TALKING GENOMICS

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The Benefits of Genomic Selection

Genomic selection, being the utilisation of information from an animal's DNA to predict its breeding value for specific traits, is now routinely utilised in livestock breeding programs all around the globe.

This edition of 'Talking Genomics' discusses what the value proposition of genomic selection is, and what benefits genomic testing offers to a livestock breeder.

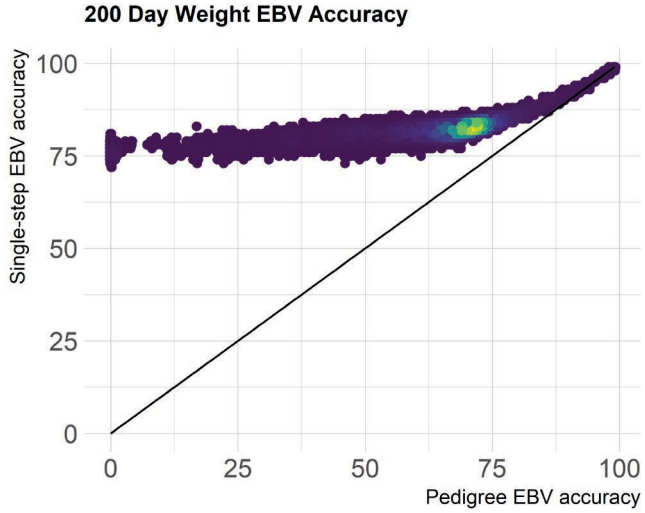
Broadly, by comparison to traditional selection methods, genomic selection facilitates more accurate selection decisions, earlier in an animal's life, and for additional traits and animals.

More Accurate Breeding Values

Genomic selection facilitates the prediction of breeding values with greater accuracy, which subsequently results in more accurate selection of breeding animals, and faster genetic improvement.

While considerable additional accuracy is observed across all traits, the most additional accuracy is realised:

- for animals that have incomplete, or a limited depth of pedigree.
- for traits that are hard to measure, or traits that cannot be measured prior to an animal entering the breeding herd or flock.
- for traits that have a low heritability.
- in situations where collecting effective performance information is problematic, such as in small herds or flocks, or when an animal has been removed from its contemporary group.

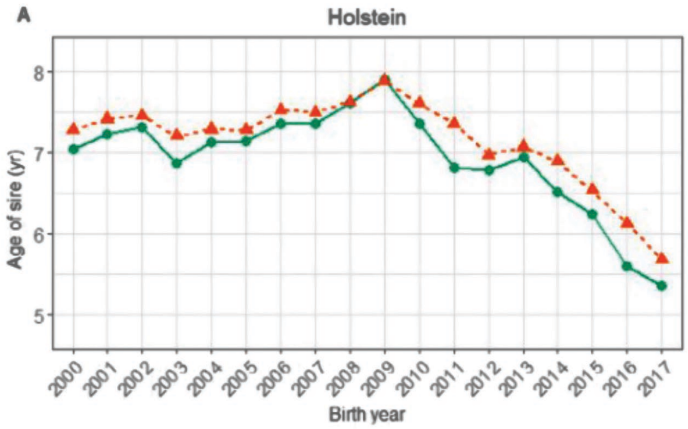


Accuracy of breeding values for 200 Day Weight in Australian Angus cattle with (blue) and without (diagonal) genomic information.

Selection Decisions Early in Life

Genomic selection facilitates the prediction of accurate breeding values early in an animal's life, which enables the mating of young animals with greater confidence, such as the use of ram lambs, yearling bulls or unproven sires, resulting in a shorter generation length, and faster genetic improvement.

The availability of accurate breeding values early in an animal's life also provides greater flexibility when making management decisions, such as the ability to make culling decisions well before animals reach breeding age.



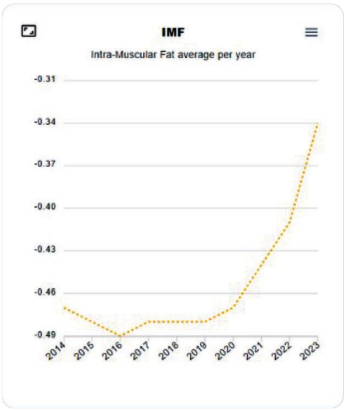
Generation interval in Holstein breeding programs in Australia has decreased dramatically with the introduction of genomic selection (Source: Scott et al, Journal of Dairy Science, 2021)

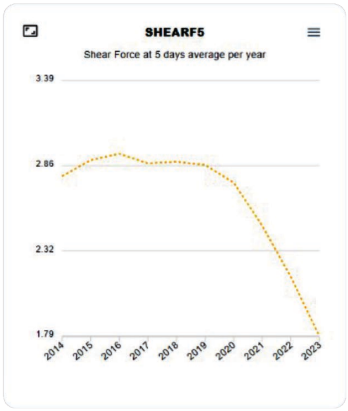
Selection for Additional Traits

Genomic selection facilitates a greater number of traits to be considered when making selection decisions by making selection possible for traits that can't be routinely, or easily measured on farm.

