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WAGYU GENETICS

Wagyu are a unique cattle breed that is characterised by exceptional marbling qualities.

Ongoing research into Wagyu genetic has enabled the breed to promote those marbling qualities, as well as improving yield and breeding traits.

All breeds of cattle, including Wagyu, are prone to undesirable genetic conditions. Fortunately, advances in molecular genetics have facilitated the development of DNA tests for their management. Breed Societies are at the forefront of the development of strategies to manage genetic conditions and seedstock members are leading the industry with their uptake of this technology.

The key inherited recessive genetic conditions in Wagyu are: Spherocystosis, Chediak Higashi Syndrome, Claudin 16 Deficiency, Factor XI Deficiency and IARS Disorder.

HOW ARE THE CONDITIONS INHERITED?

Research from Japan indicates that there are inherited recessive genetic conditions for Wagyu: Spherocystosis (B3), Chediak Higashi Syndrome (CHS), Claudin 15 Deficiency (CL16), Factor XI deficiency (F11) and IARS Disorder. This means that a single pair of genes controls each condition. For this mode of inheritance two copies of the undesirable gene need to be present before the condition is seen.

The known genetic conditions of Wagyu are as follows:

Spherocystosis (B3) – This is a disorder of the surface membrane of the erythrocyte (red blood cells). The protein from the B3 gene makes up the basic structure of the erythrocyte. Cattle that are homozygous (have two copies of the recessive allele) have pernicious anaemia (bleeding caused by the abnormal red blood cells). Death normally occurs within the first 7 days after birth. Some cases live to adulthood but there is a severe retardation in growth.

Chediak Higashi Syndrome (CHS) – CHS is a macrophage disorder (a white blood cell that has an important role in the immune response to disease). If cattle have a malfunctioning immune system, this makes them unable to resist the bacterial challenge. Blood is slow to coagulate so often the first indicator is unusual umbilical cord haemorrhage at parturition (calving). Cattle with this syndrome often have an unusually pale coat colour.

Claudin 16 Deficiency (CL16) – CL16 (also known as RTD or Renal tubular dysplasia) is a gene disorder on chromosome 1 and causes kidney failure (chronic interstitial nephritis often with zonal fibrosis or excess of fibrous connective tissue). This disorder results in terminal kidney failure and the onset can occur anytime from late adolescence. Cattle are unlikely to live more than 6 years.

Factor XI deficiency (F11) – F11 is a plasma protein that participates in the formation of blood clots. Factor XI deficiency is an autosomal disorder that is associated with mild bleeding in Wagyu. Affected animals show prolonged bleeding time and abnormal plasma coagulation after trauma or surgical procedures such as castration or dehorning. It is also possible that

Carrier x Carrier matings have increased difficulty producing viable fertilised embryos or full-term pregnancies and are may be repeated (return to cycle) breeders. Note – this is generally a non-lethal recessive condition with affected animals being able to live and breed as normal. (occurs in Holsteins)

IARS Disorder – IARS Disorder results in death of affected calves within the last few weeks of gestation, or shortly after birth. Research has identified a mutation in the IARS gene as the cause, resulting in a reduction in activity of a key enzyme, important for protein synthesis for the developing foetus and newborn. Calves affected by this exhibit anaemia, depression, weakness, variable body temperature, difficulty nursing, growth retardation and susceptible to infection.

Note – There are other recessive genetic conditions known to exist in Wagyu cattle (e.g. F13) however they have not been identified in the Australia Wagyu population.

WHAT HAPPENS WHEN CARRIERS ARE MATED?

Animals with only one copy of the undesirable gene and one copy of the normal form of the gene (i.e. no symptoms), are known as “carriers”. A carrier will, on average, pass the undesirable gene form to an arbitrary 50% of their progeny. When a carrier bull and carrier cow are mated the three outcomes may be:

- There is a 25% chance that the progeny will have two normal genes and so will never pass on the undesirable gene.
- There is a 50% chance that the mating will produce a carrier.
- There is a 25% chance that the progeny will inherit two copies of the undesirable gene and hence be affected by the genetic condition.

When a carrier animal is mated to an animal tested free of the genetic condition, three outcomes are possible:

- All progeny will appear normal and will be unaffected by the condition.
- There is a 50% chance that the mating will produce a carrier.
- There is a 50% chance that the progeny produced will have two normal genes and so will never pass on the undesirable gene.

Note that an animal that is tested free by DNA testing of the genetic condition will not pass the genetic condition to its descendants, even if it has carriers in its own ancestry. Therefore, DNA-tested free animals can be used in a breeding program with confidence that the unfavourable gene is not passed onto subsequent generations.

TESTING AND PREDICTING GENETIC CONDITIONS

Animals may be tested for genetic conditions using DNA test services. These tests may be requested using the DNA Test Request form. If the animal has already been DNA parent verified using a hair sample then some of the remaining hair samples may be used for this test. However, if no preceding DNA tests have been conducted then a hair sample must be sent with the Request Form in the standard hair collection kit which may be obtained from the Association – send an email or call 02 8880 7700.

