DairyBio DairyFeedbase

Dairy innovation news

MIR Prediction Technology
Virtual forum 21st October @ 12.30pm register here

Future Forages
Virtual forum 11th November @ 12.30pm register here

Genetic Improvement
Virtual forum 2nd December @ 12.30pm register here

Meet our team: Dr Marlie Wright, Dr Meaghan Douglas

AGRICULTURE VICTORIA · Dairy Australia · GARDINER FOUNDATION

Welcome to the first edition of the Dairy Innovation News!

When I was approached to be the inaugural Chair of DairyBio in 2016 and DairyFeedbase in 2018, I was delighted to be part of the development of an innovation model where Dairy Australia - a Research and Development Corporation (RDC) and Agriculture Victoria - a state government department were working together to develop outcomes for Australian dairy farmers. It was very pleasing when the Gardiner Foundation came on board as an additional joint venture partner.

It has been fantastic to see the synergies and leverage that these joint ventures have created to drive productivity and profitability in the dairy industry.

Alongside a range of commercial and industry partners that invest in individual projects, the three partners all share a common goal of strategic investment in research and development that leads to innovation that improves the core drivers of productivity on farm – higher yields, persistence and nutrition from pasture; improved herd level productivity; improving individual animal performance; and enabling easier proactive management decisions.

During the six years I was the managing director of the Grains Research and Development Corporation (GRDC) implementing forward thinking initiatives was a key focus. One of the challenges for the GRDC, that is shared with DairyBio and DairyFeedbase, is communicating the value that farmers and taxpayers receive from their investment in research that can have, by its very nature, relatively long lead-times to full delivery on-farm.

It is important to have a portfolio of R&D projects which include short-term incremental improvements in productivity together with longer lead-time programs that will deliver transformational change to the Australian dairy Industry.

DairyBio is four years into its five-year program and has delivered significant innovation, including:

- Innovative tools that have delivered genetic improvement at five times the previous rate for forage (20 years of forage genetic improvement delivered in 4 years) and at 4.5 times the previous rate for animals (27 years of animal genetic improvement delivered in 6 years).
- DairyBio forage has developed hybrid breeding techniques that have led to the development of a F1 hybrid ryegrass variety that will offer a 20-40% genetic gain increase in pasture yield and then an ongoing 1.5-3% gain per year (all of which is cumulative)
- DairyBio forage has developed novel endophytes and inserted them in to the F1 Hybrids to design a ryegrass plant that will be resistant to more parasites and pathogens than other ryegrass varieties resulting in greater persistence, performance, and nutrition. Ryegrass seed that contains endophytes can lead to a 15% performance improvement. This equates to three decades of genetic gain that has previously been achieved and can extend pasture life for up to three years.
- DairyBio animal program has improved the reliability of existing ABVs and developed new ABVs for desired traits. These include ABVs for heat tolerance, calving ease, gestation length and mastitis resistance. Genetic improvements, including these traits, are worth up to $300 per cow per year.
- DairyBio animal is improving productivity and health outcomes by using mid-infrared spectroscopy (MIR) application on milk. MIR technology offers the opportunity for proactive informed management decisions and economic benefit for fertility, pregnancy, milk quality, metabolic disease and to improve ABVs.

DairyFeedbase is two years into its six-year program and has already delivered:

- First 100 Days has developed a feeding strategy for increased profit of 73 cents per cow per day in first 100 days of lactation plus, 50c per cow per day carryover.
- Smart Feeding has found cows in some herds can produce up to an extra 5 litres of milk per cow daily and is experimenting with different feeding strategies.
- Pasture Smarts is completing on-farm development of prototypes for automated technology measuring pasture dry matter and other pasture characteristics.
- Future Forage Value Index has delivered benchmarked pasture cultivars for optimal performance for different regions.
- Cool Cows has found a $20 per cow per lactation benefit through adding fat to the diet before and after heat events and a heat stress risk assessment has been developed.

Throughout my career in agriculture one thing has resonated with me – all research and development must focus on ensuring a profitable and sustainable industry.

The innovation that these programs deliver, with their combination of applied and bioscience research, can transform the industry by boosting productivity and profitability while ensuring we retain our social license through environmental and animal health and welfare improvements all of which will ensure a vibrant and profitable dairy industry.

I hope you enjoy this first edition of the Dairy Innovation News and we invite you to participate in the upcoming Dairy Innovation Virtual Forums to interact with the researchers directly.

Peter Reading
DairyBio and DairyFeedbase Chair

Milk mid-infrared spectroscopy (MIR) for management and genetics

Ask the researcher virtual forum at 12.30pm on 21st October 2020 Register here

Key points

MIR prediction of fertility: with promising results so far, there is ongoing research to identify those cows that are most and least likely to conceive early in the joining period. We are currently recruiting spring calving herds across Australia to validate these results.

MIR prediction of blood metabolic profiles: MIR could prove valuable, there is ongoing and future research into the epidemiology to determine Australian concentration thresholds; this will assist in estimating the genetic parameters of metabolic disease and enable subsequent genomic prediction.

MIR detection of pregnancy status: early detection was unreliable, post 150-day insemination was reliable.

MIR mapping of genes affecting milk composition: ongoing research with a larger dataset.

MIR prediction of lameness: MIR was found to be inadequate to envisage a practical application of the technology for on-farm prediction of lameness.

