Using Enviromics to Identify More Adapted Angus Cattle

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BIF Adaptation & Efficiency Breakout
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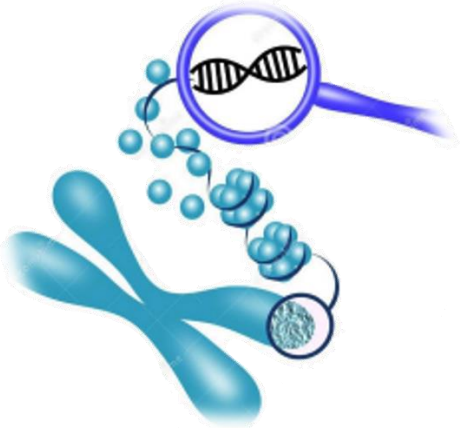
Animal Performance

Phenotype ← Genetics & Environment

Production
Reproduction
Disease resistance
Product quality

Breeds
Lines
Individual variation



Climate
Diet
Management
etc.

Phenomics

Genomics

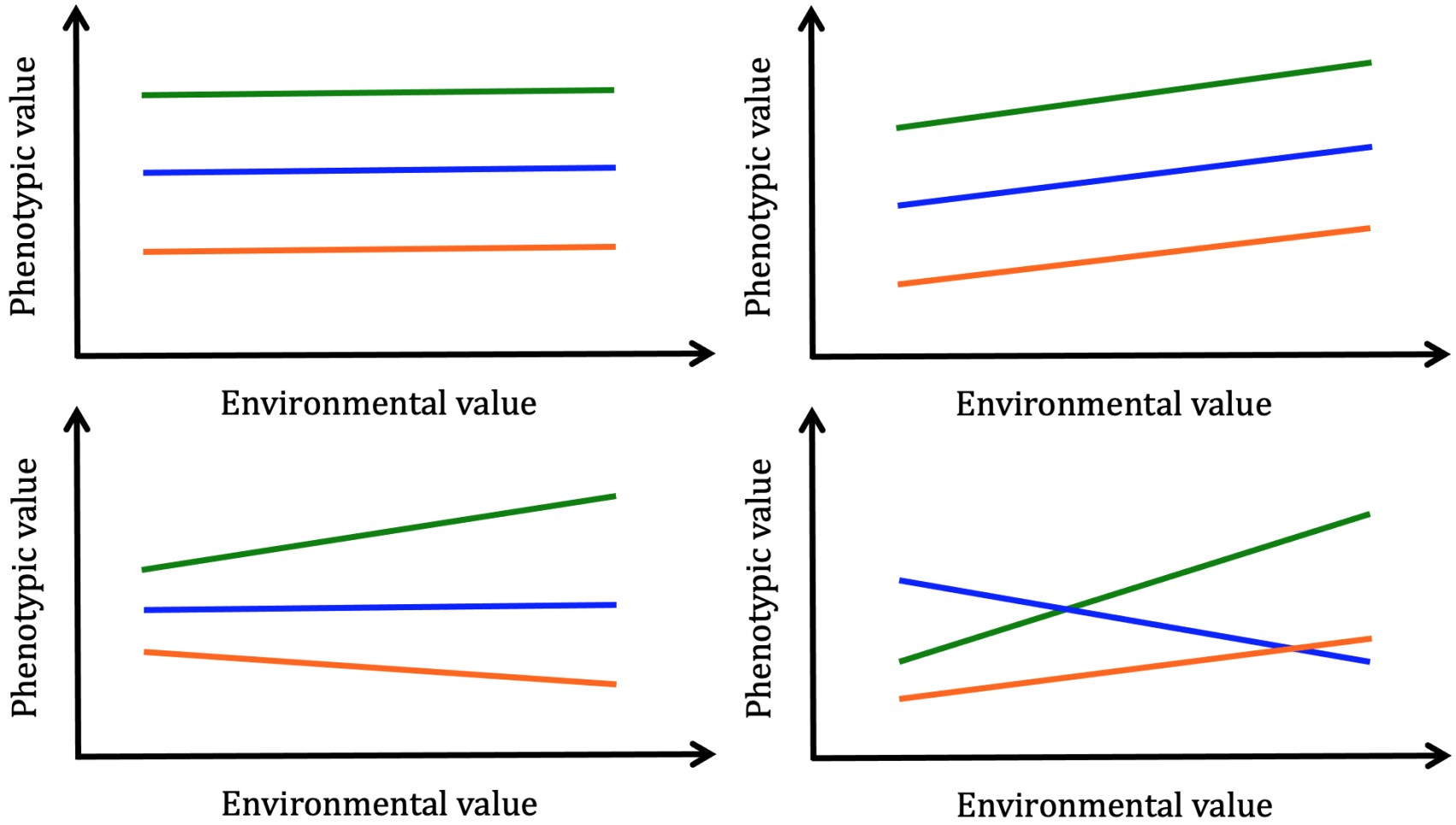
Enviromics

Optimization of Genetics, Management and Environment Combination

