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Australia

Productivity Driven Sustainability - New Genetic and Genomic Technology Developments

Tuesday 14 May 2024
Wodonga





HEREFORDS
Australia



New Genetic & Genomic Technology Developments

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Presentation for Herefords Australia Breed Forum, Wodonga, May 14th, 2024



Talking points

- **Review the role of genetic and genomic technology – what is it and how does it work?**
- **Discuss upcoming changes to Hereford BREEDPLAN**
- **Outline next generation genomic technology**
- **Introduce new breeding tools for improved sustainability**

Genetic Technology – What does it mean for you



Why are we selecting? What drives profit?

Productivity

- Weight
- Yield
- Reproduction

Price

- Intra Muscular Fat
- Shear Force

Cost of Production

- Mature size
- Disease/Parasite Resistance
- Resilience
- Welfare

What drives genetic progress?

$$\textit{Response} = \frac{\textit{selection intensity} \times \textit{selection accuracy}}{\textit{generation interval}} \textit{Variation}$$

- pick only the best
- make the right choice more often
- breed from them ASAP
- identify differences between animals.

BREEDPLAN focuses on accuracy – helping you make the right choice more often.

Your job is to pick the best and keep bringing in new genes.

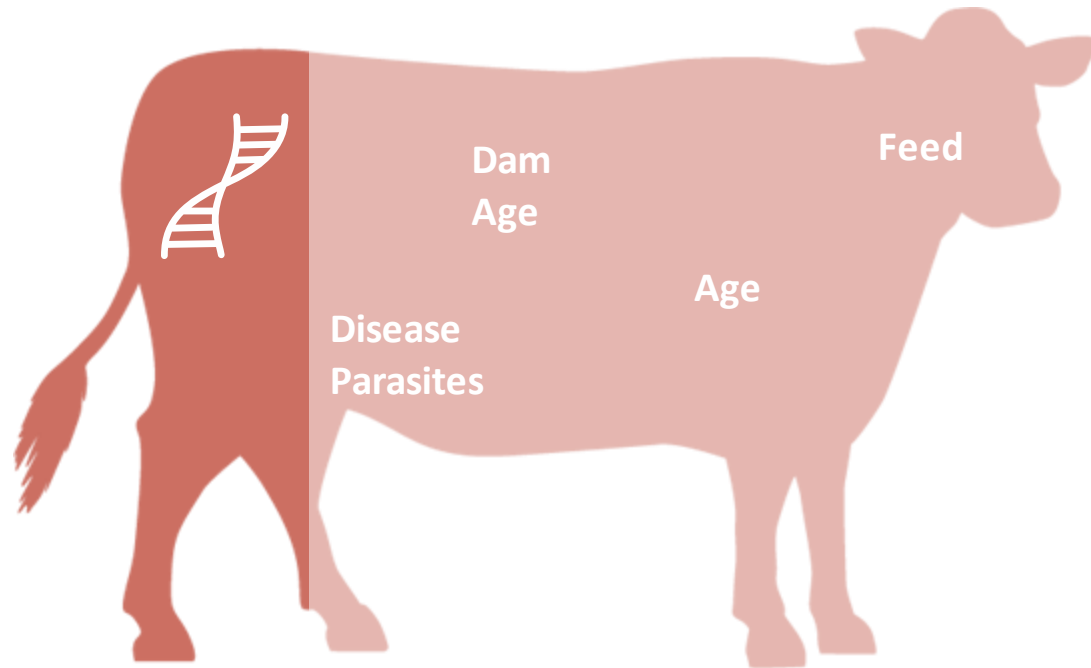
Accuracy



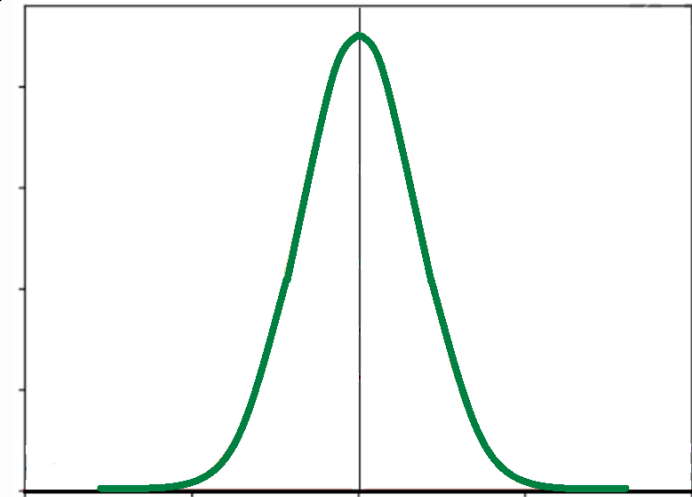
Accuracy



Performance = environment + genetics



How often do I choose the right animal?



What drives genetic progress?

$$Response = \frac{\textit{selection intensity} \times \textit{selection accuracy}}{\textit{generation interval}} \text{Variation}$$

