MIRforPROFIT

Opportunities to screen milk samples
to predict dairy cow performance

This project is supported by funding from the Australian Government Department of Agriculture and Water Resources as part of it's Rural R&D for Profit program.

Australian Government
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Agriculture Victoria

MIR involves passing a beam of light through a milk sample to provide data (spectra). This data has the potential to be widely used to understand more about a cow from a single milk sample.

About half of Australia's dairy farmers routinely herd test. This involves collecting milk samples from individual cows and sending them to a laboratory (herd test centre) for analysis. Farmers receive reports with information about individual cows, such as production levels and the composition of their milk, for example fat and protein content and milk quality. Modern herd testing equipment includes MIR technology which opens up opportunities to provide new information from milk samples.

Herd testing involves collecting a milk sample from individual cows and sending it to a herd test centre for analysis.

MIR technology offers the opportunity to understand a lot more about a cow from a single milk sample.

Overseas research has shown that MIR can also be used to indicate a cow's status for fertility, health, energy balance, methane emissions and feed efficiency. This information could be useful at two levels:

- For farmers and their advisors, MIR has the potential to provide greater insight from herd test samples into the current status of the herd and individual cows in terms of feed efficiency, negative energy balance, fertility, health and methane emissions.
- For the herd improvement industry, MIR has the potential to improve the accuracy of predications of the genetic potential of dairy cattle for specific traits. It could be used to help predict predict new traits that have been previously difficult to collect performance data, for example health traits such as ketosis.

The MIRforProfit project investigated Australian opportunities to use MIR technology to identify individual animals for targeted management decisions.

The project's objective was to develop a method for predicting the risk of an individual cow's potential health or fertility status in Australia from MIR data collected during routine herd testing. In the long term this could be used to develop:

- Reports for farmers, for example, on the risk of an individual cow developing a potential health or fertility issue.
- More accurate predictions of the genetic merit of dairy cattle (genomic Australian Breeding Values) of key traits.
- The software needed for herd test centres to use the data and algorithms generated by the project.

What we did

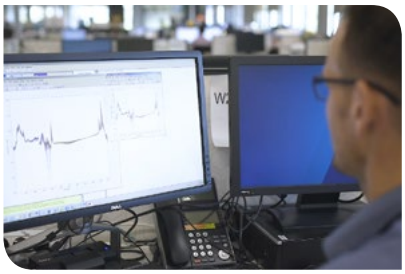
Running between 2015 and 2018, the project collected Australian data to develop prediction equations for Australian conditions.

The first step involved very intensive data collection from Agriculture Victoria's Ellinbank research herd. The second step involved collecting data from commercial dairy farms. We worked with data from:

- herd testing (milk samples): MIR spectra, milk yield and milk composition.
- animal performance measures: fertility, feed intake, body weight, body condition and methane emissions.
- DNA testing (genotypes).
- 2,000 cows in commercial herds in Victoria, NSW, South Australia and Tasmania who herd tested twice monthly.
- A further 10,000 cows in commercial herds in Victoria, NSW, SA and Tasmania who herd tested monthly.

PhD student, Tim Luke, collected blood samples from early lactation cows in commercial herds. The blood was evaluated for health indicators such as energy status, ketosis, hypocalcaemia, urea and proteins.

By matching actual performance data with MIR spectra, we were able to develop prediction equations for Australian conditions.



The project involved collecting milk samples, blood samples and other performance information.

Energy balance

The first Australian MIR prediction equation is likely to be for energy balance. Most cows in early lactation experience a period of negative energy balance: when they are unable to consume enough energy in their feed to meet their daily requirements. If cows experience excessive negative energy balance they may develop ketosis (an early lactation metabolic disease) and/or have reduced fertility. Clinical ketosis requires treatment; however, sub-clinical ketosis often goes unnoticed and has a much greater impact on herd health, productivity and profit, because it affects many more cows in the herd. Currently there is no easy way to evaluate ketosis risk other than blood testing. MIR has the potential to quantify ketosis risk from a milk sample.

MIR has the potential to measure ketosis risk from a milk sample.

Project outputs/ deliverables

The project demonstrated that MIR from milk samples can be used to predict energy balance in Australian dairy cattle. There are two future applications of this.

Firstly, a simple, fast test from a milk sample, for energy balance (and therefore ketosis risk) in early lactation cows. This would enable early intervention by farmers to prevent production losses and acute cases of ketosis.

