Update on GEMS project

Ron Lewis

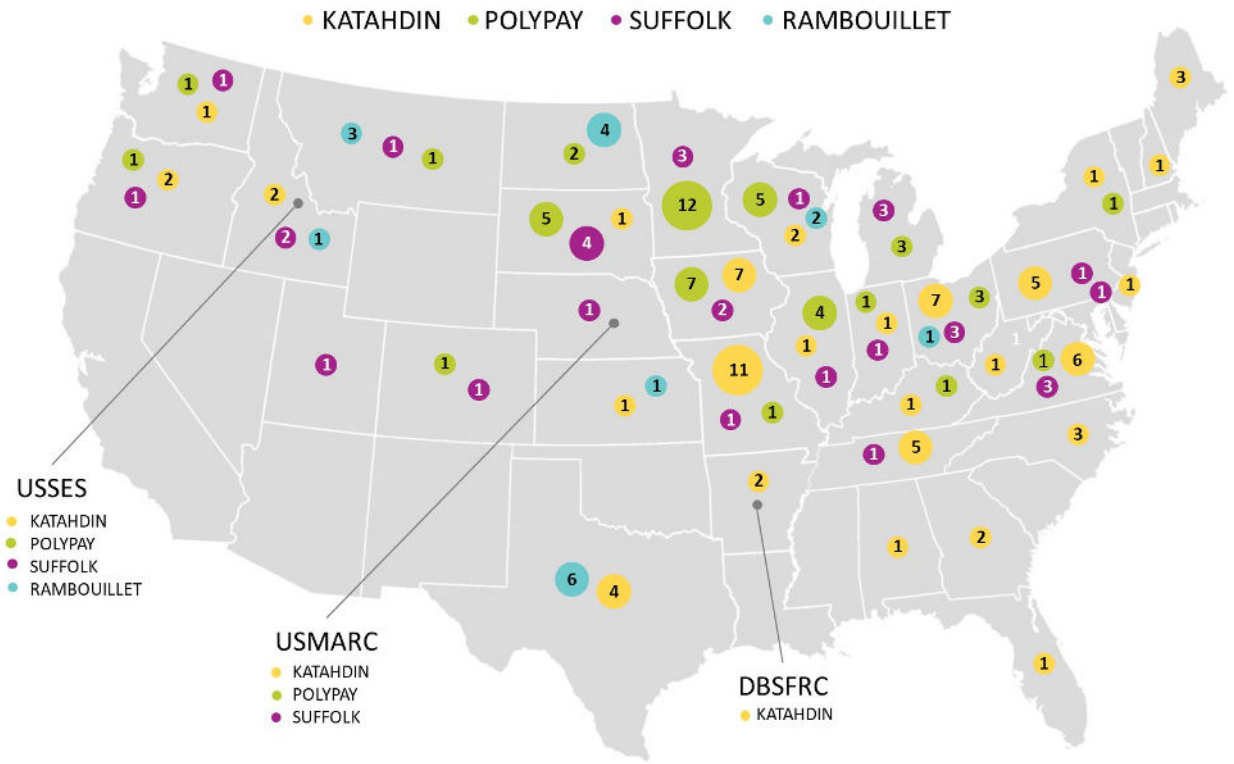
ASI Annual Convention
Genetics Forum (Jan. 16, 2025)