One of the key drivers of profitability on a dairy farm is animal performance. The DairyBio animal program has a number of key areas of focus to drive productivity improvement including: increasing genetic gain through greater reliability of Australian breeding values (ABVs); developing new and improving existing ABVs in partnership with DataGene; optimising the use of technology to support individual cow management strategies; lowering health and welfare costs through genetic selection; and, developing and enhancing proactive management tools.

Phenotypes: Are physical or biochemical characteristics that are influenced by genes and environment and include milk fat or protein, stature, feed intake, methane emissions etc. Phenotypes are a combination of the interaction of the environment with genes. Traits that are more heritable have a larger proportion of the phenotype under genetic control.

"The milk mid-infrared spectroscopy (MIR) technology has the ability to assist with all of our key animal improvement focuses," said DairyBio animal program leader, Agriculture Victoria principal researcher and La Trobe University Professor Jennie Pryce. "Previously, MIR has been used to look at what has occurred in the past; with the current research we are trying to reliably predict what will occur in the future at an individual cow level."

How it works

At herd testing a sample of each cow's milk is collected, that sample is then passed through a MIR spectrometer. This generates a spectrum of absorbance at wavelengths in the mid-infrared range that can be used to calculate fat, protein, lactose (as routinely done by processors and herd testers), specific fatty acids etc. The spectral data can also be used to predict other important traits such as probability of conception and metabolic disorders using the equations developed by scientists at DairyBio.

"MIR prediction equations developed by one country are not readily applicable to another country, due to the strong effect of genetics, feeding, and management on milk composition and as such MIR spectra," said Agriculture Victoria research scientist Dr Phuong Ho.

"There has been a lot of research internationally, but as farmers know, you can't just transfer that information to Australian herds; the prediction technology needs to be developed and tested here to be reliable."

Some of the equations that have been derived in Australia and overseas include: fatty acids, minerals, lactoferrin, ketone bodies, methane, acidity, coagulation properties, energy balance, protein fractions, cheese yield, residual feed intake, fat globule size, milk colour, blood metabolic profiles, fertility, lameness and pregnancy status.

Precision management

MIR technology offers the opportunity to enhance a dairy farmer's ability to make informed, proactive decisions at an individual cow level.

MIR prediction of fertility

Being able to rank cows in a herd most and least likely to conceive to 1st service from MIR prediction could offer early opportunities for culling, proactive management and optimising usage of sexed semen. The model using MIR of milk samples combined with other on-farm data, correctly identified the 10 percent of cows that were least likely to conceive first insemination with an accuracy of 0.75.

Dr Phuong Ho is currently working on a DairyBio project using MIR-predicted fertility to identify poor fertility cows in the herd for management purposes. "MIR fertility prediction can identify the most and least fertile cows several weeks before joining starts", he said, "this gives time for proactive management decisions around feeding and semen usage to be made before joining starts."

Agriculture Victoria researcher Dr Jo Newton OAM is working on a DairyBio project to explore on-farm applications of MIR predictions of fertility. Identifying more fertile cows for insemination with sexed semen using MIR predictions can increase the number of heifers born per straw of sexed semen used. "Sexed semen is expensive and can have lower conception rates" said Dr Newton "prioritising its use in more fertile cows can be an effective way of meeting replacement heifer needs from fewer cows if a portion of the herd is then joined to beef semen".

> "There is not only the productivity benefit to using sexed semen, there is also the animal health and welfare outcomes"

"using MIR fertility predictions in breeding decisions can offer a solution to consumer perceptions around bobby calves and at the same time offer an economic benefit for farmers".

For further information:
Ho, PN, Bonfatti, V, Luke, TDW & Pryce, JE 2019, 'Classifying the fertility of dairy cows using milk mid-infrared spectroscopy', Journal of Dairy Science, vol.102, iss.11, pp.10460-10470, **https://doi.org/10.3168/jds.2019-16412**

Ho, P & Pryce, J 2020, 'Predicting the likelihood of conception to first insemination of dairy cows using milk mid-infrared spectroscopy', Journal of Dairy Science, **https://doi.org/10.3168/jds.2020-18589**

MIR prediction of blood metabolic profiles

In the first four weeks after calving is where dairy cows generate 80% of disease costs. The early detection and treatment of metabolic disease may have positive effects on cow health and farm profitability. The most common metabolic diseases are ketosis, hypercalcemia, and hypomagnesemia. DairyBio projects have found that using MIR to assess for key biomarkers could be a useful way to predict energy balance and risk. The researchers have recently evaluated a much larger dataset (about 4x larger) and found MIR prediction accuracies consistent with the initial study. However, for the genomic prediction of these biomarkers, which might be useful for breeding for resistance to metabolic diseases, then a greater dataset is needed to assess reliability. Given that there are no recent Australian studies to validate the epidemiology of metabolic disorders, there is project work being conducted to determine the thresholds for metabolite concentrations in Australia.

Metabolites/metabolic disease: A metabolite is a substance that results from the metabolism process - which is the breaking down of food, tissues, and chemicals for the generation of energy and materials for growth, health maintenance and reproduction. Metabolic disease is when the normal process is changed and can be detected through abnormal levels of indicators in blood or milk.

