Adapting the Germplasm Evaluation Program for questions in multibreed evaluation and environmental adaptation

Larry Kuehn, Mark Thallman, Warren Snelling and Bailey Engle
USDA, ARS, U.S. Meat Animal Research Center

United States Department of Agriculture
Agricultural Research Service

Current Germplasm Evaluation Project
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, BC & F_1 Steers

PB Bulls

PB, BC & F_1 Heifers

Natural Service PB, BC, & F_1 Steers & Heifers

Current GPE Objectives

- Current Breed Differences
- Across-breed EPD Adjustment Factors
- Genomics
- Heritabilities and Genetic Correlations
- Breed-specific Heterosis
- Evaluation of Sampled Sires for Novel Traits
- Contribute to Decision Support System

Adjusting sample for current EPD

- Across-breed EPD program
  - Estimate breed differences from GPE using a sire and dam model (F_1 progeny records)
  - Adjust records for bull EPD

$$B_i = USMARC_i / b + (EPD_{i,YY} - EPD_{i,USMARC})$$

- $EPD_{i,YY}$ is the breed average EPD (current)
- $EPD_{i,USMARC}$ weighted average USMARC sire EPD
- *b* is a scaling factor to convert USMARC solution to an industry scale

Across Breed EPD adjustment factors

- Calculated by scaling the 'current' breed difference (B_i) to Angus EPD base
  - Current breed difference is 2020 this year
  - Base difference calculated by subtracting the 2020 Angus average EPD from the 2020 breed average EPD
- For Breed i:

$$Factor_i = B_i - B_{Angus} - (EPD_i - EPD_{Angus})$$

Multibreed evaluation

- Current program with International Genetic Solutions (IGS)
  - 17 breed association partners
  - Includes records from and produces EPDs for crossbred and composite populations
  - Realized goal to estimate differences across partner breeds and participating hybrids or crossbreds

Multibreed evaluation

- Big question:
  - Why is USMARC still producing ABEPD adjustment factors for breeds involved in IGS?
    - Users ask what to do with the factors
    - Adds complication to EPD program when evaluating bulls across breed
- Answer – factors are from differences based on progeny testing at USMARC

Field data vs. research herds

- While amount of data much larger with field data, estimation of breed differences (and heterosis) limited by connected contemporary groups that contain combinations of breeds
  - Also connections and adjustment for sample of breeds within these groups are important
    - What is the genetic merit of the ‘connecting animals and breeds’?
- GPE much smaller but designed to make these comparisons within groups

Field data vs. research data

- Still, field data has much to offer and is almost certainly helping to estimate differences

- How close is the multibreed model to ABEPD adjustment factors
  - Expectation would be that all ABEPD factors are equal for IGS breeds

Comparison – how close are we?

- Methodology
  - Examine fitting IGS breed as a ‘superbreed’ for GPE data
  - 2 approaches
    - Only largest 4 breeds combined
    - All IGS breeds combined
  - A single adjustment factor produced for the superbreed

Comparing ABPED/multibreed

- Methodology (continued)
  - Look at SE of breed differences (vs. Angus) as a proxy for SE of factors
  - Estimation of breed differences should be the main source of error for factors (other components are means of sire EPDs and breed EPD means for a year and should have low error)
- Summarized for growth traits

Results – birth weight

Breed	Base Factor	"SE"	Difference (4 breed)	Difference (all)
Red Angus	2.3	0.65	0.0	0.3
Gelbvieh	3.3	0.65	-1.0	-0.8
Limousin	1.7	0.64	0.6	0.8
Simmental	1.9	0.61	0.4	0.6
Shorthorn	3.6	0.79		-1.1
South Devon	3.4	1.32		-0.9
Braunvieh	3.9	0.96		-1.4
Chiangus	2.4	0.90		0.1
Salers	2.1	0.91		0.4
Combined (4 br)	2.3	0.46		
Combined (all)	2.5	0.44		

Results – weaning weight

Breed	Base Factor	"SE"	Difference (4 breed)	Difference (all)
Red Angus	-19.2	2.54	7.3	4.7
Gelbvieh	-8.5	2.55	-3.4	-6.0
Limousin	-8.1	2.52	-3.7	-6.3
Simmental	-13.0	2.38	1.1	-1.5
Shorthorn	-22.3	3.16		7.8
South Devon	-33.9	5.67		19.4
Braunvieh	-17.6	3.81		3.1
Chiangus	-22.2	3.54		7.7
Salers	-15.4	3.57		0.9
Combined (4 br)	-11.9	1.83		
Combined (all)	-14.5	1.75		

Results – yearling weight

Breed	Base Factor	"SE"	Difference (4 breed)	Difference (all)
Red Angus	-28.5	5.05	3.1	-0.8
Gelbvieh	-18.0	5.10	-7.5	-11.4
Limousin	-31.4	5.11	5.9	2.0
Simmental	-25.7	4.85	0.2	-3.6
Shorthorn	-37.8	6.22		8.4
South Devon	-66.7	10.43		37.4
Braunvieh	-35.9	7.47		6.6
Chiangus	-41.7	7.00		12.3
Salers	-28.0	7.00		-1.3
Combined (4 br)	-25.5	3.63		
Combined (all)	-29.3	3.46		

Results – milk (maternal weaning)

Breed	Base Factor	"SE"	Difference (4 breed)	Difference (all)
Red Angus	1.4	3.20	-1.9	-0.3
Gelbvieh	5.1	3.18	-5.6	-4.0
Limousin	-4.7	3.18	4.2	5.9
Simmental	-2.3	3.08	1.8	3.4
Shorthorn	-3.9	4.12		5.0
South Devon	7.5	7.50		-6.4
Braunvieh	21.8	4.95		-20.6
Chiangus	3.5	4.39		-2.4
Salers	8.1	4.48		-7.0
Combined (4 br)	-0.5	2.36		
Combined (all)	1.1	2.27		

Continued evaluation

- Worked with IGS to look at differences in how we are defining breed
  - Purebred vs. fullblood
  - Differences in solutions at error structure in both evaluations

- IGS sent the covariates they use for sires sampled in the GPE program

Breed Covariates

- Analyzed breed differences with sires as breed fractions rather than as ‘purebreds’
  - Values for percent of:
    - Simmental, Gelbvieh, Limousin, Red Angus, Shorthorn, Salers, South Devon, Angus
    - Compared Angus in IGS vs. Angus in IGS percentages
    - Examined whether considering breeds as ‘purebred’ vs. by their composition
    - Used predated solutions
      - Expect that ‘purebred’ solutions moderated and coveriates will show greater differences to Angus

Results – birth weight (from Angus)

Breed	Purebred	"SE"	Covariates	SE
Angus IGS			1.1	3.5
Hereford	7.2	1.1	7.2	1.5
Red Angus	-2.3	1.3	-3.1	1.6
Shorthorn	12.6	1.6	11.9	2.3
South Devon	7.7	2.6	8.2	3.0
Gelbvieh	6.7	1.3	8.7	5.6
Limousin	3.6	1.3	3.1	1.4
Salers	3.0	1.8	2.0	2.1
Simmental	7.7	1.2	7.9	1.5

