Results from the ARS Beef Grand Challenge – examining genotype x management interactions using the germplasm evaluation program

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What is a “Grand Challenge”

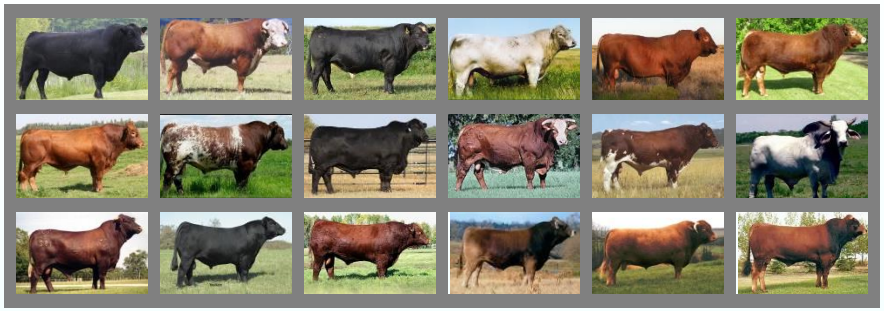
- Collaborative project designed to meet multiple goals
  - Improve production efficiency
  - Reduce environmental impact
  - Encourage sustainable production
  - Optimize whole agricultural systems
    - Integrated research programs

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.

