



# Improving Robustness & Climatic Resilience in U.S. Sheep Populations through Genomics (Sheep GEMS)

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January 11, 2024



National Institute of Food and Agriculture  
U.S. DEPARTMENT OF AGRICULTURE

## Scientific team

- Luis Fernando Batista Pinto (visiting scholar), Purdue University
- Luiz Brito, Purdue University
- Joan Burke, USDA, ARS Dale Bumpers Small Farms Research Center
- Brad Freking, USDA, ARS US Meat Animal Research Center
- Ron Lewis, University of Nebraska-Lincoln
- Tom Murphy, USDA ARS US Meat Animal Research Center
- Bret Taylor, USDA, ARS US Sheep Experiment Station
- Carrie Wilson, USDA, ARS US Sheep Experiment Station

## Post-doctoral, graduate, and undergraduate students

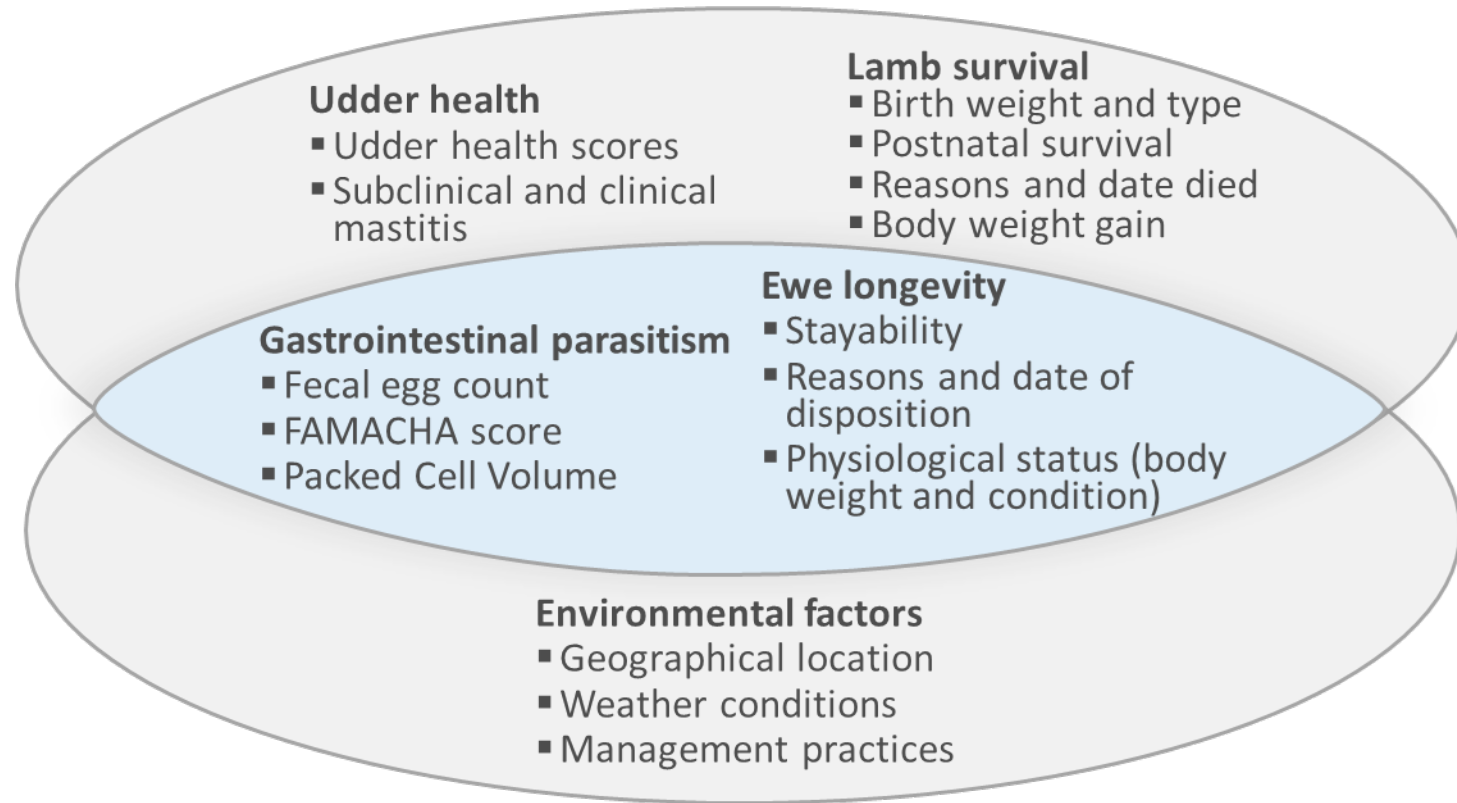
- Brian Arisman (MS student), University of Nebraska-Lincoln
- Bob Forbes (MS student), University of Nebraska-Lincoln
- Sara Nilson (Post-doctoral Research Associate), University of Nebraska-Lincoln
- Artur Oliveira Rocha (PhD student), Purdue University
- Ali Haider Saleem (PhD student), Purdue University
- Emily Schultz (Undergraduate student), University of Nebraska-Lincoln
- Hilal Yazar Gunes (PhD student), University of Nebraska-Lincoln

# Rationale

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- The U.S. sheep industry consists of a variety of breeds raised in a range of geographies that differ in their climatic conditions and management practices
- Breeding robust animals that perform well under these conditions is key
- The challenge is
  - Nearly half (44%) of ewes in the U.S. are culled prematurely for reasons other than age
  - Approximately 7% of the total U.S. lamb crop dies each year from non-predator related causes
  - Clinically healthy ewes yet with high somatic cell counts in their milk cause economic losses of \$19 to \$32 per ewe
  - More than 20% of mature ewes in most commercial flocks have been diagnosed with high somatic cell counts

## Robustness



## Climatic resilience

## Robustness

### Udder health

- Udder health scores
- Subclinical and clinical mastitis

### Lamb survival

- Birth weight and type
- Postnatal survival
- Reasons and date died
- Body weight gain

Currently such traits largely absent in U.S. sheep genetic evaluations

### Gastrointestinal parasitism

- Fecal egg count
- FAMACHA score
- Packed Cell Volume

### Stayability

- Reasons and date of disposition
- Physiological status (body weight and condition)

### Environmental factors

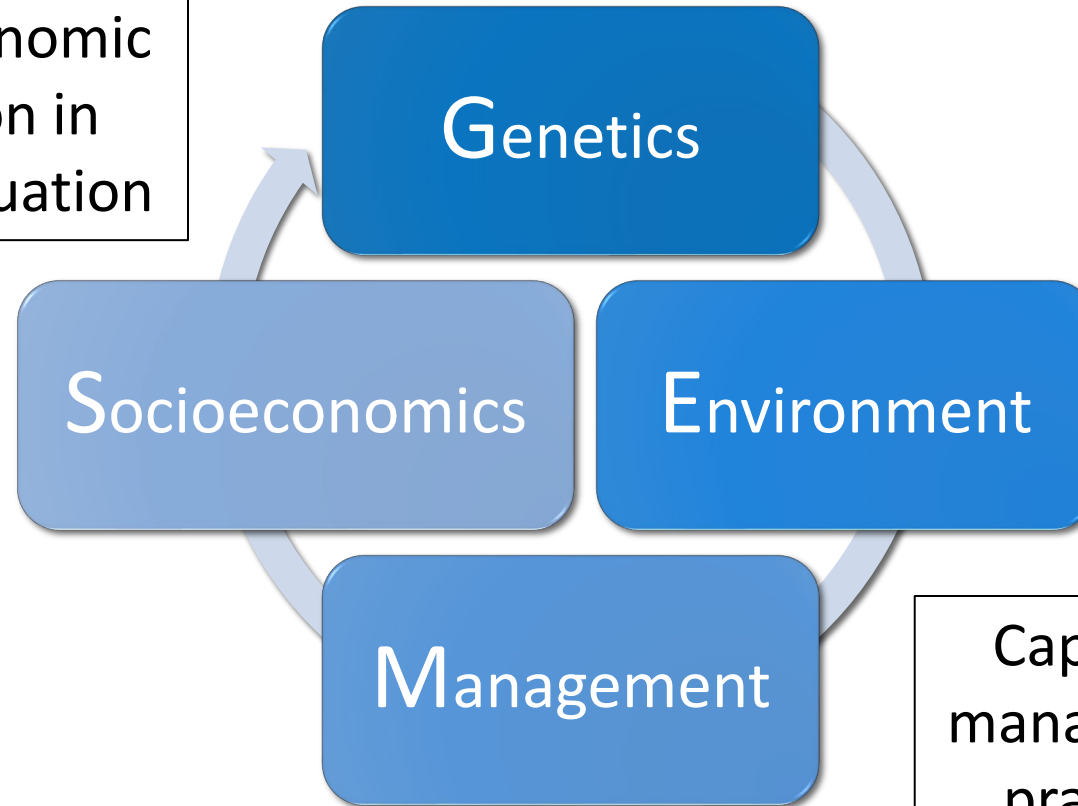
- Geographical location
- Weather conditions
- Management practices