University of Nebraska Lincoln

USDA ARS

Purdue University

Introduction

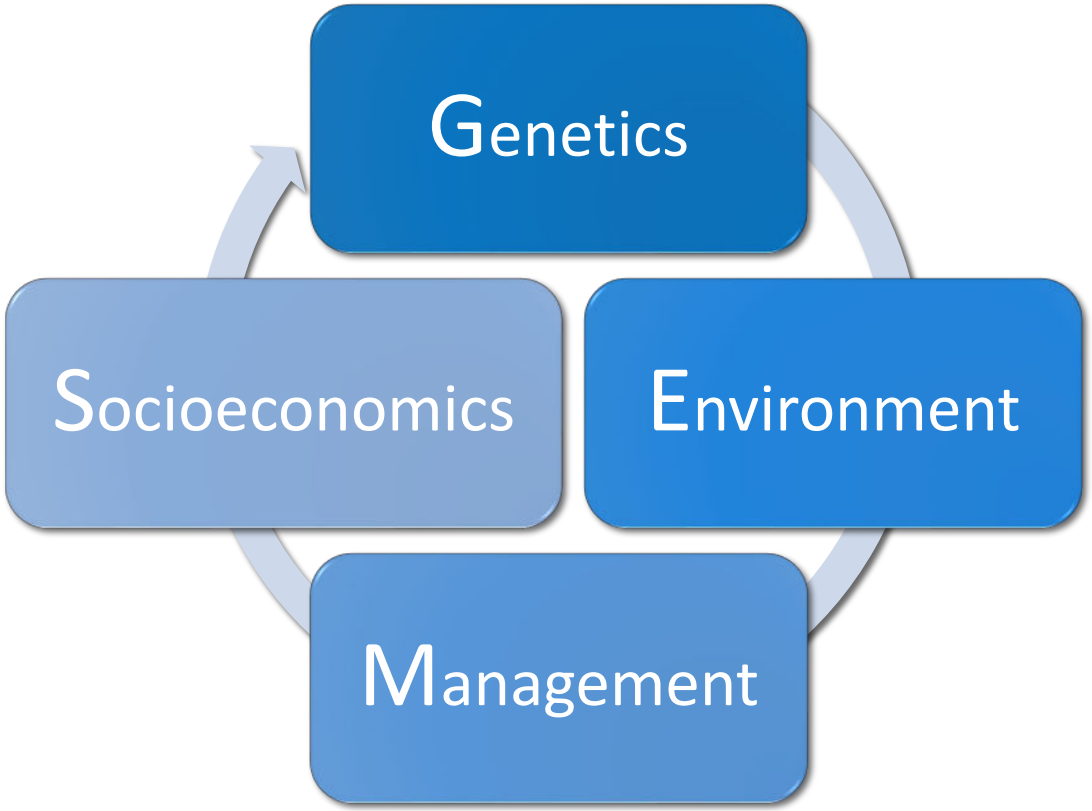


- Sheep industry
  - A variety of sheep breeds
  - A range of climates and management systems
- Need to breed robust animals that perform well under these conditions
- Key to the industry's economic sustainability

