USDA AGIL Research Updates:

Improving dairy animals by increasing accuracy of genomic prediction, evaluating new traits, and redefining selection goals

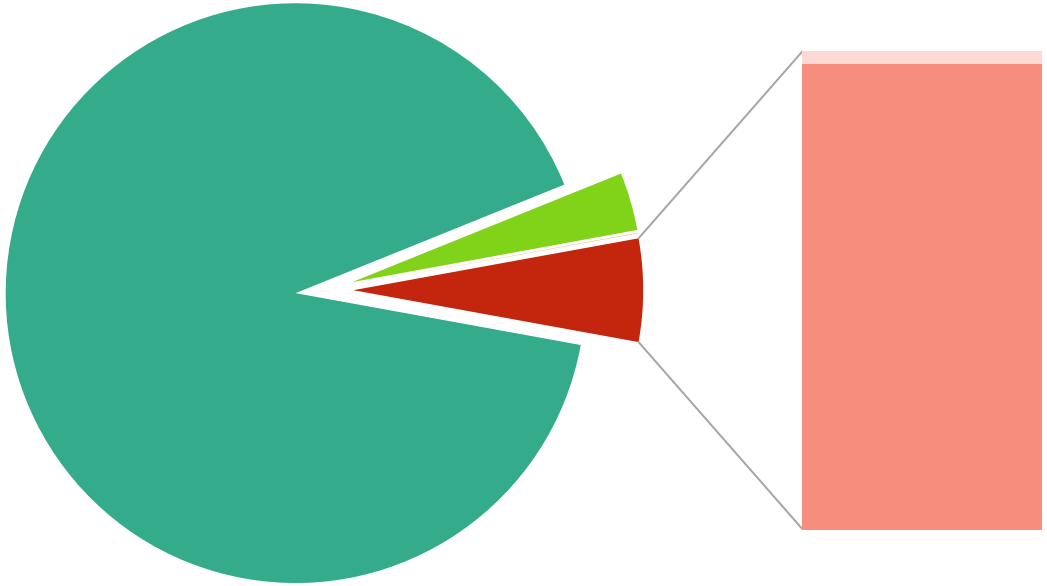
Asha M. Miles, PhD | Research Geneticist

Animal Genomics & Improvement Laboratory
USDA Agricultural Research Service
Beltsville, MD 20705
asha.miles@usda.gov

Embryo Transfer & Fertility Evaluations

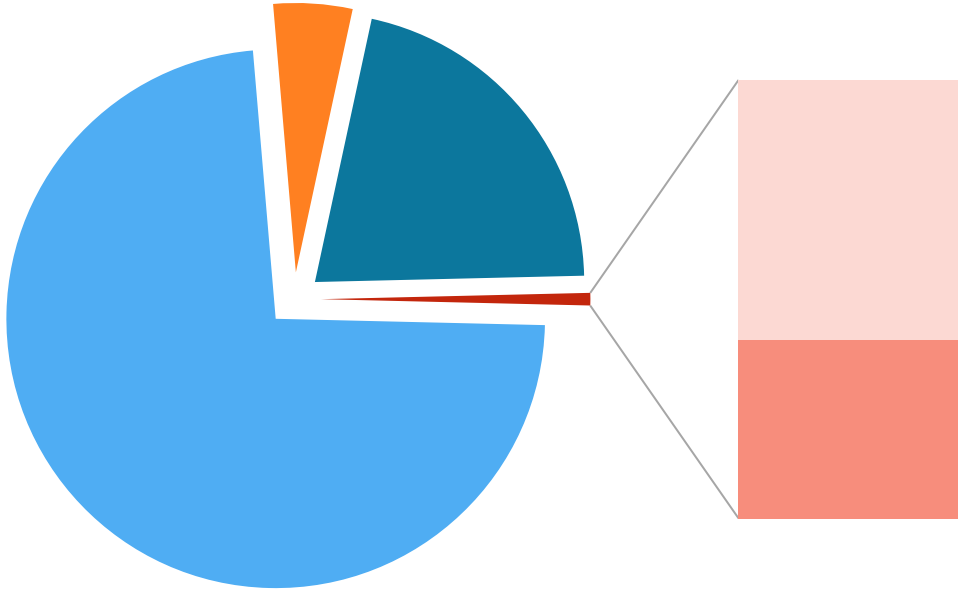
Dr. Asha Miles
Jana Hutchison
Dr. Paul VanRaden

CALVING EVENTS



- Single Birth
- Multiple Birth (not ET)
- Split Embryo (artificially)
- Clone from Nuclear Transfer
- Embryo Pedigree (implantation stored as birth date)
- Birth from ET

BREEDING EVENTS

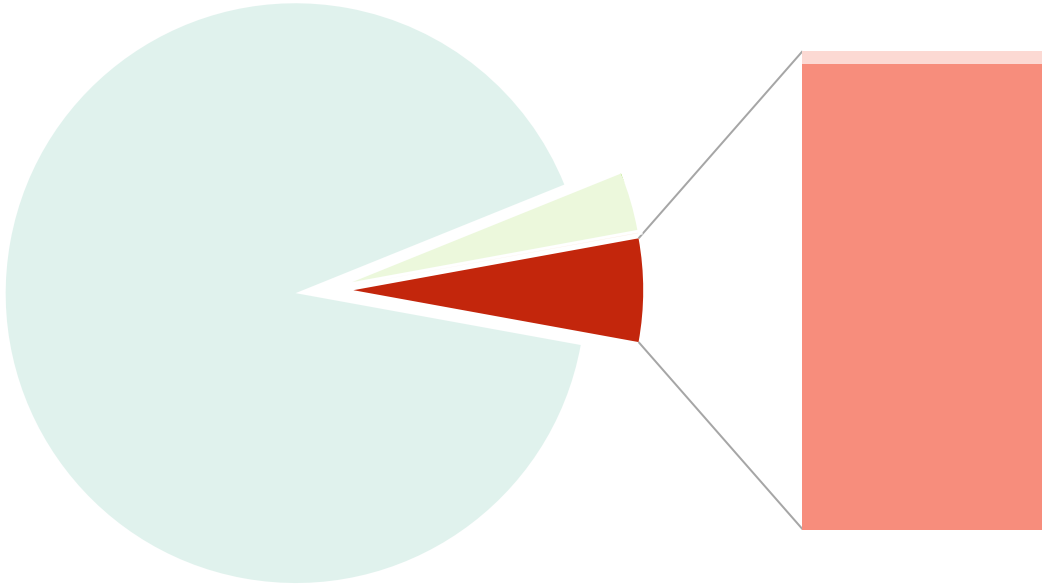


- AI Breeding
- Natural Service Breeding
- AI Sexed Semen
- Embryo Donation
- Embryo Implantation (reporting embryo sire)
- Embryo Implantation (reporting embryo dam)

