Haplotypes Explained

- JH1 and JH2 Haplotypes and their effect on fertility

Richard Bostock (Littlestar Jerseys and Progeny evaluator at Cogent Breeding Ltd) provides us with an insight into the JH1 and JH2 Haplotypes.

Over the past six decades fertility has seen a decrease across all major dairy breeds, the Jersey being no exception. This decline can be attributed to many different factors; changes in management systems, choosing bulls for type and production whilst disregarding fertility and also inbreeding. Although fertility is of low heritability, at 3% it IS heritable and can be improved through selective breeding.

Despite this low heritability, genetics have played a major part in this decline in fertility, which means that careful selection of sires can also help to reverse the trend.
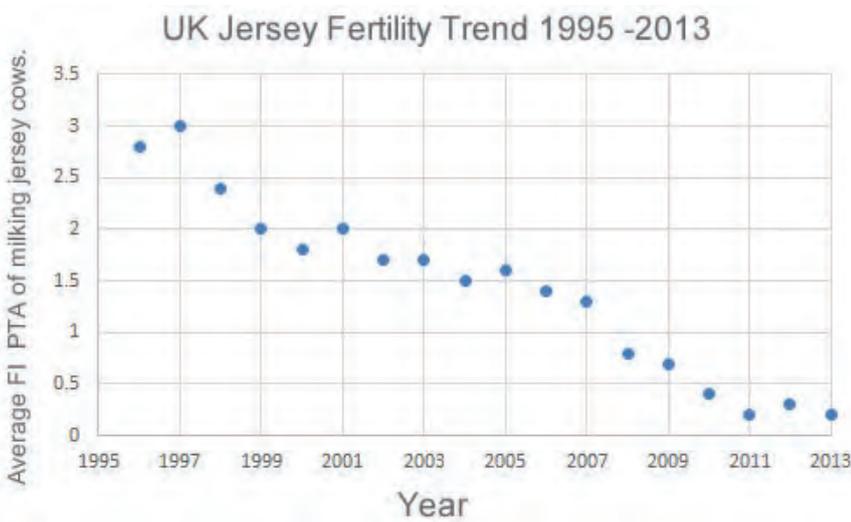

Fig 1. Chart showing decline in fertility of the UK jersey cowsover past 20 years (by Year of Birth). Source: AHDB Dairy

Glossary

Haplotype- A Haplotype is one or more allele(s) at closely located positions on a chromosome that are inherited together.

SNP- Single Nucleotide Polymorphism, a DNA sequence variation occurring commonly within a population

Allele-any of two or more variants of a gene that have the same relative position on homologous chromosomes and are responsible for alternative characteristics

Gene-A piece of DNA molecule that determines a hereditary characteristic in the phenotype.

Genome- The complete set of genes or genetic material present in a cell or organism

DNA- DeoxyriboNeucleic Acid, a self-replicating material which is present in nearly all living organisms as the main constituent of chromosomes

JH1 (Jersey Haplotype One)

In 2011 scientists led by Dr Paul Van Raden at the United States Department of Agriculture(USDA) 'Animal Improvement Programs Laboratory' identified a specific haplotype associated with infertility in Jersey cattle. It was discovered through SNP analysis of whole genome sequences and was coded JH1.

Animals with the JH1 haplotype have a defective copy of a gene called CWC15. CWC15 has acquired the nick name the 'nonsense gene' as it causes cells to be unable to process signals from gene to gene. An embryo that inherits this 'nonsense gene' from both parents is unable to complete development and therefore dies before day 60 of gestation. This is the reason why there are no living Jerseys with two copies of this gene.

JH1 is a 73 marker haplotype that is located between positions 11 and 16 on Bos Taurus Autosome 15.

So where did this haplotype come from?

Well, the CWC15 mutation originates with just one popular AI sire and that was Observer Chocolate Soldier who was bred in 1962 by the Wilde family of High Lawn Farm Massachusetts. Then marketed through Genex CRI. Chocolate Soldiers daughters produced 764kgs more milk per lactation than other bulls at the time leading to his extensive use in herds around the world and produced 1454 daughters. However this wasn't the full extent of this bulls global reach as he produced 107 sons and 715 grand sons into AI that in turn sired over 50,000 grand daughters and 200,000 great-grand daughters of Chocolate Soldier respectively.