## Climatic resilience

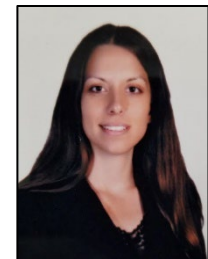
# Sheep GEMS



Including genomic  
information in  
genetic evaluation



Capturing  
management  
practices



# Hilal Yazar Gunes

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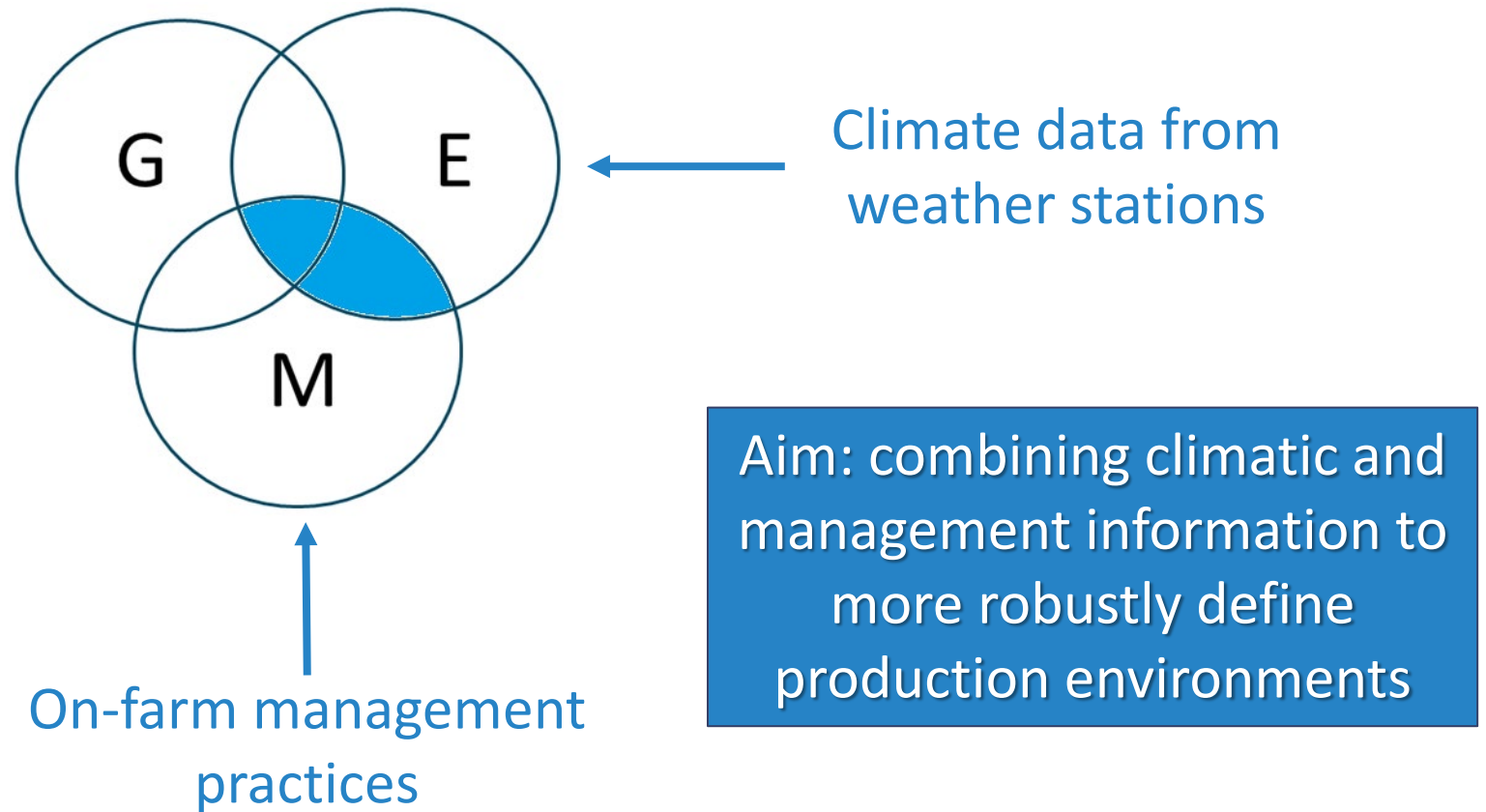
- Bachelor of Science, Animal Science, Ege University, Turkey (2012)
- Master of Science, Feeds and Animal Nutrition, Ege University, Turkey (2019)
- Master of Science, Animal Breeding and Genetics, Colorado State University (2022)  
“Genetic relationship between ewe longevity and foot and leg scores in sheep”
- Began PhD studies, University of Nebraska-Lincoln (Aug. 2022)