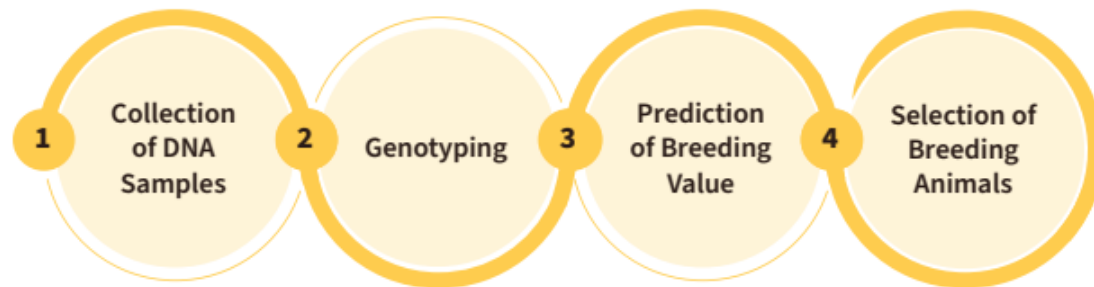
HERD	SIZE	Selection Differential Sires	Selection Differential Dams	Average Trait Accuracy	Age at first calving	Average Dam Age	\$Index Standard Deviation	ΔG - Rate of Genetic Change
1	xxx	32.1	-3.5	54%	2.6	5.4	25.5	3.0
2	xxx	38.8	3.1	56%	2.0	4.7	27.2	8.5
BREED Av.	99	31.9	-2.8		2.3	4.8	23.3	5.5

Genomic Selection – What does it mean for you



What is Genomic Selection?

- Transformation change in genetic technology
- Utilising information from an animal's DNA to predict its genetic superiority or inferiority
- Four key steps involved:



Value Proposition

More accurate selection decisions

- more accurate breeding values
- faster genetic improvement

Selection decisions early in life

- mate young animals with more confidence
- make management decisions earlier

Selection for new traits

- monitor and make genetic improvement for traits that can't be routinely measured on-farm
- E.g. immune competence, methane emissions

Selection for additional animals

- Can make use of performance information on commercial animals
- Can calculate breeding values for animals without pedigree or birth date information