Fig 2. Picture of Briarcliffes Soldier Boy.

Popular descendants include Briarcliffes Soldier Boy, Sooner Centurion, Rock Ella Paramount and Dutch Hollow Barettas Option. As a result of this the appearance of the haplotype escalated quickly from just one bull in 1962 to 20-25% of the global jersey herd in 1980. It remained at this level until recently when it began to decline.

Chocolate Soldier is a prime example of how influential genetic outliers can be to a breed in either positive or, in this case, negative ways.

JH2 (Jersey Haplotype Two)

The JH2 haplotype was more recently discovered in June of 2014 when the USDA looked into data from the Council on Dairy Cattle Breeding. This haplotype is still being researched and scientists are yet to identify the gene responsible. However the effects of this haplotype are similar to that of JH1 with 25% of progeny resulting from mating a JH2 carrier sire with a JH2 carrier female dying before day 60 of gestation. All that is known of JH2 is that it is located on Bos Taurus Autosome 26.

Should I avoid using Haplotype carrier sires?

Short answer: No. If carrier sires are avoided in your breeding programmes, bulls with exceptional transmitting abilities for production, type or health and fitness traits will be missed. Instead efforts can be made to prevent the mating of carrier sires with potential carrier females. Mating programmes are run by many of the AI organisations in the UK now and can not only help avoid matings between undesirable haplotype carriers but can also protect your herd from inbreeding. Being pedigree can help to monitor haplotypes. Breed societies around the world work alongside national Genetic Evaluation units (such as the USDA/CDCB and AHDB Dairy) and AI companies to accurately record carrier sires on pedigree databases, documents and stud books. As it stands, haplotype information is only produced as part of the genomic evaluations carried out by the American Jersey Cattle Association (AJCA), however AHDB Dairy is currently working on establishing a UK genomic service for Jerseys so hopefully screening for both males and females born in the UK will be available in the near future. Animals tested and found to be a carrier are coded JH1C and JH2C. Those tested negative are coded JH1T and JH2T respectively.

As technology and our understanding of cattle genetics develops, more haplotypes both favourable and unfavourable will be identified. For example in June this year another Haplotype was discovered in the Holstein breed coded HCD (Haplotype for Cholesterol Deficiency) that causes the death of calves in the first few weeks of life. This continual discovery is nothing but a good thing for farmers across the world and will hopefully lead to amongst other things an increase in fertility and profitability on farms.
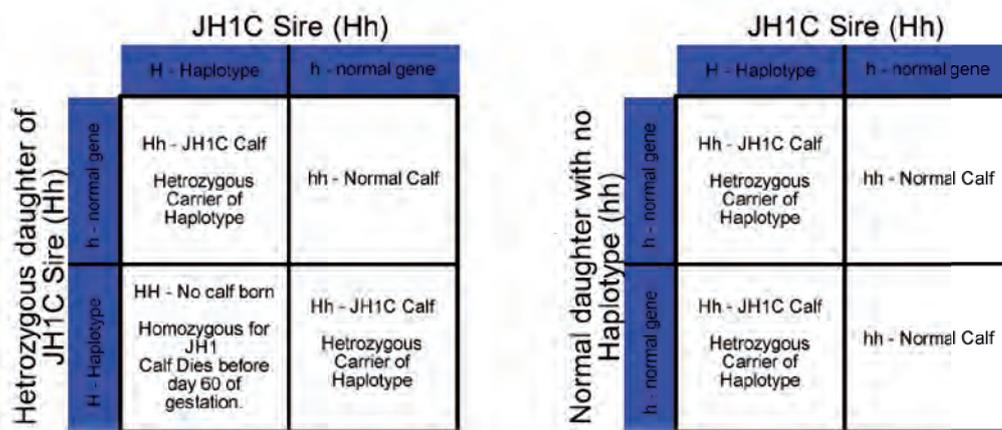

Fig 3. Breeding diagrams showing percentages of matings and resulting genotypes