Genotype x Environment

Genotype x Environment

(Plasticity)



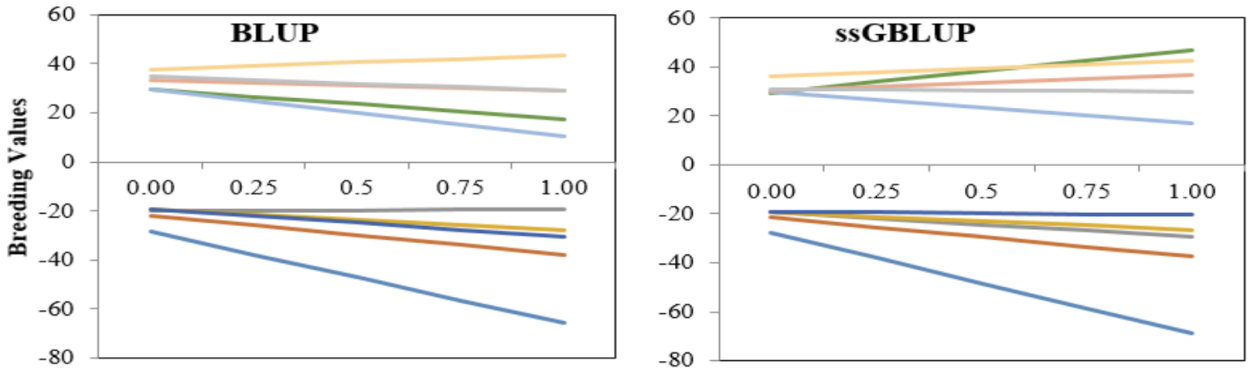


Figure 1. Estimated breeding values from BLUP and ssGBLUP for the five best and worst bulls for yearling weight in Nellore cattle over the environment gradients. Adapted from Oliveira *et al.* (2018).

What we have done:

- Single trait/env reaction norms
- Heat stress
- Regional genetics correlations
- Adaptive traits

What we haven't done:

- Dense environmental characterization
- Disentangled GxM from GxE
- Multi-trait/multi-variable work