Secondly, the development of genomic prediction (Australian Breeding Value) of the genetic merit for energy balance or the risk of early lactation metabolic disease. This would enable dairy farmers to breed cows with lower risk for early lactation metabolic disease.

Throughout the project, the team has held regular workshops and provided updates and tech notes to keep the various stakeholders informed about the research and potential applications.

A full list of publications and peer-reviewed scientific papers is provided within this report.

"MIRforProfit demonstrated the ability to use herd test samples to alert when action is needed to manage negative energy balance."

Project workshops were well attended by industry people, eager to hear how MIR technology may help them offer better services to dairy farmers.

Where to now?

With support from Dairy Australia, DairyBio and DataGene will continue to work towards these applications after the completion of MIRforProfit. The next step is to work with industry to develop useful reports. Successful delivery of these reports will involve collaboration between herd test centres, vets and nutritionists.

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Publications

The following fact sheets are available from datagene.com.au.

- Predicting performance from milk (May 2016)
- MIR UK case study (July 2016)
- MIR differences between herds (December 2016)
- Monitoring ketosis risk with milk MIR (July 2017).

Scientific publications

Bonfatti V, Turner SA, Bolormaa S, Kuhn-Sherlock B, Phyn CVC, Pryce JE. Genome-wide association study and genetic parameter estimates for blood β-hydroxybutyrate concentrations during early lactation in pasture-grazed dairy cows. International Council of Animal Recording (ICAR) Annual Meeting, Auckland Feb 8-11 2018.

Bonfatti V, Turner SA, Kuhn-Sherlock B, Luke TDW, Phuong HN, Phyn CVC, Pryce JE. 2018. Prediction of blood β-hydroxybutyrate content and occurrence of subclinical ketosis in early-lactation pasture-grazed New Zealand dairy cows using milk infrared spectra (in preparation).

Luke TDW, Rochfort S, Wales WJ, Bonfatti V, Marett L, Pryce JE. 2018. Metabolic profiling of early lactation dairy cows using milk mid-infrared spectra (submitted to Journal of Dairy Science).

Luke TDW, Rochfort S, Wales WJ, Pryce JE. Prediction of Serum Metabolic Profile Biomarkers in Early Lactation Dairy Cows Using Mid-Infrared Spectroscopy of Milk. International Council of Animal Recording (ICAR) Annual Meeting, Auckland Feb 8-11 2018.

Pryce JE, Gaddis KLP, Koeck A, Bastin C, Abdelsayed M, Gengler N, Miglior F, Heringstad B, Egger-Danner C, Stock KF, Bradley AJ, Cole JB. 2016. Invited review: Opportunities for genetic improvement of metabolic diseases. Journal of Dairy Science 99: 6855-6873.

Wang T, Chen Y-PP, MacLeod IM, Pryce JE, Goddard ME, Hayes BJ. 2017. Application of a Bayesian non-linear model hybrid scheme to sequence data for genomic prediction and QTL mapping. BMC genomics 18: 618.

Wang T, Phuong HN, Pryce JE. The investigation on the performance of genomic prediction on mid-infrared spectrometry predicted energy balance for Australian dairy cows. World Congress on Genetics Applied to Livestock Production (WCGALP), Feb 11-16 2018, Auckland New Zealand.

Wang T, Phuong HN, Wall E, Smith S, Pryce JE. The use of mid-infrared spectrometry to predict energy balance and methane emissions in Australian dairy cows. Association for the Advancement of Animal Breeding and Genetics, Townsville, June 2017.

Thank you

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MIRforProfit Strategic Steering Committee: Shawn Hollingworth (Chair), Samantha Simpson, Dr Steve Little, Prof Eileen Wall, Dr Matthew Shaffer, Graeme Gillian, Cath Lescun and Prof Ben Cocks.

MIRforProfit team: Dr Jennie Pryce (DEDJTR), Dr Phuong Ho (DEDJTR), Dr Tim Luke (PhD DairyBio), Dr Tingting Wang (DEDJTR), Dr Valentina Bonfatti (University of Padova, Italy), Dr Matthew Shaffer (DataGene), Michelle Axford (DataGene), Erika Oakes (DataGene), Lee-Ann Monks (DataGene), Jane McLennan (Dairy Australia) and Beth Scott (Dairy Australia).

Ellinbank Research Farm staff.

