3	0.1	-0.67	0.22	-0.102
Charolais	8.6	38.1	45.3	6.9	-0.44	1.02	-0.220
Chiangus	2.2	-20.5	-40.2	4.7	-0.45	0.45	-0.157
Gelbvieh	2.7	-18.2	-25.6	3.6	-0.41	0.78	-0.136
Limousin	3.8	-1.8	-35.9	-8.7	-0.71	1.09	
Maine-Anjou	4.2	-15.3	-36.7	-6.8	-0.84	0.95	-0.229
Salers	1.8	-4.8	-19.5	2.2	-0.10	0.79	-0.207
Simmental	3.7	-5.9	-10.9	-0.8	-0.42	0.53	-0.141
Tarentaise	1.7	30.3	20.3	24.1			

[a]Marbling score units: $4.00 = Sl^{00}$; $5.00 = Sm^{00}$

TABLE 2: BREED OF SIRE MEANS FOR 2011 BORN ANIMALS UNDER CONDITIONS SIMILAR TO USMARC

Breed	Birth Wt.	Weaning Wt.	Yearling Wt.	Maternal Milk	Marbling Score[a]	Ribeye Area	Fat Thickness
Angus	87.3	577.0	1045.3	565.3	6.09	13.12	0.611
Hereford	91.7	571.5	1009.7	543.2	5.36	12.87	0.552
Red Angus	88.1	561.5	1013.0	558.3	5.71	12.77	0.570
Shorthorn	93.7	556.5	1022.9	564.8	5.45	12.98	0.448
South Devon	91.4	566.0	1030.0	564.9	6.11	13.07	0.500
Beefmaster	92.1	575.6	1002.9	554.2			
Brahman	98.3	587.7	989.3	571.9			
Brangus	90.8	568.2	1008.4	559.3			
Santa Gertrudis	92.6	570.5	1013.9	555.4	4.96	12.66	0.487
Braunvieh	89.9	549.4	981.8	576.4	5.46	13.63	0.432
Charolais	94.7	592.4	1047.7	556.1	5.22	13.92	0.381
Chiangus	90.9	546.2	987.0	557.9	5.37	13.24	0.449
Gelbvieh	89.6	575.4	1027.1	571.4	5.26	13.78	0.422
Limousin	90.8	574.7	1007.7	555.7	4.90	14.33	
Maine-Anjou	91.8	554.1	1000.8	555.2	4.99	13.80	0.372
Salers	89.0	566.4	1019.5	564.0	5.73	13.52	0.394
Simmental	91.5	586.1	1038.8	564.4	5.29	13.82	0.402
Tarentaise	89.1	576.2	1008.2	567.0			

[a]Marbling score units: 4.00 = SI^{00}; 5.00 = Sm^{00}

Reviewing the ABEPD program

- Successful tool for over 20 years
- Much in National Cattle Evaluation has changed over this period
- Prudent to consider what the system would be like if newly developed today

Objectives of ABEPD program

1) Provide a tool to compare genetic merit of animals across breeds for traits predicted in national cattle evaluation (NCE)

2) Provide a tool to deliver current breed differences on economically important trait complexes

How are we doing?

- In the strictest sense, we are meeting both objectives
- However, efficiency is not optimal
  - Factors only released once per year
  - Restricted to additive adjustments
  - Factors often confused with breed differences
  - Restricted to NCE traits while other economically important traits are measured at USMARC

Goals to improve objectives

- Data processing
  1) Improve analysis to fully take advantage of the evolving structure of the Germplasm Evaluation Program

     Estimation and use of breed specific heterosis

  2) Develop methodology and agreements to include data from multiple sources (beyond GPE)

Goals to improve objectives

- Delivery of across-breed predictions
  1) Be able to update factors and esimates continuously rather than once per year
  2) Provide a delivery system without factors that accommodates non-additive adjustments
  3) Account for dam breed composition of herd (heterosis) in adjustment process
  4) Obtain EPD predictions adjusted to any breed (rather than only Angus base)

