

Annual progress report

2018–19







CONTENTS

Chair's review	2
Co-directors' review	3
DairyBio profile	4
Young Dairy Scientist Award	6
Project status and snapshots	8
DairyBio financial position 2018–19	12
DairyFeedbase profile	14
Project status and snapshots	16
Diet the key to increasing milk yield	17
DairyFeedbase financial position 2018–19	20
DairyBio commercialisation activities	23
Education and engagement	24
DairyBio PhD students	26

Chair's review

The 2018–19 year has been a year of significant progress for both DairyBio and DairyFeedbase. DairyBio completed its third year of operations and has strengthened the technology platforms that are key to delivering high-value outcomes for industry. DairyFeedbase completed its second year and is developing and delivering transformational innovation from the five key projects.

During the year we were pleased to have the Gardiner Foundation join DairyBio as a Joint Venture partner resulting in both initiatives now having the same three core investor partners.

The value of operating at scale in both bioscience (DairyBio) and agronomy/nutrition (DairyFeedbase) is significantly improving the outcomes in each initiative. This allows for the seamless movement of technology, staff, and delivered products. For example, the progress made in measurements of plants in breeding fields will be essential for addressing core challenges in measuring pasture performance in both variety trials and commercial dairy paddocks.

Governance arrangements in DairyBio and DairyFeedbase are working well, with a common Board and common management as attested to in the independent DairyBio midterm review. Our focus as a Board is to deliver on the outcome objectives for both initiatives.

A feature of DairyBio is the strong support of project partners who are investing for both commercial and industry-good outcomes. There continues to be opportunities to fund additional well-established projects in DairyBio and DairyFeedbase where further investment can leverage existing successes. The project partners bring both essential experience and know-how as well as the ability to generate wide-spread adoption of project outcomes.

An independent panel undertook the DairyBio midterm review in June 2019. The review findings were positive on progress to date and provided strong support for continuing the DairyBio investment partnership into the future. The panel made a number of considered and useful recommendations to further enhance the DairyBio initiative.

The recommendations did not suggest major changes to the current DairyBio programme, but rather identified further enhancement opportunities, many of which the Board and management had also identified.

These included; continued focus on F_1 hybrid delivery and a pivot to warm season grasses within the forage program; the need to scope and develop plans for the continuation of the research and innovation efforts following the completion date of DairyBio; and an increased focus on strategy and risk management at board level. Recommendations also included scoping and planning now for increased impact from research in environmental traits and social license to operate with increased linkages to DairyFeedbase.

It was encouraging to receive this very positive midterm review assessment of the DairyBio performance to date and the importance of the initiative going forward.

I would like to acknowledge the strength of the joint venture model that is based on the ongoing commitment of Agriculture Victoria, Dairy Australia and the Gardner Foundation to lead and invest in world-class innovation initiatives.

During the 2018–19 period there were some significant changes in key roles. Firstly, the Board welcomed Clive Noble and Bryony Fitzgerald to the Board. The Board also welcomed the appointment of Kevin Argyle as a new Co-Director. We would like to thank and acknowledge the care taker role that Peter Johnson performed during the recruitment vacancy period.

In summary, it has been a year of strong performance and has included substantial review and delivery and achievement of key milestones within projects. The present difficult conditions being experienced in the dairy industry highlight the critical importance of delivering new innovations to support a sustainable Australian dairy industry into the future.

I would like to recognise the performance of the Co-Directors, Professor Ben Cocks and Mr Kevin Argyle, the Project Leaders and the contributions from fellow Directors.



Peter Reading Chairman

A handwritten signature in blue ink, appearing to read 'P. Reading', written over a horizontal line.

Co-directors' review

The DairyBio and DairyFeedbase initiatives' are on track to generate far-reaching and positive impacts for the dairy industry.

DairyBio is on target to deliver its objectives against achieving improvement in pasture productivity of \$800/ha/year, with a concurrent target to improve animal productivity by \$350/cow/year.

DairyFeedbase is also on target to conservatively deliver impacts of at least \$100 million/year.

In this year, the linkages between both DairyBio and DairyFeedbase initiatives has been further strengthened to enhance the success of both in delivering transformational innovation to the dairy industry.

Within DairyBio, a new animal project, Project 6 (focusing on improved fertility) has been recently added within DairyBio (now a total of 13 projects) which is to compliment Project 4. This project is being supported through additional funding from the Gardner Foundation and collaboration with Dairy NZ. There are five projects in DairyFeedbase.

Improvements to many established traits and breeding values have been delivered including for fertility. These projects are exploiting recent exciting results indicating milk mid-infrared data can be used to improve breeding selections, but also predict and manage individual cow fertility. Progress on crossbreed breeding values is also being made.

One of the most significant outcomes in the past 12 months has been multiple Barenbrug Agriseeds and Heritage Seeds field trials of F₁ Hybrids at Lardner Park in Gippsland and at Darfield in NZ have shown expected levels of heterosis are present in new hybrid experimental varieties with resultant elite performance. Early in field trial data has shown yield increases of between 20 and 40 per cent.

Other DairyBio highlights during the year have been:

- Validation of F₁ Hybrid breeding technology is relevant to short-term ryegrass and generation of parental pools to evaluate potential gains.
- Genomic selection for pasture plants applied to a breeding program demonstrates more than a tripling of the rate of genetic gain achieved.
- Breakthroughs achieved in high throughput phenomics for pasture plants, endophytes and animals facilitating a new wave of innovation.
- Delivery of new traits such as calving ease, calving interval, and improvements to existing breeding values such as fertility.

In both forage and animal improvement programs, progress has been actively monitored by Project and technical committees and shifts in emphasis and approved by management where appropriate. Substantial biological and technical challenges have hampered progress in specific areas and as a result a refocus has been recommended, approved and implemented to retain delivery of target outcomes e.g. in endophyte development and tall fescue development.