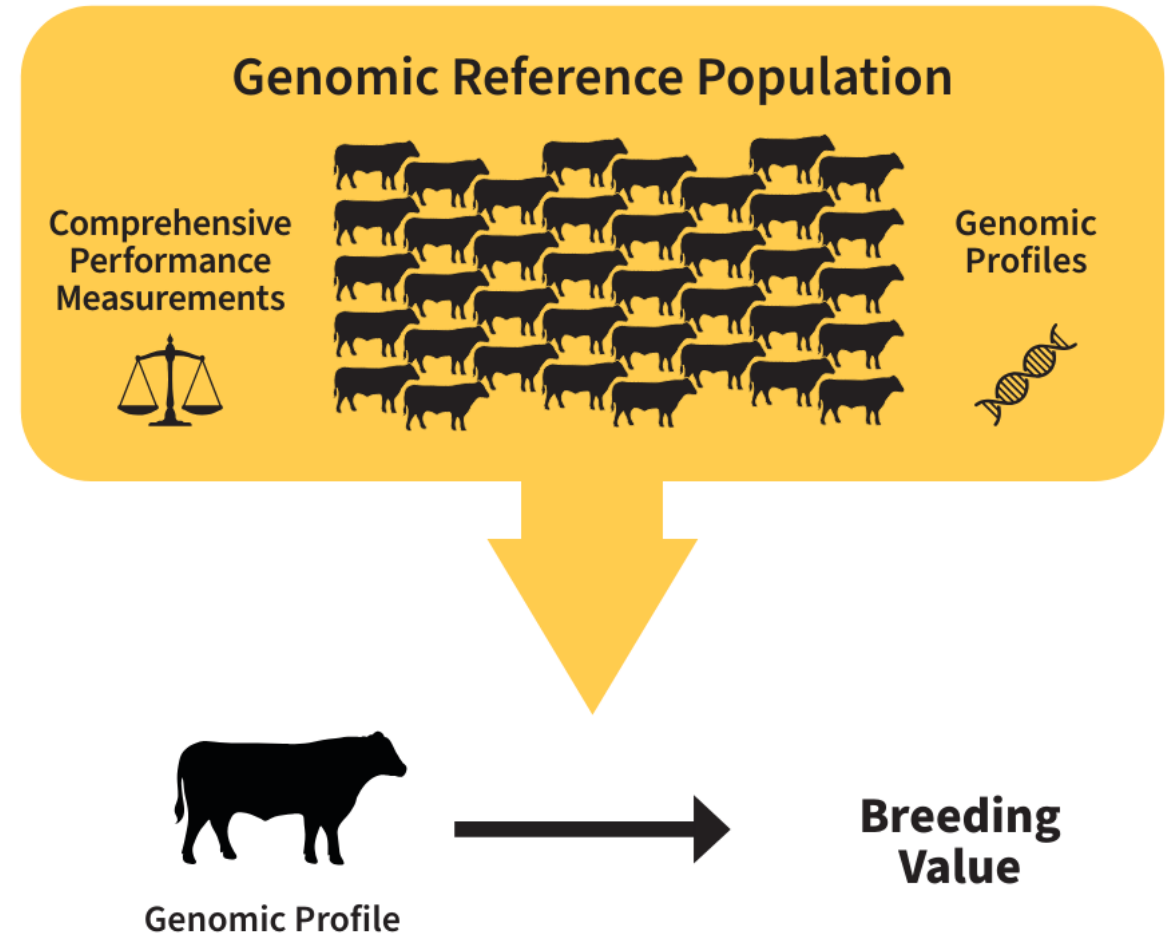


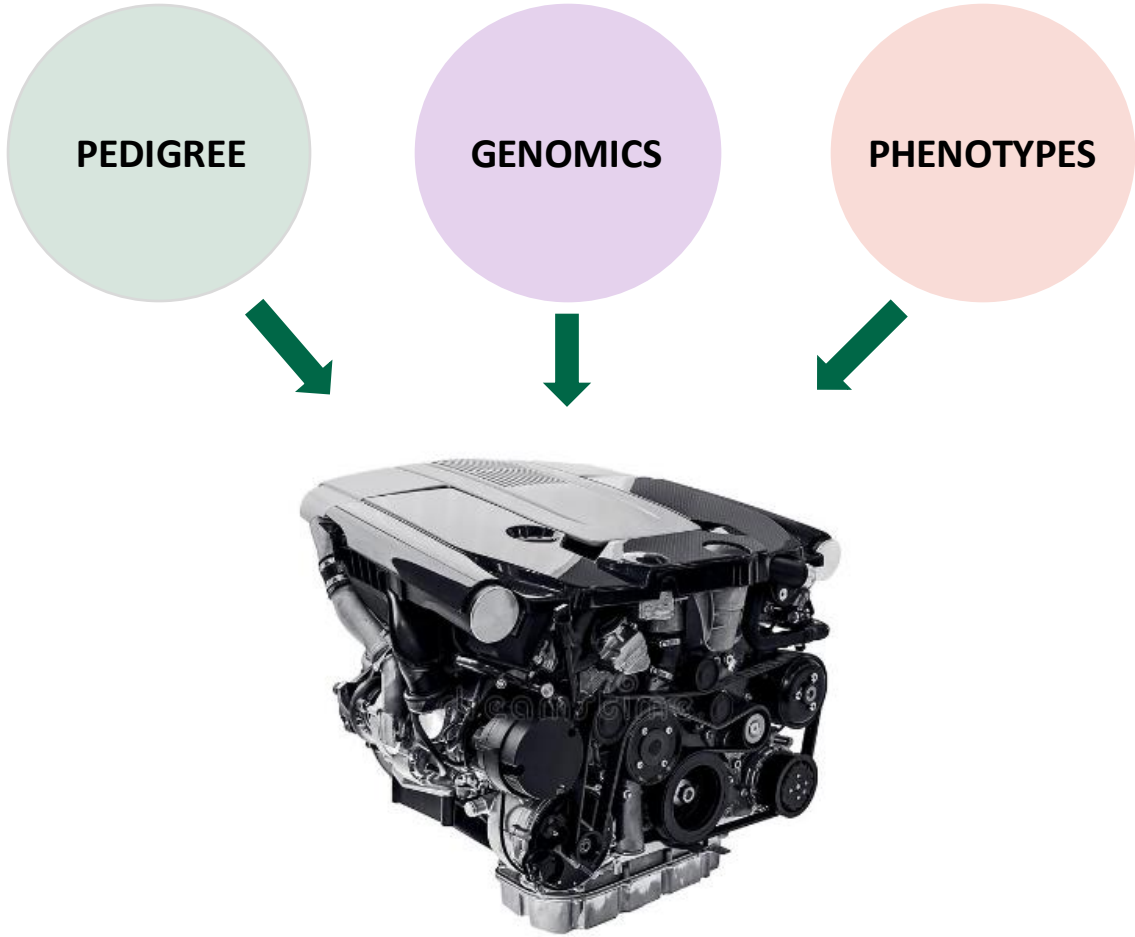
What Genomics Is Not?

- Doesn't replace the need for breeding values
- We don't know the genes
 - Genes largely haven't been identified
 - Genomic selection is based on gene markers
- Doesn't replace the need to collect performance measurements
 - Need a genomic reference population



- Accuracy of genomic selection influenced by:
 - size of genomic reference
 - heritability of trait
 - effective population size
 - relevance of production system