**Producer Management Survey**

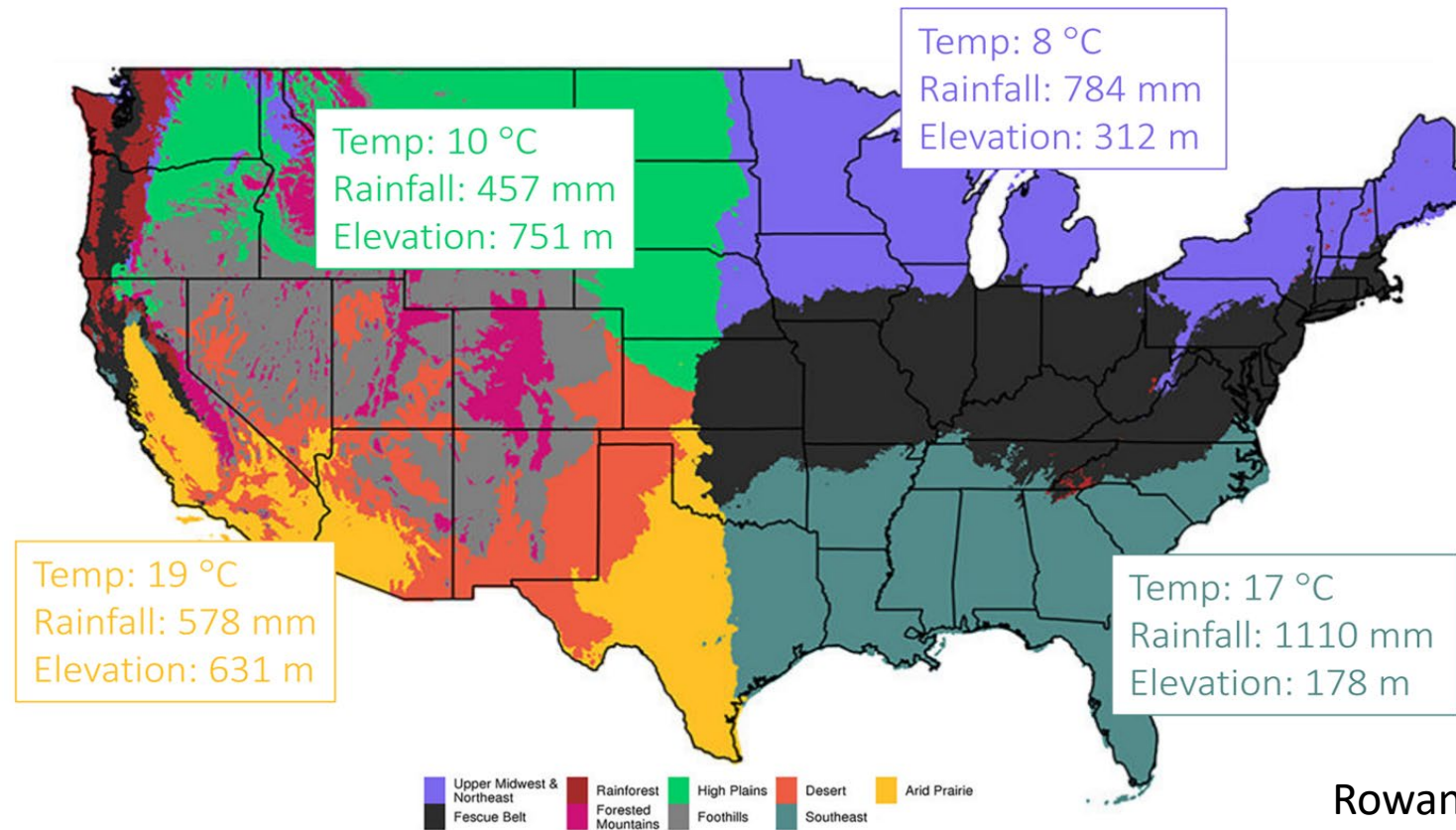


# Phenotype = Genetics + Environment + Management

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# Climatic regions

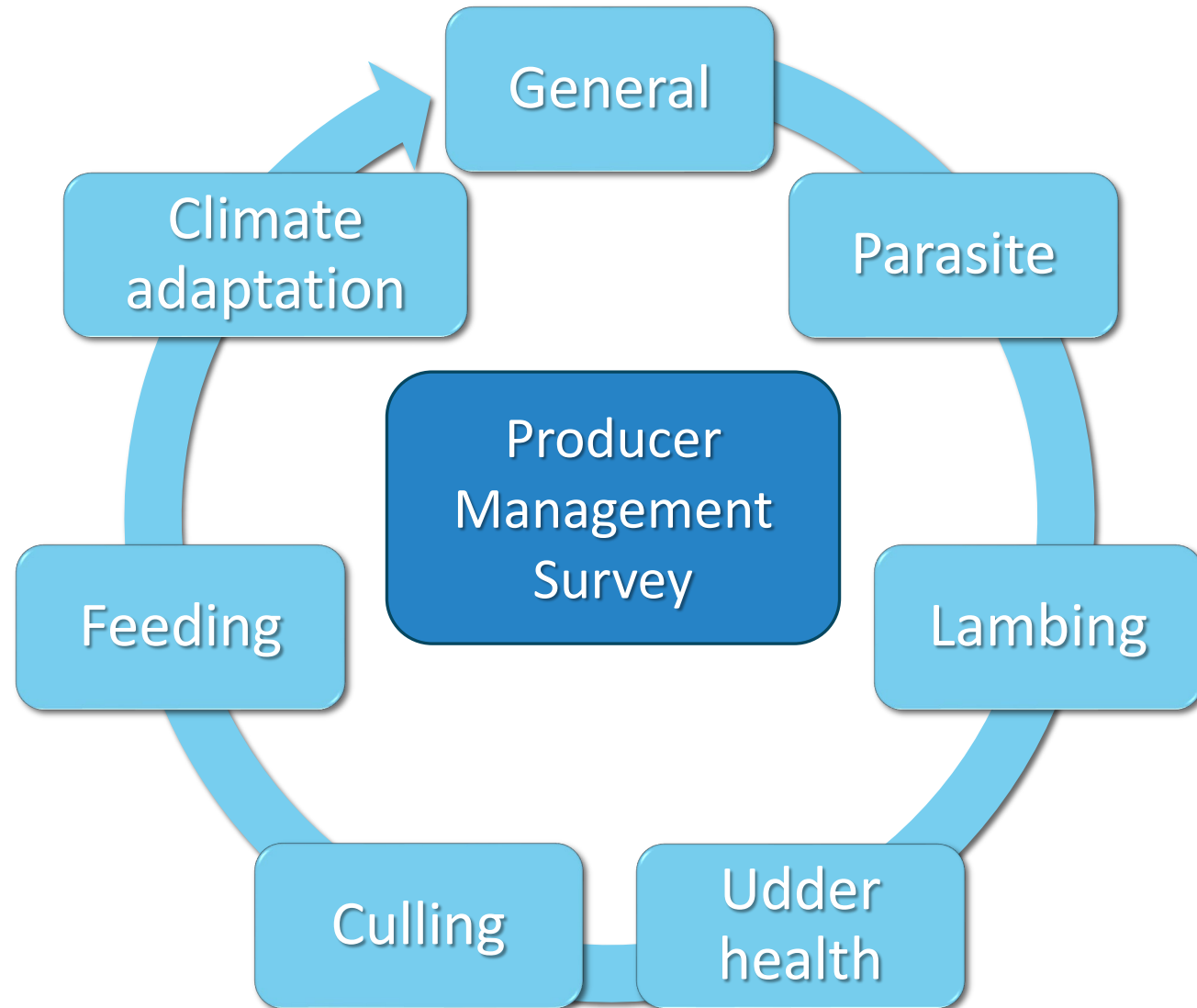


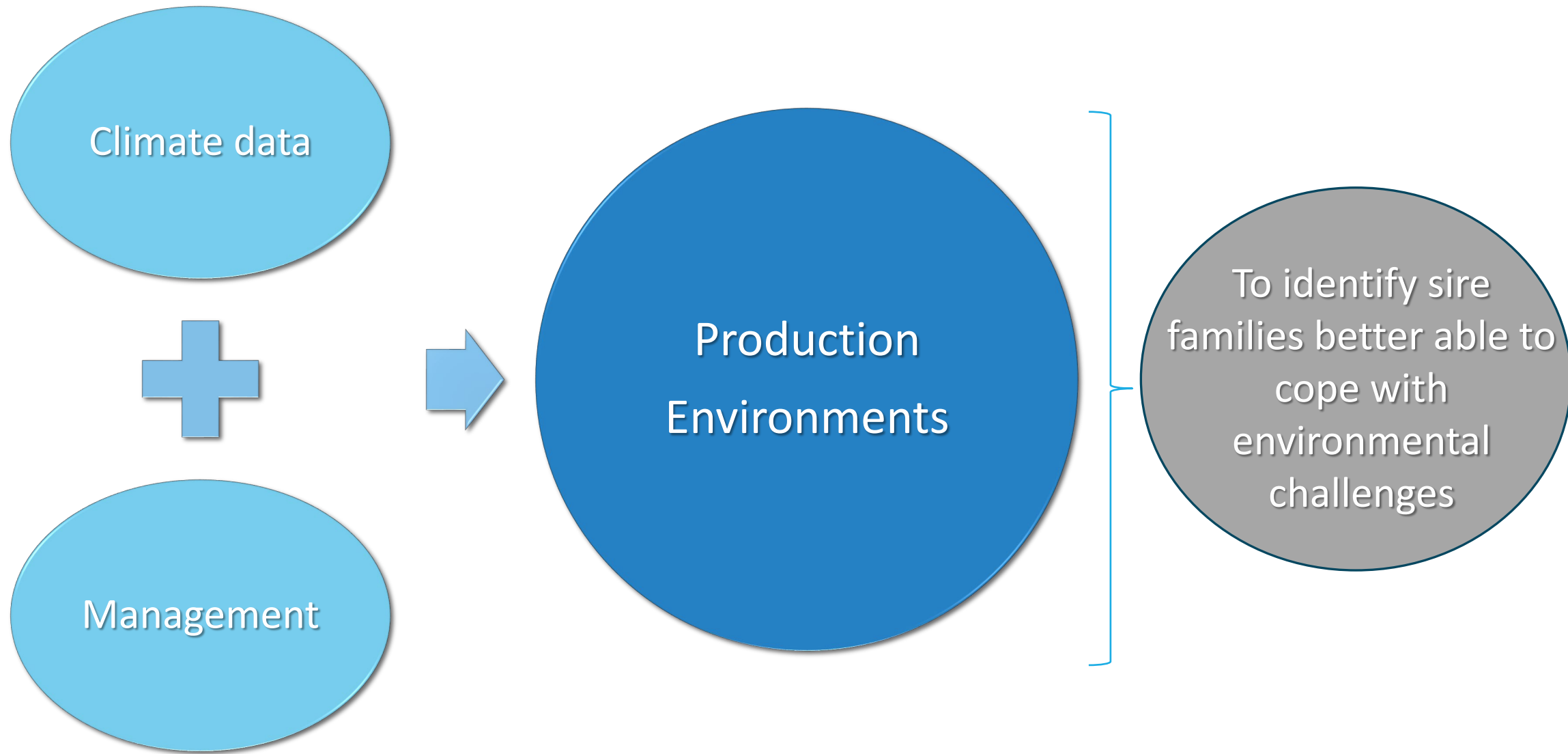
Rowan et. al (2022)

# By 2050, climate in many cities will be like southern cities today

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# Target breed groups (NSIP recorded)

