Managing 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 but increases in inbreeding or the rapid dissemination of genes through artificial breeding, can lead to a rapid escalation in the prevalence of a condition.

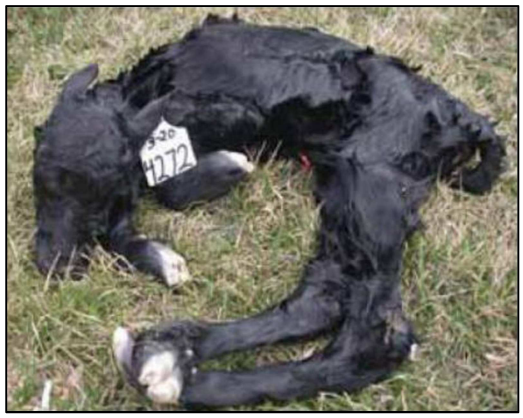
Over 400 genetic conditions have been identified in beef cattle. Approximately one quarter of these are caused by a single gene mutation, making them easy to manage through DNA testing. Historically, genetic conditions were managed by extensive progeny testing or by eradicating all known relatives of the effected animal. This resulted in production losses and the potential loss of superior genetics. Developments in DNA testing and gene probability technology now allow breeders to more easily manage genetic conditions such that production losses and spread of the mutation can be minimised.

Recognising Genetic Conditions

Genetic conditions generally result in:

- *Poor growth and fertility performance*. For example, calves with Protoporphyria (photosensitivity) develop scabs and open sores when exposed to sunlight and have reduced liver function, which in turn decreases their overall performance.
- *Structural unsoundness*. For example, animals with Snorter Dwarfism have a short, blocky appearance with deformed bone growth in the nose, causing difficulty breathing.
- *Semi-lethal - Not all affected individuals survive to maturity*. For example, many calves affected by Contractural Arachnodactyly (CA) will die shortly after birth because they are unable to stand and suckle. Those calves who are able to stand will often survive to maturity but have poor growth performance.
- *Lethal - No affected animals survive to maturity*. For example, animals affected by Pompes will typically die between 6 to 12 months of age after displaying progressive muscular weakness.

The symptoms of genetic conditions can be quite nonspecific. When large numbers of calves are dying or being born with similar abnormalities, both environmental and genetic causes are suspected. Consequently, there is a need for the surveillance and reporting of abnormal calves to breed societies, veterinarians or beef technical officers if genetic conditions are to be identified. Photographs and DNA samples from affected animals should be collected to aid in the identification of the condition.



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Mode of Inheritance

Genetic conditions have different modes of inheritance. Many have a simple recessive inheritance of a single gene mutation making them easy to manage. These single gene recessive genetic conditions result in 3 possible genotypes:

- *Free* – animal carries two normal genes and no copies of the mutation

- *Affected* – affected or abnormal animal which carries two copies of the mutation
- *Carrier* – animal which looks normal but carries one copy of the mutation which can be passed onto offspring

Figure 1 below provides an illustration of the possible mating outcomes from different mating combinations for a single gene recessive genetic condition.

As illustrated in the diagram, mating a carrier animal to a free animal will avoid production losses, with 100% of calves being unaffected by the genetic condition. But, 50% of the resulting offspring will still be carriers. Mating carrier to carrier will result in 75% normal calves and 25% affected, with two thirds of the normal calves being carriers.

Tools Available to Manage Genetic Conditions

Developments in DNA technology have resulted in diagnostic tests being available for several single gene recessive genetic conditions. The ability for beef producers to collect a DNA sample (either hair, semen, blood or tissue) and send it to a DNA lab for testing has significantly assisted the management of genetic conditions.

In addition to the development of DNA tests, a range of gene probability software (such as GeneProb) is now available to estimate the probability that an untested animal is a carrier, based on their pedigree and the known DNA test results for animals within that pedigree.

Results from gene frequency software such as GeneProb identify animals as either being free untested (XXFU) or the percentage chance of being a carrier (XX__%) as illustrated in the example in Figure 2.

Code	Description
AMF	Tested Free
AMFU	Not tested, based on pedigree expected to be free
AM__%	Not tested, based on pedigree the animal has the indicated percentage chance to be a carrier
AMC	Tested Carrier
AMA	Tested Affected

Figure 2. The possible genotype results for the genetic condition Arthrogryposis Multiplex (AM). DNA testing reports AMA, AMF and AMC while the GeneProb predictions report AMFU and AM__% (eg. AM25%).