Embryo Transfer & Fertility Evaluations

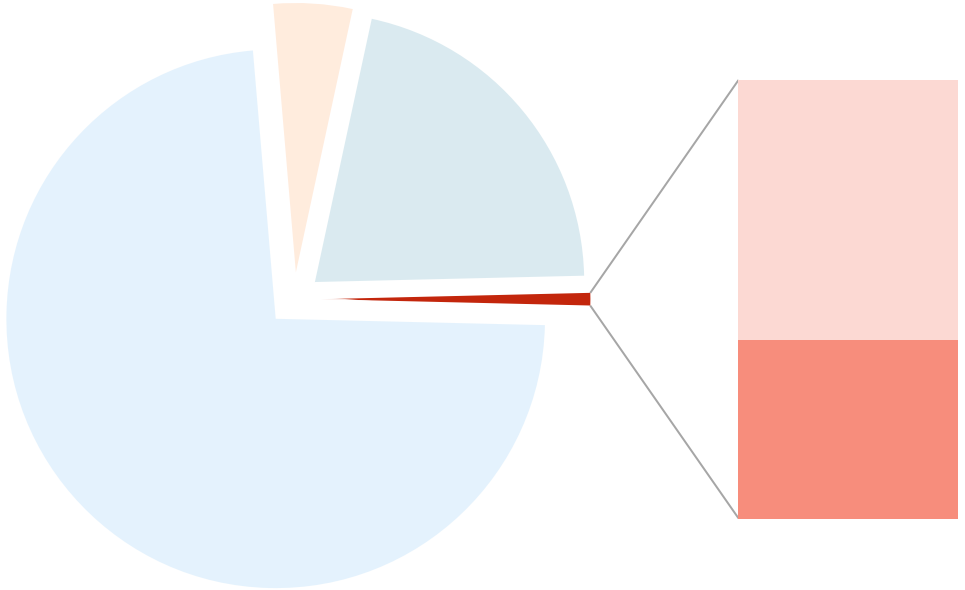
Dr. Asha Miles
Jana Hutchison
Dr. Paul VanRaden

CALVING EVENTS



- Single Birth
- Multiple Birth (not ET)
- Split Embryo (artificially)
- Clone from Nuclear Transfer
- Embryo Pedigree (implantation stored as birth date)
- Birth from ET

BREEDING EVENTS



- AI Breeding
- Natural Service Breeding
- AI Sexed Semen
- Embryo Donation
- Embryo Implantation (reporting embryo sire)
- Embryo Implantation (reporting embryo dam)

Format 5:
Code E
Code I
Code J

Embryo Transfer & Fertility Evaluations

Dr. Asha Miles
Jana Hutchison
Dr. Paul VanRaden

Is this discrepancy because ET is incorrectly being coded as AI?

Code	Mating Type	ET Births	All Other Calvings	
A	AI	35,100	11,060,000	**0.32%**
G	AI (sexed semen)			
N	Natural Service			
E	Embryo Donation			
I/J	Embryo Implantation			

The rate at which ET is incorrectly recorded

Embryo Transfer & Fertility Evaluations

Dr. Asha Miles
Jana Hutchison
Dr. Paul VanRaden

Is this discrepancy because ET is incorrectly being coded as AI?

Code	Mating Type	ET Births	All Other Calvings	
A	AI	35,100	11,060,000	**0.32%**
G	AI (sexed semen)	14,833	1,175,795	**1.25%**
N	Natural Service	2,035	584,971	**0.35%**
E	Embryo Donation	0	13	**0.00%**
I/J	Embryo Implantation	372	29,416	**1.25%**

The rate at which ET is incorrectly recorded

The rate at which ET is correctly recorded

This suggests ET is not being reported at all, rather than being reported incorrectly

Embryo Transfer & Fertility Evaluations

Dr. Asha Miles
Jana Hutchison
Dr. Paul VanRaden

- Some solutions:
  - Cleaning-up historical data
  - Breed associations report ET
  - Better on-farm ET recording (VAS, DC305)

- This has implications for:
  - On-farm reports about fertility
  - Fertility evaluations (e.g., SCR, HCR, and CCR)
  - Bulls whose 1st calves may all be ET but are not reported as such

Mature Equivalent & Age Adjustment

Dr. Asha Miles
Dr. Paul VanRaden

- Official factors for adjusting lactation records to mature equivalent were last estimated in 1994 by Mike Schutz

- At that time, additive adjustment factors were included in the animal model by George Wiggans to automatically adjust future data for changes in maturity rates

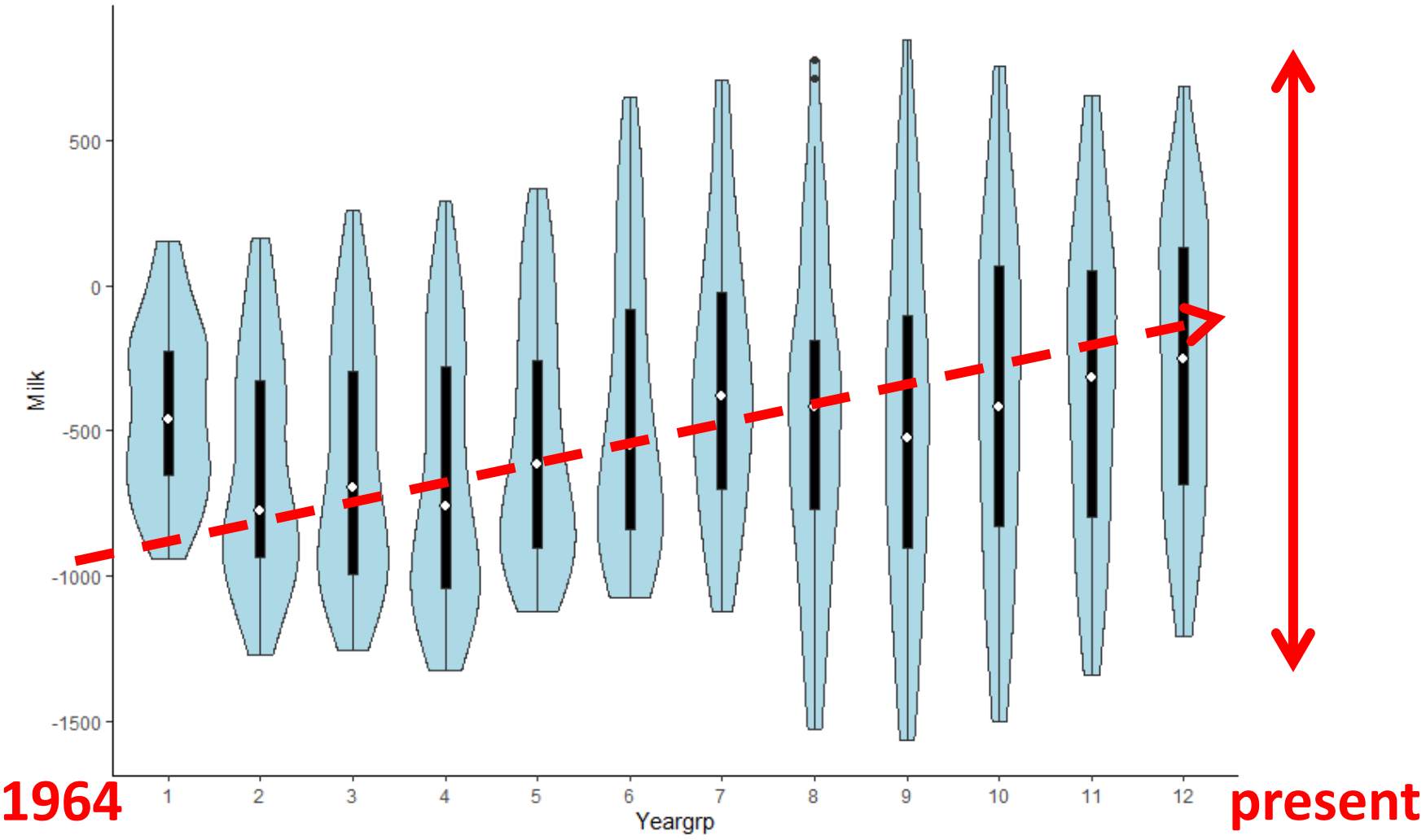
1. Look at size of additive corrections to assess how well preadjustment factors are working