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

ARS Locations

Livestock and Range Research Laboratory

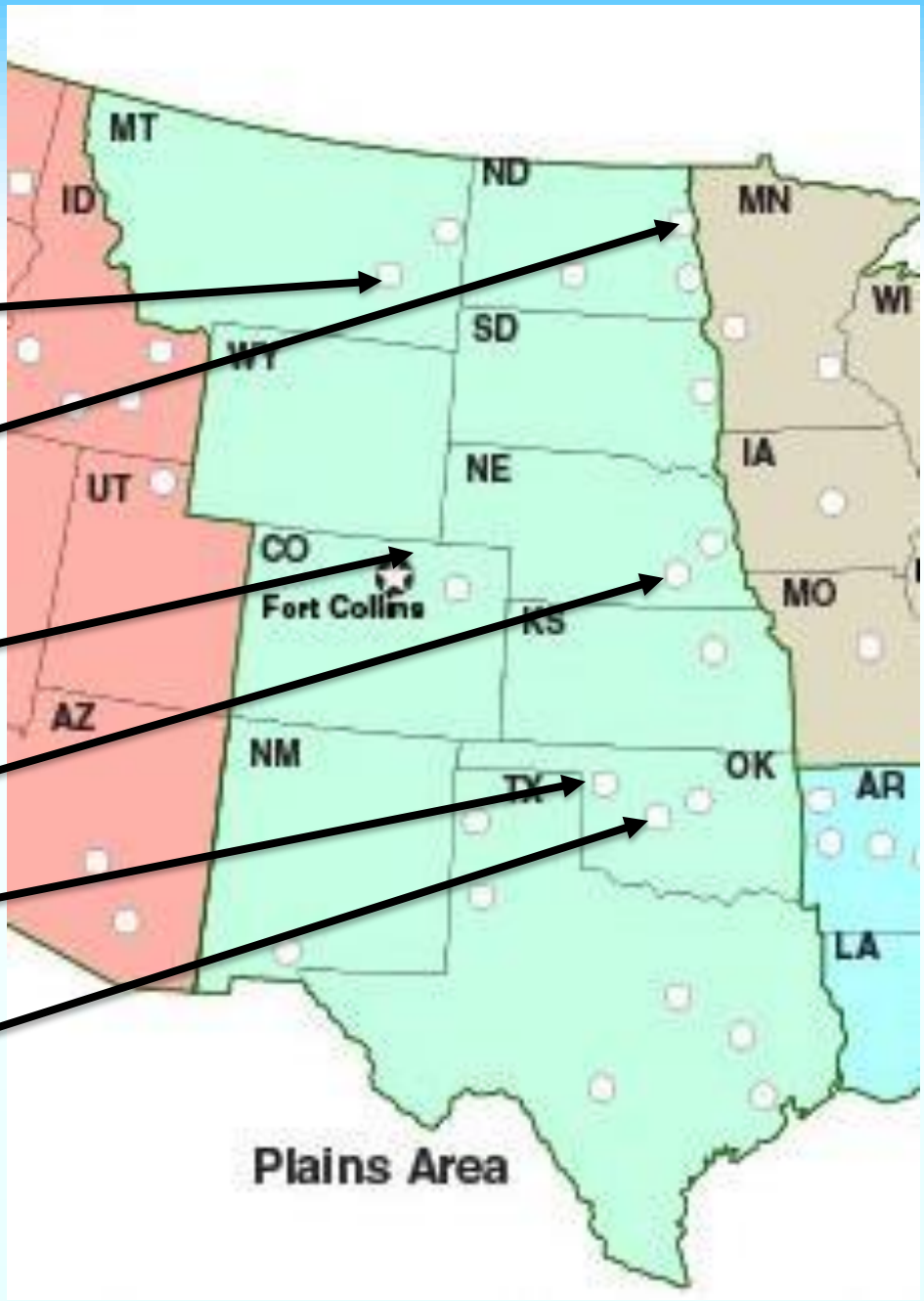
Grand Forks Human Nutrition Center

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

Angus

Hereford

Simmental

GPE females

Charolais

Brahman composite

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

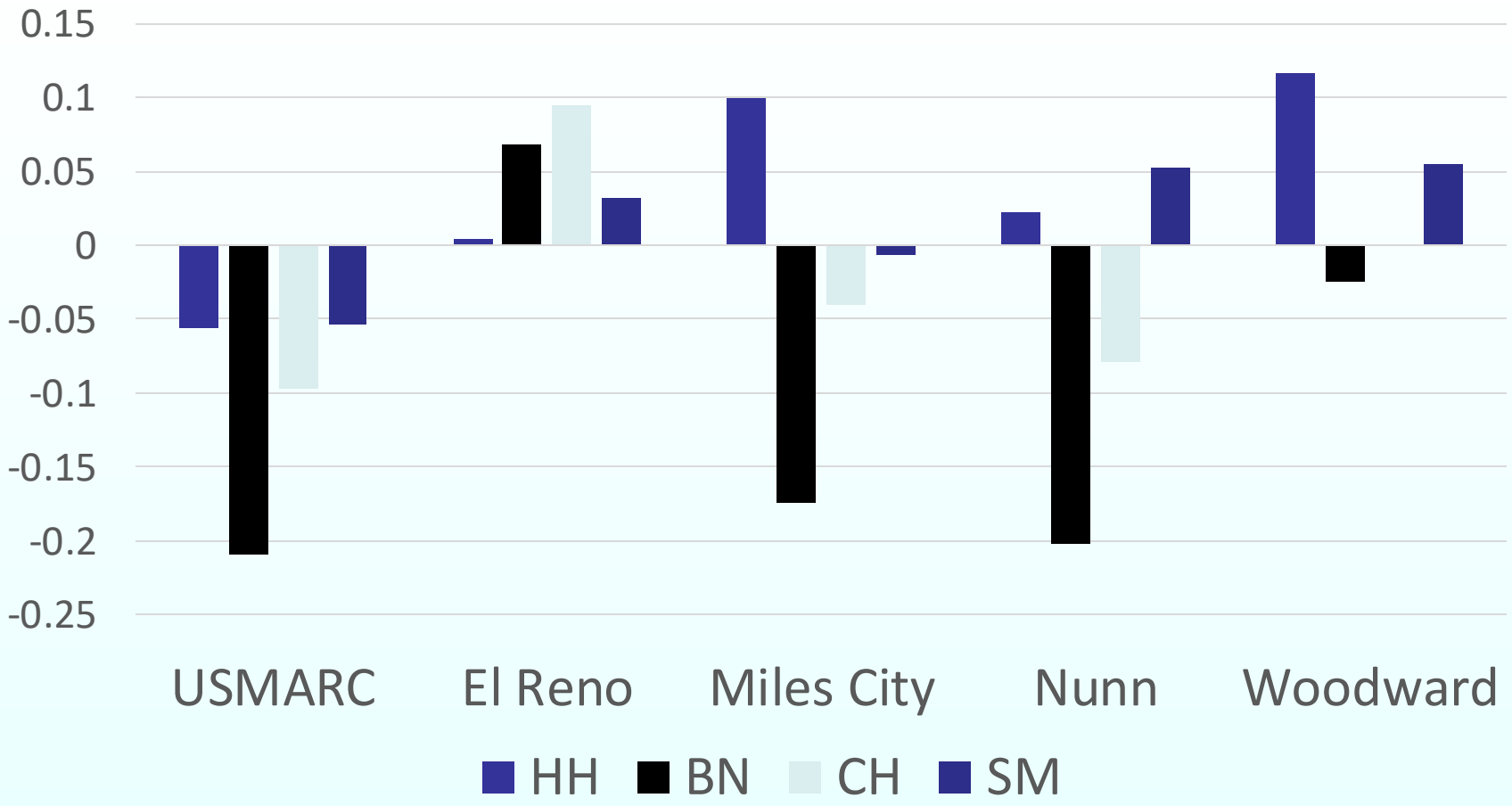
SSF = Slice Shear Force

Results – Carcass

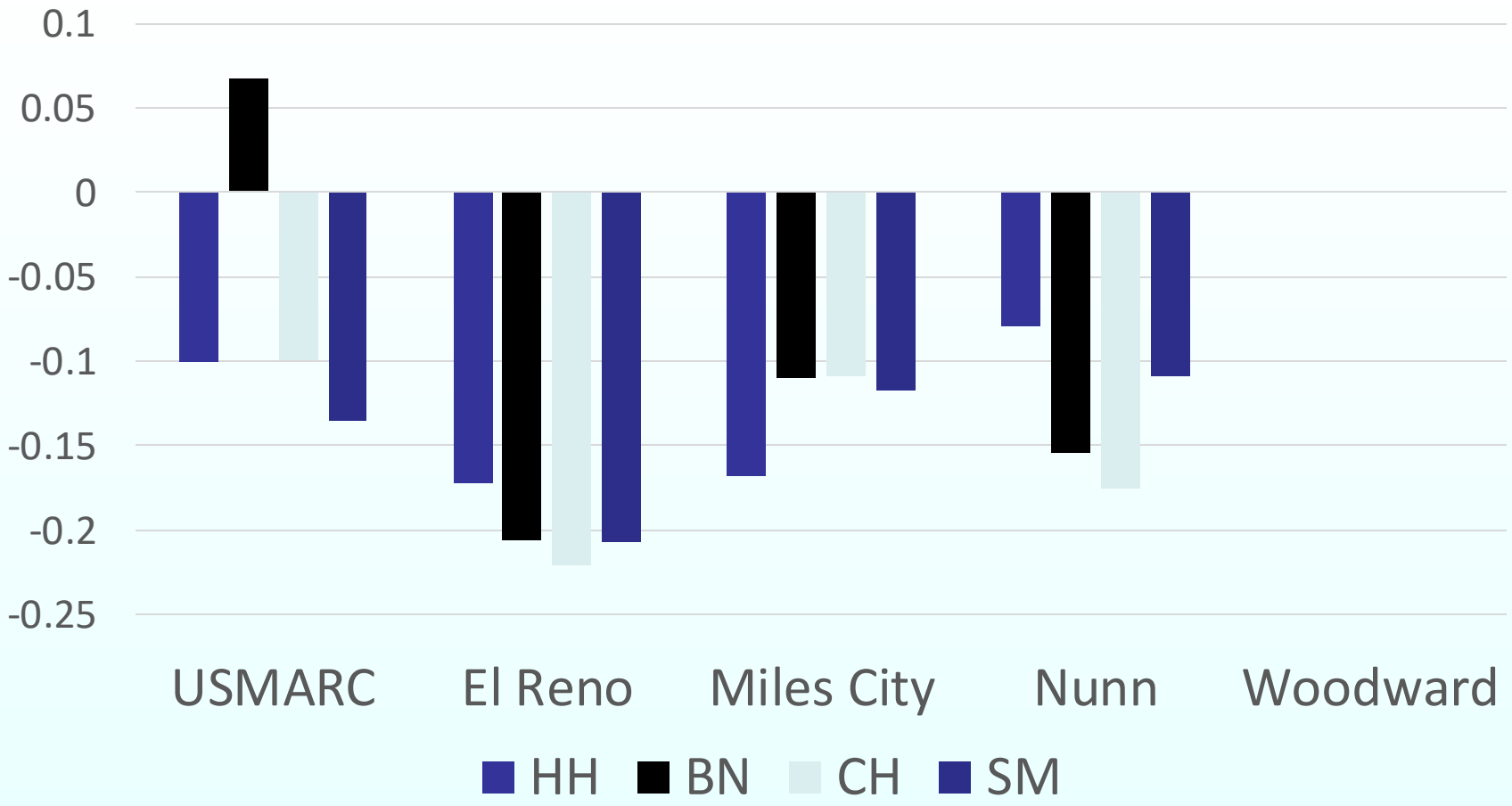
Location	Sex	Marbling	Fat (cm)	Rib Area (cm^2)	Yield Grade	SSF (kg)
USMARC	Steer	6.0	1.44	84.5	3.3	7.1
	Heifer	6.1	1.44	85.0	3.1	7.2
Nunn	Steer	5.7	1.06	84.5	2.9	6.9
Woodward	Heifer	6.1	1.32	86.7	2.9	7.5