For further information:
Luke, TDW, Rochfort, S, Wales, WJ, Bonfatti, V, Marett, L & Pryce, JE 2019, 'Metabolic profiling of early-lactation dairy cows using milk mid-infrared spectra', Journal of Dairy Science, vol.102, iss.2, pp.1747-1760, **https://doi.org/10.3168/jds.2018-15103**

Ho, PN Luke, TDW & Pryce, JE 2020, 'Validation of milk mid-infrared spectroscopy for predicting the metabolic status of lactating dairy cows in Australia', Journal of Dairy Science, (submitted for publication August 2020)

MIR detection of pregnancy status

High reproductive efficiency is a key to profitability. MIR technology could offer the early detection of pregnancy status that would enable cows to be re-inseminated earlier, to plan feed budget and to make culling decisions without a high cost and excessive animal handling. Models developed as part of the MIRforProfit project (2015-2018) showed prediction accuracy of around 78% after 150d pregnancy; this could detect foetal abortion and assist in detecting the cause. While earlier detection of pregnancy was not found to be reliable, in this project's research with a larger dataset reliability could be improved.

Reliability: Reliability is given as a percentage and is an indication of the accuracy of the ABV. Reliability of genomic selection is now at 78% (in 2019) up from 44% in 2009. The reliability of the Fertility ABV was 18% in 2009 and is now at 56% in 2019. The increase in reliability is valued at $27 per cow per year.

For further information:
Delhez, P, Ho, P, Gengler, H, Soyeurt, H & Pryce, JE 2020, 'Diagnosing the pregnancy status of dairy cows: How useful is milk mid-infrared spectroscopy?', Journal of Dairy Science, vol.103, iss.4, pp.3264-324, **https://doi.org/10.3168/jds.2019-17473**

MIR mapping of genes affecting milk composition

With farmgate prices determined by milk fat and protein content, breeding to boost those components would be economically advantageous. MIR is currently used to assess the concentration of milk components such as fat, protein, lactose and fatty acids. "Finding the genome location responsible for those components has proven somewhat harder," said Dr Ho. "They tend to be multi-locational with a number of traits affecting the components." MIR could prove useful as a tool to increase the reliability of the genome identity and location due to its low cost and it is used routinely during milk recording providing information on thousands of cows. This data could then be used to increase the reliability of ABVs to give greater confidence to farmers in their bull selection decisions.

For further information:
Benedet, A, Ho, PN, Xiang, R, Bolormaa, S, De Marchi, M, Goddard, ME & Pryce JE 2019 'The use of mid-infrared spectra to map genes affecting milk composition', Journal of Dairy Science, vol.102, iss.8, pp.7189-7203, **https://doi.org/10.3168/jds.2018-15890**

MIR prediction of lameness

Lameness is the third-highest cost to a dairy business in Australia, and lameness has a correlation to other issues like reduced fertility and milk yield, mastitis and metabolic disorders. The research conducted by DairyBio found that MIR was not reliable in detecting lameness. The reasons for that were believed to be because metabolic changes are not a major cause - environmental and management effects have far greater influence and metabolic changes and genetics cannot predict for those factors before lameness develops. Also, that the sensitivity of the metabolic change was too small to be detected and the biochemical indicators are not necessarily fixed.

For further information:
Bonfatti, V, Ho, PN & Pryce, JE 2020, 'Usefulness of milk mid-infrared spectroscopy for predicting lameness score in dairy cows', Journal of Dairy Science, vol.103, iss.3, pp.2534-2544, **https://doi.org/10.3168/jds.2019-17551**

Importance of on-going research

MIR technology is advancing as it is a cheaper and less intrusive way to assess and predict a dairy cow's health and productivity, and to gain large amounts of phenotype data. The DairyBio program will continue to invest in this research to help farmers achieve productivity outcomes on-farm.

"Working with other DairyBio and DairyFeedbase project teams, we are using MIR to determine environmental and phenotype effects on milk composition, metabolic disease and productivity, and strengthening the reliability of ABVs," said Dairy Australia's major innovation projects director and DairyBio co-director Kevin Argyle.

> "We are looking for productivity and profitability outcomes through greater utilisation of this technology that is already used on milk samples collected."

DairyBio is a research and innovation initiative of Agriculture Victoria, Dairy Australia and Gardiner Foundation.

Ask the researcher

Join Murray Dairy extension officer Ross Read and Agriculture Victoria research scientists Dr Jo Newton and Dr Phuong Ho to hear more and 'Ask the researcher' about the application of MIR technology on-farm at the

MIR prediction virtual forum
at 12.30pm on 21st October 2020
Register here for the Zoom link