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Katahdin



Polypay



Rambouillet



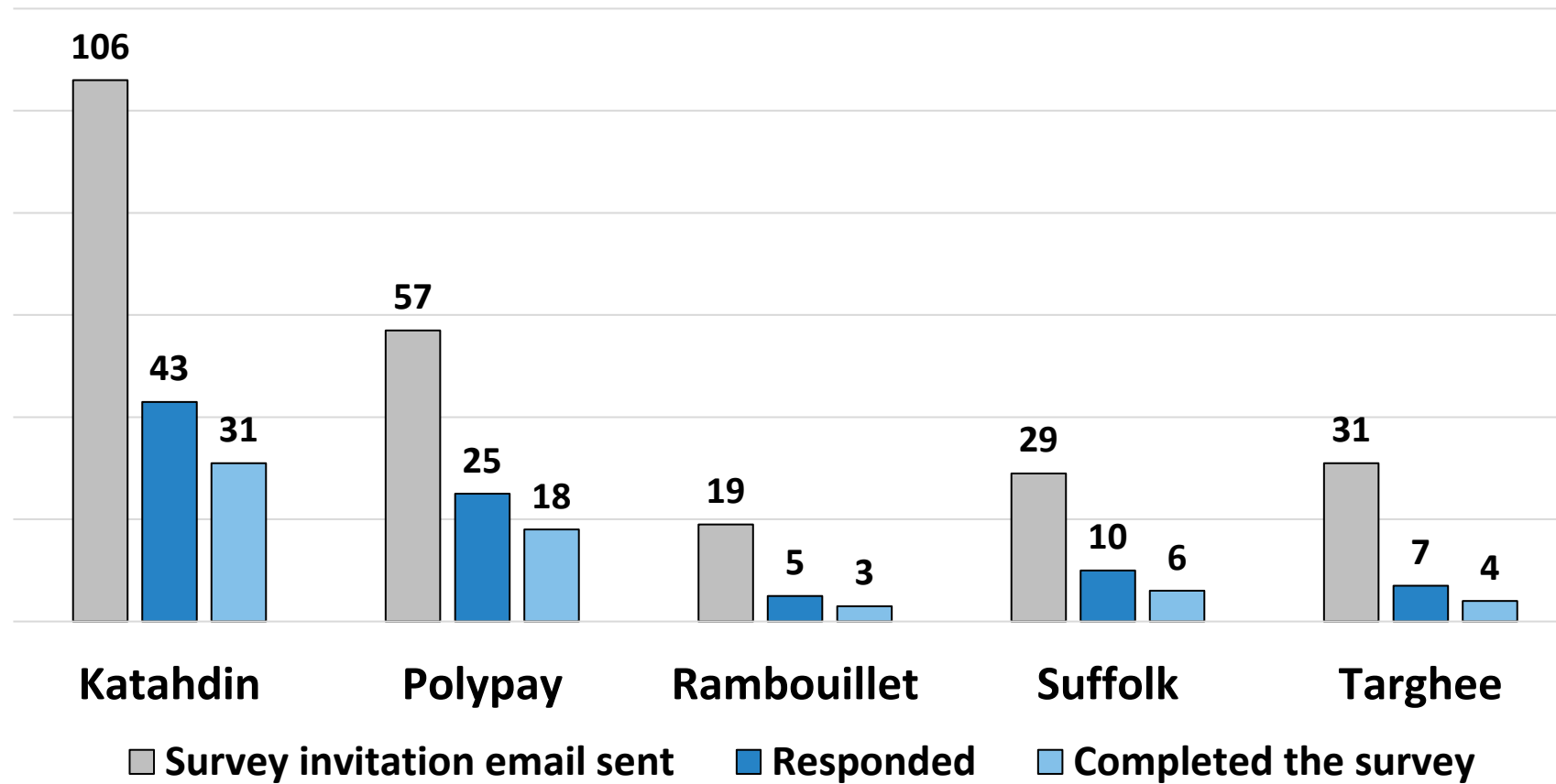
Suffolk

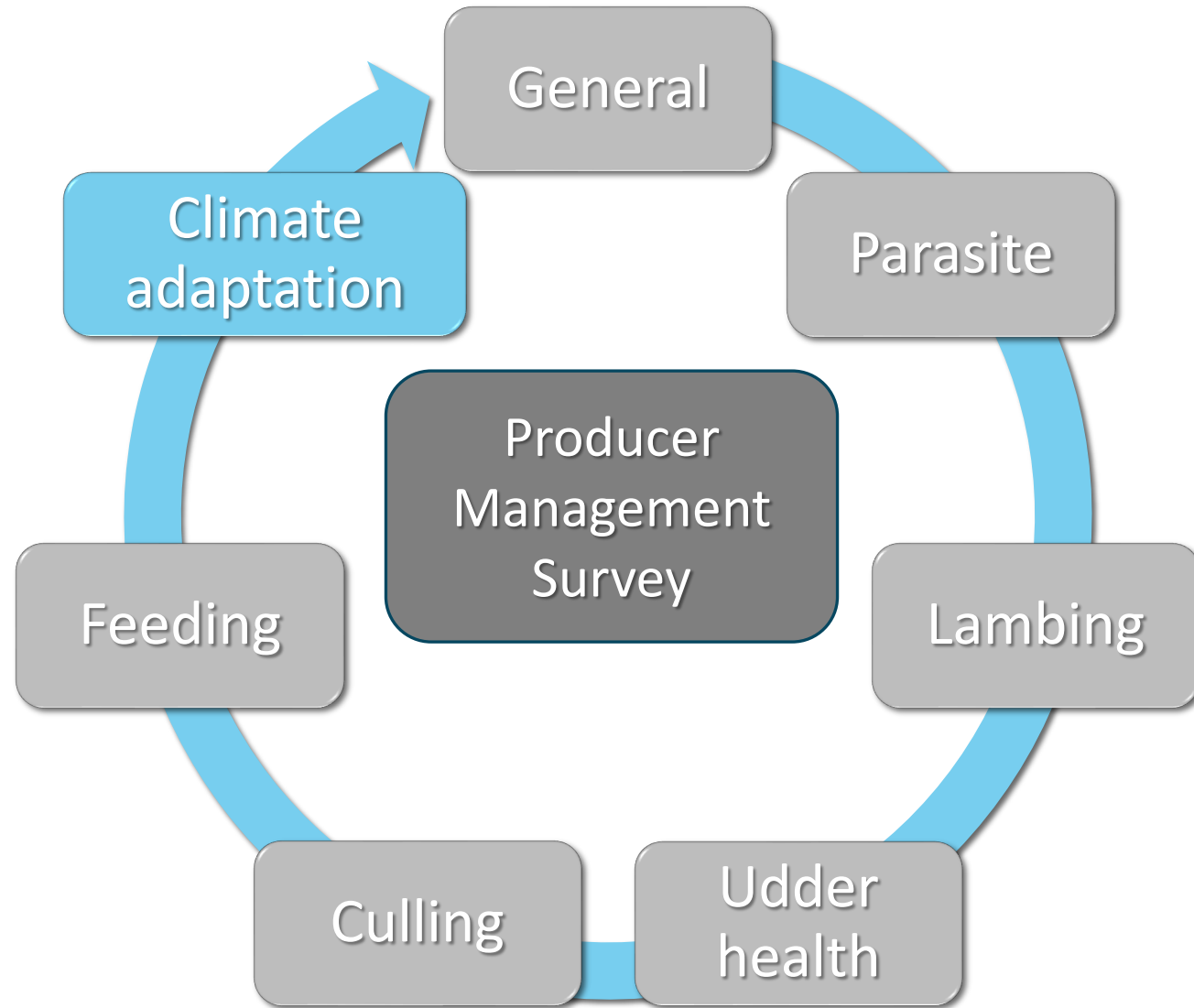


Targhee

# Survey response rate of breeds (preliminary results)

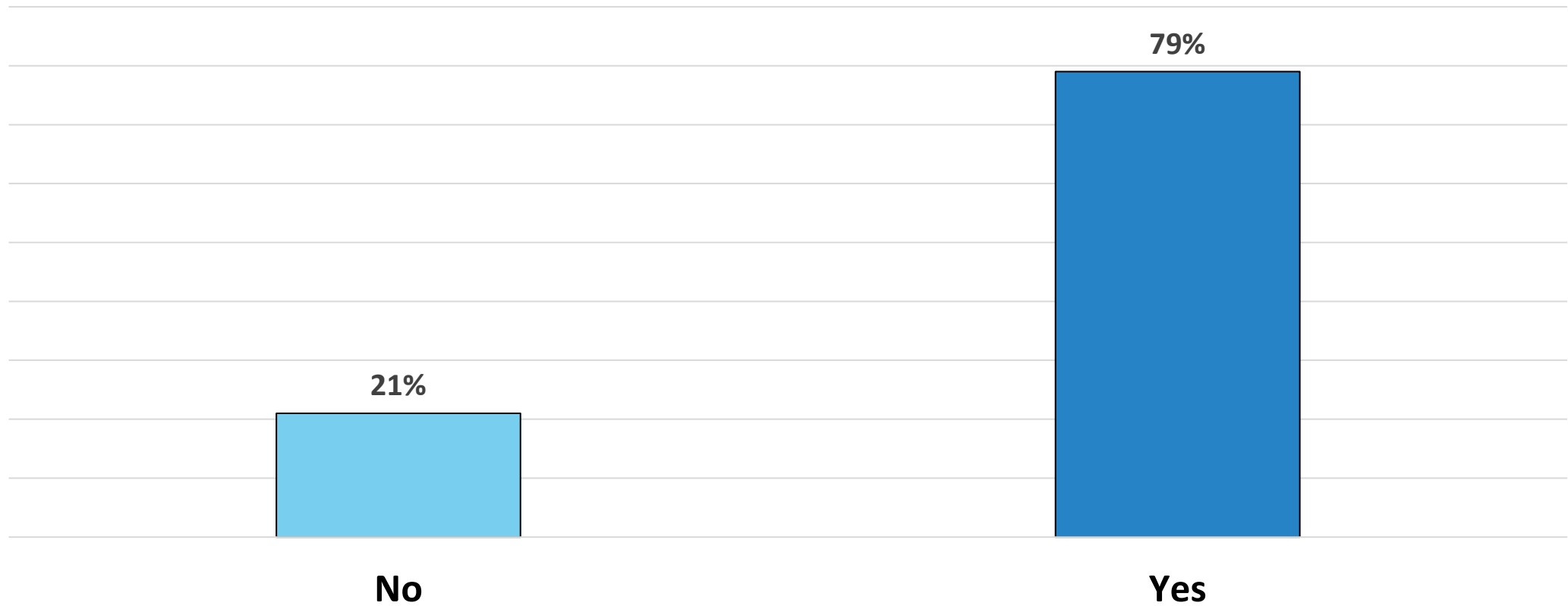
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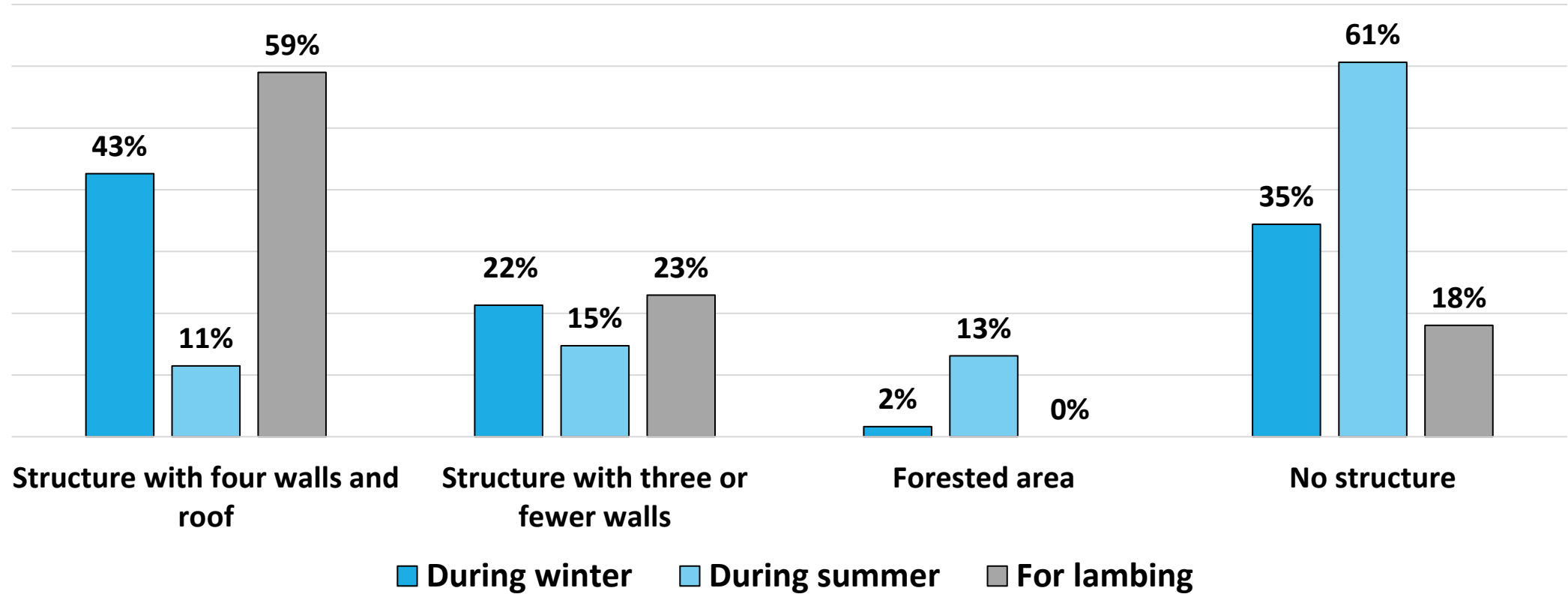