Results – yearling weight (from Angus)

Breed	Purebred	"SE"	Covariates	SE
Angus IGS			-79.7	27.2
Hereford	-79.4	9.0	-79.6	9.0
Red Angus	-46.7	10.0	-38.3	12.7
Shorthorn	-73.6	12.4	-58.3	17.8
South Devon	-105.7	20.9	-109.6	23.5
Gelbvieh	-24.8	10.2	38.0	42.3
Limousin	-61.2	10.2	-55.6	11.4
Salers	-68.3	14.0	-61.4	16.1
Simmental	10.5	9.7	29.3	11.9

Summary

- In general factors are well within error in changes from individual breed approach relative to consolidated breed estimate
  - Adding all breeds moderated further
  - Smaller breeds not always estimated as well

- Reflecting the groups fitted in multi-breed evaluation rather than using purebred assumption may improve concordance

Summary

- We are continuing to collaborate to make improvements and agreement between the GPE data and IGS multibreed
  - Also changing how we are thinking about bull sampling next in GPE
- Need to think about what is the best way to

ARS Beef Grand Challenge

- Objective
  - Provide all segments of beef production with the genetic and management knowledge to optimize genetic x environment x management x product interactions to increase production efficiency of high quality, safe and healthy beef products with reduced environmental impact.