Mature Equivalent & Age Adjustment

Dr. Asha Miles
Dr. Paul VanRaden

Milk

Factors are indeed changing over time

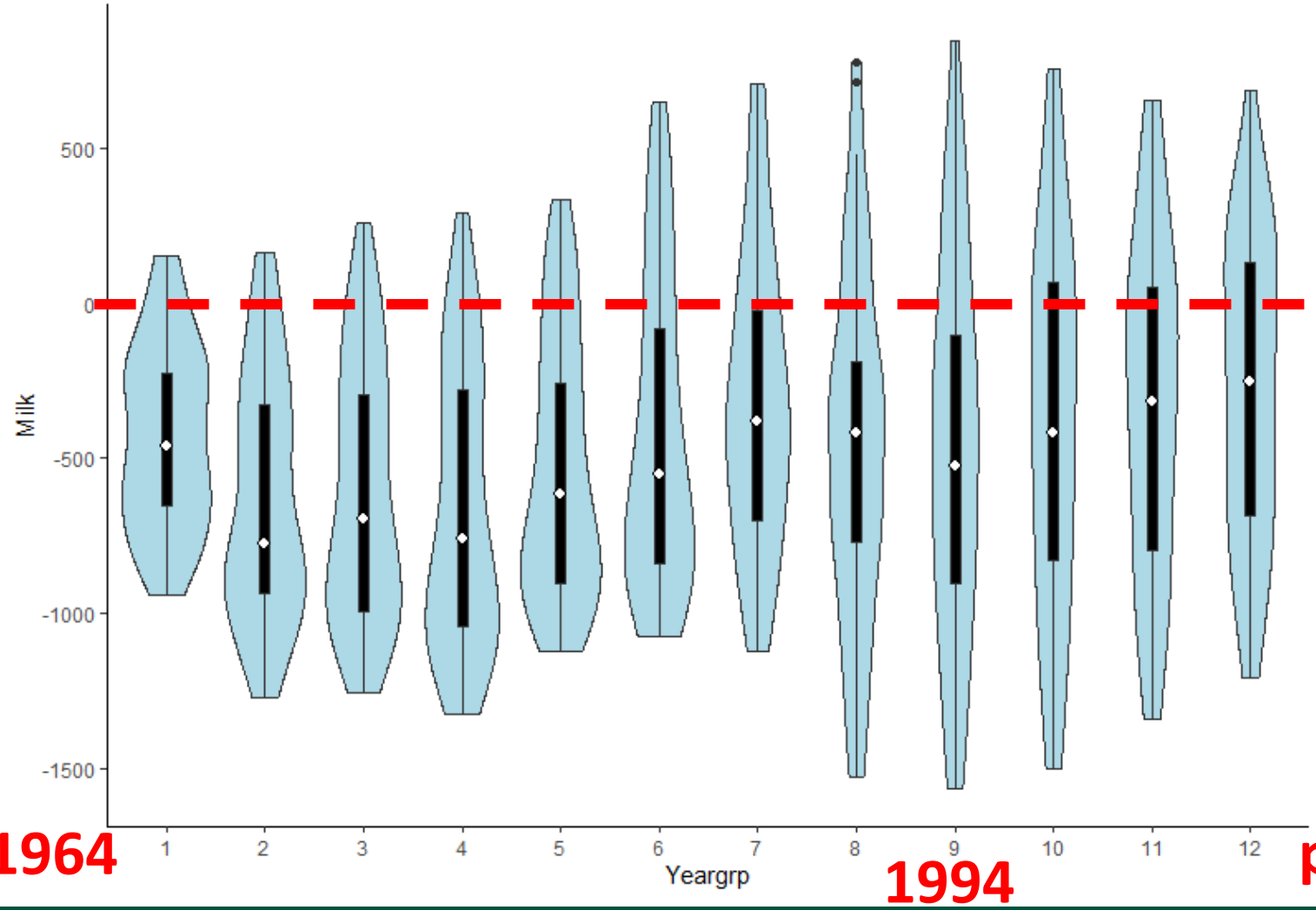


Mature Equivalent & Age Adjustment

Dr. Asha Miles
Dr. Paul VanRaden

Milk

Factors are indeed changing over time



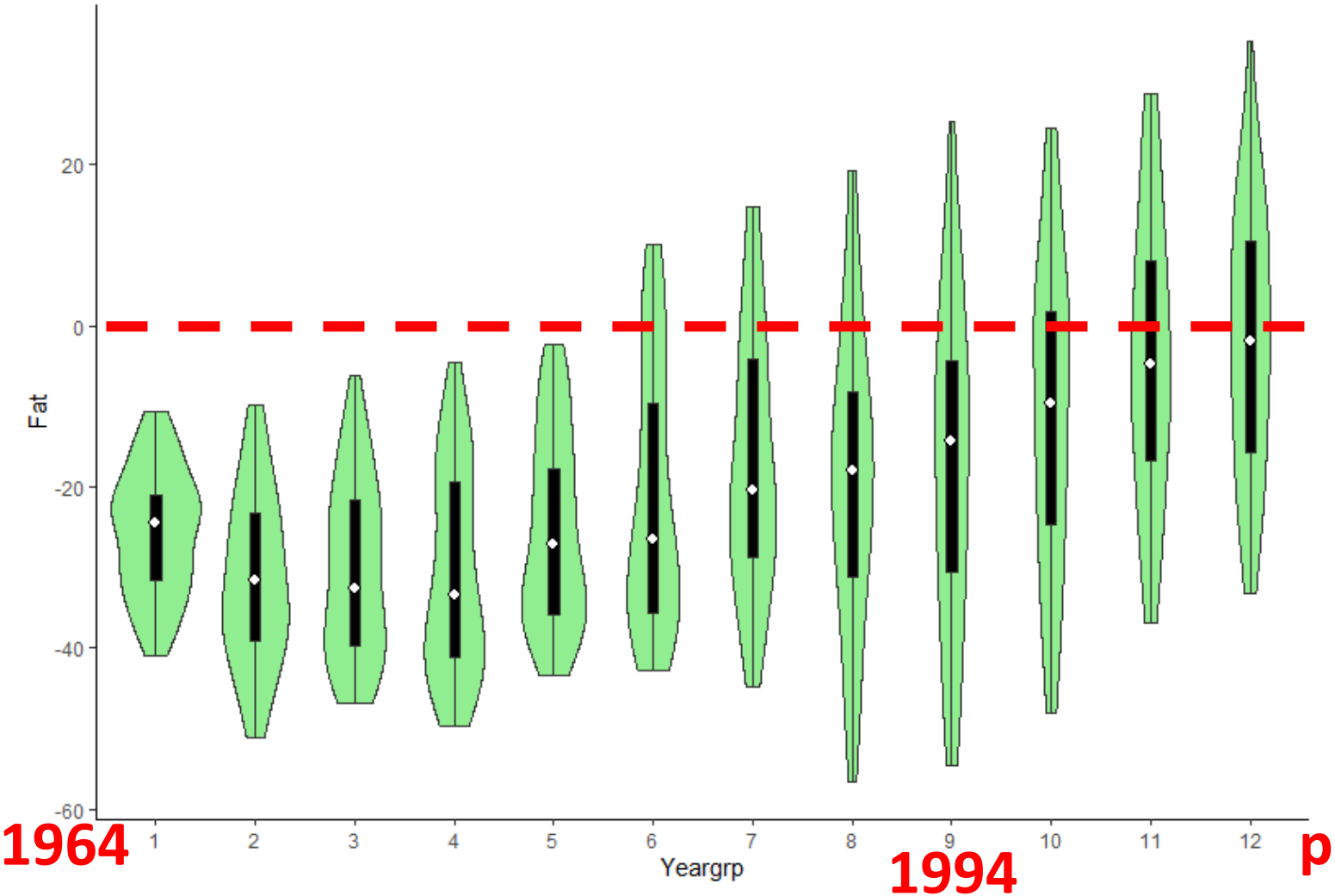
1964 1994 present

Mature Equivalent & Age Adjustment

Dr. Asha Miles
Dr. Paul VanRaden

Fat

Factors are indeed changing over time



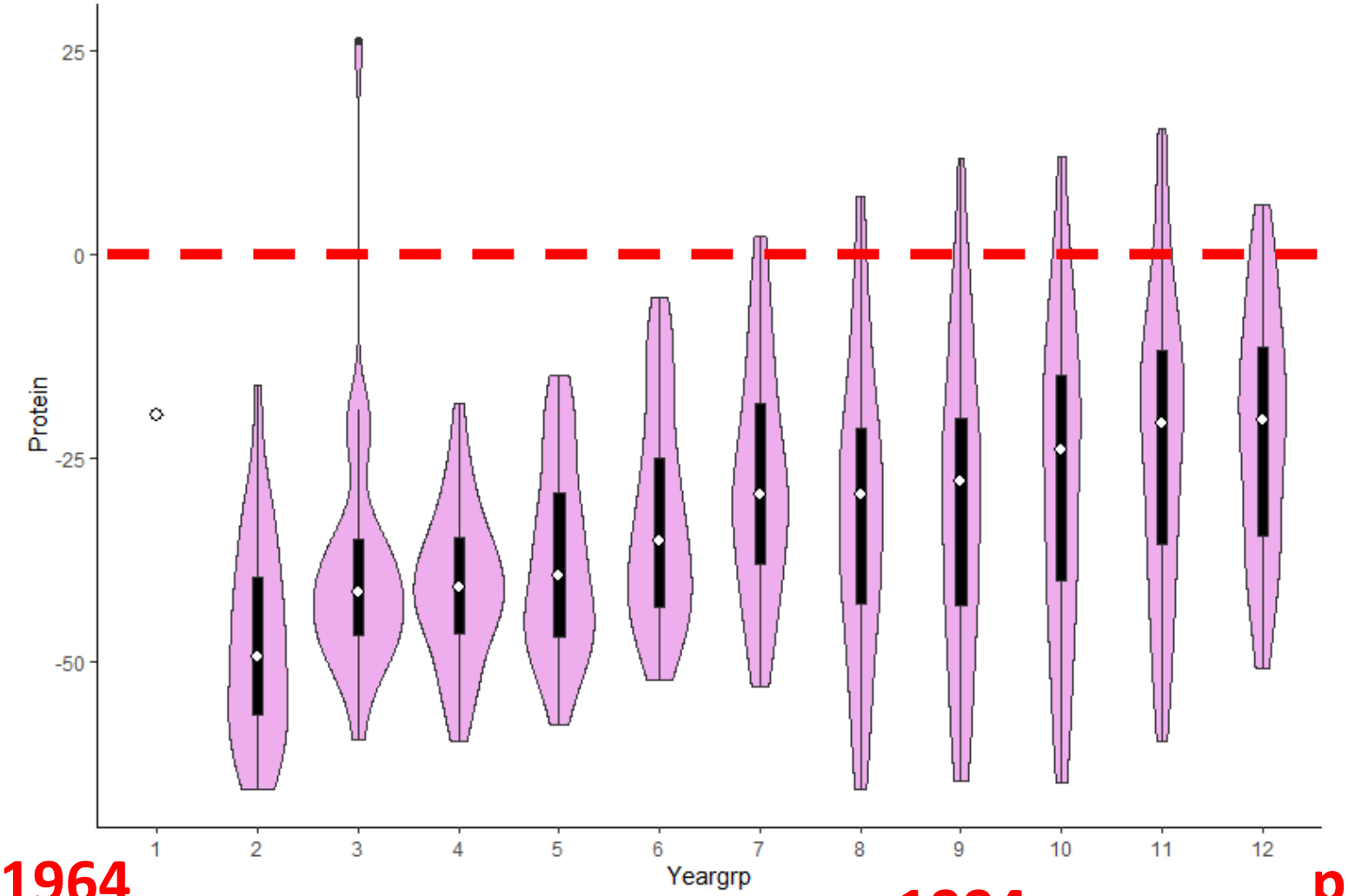
1964 1994 present

Mature Equivalent & Age Adjustment

Dr. Asha Miles
Dr. Paul VanRaden

Protein

Factors are indeed changing over time



1964

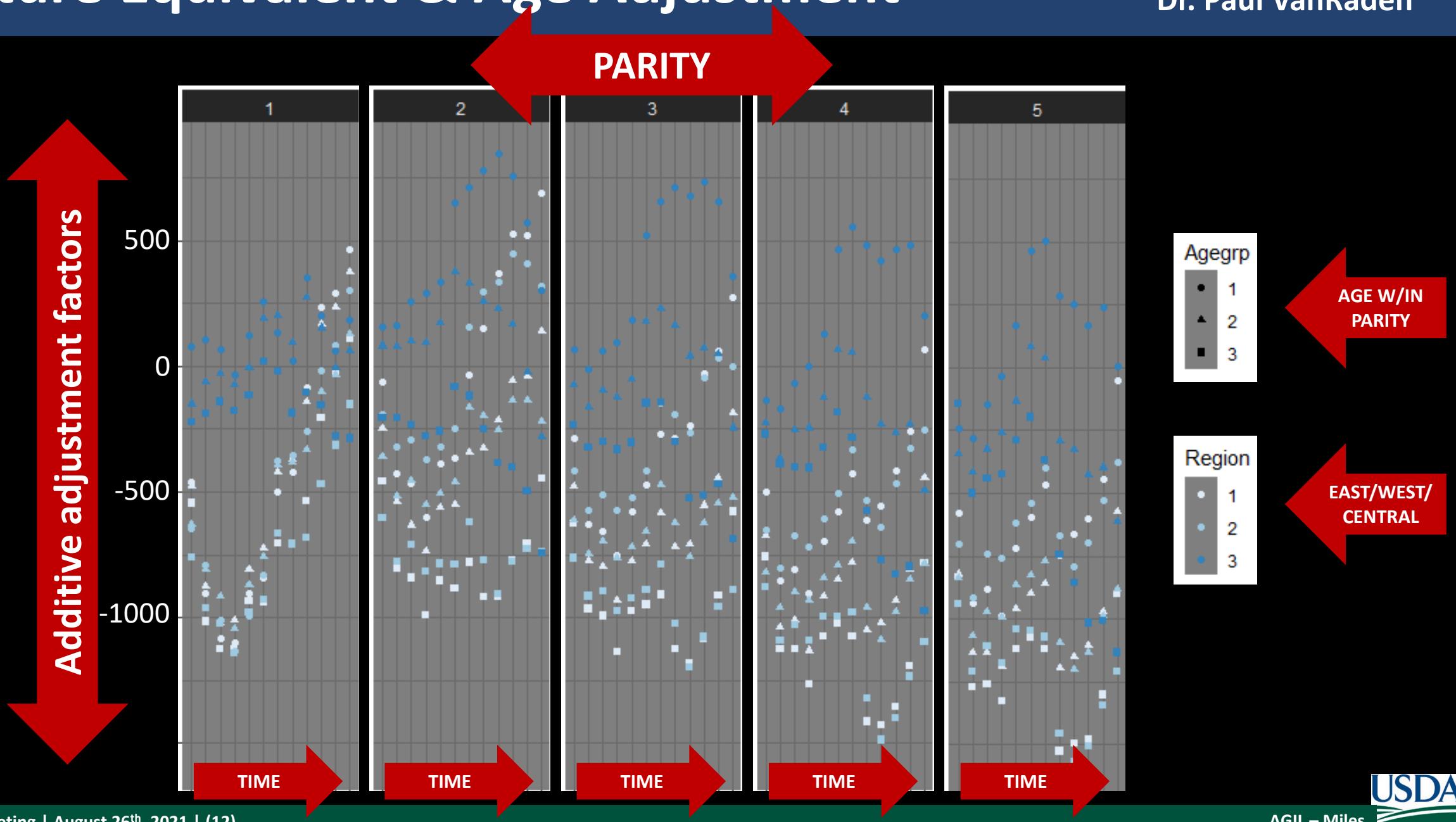
1994

present