The project teams in DairyFeedbase have worked diligently to achieve milestones and where possible identify any 'quick wins' which can be made available to dairy farmers. The most notable being the pasture smarts commercial trial on six commercial farms which was setup to help develop a commercial prototype.

The team have also been able to disseminate to farmers early insights on minimising the impacts of heat stress in cows and major outcomes of nutrition work that improved the use of partial mixed rations and use of key supplements.

Critical development tasks have been completed across all five projects, including reviews of sensor-based methods, forecasting tools, feed allocation improvements, and testing of diets for hot weather.

Milestone-based measurement of performance continues to drive delivery with 30 of 30 milestones achieved in DairyBio and 32 of 35 milestones achieved in DairyFeedbase. Of the remaining milestones, three milestones have short term delays (six months to accommodate addition of one new milestone for commercial PastureSmarts trial) which are contained and do not affect subsequent project milestones or outcomes.

We would like to recognise the important contributions of the Board over the past year. Their insightful governance is a great advantage to the benefit of industry, project partners, and management.

All of the projects are complex and require quality governance, management, science, research and innovation and we thank all the project leaders and their respective teams for their contribution. We also thank our collaboration and industry partners.



Kevin Argyle Co-Director



Ben Cocks Co-Director



Profile

DairyBio was established in 2016 as a major investment in dairy bioscience. The core investment proposition is to generate large-scale impacts for Australian dairy farmers through the advanced and industrial-scale application of biological sciences. The investment portfolio is based on a limited set of defined impacts that have strong scientific rigour and substantial market value.

Headline impacts include:

- Dairy farmers will benefit from improved perennial ryegrass through:
- 20 per cent increase in yield through the use of hybrid technology
- Three-fold increase in genetic gain for all yield and nutrition traits through the use of genomic selection
- Three-year extension of productive life through the improved use of endophyte technology
- 2MJ increase in metabolisable energy concentration of pastures (i.e. increased energy density) through the use of genome editing.

Dairy farmers will benefit from improved herds:

- 50 per cent further improvement in the rate of genetic gain from the more reliable use of genomics to estimate genetic merit
- \$80/lactation improvement in cow performance through the use of genomics to assess the merit of each cow
- 10 per cent lower health costs through genetic selection for health traits
- 50 per cent further reduction in costs of genotyping, which will stimulate the routine use of genotype services.

One of the major goals in the current five-year investment is to develop turnkey solutions for perennial ryegrass breeding and for a new and improved method of genomic selection of cattle. This means that all of the current innovations can be routinely applied in a commercial environment, and farmers can then easily access these innovations through the purchase of pasture seed and cattle semen.

DairyBio investors 2018–19

Joint venture partners



Project partners



Major supporting partners



Highlights

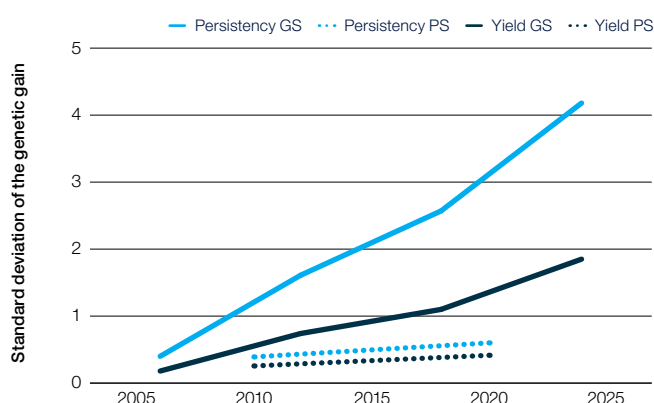
All DairyBio forage and animal projects have achieved significant milestones and delivered a range of exciting new innovations in 2019. Critical activities that have been achieved include:

Forage improvement

- Multiple Barenbrug Agriseeds field trials of F₁ Hybrids at Lardner Park in Gippsland and at Darfield in NZ have shown expected levels of heterosis are present in new hybrid experimental varieties with resultant elite performance. Early in field trial data has shown yield increases of between 20 and 40 per cent.
- Implementation of genomic selection into the Barenbrug Agriseeds commercial breeding program for three successive years of breeding.
- Validation of F₁ Hybrid breeding technology is relevant to short term ryegrass and generation of parental pools to evaluate potential gains.
- New capability for genome editing ryegrass that has led to creation of the first genome edited plants with improved quality traits now transferred to soil.
- New prospective technology applications in other forage species including microbiome and other species.
- Breakthroughs have been achieved in high throughput phenomics for pasture plants, endophytes and animals facilitating a new wave of innovation.

Genomic selection developed in ryegrass

- Developed with commercial data and seed
- Application will treble the rate of genetic gain



Animal improvement

- Delivery of new traits such as calving ease, calving interval, and improvements to existing breeding values such as fertility.
- New methods under development for genomic selection of cattle on an across-breed basis.
- Commercial data that clearly demonstrates the value of genetic improvement and herd testing directly to farmers.

- The 1,000 Bull Genomes project led internationally now contains whole genome sequences of over 4,000 animals improving accuracy of genomic prediction.

DairyBio regularly publishes new articles online that are available at dairybio.com.au.

AgriBio's upper atrium area has taken on a new look, with route-to-impact partners for DairyBio having taken up residence at AgriBio during 2018. The industry organisations DataGene, Holstein Australia, Jersey Australia and the National Herd Improvement Association of Australia are in the new 'Dairy House'.

It demonstrates amazing progress towards the founders' vision for AgriBio – making it a powerhouse of research, innovation and delivery of productivity and biosecurity outcomes for food and agriculture; creating an innovation ecosystem that converges government, industry, agribusiness and academia.