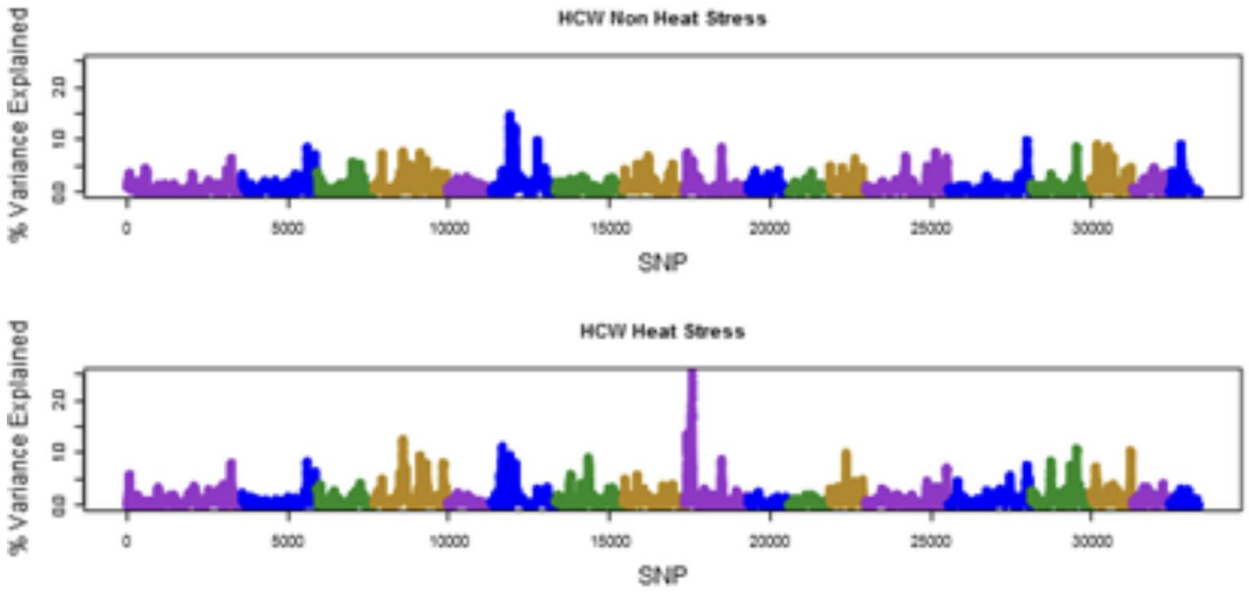
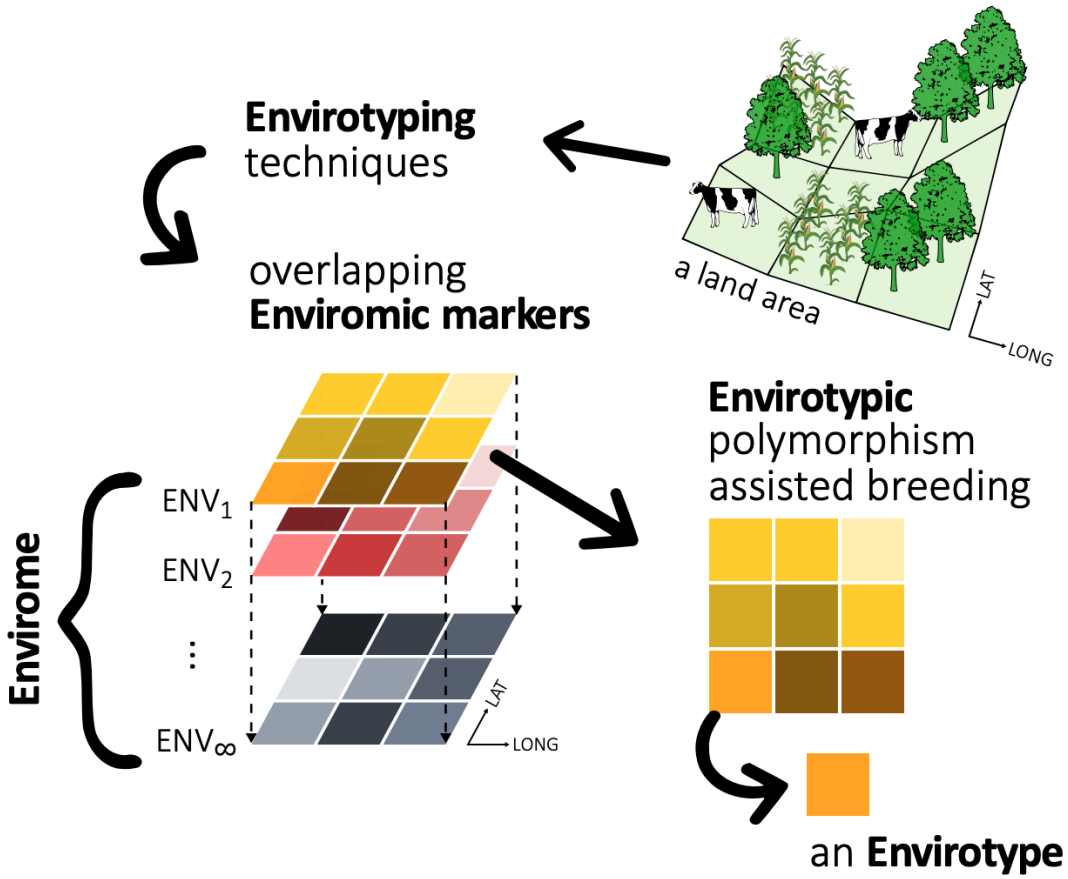


Figure 2. Manhattan plots for hot carcass weight (HCW) under no heat stress and heat stress. Chromosomes are indicated with different colors.