Researcher Profile
Dr Jo Newton OAM

1. How did you end up here/Why did you become a scientist?
   My interest in livestock was sparked during time spent on a family friend's sheep & cropping property in Western Victoria. Being part of the Young Farmers program at Tintern Grammar and attending local agricultural shows with the school's sheep, chickens and cows showed me that my future lay in agriculture.I combined my strengths in science and maths and love of animals and moved to Armidale, NSW to study Rural Science. My genetics lecturers encouraged my interest in genetics and pursued a PhD. I worked for Tim Bower of Stanley Vale Merinos while studying. Tim gave me the opportunity to apply my uni learnings in his Merino stud. Leading the introduction of breeding values and electronic record keeping fostered a fascination of how research gets translated into tangible benefits for farmers.
2. What drew you to dairy research?
   After finishing my PhD, I was drawn away from the sheep industry and into the dairy industry by the opportunity to work on the ImProving Herds Project. The applied nature of the project, with a focus on demonstrating the value of genetics and herd improvement to the dairy industry plus working alongside the project's focus farms and key industry organisations appealed to me. I've stayed with dairy ever since because of the warm welcome I received and the exciting opportunities to keep contributing to collaborative industry focused projects.
3. What makes you get up in the morning?
   My alarm usually wakes me up in the morning. I'm passionate about advocating for young people – particularly women – in agriculture and ensuring that research outcomes translate into tangible benefits on-farm.
4. PhD title (if applicable)/where you did it and when:
   I did a PhD in animal breeding and genetics at the University of New England in Armidale NSW. When asked to explain my research in general terms I say I studied teenage pregnancy in sheep. The formal title of my thesis was: Sexual maturity and yearling reproductive performance in ewes: Genetic analysis and implications for breeding programs.
5. Why is your research important? What are the possible real-world applications?
   Since finishing my studies all the projects I've worked on have focused on the benefits of better herd-improvement decisions on-farm. For example, in the ImProving Herds project I worked on valuing genetic gain and herd improvement in Australian dairy herds using real farm data. I spent 6 months as a visiting scientist with Teagasc valuing the benefits of genotyping sheep and cattle. Currently my work is focusing on applications of novel herd-testing tools looking at how they can support informed decision making. Research that focuses on-farm applications is important for understanding how new decision-making tools can be used on-farm and making sure they align with farmers' needs.
6. What question or challenge were you setting out to address when you started this work?
   To support a sustainable, efficient and profitable dairy industry through delivering new and improved genetic and herd improvement tools.

Researcher Profile
Dr Phuong Ho

1. How did you end up here/Why did you become a scientist?
   I grew up on a farming family and have developed my passion for animal production since then. I have always been interested in understanding the biology/physiology behind different processes/behaviours of animals, which drew me to becoming a biologist. After completing my undergraduate in Animal sciences in Vietnam, I moved to the Netherlands for my master study (Wageningen university) and France for my PhD (the French National Institute for Agricultural Research). I moved to Australia and joined Agriculture Victoria Research in August 2015 after completing my PhD in dairy nutrition in France.
2. What drew you to dairy research?
   Initially, I started my career as a pig nutritionist but then decided to move to dairy research as it was a growing industry in my home country at that time.
3. What makes you get up in the morning?
   A new and fresh day always offers new research ideas (although I am an afternoon person). I like to start a day by having a cup of coffee under the morning sun.
4. PhD title (if applicable)/where you did it and when:
   I did my PhD at the French National Research Institute for Agricultural Research in Paris – France, from 2011–2014. The title of my PhD was: Towards predicting consequences of management strategies on lifetime efficiency of individual dairy cows.
5. What projects are you working on?
   My current project focus is on collecting novel phenotypes underpinning the development of breeding values of health (walkability and metabolic disorders) and fertility traits. Also, we develop novel tools that assist farmers in making informed breeding and management decisions, using milk mid infrared spectroscopy and other on-farm data. Some examples include a model for ranking animals within herd for their fertility or the models for predicting serum metabolic profiles as indicators of metabolic diseases (e.g. hyperketonemia).
6. Why is your research important? What are the possible real-world applications?
   How can we help farmers better manage their herds and improve their profitability.
7. What question or challenge were you setting out to address when you started this work?
   Mid-infrared spectra from milk samples have been used routinely by worldwide milk recording organisations to analyse milk composition such as fat, protein, and lactose percentages. However, in Australia, we have shown that the combined milk MIR and other on-farm data can also be used to predict fertility and metabolic health with promising accuracies. Particularly, our model for fertility prediction could identify cows that are most or least likely to conceive before the joining period. This information can support farmers in making different management decisions such as the use of sexed or premium semen on top-ranking cows while bottom-ranking cows could be inseminated with beef semen. The model has been well validated using data collected in different years and from different dairy regions. In collaboration with DataGene and Dairy Australia, we are now recruiting farmers to participate in a trial to test this tool for this spring calving.

Future forages for a warmer and changing climate

Ask the researcher virtual forum at 12.30pm on 11th November 2020 Register here

Key points

- **Modelling shows a substantial drop in profitability from a changing climate**
- **Current locations of breeding and testing sites for pastures are inadequate**
- **New forage species and traits will become more important over time**
- **A warmer, drier climate with more extreme weather events will adversely affect nutrition and persistence of current forage**

Modelling undertaken in 2016 by the University of Melbourne found that profitability could drop by 10-30% by 2040 due to climate if dairy farmers did not adapt to the warmer and drier conditions. Dr Brendan Cullen and Dr Margaret Ayre's research showed year-to-year profit variability that depended on the production system – more intensive systems are more reliant on high milk prices and lower feed prices and capable of making a large profit (and conversely a large loss). Less intensive systems have a similar average level of profitability but did not have the same levels of variability – meaning in the future less intensive systems in some regions could carry less risk and drive a reverse in current trends to smaller herd sizes, less grain feeding and a lower stocking rate.

The project demonstrated that for dairy farming to be viable into the future farmers need to continue to adapt to the changing climate and part of that adaption is growing the best pasture for the conditions.

Pasture is one of a dairy farm's biggest assets and the Australian dairy industry's ability to grow good quality home feed is a competitive advantage in the international market.

To better understand the way that future climates will affect the seasonal pattern of pasture growth and digestibility, Agriculture Victoria research scientist and University of Melbourne Professor Kevin Smith has been working on the 'Future Forages' project funded by Agriculture Victoria. The project aims to use climate modelling to determine what the future temperature and rainfall looks like in 2030, 2050, 2070 and 2090 at a regional level to determine future forage needs.

