Australia's genetic evaluation system

Independent I underpinned by science I Australian data

The Australian dairy industry has a world class genetic evaluation system. It combines international best practices with a rich database of performance records from animals managed under Australia's diverse dairying environments.

Australia's main index for genetic merit is the Balanced Performance Index (BPI) – see box. It's designed (and proven) to give the best prediction of an animal's performance under Australian dairying conditions.

Suited for Australia

Australian Breeding Values draw upon Australian performance data to give the best possible prediction of an animal's performance under Australian conditions. Overseas breeding values are designed to give the best predictions for performance under their local conditions.

Performance data used in Australia's genetic evaluation system includes genomics, herd testing, pedigree, conformation, health, fertility and management records.

A group of dairy herds with exceptional records plays a special role in Australia's genetic evaluation system. Collectively known as Ginfo herds (short for Genetic Information), their animals are genotyped for crossmatching with performance records. This enables researchers to identify DNA patterns for traits of importance to dairy farmers.

Ginfo currently consists of detailed records from about 150 dairy herds, with Holstein, Jersey, Aussie Red and cross breed cattle located across Australia's eight dairying regions.

Australia is at the forefront of countries partnering with farmers to maintain a national genomic reference data set based on cows.

Australian Breeding Values & Indices

Australia uses Australian Breeding Values (ABVs) to express the genetic merit of dairy cattle for a given trait. ABVs are available for 40 traits including various production, type (conformation), health and management traits.

DataGene publishes updated ABVs in April, August and December each year and releases genomic evaluations every month.

Breeding indices combine multiple ABVs into a single index to allow farmers to breed for more than one trait at a time. Australia's three indices account for the eight key traits that affect a cow's contribution to farm business profit. The indices all account for the same traits, but with different emphasis to reflect different farmer priorities.

Balanced Performance Index (BPI): is an economic index, reflecting more farmer preferences.

Health Weighted Index (HWI): to fast track traits such as fertility, mastitis resistance and feed efficiency.

Sustainability Index: to fast track genetic gain for lower emissions while continuijng gains for important economic traits.

The **Good Bulls** logo is an easy way for farmers to select for BPI. Animals that carry the Good Bulls logo meet DataGene's minimum criteria for BPI and reliability and are available for purchase.

More information: A pocket Guide to Australian Breeding Values

Big data

Linking differences in cow performance to genetic markers is a challenge given the very large data sets involved.

Each ABV run involves evaluating more than 66 million animal/trait combinations and 250 million observations in the Australian database.

Adding to the complexity is the fact that most traits are influenced by multiple genes. For example, fertility and protein production are each influenced by thousands of separate genes that mostly have a small effect individually, but together are highly predictive.

Australia's genetic evaluation system is powered by huge, scientific computer systems capable of processing the massive volumes of data. The super computers can complete an analysis in three days that would take over three years on the best desktop computer.

Independent

DataGene is responsible for genetic evaluation for the Australian dairy industry. As an independent, industry-owned organisation, DataGene has no commercial interests in selling semen or cattle. This is not necessarily the case overseas.

World class

Australia's genetic evaluation system is underpinned by world class science. The DairyBio collaboration brings together researchers and industry to create practical tools for dairy farmers, based on robust science.

DairyBio is a joint initiative between Agriculture Victoria, Dairy Australia and the Gardiner Dairy Foundation. The team works in purpose-built facilities at the AgriBio Centre for AgriBioscience at LaTrobe University, Melbourne.

With molecular and quantitative geneticists in the same building, it is one of the few integrated genetic research facilities in the world. It's also home to industry organisations like DataGene, Holstein Australia, Jersey Australia and NHIA.

Genetics and environment (GxE)

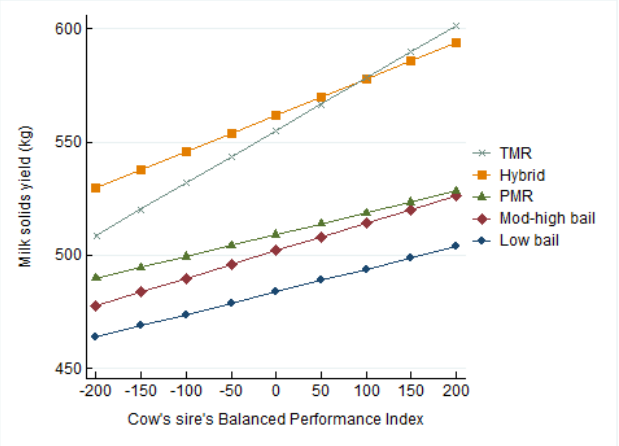
An animal's performance is influenced by both its genetics and environmental conditions. The environment has more impact on some traits than others. A high degree of genetic by environment interaction (GxE) means that genetic evaluations performed in one place are not always a good prediction of performance in places with different environmental conditions.