The co-location of DataGene, Holstein Australia, Jersey Australia and the National Herd Improvement Association here at AgriBio – joining forces with DairyBio – as a major strategic partnership between Dairy Australia, the Gardiner Foundation and Agriculture Victoria epitomises this vision. It has consolidated these strategic partners at AgriBio as a 'one-stop-shop' for dairy bioscience nationally, further enhancing our global positioning in dairy innovation and growing opportunities to realise synergy potential.

Projects

Thirteen projects operated in 2018–19, under the direction of project leaders. Project descriptions are set out below.

Forage projects	Project leader
1 Perennial ryegrass	Noel Cogan
2 Fungal endophytes	Kathryn Guthridge
3 Short-term ryegrass	Noel Cogan
4 Tall fescue	Noel Cogan
5 New breeding methods	Matt Hayden
6 Plant microbiome	Tim Sawbridge
7 High energy ryegrass	Noel Cogan & Pieter Badenhorst

Animal projects	Project leader
1 Improved reliability	Hans Daetwyler
2 Improve existing traits	Jennie Pryce
3 Develop new traits	Jennie Pryce
4 Novel phenotypes	Jennie Pryce
5 Trans-Tasman project	Jennie Pryce
6 Improved fertility prediction	Jennie Pryce

Young Dairy Scientist Award

Caeli Richardson



Agriculture Victoria Research PhD student Caeli Richardson presenting her research at the Australian Dairy Conference

Agriculture Victoria Research PhD student Caeli Richardson became the recipient of the prestigious 2019 Young Dairy Scientist Award at the recent Australian Dairy Conference in Canberra.

The award is an opportunity for early-career dairy scientists to communicate their research to industry and farmers in a way that is understandable, relevant and that showcases the positive implications for the future of the dairy industry.

Caeli presented her research and hosted a display exhibit on 'breeding burpless cows' at the conference and submitted an article for a lay audience for publication in *The Australian Dairyfarmer*.

Caeli's PhD is part of a DairyBio project to reduce dairy cow methane emissions and improve feed-efficiency, leading to a more economically and environmentally sustainable dairy industry.

"My aim is to provide dairy farmers with a genetic tool to breed more efficient cows and potentially have this trait available for selection in the breeding index," Caeli said.

My aim is to provide dairy farmers with a genetic tool to breed more efficient cows and potentially have this trait available for selection in the breeding index

Caeli received a \$3,000 travel bursary to advance her study, which she hopes to use to develop collaborations with the European dairy industry.

She is supervised by joint appointees of Agriculture Victoria Research and La Trobe University, Professor Ben Cocks and Dr Jennie Pryce.

Agriculture Victoria Research PhD student Chaya Smith (Hamilton) was also one of six finalists for this year's award.



Project status and snapshots

FORAGE PROJECT 1

Integrative genomics-assisted F₁ hybrid breeding of perennial ryegrass-endophyte symbiota for pasture improvement

OVERVIEW

Status On track

Expenditure \$4.560 million

Milestones achieved 11 of 11

FORAGE PROJECT 2

Endophyte technologies for pasture improvement

OVERVIEW

Status On track

Expenditure \$0.980 million

Milestones achieved 12 of 12

FORAGE PROJECT 3

Integrative genomics-assisted F₁ hybrid breeding of short-term ryegrass (Italian and Westerwold) for pasture improvement

OVERVIEW

Status On track

Expenditure \$0.777 million

Milestones achieved 1 of 1

FORAGE PROJECT 4

Increased digestibility and productivity through EXZACT genome editing and development of F₁ hybrid breeding for tall fescue

OVERVIEW

Status On track

Expenditure \$0.313 million

Milestones achieved 1 of 1

FORAGE PROJECT 5

Efficient doubled haploid production and targeted gene editing in *Lolium* and *Festuca* spp.

OVERVIEW

Status On track

Expenditure \$0.290 million

Milestones achieved 2 of 2

FORAGE PROJECT 6

Exploiting the *Lolium* microbiome to enhance performance of pasture and turf temperate grasses

OVERVIEW

Status On track

Expenditure \$0.537 million

Milestones achieved 3 of 3

FORAGE PROJECT 7

Efficient doubled haploid production and targeted gene editing in *Lolium* and *Festuca* spp.

OVERVIEW

Status On track

Expenditure \$0.363 million

Milestones achieved 4 of 4

Endophyte technologies for pasture improvement



The program is a flagship initiative of the DairyBio joint venture between Agriculture Victoria Research, Dairy Australia and the Gardiner Foundation. It focuses on developing world-leading technologies for novel endophyte strains, diagnostics and evaluation.

Endophytes are fungi that live within healthy plant tissue, including pasture grasses, improving the host plant's resistance to pests, heat tolerance and production, but that can also be extremely toxic to animals.

"We aim to deliver superior fungal endophytes to enhance perennial ryegrass persistence in grazing systems, with an emphasis on the dairy industry. This has a direct benefit to farmers by allowing them to utilise a more resilient grass in their grazing systems," Kathryn Guthridge said.

Now a globally recognised expert in fungal endophytes, Kathryn leads a 15-person multi-disciplinary team across the program, including four PhD students.

The team has produced 10 Australian and international patents and developed significant technologies for generating and characterising novel endophytes that have been integrated into commercial plant breeding programs.

“The program has been very successful; we have developed and delivered world-leading endophyte technologies for pasture grass improvement for the benefit of the Australian dairy industry.

“We have achieved outstanding outcomes represented in patents, peer-reviewed publications, and world-leading positioning in research and commercial implementation,” she said.

Kathryn attributed the success of the program to the high-quality scientists in the Agriculture Victoria Research team, strong culture of innovation and collaboration, and the world-class facilities at AgriBio.

