

Patterns of genetic change

Dairy genetic evaluation is advancing in leaps and bounds, thanks to the availability of 'big data' from DNA testing of dairy cattle across the globe and improvements in computing power.

If you find processing your herd records overwhelming, spare a thought for Agriculture Victoria quantitative geneticist Dr Iona MacLeod. She works with millions of cow records looking for genes associated with traits that are important to dairy farmers.

While Dr MacLeod's complex mathematics may seem far removed from the practicalities of day-to-day milk production, it makes a direct contribution to the information reported in DataGene's Good Bulls Guide.

Dr MacLeod is part of a world leading team of researchers at DairyBio, a joint initiative between Agriculture Victoria, Dairy Australia and the Gardiner Dairy Foundation. The DairyBio team works in purpose-built facilities at the AgriBio Centre for AgriBioscience in Bundoora. It's home to Agriculture Victoria Research molecular scientists and quantitative geneticists, as well as industry organisations such as DataGene, Holstein Australia, Jersey Australia and NHIA. Being co-located creates a unique mix of great scientific minds, cutting edge technology and real-world perspective.

The molecular geneticists extract and process the DNA from hair and skin samples while quantitative geneticists, like Dr MacLeod, analyse this data. However, there is much more to both these roles.

They work in one of the few integrated genetic research facilities in the world, with state-of-the art laboratories and equipment for molecular research and a monster

Summary

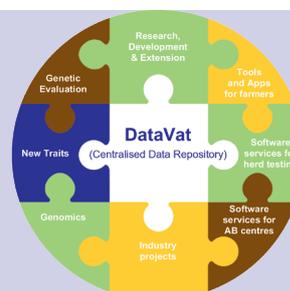
- Behind a single Australian Breeding Value there are millions of computations. Dr Iona MacLeod works in a team that develops and tests new statistical approaches for genetic evaluation.
- Her work has been transformed by the availability of large amounts of genomic data from Australia and across the globe, and advances in computing power to process 'big data'.



Dr Iona MacLeod loves crunching the data to increase the accuracy of Australian Breeding Values.

About DataGene

DataGene is an independent, industry-owned organisation responsible for driving genetic gain and herd improvement in the Australian dairy industry. It is an initiative of Dairy Australia and industry. DataGene performs many pre-competitive herd improvement functions, such as genetic evaluation, herd testing and herd improvement software development and data systems.



advanced scientific computer able to process the massive numbers of analyses required to produce genomic predictions.

Internationally recognised research team

The best laboratories and computers are of little value without the scientific minds to make use of them.

“Working with world leading geneticists, including Professor Mike Goddard, Dr Jennie Pryce, Dr Hans Daetwyler and many up-and-coming students and post doctorate fellows means there are always plenty of ideas, opinions and support to help develop new and better techniques of genetic evaluation,” Dr MacLeod said.

They have been developing and testing new statistical approaches for genetic evaluation using genomics.

Genomics uses DNA testing to find genetic markers associated with traits that can be observed and measured; they are used to produce a prediction of genetic merit, an Australian Breeding Value (ABV). Genomics is particularly useful for traits that are difficult to measure, like health, heat tolerance and feed efficiency.

Genomic evaluation is only possible due to availability of large amounts of data from Australia and across the globe and advances in computing power to process it.

Generating genetic predictions

Dr MacLeod is applying sophisticated statistical approaches to identify places in the genome where the genetic code has changed and is affecting traits such as fertility or protein yield.

This is no small task. The complete bovine genome contains three billion genetic codes arranged in different sequences to make 22,000 genes; it is a huge amount of data to analyse.

Rather than sequencing the whole genome of every individual in the lab, quantitative geneticists use several thousand real genetic sequences from cattle and then impute the sequence data for all other animals that have a low-density genotype record.

“Imputing is a bit like doing a crossword where you have clues and some letters in a word and from those letters the whole word can be recognised,” Dr MacLeod said.

“I then look for patterns that identify changes in the genome that can have a positive or negative influence on animal performance. In dairy cattle, we estimate there could be 25 million of these changes.”

Many of these changes occurred before breeds developed and some much more recently. These new methods of analysis will result in genetic predictions that work across breeds and even for crossbreeds.

Trait association

Trait data is performance information on the characteristics of cows that are important to commercial farmers, including production, conformation, fertility, health and workability traits.

Finding changes in the genome and linking them to traits is relatively straightforward when the trait is associated with a single gene, such as coat colour. However, it is far more complex when a trait is associated with multiple genes.

For example, fertility is thought to be associated with between 1000 and 5000 genes, which is why it is so challenging to unravel. Milk protein is also associated with thousands of genes.

Another layer of complexity comes from the fact that not every gene is expressed in every cell; and some can be switched on or off by environmental conditions or only switched on intermittently.

Dr MacLeod says that large volumes of data are needed for genomics to work for the Australian dairy industry. “Herd records are central to our work, for example, herd test results, pregnancy, calving and health records, and workability reports. We add to that through international sharing of genetic data.”

Luckily for the dairy industry, Dr MacLeod loves data, enjoys number crunching and is fascinated by what genomics reveals about a dairy cow.

“This is a very exciting time to be involved with dairy genetics and if I had to make the choice to work anywhere in the world it would be here with this team,” Dr MacLeod said.

CONTACT US

ABN: 78 613 579 614

DataGene Limited, AgriBio, 5 Ring Road,
La Trobe University, Bundoora Victoria 3083



email: enquiries@datagene.com.au



www.datagene.com.au



T (03) 9032 7191



Disclaimer: This report is published for your information only. It is published with due care and attention to accuracy, but DataGene accepts no liability, if, for any reason, the information is inaccurate, incomplete or out of date whether negligent or otherwise.

Copyright © DataGene Ltd. All Rights Reserved.

August 2019