Genotype by environment interaction for fertility traits

Reproductive performance in Northern Australia can be poor, often due to harsh environment. Animals that can maintain reproductive performance despite environmental conditions are extremely valuable.

DNA: The Instruction Manual

Genomic Breeding Values use DNA information to make informed breeding decisions and select for heritable traits. Rather than associating traits (like fertility) with a particular animal, traits are associated with specific genes.

DNA: The double helix the contains the instructions for all life, coded as four base pairs (ACTG).

Genome: All of an animal's DNA, in cattle it is 3 billion base pairs long.

Gene: A smaller segment of the genome, varies in length, that codes for a protein.

SNP: Used as a marker to identify genetic differences between individual animals. It is the variation at a single point along the genome.

Quantitative traits: Very few traits are controlled by a single gene (polled cattle are one example) other traits such as growth and fertility are controlled by thousands of genes, each with an extremely small effect.

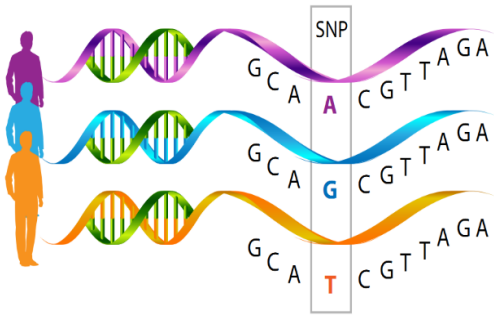

Figure 1: *The Genomes of individuals are 99.9% identical, SNP's allow for the 0.1% genetic difference to be identified.*

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QAAFI is a research institute at The University of Queensland supported by the Queensland Government via the Queensland Department of Agriculture and Fisheries.

GxE

Female reproductive performance is central to the profitability of beef businesses but can be poor across the North.

Recent results from Northern Genomics Project:

- <50% pubertal prior to joining
- 71% first pregnancy
- 63% second pregnancy.

Reproduction can be severely hampered by harsh environmental conditions such as lack of nutrition and exposure to heat stress.

Some animals remain fertile under harsh environmental conditions, these are not necessarily the same animals that will give the best performance under favourable conditions.

This concept is Genotype by Environment interaction (GxE) where different genotypes respond differently to environmental variation.

Key Question: Is it better to improve fertility in adapted cattle, or improve adaptation in fertile cattle?

My Project

Aim: Select animals that can reproduce despite harsh environmental conditions.

Methods

Data: From the Northern Genomics project. ~25 000 heifers from 54 commercial herds across Qld and NT recorded for three fertility traits.

- Puberty status at ~600 days.
- First pregnancy (~2.5 years)
- Second pregnancy (~3.5 years)

Step One: Define environmental descriptors for each location that measure exposure to heat stress and availability of nutrition. These continuous descriptors, as opposed to segregating herds in regions, will be used to define an environmental gradient

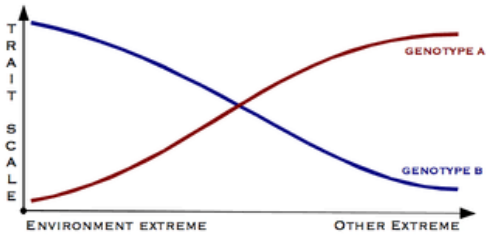

Figure 2: *Example of a 'Reaction Norm Model', showing how the response to environment can vary along an environmental gradient*

Step Two: Compare fertility records to environment to verify a significant effect on fertility.

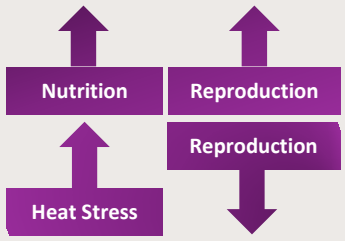

Figure 3: *Hypotheses for the relationships between environment and reproductive performance.*

Step Three - ONGONG: Incorporate genomic information into analysis, a reaction norm model approach, to verify GxE interaction for fertility.

Interim Conclusions

- **Heifers that were pubertal at 600 days were more likely to be pregnant at first pregnancy.**
- **Exposure to heat stress reduced the odds of successful rebreed in lactating heifers.**

Researcher Profile

James Copley
PhD candidate, QAAFI (Centre for Animal Science)
Supervisors: Ben Hayes, Bailey Engle, Elizabeth Ross, Kai Voss-Fels, Ben Wood

James grew up on a beef cattle property in Southern Queensland breeding Brahman cattle. James has always had an interest in beef cattle fertility and profitability. He has a Bachelors degree in Agricultural Science (Hons) from UQ Gatton, finishing in 2018. During his final year, he completed an honours project at QAAFI, investigating the link between fertility and temperament. Now enrolled in a PhD, since 2019,continuing to investigate fertility, James hopes to combine his practical skills and knowledge with scientific research to improve fertility and profitability in beef herds.

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