“One of the things I most enjoy in my current role is the strong culture of innovation and collaboration that the people in the program bring. This culture allows us to identify and harness synergies and builds on the multidisciplinary team approach for maximal positive impact and outcomes.

“We began the program with endophyte discovery, looking to find and characterise novel endophyte strains. Over the last 10 years we have accumulated a wealth of knowledge on what the ‘perfect’ endophyte looks like. Now, using all the technologies available to us at AgriBio, we are looking to create our own ‘perfect’ endophyte using genome editing,” she said.

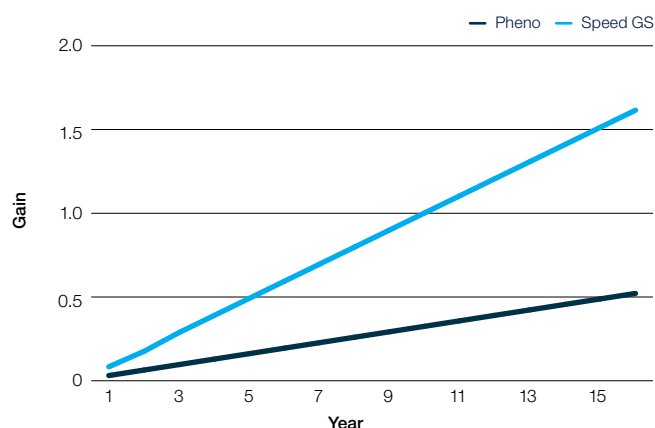
An increasingly important component of the program is the high quality and internationally regarded diagnostic services the team provides to industry.

“Our endophyte diagnostic technologies were developed by the team and it is very satisfying to provide this service to industry, giving our clients the confidence they need to make commercial decisions,” she said.

Kathryn was awarded her PhD at La Trobe University in 2004 for her work on molecular marker analysis of perennial ryegrass before joining Agriculture Victoria Research in 2008.

In her spare time, Kathryn enjoys spending time with her partner and two daughters and exploring her local neighbourhood. Gardening and cooking are her ‘happy places’ and what she does to wind down.

The Endophyte Technologies Program is co-funded by Agriculture Victoria Research, Dairy Australia, the Gardiner Foundation and Heritage Seeds.

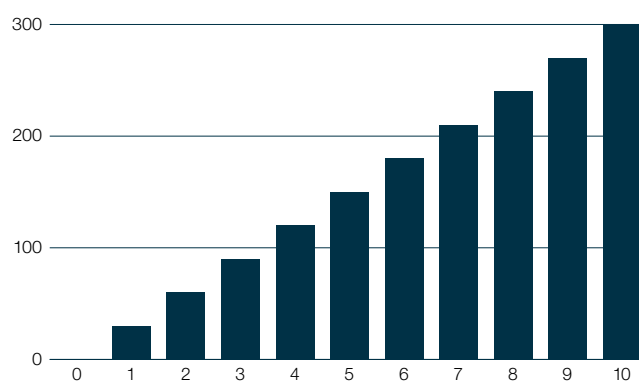


This graph compares the average genetic gain per year for five traits for speed-genomic and phenotypic selection. After 16 years, speed genomic selection is expected to achieve around three fold higher genetic gain compared to the conventional phenotypic selection.

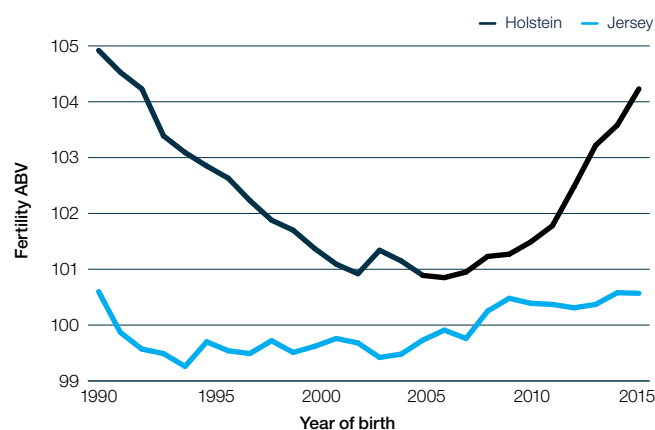
Achieving our targets

- \$350/cow/year
- Genetics permanent and cumulative
- \$300/cow/year achievable in 10 years

Taking a herd to \$300 BPI



Gradual improvement through availability of fertility BV, inclusion in the selection index and good bulls!



ANIMAL PROJECT 1

Enabling multiple generations of highly reliable genomic selection to accelerate genetic gain in dairy cattle

OVERVIEW

Status On track

Expenditure \$1.968 million*

Milestones achieved 6 of 6 (one milestone has a short-term delay to improve final outcome)

**Expenditure for project is shared with Animal Project 5*

ANIMAL PROJECT 2

At the cutting edge: world-leading breeding values and genomic services for the Australian dairy industry

OVERVIEW

Status On track

Expenditure \$0.728 million

Milestones achieved 2 of 2

ANIMAL PROJECT 3

Accelerating improvement in health and resilience, and reducing the environmental impact of the Australian dairy herd

OVERVIEW

Status On track

Expenditure \$0.808 million

Milestones achieved 2 of 2

ANIMAL PROJECT 4

Oversight of existing projects (Improving Herds and MIR for Profit) with a focus on planning future activities