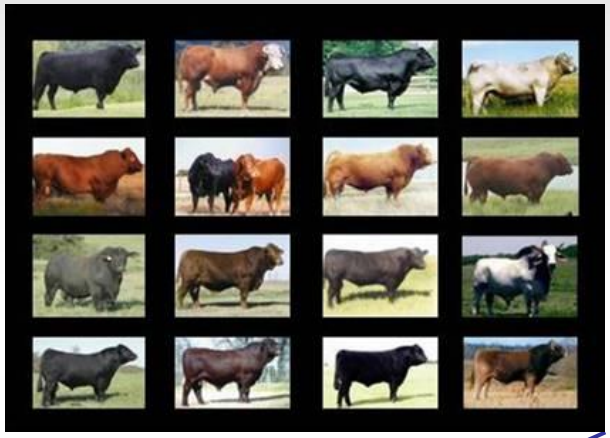
Data processing

- Original GPE (Cycle) structure easily analyzed with a simple sire model
  - Dickerson ‘principals’
  - AI sires mated to base cows (primarily Angus and Hereford)
  - Assume heterosis constant
  - Some diallele A x H crosses in design to estimate heterosis

Current 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



×

PB & F_1 Steers

PB & F_1 Bulls

×

PB & F_1 Heifers

Natural Service PB, F_1, & F_1^2 Steers & Heifers

Analysis of current structure

- Animal model has been implemented and is necessary
- Currently prototyping breed specific heterosis estimation (UNL collaboration)
  - 18 x 18 diallele takes time to implement…
  - Project exploring random breed x breed heterosis as a deviation from overall

Analysis of current structure

- Other improvements possible
  - Autocorrelation of base cow genetic groups
  - Weighting of old GPE records relative to data from more recent sampling
    - Decrease reliance on NCE genetic trend to adjust data from earlier GPE cycles
  - New GPE analysis example

Analysis of New GPE data only

- Compared to cumulative GPE data
- Used same analysis as ABEPD
- Results are shown relative to Angus
- Breed of sire differences
  - 1/2 of actual breed effect
  - Shown as differences from Angus
- Birth weight example

Birth Weight – breed of sire effect

Breed	New GPE	Cumulative GPE	Diff
Angus	0.0	0.0	0.0
Hereford	4.4	4.5	-0.1
Red Angus	0.2	0.8	-0.7
Shorthorn	5.1	6.5	-1.3
Beefmaster	3.5	4.8	-1.4
Brahman	11.9	11.1	0.8
Brangus	3.4	3.5	-0.1
Santa Gertrudis	4.7	5.4	-0.6
Braunvieh	2.3	2.6	-0.3
Charolais	7.1	7.5	-0.4
Chiangus	3.0	3.6	-0.6
Gelbvieh	2.5	2.4	0.1
Limousin	2.6	3.6	-0.9
Maine Anjou	2.2	4.5	-2.3
Salers	0.2	1.8	-1.6
Simmental	3.8	4.3	-0.5

Data processing

- Incorporation of data from other sources
  - Currently at least one mutlibreed system aiming to put breeds on the same base
  - Would be desirable for agreement with across-breed system
  - How to combine data?
    - Sources – contemporary comparisons important
    - Must be able to account for genetic trend of sires in contemporary groups
    - Need a broad discussion on feasibility

Data processing

- Data from research institutions
  - USMARC is not enough
  - Specific to one region of the country
  - Desirable to detect potential for breed reranking in different environments (G x E)
    - Southeastern U.S. seems most important
  - Increased data would improve overall across-breed program as well