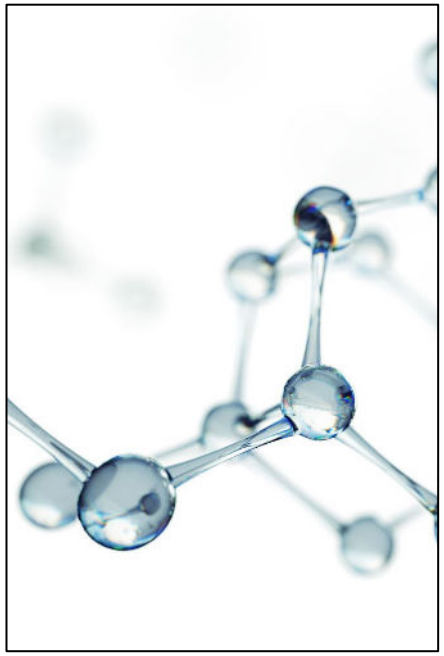
Objectives

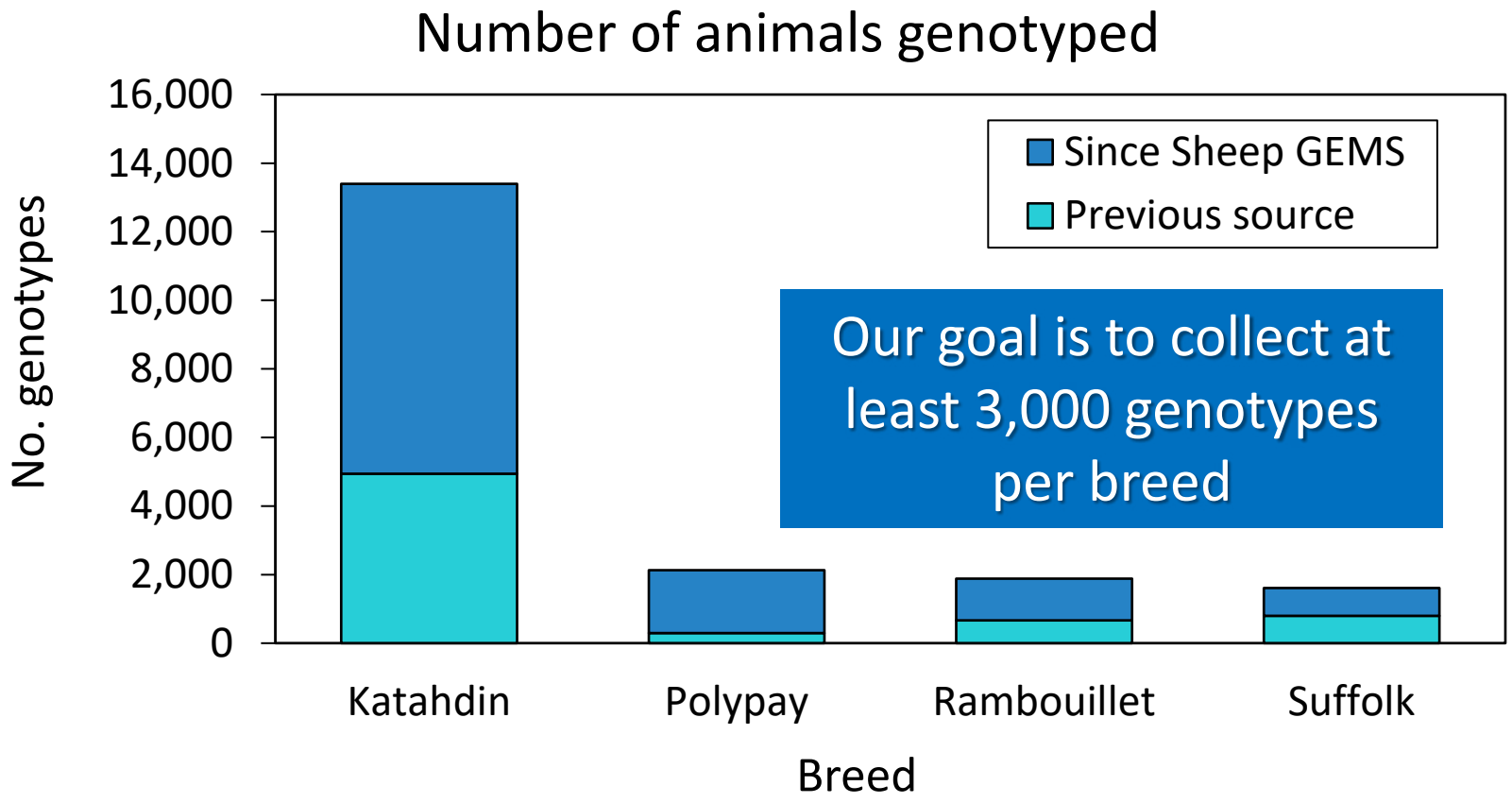
- Evaluate key robustness and climatic resilience traits
  - Lamb survival, ewe longevity, udder health, parasite resistance
- Build genomic reference populations in several U.S. sheep breeds for these traits
- Evaluate genotyping strategies and methods for genetic evaluation to incorporate these traits into breeding objectives