"Climate analogues are where the expected future climate of the place of interest is matched with the current climate of somewhere else," said Professor Kevin Smith. "They allow us to see in a practical way what the climate of the place of interest will look like in the future."

The project investigated six different general circulation models (GCMs) and determined that the CSIRO-BOM GCM was the most appropriate one. The researchers then used the climate forecast model with a Representative Concentration Pathway (RCP) of 8.5.

General circulation models (GCMs)

Climate and climate system component models are used to make projections about the response of the climate system to changes in initial conditions and applied climate forcing. Applied forcing may, for example, include changes to the level of the atmospheric carbon dioxide concentration. The computing power required by these complex models is huge – for example, in 2002 Japan's Earth Simulator was the largest supercomputer on Earth and capable of completing 40 trillion calculations per second.

"We used the climate scenario predictions with a focus on rainfall rates, and minimum and maximum temperatures alongside historical climate records from 1986 to 2015 to create a baseline and model the predicted changes," said Professor Smith. "The results for each area were calculated using low, moderate and high rainfall and temperature ranges and then compared to what current climates are elsewhere to choose climate analogues."

The benefit of this research for future forages is that nurseries and trial plots can be located at the climate analogues to ensure adaptation to the future environment. "Unfortunately using the current breeding and evaluation sites will not facilitate breeding for the future environment," Professor Smith said, "except at Hamilton where the site remains relevant - now and into the future".

Representative Concentration Pathways (RCPs)

RCPs are based on historical data and plausible assumptions that lead to values that define specific emissions trajectory of greenhouse gas emissions (carbon dioxide, methane and nitrous oxide) and the resulting forcing effects. 8.5 refers to the pathway that in 2100 there will be 8.5 Watts per metre squared of radiative forcing in the lower atmosphere.

After determining the climate analogue sites for Shepparton, Traralgon, Warrnambool, Bega and Burnie the researchers found that the species that are adapted to these analogue sites lack the qualities for dairy grazing, including digestibility and nutrition. These changes to yield, persistence and nutrition from climate are anticipated to affect all temperate forages. Perennial ryegrass will be further affected by the forecasted increased extreme heat events in spring as early spring is the key season for production.

This project has identified that there are a number of research priorities for future forages to allow time for the dairy industry to adapt to the future climate. "We need to expand the modelling work and include sub-tropical grasses in all environments," said Professor Smith. "We need to be also including persistence in the modelling with the increased frequency of extreme weather events and re-sowing requirements for all species."

Targeted breeding of forage species with a focus on quality is essential, as is investigating and improving the digestibility of warm season (C4) grasses. It is also essential to develop breeding and demonstration sites now that will be future climate aligned with dairy areas to breed and test forages.

"The climate and pasture modelling project findings will prove invaluable to developing future forages for the dairy industry," said director of major innovation projects and DairyBio co-director Kevin Argyle. "We know that the climate is changing and we need to adapt for it, this is the continuation of the DairyBio forage programs' pasture species work into the proposed 2021-26 program."

The Future Forages project used outcomes from DairyBio and DairyFeedbase research projects, including the pasture parameters, the F1 Hybrid perennial ryegrass, model validation and the future forages economic value index.

DairyBio is a research and innovation initiative of Agriculture Victoria, Dairy Australia and Gardiner Foundation.

Ask the researcher

Join Gipps Dairy extension officer Karen Romano and Professor Kevin Smith to hear more and 'Ask the researcher' about future forages modelling and the implications for research and on-farm activities at the

Future Forages virtual forum

at 12.30pm 11th November 2020

Register here for the Zoom link

For further information:

Cullen, B and Ayre, M 2016, 'Dairy's (climate) changing future', University of Melbourne Pursuit, **https://pursuit.unimelb.edu.au/articles/dairy-s-climate-changing-future**

Dairy Australia's 'Dairy climate toolkit': **http://www.dairyclimatetoolkit.com.au/adapting-to-climate-change/adapting-the-dairy-industry**

Agriculture Victoria's 'Cents of Carbon': **https://agriculture.vic.gov.au/climate-and-weather/understanding-carbon-and-emissions/making-cents-of-carbon-and-emissions-on-farm**

CSIRO-BOM GCM
Collier, M & Uhe, P 2012, 'CMIP5 datasets from the Access1.0 and Access1.3 coupled climate models', CAWCR technical report, CSIRO, Canberra. **https://www.cawcr.gov.au/technical-reports/CTR_059.pdf**

RCPs
Department of Environment, Representative Concentration Pathways (RCPs) Fact Sheet, **https://www.environment.gov.au/system/files/resources/492978e6-d26b-4202-ae51-5eba10c0b51a/files/wa-rcp-fact-sheet.pdf**

van Vuuren, DP, Edmonds, J, Kainuma, M, Thomson, A, Hibbard, K, Hurtt, GC, Kram, T, Krey, V, Lamarque, J, Masui, T, Meinshausen, M, Nakicenovic, N Smith, SJ & Rose, SK 2011, 'The representative concentration pathways: an overview', Climatic Change, vol. 109, iss.5. **https://doi.org/10.1007/s10584-011-0148-z**