Gene analysis interrogates the pedigree of each animal and calculates the probability that the animal is a carrier for each genetic condition from the known DNA information of their relatives. For example, if an animal's dam had been tested free of the genetic condition but the sire was a tested carrier, the animal would be reported as having a 50% chance of being a carrier.

The gene probability analysis includes all known DNA information for animals recorded on the Australian Wagyu Association (AWA) database. Genetic test results are based on samples provided by breeders.

Disclaimer: The Australian Wagyu Association makes no statements, representations or warranties about the accuracy or completeness of any information relating to the status of a particular animal: and disclaims all responsibility for information and all liability (including without limitation, liability in negligence) for all expenses, losses, damages, and costs you may incur as a result of information being inaccurate or incomplete in any way for any reason.

Code Explanation

Wagyu that have been registered with the AWA will be reported with the vital information to identify the animal and will include the status of genetic conditions. For example:

Identifier	ABC00101
Sex	Female
Birth Date	01/01/20014
Grade	Fullblood
Genetic Test Status	**B3FU, CHSFU, CL16FU, F1199%**
Sire	ABCBull050
Dam	ABCCow049
Owner	ABC Wagyu

The first two, three or four characters indicate the genetic condition – ie. B3, CHS, CL16 or F11, the suffix indicates the testing status and outcome.

_ _F	Indicates that the sample submitted for this animal **has been tested** and found to be **free** of the causative mutation responsible for the indicated genetic condition. This animal is homozygous free, meaning that it has two copies of the normal variant (or allele) of the gene.
_ _C	Indicates that the sample submitted for this animal **has been tested** and found to be **a carrier** of the causative mutation responsible for the indicated genetic condition. This animal is heterozygous for the mutation, meaning that it has one mutant allele and one normal allele. This animal could pass the mutation to approximately half of its progeny.
_ _ _%	Indicates that, based on pedigree information supplied by the breeder of the animal, the animal **has a chance to be a carrier** of the mutation responsible for the indicated genetic condition but **has not been tested**. The higher the indicated percentage, the larger the chance the animal may be a carrier
_ _FU	Indicates that, based on pedigree information supplied by the breeder of the animal, the animal is **expected to be free** of the mutation responsible for the indicated genetic condition. However, this animal **has not been tested** for the causative mutation and the AWA gives no guarantee as to the animal's "free" status.
_ _A	Indicates that the sample submitted for this animal **has been tested** and found to be **affected** by the genetic condition. This animal is homozygous for the mutation responsible for the genetic condition and has two copies of the mutant variant of the gene.

It is important to note that the results are current at the date of publishing and are limited by the DNA test result and pedigree information available. The results may change as further DNA testing is performed, particularly when the level of testing that has been conducted is relatively low. The AWA Animal Search facility will consequently become the best source of data on an animal's status, with the genetic results routinely updated.

POLLED WAGYU

Fullblood Wagyu do not appear to have the polled (non-horned) gene, but may come through in purebred Wagyu cattle, particularly if they have been upgraded from an Angus base.

The polled gene is the same gene in all breeds and is dominant. Therefore it is not important which base breed is used to introgress the polled gene into a breed. Homozygous (both copies of the poll gene are polled) polled sires are most desirable as they will always breed polled progeny.

If a breeder started with a Fullblood sire over base Angus females 100% of the F1 progeny would be polled and heterozygous ie one copy of the poll gene and one non-polled gene. In the grading up process using Fullblood sires 50% of the F2 progeny would be polled, 25% of the F3 progeny would be polled and 12.5% of the Purebred progeny would be polled. Mating of a polled Purebred sire to a polled Purebred dam the probability of the progeny being homozygous polled would be 25%.

The scurred condition (small, loose, horny growths in the skin where horns would be) is controlled by a different gene to the polled gene and scuds are only expressed in polled cattle. The scur gene is sex linked and is dominant in males (animals with

one copy have scurs) and recessive in females (scuds only expressed when the animal has two copies of the scur gene). Homozygous polled animals do not exhibit scurs so long-term selection for polledness will also eliminate scurs.

POLLED TESTING

Wagyu breeders can test their animals for homozygous polled. If you are breeding for polledness in Wagyu animals then identification of a homozygous polled bull will be very valuable as it will produce 100 percent of polled progeny if mated to horned cows. A heterozygous polled bull will produce only 50 percent of polled animals when mated to horned cows.

The test for homozygous polled animals should only be used on animals which are polled and both parents are polled.

The test is conducted on hair samples with hair roots intact taken from the switch of the tail. If you wish to discuss the use of the horn/poll test for Wagyu cattle please call the AWA Technical Officer, Carel Teseling.