Sheep GEMS

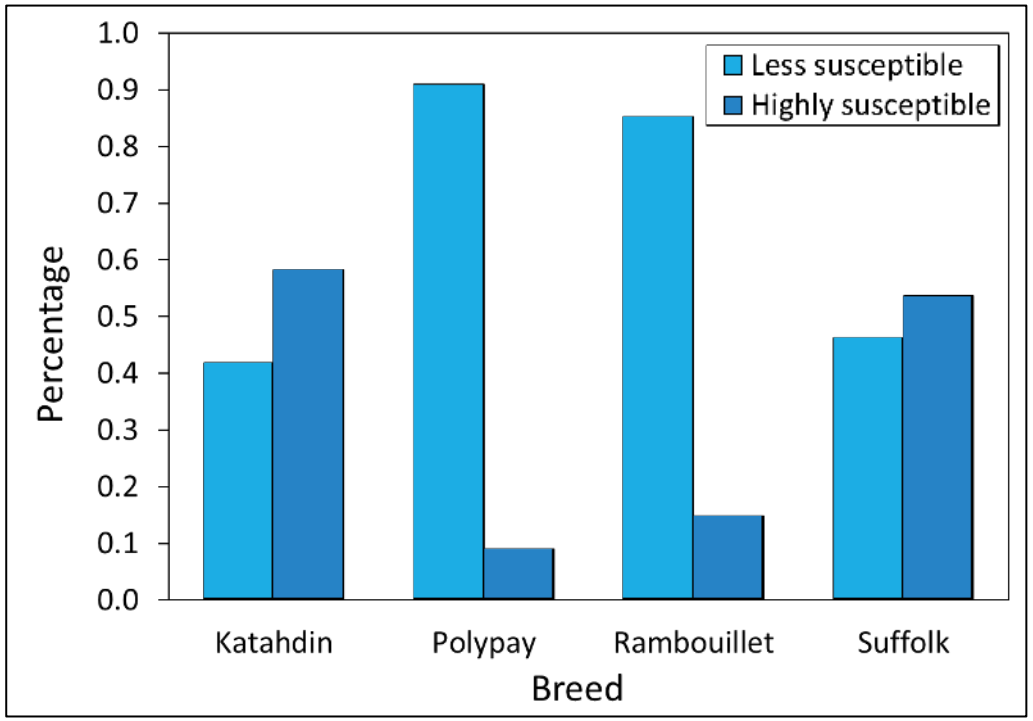


Genetics



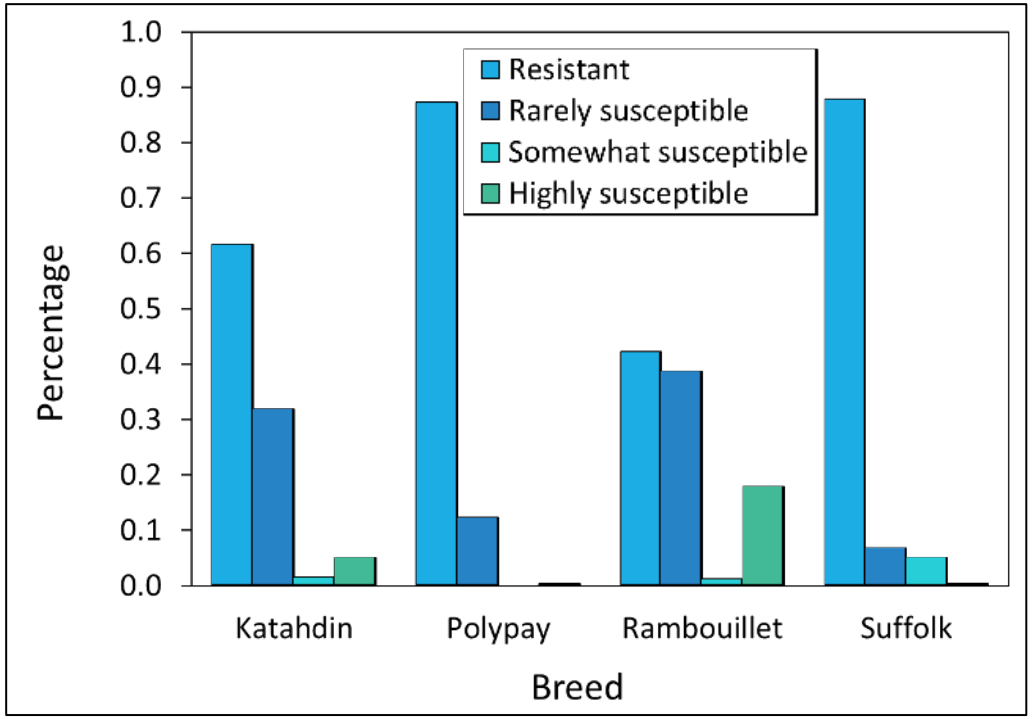

Number of animals genotyped
No. genotypes
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Since Sheep GEMS
Previous source
Our goal is to collect at least 3,000 genotypes per breed
Katahdin
Polypay
Rambouillet
Suffolk
Breed

Genetic conditions



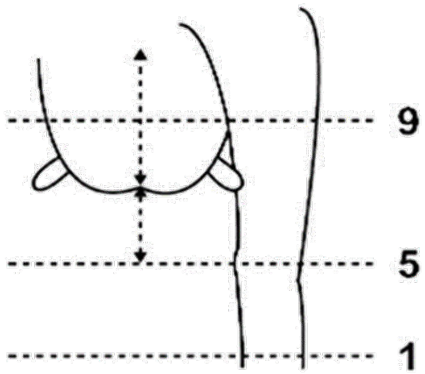
Ovine Progressive Pneumonia (OPP) susceptibility