Genomics provides a 'new generation' genetic evaluation engine

→ Let's us go faster

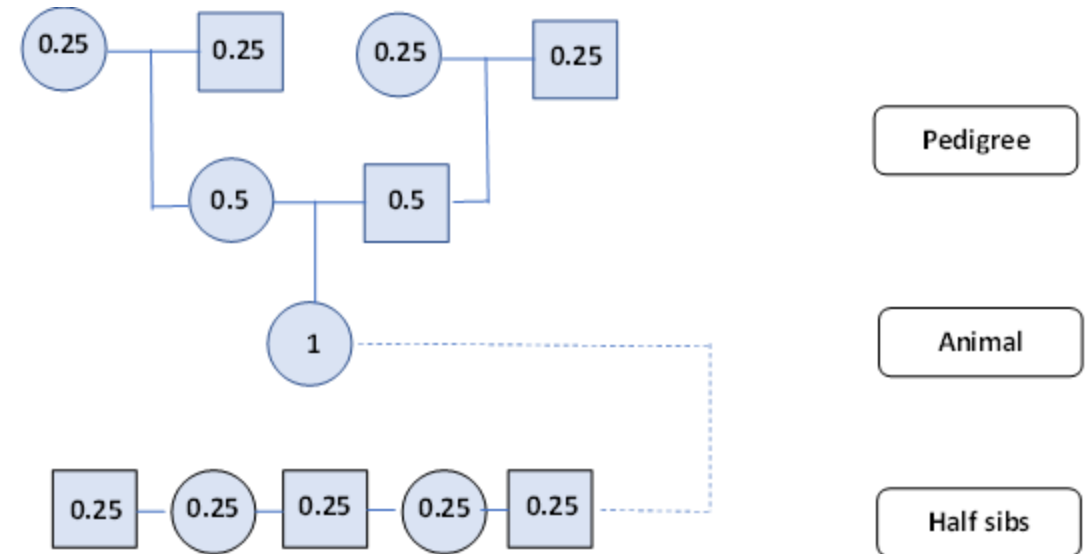


**GENETIC
IMPROVEMENT**

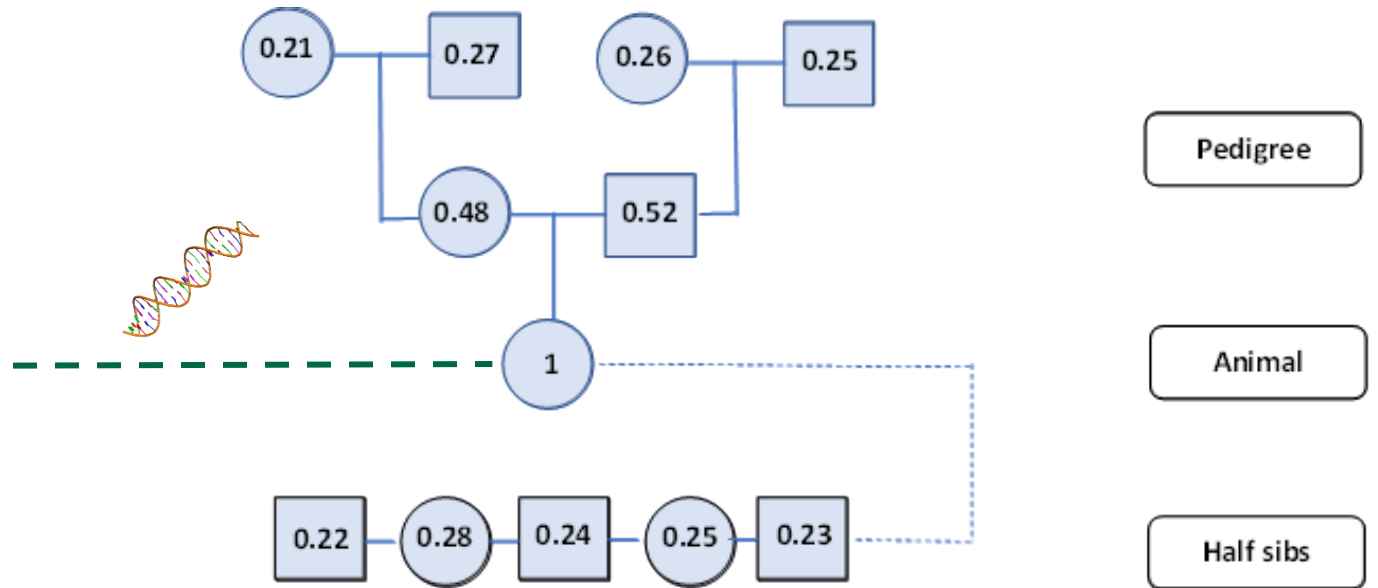
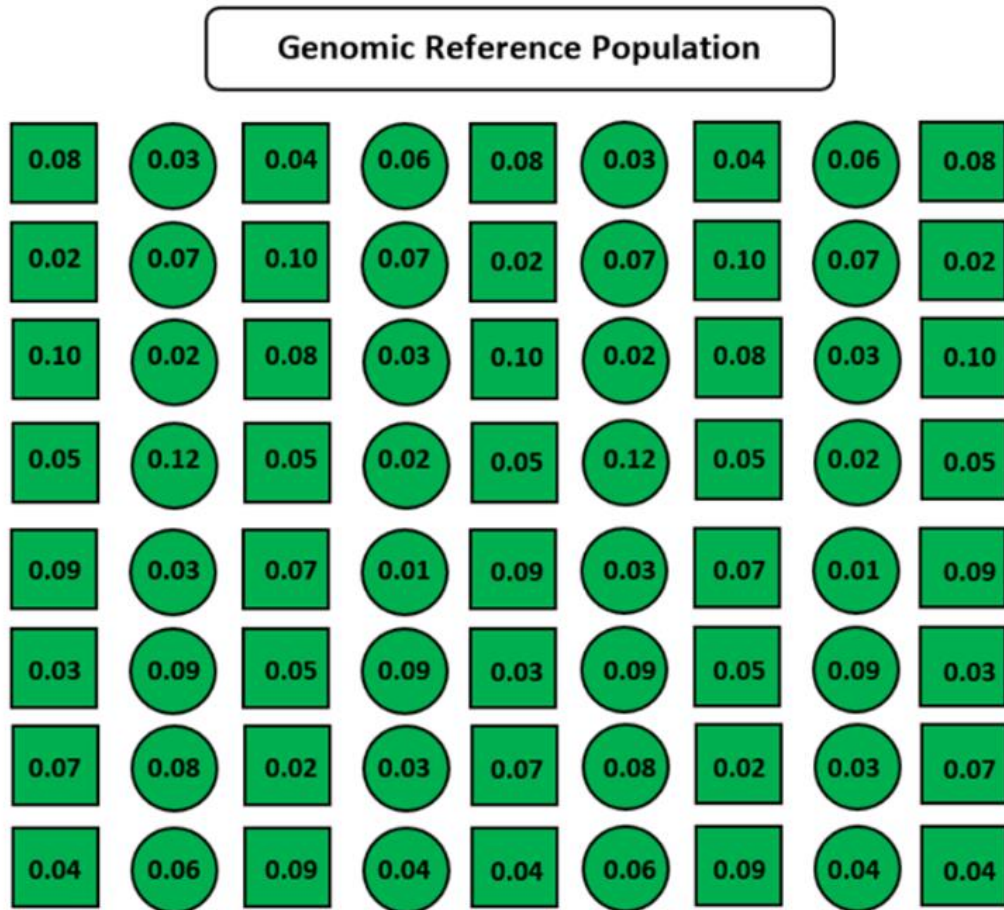


How does genomics work?

