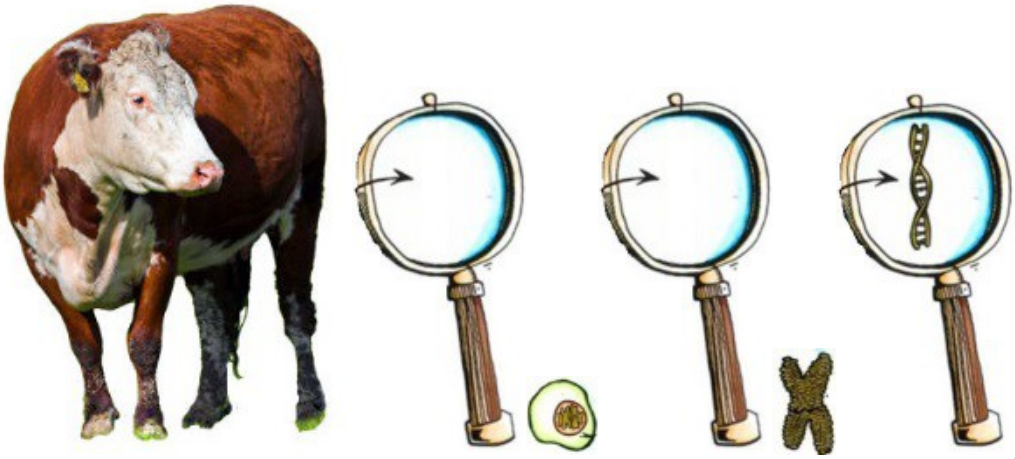
Title: DNA technologies for beef cattle

Words: SBTS/NZHA

There is now a range of DNA-based technologies available that can be applied within a beef enterprise. Before making the decision to invest in DNA technologies, it makes sense to be informed about the theory of DNA and the current applications available.



The theory of DNA

What is DNA?

Deoxyribonucleic acid (DNA) is a molecule found in all bovine cells. It is often described as the 'blueprint' of an organism because it codes the instructions for how that organism will develop, function and appear.

For storage, DNA is bundled into chromosomes, of which cattle have 30 pairs. Within the chromosomes, there are approximately three billion base pairs of bovine DNA. The base pairs are made up of four types; Adenine (A), Thiamine (T), Guanine (G) and Cytosine (C). The sequences of these base pairs make up the 'message' of DNA, and differences in sequences provide the basis for variation between individuals.

What is a gene?

A gene is a sequence of base pairs at a particular location on the chromosome, which codes for a specific product. It is estimated that there are between 22,000 and 28,000 genes in the beef animals. For each gene there may be two or more variants, known as alleles, which can result in different

phenotypes or observable characteristics. Each individual has two alleles for each gene, one copy inherited from their father and one copy from their mother.

What is a gene marker (or DNA marker)?

The two types of DNA markers commonly used in beef cattle are microsatellites and single nucleotide polymorphisms (SNPs). A **microsatellite** is a repeat of a particular base pair sequence at a specific location in an animal's DNA. The number of base pair repeats can differ between animals.

SNPs occur where there is a difference in a single base pair, as highlighted in Fig 2, where the top animal has a C and G base pair at a particular location whereas the bottom animal has a T and A base pair.

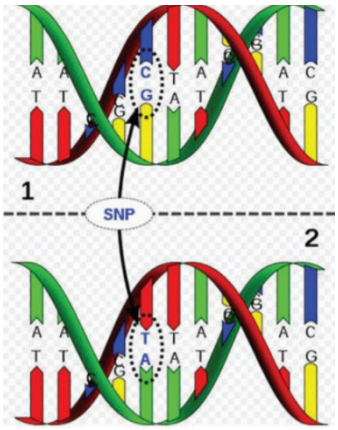


Fig 2

SNPs are replacing microsatellites as the genetic marker of choice because of their greater abundance and stability. The greater abundance of markers means more markers can be included in any test, allowing them to be more powerful and accurate, and the greater stability means the test will remain accurate over many generations. DNA laboratories are also phasing out microsatellite testing due to difficulties in obtaining replacement equipment and reagents to perform the tests.

Current applications of DNA technology

There are many potential applications of DNA technology within a beef seedstock enterprise. Some of the most common current applications include:

i. Parentage verification – DNA parentage verification works by analysing a series of DNA markers in the progeny and in potential parents. For each DNA marker, one of the two variants observed in progeny must have come from the dam and the other from the sire.