OVERVIEW

Status On track

Expenditure \$0.560 million

Milestones achieved 2 of 2

ANIMAL PROJECT 5

CRV collaboration

OVERVIEW

Status On track

Milestones achieved 4 of 4

**Expenditure for project is shared with Animal Project 1*

ANIMAL PROJECT 6

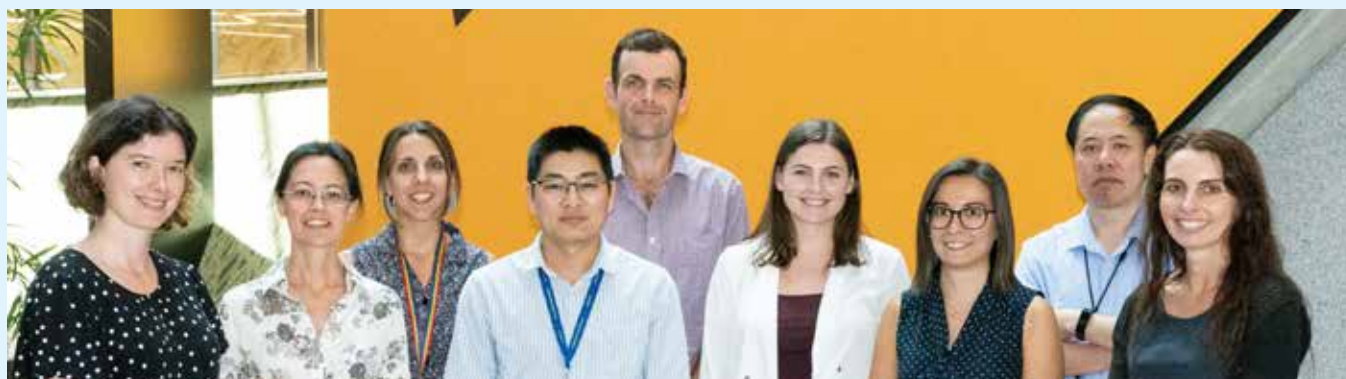
Improved prediction of the daughter fertility breeding value

OVERVIEW

Status On track

Expenditure \$0

Milestones achieved commencing December 2019



Some of the speakers at the special symposium: Dr Jennie Pryce, Dr Valentina Bonfatti (University of Padova), Dr Simone Vassiliadis, Dr Phuong Ho, Dr Tim Luke, Caeli Richardson, Pauline Delhez (University of Liege), Dr Zhiqian Liu and Kathryn Sanders (LIC New Zealand)

About 80 Agriculture Victoria Research staff, industry partners and international scientists attended a special symposium about how metabolomics and genomics are converging in dairy industry research and innovation at AgriBio.

The convergence of these two powerful bioscience disciplines has already delivered important improvements to forage breeding.

Agriculture Victoria Research, in collaboration with industry partners, is now extending this cross-disciplinary, outcome-focused research into applications for dairy herd improvement.

Speakers at the special symposium included visiting scientists hosted by Agriculture Victoria Research at AgriBio, Dr Valentina Bonfatti, Kathryn Sanders and Pauline Delhez, who are world-leaders in applying mid-infrared spectroscopy (MIR) for dairy herd improvement.

Dr Jennie Pryce, a joint appointee of Agriculture Victoria Research and La Trobe University, leads the dairy genomics team at AgriBio, where MIR is used to predict traits of importance for dairy cows (MIR for Profit project).

“Mid-infrared spectroscopy is one of the most transformational technologies we have in dairy science right now – the potential is enormous,” Jennie said.

“The most exciting part is how we can use MIR with metabolomics data, to develop more precise phenotypes for genomic selection.”

Dr Simone Rochfort, a joint appointee of Agriculture Victoria Research and La Trobe University, heads the molecular phenomics team at AgriBio where the metabolome analytical equipment is so sensitive it can measure down to a part per trillion level.

“Metabolomics and proteomics can provide additional molecular phenotype data that can be used to improve phenotype predictions and genomic predictions. This is important because it can provide additional hypotheses for genetic and on-farm management, as well as strengthen selection for desired traits leading to a more robust and profitable system for farmers,” Simone said.

This research is an initiative of the DairyBio and DairyFeedbase joint ventures between Agriculture Victoria Research, Dairy Australia and the Gardiner Dairy Foundation, in collaboration with DataGene.

What is MIR?

Many farmers undertake routine milk tests to evaluate the productivity of their cows. During testing, samples are exposed to infrared light to determine the fat and protein contents of the milk. The mid-infrared spectra from these tests can also provide information about other traits such as fertility, early lactation disease and methane emissions.



Dr Jennie Pryce

DairyBio financial position 2018–19

Cash position	
Opening balance	828,492
Income received	11,929,407
Expenditure	12,196,422
Closing balance at 30 June 2019	561,477

Expenditure	
Forage improvement projects	7,822,724
Animal improvement projects	4,065,660
Education and management activities	308,038
Total expenditure	12,196,422

Notes on the financial position

- Financial position is reported on a cash basis.
- A five-year cash position analysis is routinely provided to the board to ensure that the joint venture remains in a positive cash position.



Profile

DairyFeedbase was established in 2017 as a major investment in transformation of the dairy feedbase. The core investment proposition is to generate step change for Australian dairy farmers through the advanced development, application and deployment of transformational feeding, nutrition and feed management insights and tools.

The aim of DairyFeedbase is to deliver innovations that will transform productivity of the feedbase and ensure the dairy industry is cost competitive as a global dairy producer. DairyFeedbase will improve the management of a high performance feedbase through new management tools, improved on farm decisions and more effective use of resources. It will deliver improved productivity for home grown forages, improved allocation of feed and deliver profitable improvements in cow and herd performance based on improved nutrition.