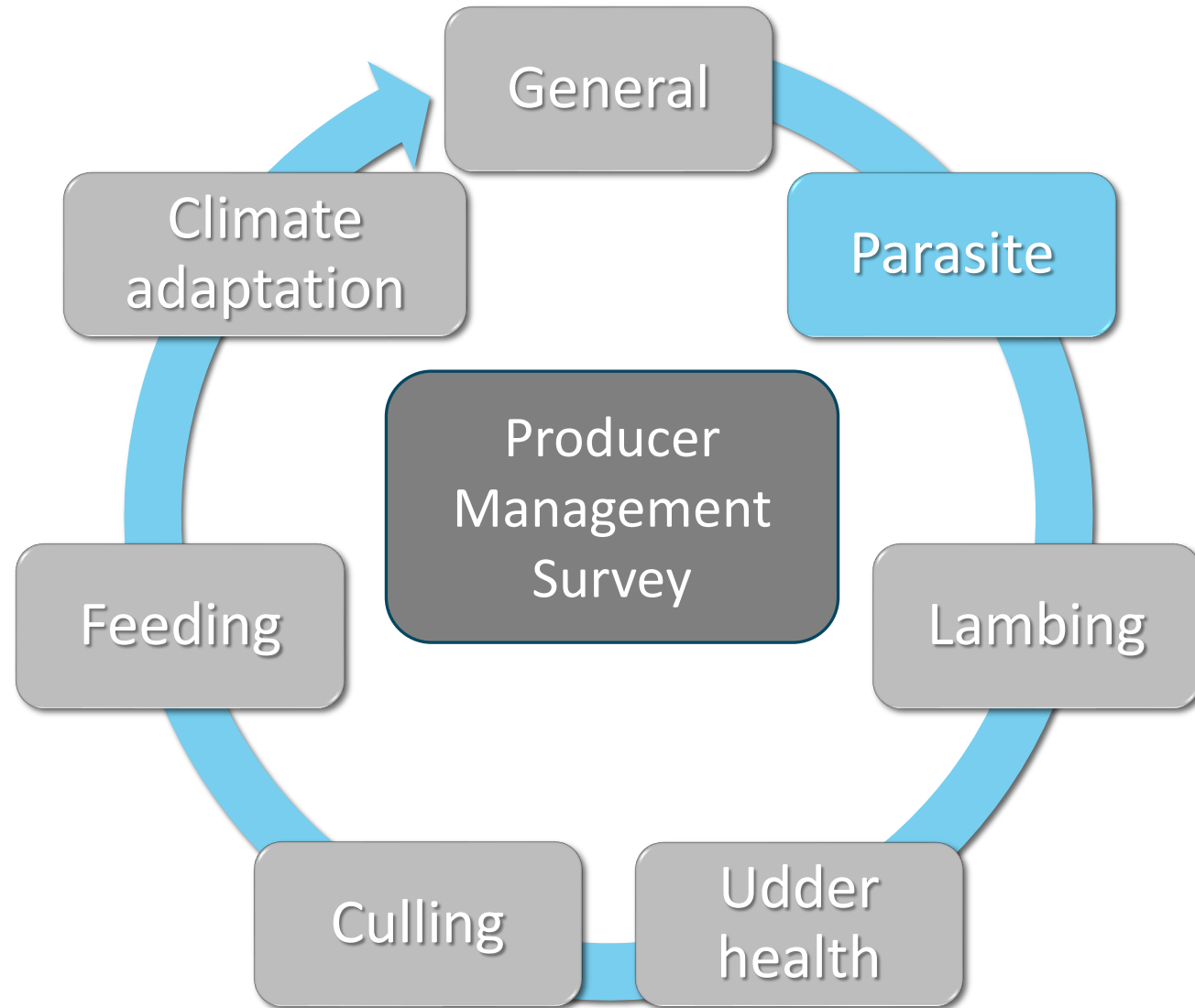


# Do you provide additional supplemental feed when the weather is cold?

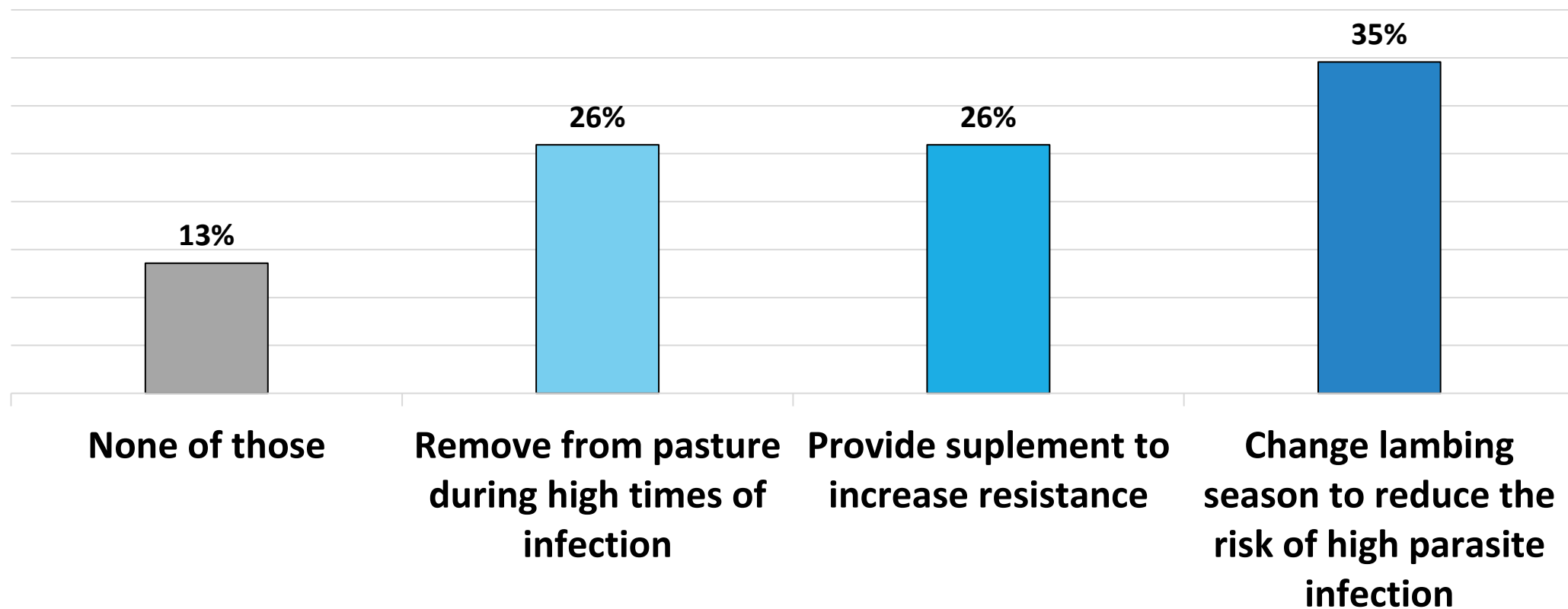


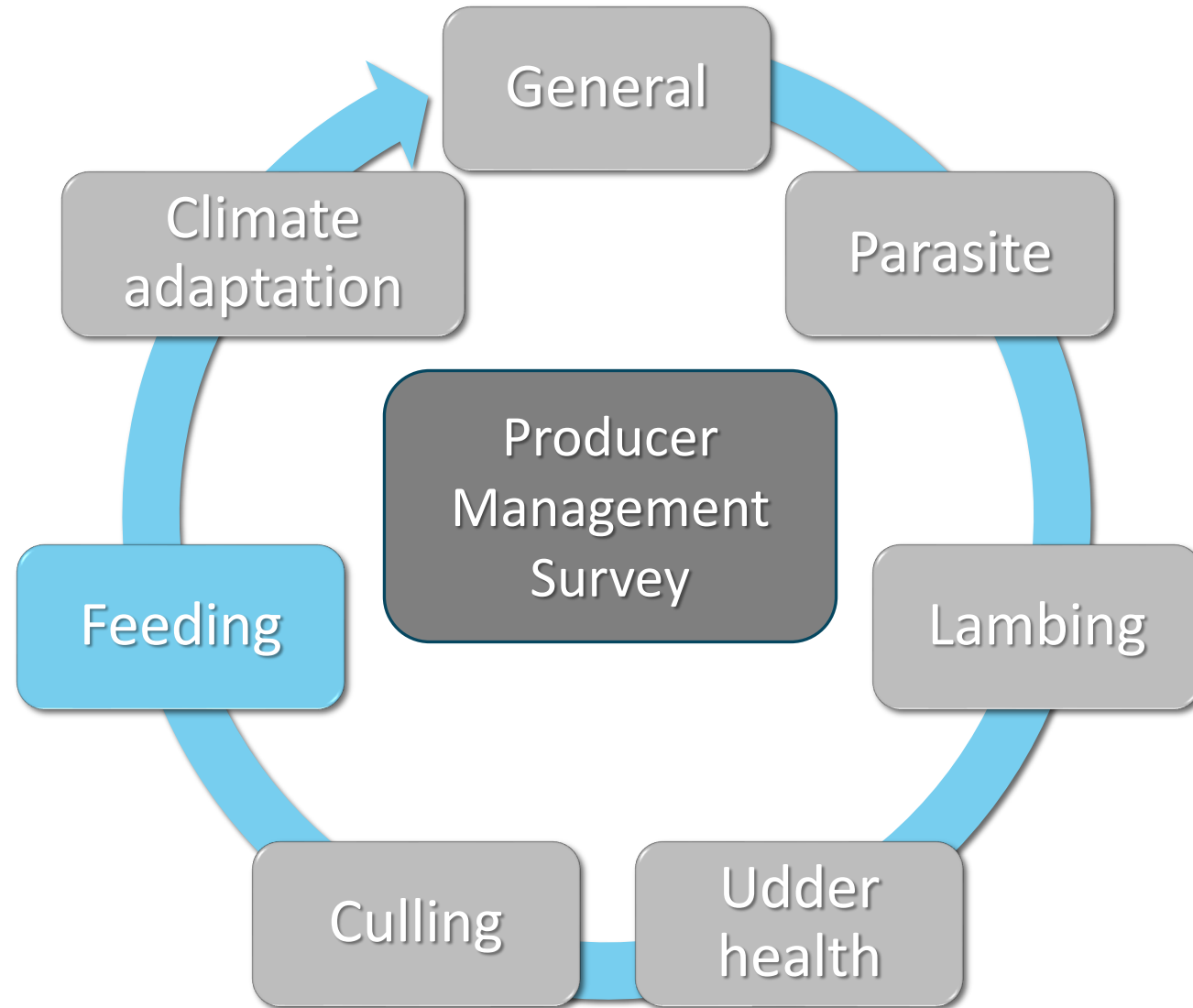
# Which of the following housing structures were used?



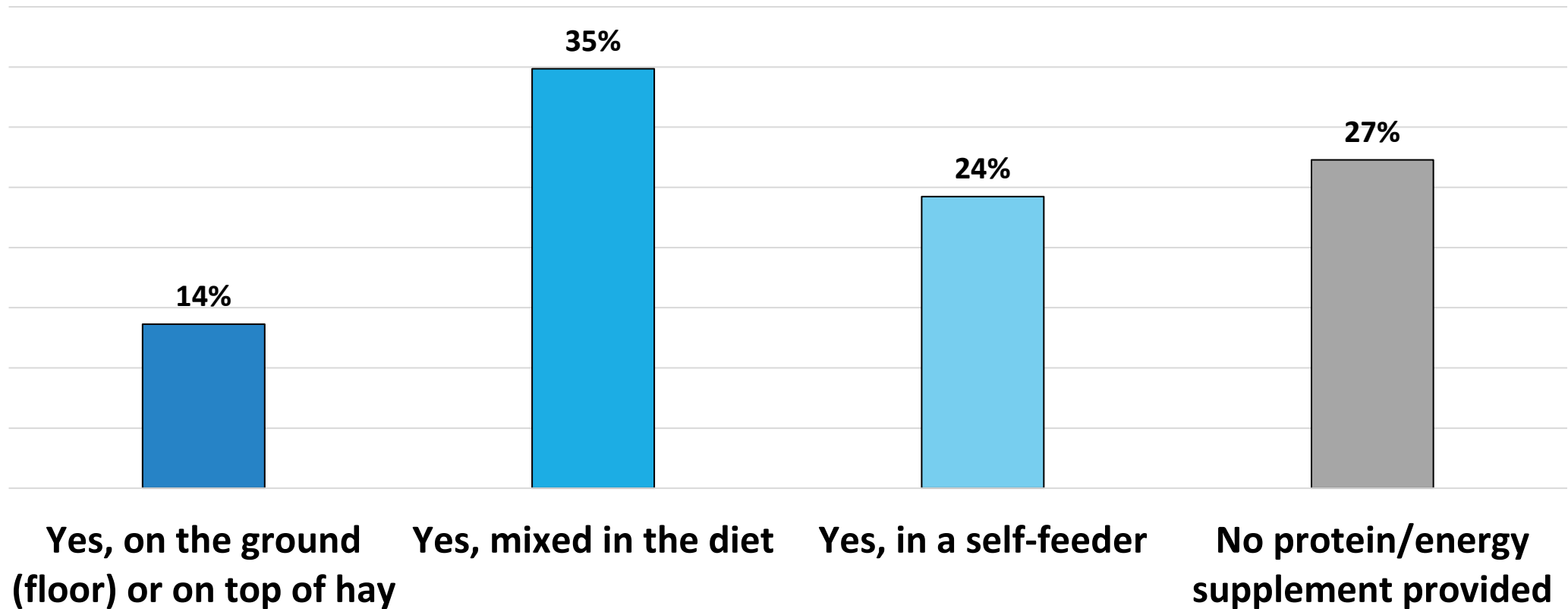


# Do you do any of the following as part of your internal parasite control program?





Do you provide protein/energy supplements to your flock? If so, how are the supplements provided?



