Haplotypes
Technote 16

HIGHLIGHTS

- Fertility is a complicated trait and influenced by many genes.
- Genetic mutations that cause embryonic loss have been identified in several breeds of dairy cattle.
- The mutations are at such low frequency in the Australian population their effect on overall conception rates is minor.
- ABVs and ABV(g)s are the best guide to select cows and bulls with superior genetics for daughter fertility as they capture all the genes affecting fertility.
- Farmers encouraged to use inbreeding reports to remove any potential carrier to carrier matings.
- Use Semen Fertility Values to select bulls with higher conception rates as single gene mutations are already accounted for.
- To find the haplotype status of bulls, go to www.datagene.com.au – Bull ABVs – Haplotypes

Single gene mutations affecting fertility

Genomics has opened a whole new world of study to better understand the DNA of dairy cattle. Dairy cattle fertility has been an area of significant research given the importance of this trait to the profitability of farmers. Fertility is a complicated trait and is influenced by many genes. Scientists have found segments that are linked to fertility in the DNA of dairy cattle – commonly referred to as haplotypes – linked with early embryonic loss.

On average bulls carrying these haplotypes will have lower semen fertility because half the embryos produced will inherit the lethal mutation from the bull and, if they inherit another copy from their dam, the embryo will die, and the mating will be recorded as a failure. Also, on average, sires carrying this haplotype will produce daughters that are less fertile than average because some of the daughters will be carriers and if they are mated to a carrier bull one quarter of the embryos will die.

It is important to note these haplotypes explain a very small amount of the variation in fertility. A carrier bull can still have daughters that are more fertile than the national average because he carries good alleles at the other genes.

Holsteins

There are six known haplotypes affecting fertility in Holsteins known as HH1, HH2, HH3, HH4, HH5, HH6. Scientists have screened 2620 Holstein bulls and 6002 Holstein cows in Australia. The frequency of carriers of HH1, HH2 and HH3 was 1.3%, 0% and 1.0% respectively. This suggests the gene defects are lower frequency in our population than in the United States[2]. However, we should recognise that importations from the United States have increased over time, so in young bulls the frequency could be higher.

Given a frequency of carriers of 1% and average conception rate of 50%, we would expect that the semen fertility of carrier bulls is reduced by 50%*0.01/4 = 0.13%. Also the conception rate of the daughters of carrier bulls will be reduced by 0.07% because about half the daughters will themselves be carriers[2].

Jersey

There are two known gene defects associated with embryonic loss in the Jersey breed known as Jersey Haplotype 1 (JH1) and Jersey Haplotype 2 (JH2). Scientists at the Department of Primary Industries - Victoria screened Jersey bulls with genotypes available in Australia. Out of 540 bulls that were screened, 35 carried one copy of JH1. So the frequency of carriers is 6.5%. This suggests JH1 is found at lower frequency in our population than in the United States (23.4%)[1]. However, it is important to recognise that importations from the United States have increased over time, so in young bulls the frequency could be higher.

Given a frequency of carriers of 6.5% and average conception rate of 50%, we would expect that the semen fertility of carrier bulls is reduced by 50%*0.065/4 = 0.8%. Also the conception rate of the daughters of carrier bulls will be reduced by 0.4% because about half the daughters will themselves be carriers[1].

Implications for your breeding program

Daughter Fertility ABVs, ABV(g)s and semen fertility values remain the most useful tools when selecting bulls to improve fertility. The ABV and ABV(g)s capture the effect of all genes affecting fertility, not just the ones tracked by the haplotypes.

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Attempting to eradicate every animal with an undesirable gene defect is not recommended because these animals may carry desirable genes for other traits. Furthermore, it is not practical because it is likely that more undesirable gene defects will be found in further investigations.

The use of inbreeding reports is a useful risk management strategy. Mating programs reduce the risk of haplotype carrier to carrier joinings.

There is also the potential for mating programs to be developed using SNP chip data, which is used to recognise the fertility haplotype carriers, in order to avoid embryonic losses from mating carriers. This may be particularly useful for cows used in embryo transfer programs.

DataGene screens animals during genotyping to record their haplotype carrier status. The presence of haplotypes, ABV, ABV(g) and semen fertility data is available at www.datagene.com.au

Note - Haplotype carriers are identified using an analysis of their genotype as described in scientific publications, Apart from Haplotype HH1 the actual mutation within each haplotype has not yet been identified

References
1. Hayes, B. 2011. Report on frequency and effect of Jersey Haplotype 1 (JH1) in Australian Jerseys
2. Hayes, B. 2011. Report on frequency and effect of Holstein Haplotype 1, 2 and 3 in (HH1, HH2 and HH3) Australian Holsteins
3. Weigel, K. 2011. Haplotypes Affecting Fertility and their Impact on Dairy Cattle Breeding Programs

For more information

www.datagene.com.au to find

- Semen fertility values
- Bull lists containing single gene defects in 'Bull ABVs'

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