SSF = Slice Shear Force

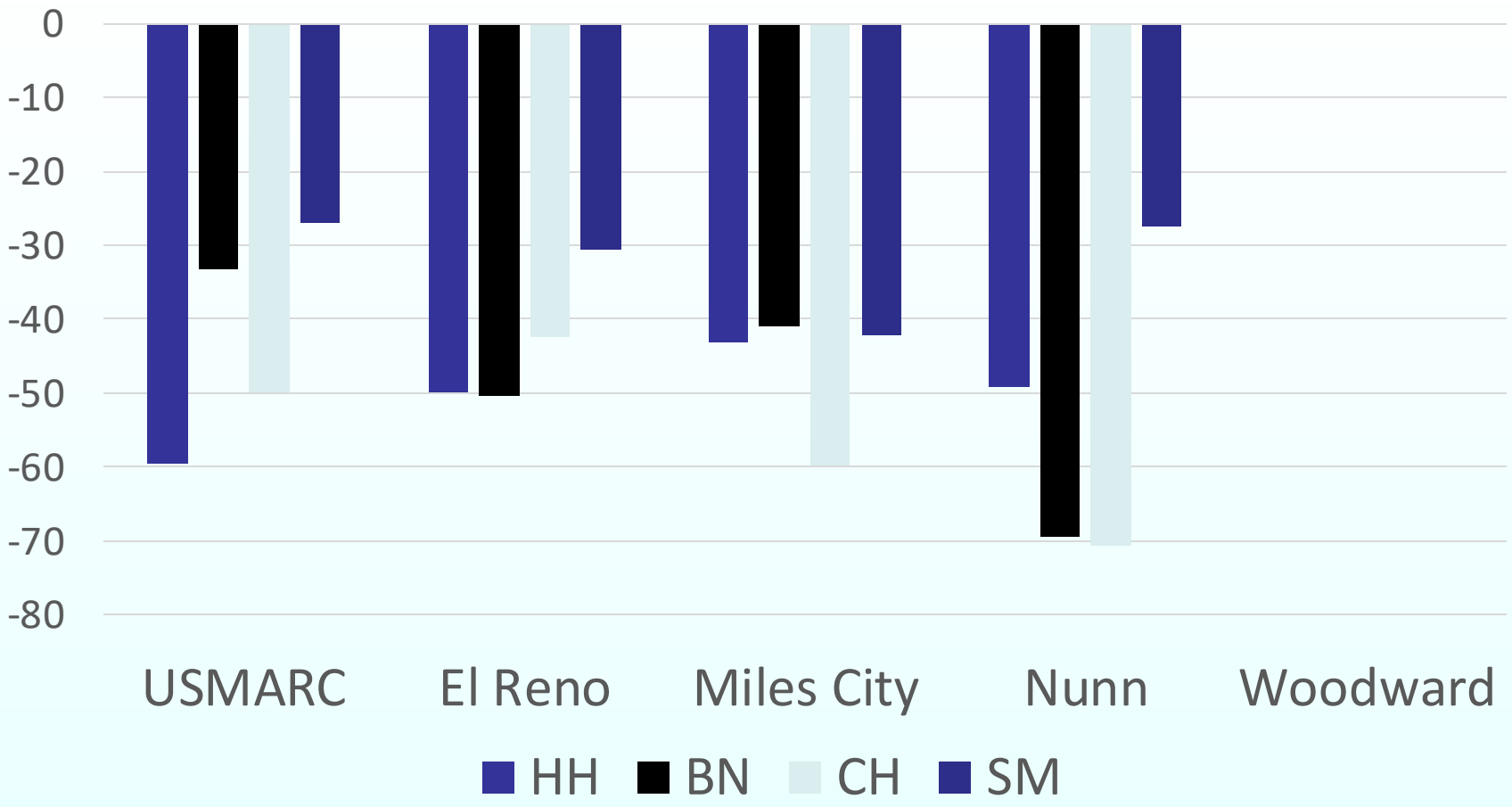
Interactions – BG ADG



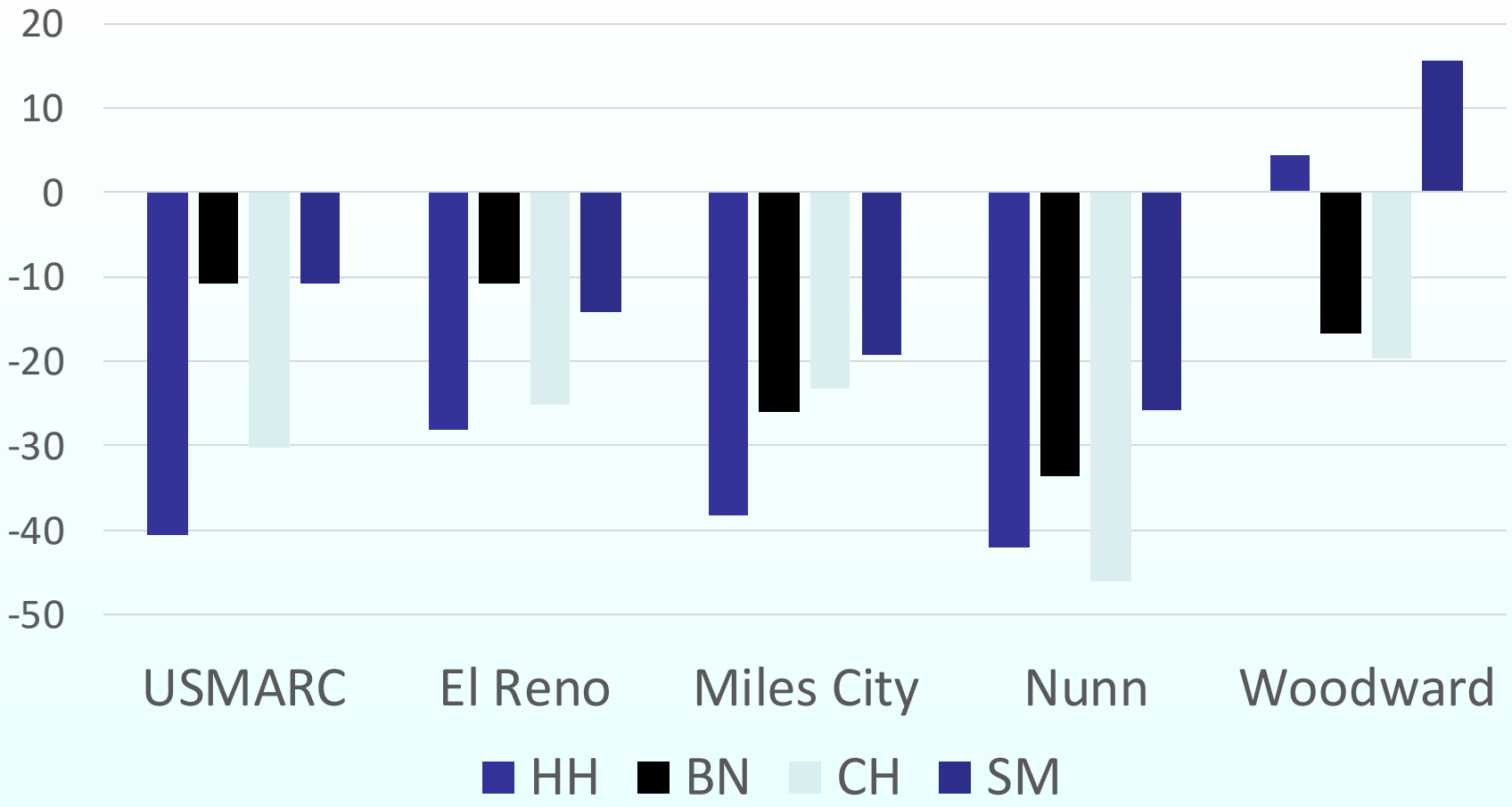