# Interpretations

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- The survey provides snapshot of how U.S. sheep breeds are currently managed
- Parses management from phenotypes to better identify genetically robust and climatically resilient sire families

$$P = G + E + M$$

# If you are a NSIP member

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Katahdin



Polypay



Rambouillet



Suffolk



Targhee

**Please contact me by email**  
to contribute to this research and help  
improve robustness and climatic  
resilience of U.S. sheep populations

**My email address:**  
[hyazargunes2@huskers.unl.edu](mailto:hyazargunes2@huskers.unl.edu)



# Artur Oliveira Rocha

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- Bachelor Veterinary Medicine, Federal University of Piaui, Brazil (2021)
- Visiting Scholar, Purdue University (2021)  
“Evaluating genotyping strategies and statistical methods for prediction of genomic breeding values in U.S. sheep breeds”
- Began PhD studies, Purdue University (Aug. 2022)

Impact of genomic information  
inclusion in genetic evaluation

# Research questions

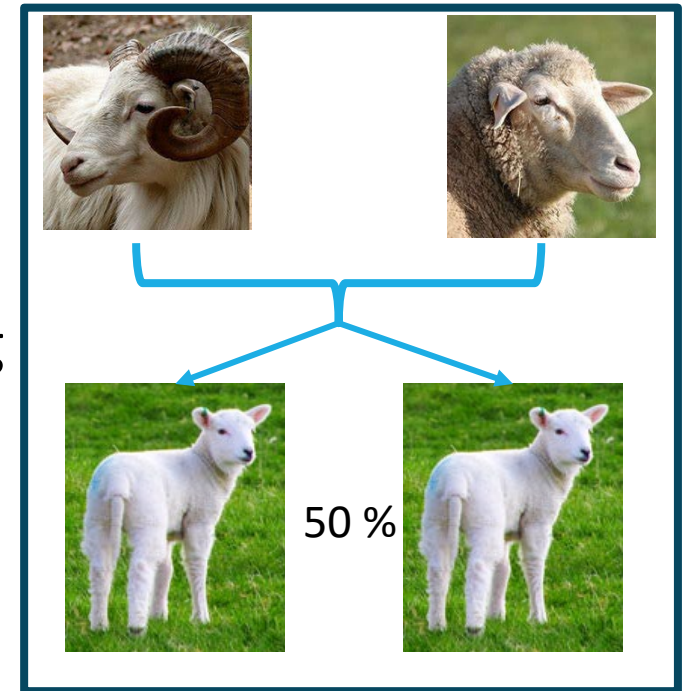
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1. Do errors in the pedigree data impact the accuracy of estimated breeding values (EBV)?
2. Does including genotypes improve the accuracy of EBV in sheep populations?

# Improving the accuracy of estimated breeding values

Estimated  
breeding  
values  
(Pedigree)

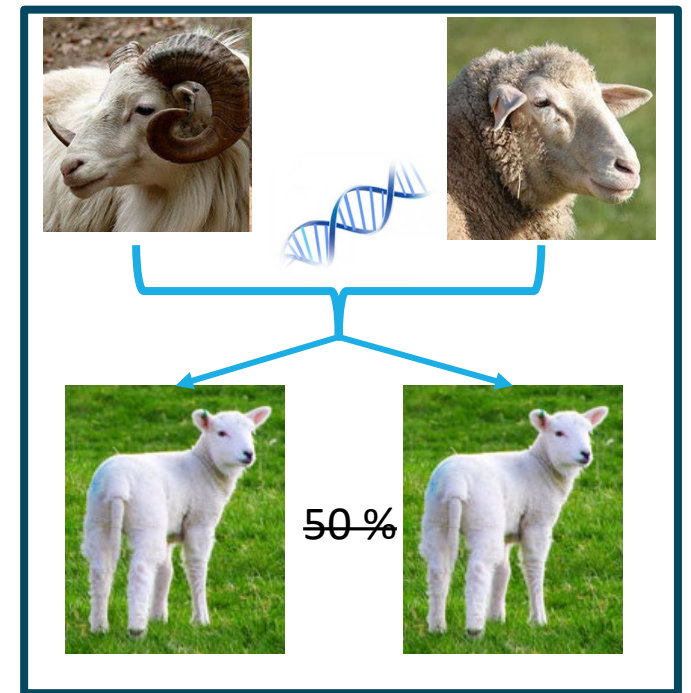
- Well-known and adopted in national sheep evaluation
- Producers can benefit from the EBV for selecting their animals



# Improving the accuracy of estimated breeding values

Estimated  
breeding  
values  
(Genomics)

- Gives us GEBV
- Genotyping still has a higher cost relative to the animal cost



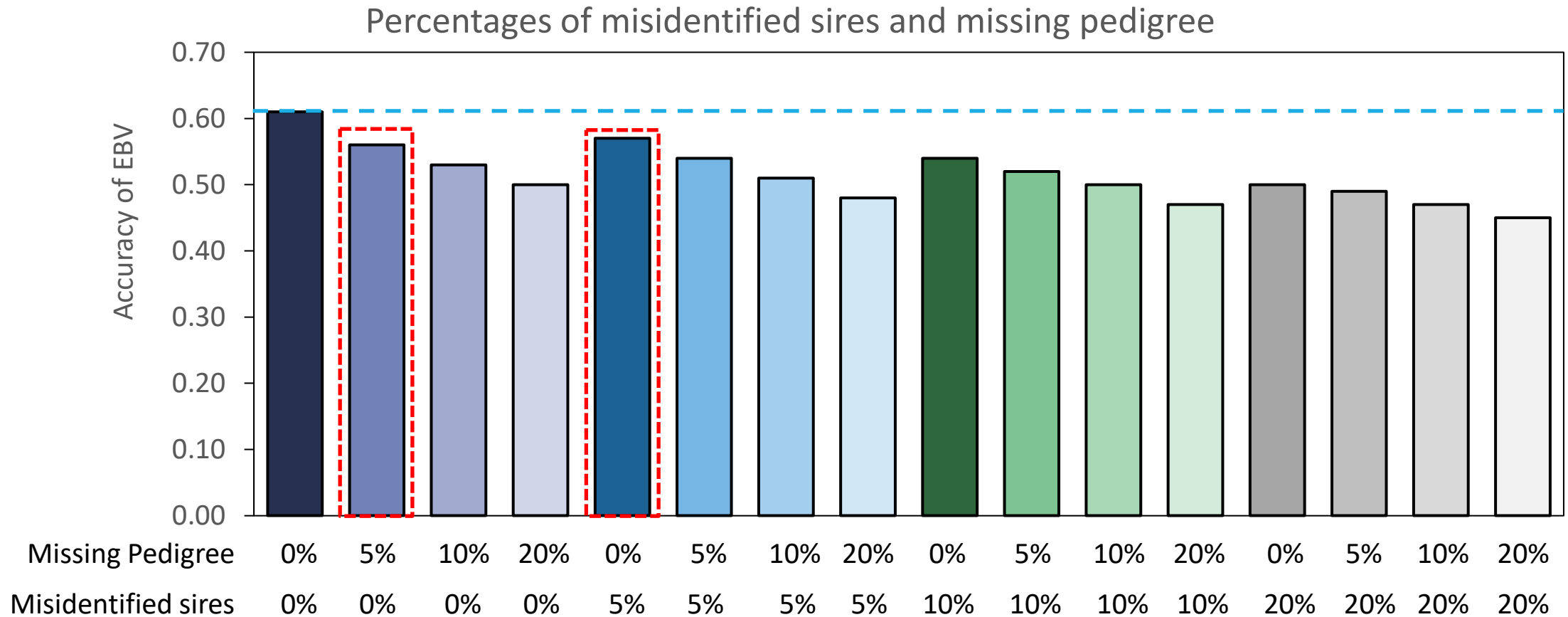
# Data set

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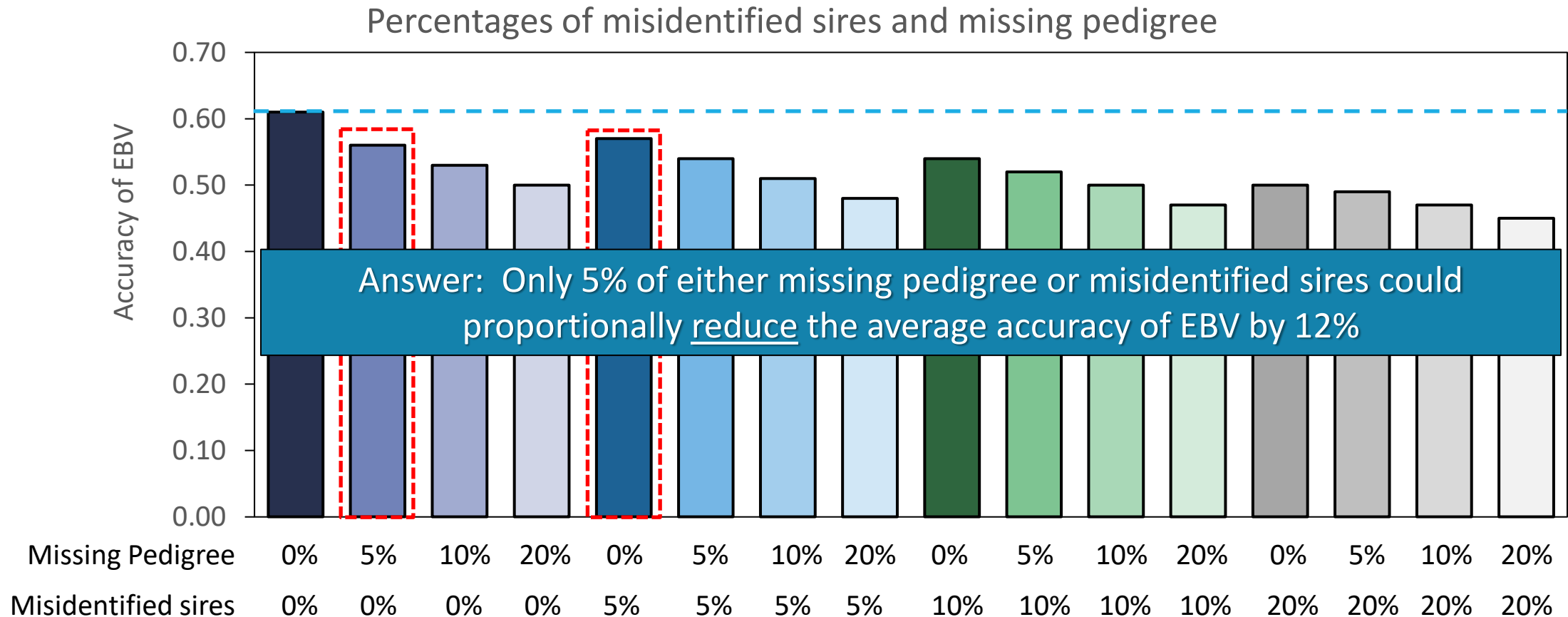
- Composite sheep population was simulated, mimicking flocks and regions in the U.S. for four years
  - Post-weaning weights (PWT): 20,000
  - Animals in the pedigree: 23,000
  - Genomic data: 20,000 animals genotyped (medium density panels)
- Scenarios for comparing accuracy
  - Proportion of missing pedigree
  - Proportion of misidentified sires
  - Proportion of animals with genotypes