International collaborators: Teagasc, Ireland, University of Liege, Belgium, CRA-W (Walloon Agricultural Research Centre), Scotland Rural College, SRUC, UK and DairyNZ Ltd.

Herd Test Centre collaborators: TasHerd, Herd Improvement Co-Operative Australia (Hico), National Herd Development (NHD) and Dairy Express.

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Photo credits: Chalk family, Dr Tim Luke, and TasHerd.

More information

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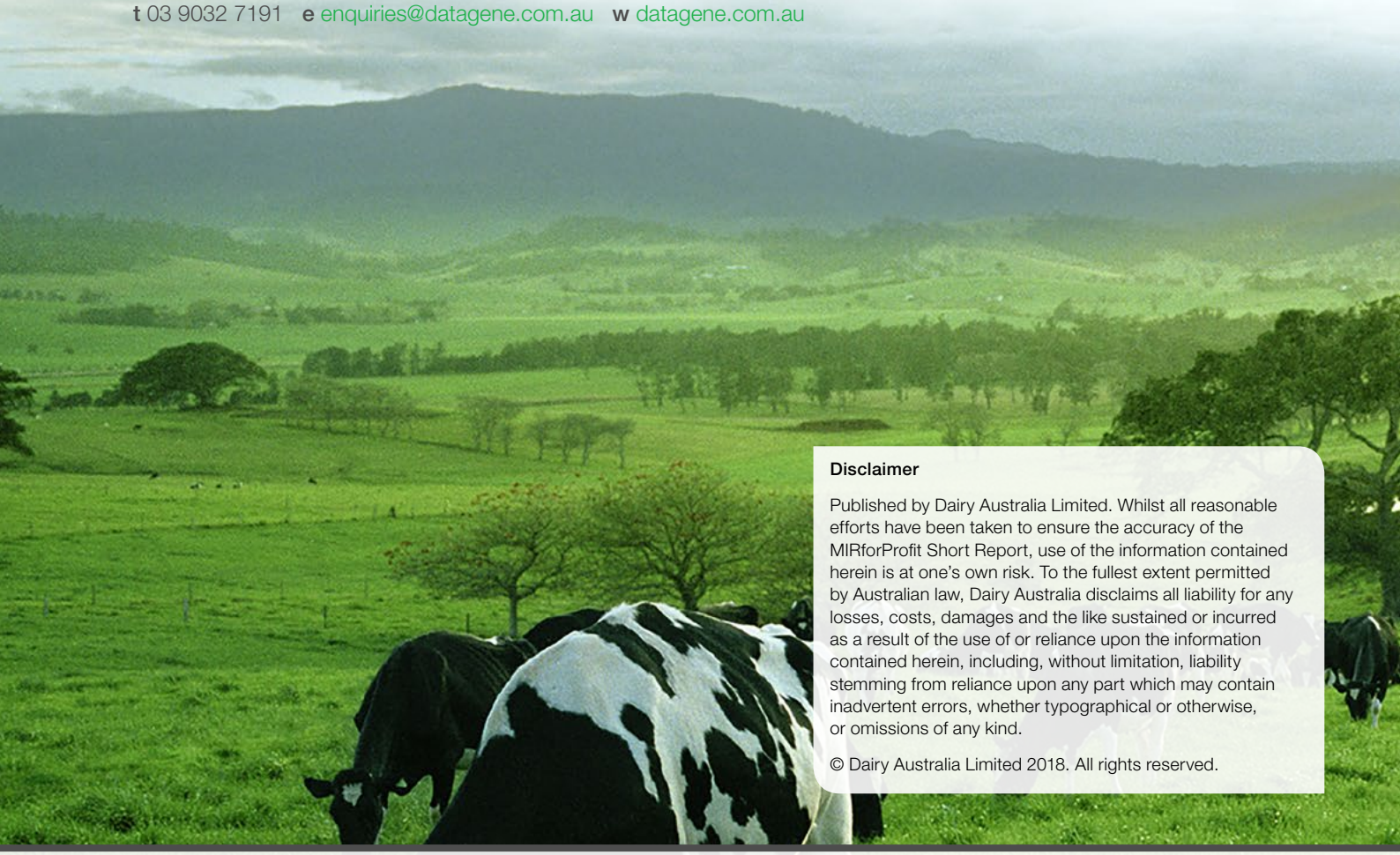

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