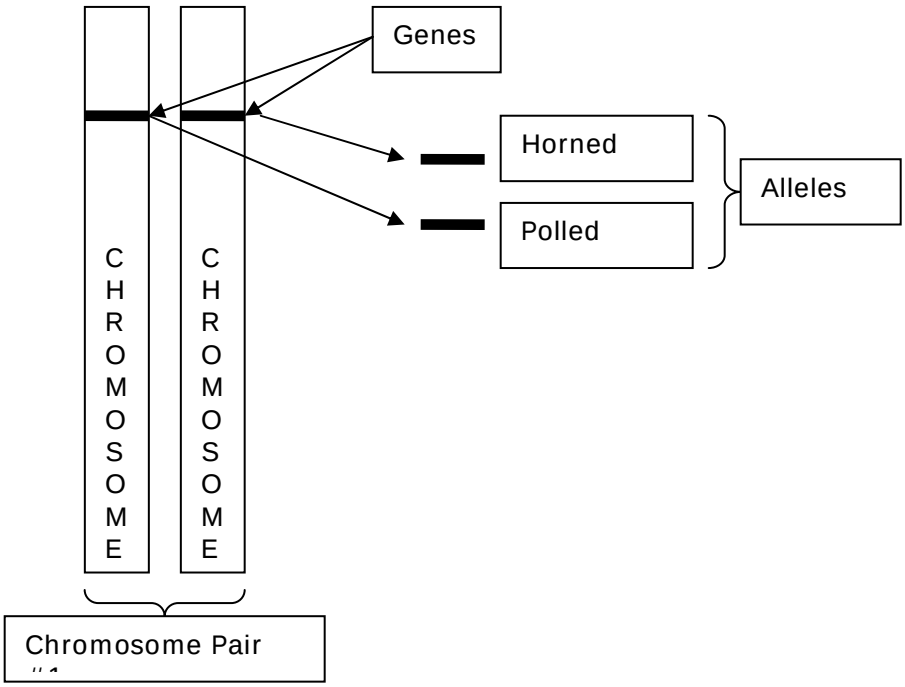
Breed Improvement Article

Gene Markers

By Sean McGrath

A beef animal has 60 chromosomes arranged in 30 pairs. These chromosomes are made up of DNA. 1 chromosome of the pair comes from the father and 1 from the mother. When an animal becomes a parent itself, the pairs split and one chromosome is passed on to the offspring. Along each of these chromosomes, are sequences of DNA that control aspects of the animal's growth. These areas are called genes. Generally a gene is located in a specific region of a specific chromosome. For example; the gene for horned/polled resides near the end of Chromosome #1. Different variations of a gene are called alleles. A different variation of a gene may produce a different result. If the animal carries a horned version of the gene on each copy of Chromosome 1, then the animal has horns. If the animal carries a polled gene, then it will appear polled. Horned/polled variations of the gene are alleles.



Gene markers are a relatively new technology that “flags” the areas of the chromosome that contain specific genes. The reason that alleles produce different results is because they contain slight differences in their DNA sequence. Gene markers identify these areas to tell us which copies of the gene the animal carries.

With some genes, we don’t know the exact location of the gene on the chromosome. Many times we can get close to the area the gene is in by using markers that we know attach to areas of the chromosome where the gene is located. It is bit like being able to narrow an address down to a specific area of town, but not being exactly sure which house on the block we are looking for. The tests to identify these alleles, generally requires family and pedigree structures, and the testing of several animals to identify the allele with certainty. It could be compared to going door to door on the block and asking who lives in each house, rather than having the exact street address.

Because beef cattle are incredibly complex organisms, one gene may not control all aspects of a trait. For example, muscle growth is controlled by a variety of genes spread across a wide number of chromosomes. Marbling is another good example. There are already various commercial tests available to identify different genes that impact marbling, however none of these genes account for all of the variation in the trait. For example, there are bulls with several hundred carcass progeny records that are at the top of there breed for marbling, and yet do not contain a single favourable allele for one of the major marker tests. These sires, may however contain a good combination of other genes that positively impact the marbling of their progeny.

Most experts agree that gene marker information will be combined with traditional performance testing information to produce evaluations that look very similar to the EPDs we see today. EPDs use performance and pedigree information to determine the relative genetic merit of animals in the population (the animal’s genes). The major impact of marker information will be to increase the accuracy of the prediction. Rather than assuming the genes that are present, based on an animal’s relative performance, gene markers can be combined with performance data and allow us to assure ourselves that specific genes are present. This is much easier to use in terms of selection than trying to assess what could potentially be several hundred or thousand gene marker results.

Many new tests are being marketed, and more are coming on stream. For those interested in marker testing, it is often difficult to know where best to invest limited funds. If only for this reason it is important to have breeding goals. By knowing what you are trying to select for, you can more readily determine if the test will impact one or more of your selection criteria. It is also useful to obtain as much information as possible about how much variation the gene can explain. If the gene accounts for a lot of the variation in the trait, then it is likely a better investment than a test for a gene that has limited impact on the trait of interest. Also important is to know whether or not the gene has an impact on more than one trait, and if that impact is positive or negative. For example, is a gene specific to growth rate, or does it also impact mature size. All of these are important factors to consider when investing in marker testing.

The Canadian Limousin Association has adopted a policy of trying to work with various providers of gene tests, to not only facilitate testing but also to confidentially record results and work towards inclusion of marker results in genetic evaluation. It is important to not only report what are perceived as favourable results, but also animals that contain 1 or 0 copies of the “favourable” allele. This is similar to the concept of total herd reporting, in that only reporting the perceived “good” animals distorts the dataset and does not provide the most useful information on Limousin genetics.

Gene markers are an exciting and rapidly emerging technology that can greatly enhance the power of seedstock producers to create change. There is a lot of good and interesting information available on the internet.

- www.marc.usda.gov/genome/genome.html
- www.geneticsolutions.com.au
- www.igenity.com
- www.genomecanada.ca