Scrapie susceptibility

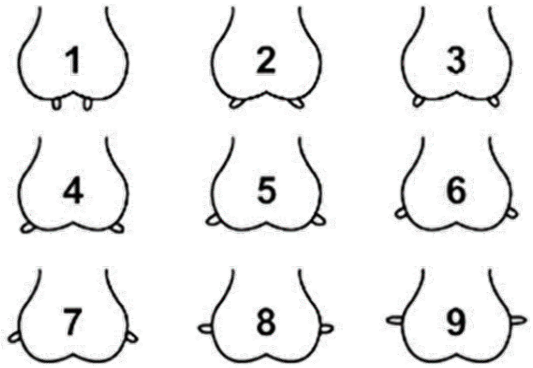


Genetic evaluation of robustness traits

Udder depth



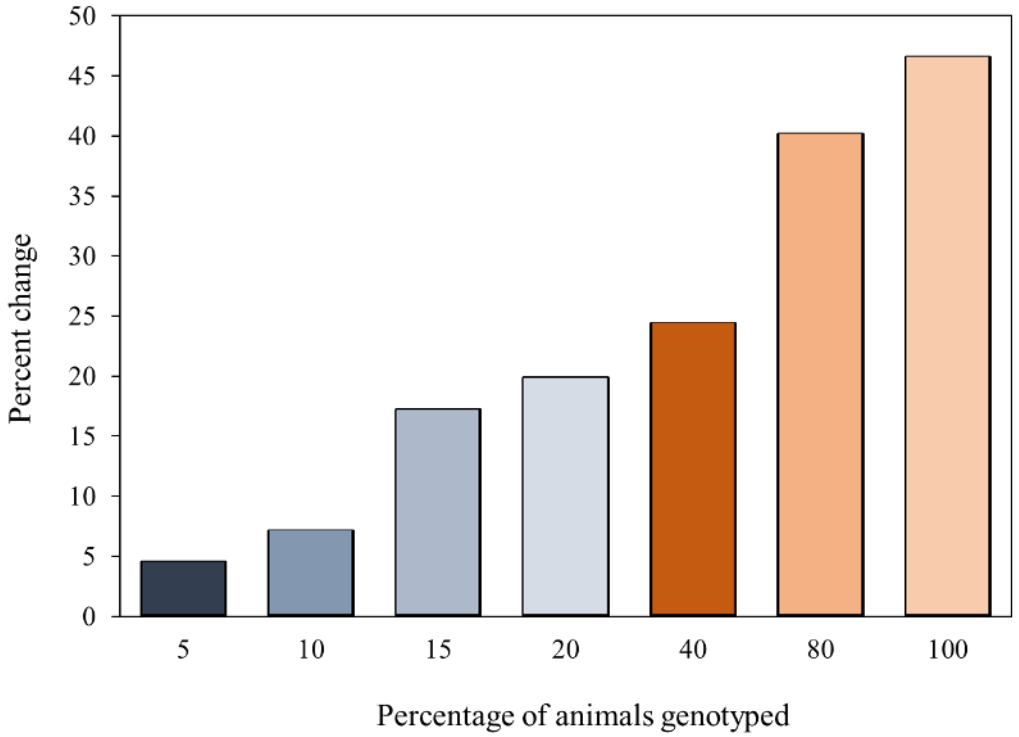
Teat placement



- Evaluated udder depth and teat placement in Polypay sheep
  - Heritable (~35%) and highly (negatively) genetically correlated
- Defined eight ewe longevity traits in Katahdin sheep
  - Heritable (6% to 15%) and highly (positively) genetically correlated
- Can therefore improve through selective breeding
  - More so once incorporating genomic information

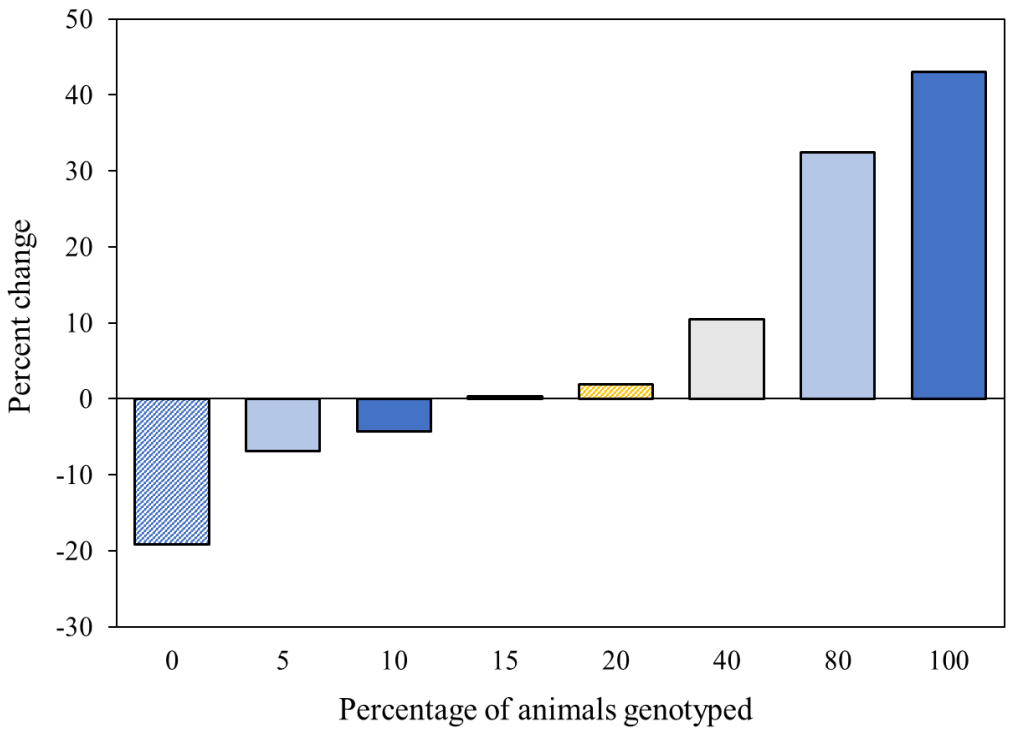
(Pinto et al., 2024, 2025)

Genotyping strategies



- Percent change in accuracy as more animals genotyped
  - Gradual yet substantial improvements