ARS Locations

Livestock and Range Research Laboratory

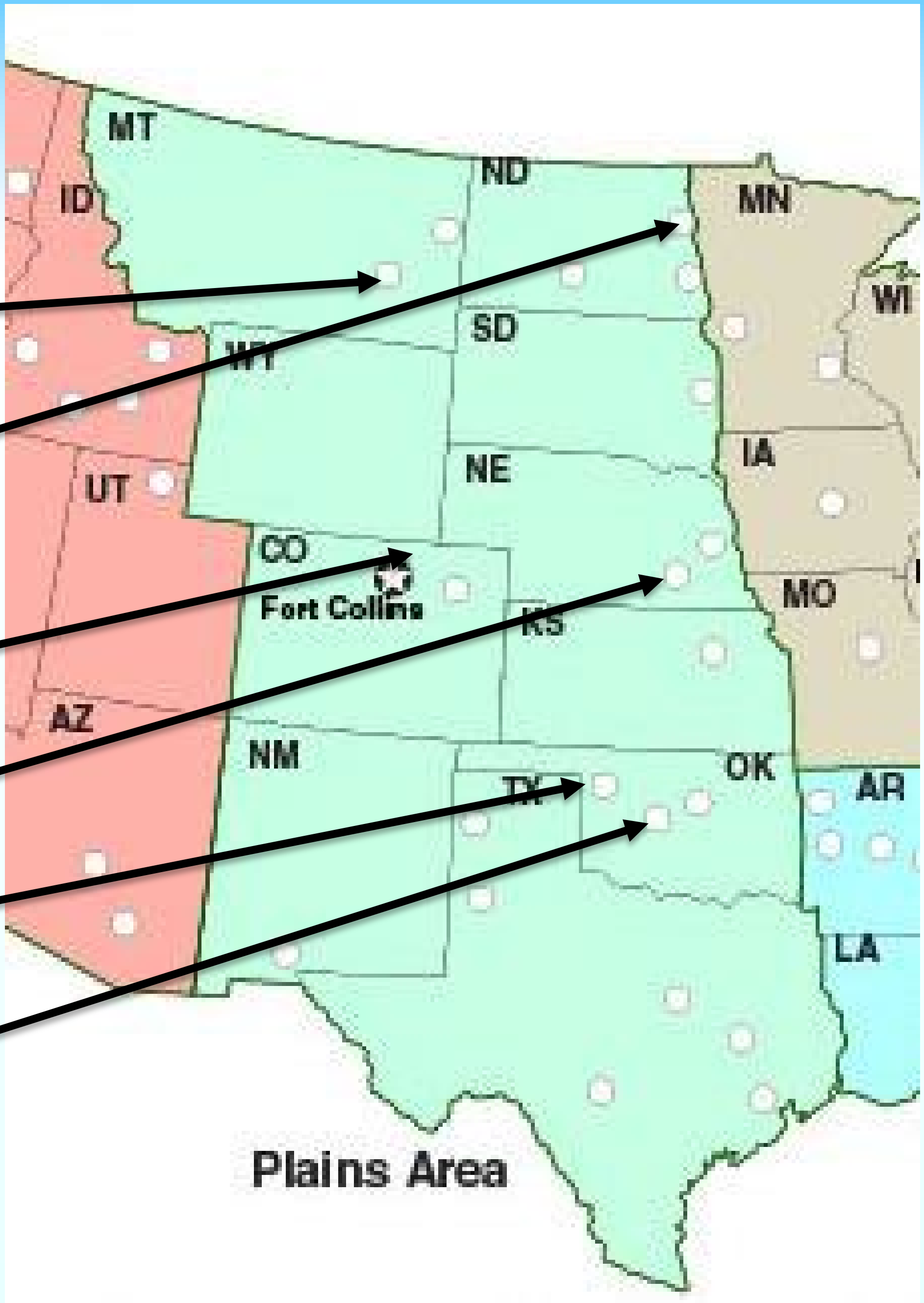
Grand Forks Human Nutrition Center

Central Plains Experimental Range

US Meat Animal Research Center

Rangeland and Pasture Research

Grazinglands Research Laboratory



Main project to assess objectives

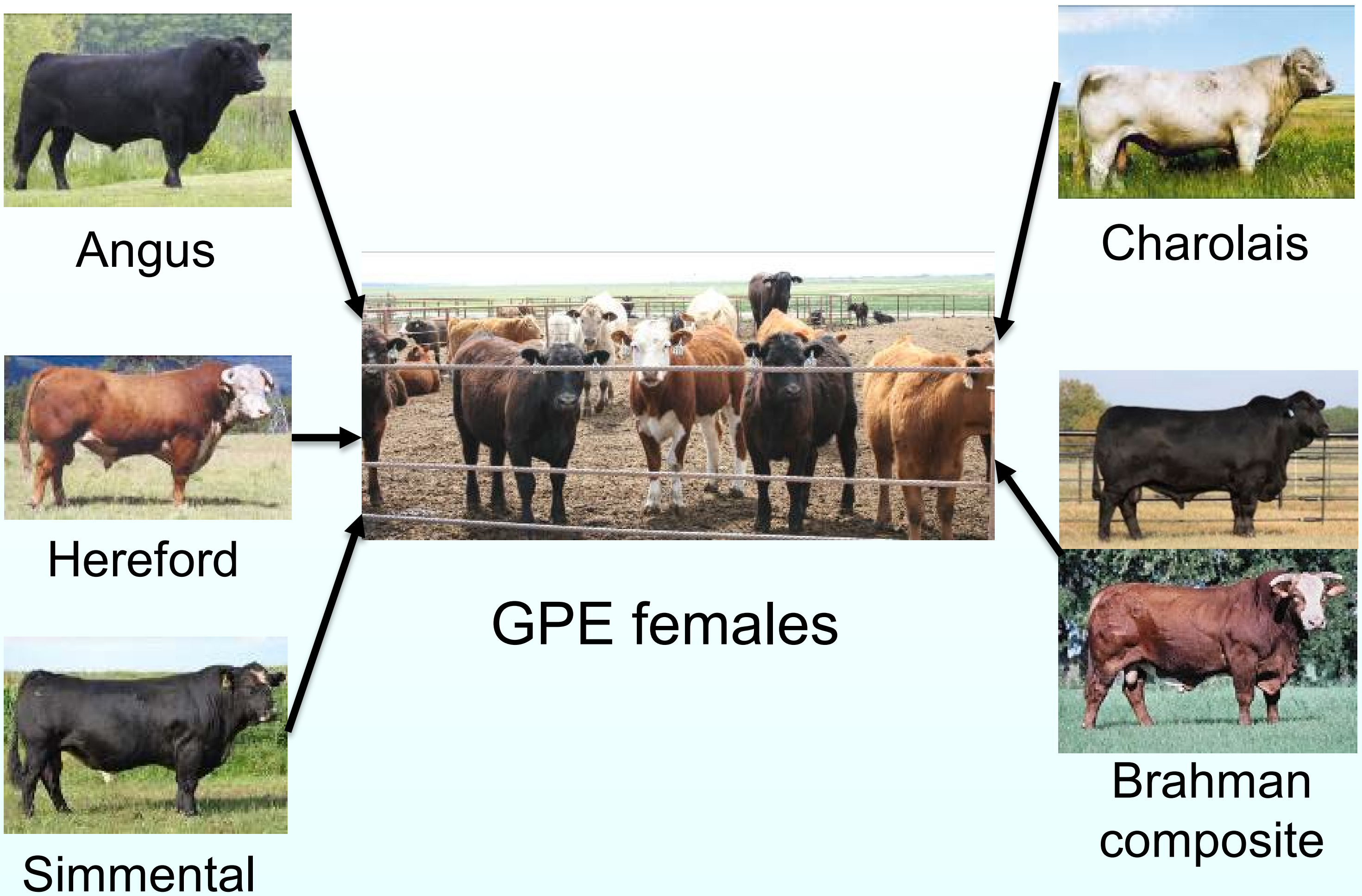
- Collaborative stocker program to evaluate genotypes (breeds as primary proxy) in multiple environmental and management systems

- First project to establish how we can take advantage of GxExM interactions

Grand Challenge Project

- Goal to have breeds of sires and large sire families evaluated at multiple locations and management systems
- Utilize females from GPE mated to purebred bulls

Crossing strategy



Environment x Management

- SPRING: Send approximately 120 hd to ARS locations in Miles City, MT and El Reno, OK while keeping 120 at Clay Center, NE
  - Ship 0-5 weeks after weaning (Early October)

- FALL: Send approximately 40 hd to ARS locations in Nunn, CO and Woodward, OK while keeping 40+ at Clay Center, NE
  - Ship ~2-3 months after weaning (February)

Genetic Balancing

- Goal is to make sure genetic contributions are as similar as possible across locations
  - Parentage testing
  - Same number of progeny from each sire and breed of sire at each location within year, season
  - Secondarily, balance dam breed contributions (try to average across as well as possible)

Management Systems (stockers)

- Clay Center, NE – Receiving ration
- Miles City, MT – Winter range
- El Reno, OK – Wheat grazing
- Nunn, CO and Woodward, OK – Summer stocker on short grass and mixed grass, respectively

Main question

- Are top performing breeds/sires consistent under different management programs and environments?
  - Sub-treatments applied in range situations
    - Supplementation, stocking rate calculations

- Multiple production measures at each location

Measurements – production efficiency

- Monthly weights (gain)
  - Stocker gain, finishing gain
  - Attempting to keep energy/protein consistent at finishing phase in each location
  - Estimate feed usage, cost, days on feed
  - Target 1350 lb steer finish

- Harvest
  - Hot carcass weight
  - Marbling
  - Yield
  - Tenderness
  - Color Stability
  - Dark Cutting

Additional measures

- Rumen fluid
  - Rumen metagenome differences between systems
- Measures of stress across production systems
  - Cortisol as a proxy
- Healthfulness of beef
  - SFA, MUFA, PUFA profiles –
  - Looking at other health benefit measures
- Food safety
  - Fecal samples, pen surface sampling
  - *E. col* O157:H7, *Salmonella,* AMR

Results – gains and weights

Location	Sex	BG ADG (kg/d)	Finish ADG (kg/d)	Final Weight (kg)	Carcass Wt (kg)
USMARC	Steer	0.99	1.35	614	379
	Heifer	0.96	1.24	576	357
El Reno	Steer	1.22	1.26	630	386
	Heifer	1.09	1.27	598	363
Miles City	Steer	0.17	1.63	616	370
	Heifer	0.15	1.57	591	356

Results – gains and weights

Location	Sex	BG ADG (kg/d)	Finish ADG (kg/d)	Final Weight (kg)	Carcass Wt (kg)
USMARC	Steer	1.00	1.50	622	382
	Heifer	1.09	1.35	585	358
Nunn	Steer	1.63	1.50	582	369
Woodward	Heifer	0.74			354

Results – Carcass

Location	Sex	Marbling	Fat (cm)	Rib Area (cm^2)	Yield Grade	SSF (kg)
USMARC	Steer	6.0	1.38	85.5	3.2	6.5
	Heifer	6.1	1.58	82.2	3.4	6.9
El Reno	Steer	5.8	1.21	89.0	3.1	7.3
	Heifer	5.9	1.35	87.0	3.1	7.4
Miles City	Steer	5.9	1.24	85.7	2.9	7.2
	Heifer	5.9	1.52	82.8	3.3	8.0