Interactions – Finishing ADG



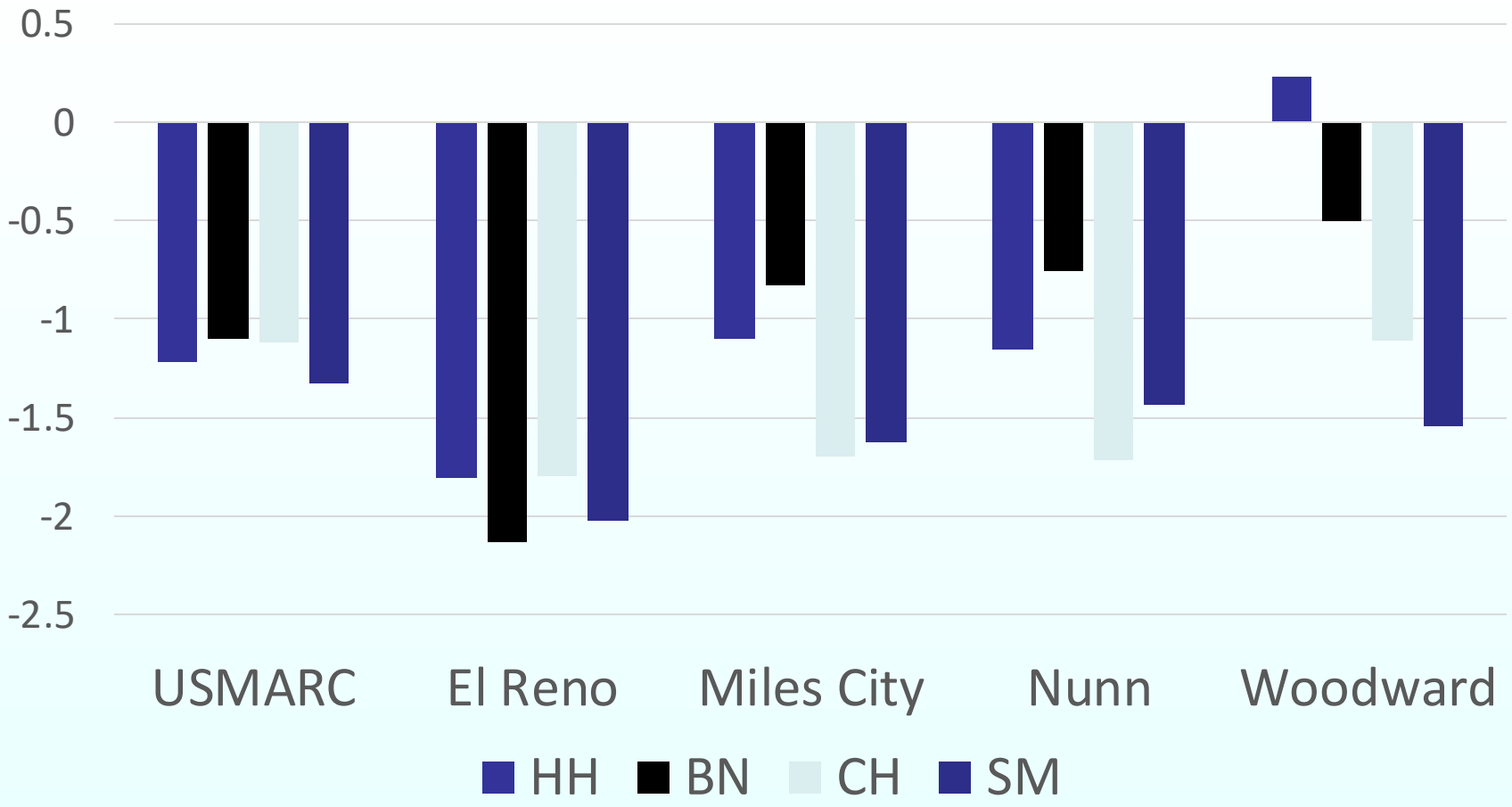
Interactions – Finishing weight



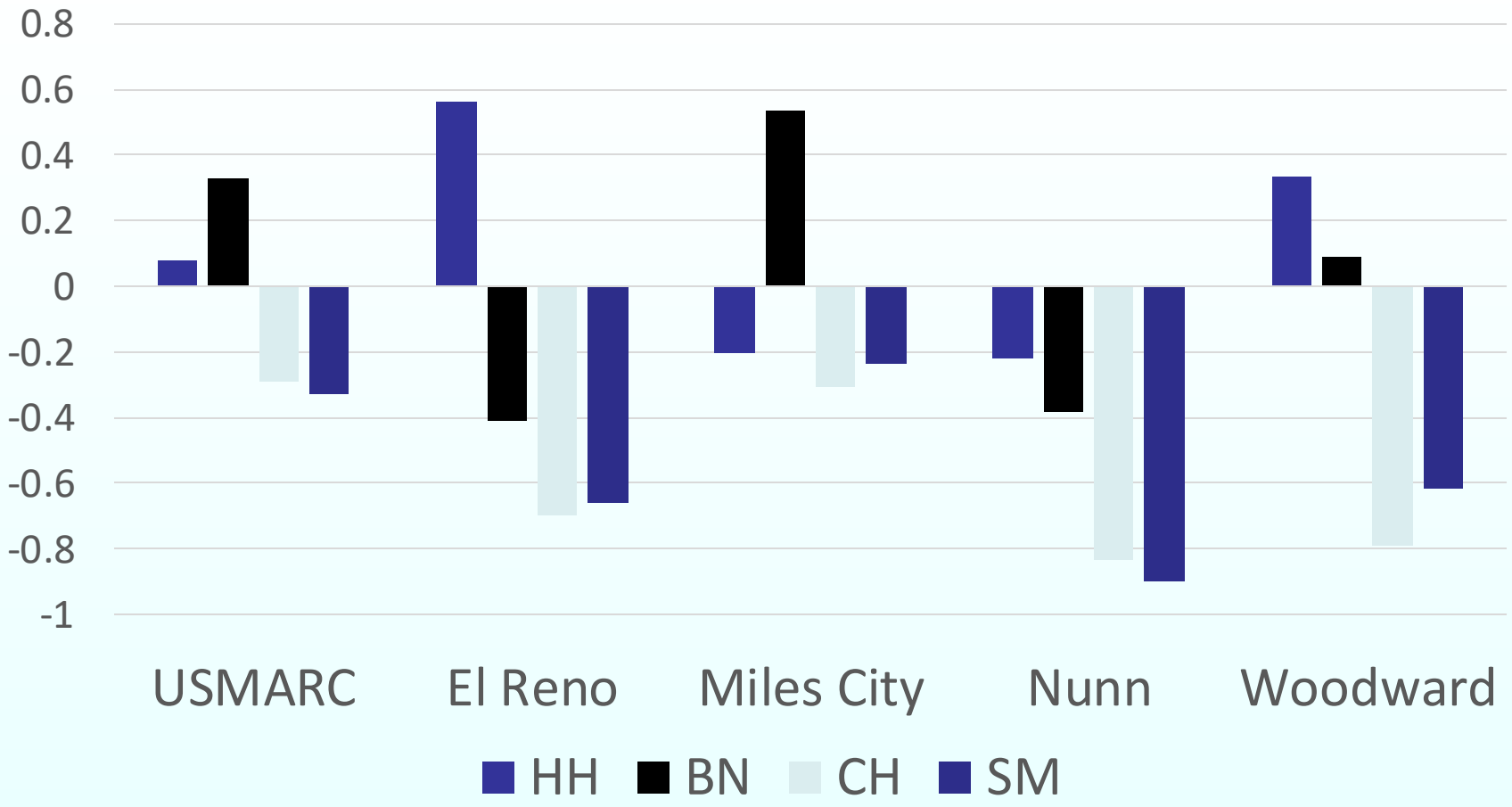