Pedigree errors

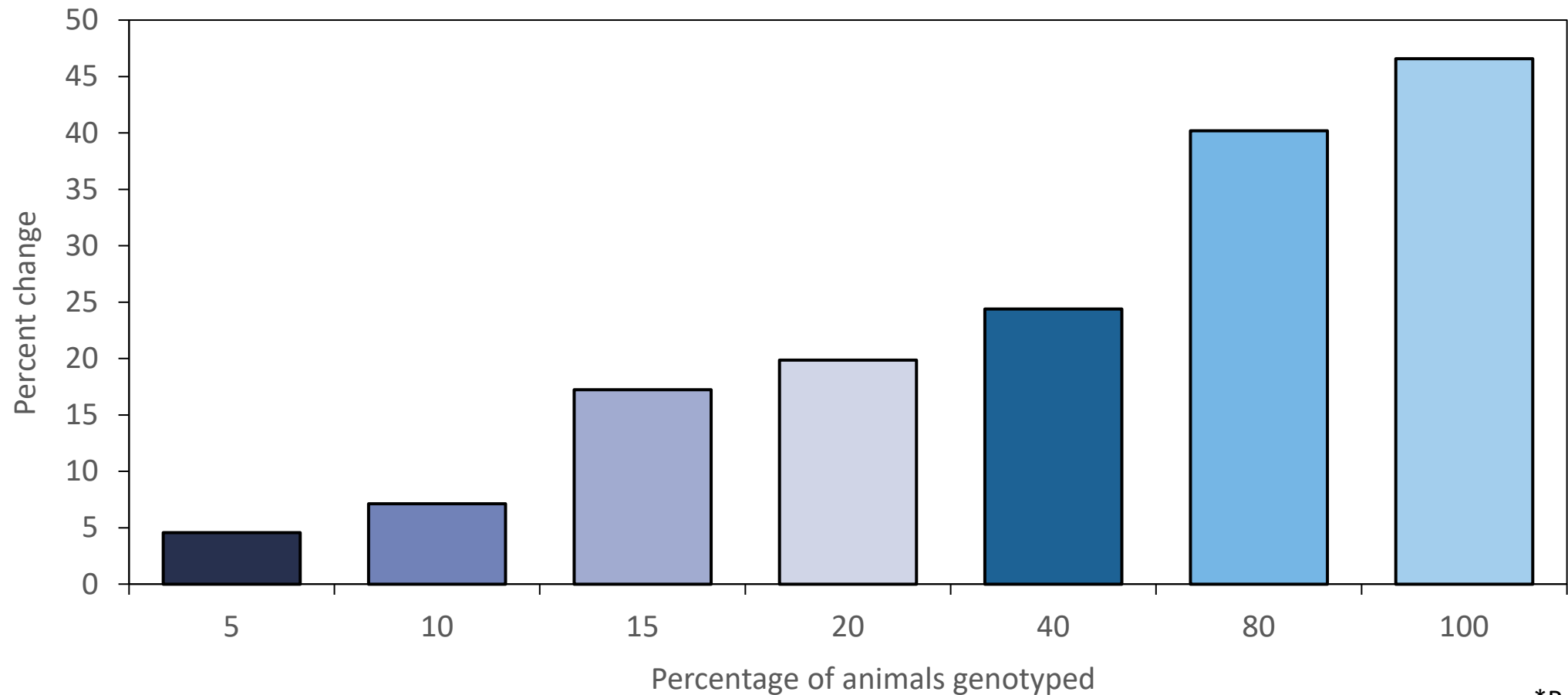
# Do errors in the pedigree data impact the accuracy of EBV?



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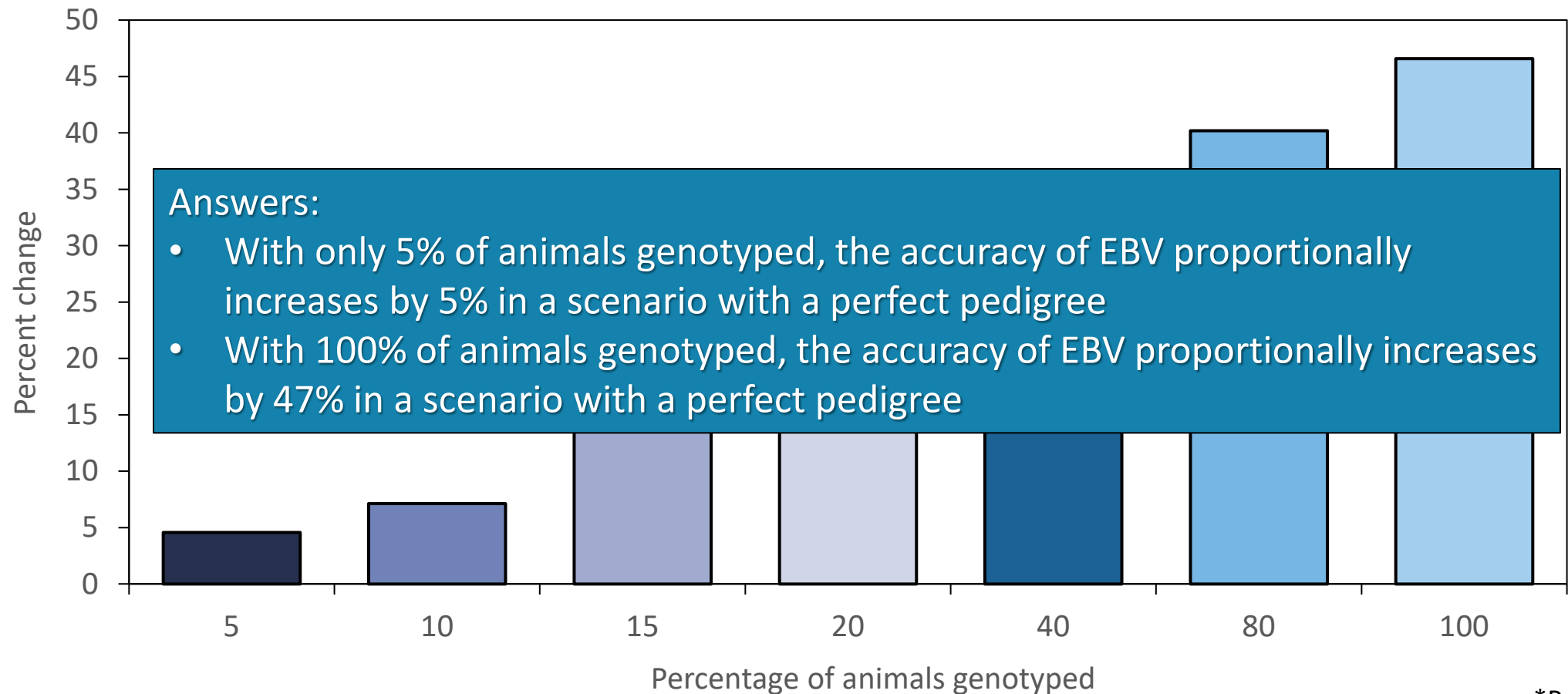
# Does including genotypes improve the accuracy of EBV in sheep populations?