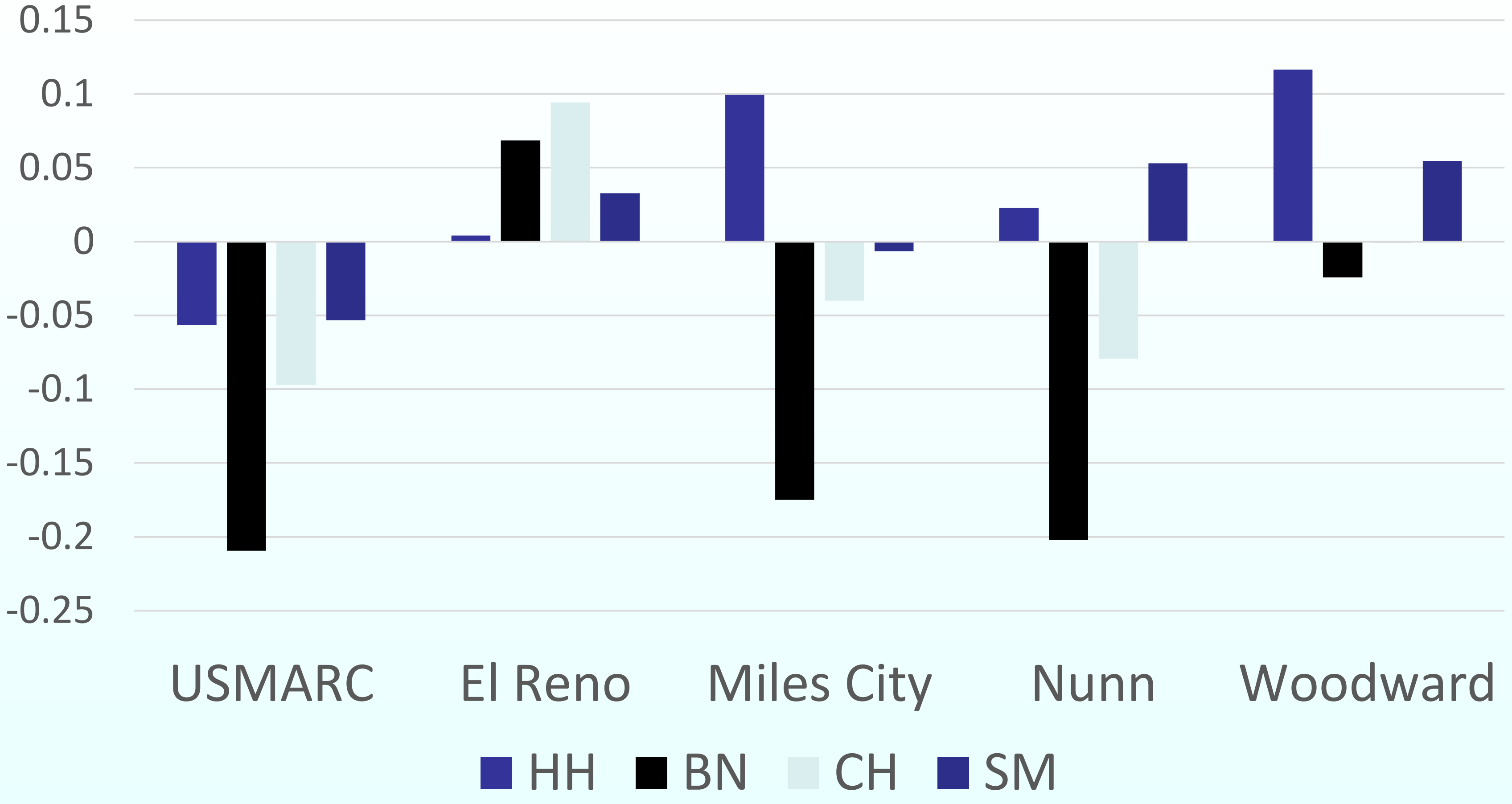
SSF = Slice Shear Force

Results – Carcass

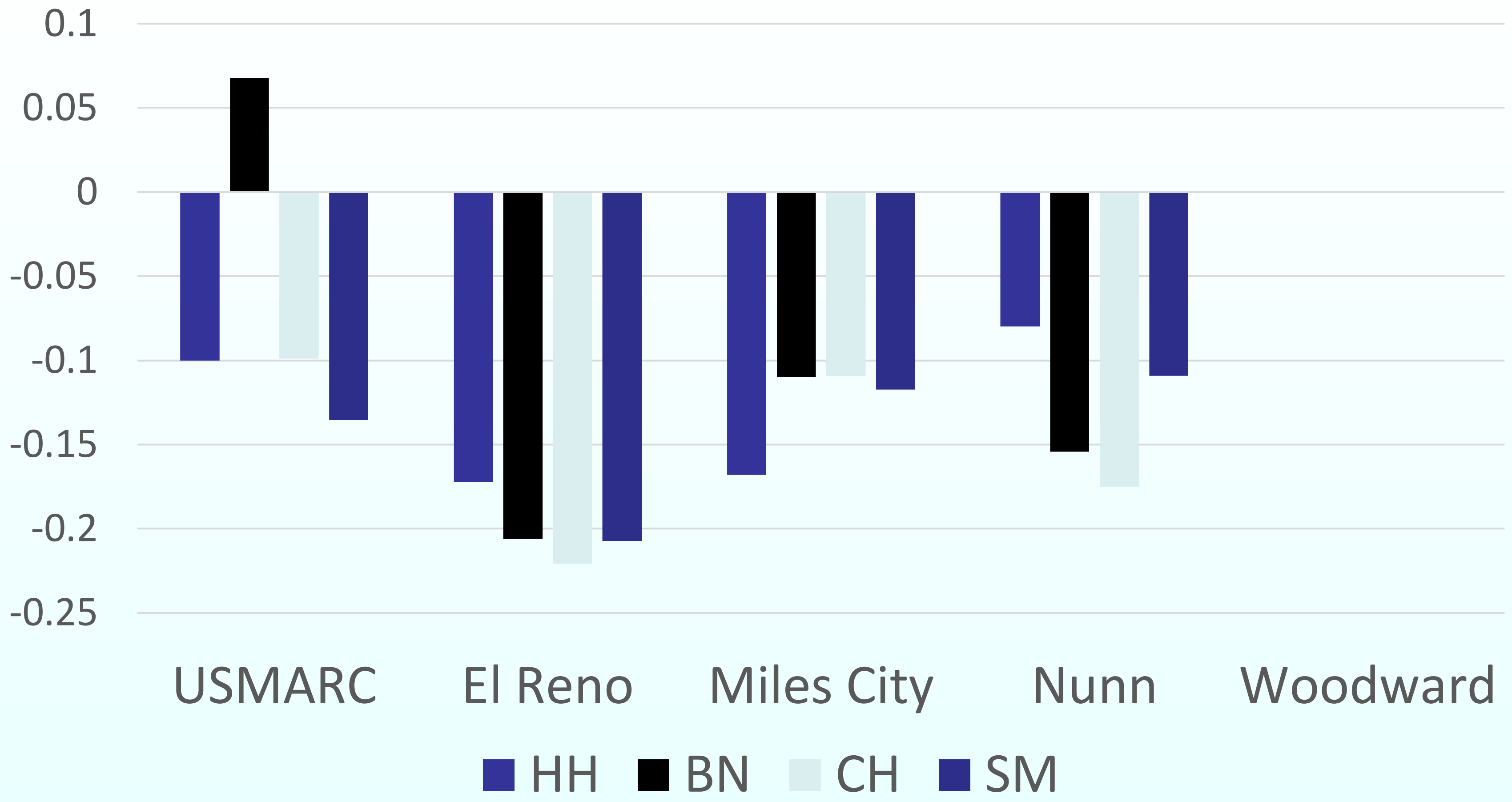
Location	Sex	Marbling	Fat (cm)	Rib Area (cm^2)	Yield Grade	SSF (kg)
USMARC	Steer	6.0	1.44	84.5	3.3	7.1
	Heifer	6.1	1.44	85.0	3.1	7.2
Nunn	Steer	5.7	1.06	84.5	2.9	6.9
Woodward	Heifer	6.1	1.32	86.7	2.9	7.5

