Genetic Defects Wagyu Cattle

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Random mutations in the genome occur every generation, and are not necessarily bad. Many of these mutations do not create a noticeable change in phenotype and in fact mutations give rise to new sources of genetic variation which enable continued genetic selection and progress. However, periodically mutations occur that are deleterious. If these unfavorable mutations occur in an animal that is heavily used (i.e., a popular AI sire) then they begin to increase in frequency to the point where the actual defect phenotype is noticed in the population. The majority of genetic defects that are currently being monitored by US breed associations are autosomal recessive. Autosomal recessive means that two copies of the mutated allele are needed for an animal to be afflicted.

Inheritance Example

Following is an example of a recessive genetic lethal defect. If a heterozygous bull (Nn) is mated to a homozygous normal female (NN) then the resulting offspring would be 100% normal (i.e. not afflicted) with 50% of them being homozygous and the other 50% heterozygous (carriers).

	N	N
N	NN	NN
n	nN	nN

If two heterozygous (carrier) animals are mated (example below) then there is a 25% chance that the calf will be afflicted (nn), 25% chance it will be homozygous normal (NN) and a 50% chance it will be a carrier (Nn & nN). The only time an afflicted calf can be produced is when two carriers are mated, and then the odds are that the calf will be normal 75% or the time.

	N	N
N	NN	Nn
n	nN	Nn

Descriptions of Genetic Defects in Wagyu populations

Erythrocyte Membrane Protein Band III Deficiency (Spherocytosis) (Band 3). Affected cattle are morbidly anemic. Calves are typically born weak and small with severe anemia, labored

breathing, palpitations, and not able to stand or suckle at birth. This disorder is often lethal although some cattle survive albeit with severely retarded growth.

Claudin 16 Deficiency (CL16). Affected cattle suffer from a severe risk of kidney failure throughout their lives. Other symptoms include growth retardation, increased blood urea nitrogen and creatinine values, diarrhea and overgrowth of hooves. It may or may not be lethal, but affected cattle tend to have shorter lives.

Chediak-Higashi Syndrome (CHS). These calves are often more susceptible to disease and infection. These cattle may also have a light coat color, and slight hemorrhaging. This disorder is usually not lethal.

Bovine Blood Coagulation Factor XIII Deficiency (F13). Symptoms include severely prolonged bleeding time, bruising from castration/branding, and severe anemia. This is generally lethal.

Factor XI Deficiency (F11). Affected cattle suffer from mild hemophilia-like bleeding tendencies, either spontaneously or following trauma and surgical procedures. It is also possible that Carrier x Carrier mating have increased difficulty producing viable fertilized embryos and full-term pregnancies and are often Repeat Breeders.

IARS Disorder (perinatal weak calf syndrome). IARS Disorder results in a high frequency of death in affected calves within the last few weeks of gestation or first few days of life.

At Risk Populations

Breeds where the defect was discovered are at risk but genetic defects are not limited to purebred cattle. Composites (crossbreds) that contain a breed from an at risk population are also at risk. At risk animals are those that have a known carrier in their pedigree. The probability that an animal is a carrier given that they have a known carrier in their pedigree is a function of how far back in the pedigree the known carrier is. The probability is $(1/2)^n$ where n is the number of generations between the animal in question and the known carrier. Table 1 illustrates this. Inbreeding increases the likelihood that recessive alleles can pair and in the case of genetic defects, produce afflicted calves. Crossbreeding can help mitigate the risk of genetic defects.

Table 1. Probability of an Animal receiving a defect allele from a known carrier ancestor

Relationship of Known Carrier to Animal	Number of Generations of Separation	Probability Animal is a Carrier
Parent	1	50%
Grandparent	2	25%
Great-grandparent	3	12.5%
Great-great-grandparent	4	6.25%

Use of Carrier Animals in Breeding Programs

The question cattle producers have to answer is, "Can I safely use a carrier bull?" This requires knowledge of your cowherd. If there is a risk that your cows are also carriers, then you should avoid mating them to a bull that is a carrier of the same defect as the cows. However, if you are confident your cows are clean (i.e. non-carriers) then you should choose the bull, based on EPDs, that best fits your breeding objectives, carrier or not. Realize that in this scenario there is a 50% chance that the resulting calves will be carriers and if replacement females are retained, they should not be mated to a carrier bull. If you have carrier females in your herd there are three primary options:

1) Cull all carrier females. If they are sold through a sale barn, full disclosure of their defect status should be provided. It is a falsehood to think that the seedstock sector is helping the commercial sector by putting numerous carrier breeding females on the market without providing knowledge of their defect status to potential buyers.
2) Use carrier females as recipient cows in an embryo transfer program.
3) Continue to breed the carrier females and routinely test their calves.

The reality is that there are genetic defects that we do not yet know about. There are also those that we know about and are monitoring. For those that are being monitored and a DNA diagnostic test exists, strategies can be employed to utilize them in breeding programs to avoid purging animals that might be genetically advantageous for traits of economic importance. Overtime the frequency of the defect allele can then be reduced. If you think you might have an afflicted calf, it is important to take a DNA sample from the afflicted animal and submit it to be tested. It is also important to be able to correctly identify the parentage of the animal so that the carrier sire can be identified which may require genetic based parentage testing. DNA samples can be garnered via hair follicles, blood, semen, and ear notches. Check with the lab that will perform the test to determine their preferred sample type.

Summary

With advancements in molecular technology, genetic defects can be effectively managed in beef cattle populations. Instead of purging entire lines of cattle, carrier animals can be identified and either culled or used in certain circumstances with confidence. There are numerous genetic defects currently being monitored by US beef cattle breed associations and there are likely to be others discovered in the future. It is important to realize that there are environmental factors that produce phenotypes similar to the genetic defects described. However, genetic testing can confirm if the defect is due to environmental of genetic causes assuming a test exists for the defect in question. Cattle producers need to understand the risk of defects in their cowherd by knowing the pedigree of sires they have used and their defect status. Crossbreeding has many benefits and can help mitigate the risk of producing afflicted calves by decreasing the level of

inbreeding. Seedstock producers should practice full disclosure when selling carrier animals, either as breeding animals or as intended culls.