Managing Genetic Conditions

There is no "one size fits all" strategy for managing genetic conditions. Before embarking on a management strategy producers should consider:

- the economic impact of the condition
- the frequency of the condition within the herd
- the availability and cost of DNA tests
- researching the genetic condition status of any animals being brought into the herd
- their legal obligations about disclosing the carrier status of sale animals
- the relevant Breed Society regulations

Generally, the management of genetic conditions can be broken into two components.

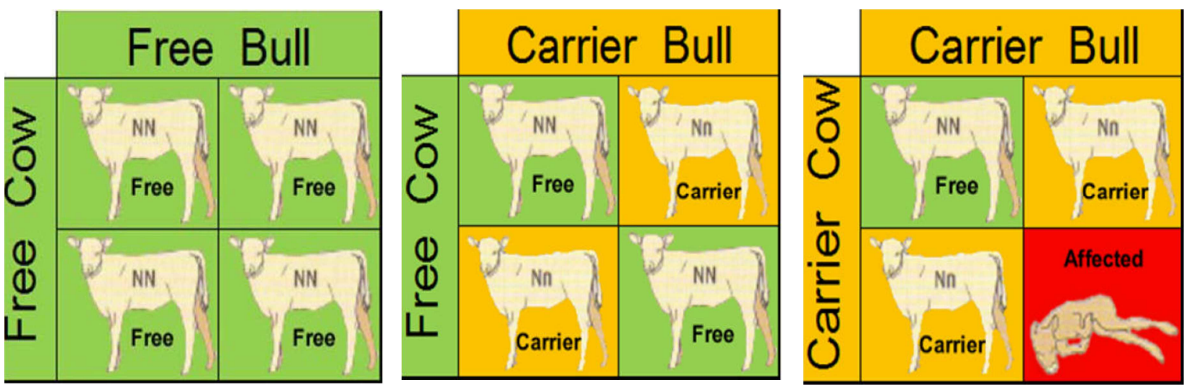

Figure 1. Possible mating outcomes for different genetic condition genotypes

Managing the Incidence of Affected Animals – In simple terms, the incidence of animals affected by the genetic condition can be managed by avoiding mating carrier dams to a carrier sire. This may be relatively easy to manage in seedstock herds, but can be extremely difficult in commercial herds which keep no pedigree records. For this reason it is recommended that commercial herds, or seedstock herds that have done minimal DNA testing, should always use bulls that are tested free.

Managing the Incidence of Carriers – Managing the frequency of carrier animals is important in seedstock operations. Where available, the use of DNA testing to determine if an animal is either free or a carrier for a genetic condition broadens the options for breeders looking to manage or eradicate the mutation. Use of software like Geneprob to calculate the risk of particular untested individuals being carriers enables DNA testing efforts to focus on the most high risk animals.

Breeders should carefully consider and develop a management strategy that will be used to manage each genetic condition. Some examples of management strategies are as follows:

- DNA test all animals in the breeding herd to identify and cull carrier animals. Rather than being sold, carrier females can be retained for use as recipient dams in embryo transfer programs.
- Conduct strategic DNA testing of highly influential animals (eg. sires, donor dams) to calculate the probability of animals being carriers, and better identify the "at risk" bloodlines. Further testing can then be conducted to better isolate the carriers present in the herd.
- Continue to use carrier animals in the breeding program by joining them only to tested free sires/dams and routinely testing the progeny. As outlined previously, mating a carrier to a free animal will result in 100% of calves being unaffected by the genetic condition, with 50% of the resulting offspring being free of the condition and 50% being carriers. This approach is of particular benefit when the carrier animal is of high genetic merit and the producer wants to utilise these desirable genes in the breeding program.
- Only use sires that are tested free or are expected to be free by inheritance to ensure that the incidence of the condition does not increase. This is a common approach for genetic conditions of low economic impact.

Fast Facts

- There are over 400 genetic conditions identified in beef cattle.
- There are currently DNA tests for several of the most prevalent genetic conditions.
- DNA testing identifies 3 possible phenotypes – Free, Carrier and Affected.
- The incidence of affected offspring can be eliminated by avoiding carrier to carrier matings.

In all situations, if carrier animals are sold, full disclosure of their genetic condition status should be provided.

For further advice regarding the management of genetic conditions, or to find out which genetic conditions have DNA tests available, contact staff at Southern Beef Technology Services (SBTS) or Tropical Beef Technology Services (TBTS).