SSF = Slice Shear Force

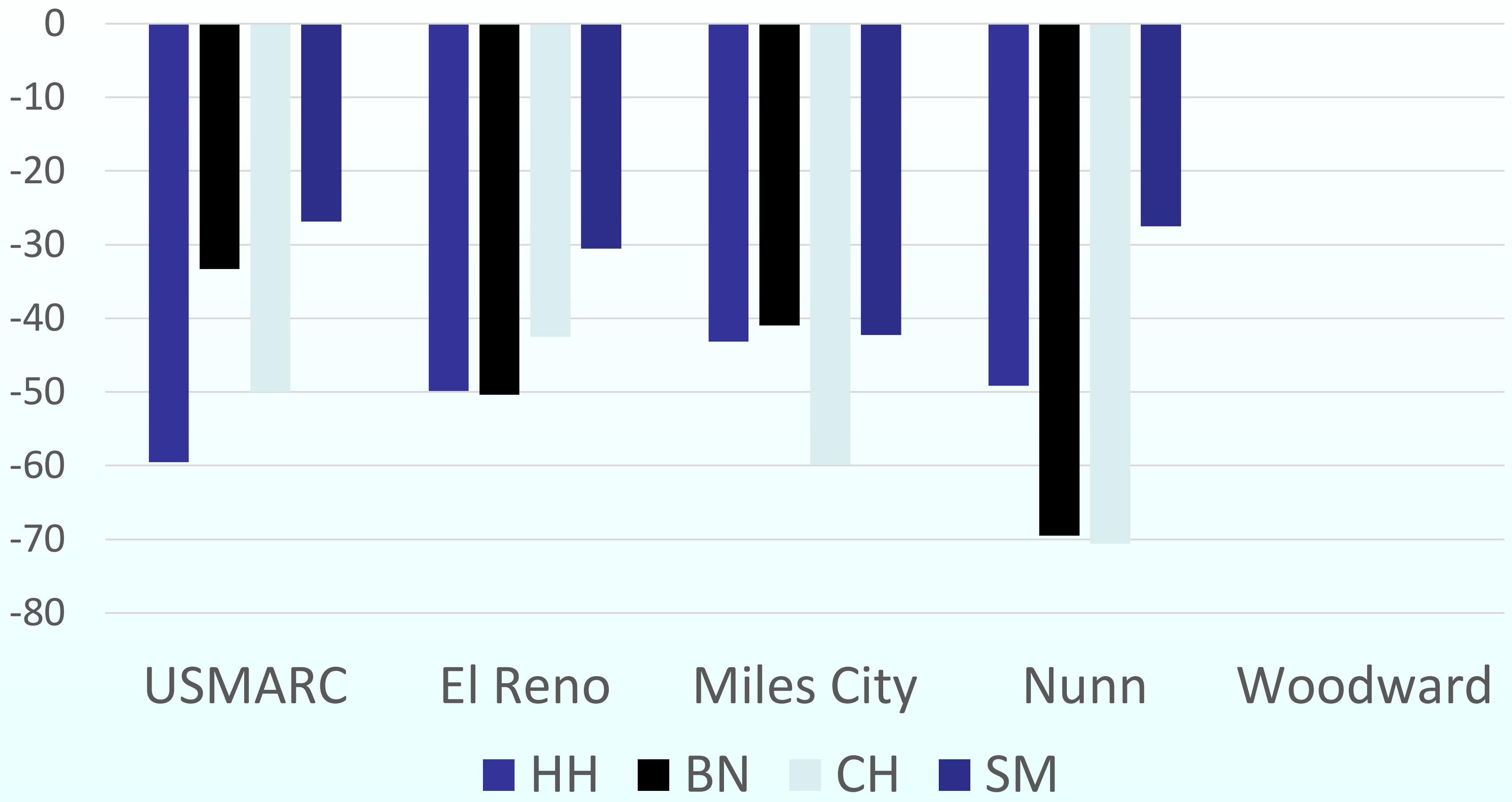
Interactions – BG ADG



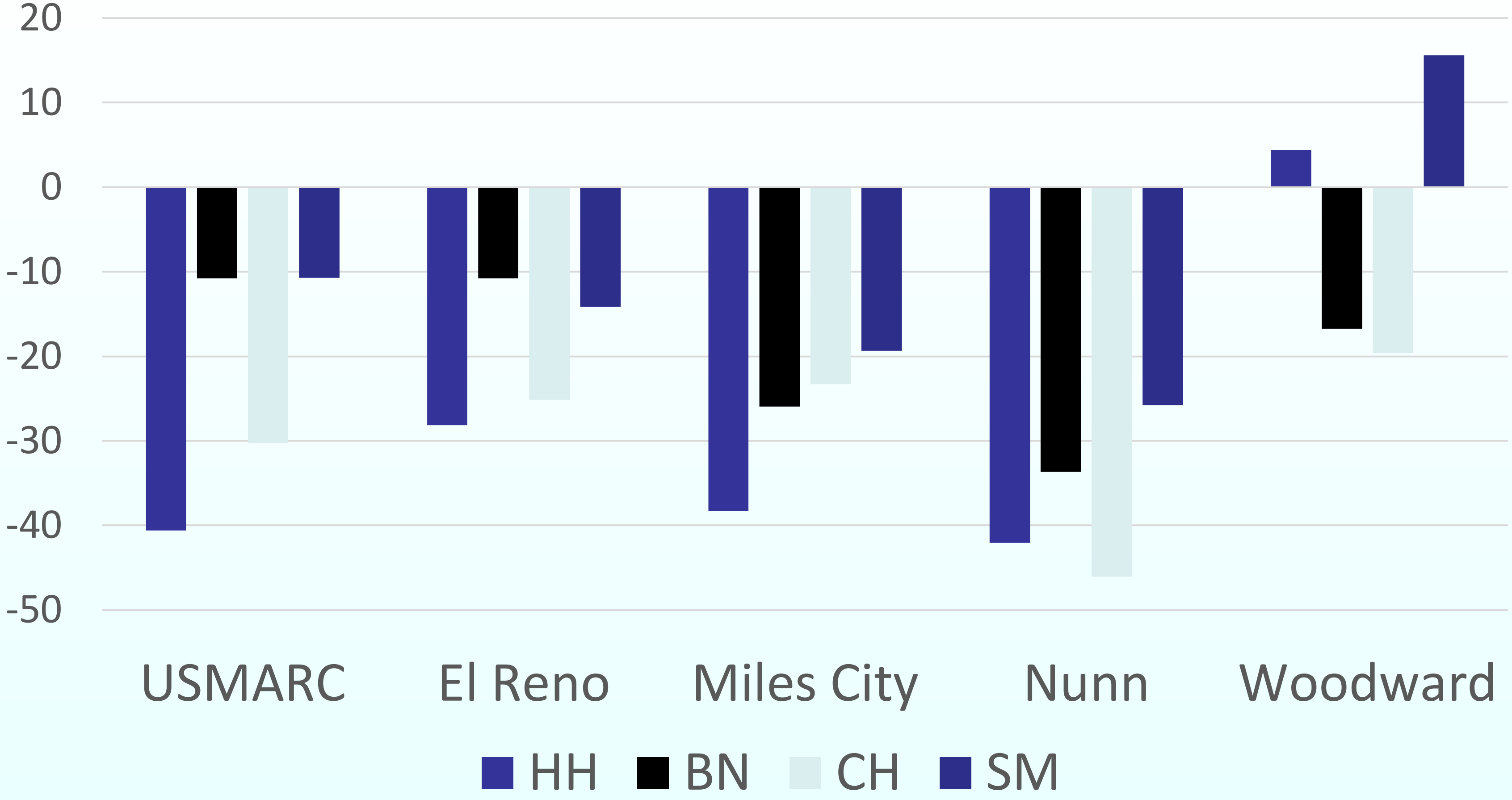
Interactions – Finishing ADG



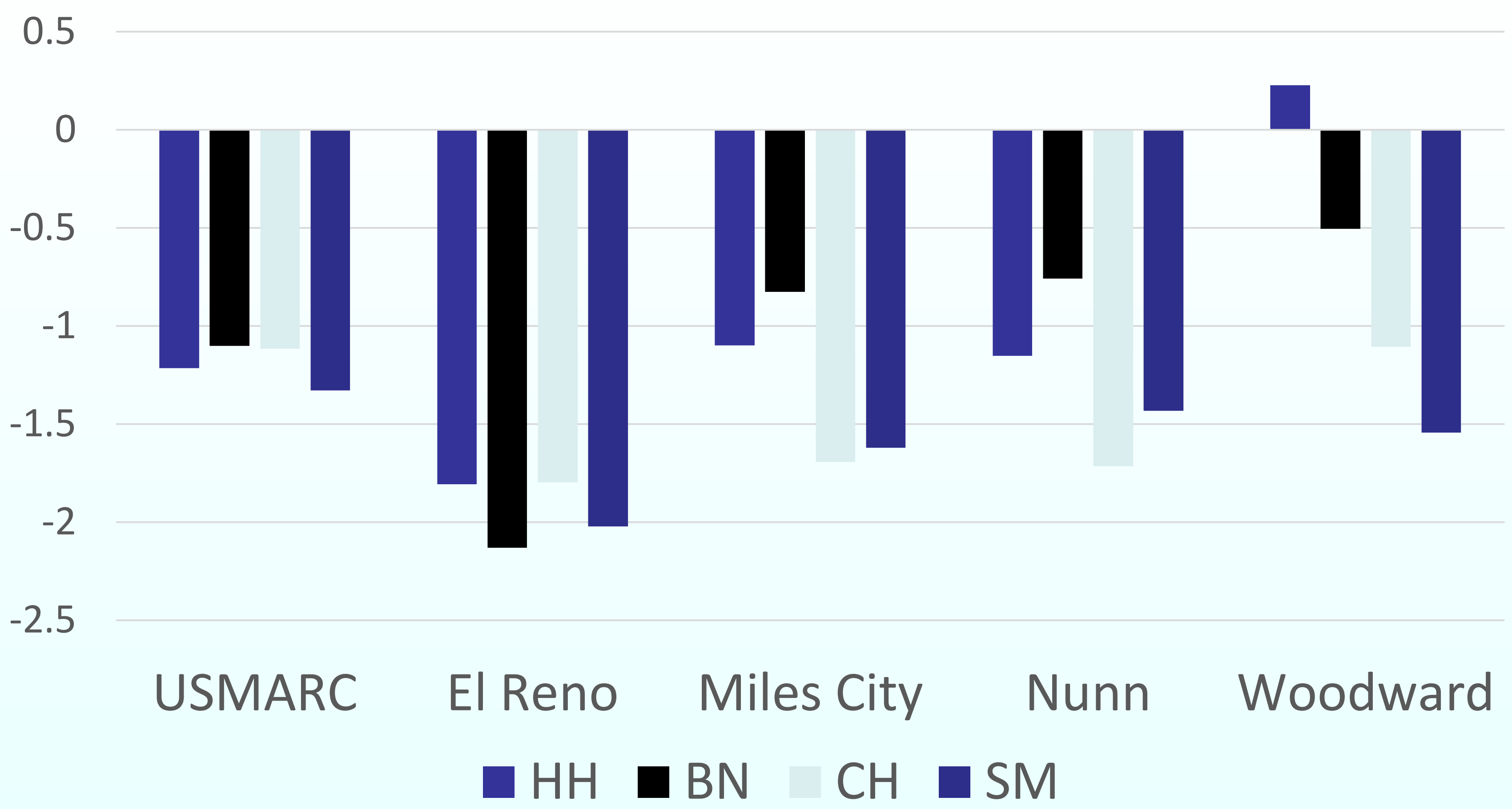
Interactions – Finishing weight



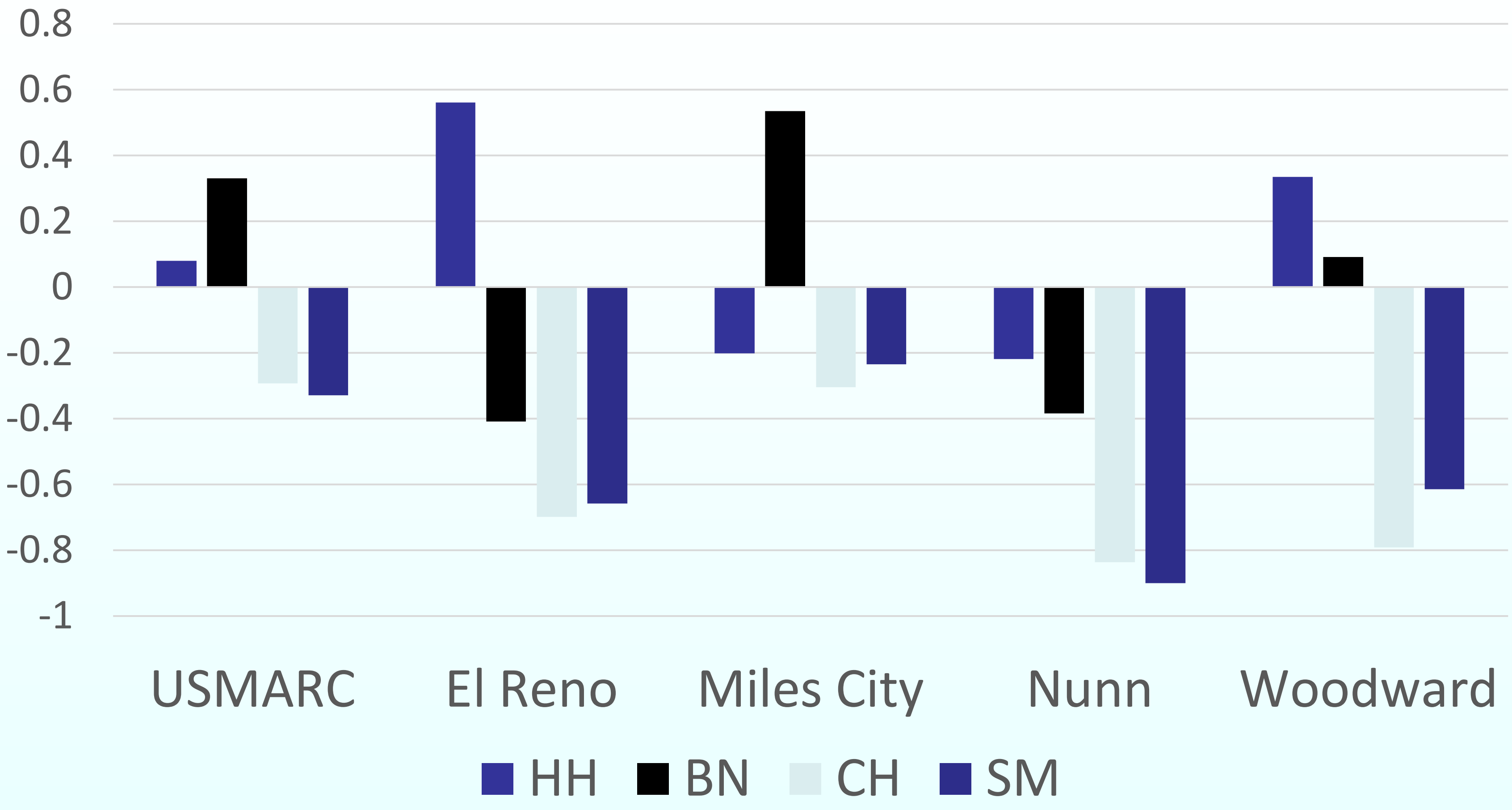
Interactions – Carcass weight



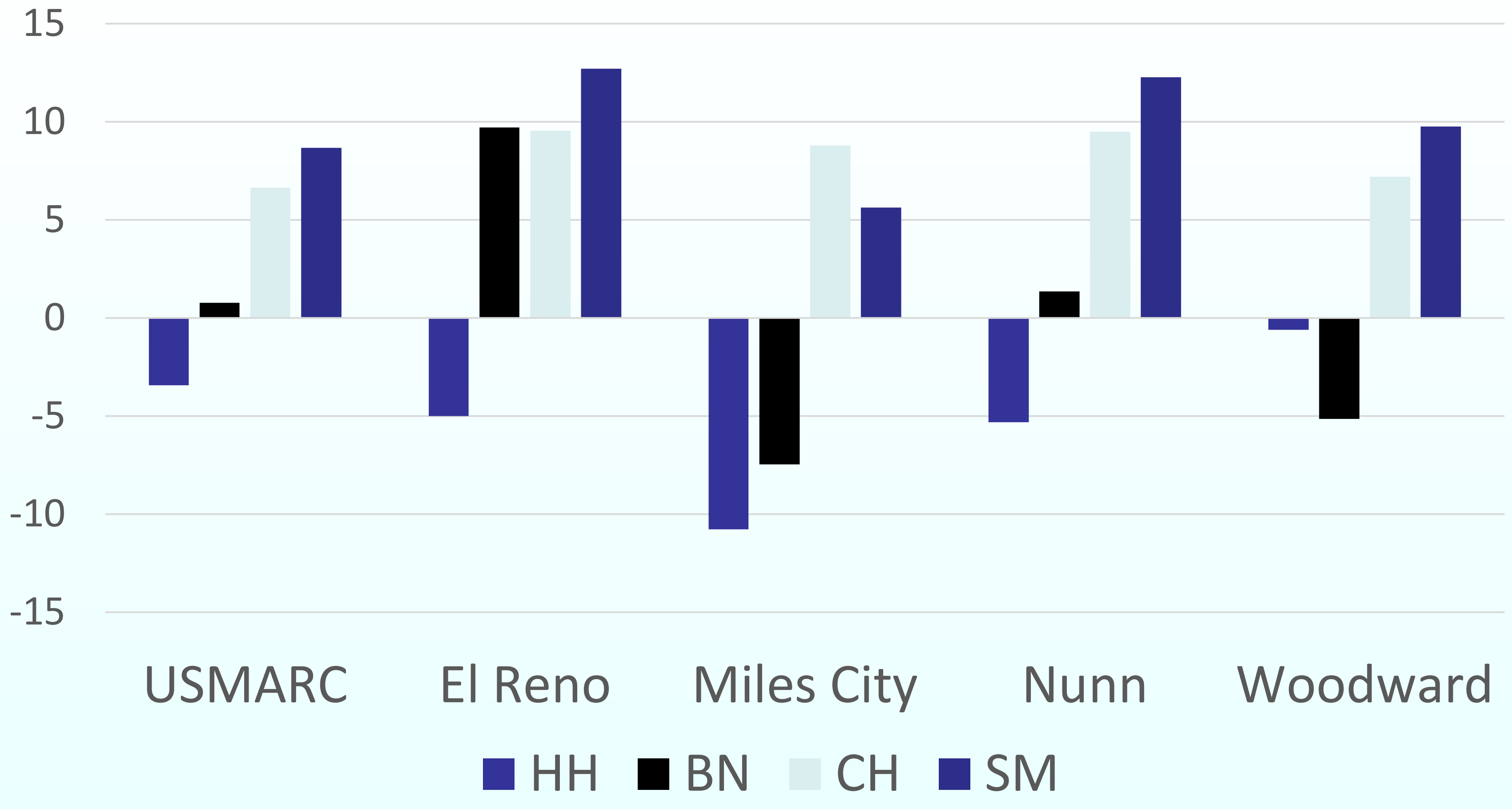
Interactions – Marbling