Mature Equivalent & Age Adjustment

Dr. Asha Miles
Dr. Paul VanRaden

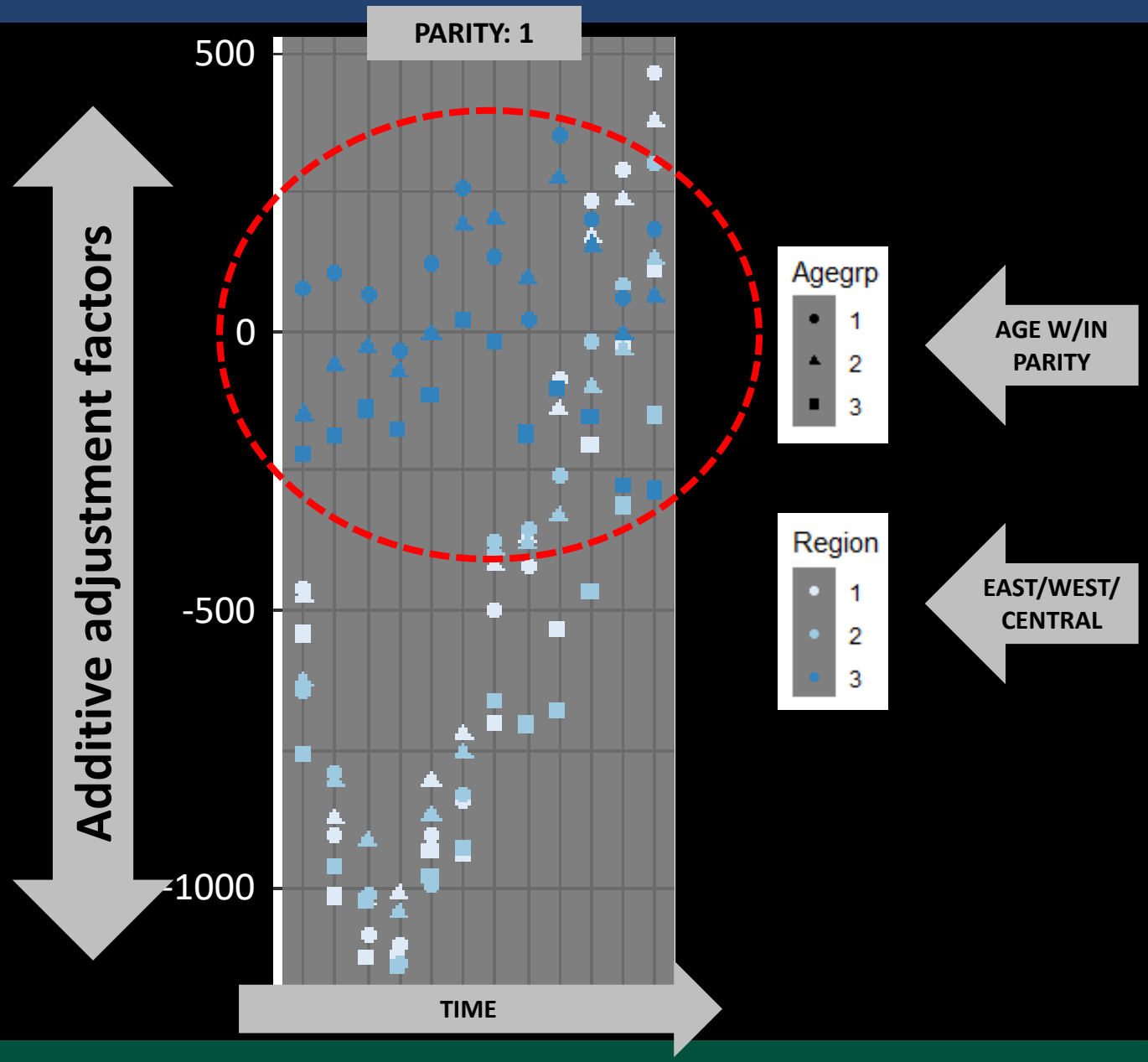
Milk



Mature Equivalent & Age Adjustment

Dr. Asha Miles
Dr. Paul VanRaden

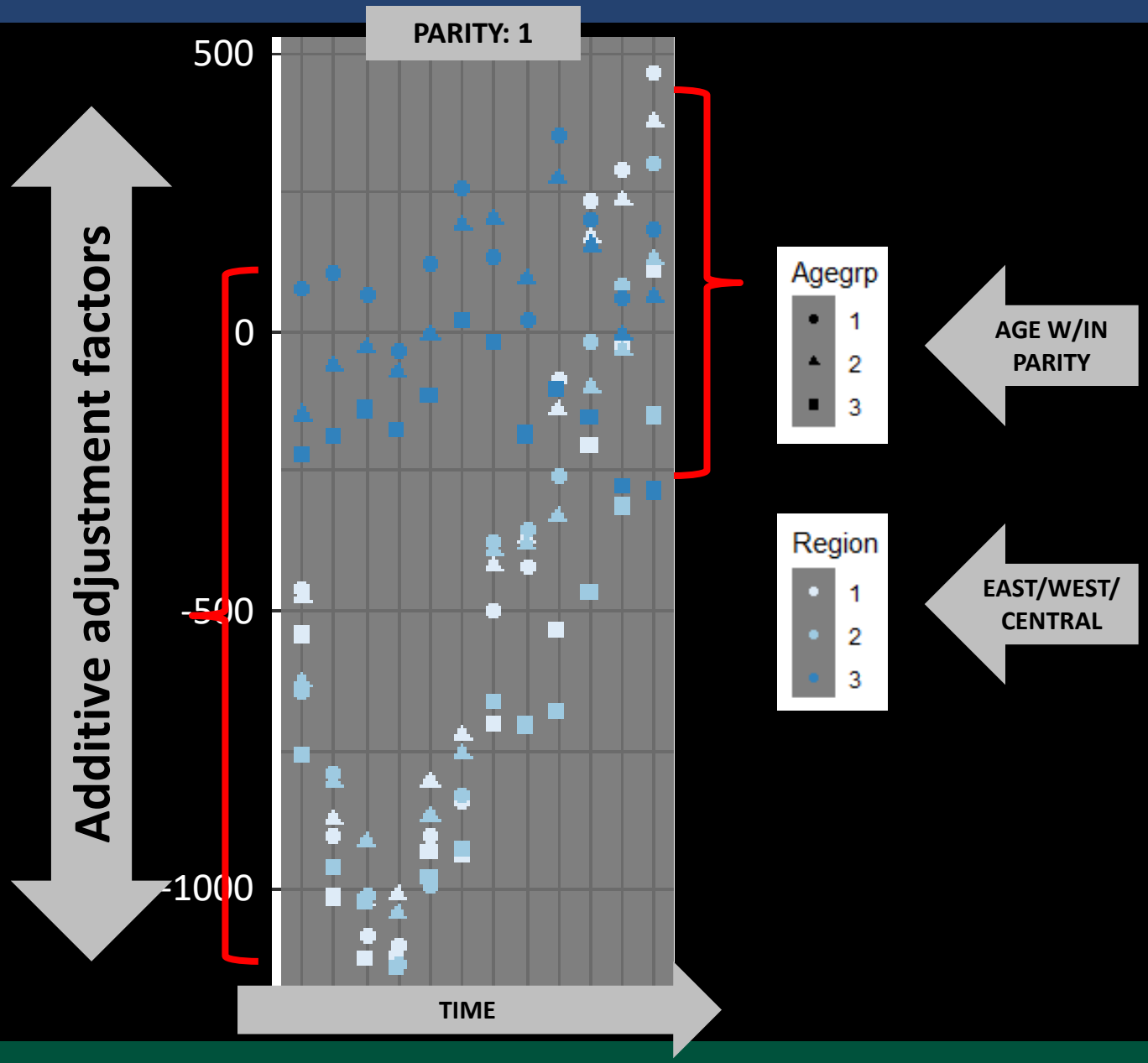
Milk



Mature Equivalent & Age Adjustment

Dr. Asha Miles
Dr. Paul VanRaden

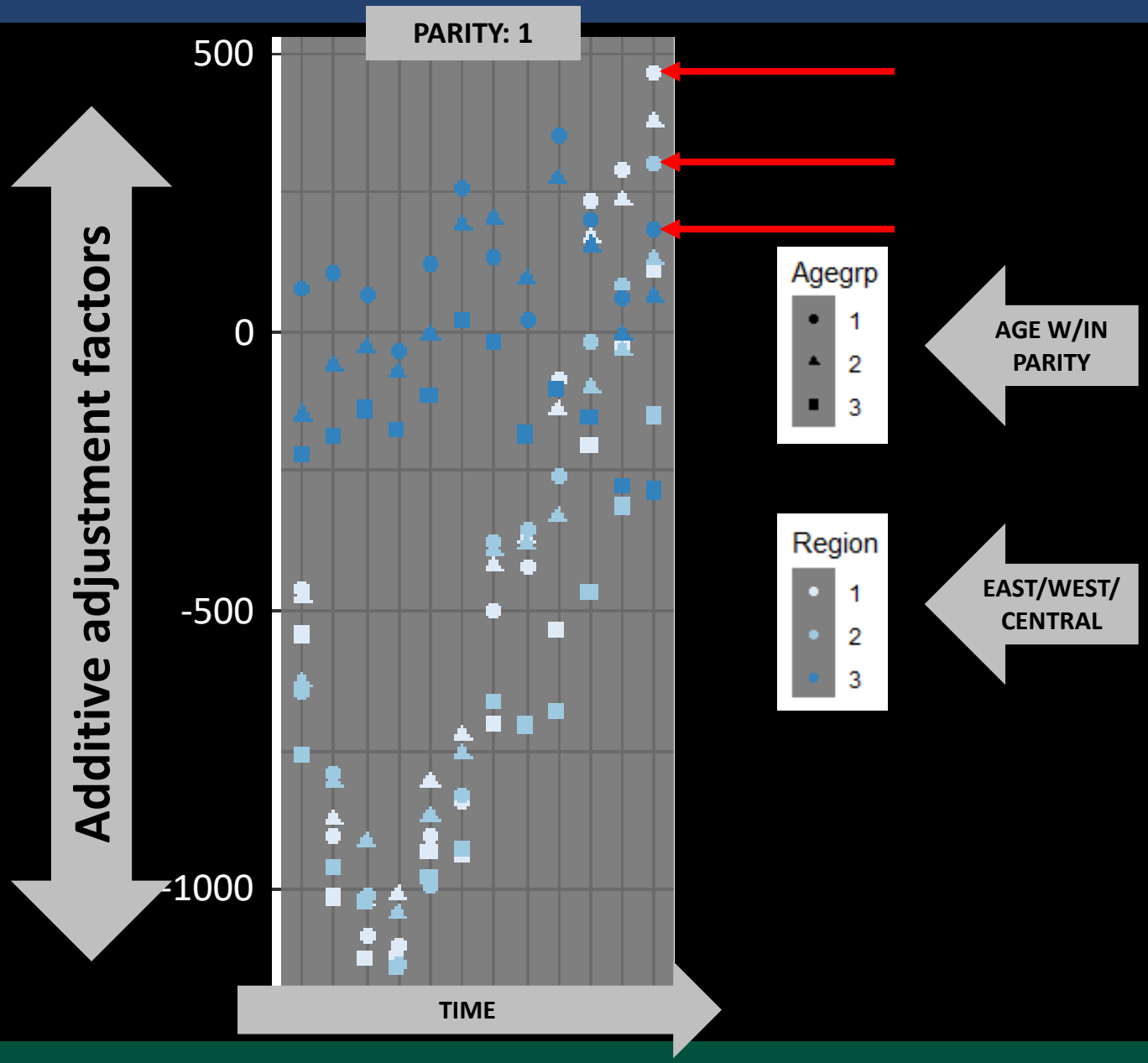
Milk



Mature Equivalent & Age Adjustment

Dr. Asha Miles
Dr. Paul VanRaden

Milk



Mature Equivalent & Age Adjustment

Dr. Asha Miles
Dr. Paul VanRaden

2. Improve preadjustment corrections

- **In 2005, PTAs were adjusted to 36 months instead of mature age to make predicted yield differences more similar to actual average yields and to make breed comparisons fairer in the all-breed animal model (est. 2007)**