Interactions – Carcass weight



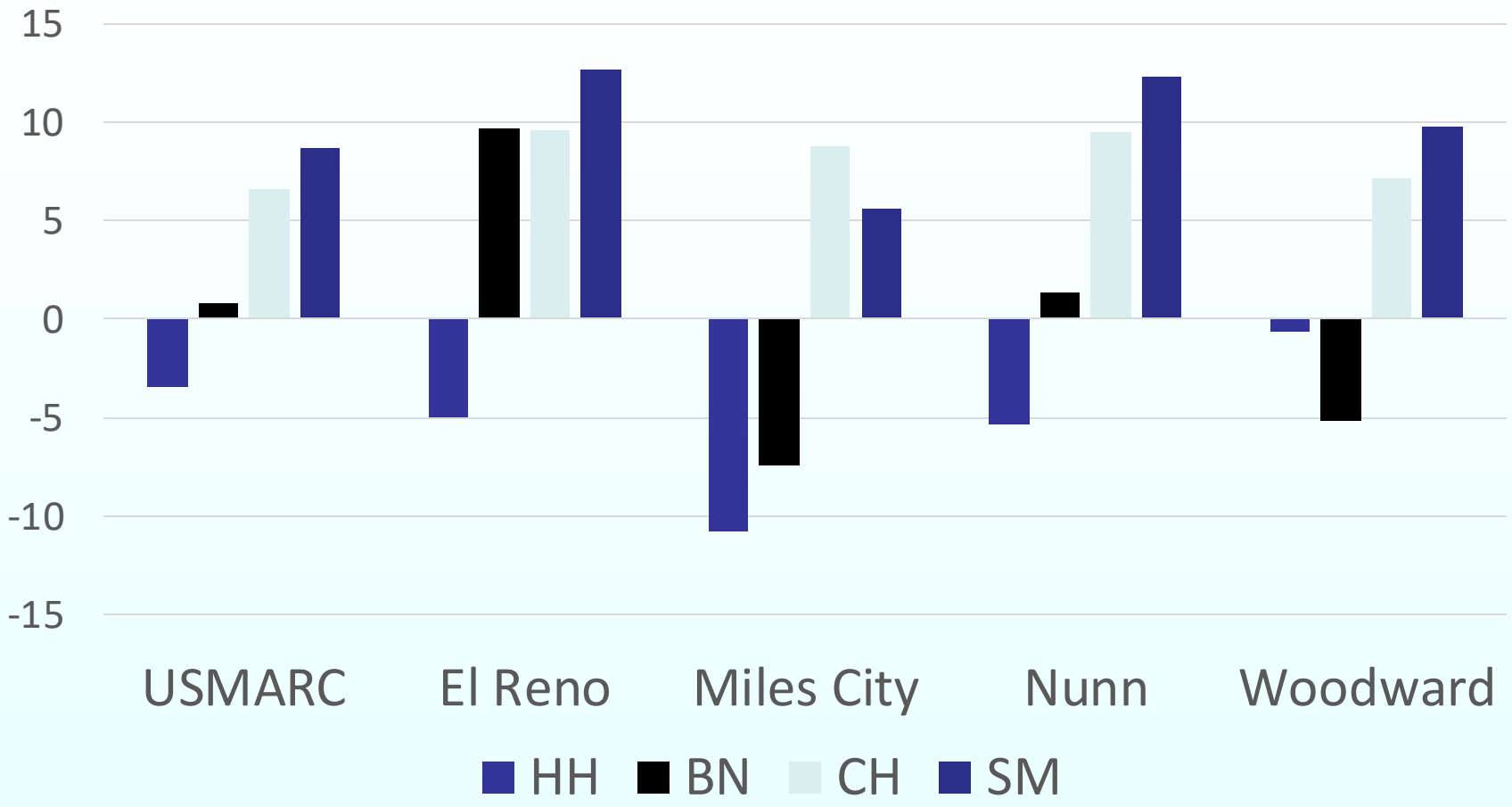
Interactions – Marbling



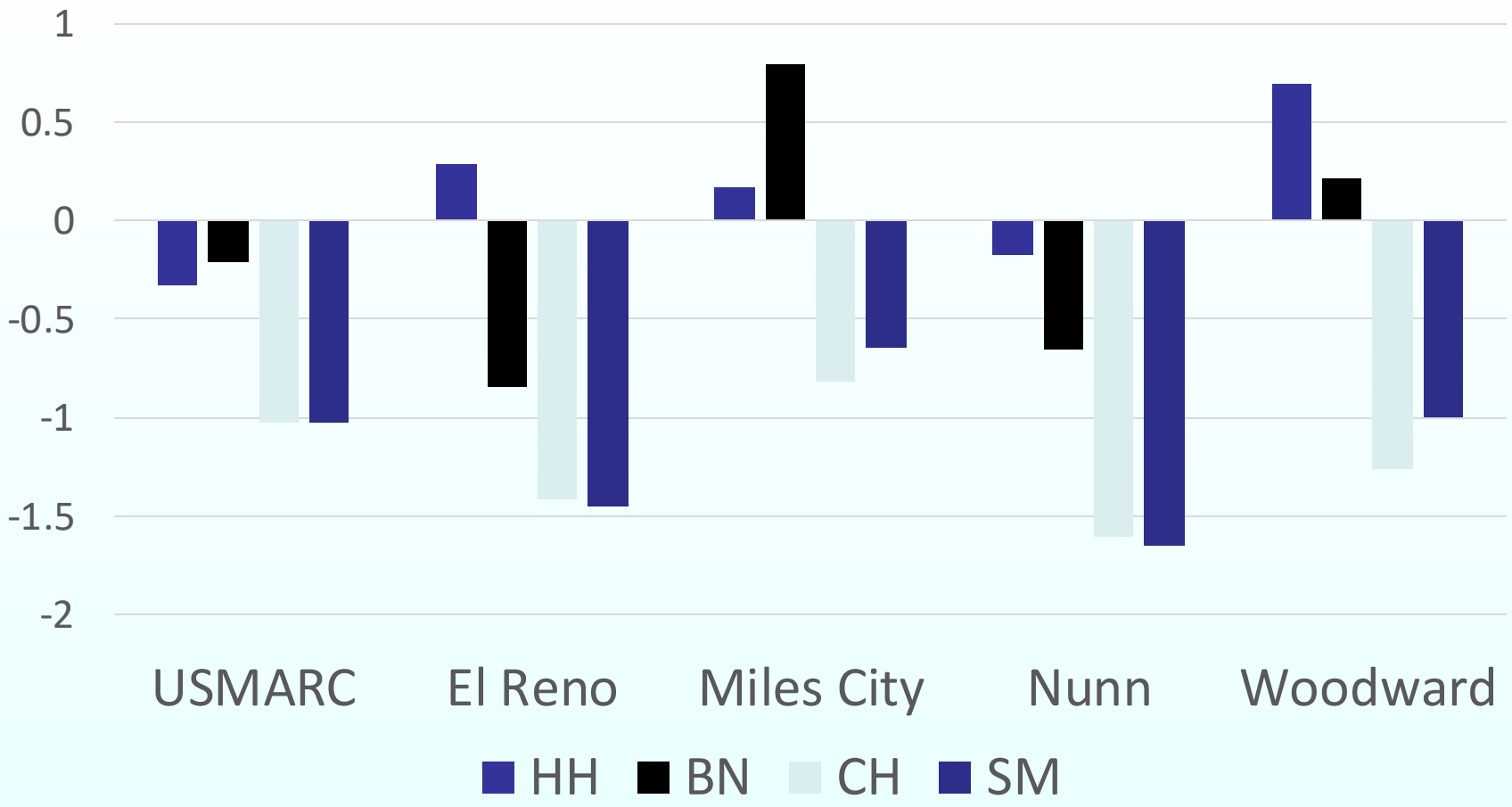