Researcher Profile

Professor Kevin Smith

1. How did you end up here/Why did you become a scientist?
   I have always had a passion for genetics and agricultural science allows a very practical application of this passion.
2. What drew you to dairy research?
   I come to it from the forage side of the equation rather than the animal one. The dairy industry has always been very supporting of my research into pasture.
3. What makes you get up in the morning?
   It's a lot better than the alternative.
4. PhD title (if applicable)/where you did it and when?
   The genetics and physiology of water-soluble carbohydrate accumulation in perennial ryegrass. My degree comes from University of Melbourne but I undertook the research at CSIRO Canberra and at Aberystwyth in the UK with support from Dairy Australia.
5. What projects are you working on?
   I work on a range of projects looking to breed new pasture cultivars with benefit to dairy farmers and to develop new automated methodologies to measure pasture yield and quality from breeding programs through to on-farm application. Some of the projects include DairyBio where genomic selection technologies similar to those used in cattle breeding are being used to increase the rate of genetic gain in forages, the Forage Value Index project and Future Forages where we are modelling the effects of climate change on the growth and quality of the feedbase looking forward.
6. Why is your research important? What are the possible real-world applications?
   The big question is to ensure that we have a productive and sustainable feedbase that matches the needs of dairy cattle as closely as possible.
7. What question or challenge were you setting out to address when you started this work?
   I'm going to answer this question with a question.What if we knew the amount of forage and its quality in every paddock every day and we used this information to drive the breeding of even better cultivars to meet changing conditions?We are not there yet, but by ensuring that new cultivars and technologies are released along the way we will ensure that dairy farmers have better tools to manage pasture based dairy production.

Genetic improvement: Driving productivity

Ask the researcher virtual forum at 12.30pm on 2nd December 2020 Register here

Key points

Genetic gain has doubled in sires since 2010

DairyBio drives innovation through improving and developing new ABVs, that are adopted into DataGene's BPI and HWI

A BPI of 300 means that the animal is $300 more profitable than the average

Increases in reliability are valued at $27 per cow per year

Imagine trying to feed the world on what a dairy cow produced 50 years ago – the milk yield per cow has doubled since 1970 in Australia and this would not be possible without improved animal breeding. Not only have our cows been bred to be more productive, they have become much more efficient in utilising the feed they have.

Under the leadership of Agriculture Victoria research scientist Professor Jennie Pryce, the DairyBio animal program is focused on driving productivity and profitability gains through genetic improvement, lowering costs by enabling selection for health traits and developing improved breeding management tools. DairyBio is on track to deliver an additional value of $350 per cow per year.

English sheep stud owner Robert Bakewell, who became the world's first "scientific breeder" 250 years ago by selecting parents to breed from according to observable characteristics, could have had no concept of the massive gains that have led from Gregor Mendel's genetics research using peas in 1865 to a facility like the AgriBio Centre for AgriBioscience in Melbourne, where supercomputers crunch millions of calculations per second across multiple machines and there is a library of the entire genomic sequence of over 200,000 cows and bulls (DairyBio Animal project 1). That library contains details of genetic markers - the variation in the DNA that influences animal performance – and is used to identify the multiple markers (sometimes thousands) linked to a performance trait like fertility, heat tolerance and feed efficiency.

Genomic Selection is the identification of superior genotypes (which dictate characteristics like body features, milk production and resistance to disease) to enable selection of the best parent to breed plants and animals from according to your objectives. It drives rapid genetic gain (improvement) by reducing the generation intervals by evaluating traits at an early age. The DairyBio Forage Program is also using this tool to successfully drive rapid genetic improvement in pasture yield, persistence and quality.

The large-scale step change innovation projects that the DairyBio animal program are conducting are having an ongoing significant impact on productivity through greater accuracy of selection of breeding stock, reduction in generation intervals through genomic selection and driving the use of technology – like MIR – to make herd management decisions. Increasingly reliable genetic information also drives reliable management decisions, as understanding your cows' genetic makeup will make decisions about pasture, supplementary feed, infrastructure and culling more reliable.

Like Robert Bakewell the main objective of modern breeding programs is to select the best parents for the next generation according to farmer and industry objectives. Unlike Bakewell though we now combine information from progeny, ancestors, genomics and performance records from Australia and overseas to select according to unobservable characteristics and in Australia the main focus is on traits that improve animal productivity, health outcomes, feed efficiency and resilience (including resilience to environmental factors like heat).

DairyBio (since 2016) and Dairy Futures CRC (2010-16) have delivered significant bioscience research outcomes – see figure 1 - including being the first in the world to identify and enable selection according to a heat tolerance ABV, in addition to reversing the fertility rate trend, developing genomic selection tools that have enabled a threefold increase in genetic gain for cow profitability and developing a feed efficiency ABV (Feed Saved ABV) – where some bulls can have daughters that eat 100kg less of dry matter per year for the same milk yield and body weight – a significant cost saving.

The genetic research being conducted by DairyBio has also developed new ABVs and improved the reliability of existing ABVs to assist the dairy industry to respond to the changing societal demands around health and welfare including being able to select for daughter fertility, mastitis resistance, heat tolerance, feed efficiency, functional conformation, reduced lameness, reduced greenhouse gas emissions and improved metabolic health.