Flexible Testing & Milk-Only Records

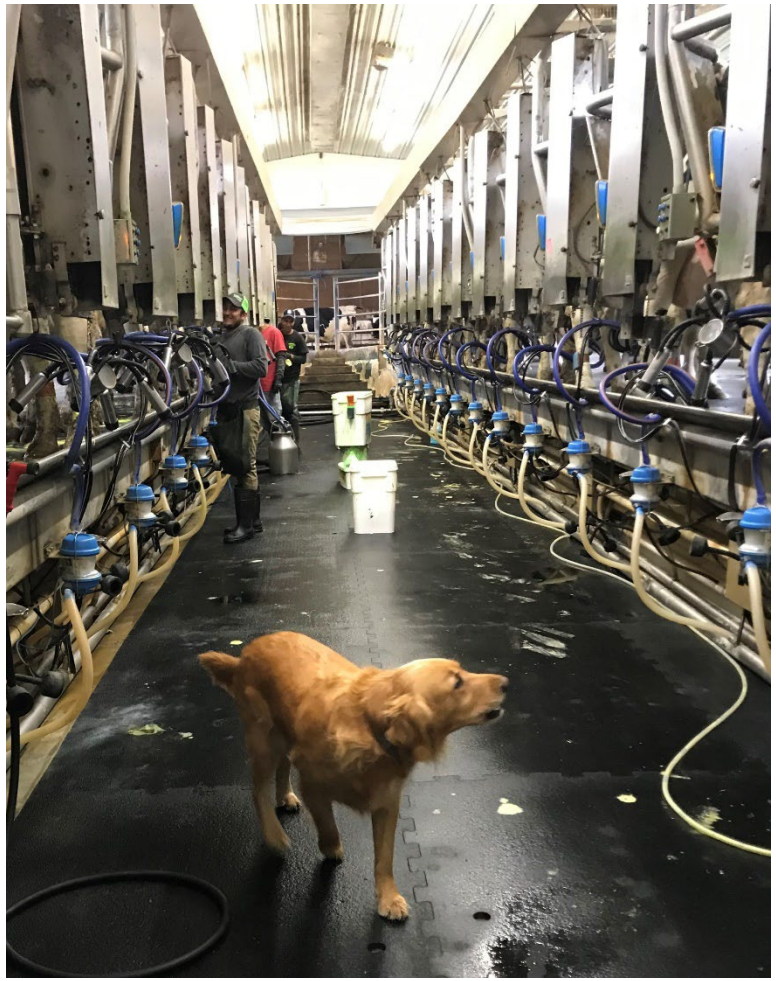
Dr. Paul VanRaden
Gary Fok

- Some farms with in-line milk meters do not participate in DHI testing; they record milk weights but not fat and protein

- National genetic evaluations exclude milk-only records; these records are stored but never extracted

- There is not a need for more milk records, but removing the censorship of herds without approved component sampling will allow us to use all of their other traits

This will improve the accuracy of prediction for lower heritability traits



Jack, a Pennsylvania Herd Manager, surveys morning milking

International Bull Rankings

Dr. Sajjad Toghiani
Dr. Paul VanRaden

- **Top bull lists obtained using Multitrait Across-Country Evaluations (MACE) on each country's scale**

Table 1. Actual percentages of foreign sire use and expected use based on the top 100 or top 1000 proven Holstein sires in each country's ranking

Foreign%	AUS	CAN	CHE	DEU	DFS	ESP	FRA	GBR	IRL	ISR	ITA	JPN	NLD	NZL	USA
Expected[2]	96	83	100	94	90	100	98	100	81	91	100	98	87	24	8
Expected[3]	98	88	100	91	90	99	95	99	86	95	98	96	92	54	23

[1] Percentages of milk-recorded cows with foreign sires born since 2008.
[2] Percentages of top 100 proven sires born 2005-2013 that are foreign.
[3] Percentages of top 1000 proven sires born 2005-2013 that are foreign.