Interactions – Fat depth



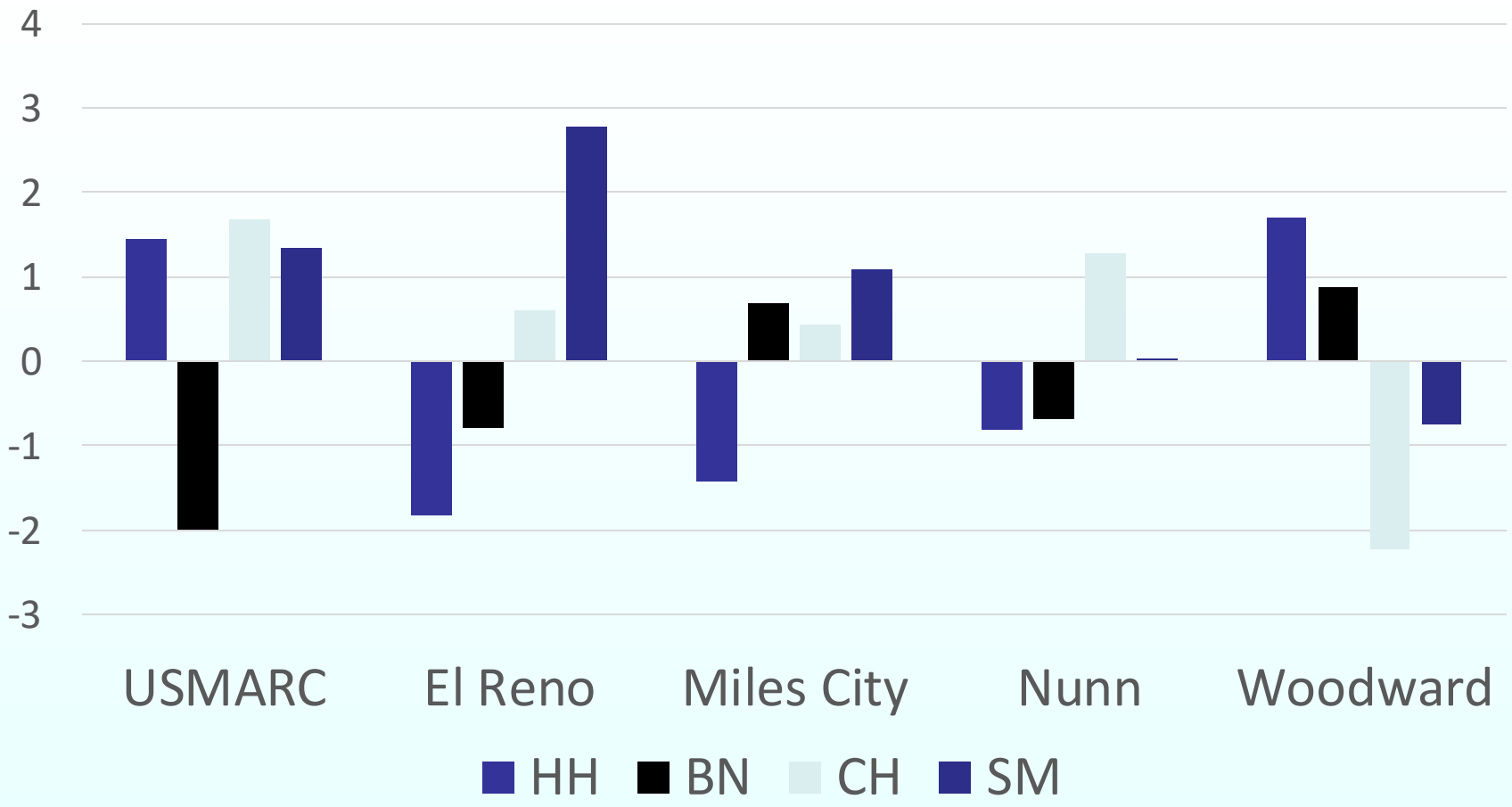
Interactions – Ribeye area



Interactions – Predicted yield grade