\*Perfect pedigree

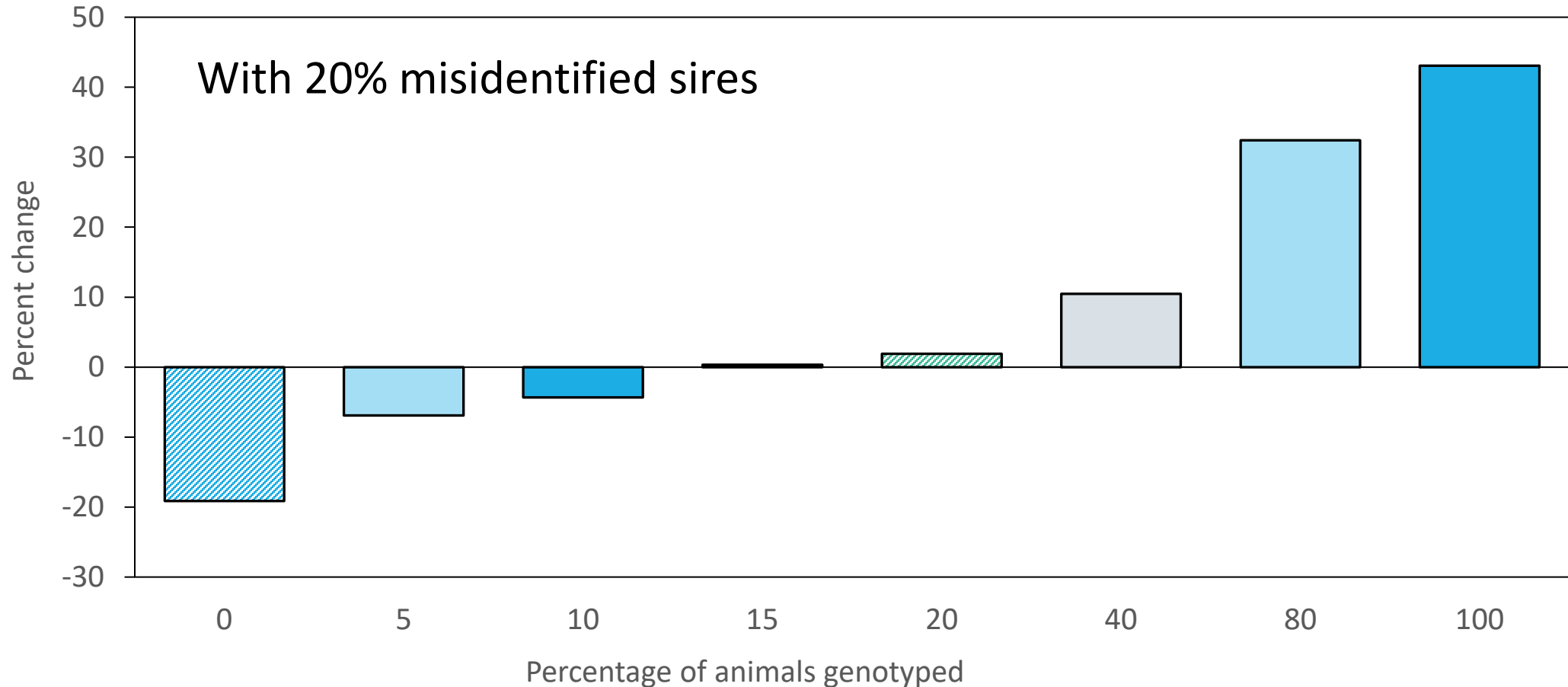


# Does including genotypes improve the accuracy of EBV in sheep populations?

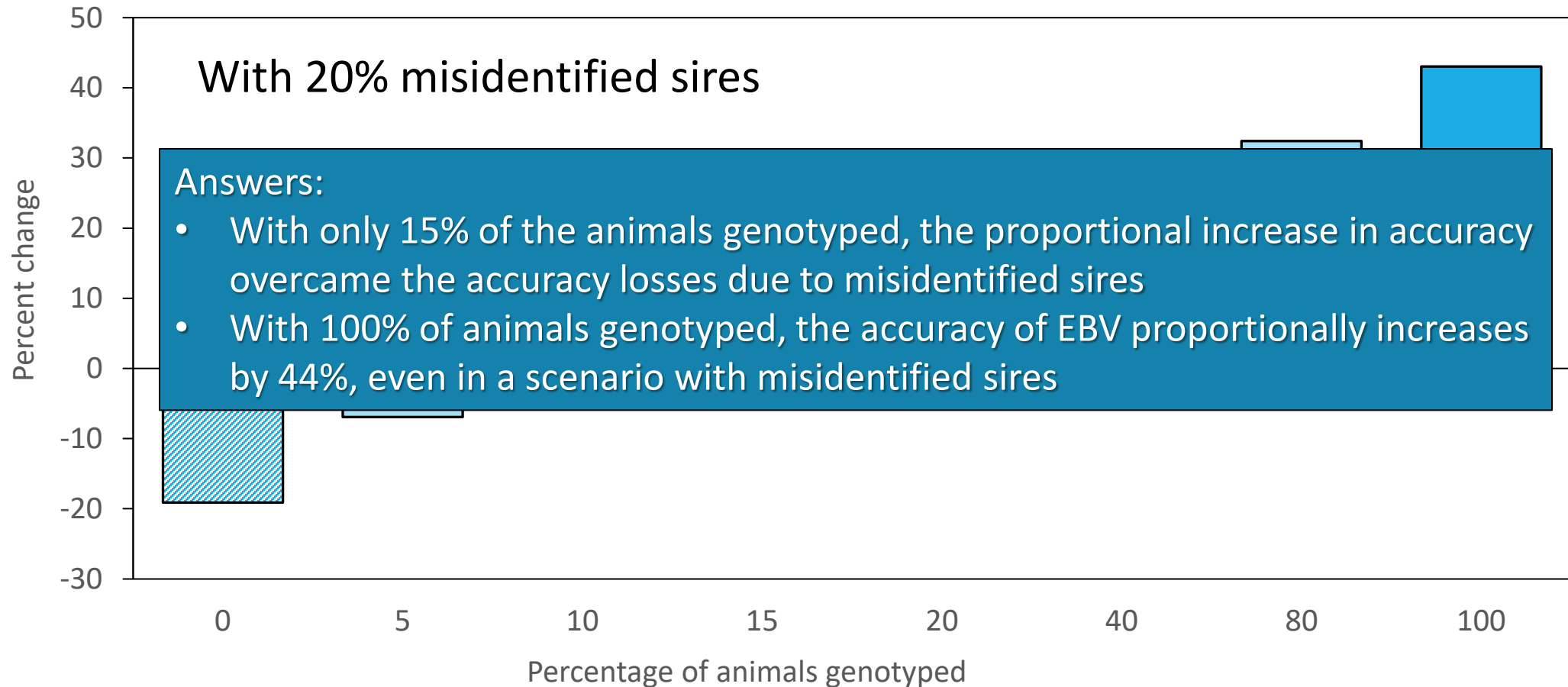


\*Perfect pedigree

# Does including genotypes improve the accuracy of EBV in sheep populations?



# Does including genotypes improve the accuracy of EBV in sheep populations?



# Answers

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1. Do errors in the pedigree data impact the accuracy of EBV?

Yes, even a small proportion of misidentified sires and missing pedigree information can reduce the accuracy of breeding values by a considerable amount

2. Does including genomic information improve the accuracy of EBV in sheep populations?

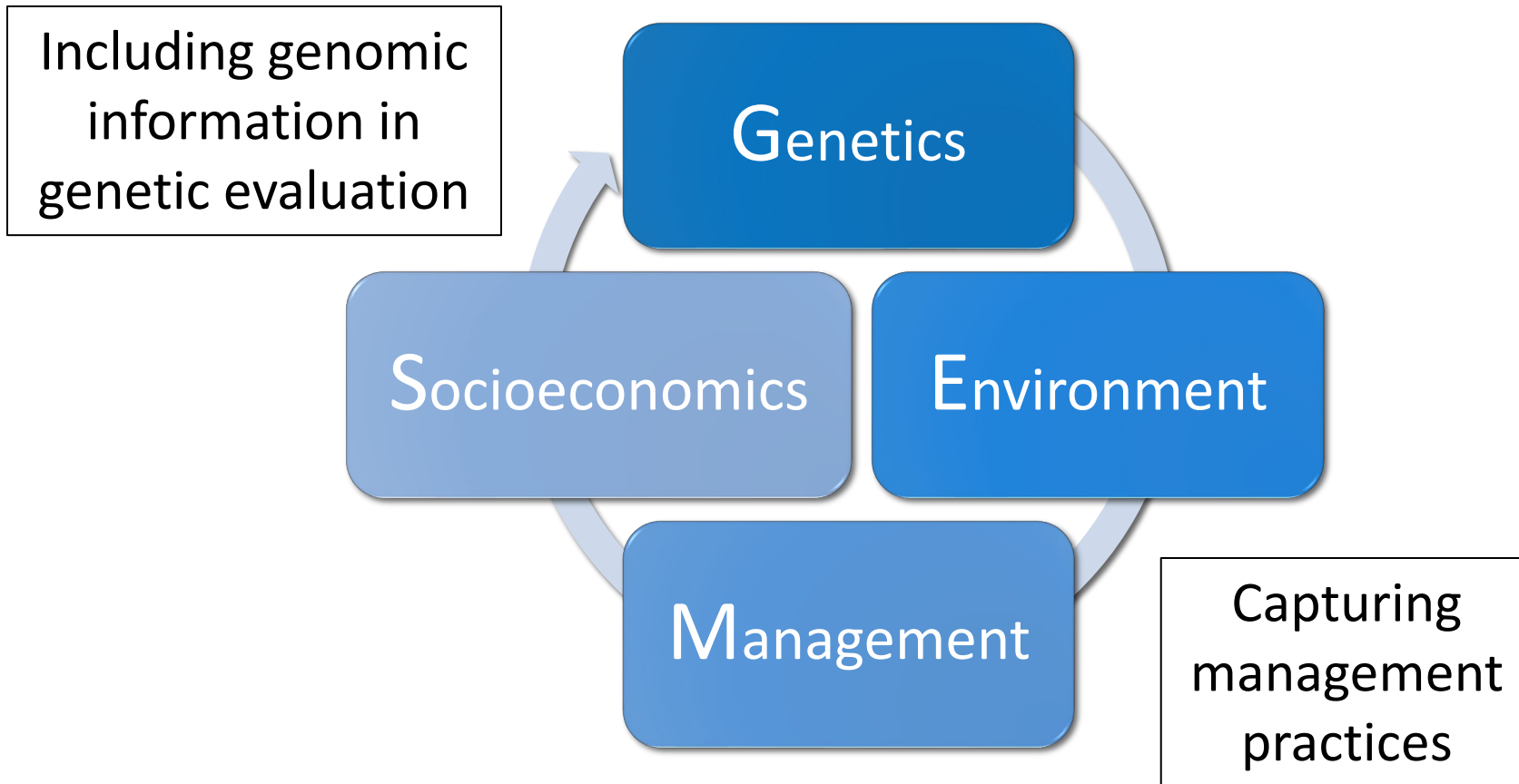
Yes, genomic information will be able to correct for pedigree errors and also increase the accuracy of breeding values in sheep populations

# Interpretations

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- Even with a limited number of animals genotyped, genomics was able to improve the accuracy of EBV and correct for pedigree errors
- Continuing genotyping is crucial for future improvements and increasing genetic gain over generations

# Sheep GEMS



# Thank you

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Finewool Breeders Consortium



# Thank you

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- Project Advisory Board

Matt Benz, Harvey Blackburn (Senior Scientist), Tom Boyer (Chair), Rusty Burgett, Brad Carothers, Alan Culham, Mike Duff, Lynn Fahrmeier, Jeremy Geske, Andrew Hess (Junior Scientist), Russell Kott, Dan Macon, Mark Meurer, Ben Pejsar, Bill Shultz, Todd Taylor, Cindy Wolf (Veterinarian)

- Producer Advisory Group

John Anderson, John Bare, Matt Benz, Kristin Bieber, Gavin Blonquist, Rusty Burgett, Michelle Canfield, John Carlson, Amanda Everts, Lynn Fahrmeier, Jeremy Geske, Tom Hodgman, Russell Kott, Zach Meinders, Jim Morgan, Wacy Ortmann, Brett Pharo, Brenda Reau, Bill Shultz, Todd Taylor



# Questions



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