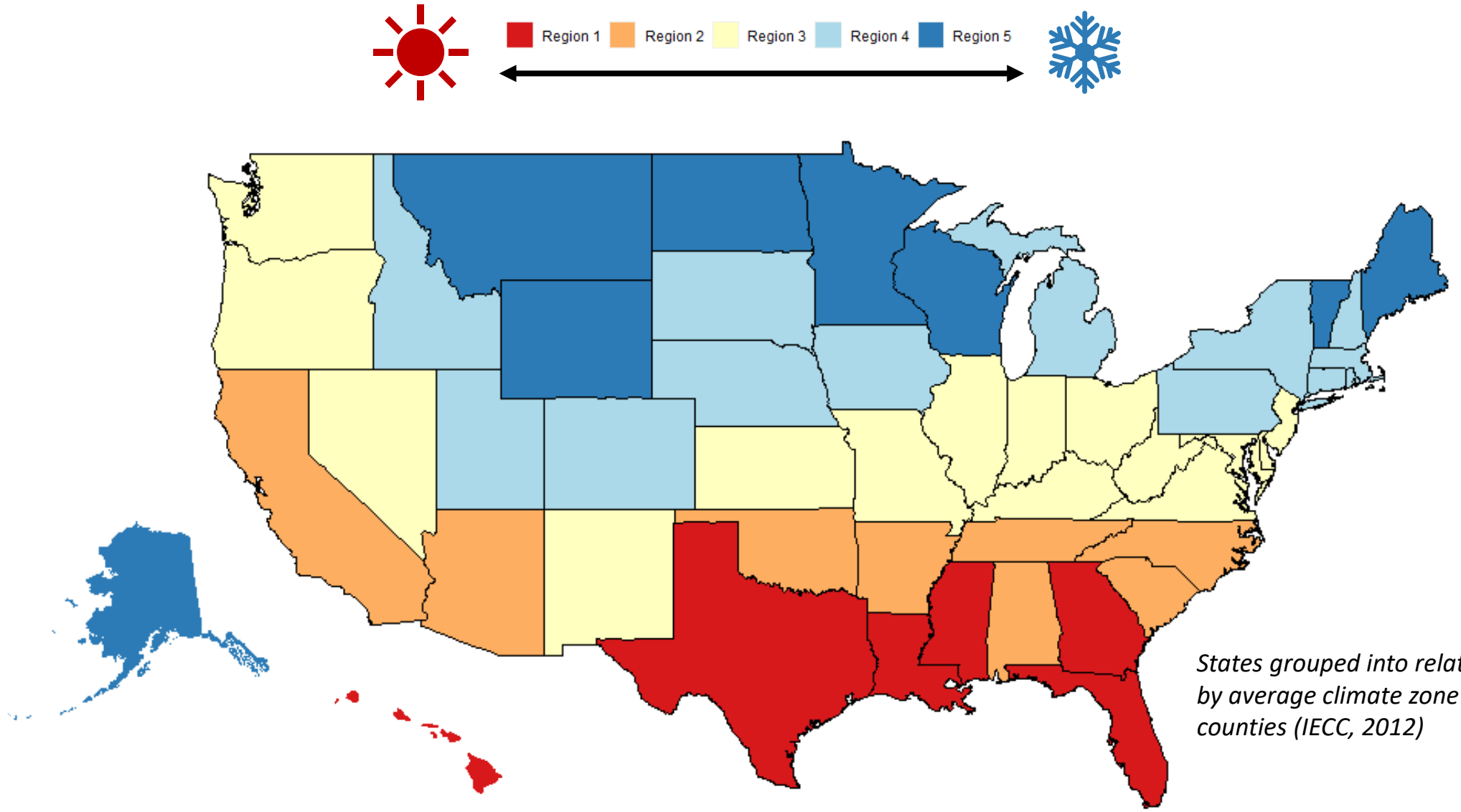
Most countries should increase their use of foreign sires

Long term considerations

USDA is writing our 5-year plan for submission this November

PTAs accounting for Heat Stress

Dr. Breno Fragomeni
Dr. Asha Miles

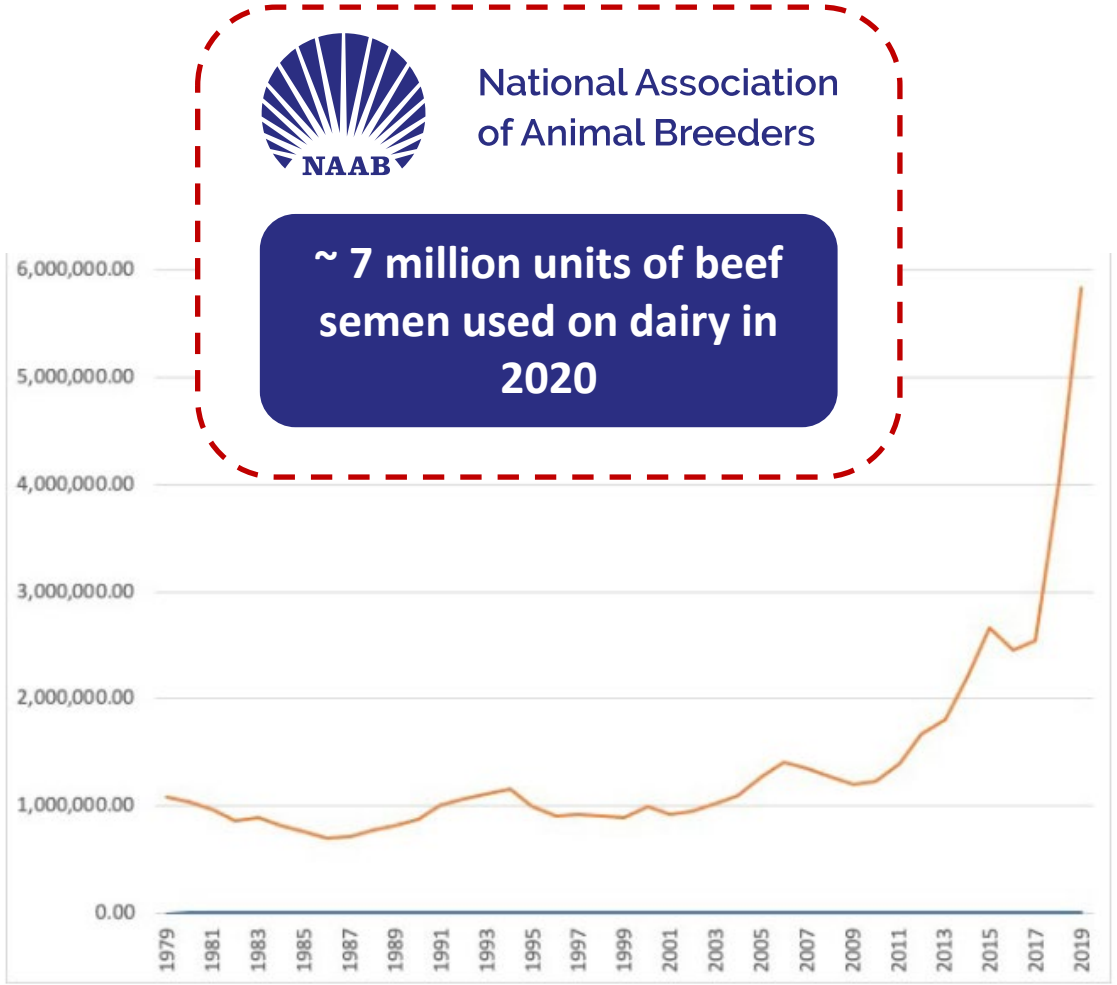


States grouped into relative-heat regions by average climate zone score across all counties (IECC, 2012)