There are five projects running under three core themes:

Theme 1 Management tools that improve productivity in the paddock

- Improved on-farm agronomy decisions
- Better selection of pasture cultivars

Theme 2 Smarter allocation of feed for each herd

- More effective allocation of existing feed resources
- Reduced economic impact of hot weather

Theme 3 Right feed for each cow

- More profitable individual cow performance from increased feed intake and peak milk yields

DairyFeedbase investors 2018–19

Joint venture partners



Management tools that improve productivity in the paddock		
	Via	Targets
Automated measurement of pasture quantity and quality	↓	1 Increased pasture productivity (more pasture grown, fed and conserved) to deliver a 20% increase in pasture utilisation for 40% of farmers
Alerts and forecasts		
Tools to make effective decisions		2 More confident selection of pasture varieties enables a focus on varieties with 20% more productivity
Improve cultivar selection: innovations for the Forage Value Index		
Smarter allocation of feed for each herd		
Measure intake of each cow	↓	3 More effective allocation of existing farm resources based on new feed allotment methods to increase average lactation value by \$120/cow
New approaches to allocate feed		
Diets for hot weather		4 Reduce economic impact of hot weather by 50%
Right feed for each cow		
Early lactation monitoring of performance and health	↓	5 Increase feed intake in early lactation in a profitable manner that lifts average lactation value by \$300/cow and reduces health costs by \$50/cow
New feeding strategies for peak lactation (First 100 Days)		
New targets for genetic selection (performance and health)		6 Breeding more suitable cows for Australia (via DataGene)

Highlights

All five projects have achieved a number of significant milestones and delivered a range of exciting new innovations for farmers. Critical activities that have been achieved include:

- The PastureSmarts automation of pasture measurement technology and innovation was implemented on six commercial farms in Victoria and South Australia and continues to be run as a pilot trial. The intention is to have a fully developed commercial prototype by December 2019.
- Production of Forage value index results for 2019 have been included in the FVI for farmers and service providers to provide pasture cultivar insights to enable them to select the cultivar best for their farm and farm system to optimise pasture productivity.
- Engaged with commercial partner farms across dairying regions in Australia to investigate the impact of implementing 'cool diets' at the herd level
- Dissemination to farmers of early insights on minimising the impacts of heat stress in cows
- Dissemination to farmers of major outcomes of nutrition work that improved the use of partial mixed rations, formulated grain mixes, and use of key supplements such as canola and maize.

Other achievements

- Completion of defining experiments at Ellinbank for the Smart Feeding, Feeding Cool Cows and First 100 Days projects
- Development of the best approach for pasture forecasting and modelling activities
- Training of staff in new technology required or future experiments (including accredited drone pilots)
- Development of the use of automated sensors (e.g. drones and satellites) for measuring dry matter yield
- Establishment of sentinel paddocks for predicting pasture performance
- Establishment of pasture persistence trials

- Developed understanding the different feed on offer to the first and last cows to return to the paddock to graze
- Development of new sensor technology that can provide more efficient future methods of varietal assessments
- Fast-track the ability to perform sensor-based estimations of pasture dry-matter yield. Production of Forage Value Index results for 2018, including a parallel assessment of new sensor technology that can provide more efficient future methods of varietal assessments.
- Critical development tasks, including reviews of sensor-based methods, forecasting tools, feed allocation improvements, and testing of diets for hot weather.
- Distribution of major outcomes of nutrition work that improved the use of partial mixed rations, formulated grain mixes, and use of key supplements such as canola and maize.

DairyFeedbase regularly publishes new articles online that are available at dairyfeedbase.com.au.

Projects

Five projects operated in 2018–19, under the direction of project leaders. Project descriptions are set out below.

Project	Project leader
1 PastureSmarts	Elizabeth Morse-McNabb
2 FVI More confident selection of pasture cultivars	Kevin Smith
3 Smarter allocation More effective allocation of existing feed resources	Martin Auldist
4 Cool Cows Reduced economic impact from hot weather	Leah Marret
5 First 100 Days More profitable individual cow performance from increased feed intake and peak milk yields	Bill Wales

Project status and snapshots

PROJECT 1

PastureSmarts

OVERVIEW

Status On track

Expenditure 1.974 million

Milestones achieved 9 of 12

New milestone added, 3 milestones delayed 6 months to accommodate commercial trial

PROJECT 2

FVI – More confident selection of pasture cultivars

OVERVIEW

Status On track

Expenditure 0.914 million

Milestones achieved 5 of 5

PROJECT 3

Smart Allocation – More effective allocation of existing feed resources

OVERVIEW

Status On track

Expenditure 1.513 million

Milestones achieved 6 of 6

PROJECT 4

Cool Cows – Reduced economic impact from hot weather

OVERVIEW

Status On track

Expenditure 1.519 million

Milestones achieved 2 of 2

PROJECT 5

First 100 days – More profitable individual cow performance from increased feed intake and peak milk yields

OVERVIEW

Status On track

Expenditure 2.245 million

Milestones achieved 6 of 6

Diet the key to increasing milk yield

Ellinbank, AgriBio and Tatura

Agriculture Victoria Research scientist Dr Bill Wales is leading world-first research into dairy cow nutrition that could see the average annual milk yield per cow increase by more than 60 per cent within the next five years.

Based at Agriculture Victoria Research's Ellinbank centre, Bill leads a 35-person research team across Agriculture Victoria Research sites at Ellinbank, AgriBio, Tatura and Warrnambool.

"During my 30 years with the department my focus has been on improving the relationship between dairy cow nutrition, physiology and milk production," Bill said.

Bill is currently spearheading the First 100 Days of Lactation project, a five-year DairyFeedbase initiative that could significantly increase the profitability of Australia's dairy industry

"This project involves assembling different feed supplements to increase peak milk yield of dairy cows and maintain the peak milk yield for longer.

"Through manipulating diet, this project has enormous potential for improving the profitability of the dairy industry by allowing dairy farmers to maximise their milk solids.

"In five years' time we will increase peak milk yield, the duration of peak milk yield, and fat and protein concentrations, and also identify early lactation diseases and management strategies, using the unique facilities at Agriculture Victoria Research's Ellinbank SmartFarm with support from national and international collaborations.

"Current pasture-based systems restrict milk yield to 6,000 litres per cow per year. Through optimising supplement feeding, there is potential to increase milk yield to 10,000 litres per cow per year," he said.