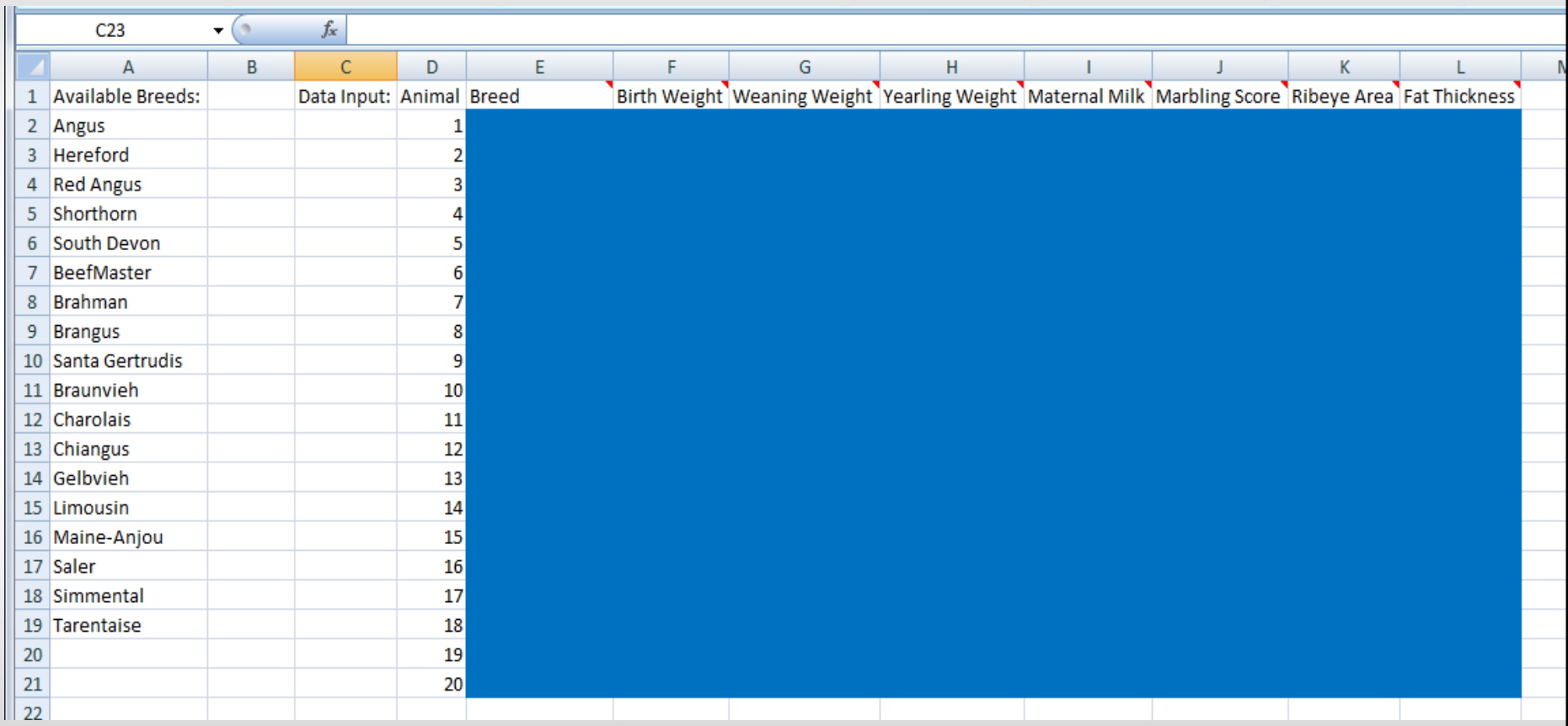
Across-breed delivery

- Delivery goals seem easiest to accomplish with a web-based delivery system
  - Allows for continuous updating due to changes in estimated breed differences (USMARC) or due to NCE changes
    - USMARC data added on regular intervals; NCE updated weekly in many cases
  - Have discussed a possible collaborative website with extension arm of NBCEC (Spangler)

Web-based system

- Producers could enter information (EPDs) on bulls they are interested in and request the resulting EPDs back on the scale of any breed
- Currently spreadsheet/database methods that already perform this operation
  - Rolf (Oklahoma State University extension)
  - GPS has done for Brangus

Example (Rolf)



C23

	A	B	C	D	E	F	G	H	I	J	K	L
1	Available Breeds:		Data Input:	Animal	Breed	Birth Weight	Weaning Weight	Yearling Weight	Maternal Milk	Marbling Score	Ribeye Area	Fat Thickness
2	Angus			1								
3	Hereford			2								
4	Red Angus			3								
5	Shorthorn			4								
6	South Devon			5								
7	BeefMaster			6								
8	Brahman			7								
9	Brangus			8								
10	Santa Gertrudis			9								
11	Braunvieh			10								
12	Charolais			11								
13	Chiangus			12								
14	Gelbvieh			13								
15	Limousin			14								
16	Maine-Anjou			15								
17	Saler			16								
18	Simmental			17								
19	Tarentaise			18								
20				19								
21				20								
22												

Web-based system

- Ability to access breed association databases could improve user experience further, but would not be necessary
- Producers could enter herd composition (dam breed) to receive predictions of merit that account for heterosis potential
- Whole system could be improved with NBCEC developed decision support tools

Web-based system

- Scaling
  - Current additive factors assume that NCE EPDs have ‘similar’ variances
  - Would like to add an across-breed solution for calving ease (currently prototyping with UNL)
    - Most likely does not meet scaling assumption
      - EPD returned on a probability scale assuming calving difficulty incidence
      - Some breeds use linear model to analyze CE data

Web-based system

- Would allow breed associations to change parameters (average EPD, sampled bull EPDs) whenever they change
- Updated across-breed predictions in real time
- Simple ftp-type transfer could be implemented