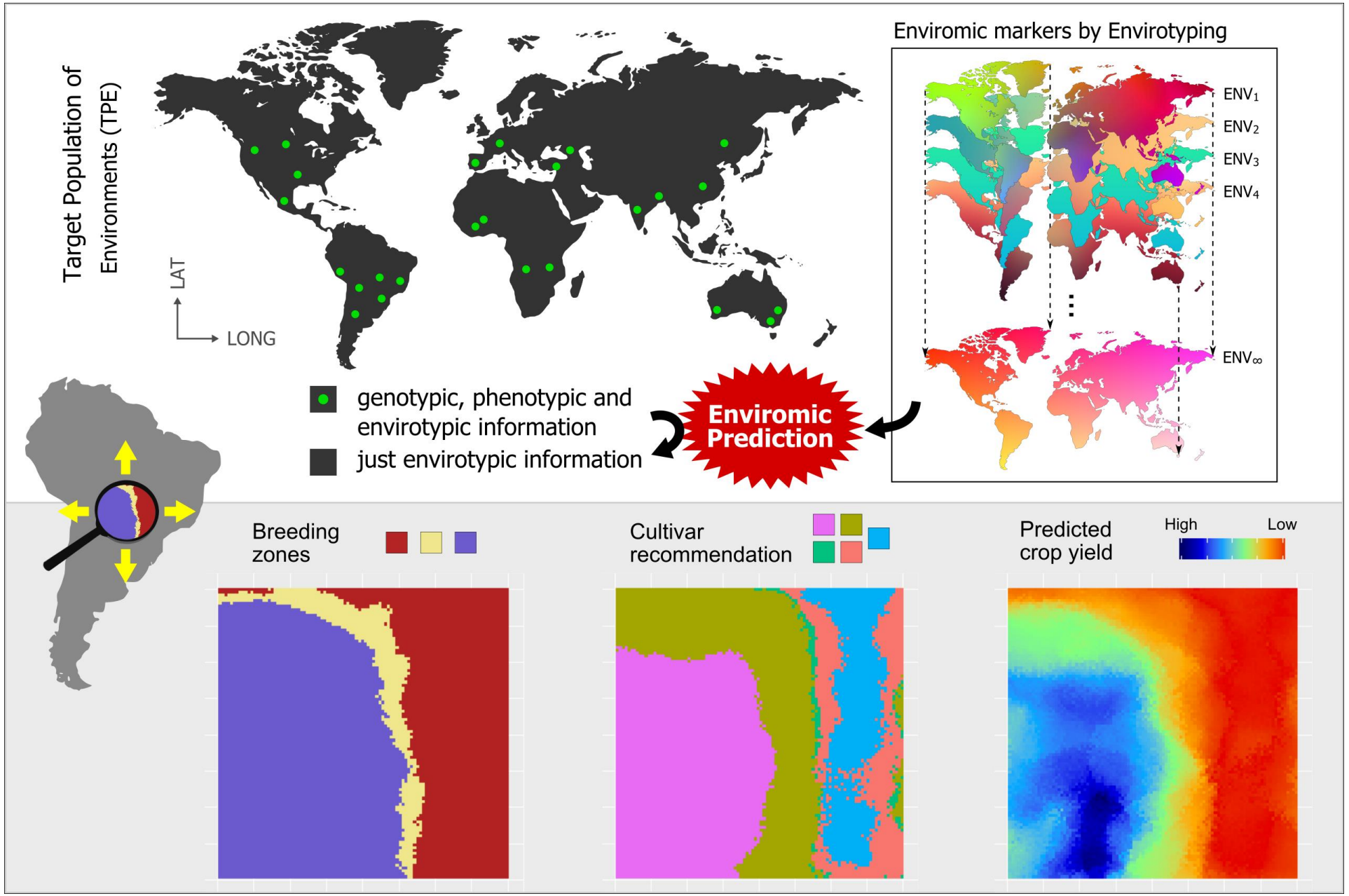
G x E Analysis

- Visualization Tools and Modeling Approaches
  - Finlay–Wilkinson, AMMI, GGE biplot
  - Interaction term ($P = G + E + GxE + e$)
  - Multi-trait models
  - Reaction norms

Enviromics in Breeding

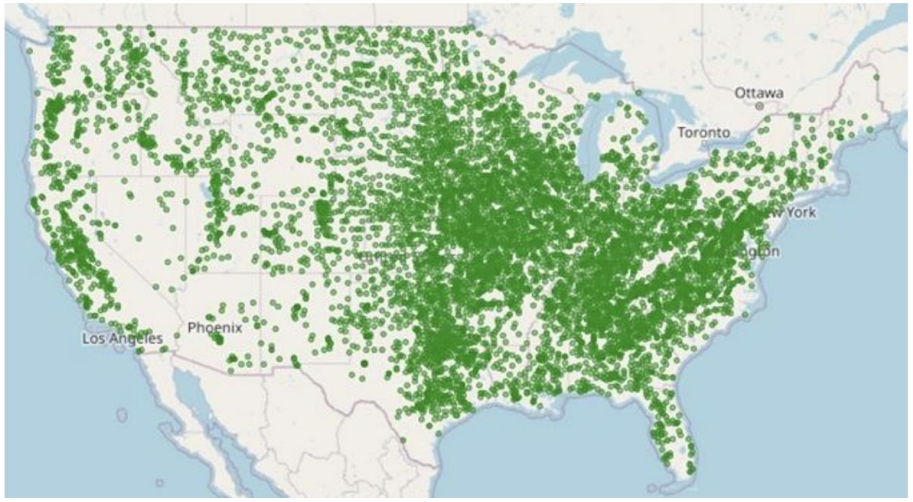


Resende, R. T., Piepho, H.-P., Rosa, G. J. M., Silva-Junior, O. B., Silva, F. F., Resende, M. D. V and Grattapaglia, D. Enviromics in breeding: applications and perspectives on envirotypic-assisted selection. *Theoretical and Applied Genetics* 134: 95–112, 2021.


