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What is genomics?

Genomics is the study of small differences (called SNPs), in the DNA of animals, and the variation in SNPs that exists between individual animals. It is therefore possible to determine which SNP combinations can relate to specific genes and traits. SNPs influence observable traits on a biochemical level, such as the production of proteins and enzymes. Genomics is therefore a complex new field with many new possibilities.

PRACTICAL GENOMICS

What can we already do with genomics?

Genomics is currently used very successfully to improve existing technologies, such as very accurate parenting determination, simply because thousands of more markers are available to solve parentage than with previous DNA technology.

Genomics is also used to detect the carriers of single genes, such as horned / polled, or genetic defects such as double muscling. Adverse genes have also been discovered, such as the infertility haplotypes identified in dairy cattle.

It is also used very effective for estimating more accurate breeding values. Traditional breeding values are based on pedigree information and measurements, while genomic information is included for GEBVs (genomically enhanced breeding values) as an additional source of information. GEBVs are already available for some South African beef cattle breeds. This has the added benefit of improving BLUP technology because breeding values are estimated more accurately at an earlier age, especially for so-called 'difficult' traits that are expensive to measure, such as carcass traits, or only late in an animal's life, such as fertility or milk production.

Genomic research

The terminology used in genomic research includes terms such as GWAS, 'gene ontology', 'signatures of selection', and 'runs of homozygosity'. Genomics is therefore also the beginning of a new science. With genomics, it is now possible to identify specific genes through SNP markers. For example, an animal that has a certain SNP marker may have the ability to produce a protein that increases the efficiency of a biological pathway. These may have a ripple effect on other biological pathways and result in a cow, for example, that is better adapted to a hot environment. Genomics is thus used to identify large networks of gene interactions. Animals with beneficial combinations will then be able to be identified genomically.

Current BLUP technology works on specific economic traits that can be measured, for example weaning weight, and the heritability and genetic correlations with other traits. However, other traits like for example adaptation and disease resistance, are also important, but relatively difficult to define and measure. Fertility, one of the most important traits for successful beef farming, is also a good example of such a trait. Genomic selection will not only focus on the trait 'fertility', but on the complete gene network, which also considers all biological, metabolic, and biochemical traits that affect fertility.

Where do we stand now?

Man wants simple answers to complex questions. The true potential of genomics in beef cattle is great, but it is not yet fully understood. It will probably be used as part of a total system of information. The potential of genomics extends far beyond genetic improvement and can affect the resilience of the entire farming system. It can also be used, for example, to promote genetic diversity in breeds, bring about more balanced genetic progress, as well as identify the specific characteristics that make a breed unique.

As many measured animals as possible should be genomically typed. Genomics adds thousands of additional records (SNPs) to each animal. So far, research has concentrated on developing statistical methods to handle the large amount of information and incorporate it into genomic evaluations. It is therefore important to build local capacity in these aspects, as well as in statistical modelling and quantitative genetics, to perform accurate and stable genomic analyses.

For the beef breeder, more genomic information is likely to become cheaper, but it should be kept in mind that it will not change the fundamental concepts of animal husbandry. Producers will still need to maintain a balanced approach to selection, although more important traits, such as adaptation and disease resistance, are also likely to be available when selecting animals. ■