A career highlight for Bill has been supporting Agriculture Victoria Research's world-first heat tolerance research as part of a DairyBio project.

"We validated a genomic test for heat tolerance that was developed by Agriculture Victoria Research scientists at AgriBio and found that, due to physiology, individual cows are fundamentally different in their ability to cope through a heatwave.

"A significant outcome from this research is that farmers can now identify and select animals based on heat tolerance.

"One of the big highlights was the opportunity to collaborate internally and externally and make a significant impact on the industry."

Bill worked for 21 years at the department's former Kyabram site before relocating to Ellinbank nine years ago.

Bill is also working on the Cool Diets DairyFeedbase project, assessing supplements, forages and additives commonly fed to dairy cows for their ability to maintain a lower body temperature during heatwaves, with the aim of assembling diets that keep cows cool through summer.

At Ellinbank, Bill has rebuilt the dairy nutrition capability and has seen the team increase from one research scientist to 12.

Dairy is a key agricultural industry in Victoria, accounting for more than 65 per cent of annual national milk production and 79 per cent of Australia's dairy exports worth \$1.9 billion in 2017–18.

DairyBio and DairyFeedbase are joint initiatives for the dairy industry between Agriculture Victoria Research, Dairy Australia and the Gardiner Dairy Foundation.



Sensor technology on dairy cows at Agriculture Victoria Research's Ellinbank SmartFarm



Dr Bill Wales discussing dairy cow nutrition research in Agriculture Victoria Research's dairy facility at Ellinbank

Pasture Smarts team comes together



Dr Anna Thomson, Dr Elizabeth Morse-McNabb and Dr Senani Karunaratne at Agriculture Victoria Ellinbank research centre

Three new scientists have joined Agriculture Victoria Research at the Ellinbank research centre to implement the DairyFeedbase Pasture Smarts project.

As part of the five-year project (2018–2023), Agriculture Victoria Research scientists will develop non-destructive technologies to forecast pasture performance, rapidly and accurately measure forages at a paddock scale, and assess pasture dry matter yield and nutrients.

These technologies will enable farmers to grow and utilise more pasture and make more informed pasture management decisions.

Here we introduce three new scientists to the team and their contribution to the project.

Dr Elizabeth Morse-McNabb

Elizabeth will lead the implementation of the Pasture Smarts project, initially focusing on the development of smart tools for measuring and predicting pasture performance. These tools will enable farmers to better allocate their pasture and profitably increase pasture utilisation at a farm scale.

Elizabeth has expertise in spatial sciences, satellite sensor technologies and data integration.

Dr Senani Karunaratne

Senani will use data from sensor technologies to predict biomass and nutritive quality of perennial ryegrass. He will also use modern data-mining and machine learning algorithms to perform predictive modelling work.

Senani joins us from the University of Sydney where he researched digital soil modelling and mapping, soil carbon, simulation modelling, climate change and spatial modelling.

Dr Anna Thomson

Anna will use advanced sensors in dairy production systems to provide real-time data on pasture availability and animal nutrition to farmers. She will integrate this data with feed allocation technologies, allowing farmers to utilise their resources more efficiently.

Anna joins us from the University of Reading (UK) where she researched complex mixed-species pasture as a productive, nutritious and environmentally-beneficial source of forage for grazing cattle.



DairyFeedbase financial position 2018–19

Cash position	
Opening balance	3,115,499
Income received	4,225,000
Expenditure	8,166,459
Closing balance at 30 June 2019	(825,960)

Expenditure	
Project expenditure	8,166,459
Total expenditure	8,166,459

Notes on the financial position

- Financial position is reported on a cash basis.
- A six-year cash position analysis is routinely provided to the board to ensure that the joint venture remains in a positive cash position.





DairyBio commercialisation activities

Forage Projects 1 and 3

- AVS, DBMC and the commercial Project Partner, the Royal Barenbrug Group, advanced a commercialisation plan to deliver the first superior, F₁ hybrid *perennial ryegrass* products with improved herbage yield in Australia and New Zealand. The Plan also contemplates the delivery of other DairyBio technologies in an integrative manner, including genomic selection and gene editing in the Barenbrug ryegrass and tall fescue pipelines.
- Following population field trials to identify heterotic groups in perennial ryegrass, parental pool combinations have been determined for test-crossing to generate the best F₁ hybrid populations and planning is underway for the staged transfer of fifty first generation F₁ *perennial ryegrass* hybrid parental pools to Barenbrug Agriseeds by June 2021.
- An analogous timeline for the delivery in Australia and New Zealand of F₁ hybrids for short-term ryegrass is also now under development.
- Barenbrug also reported that company's plans for meeting seed certification requirements for future commercial perennial ryegrass F₁ hybrid products are on track.

Forage Projects 1 and 3

Genome edited perennial and short-term ryegrass

- AVS and Barenbrug commenced commercialisation planning for the future evaluation and commercial release of gene-edited perennial ryegrass events, aligned with the agreed DBFP1&3 Licence Rights Frameworks. This followed Barenbrug formally advising AVS that it wished to invoke its licence option to negotiate a non-exclusive licence for DairyBio genome edited perennial ryegrass events, specifically populations of *perennial ryegrass* with gene edits of key lignification and/or pollen allergen genes.
- Licence option invocation terms were agreed between AVS and Barenbrug and, following the planned DairyBio delivery of gene-edited ryegrass populations in June 2021, AVS and Barenbrug will annually meet to devise and review a commercial evaluation and development strategy and agree upon the final terms of a Licence Agreement for the commercial release of novel *ryegrass* edited products.