GxE within Australia

Australia's diverse dairy systems and environments mean it is important to investigate whether bulls' progeny rank the same across these systems. Across all Australian feeding systems and environments, the BPI has been proven to be effective.

The Feeding the Genes[1] study conducted by Dr John Morton, investigated interactions between dairy cow genetics and feeding systems. The study found that the daughters of high genetic merit bulls produce more milk and are just as likely to last in the herd as their lower genetic merit herdmates. However, the scale of benefit varied with breed and feeding system. The greatest benefit was seen in Holstein herds with more intensive feeding systems (hybrid or TMR).

These findings were based on an analysis of 300,000 records from 500 Australian Holstein and Jersey herds.



▲ **Feeding the Genes:** In every feeding system, the daughters of high BPI sires produced more milk solids (305d) then the daughters of lower BPI sires.

Another recent example of a study of GxE has been on heat tolerance. Heat tolerance ABVs were first released in December 2017. The research team investigated whether there were meaningful differences in bull progeny rankings for production performance in hot conditions compared to moderate conditions. Even at the extremes of cool versus hot conditions, there was not significant re-ranking. The Heat Tolerance ABV is working to accurately rank bulls in Australia's sub-tropics as well as its cooler temperate regions.

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GxE across countries
The impact of environment on genetics is larger between Australia and other countries than within Australia.

Interbull (based in Sweden) is responsible for providing breeding values using data from multiple countries. The process that is used is called MACE, which stands for multiple across country evaluations.

MACE allows data from 35 countries to contribute to Australian Breeding Values. MACE accommodates differences between countries in trait definitions and management practices.

For example, a bull that ranks highly for fertility in one country may not necessarily rank highly in Australia. There is re-ranking between countries because the feeding and management systems in Australia are rather different to the Northern Hemisphere and the traits are defined differently.

How do we know that the Australian system works?

Multiple Australian studies (including Feeding the Genes mentioned earlier) have determined that higher genetic merit cows (based on BPI) produce more milk than their herdmates with lower genetic merit. They also last just as long, if not longer in the herd, debunking the theory that higher genetic merit cows are less fertile and less likely to last. These findings hold across different breeds, dairy regions and feeding systems.

The **ImProving Herds**[2] project compared the production and financial contribution of high and low BPI groups within individual herds. This involved a detailed analysis of 27 dairy farms with excellent herd and financial records spanning multiple years.

It concluded that the top 25% of cows (based on BPI) contributed more to the farm business than the bottom 25%. On average, the high BPI cows in the 27 herds produced more milk solids and had an 8-month longer productive life than their low BPI herd-mates. The extra milk income more than compensated for higher feed costs.

This study also compared the actual performance of first lactation heifers with their predicted performance based on genomic testing before they entered the herd. The relationship between production records and ABV(g)s matched the national mean reliabilities for equivalent traits. This confirmed the genetic merit prediction is exactly as reliable as claimed by the genetic evaluation system.

A detailed analysis of the performance of the **Daugther Fertility ABV**[3] was undertaken by EE Cheng Ooi. This study compared the actual reproductive performance of cows with their predicted genetic merit (Daughter Fertility ABV). The study drew upon records from 38 herds and about 87,000 cows.

In both Holstein and Jersey breeds, the study found that cows with higher Daughter Fertility ABVs had better reproductive performance in terms of conception rate, submission rate and in calf rate.

The study concluded that farmers could have confidence that using the Daughter Fertility ABV to select bulls would make a difference to herd reproductive performance. However, it acknowledged that management practices such as calving pattern, heat detection, nutrition and cow health also have a strong influence on herd fertility.

Further reading

[1] Feeding the Genes
[2] ImProving Herds
[3] Validating Daughter Fertility ABV, 2019 Herd 19 proceedings p31
* 2017 Australian Dairy Herd Improvement Report p 16

More information

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ImProving Herds: Average difference between high and low BPI cows for milk production in 27 Genetic Focus Farms				
Compared to their lower BPI herd mates, high BPI cows produced…				
Milk (L)	649 more L/cow/year	Fat (%)	0.29% higher fat content	**+ Last 8 months longer in the herd**
Fat (kg)	50 more kg/cow/year	Protein (%)	0.19% higher protein content	
Protein (kg)	38 more kg/cow/year			