Therefore, potential parent combinations can be ruled out as the parents if their DNA markers do not match those observed in the progeny. While both microsatellite and SNP markers have been used in parent verification, SNPs are becoming the marker of choice due to their greater abundance/accuracy and stability.

ii. Management of genetic conditions – genetic conditions or defects are caused by DNA abnormalities and are present in all species, including beef cattle. The incidence of genetic conditions is normally low within a population, though more inbreeding or the rapid dissemination of genes through artificial breeding can lead to an escalation in the prevalence of a genetic condition. Over 400 genetic conditions have been identified in beef cattle. Approximately 25% of these are caused by a single gene mutation, making them easy to manage through DNA testing.

iii. Change in qualitative traits – a number of genes that contribute to coat colour and horned/polled status have been identified and have genetic tests available.

iv. Genetic improvement in production traits (genomic selection) – genomic prediction of production traits involves identifying the relationship between the genetic markers and production traits in a reference population. The genetic component of the production traits can then be inferred using this relationship. The genomic information is then used, in addition to the traditional pedigree and performance data, to increase the accuracy of the resulting BREEDPLAN EBVs. It is important to note that the number of markers required for genomic prediction is much larger than what is required for the other applications discussed in this article. Therefore, the SNP chips required for genomic prediction must be of higher density, and thus are more expensive.

Typically, parentage verification, genetic conditions and qualitative trait tests can be obtained individually, or bundled within a genomic selection test (typically 50,000 SNP markers or more) at a price less than the total price of the individual tests performed separately.

SNP facts

While early DNA technology only evaluated an animal's DNA for a relatively small number of SNPs, SNP chips now routinely evaluate animals at many thousands of individual SNPs.

Low- density (LD) are DNA chips with anywhere between 10K and 50K (10,000 and 50,000) of individual SNPS markers). 50K is an ideal tool to test an entire bull calf crop, with high-accuracy performance at an affordable price. Detects gene markers that have the greatest influence on economically important traits and the most impact on key traits that cattle inherit from their parents.

High-density (HD) chips provide greater accuracy testing 150,000 (150K) genetic markers – ideal cattle DNA testing solution for elite seedstock, donor dams, A.I. studs and high-impact cattle. Contains tens of thousands more markers than any other commercial profiler, including gene markers from chromosome areas actively involved in cattle variation.

The parameters are likely to change for each definition as the science and technology improves.

Summary

Why has NZHA moved to SNP testing in 2018? SNP testing is more accurate and provides more information than the older style microsatellite testing.

How to select the right DNA test for you
The most appropriate DNA test for you and your operation will come down to several things:

- The animal being tested: Is this a calf you wish to PV? A herd sire? An AI sire, or is it a cow you wish to flush for embryos?
- What information do you wish to gain from conducting the test?
- Does the DNA test you are requesting meet the most current regulations?

How do genomics help me?
SNP genotypes, along with pedigree information and performance information, are incorporated into the calculation of BREEDPLAN EBVs. They assist in increasing the accuracy of an animal's EBV figures, by combining observed trait data, pedigree performance data and the genomic predictions. Genotype testing your animals will also benefit those related to them.

SIDE PANEL: Service providers

Service provider: GeneSeek Australasia
Location: Gatton, Australia

Tests available:

GGP 50K
GGP HD 150K
SeekSire – Approximately 500 SNP markers for parentage only.
Genetic testing: Hypotrichosis, Idiopathic Epilepsy**,** Diluter**,** HornPoll

Sample type:

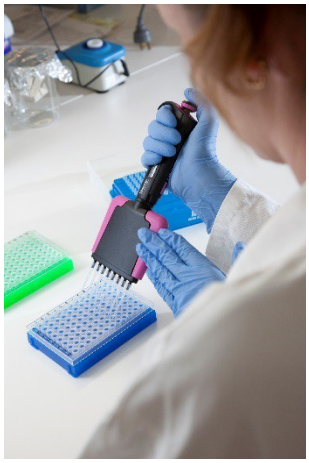
Preference is Hair or TSU*, but can accept semen, blood and extracted DNA (additional charge).

*At time of print GeneSeek were still investigating importing TSU samples into Australia.

Turnaround time:

*4.5 weeks on average – 3 weeks for samples arriving at the laboratory plus 10 days of travel.

Picture:



Service provider: Genomnz

Location: Mosgiel, New Zealand

Tests available:

10K
200 SNP ISAG parentage
Genetic testing: Hypotrichosis, Idiopathic Epilepsy**,** Diluter.

Sample type:

TSUs

Turnaround time:

*4 weeks (dependent on number of samples received by Genomnz).

Picture:

COMING

Service provider: Massey

Location: Massey University, Palmerston North, New Zealand

Tests available:

COMING

Genetic testing: Hypotrichosis, Idiopathic Epilepsy**,** Diluter**,** HornPoll.

Sample type:

COMING

Turnaround time:

Picture:

COMING

*Turnaround for all service providers is dependent on suitable samples and accurate information being submitted.

** Other service providers are available in addition to the three named above.

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