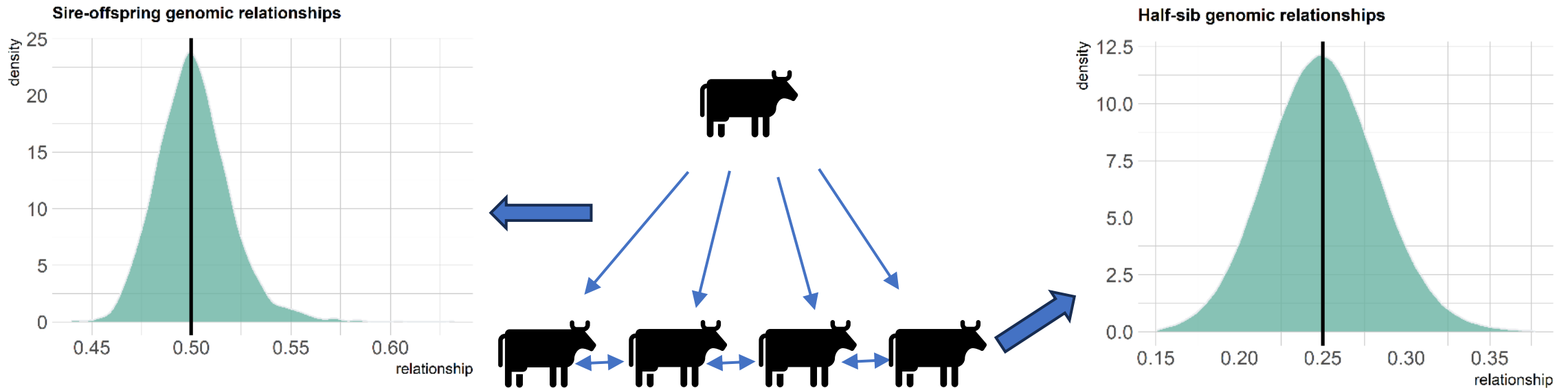
- Prediction of breeding value is based on:
 - understanding the relationship between animals
 - using the information that is available on an animal and other animals to which is it related to estimate genetic merit
- Prior to genomics, relationships based on pedigree



How does genomics work?