Beef on Dairy: Effects on Dam Productivity

Dr. Asha Miles

- With recent low milk and heifer prices, producers have turned to beef supply chain as an alternative revenue source
- In 2017, up to 20% of fed cattle were Holstein[1]
- Cow conception rate does not appear to be affected by breed of service sires (McWhorter et al., 2020)



From: Geiger, C. Beef on dairy more than doubled in two years. https://hoards.com/article-27667-beef-on-dairy-more-than-doubled-in-two-years.html

[1]*NBQA. National Beef Quality Audit: Steer and Heifer. (2016).*

Beef on Dairy: Effects on Dam Productivity

Dr. Asha Miles

Question: how does carrying a crossbred calf affect milk production?

Growing a bigger calf requires more metabolic resources, leaving less available for milk

A bigger calf will require more milk to thrive; consequently, more milk is produced to raise it

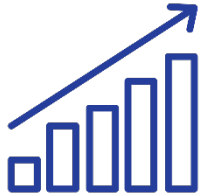
A recent study found dairy cows do have decreased milk production if bred to beef service sire, but the higher value of her calf makes this loss negligible

Berry and Ring 2020. J Dairy Sci 103(9)

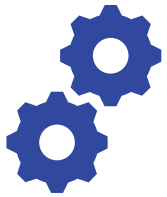
Beef on Dairy: Effects on Dam Productivity

Dr. Asha Miles

This will not always be the case depending on variable meat and milk markets



Quantify effects of beef service sire merit on milk yield & quality



Develop decision-making tool for producers based on this data and current market trends

Energy Efficiency & Rumen Microbiome

Dr. Asha Miles
Dr. Randy Baldwin

Phenotype (P) = Genotype (G) + Environment (E)

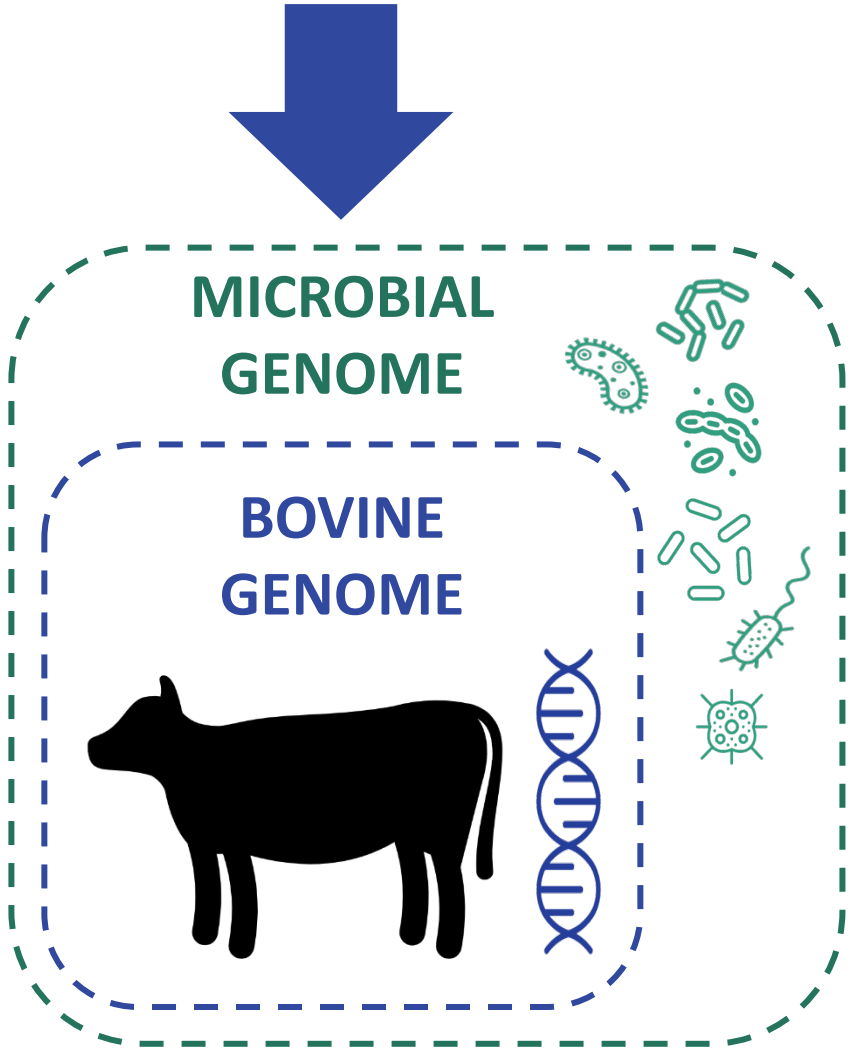
Metagenomics can provide insight into metabolic efficiency

We need solutions to mass-produce this information

-buccal swabs & pooling

-representative environmental sampling

-high covariance with other traits



Energy Efficiency & Rumen Microbiome

Dr. Asha Miles
Dr. Randy Baldwin

- How is the rumen microbiome related to:
  - Heifer growth and feed efficiency?
  - Lactating cow feed efficiency?
  - Milk yield & quality?
  - Enteric methane emissions?

-6% ingested energy

- Do low efficiency heifers necessarily turn into low efficiency cows?

- Can cows be well-adapted to both high efficiency and high forage diets?

Stakeholder Input Summary

Dairy Research Priorities

- **Milk Spectral Data**
  - -Add new measures (i.e., P, minerals, DMI, pregnancy)
  - -currently done in research settings; has not been widely applied yet
- **Herd Management Tools**
  - -Review/optimize methods and prediction factors used for estimating lactation yields
- **Sire Fertility**
  - -Improved genomic prediction/evaluations for bulls
- **High-throughput Data Systems**
  - -Evaluate the use of metabolic activity indicators for selection purposes
  - -Incorporate high throughput phenotypes available @ commercial dairies into national evaluation systems
  - -Assess the use of high throughput phenotypes as proxy for traits difficult or costly to collect
  - -Explore application of deep learning techniques for decision-making tools
- **Animal Welfare & Sustainability**
  - -Identify & develop new traits for animal welfare & sustainability
  - -Quantify their long-term economic impact on dairy breeding goals
  - -Develop long-term selection and mating strategies to maintain diversity
- **Major Theme: Data Availability & Reporting**
  - -a lot of data is available; what will it take to get it flowing
  - -we need a path for data reporting and standardizing
  - -we need better communication with the data providers on what the return on their investment is

National Program 101 ABBL/AGIL Stakeholder Meeting 2021

Breakout session report

USDA United States Department of Agriculture Agricultural Research Service

Dairy Research Priorities

- **DNA Sequencing**
  - -Assess the impact of low pass sequencing on genomic predictions
  - -Facilitate the identification of functional genes and pathways for traits of economic importance
- **Quantitative Genetic Tools**
  - -Develop methods & tools to monitor economic weights of traits to select for
  - -Assess the impact of predicting retained heterosis in crossbred animals
  - -Assess the impact of genotype by environment interactions on selection programs (e.g., heat stress)
  - -Investigate techniques to manage increasing volumes of data and improving accuracy of prediction

- **Milking Speed**
  21 reports of MSPD from 2006-2010

Thank you. Questions?

Contact: asha.miles@usda.gov

https://www.ars.usda.gov/northeast-area/beltsville-md-barc/beltsville-agricultural-research-center/agil/