Examples include traits associated with the sustainability of a beef enterprise, such as animal resilience and methane emissions, or selection for intramuscular fat and meat tenderness in sheep breeding programs.

The consideration of additional traits makes selection possible for a greater proportion of a breeding program's overall breeding objective, resulting in faster genetic improvement.





Genomic selection has enabled selection for improved eating quality in the Australian sheep industry (Source: Sheep Genetics)

Selection for Additional Animals

By comparison to traditional genetic evaluation programs that required pedigree information for the calculation of breeding values, genomic selection enables the calculation of breeding values for animals in the absence of pedigree information.

This enables:

- additional populations of animals to be considered when making selection decisions.
- more accurate selection decisions to be made in commercial herds or flocks. For example, when selecting female replacements, or males in multiplier breeding programs.
- drafting of commercial animals into production systems aligned with their genetics. For example, the drafting of steers into short or long fed feedlot finishing programs.

Other Benefits

In addition to facilitating more accurate selection decisions, earlier in an animal's life, and for additional traits and animals, genomic selection also offers a number of other benefits in a livestock breeding program.

- **Genetic Benchmarking of Livestock Enterprises**

  Genomic selection makes it possible to benchmark the genetics in a livestock enterprise across enterprises and over time, providing benefits such as more targeted ram and bull purchase decisions in commercial breeding programs, and the tracking of the genetic change that is occurring over time within a commercial breeding program.

- **Less Reliance on Performance Measurements**

  Whilst in most situations the accuracy of breeding values will be maximised when both genomic information and effective performance information is available, subject to the availability of well recorded, genomic reference population, genomic selection makes it possible to achieve useful breeding value accuracy from genomic information alone.

  This prevents the need for the on-farm collection of performance measurements in some situations, such as in smaller breeding enterprises, for difficult or expensive to measure traits, when animals are managed on agistment or lease blocks with limited facilities or labour, or where contemporary groups need to be dispersed for management purposes, such as in times of drought, flood or fire.

- **More Accurate Animal Pedigrees**

  Genomic selection improves the accuracy of animal parentage information, reduces the effect of historic pedigree errors on the calculation of breeding values, facilitates better management of inbreeding, and increases the reliability of the information presented on sale animals.

- **Parentage Assignment**

  Genomic selection makes it possible to assign parentage information from an animal's DNA profile, offering advantages such as the ability to utilise syndicate joining in seedstock operations, shortening the duration of calving and lambing periods in breeding operations utilising artificial insemination, and reducing the on-farm labour requirements associated with the collection of parentage information using traditional methods.

- **Marketing of Seedstock Animals**

  Genomic selection provides a number of advantages to the marketing of sale animals in a seedstock operation. Utilisation of genomic selection not only demonstrates a seedstock operation is 'progressive', which may be appealing to some bull or ram buying clients, but it reduces the risk associated with post-sale changes in the breeding values of sale animals, and removes barriers to purchase by buyers who are reluctant to purchase animals without genomic information.

- **Compatibility with Add-On DNA Tests**

  Genomic selection is compatible with other forms of DNA testing that can be conducted in association with genomic selection. Add-on DNA testing can be used for the management of important genetic conditions, to fast track the introgression of favourable qualitative traits into a breeding herd, such as polledness, and to meet the requirements for the registration of animals with breed associations.

What Genomics is Not?

While genomic selection offers many advantages, it is equally important to understand what genomic selection doesn't provide to a livestock breeding program.

A common misconception is that genomic selection directly assesses the genes that control productivity traits in livestock breeding program, whereas in reality, the genes have largely not been identified. Rather than assessing the genes of an animal directly, genomic selection is predominantly based on gene markers, which are used to predict an animal's genetic superiority or inferiority.

Likewise, genomic selection doesn't replace the need for breeding values. Whilst some livestock breeders may have hoped that genomic technology would make breeding values redundant, the reality is the opposite. Genomic selection utilises the information from an animal's DNA to predict its breeding value, rather than replacing the need for breeding values.

Another common misconception is that genomic selection replaces the need for the collection of performance measurements. The availability of performance measurements is a critical requirement of genomic selection, with performance measurements essential for the establishment and maintenance of a genomic reference population. Further, in most situations, the accuracy of breeding values will be maximised when both genomic information and effective performance measurements are included in the calculation of the breeding value.

In seedstock operations, genomic selection also doesn't replace the need for the collection of important information that is required for the genetic evaluation of performance measurements, or for the registration of animals, such as birth date information.

Further Information

To further discuss the utilisation of genomic testing within your livestock breeding program, contact staff at Neogen Australasia.

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