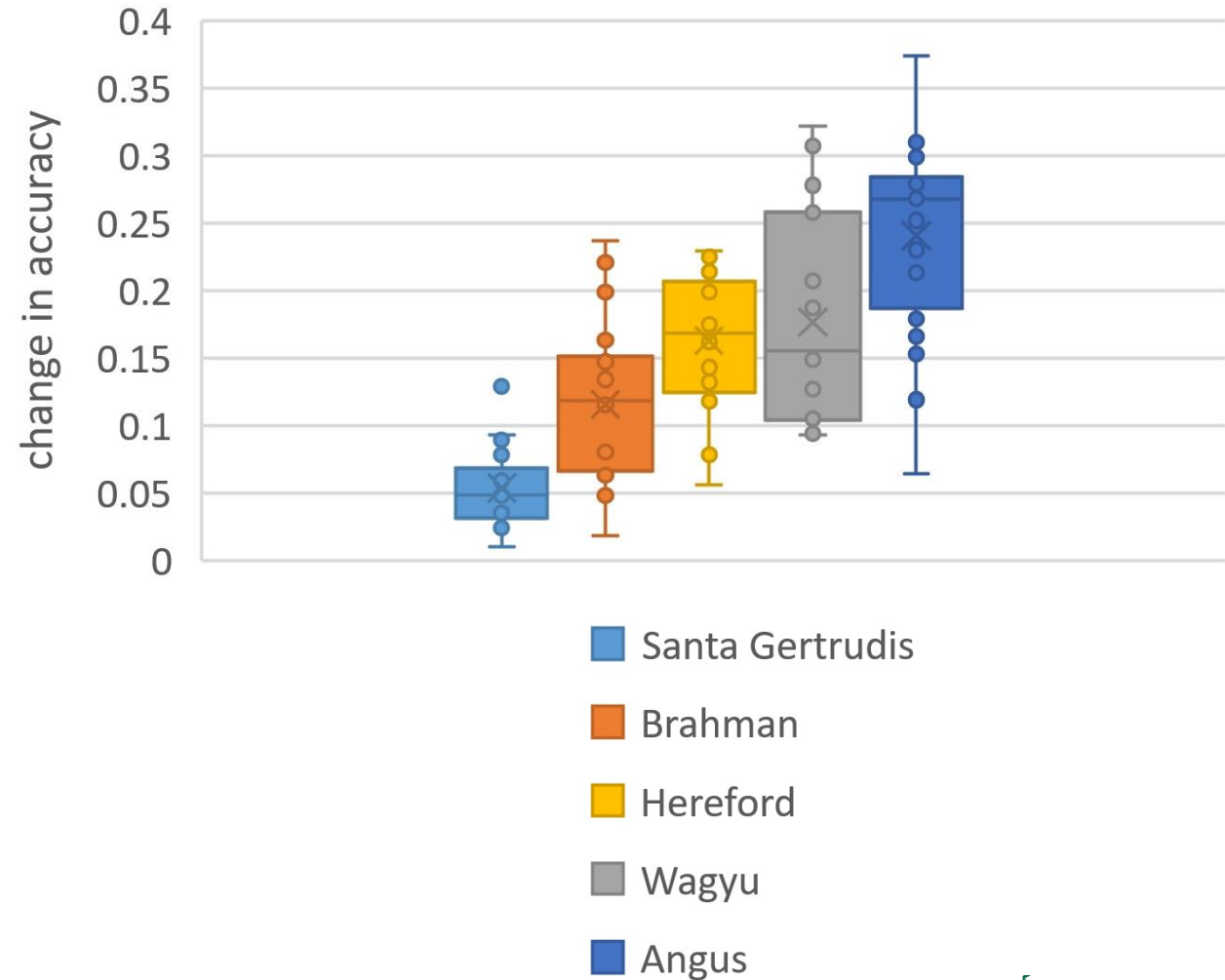
Genomic relationships in practice



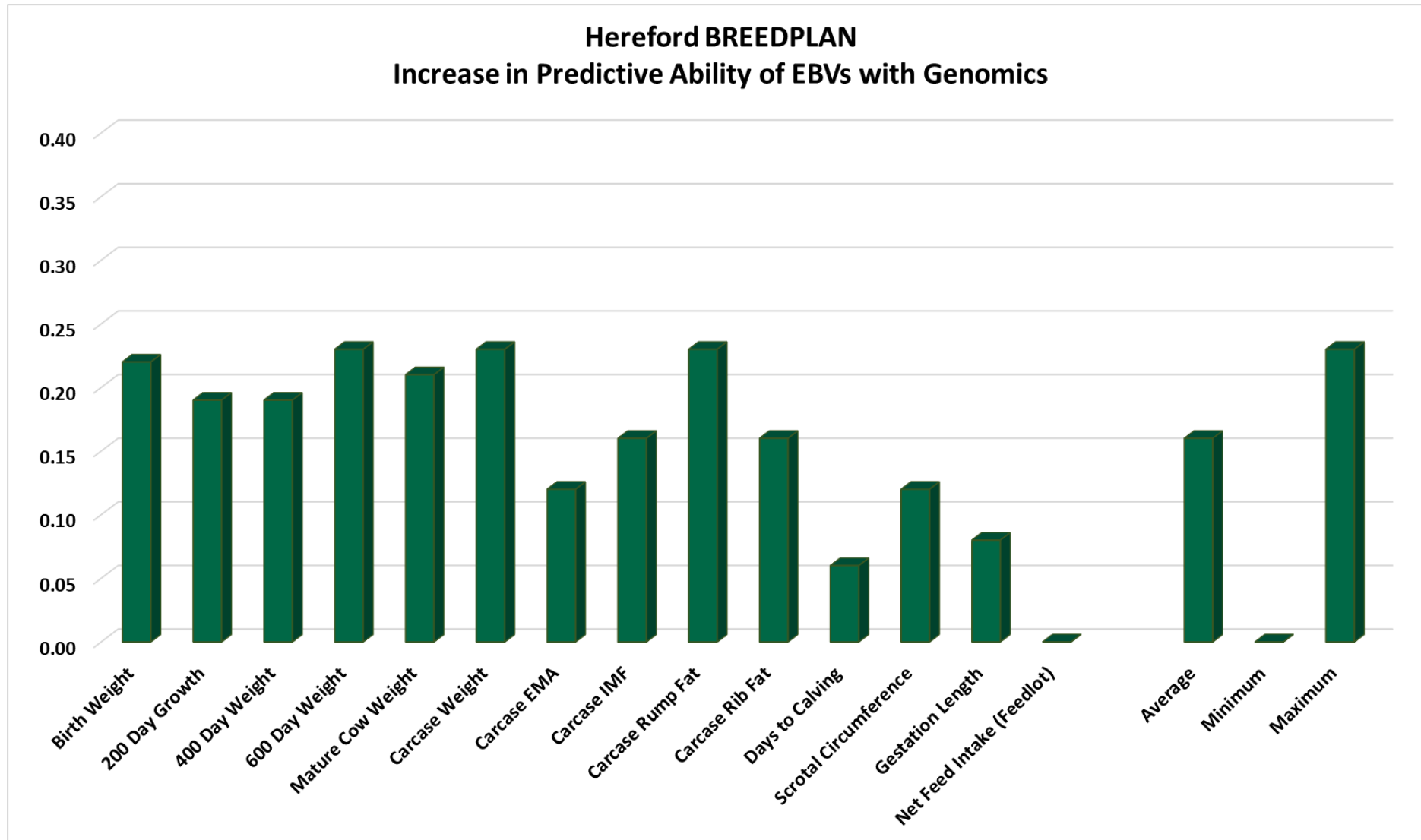
Genomic relationships between 2,259 progeny of Angus sire, Millah Murrah Paratrooper P15, in the TransTasman Angus Cattle Evaluation. (Source: AGBU).

Validation of Genomics

- Johnston et al., AAABG, 2023
- EBVs are more closely aligned with animals' true breeding values → greater predictive ability
- Increase in predictive ability will vary by breed and trait (subject to genomic reference population)



Validation of Genomics



- Increase in predictive ability will be greater with upcoming technology improvements



Actionable Insights

- Use genomically enhanced breeding values when making selection decisions
- Develop a genotyping strategy for your operation (seedstock)
 - When and how will samples be collected
 - What animals will be genotyped and when
 - Which genomic tests will be undertaken



Genetic Technology – Upcoming changes to Hereford BREEDPLAN



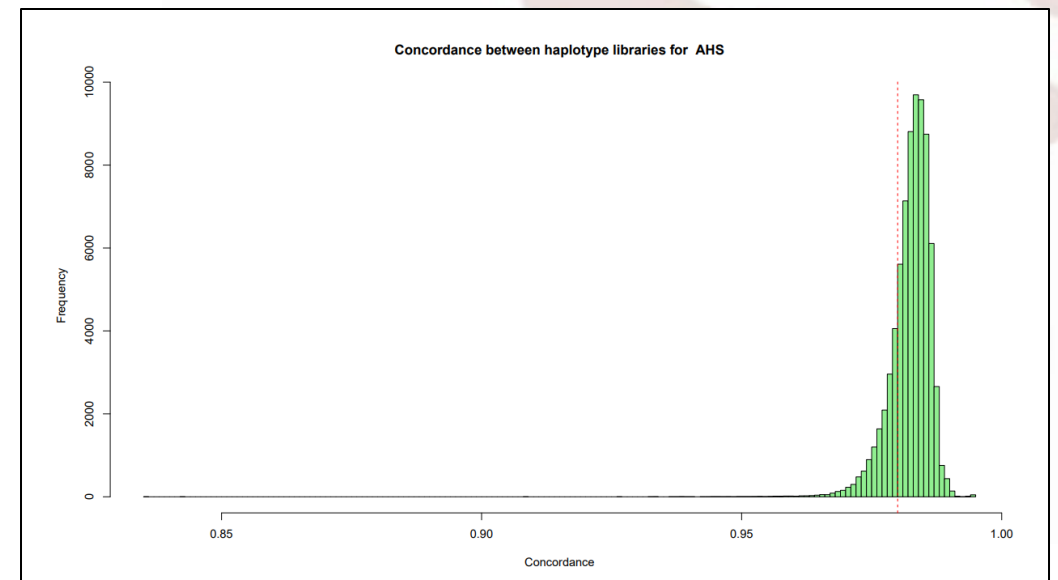
Hereford BREEDPLAN analysis updates for 2024