Genotyping strategies



- Percent change in accuracy as more animals genotyped
  - Gradual yet substantial improvements
- Percent change in accuracy with genomic information when 20% of sires are misidentified
  - Compensate for pedigree errors once 15% of animals genotyped
  - Improvements in accuracy continue to accrue thereafter

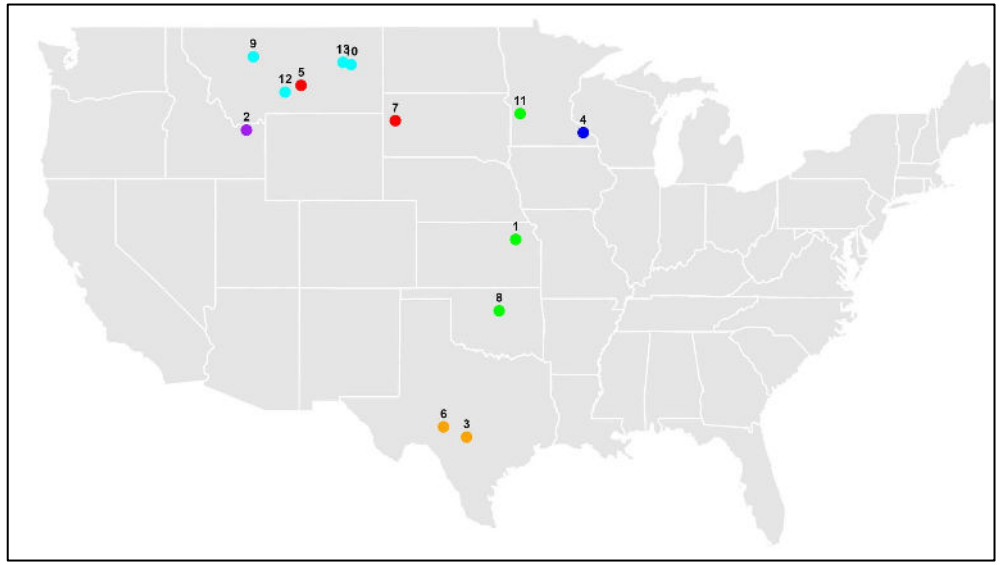
Environment

- By combining climate and management information, can more robustly define production environments
  - Conducted management survey of NSIP flocks in several breeds spread across the U.S.
  - Collated with climate information from national weather service drawn for flock location

Eco-management clusters

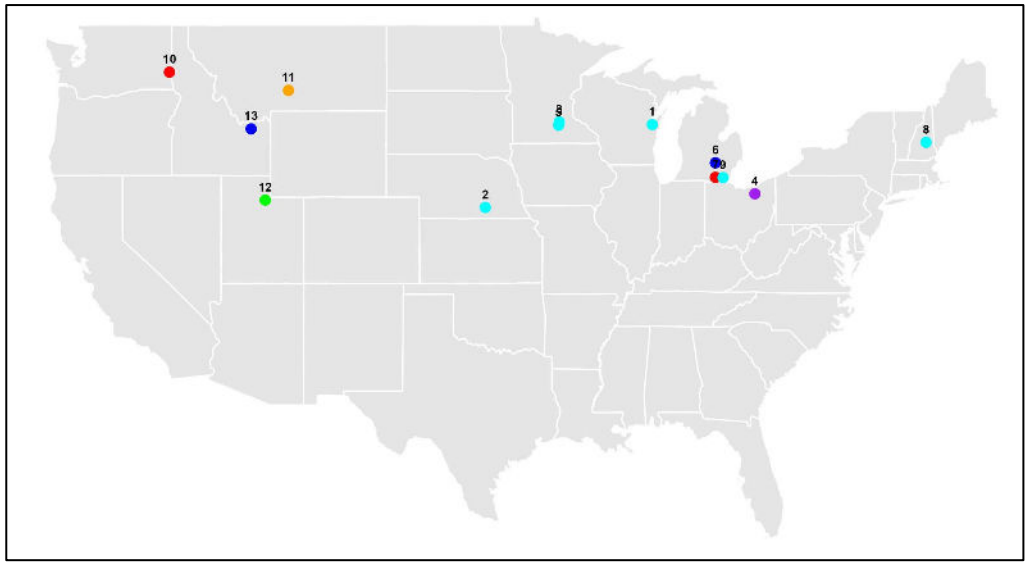
Eco-management clusters

- Defined eco-management clusters of flocks to more wholistically describe production environments