Target Population of Environments (TPE)
LAT
LONG
Enviromic markers by Envirotyping
ENV1
ENV2
ENV3
ENV4
ENV∞
genotypic, phenotypic and envirotypic information
just envirotypic information
Enviromic Prediction
Breeding zones
Cultivar recommendation
Predicted crop yield
High
Low

Integrating Enviromics, Genomics, and Machine Learning for Precision Breeding of Resilient Beef Cattle

(USDA AFRI 2023-68014-39816)



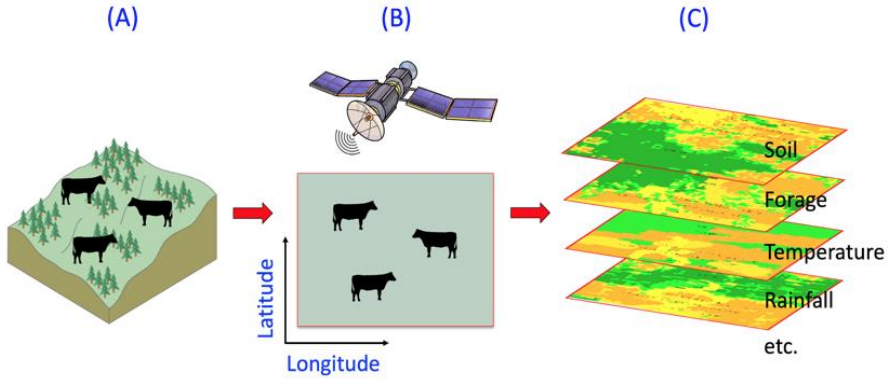
What does a zip code miss?