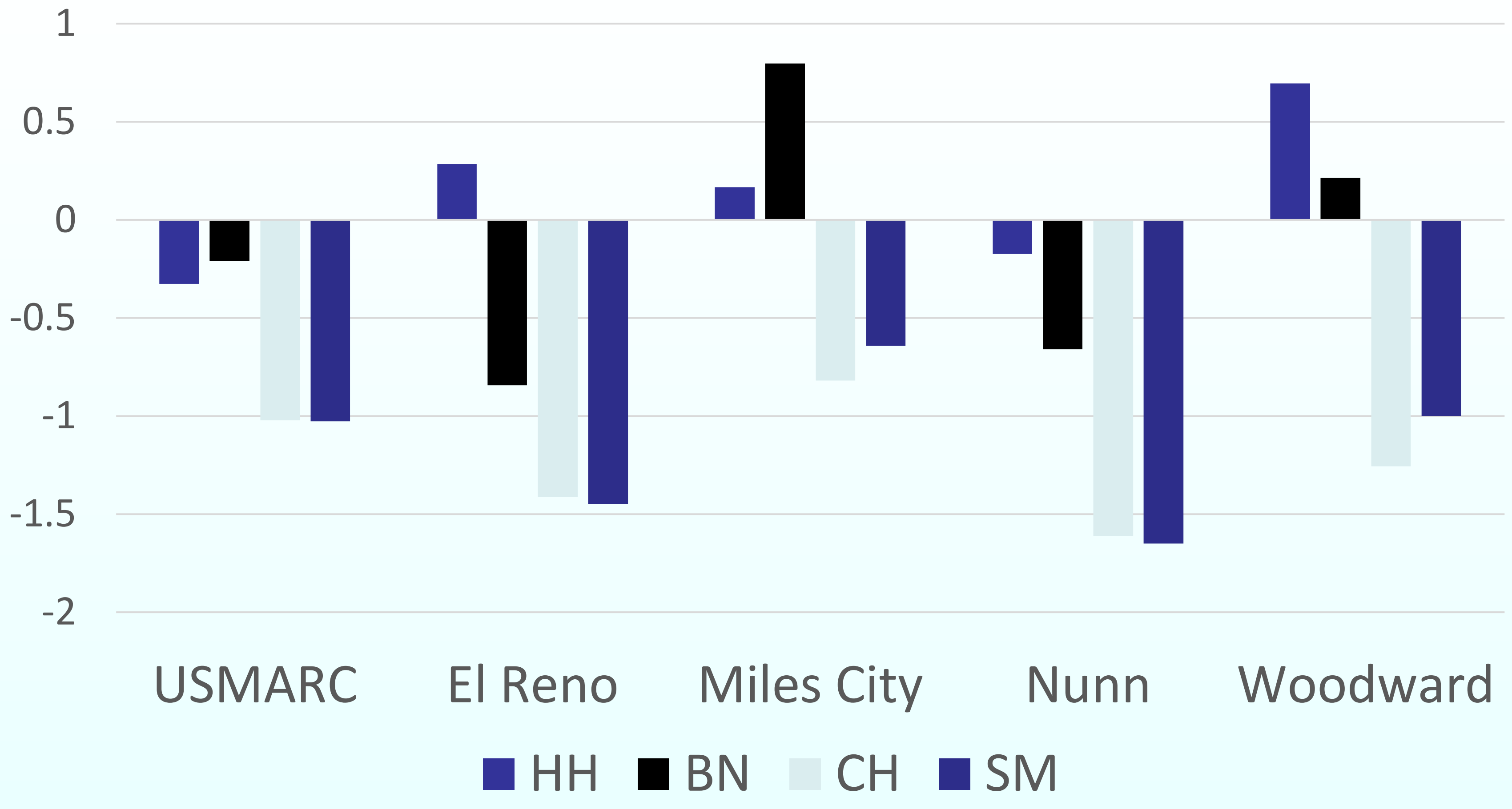
Interactions – Fat depth



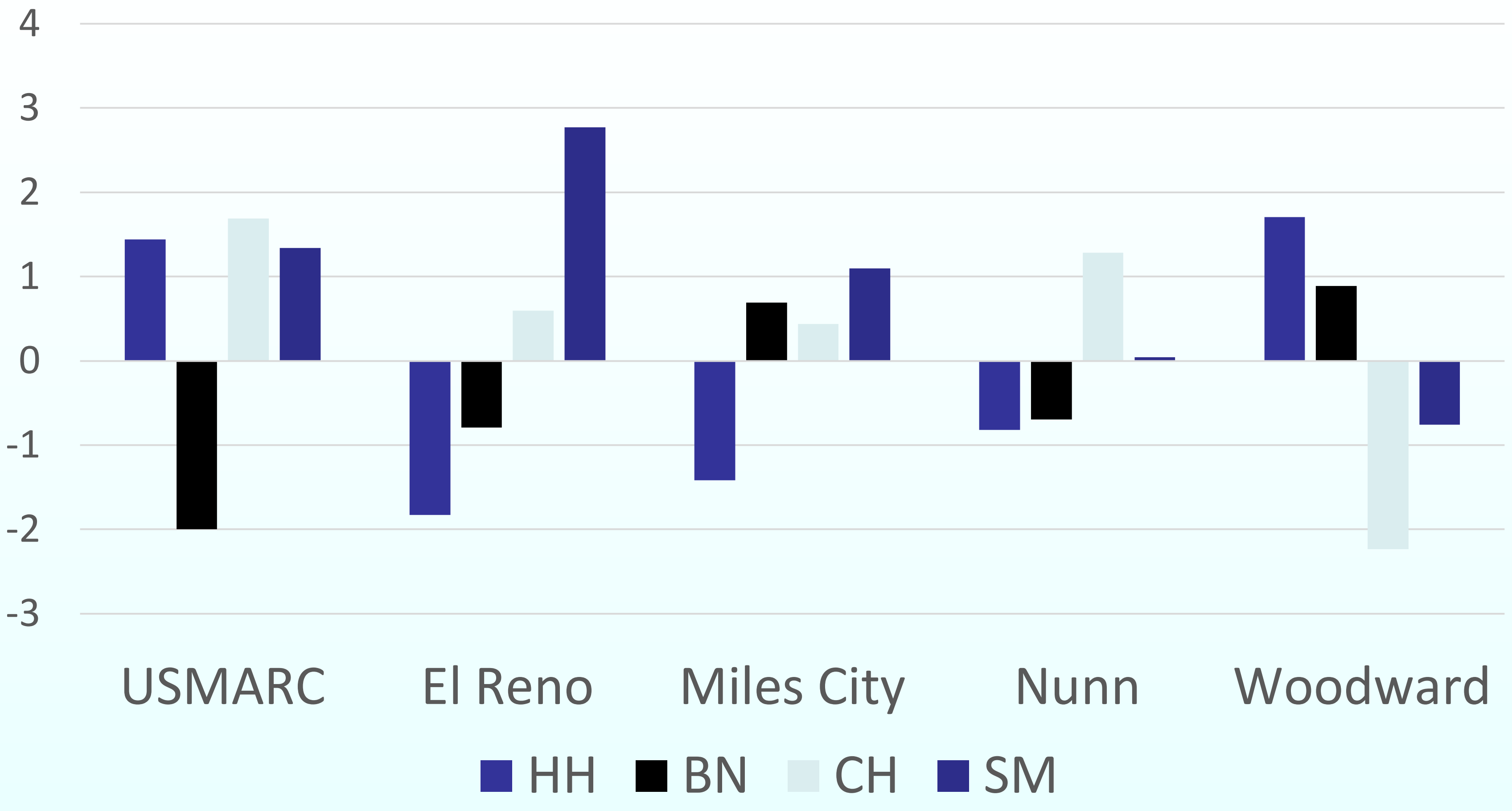
Interactions – Ribeye area



Interactions – Predicted yield grade



Interactions – Tenderness (SSF)



Conclusions

- Early start at to looking at GxE interactions across representative management practices
- Several places where breed differences are fairly robust, but also some indication of reranking relative to Angus
- Will be examining with more detail soon.

Overall considerations

- GPE program is a unique resource
  - Public release of results important
  - Can be used to tackle several unconventional research questions

- Related to both projects, we as a beef cattle genetics group, need to think about the target of our genetic predictions

Genetic prediction targets

- Commercial cattle production
- Crossbreeding
- All environments/management
- Genomic enhancement, higher accuracy

- Who and how are we serving all interests
- Continued emphasis on decision support is important and undervalued (iGENDEC)

Acknowledgements

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USMARC Cattle Operations

Questions