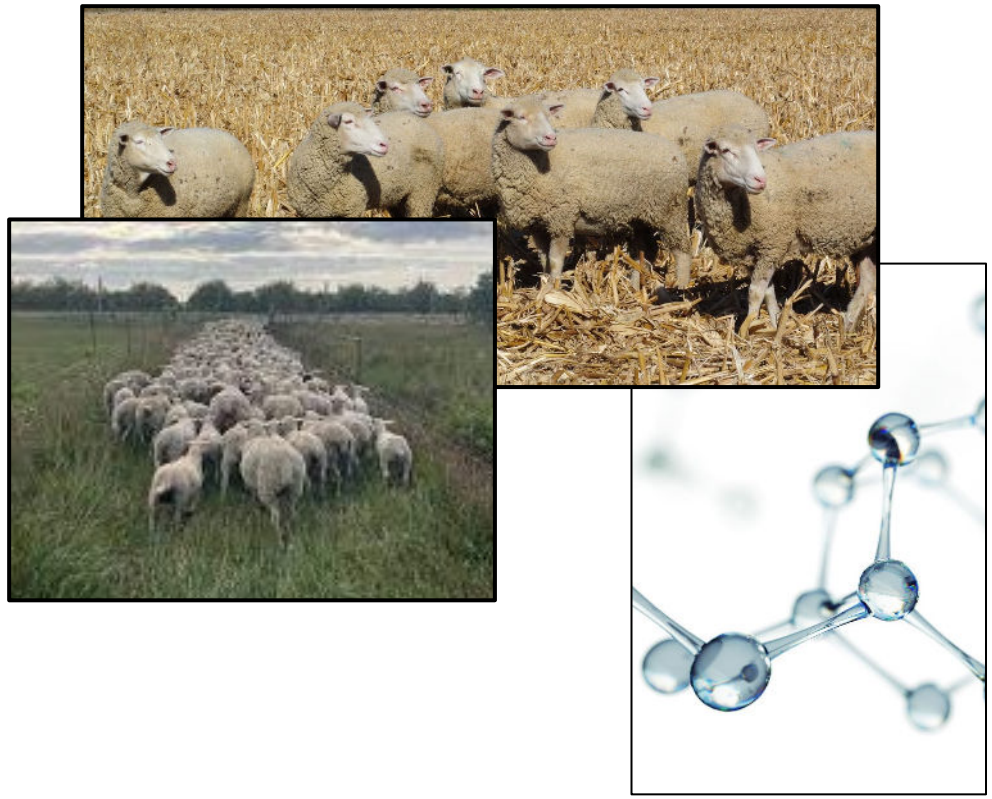


Rambouillet and Targhee

Suffolk



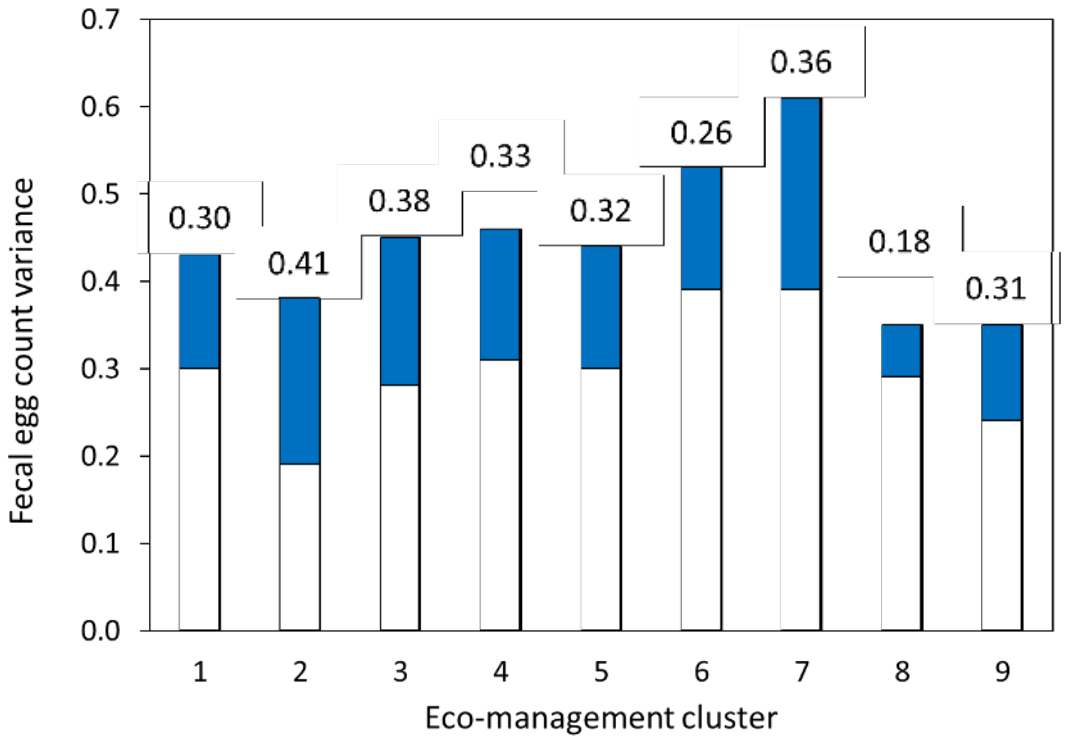
Genotype by environment interaction



- Do sire families perform differently in different environments (G x E)?
- Defined environments using eco-management clusters