- Single step genomic pipeline update
- Lambda updates
- Calving Ease analysis update



Genomic Pipeline update – haplotype library

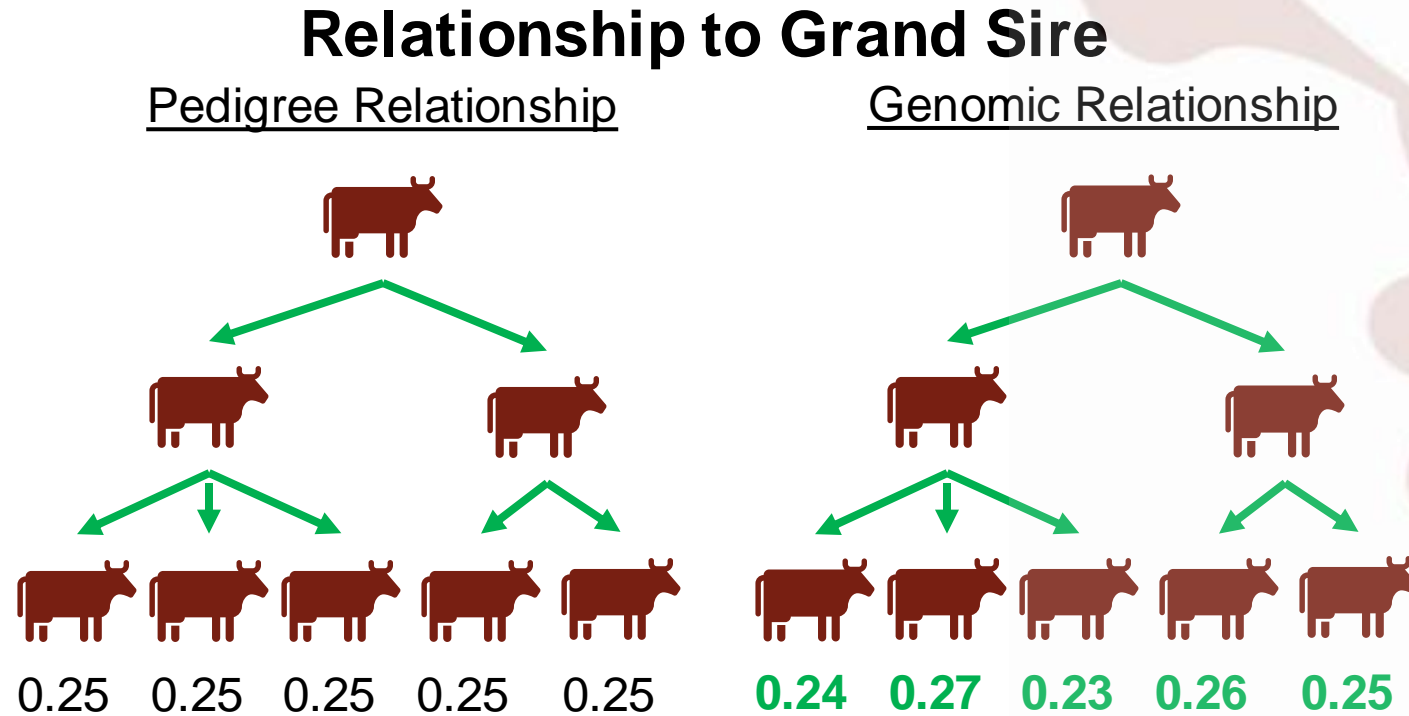
- Haplotype library is used for imputation of missing SNPs and imputing sires
 - Updating the library ensures new cohorts of animals are represented during the imputation process, increasing imputation accuracy.
- Some animals previously excluded as too lowly related to the genomic reference population (RG) are now added (<5 animals).
- Very high concordance between libraries.
- Approximately 75,000 animals with genotypes
- Annual updates no longer required now the population is stable