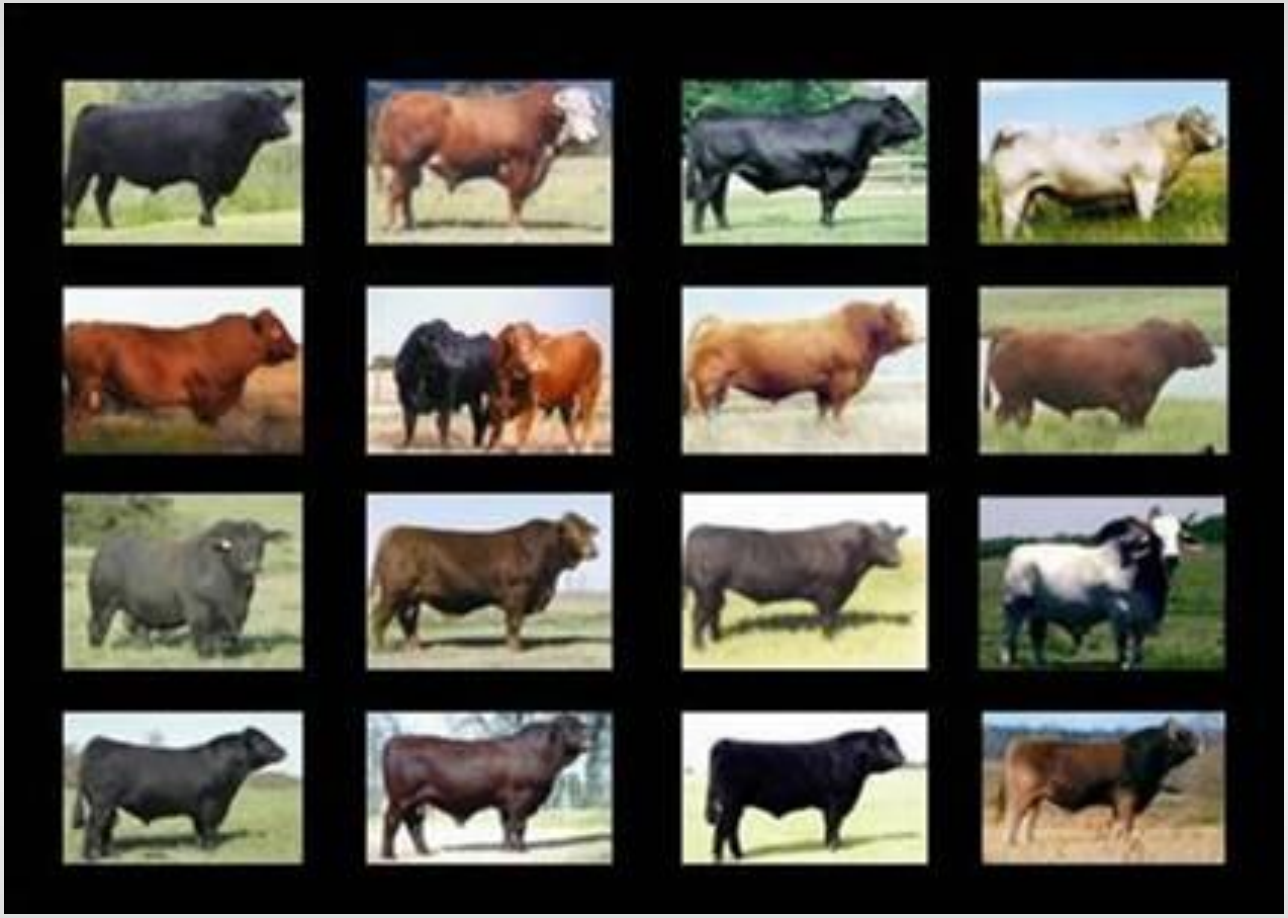
Web-based system

- Could also provide an avenue for breed differences and/or genomic predictions for traits that are not part of NCE
- Focus in genomics has been on NCE traits due to data availability
- Other expensive traits still important and under emphasized in selection programs
- Could replace ‘GPE Progress Reports’ with differences as data are analyzed

Conclusions

- We welcome suggestions and further discussion
- Program is important and needs to be adaptable to future needs and research results
- Ideal to produce a product that is easy to understand, minimizes user errors, and increased the efficacy of the tool

Questions



- Mention of a trade name, proprietary product, or specific equipment does not constitute a guarantee or warranty by the USDA and does not imply approval to the exclusion of other products that may be suitable.