SPEAKER PAPERS DR. JENNIE PRYCE

The vision for MIR at DairyBio

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Key points

- The use of mid-infra-red spectroscopy to predict traits of importance is an area of growing research globally. In Australia, we have had research projects in this area since 2015.
- The vision of DairyBio scientists is to develop accurate predictions of traits of importance that can be used for meaningful management and breeding purposes.
- The process includes collection of data, analysis of data and validation in independent data. consultation.
- Traits that are measurable directly in milk (e.g. fat, protein etc) are generally straightforward to predict using MIR, while, characteristics associated with health and fertility are much more difficult to predict consistently well.

It has been just a few years since we started research into the application of mid-infrared (MIR) spectroscopy of milk (i.e., the same technique routinely used worldwide to predict milk composition during herd testing) to predict novel traits.

Traits that are measurable directly in milk are generally straightforward to predict using MIR (e.g. protein, fat etc). However, characteristics that are part of the cows physiology e.g. health and fertility, are much more difficult to predict consistently well across.Australia's diverse feeding systems. This issue presents a considerable challenge in assembling the size of dataset required to generate robust results across these feeding systems. The DairyBio team in partnership with DataGene remains committed to collecting more phenotype data and using it for research purposes. We are optimistic that the obstacles will eventually be overcome.

In addition, there are opportunities to use MIR predictions of traits that are high value, for genomic selection. The vision here is that very large populations of genotyped cows with mid-infrared spectral data could lead to an increase in genomic prediction accuracy for traits that are only measurable in small populations, due to either expense or difficulty in obtaining measurements (or both), for example metabolites measured in blood serum that are indicative of early lactation health status. Even though we currently have only small populations of cows with MIR and genomic data we are generally seeing a benefit of MIR predictions on top of having measurements on the trait itself. It is anticipated the modest gains so far seen would be enhanced by larger data sets.

MIR technology

Modern herd test equipment has the capacity for MIR analysis.

MIR stands for mid-infrared spectroscopy, which involves passing a beam of light through a milk sample to provide data in the form of spectra (absorbance at specific wavelengths). The absorbance spectra are unique to the sample and tell us about milk composition in addition to the health of the cow. Farmers currently receive regular reports from their herd test centres with information on milk volume and fat and protein content.

The MIR for Profit project set out to explore opportunities for the Australian dairy industry. It ran from 2015-18 with funding by the Rural R&D for Profit Programme. Since then DairyBio projects have been established to continue MIR research.

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MIR for Profit

Our journey into the application of MIR data to predict traits of importance started in July 2015, through a project known as MIR for Profit, funded by the Rural R&D for Profit Programme.

Agriculture Victoria's interest in the application of MIR to predict phenotypes of importance in dairy cattle came from overseas research that suggested MIR could also be used to predict some traits associated with the health and fertility status of the cow. The aim of the project was to investigate whether MIR prediction of traits of importance in Australian production systems is possible.

Since the MIR for Profit project started, DairyBio (a co-investment of Agriculture Victoria, Dairy Australia and the Gardiner Dairy Foundation) has expanded the scope of MIR prediction. Firstly, through the use of MIR and genomics to provide initial predictions of blood metabolites indicative of animal health in early lactation cows. The intention is development of management and breeding solutions.

In 2018, a new DairyBio project started that has extended the traits we measure (such as fertility and lameness).

Application to the Australian dairy industry

To be useful for the industry, the MIR predictions have to satisfy a number of requirements:

1. They must be able to accurately predict the status of animals that are not present in the dataset used to generate the prediction equations. This is very important, as erratic results, or failure to work in some production systems could very quickly erode confidence in the technology.
2. Working with experts (nutritionists, epidemiologists, veterinarians) to understand whether a MIR prediction could be useful for management strategies. This is important, because incorrect or inconsistent advice will also reduce confidence.
3. Determining acceptable levels of prediction accuracy needed to be used for prediction of individuals or groups of cows. This is the last step in the process of prediction equation development and involves engagement with industry stakeholders and experts.

Once these three points meet industry and stakeholders' expectations, there needs to be development of user-friendly management tools to allow farmers and their advisers to identify and take early action for at risk animals (or groups of animals) for issues such as fertility or ketosis/acidosis.

Findings so far

To date, we have published four peer-reviewed scientific papers (with more currently under consideration and preparation). Our team of scientists have shown that:

- Traits that are measurable directly in milk (e.g. milk fatty acids) can be predicted with high accuracy.
- Traits that are associated with animal health and measured directly on the animal (e.g. lameness and fertility), or in blood (metabolites), are much more difficult to predict with consistently high accuracy.
- MIR predictions generated in Victoria for predictors of ketosis/energy balance initially showed promising accuracies based on a relatively small dataset. However, the validation has been somewhat erratic, especially for herds that have different feeding systems from the reference data. This tells us that roll out of the technology for these traits is too early and that more samples need to be added to increase model robustness.

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- We have tested MIR predictions that are in-built into Bentley machines and they are excellent for predicting fatty acids measured in milk. While for traits that are often measured in blood, rather than milk, such as beta-hydroxy-butyrate (an indicator of ketosis) the in-built equations are not as accurate. Our hypothesis, and results so far, show that MIR predictions of animal health traits are likely to better when based on Australian data.
- We have developed a MIR prediction equation for conception to first service using early lactation herd-test data. Currently, we can identify cows that are less likely to get in-calf using an early lactation milk-test with reasonable accuracy. We still have more work to do to refine and validate this prediction.
- MIR can be used to complement gene discovery methods for traits associated with production.
- When we have used MIR to enhance genomic prediction accuracies the results are in line with expectation for the size of reference population available. We see a lot of merit in expanding the reference population of genotyped cows with either (or all) of MIR data, genomic data and high value phenotypes.