Lambda Update - Single step combines all information

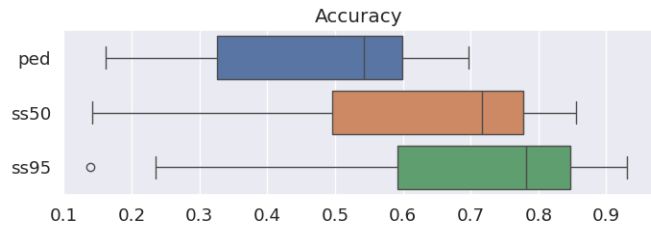


Lambda Update - Difference between pedigree and genomics

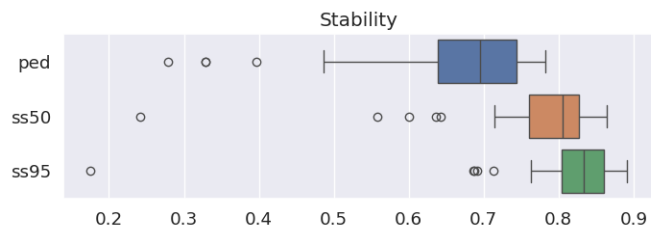


Weighting between genomic and pedigree relationships
to increase from 50% to 95%

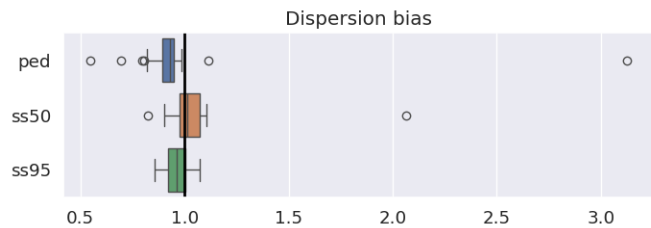
Lambda Update - Results for Herefords



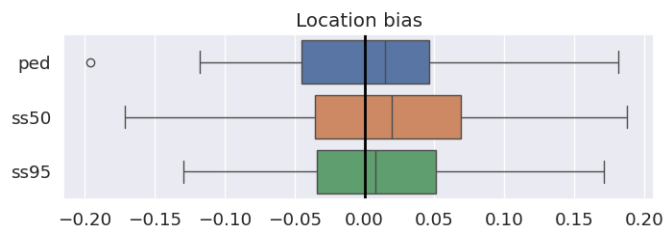
- Accuracy of the prediction → accuracy of selecting with a group of animals



- Stability = correlation between part and whole EBV
- When you genotype at birth, the EBV will change less as records are added in ss95
- Don't genotype just before your bull sale

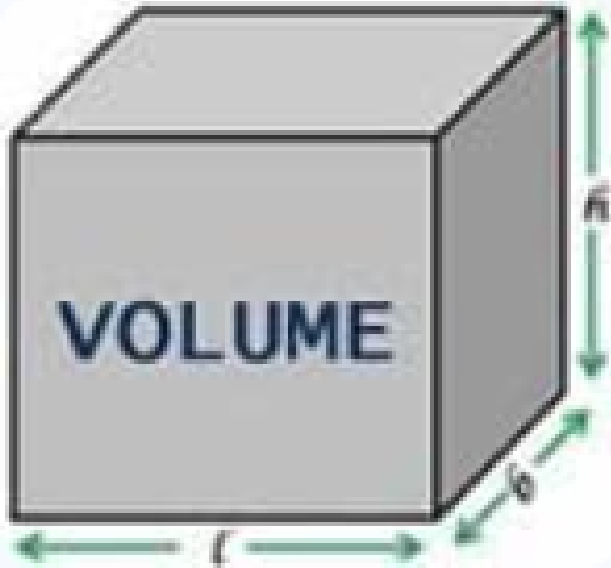


- Regression needs to be 1 → similar variation in both part and full EBVs
- The extreme values in this and other plots are generally for traits with limited reference data
- Worst is NFI in the pedigree model. Actually gets better in the genomic model, but it would be good to get more data for traits like this (SMB?)



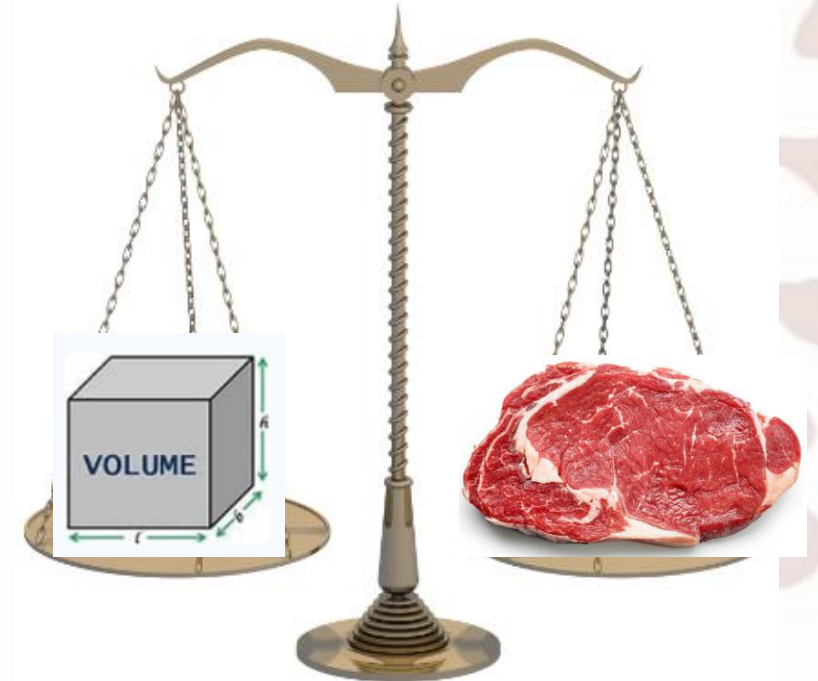
- Mean difference between part and full EBVs, scaled to genetic standard deviations.
- Most traits within 0.05SD of zero
- Looks very good

Lower emissions using selection indexes that:



Decreases methane **production** by:
Reducing mature cow weight
Reducing feed intake

Decreases methane **intensity** by:
Reducing methane production
Increasing growth
Increasing fertility



Hereford Grass – Feed Price Index



Hereford Grass – Feed Price Index



Hereford Grass – Feed Price Index



Hereford Grass – Feed Price Index



Summary

- **Genomics represents a step change in the technology that is available to beef breeders**
- **Changes coming to Hereford BREEDPLAN**
 - **Inclusion of genomics in CE EBVs**
 - **Increased weighting on genomics**
 - **New sustainability indexes**
- **New genomic tools for commercial Hereford breeders coming soon**