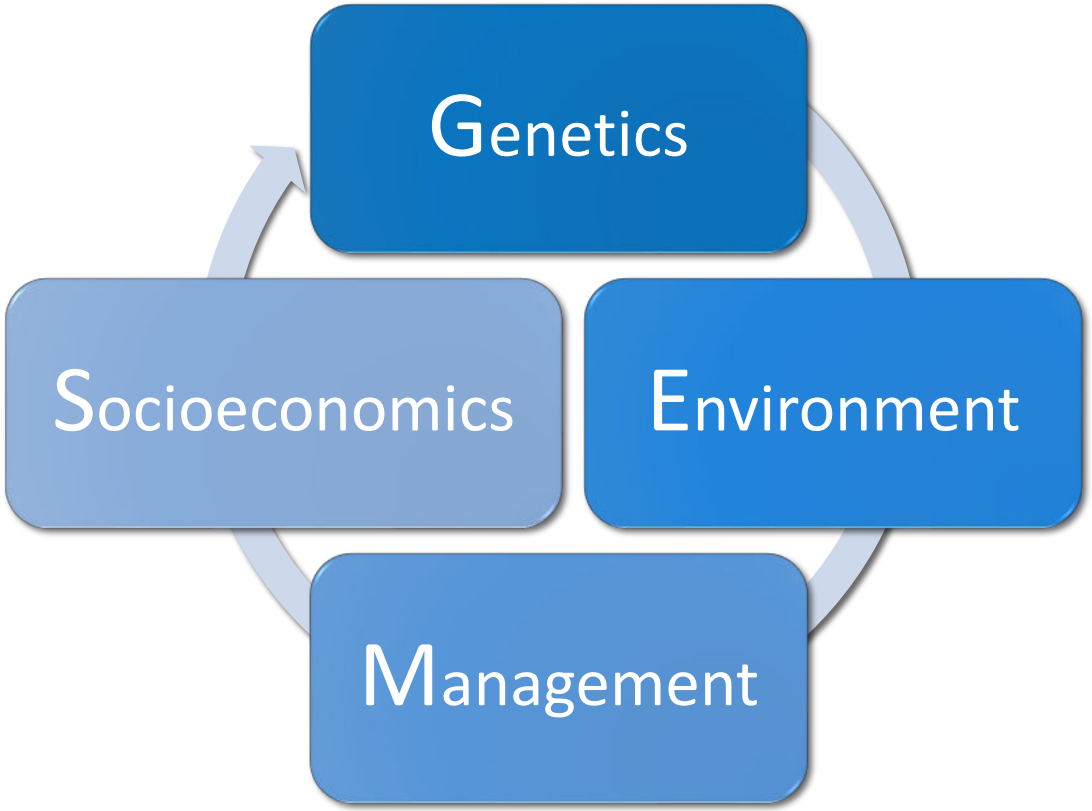
G x E

- Variation in fecal egg counts (FEC) and FAMACHA scores differed appreciably among clusters in Katahdins
- Significant sire by eco-management cluster interactions detected
  - Explained 12% (FEC) to 20% (weight) of phenotypic variation
- Need to consider G x E in our breeding programs



(Arisman et al., 2023 a,b)

Sheep GEMS



Scientific team

- Brian Arisman (MS student), University of Nebraska-Lincoln
- 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
- Luis Pinto (Visiting Scientist), Purdue University
- Sara Nilson (Post-doctoral Researcher), University of Nebraska-Lincoln
- Artur Oliveira Rocha (PhD student), Purdue University
- Bret Taylor, USDA, ARS US Sheep Experiment Station
- Carrie Wilson, USDA, ARS US Sheep Experiment Station
- Ali Haider Saleem (PhD Student), Purdue University
- Alejandra Toro-Ospina (Post-doctoral Researcher), Purdue University
- Hilal Yazar Güneş (PhD student), University of Nebraska-Lincoln

Acknowledgements

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American Lamb Resource Center

NSIP National Sheep Improvement Program

Sheep Genetics USA

American Rambouillet Sheep Breeders Association

Finewool Breeders Consortium

EST 2020 Eastern Alliance for Production Katahdins

Katahdin Hair Sheep International

United Suffolk Sheep Association

American Polypay Association -Tomorrow's Sheep Today-

Questions?