Australian cattle breeders to increase their rates of genetic gain. The genomic predictions, which have been developed and tested on Australian animals in Australian beef production systems, are designed to work across breeds represented in the CRC's datasets (though breeders need to be cautious about assuming they will work in breeds not included in the CRC database). These genomic predictions will help more accurately describe the genetic qualities of individual animals for hard-to-measure production and reproduction traits and will improve the accuracy of all BREEDPLAN traits.

**Discovery population and validation population**

In developing its genomic predictions, the Beef CRC used diverse populations of *Bos indicus*, *Bos taurus* and Tropical Composite cattle for both ‘discovery’ and ‘validation’. The discovery process involved collecting detailed performance information for many hard-to-measure traits and then matching the performance data with the animal’s DNA marker information. The validation cattle populations are independent of the discovery population and are used to assess the strength of relationships between an animal’s performance and DNA marker information in another population (i.e. to independently validate the initial prediction).

**Harnessing the power of genomic predictions**

The genomic predictions can be applied to any BREEDPLAN-recorded animal once testing of that animal’s DNA sample is complete and its genomic information integrated into BREEDPLAN analysis (Figure 1). The best way to select animals is to utilise all available information to get the most accurate picture of the genes an animal carries. BREEDPLAN EBVs can now be enhanced when combined with DNA marker information to generate more accurate EBVs. BREEDPLAN EBVs that include DNA marker information are used in the same way as BREEDPLAN EBVs have always been used. The major benefit from including genomic information is an increase in the accuracies of EBVs, particularly for expensive- or difficult-to-measure traits, thereby supporting more accurate selection decisions and increased genetic gains.

**DNA technology can increase the accuracy of BREEDPLAN Estimated Breeding Values (EBVs) for economically important traits such as reproduction and feed efficiency in beef cattle. This fact sheet describes the potential role of DNA technology in improving genetic gain.**

**The potential of DNA technology**

Economically important productive traits such as feed efficiency, carcase and beef quality and reproduction are controlled by a very large number of genes, all of which add a small effect to the expression of a trait. This results in a large variation between animals in performance for a particular trait. Genetic selection for these traits aims to identify those animals that are genetically superior for the particular trait.

**Development of Beef CRC genomic prediction equations**

The Beef CRC’s release of genomic prediction equations based on DNA marker information represents a significant opportunity for Australian cattle breeders to increase their rates of genetic gain. The genomic predictions, which have been developed and tested on Australian animals in Australian beef production systems, are designed to work across breeds represented in the CRC’s datasets (though breeders need to be cautious about assuming they will work in breeds not included in the CRC database). These genomic predictions will help more accurately describe the genetic qualities of individual animals for hard-to-measure production and reproduction traits and will improve the accuracy of all BREEDPLAN traits.

**FAST FACTS**

- Productive traits are usually controlled by a very large number of genes, each with a small effect.
- The greatest value of DNA marker information is realised when it is integrated with existing BREEDPLAN EBVs.
- The development of Beef CRC genomic prediction equations for hard-to-measure productive and reproductive traits will improve the accuracy of all BREEDPLAN EBVs.
- Genomic prediction equations will help Australian cattle producers increase their rates of genetic gain through access to more accurate BREEDPLAN EBVs on young animals.

**Terminology**

EBV: Estimated Breeding Value, calculated from performance measurements, pedigree information and, where available, DNA marker information.

**Beef CRC genomic prediction equation**: across-breed predictions of the genetic merit of individual animals based on DNA marker information from a 700k SNP chip for many economically important traits.
Beef CRC Genomic Prediction Equations: Improving Productive Traits With DNA

Fact Sheet

ABRI calculates prediction (using CRC prediction equation) and blends with BREEDPLAN breeding values

Seedstock producer takes a hair sample from a young bull

BREEDPLAN returns breeding values to the Breed society and the seedstock breeder

Breeder supplies hair sample to laboratory for testing

Days to calving (days) | Carcass weight (kg) | Eye muscle area (sq. cm) | Rib fat (mm) | Rump fat (mm)
---|---|---|---|---
-5.1 | +61 | +11.6 | -1.1 | -0.2
61% | 90% | 84% | 91% | 91%

Figure 1: Commercialisation of genomic prediction equations and integration with existing BREEDPLAN EBVs

Achieving genetic gain

Genetic gains in a beef breeding operation depend on identifying and selecting the best animals, the accuracy with which these animals are being selected and how quickly generations can be turned over.

BREEDPLAN EBVs that combine both performance information and DNA marker information can fast-track genetic gains by increasing the accuracies of the EBVs. This trend is more pronounced for difficult-to-measure traits or traits of low heritability. For such traits, little performance information is available at the time animals are selected and estimating breeding values often relies on use of correlated traits that are easier to measure. Therefore, the addition of DNA marker information provides useful additional information for such traits.

DNA marker information allows the estimation of a breeding value on young animals as soon as DNA marker data is available, e.g. on a DNA sample taken at birth. At any stage, DNA markers have the same predictive ability of an animal’s genetic merit because the genetic make-up of an animal does not change over that animal’s lifetime. Even though BREEDPLAN EBVs are less accurate for young animals, combining DNA marker information and performance on relatives (e.g. parents) provides higher BREEDPLAN EBV accuracies on animals before they are old enough to be recorded for the particular trait under selection.
Benefits of Beef CRC genomic prediction equations

- Increases accuracy of EBVs calculated from pedigree and performance information
- Provides an early measure of an animal’s genetic merit for traits that can’t be measured until later in life (e.g. reproductive performance)
- Offers an alternative to traits that are difficult or costly to measure (e.g. feed efficiency)
- Offers an alternative in situations where it is difficult to collect useful performance information (e.g. small herds, where some animals are managed differently to others in the herd)
- More accurate EBVs will be presented on sale animals allowing more informed selection
- Increasing the accuracy of existing EBVs will ultimately increase overall rates of genetic improvement

Genomic prediction equations increase the rate of genetic improvement by

- Increasing the accuracy of selection decisions particularly for traits not currently measured or with low heritability
- Increasing the intensity of selection by enabling more animals to be screened
- Reducing generation length by enabling earlier prediction of breeding value and selection

Considerations for the producer when deciding to invest

- Relevance of the test based on relatedness of the producer’s herd to discovery and validation populations
- Level of additional accuracy in EBVs achieved by DNA testing
- Level of increase in the rate of genetic progress being achieved
- The cost of the test
- Other options to improve the accuracy of EBVs (e.g. measure more animals versus DNA test)
- The value of an increase in the rate of genetic progress for your operation and for your clients

Assessing the value of Beef CRC genomic prediction equations

The benefits of the Beef CRC’s genomic prediction equations have been modelled and the rates of genetic gain estimated. Three breeding objectives were considered: Angus short-fed for the domestic market; Angus long-fed for the high-marbling north Asian markets; and Brahmans for the grass-fed Japanese and Korean steer markets. The value of the Beef CRC genomic predictions for seedstock and commercial beef producers is described in detail in three accompanying fact sheets (The benefit of Beef CRC prediction equations – Angus short-fed; Angus long-fed and Brahman).