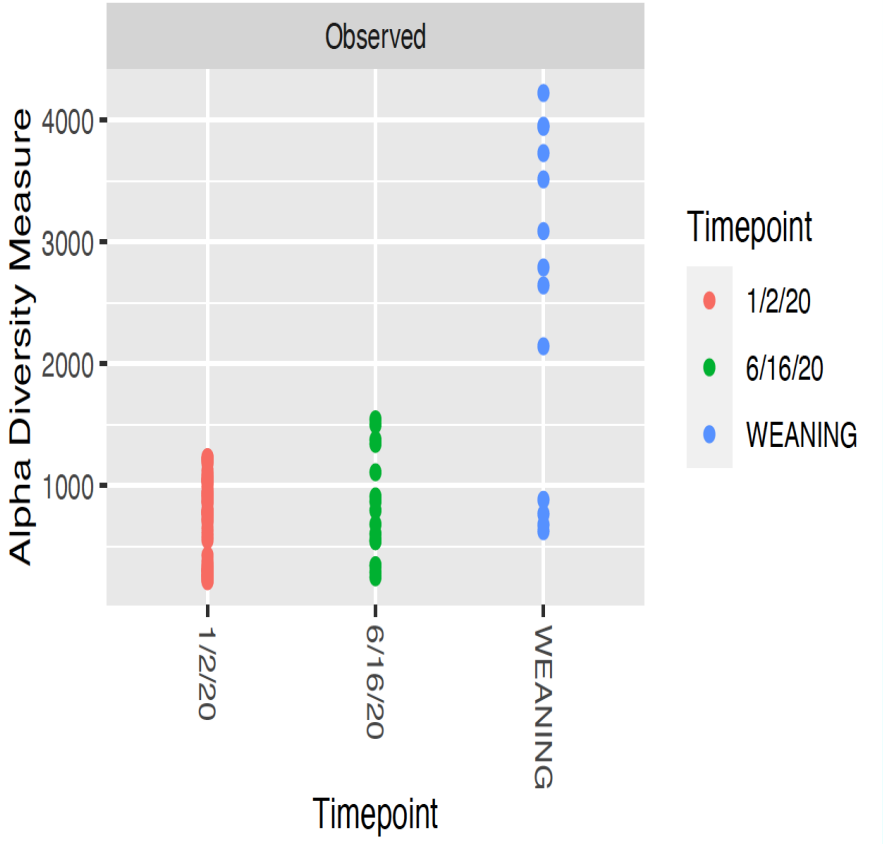


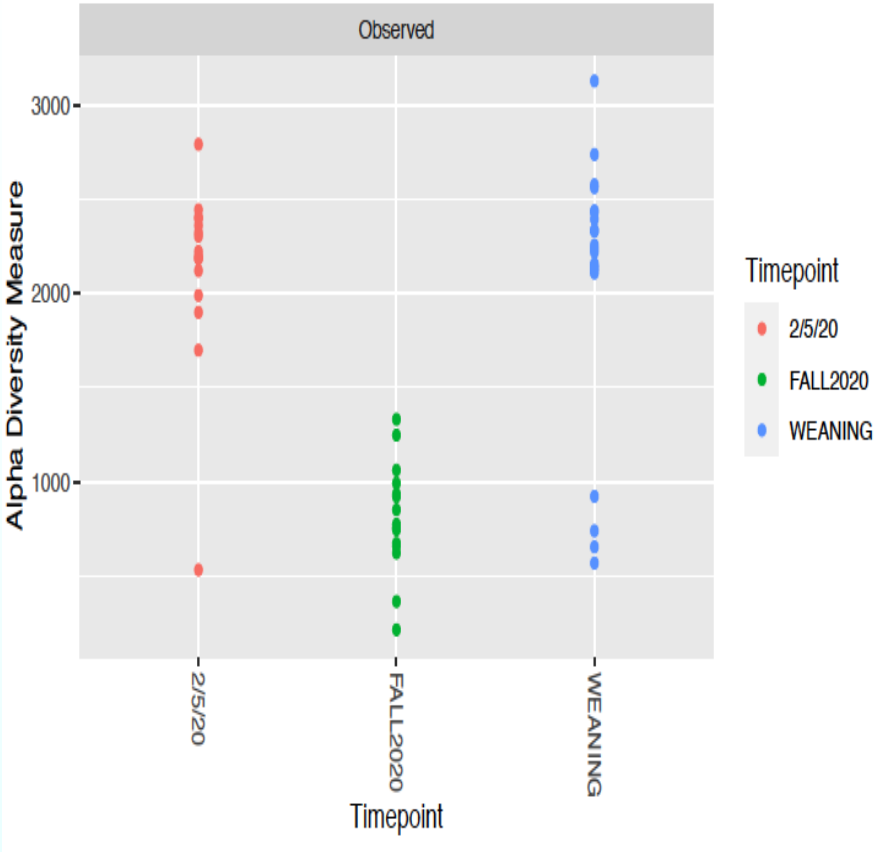
Interactions – Tenderness (SSF)