DataGene's Good Bulls Guide utilises the DairyBio new and improved ways to calculate ABVs to rank bulls available in Australia so that farmers and advisers can use the Balanced Performance Index (BPI) and the Health Weighted Index (HWI) for the selection of bulls to meet their breeding

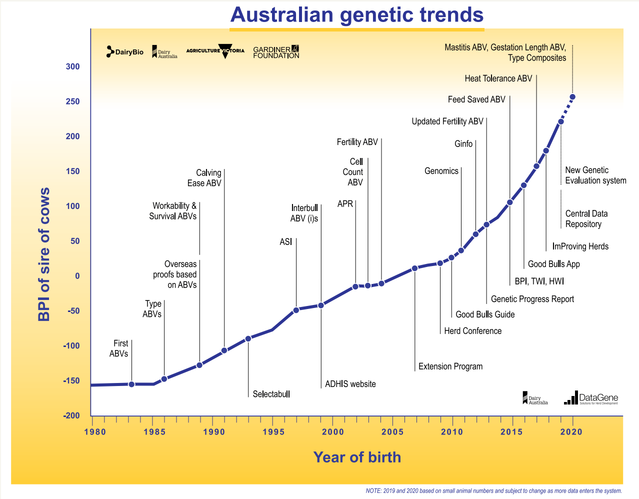

Figure 1: The above graph shows the genetic improvement in the Australian dairy herd achieved through innovation and adoption since 1980 using the Balanced Performance Index (BPI) as the rate of improvement. A BPI of 300 means that the animal is $300 more profitable than the average – the average is 0 (Graph courtesy of DataGene).

Figure 1 shows that herds selecting bulls through DataGene's BPI yield productivity gains through the genetic improvement innovation since 1980. BPI incorporates the ABVs for traits that influence a cows performance including production, fertility, functional type, survival, cell count, workability and feed saved. These advances have enabled the dairy industry to remain competitive internationally against strongly subsidised competition and maintain productivity against rising input costs and dropping dairy cow numbers. As genetic improvement in herds is permanent and cumulative, with rising input costs and climatic uncertainty they are one of the most important profitability improvement drivers in a dairy farmer's business.

The National Breeding Objective (NBO) sets the collective breeding objectives for the Australian dairy herd. The NBO sets the weights that each ABV receives within DataGene's BPI and Health Weighted Index (HWI) to ensure that the indexes used to rank sires align with the dairy industry's priorities, as figure 2 shows the changes in the emphasis of traits over time in the BPI. The NBO is reviewed every five years with the latest review outcomes being released in December 2020.

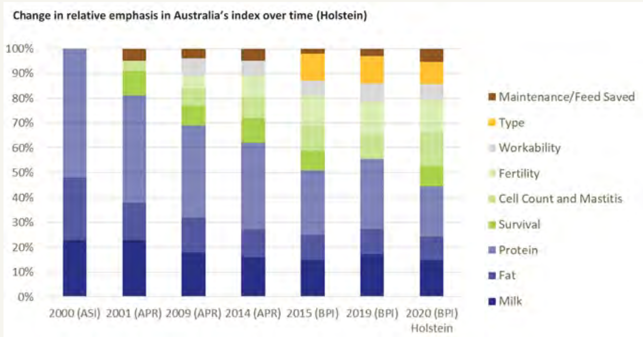

Figure 2: Change in the relative emphasis of traits in the BPI over time (courtesy of DataGene)

Genetic improvement has resulted in dairy cows that eat more, convert more efficiently and waste less and through the DairyBio initiative we will continue to see greater productivity gains as highly sophisticated breeding programs – driven by genomic selection– are adopted by industry.

DairyBio is a research and innovation initiative of Agriculture Victoria, Dairy Australia and Gardiner Foundation.

Ask the researcher

Join Murray Dairy extension officer Ross Read and Agriculture Victoria research scientist Professor Jennie Pryce to hear more and 'Ask the researcher' about genetic improvement, the NBO and ABVs at the

Genetic improvement virtual forum

12.30pm on 2nd December 2020

Register here for the Zoom link

Researcher Profile

Professor Jennie Pryce

1. How did you end up here?
   I came to Melbourne after seven years in New Zealand with the Livestock Improvement Corporation for the chance to work with Professor Mike Goddard and Ben Hayes who along with Theo Meuwissen invented genomic selection.
2. What drew you to dairy research?
   I grew up on my parents' dairy farm in Shropshire and at 11 I started building my own herd of pedigree Holsteins. This experience made me want to become a geneticist as I could see the difference that selection for traits made to the next generation of a herd.
3. What makes you get up in the morning?
   My family is my main motivation and my 4 year old is a good alarm clock! I also feel incredibly lucky to be working in the era of genomics matched to new trait development. It's very gratifying to see practical implementation of our research through DataGene.
4. PhD title (if applicable)/where you did it and when:
   I completed my PhD in 1998 at the University of Edinburgh in "The Genetics of Health and Fertility of Dairy Cattle" under the supervision of Professors Geoff Simm, William G. Hill, Robin Thompson and Roel Veerkamp.
5. What projects are you working on?
   I am the DairyBio animal program leader and we focus on using bioscience to get profitability, productivity, animal welfare and environmental outcomes for the Australian dairy herd.
6. What question or challenge were you setting out to address when you started this work?
   We know that we need to boost profitability and productivity in the dairy industry, bioscience research offers the greatest opportunity to drive that transformational improvement.
7. Why is your research important? What are the possible real-world applications?
   We were the first in the world with a heat tolerance ABV and a feed efficiency ABV, other researchers around the world are copying our approach. If you look at the Australian genetic trends graph (figure 1), DairyBio research coupled with DataGene has driven the increased steepness of the angle of the curve in per cow genetic gain in dollars from 2011 with just the initiation of major investment in dairy genetics research – that's permanent and compounding value for Australian dairy farmers and with the proposed DairyBio21-26 program we will be aiming to continue driving that gain.