Integrating Enviromics, Genomics, and Machine Learning for Precision Breeding of Resilient Beef Cattle

(USDA AFRI 2023-68014-39816)

Research-Extension Integrated Objectives:

1. Generation of data lake and data processing pipelines for comprehensive environmental characterization of US beef cattle production systems.
2. Comprehensive evaluation of genotype-by-environment interactions and future performance through an enviromics approach.



3. Definition of novel indicators of animal resilience through in-depth phenotyping of genetically divergent animals.

Rosa, Huang | Lourenco | Rowan | Brito, Johnson | Gondro, Valle de Souza | Retallick

Overall Project Structure

Farm management

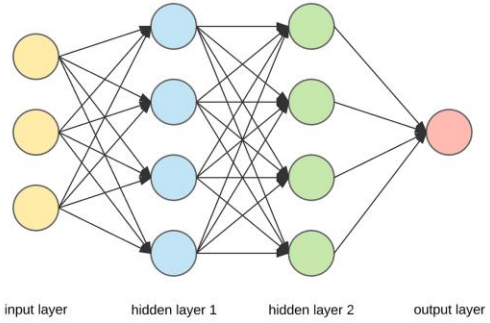
Soil, climate, and weather information

Forage density and quality

AGI

- 9K+ herds (1970-2020)
- 9.3M+ birth weights
- 9.8M+ weaning weights
- 4.8M+ post-weaning weight gain
- 126K+ heifer pregnancy
- full pedigree information
- 1M+ genotypic information

Data analytics



Extension and outreach

Novel indicators of animal resilience

How do you understand management? Ask about it!

Developing a survey to refine intensity of management:

- Forage and Grazing Management
- Health
- Reproduction
- Business Decisions
- Technology adaptation
- Genetic Decision-Making
- Demographics

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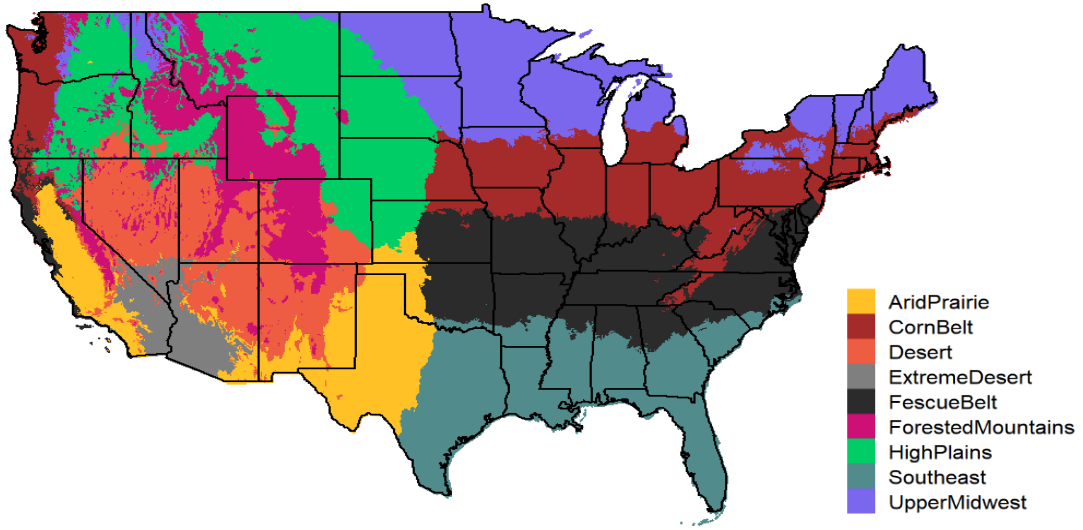
How will we model GxE(xM)?

Regional GxE(xM) genetic correlations

Multi-Dimensional Reaction Norms

Geographically Weighted Regression (GWR)

Ensemble of Machine Learning approaches



Thanks for Listening!

Angus Producers: Stay tuned for communication about survey rolling out in July/August!

Reach out with questions and ideas!

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