Rumen diversity
USMARC versus LARRL

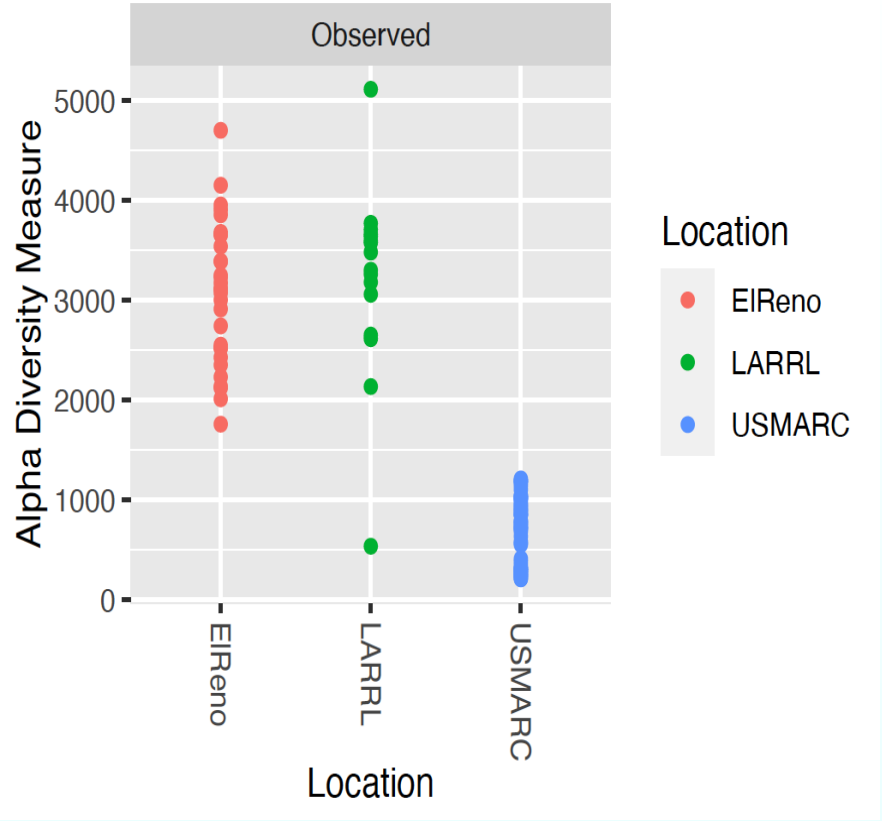
Alpha Diversity



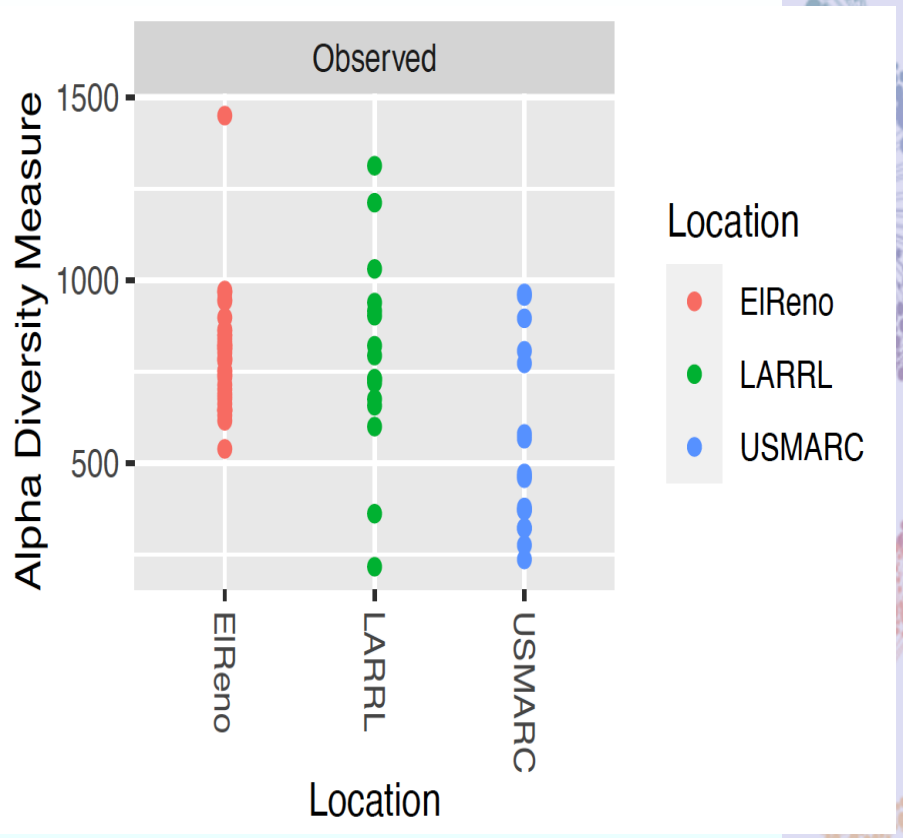


Winter versus fall

Winter 2019



Fall 2019



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

- 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

Multilocation Leadership Team

Grand Forks, ND	**El Reno, OK**	**Miles City, MT**
Shanon Casperson	Jim Neel	El Hamidi Hay
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	Corey Moffet	Tommy Wheeler

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Jim Wells			
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USMARC Cattle Operations

Questions