Meet our team
Dr Meaghan Douglas

Role: Agriculture Victoria Research Scientist
Location: Ellinbank research farm
PhD title: 'The nutritive characteristics of perennial ryegrass and implications for diet formulation for grazing dairy cows'
Current project: DairyFeedbase 'Smart Feeding'

1. How did you end up here/Why did you become a scientist?
   I have always loved animals and grew up aspiring to become a vet. However, during my third year of undergraduate studies we heard from a young researcher who had done an Honours research project and loved it, so I looked into what projects the university had planned for the following year. I wanted to work with large animals, dairy cattle in particular, and so when I found a research project that was to be based at the Dairy Research Centre in Ellinbank I applied straight away. At Ellinbank I had the opportunity to be around the cows quite a lot, as everyone was keen to get me involved and help me to learn as much as I could. I had been there about three weeks when I decided that I enjoyed undertaking research, and that was what I wanted to do.
2. What drew you to dairy research?
   Mostly, the fact that I love cows. But I'm also passionate about the dairy industry and so being involved in dairy research is really rewarding, particularly when you have the opportunity to help farmers to make decisions that could improve the health and productivity of their cows.
3. What makes you get up in the morning?
   My partner is a dairy farmer and I love getting the cows in from the paddock in the morning. It's such a quiet and peaceful time of the day.
4. PhD title (if applicable)/where you did it and when:
   I have just been awarded my PhD through the University of Sydney, and am set to graduate (in absentia) in October. My PhD was titled 'The nutritive characteristics of perennial ryegrass and implications for diet formulation for grazing dairy cows'.
5. How long have you been working in dairy research?
   A little over 6 years. I completed my Honours research project, looking at the positive association between milk protein concentration and fertility in primiparous dairy cows, in 2014, and have been undertaking dairy research at Ellinbank ever since.
6. What project are you working on Why is your research important? What are the possible real-world applications?
   I am part of the Smart Feeding project team, which is part of Dairy Feedbase. This project aims to develop farm management systems that will allow a more effective allocation of available feed resources across a herd and an overall increase in the herd's average milk response to feeding. This includes focusing on the individual intake of each cow and the inherent variation in productivity of the herd.

   In particular, I am focused on the systems that will allow us to more effectively re-allocate the grain, without the need to purchase more, that is fed to grazing cows in the dairy to complement the nutrients that they will consume from pasture, which is impacted upon by their milking order. This is particularly important to farmers that have herds that spend long times at the dairy waiting for milking, and therefore there can be a significant time difference between when cows return to the paddock. We hope to alleviate some of the lost milk production by the cows that return to the paddock later and have reduced pasture quantity and quality by investigating their grain mix in the dairy.
7. What do you like to do when you aren't working on research?
   When I'm not working with the cows at Ellinbank, I'm often working with the cows at home. I take a lead role in rearing our calves and have a few pet sheep. I've also got a few sewing tricks up my sleeve which keep me busy in the quiet times.

Meet our team
Dr Marlie Wright

Role: Agriculture Victoria Research Scientist
Location: Ellinbank research farm
PhD title: 'Quantifying the individual intake of grazing dairy cows offered mixed rations'
Current project: DairyFeedbase 'Smart Feeding'

1. How did you end up here/Why did you become a scientist?
   I ended up at Agriculture Victoria after speaking with a supervisor at The University of Melbourne and expressing my interest in a career in research. I developed a passion for dairy research during my Honours year, when I investigated the walking activity of dairy cows as a predictor for the onset of oestrous.
2. What drew you to dairy research?
   A career in research appealed to me because it's a job that requires constant problem solving, there is also a perfect mix of field work, data crunching and writing. The dairy industry is a fantastic industry to work in and I love working with cows and pasture.
3. What makes you get up in the morning?
   Working at Agriculture Victoria, Ellinbank makes it easy to go to work each day, we're conducting exciting research and have amazing facilities to work with. I am also lucky enough to work with an amazing team, making it easy to get up each day.
4. PhD title (if applicable)/where you did it and when:
   I undertook a PhD at The University of Melbourne three years ago, titled 'Quantifying the individual intake of grazing dairy cows offered mixed rations'. This research investigated a technique to estimate individual intake, which then enabled me to investigate the variation in individual intake between cows. During my PhD I was lucky enough to travel to Ireland to conduct research at Teagasc, Moorepark.
5. How long have you been working in dairy research?
   I have worked in dairy research at Ellinbank for 8 years. During this time, I have worked on numerous experiments primarily investigating feeding supplements to grazing dairy cows.
6. What project are you working on?
   I'm currently working with a team on the Smart Feeding Project. This project started off looking at farm management issues that large herd mangers face with regards to time away from pasture, and the variation in feed intake and milk production. The Smart Feeding project has since evolved to focus on the individual intake of each cow and the variation in the milk production of the herd to improve overall herd milk production. To achieve this, we are currently investigating strategies that reallocate on farm feed resources to achieve more uniform intakes of pasture.

7. Why is your research important? What are the possible real-world applications?
   This project will develop farm management systems that allow for a more effective allocation of on farm feed resources across a herd and an overall increase to the herd's average milk production.
8. What do you like to do when you aren't working on research?
   When I'm not at work I like to spend time with my family, keep fit and ride my horse.

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