CRC FOR BEEF GENETIC TECHNOLOGIES

FACT SHEET

Utilising DNA to Change Qualitative Traits




FAST FACTS

- **Qualitative traits are those that show a clear distinction between phenotypes, such as coat colour and horns**
- **DNA tests for coat colour directly detect alleles at a locus known as the 'Extension' locus, one of the main genes involved in coat colour**
- **DNA tests for the horned/polled gene use gene markers to predict an animal's genotype, and are not 100% accurate**
- **The Beef CRC polled gene test provides more accurate predictions in some breeds, such as Brahmans, than others**

Qualitative traits, or type traits, are those that show a clear distinction between phenotypes, such as coat colour and the presence or absence of horns. The expression of these traits is controlled by only a few genes or one gene. DNA tests to detect the genes that influence coat colour and the appearance of horns are currently available, and offer obvious advantages over progeny testing for elucidating an animal's genotype for these traits.

The genetics of coat colour

The three basic coat colours—red, black, and brown— result from the relative presence of eumelanin (black-brown pigment) and pheomelanin (red-yellow pigment). The Extension locus, located on bovine chromosome 18, plays a major role in regulating the synthesis of these two pigments, although coat colour may be further modified by the action of additional genes that cause spotting, dilution, roaning and brindling.

The genetic inheritance of coat colour in cattle is quite complex and not yet fully understood. DNA tests can detect the three possible forms, or alleles, at the Extension locus: ED (black), e (red), and E+ (wild type).
ED is dominant over the recessive allele, e. ED is mostly dominant over E+, but incomplete dominance is sometimes seen. Each animal will inherit two alleles: one from its dam and one from its sire. All of the possible genotype combinations and their corresponding phenotypic expressions are shown in Table 1.

Table 1: *Possible genotypes for the Extension locus and corresponding phenotypic expression of colour.*

Coat colour phenotype	Possible genotypes
Black	ED ED, ED e, ED E+
Red	ee, e E+
Various colours	E+ E+

Coat colour tests available in Australia

DNA testing allows breeders to differentiate between homozygous and heterozygous black animals and to determine the incidence of the wild type allele.

In Australia, DNA tests for the Extension locus are offered by Pfizer Animal Genetics (PAG, Genestar Black) and The University of Queensland (UQ, Red factor/dominant black). These tests are also available through a number of overseas laboratories. Contact your breed society to find out whether cost savings are available to members.

The genetics of horns

An animal's phenotype can be horned, polled or scurred (the presence of small horns not attached to the skull). The inheritance of these phenotypes is complex and not fully understood. All of the currently available DNA tests indirectly detect the polled gene through linked gene markers.

The polled gene (PP) is dominant to the horned gene (hh) and heterozygous animals (Ph) will be polled (Figure 1). The scurs gene interacts with the polled gene and is only expressed when the polled allele is present (in PP or Ph animals). Expression of the scurs gene differs between males and females, being dominant in males and recessive in females. Males with one or two copies of the scurs allele will develop the scurs phenotype, whereas females require two copies of the scurs allele before they will express the scurs phenotype.

Genotype: PP or Ph

Genotype: HH

Figure 1: *Possible genotypes at the polled locus and their phenotypic expression.*

Tests for polledness available

While gene markers for scurs are not yet available, several tests using gene markers linked to the polled gene are available from Igenity and MMI genomics in the United States, and from The University of Queensland and Pfizer Animal Genetics in Australia. Both Australian laboratories are using the linked marker test released by the Beef CRC.

Accuracy of the Beef CRC test

The Beef CRC's linked marker has many alleles: some are always associated with the polled phenotype, some are always associated with the horned phenotype, and some—referred to as ambiguous alleles—are associated with both the polled and horned phenotypes. The frequency of ambiguous alleles varies between breeds and determines the test's usefulness in a particular breed. Where ambiguous alleles occur with low frequency the test is reliable, although some phenotype inconsistencies have been identified.

The Beef CRC's test was developed in Bos indicus animals and shows considerable promise in Brahmans. Extensive validation has been undertaken by the Beef CRC using experimental populations, industry sires and breeder-submitted samples. Full results for the 10 breeds tested to date are available at http://beefcrc.com.au/PolledGeneMarkerTest.

The Beef CRC polled gene test cannot always identify a definitive genotype and reporting of the test reflects the level of uncertainty in test results. Test reporting indicates the probability that an animal is homozygous polled (UQ) or the probability of an animal's most likely genotype (PAG). These probabilities are based purely on test results without reference to the animal's actual phenotype. Considering an animal's phenotype in conjunction with the test prediction will therefore assist breeders to interpret the test result.

The Benefits of DNA for Changing Qualitative Traits – Polledness

Producers wanting to transition to a polled herd can achieve the desired outcome in a variety of ways. The pathway chosen will affect the time taken to achieve a polled herd and will also affect the cost. The benefit of DNA is that producers can better identify sires that are homozygous polled (PP) rather than having a polled appearance but actually being heterozygous (Ph). Overall, homozygous polled bulls will achieve the transition to a poll herd more rapidly than simply using bulls that appeared polled but may be heterozygous polled (Ph) and thus passing the horn allele onto 50% of their progeny. The alternative to DNA testing is progeny testing which takes many years to confirm the genotype, either PP or PH of a phenotypically polled bull. Further information on the application of the Polled Gene Marker test is available in the Beef CRC fact sheet – Transitioning to a Polled Herd.

Further information

The Beef CRC website (http://www.beefcrc.com.au/) and the SBTS/TBTS webinar series (http://sbts.une.edu.au/Webinars/webinars.html) have additional information on utilising DNA technology to manage qualitative traits and on transitioning to a polled herd.