Forage Project 6 Beneficial microbiomes – perennial ryegrass and tall fescue

- The DairyBio Forage Microbiomes Project has led to the discovery and characterisation of eight (8) novel *Lolium*-derived bacterial strains, for complementary industry and commercial benefits, to assist varietal development and seed production for global pasture, turf and lawn grass production (for improved production, environmental and amenity outcomes).
- A Commercialisation (Agency) Agreement was signed by DJPR (Agriculture Victoria), Dairy Australia, The Gardiner Foundation and Agriculture Victoria Services Pty Ltd on 30 April 2019 to commercialise these project outputs.

Forage Project 7 High energy ryegrass

AVS and the DBMC continued to monitor the Material Transfer Agreement reporting obligations of FAUBA in the conduct of animal performance field trials of the technology by FAUBA in Argentina under a dairy grazing regime with sheep and cattle.

Animal Project 1 Genomic selection

Executed a Project Agreement consistent with terms agreed by the DairyBio Board in February

Completed an exchange of letters with DataGene to ensure that there is appropriate commitment of resources from DataGene and clarity of roles of each party to deliver timely impacts from each project output.

Animal Project 2 Improve existing traits

Executed a Project Agreement consistent with terms agreed by the DairyBio Board in February

Completed an exchange of letters with DataGene to ensure that there is appropriate commitment of resources from DataGene and clarity of roles of each party to deliver timely impacts from each project output.

Animal Project 3 New traits

Executed a Project Agreement consistent with terms agreed by the DairyBio Board in February

Completed an exchange of letters with DataGene to ensure that there is appropriate commitment of resources from DataGene and clarity of roles of each party to deliver timely impacts from each project output.

Education and engagement

Education

Across both programs, there are 21 active higher degree by research (HDR) students engaged. This will increase over the 2019–20 year as DairyFeedbase students come online under the Centre of Agricultural Innovation initiative setup with Melbourne University. Mentoring and communication programs are in place to develop the complete skill set of students as they undertake their studies. All milestones are on track in terms of education.

Summary information regarding the destination in industry of graduating students is provided in this report.

Engagement

There were a range of engagements with next user and farmer groups throughout the financial year 2019. This included a range of dedicated presentations and inclusion of innovation messages for both DairyBio and DairyFeedbase. Communication planning and measurement of engagement is being developed with the communications team at Dairy Australia.

As part of the Engagement Program we have a professional development program for PhD students and early career researchers. The aim of this program is for students (and Early career Researchers) to broaden their skillset beyond the science. Students are encouraged to take on new challenges and to develop self-awareness, collegiality, problem solving and entrepreneurial skills. Therefore, DairyBio HDR students undertake one activity from five development modules per annum.

- **To be part of the DairyBio community** to be an active participant in DairyBio events, such as, forums, social gatherings, graduation afternoon teas etc.
- **To be an effective communicator** such as, attend communication workshops on offer through universities, involvement in the three minute thesis annual competition. Some of our PhD students are engaged as demonstrators for the *Get into Genes* program (GIG). These activities expand the students communication skills.
- **To be job ready** engage in the mentoring program on offer, undertake workshops through universities, such as, La Trobe University's Career Ready program.
- **To understand and connect to the dairy industry and supply chain** site visits to companies like the Chobani yoghurt factory tour late last year, organised by DA.
- **To be an expert scientist/researcher** participation in the Systems Biology Workshop AVR offers every year in May. Presentations at international conferences, supported by DA and AVR.

DairyBio students were provided with a calendar of events which highlights the workshops, forums, industry events, scientific conferences that are on offer in a given year.

OVERVIEW

Status On track

Expenditure 0.308 million

Milestones achieved 6 students graduated
21 students commenced or continuing
100+ dairy industry visitors
4,337 students and teachers in *Get into Genes*



PhD student poster presentations



Mijail Andrei
Karpyn Esqueda
PhD La Trobe University

PhD research Bioassays for assessing effectiveness of epichloë-endophytes in pasture pest control

Current role Program Support – Feedbase: Farm Profit and Capability, Dairy Australia

“The DairyBio education program offers a range of skill training for research students wishing to further their careers by undertaking a PhD candidature. From the purely academic research structure of the university to the engagement with stakeholders that want to see the research been applied into the real world to solve real problems. The DairyBio program has opened the door for me to explore the different job opportunities that exist for a PhD graduates. I have found my calling in extension and science communication. I seek to be the bridge between scientists and stakeholders to better communicate the science and translate this knowledge into practical terms. Ultimately, I would like to contribute to the industry by improving productivity, increasing adoption, instating best practice, and identifying and addressing the gaps in the current system.



Rafael Narancio
PhD La Trobe University

PhD research Transgenic white clover plants with a molecular stack of traits for delayed leaf senescence, aluminium tolerance and alfalfa mosaic virus resistance. Generation and molecular and functional characterisation

Current role Research Scientist, National Institute of Agriculture Research (INIA), Uruguay

As a Dairy Futures CRC and DairyBio student, I was able to visit dairy farms, and interact with farmers and industry leaders. This provided me with the possibility of learning how the Australian dairy industry works and understand its major demands. Furthermore, I was also able to expand my professional network as a consequence of these connections.

The DairyBio program also allowed me to have a more fluent interaction with other PhD students and scientists, which was highly relevant in order to exchange research ideas and experiences during the course of the project.



Priyanka Reddy
PhD La Trobe University

PhD research Development of screening assays for determining toxicity of grass-associated fungal endophytes

Current role Research Scientist, Agriculture Victoria

The Dairy Futures CRC and DairyBio education program provided opportunities for personal and professional development that enabled me to participate in competitions such as the CRCA (Co-operative Research Centre Association where I was one of five finalists from across Australia to present at the Australia 2040 Symposium.

Particular highlights were attendance to international conferences, training in intellectual property, and learning about the broader science happening within the DFCRC from other PhD students. Also with the support of the Dairy Futures CRC and DairyBio I was able to present my research at the AOMSC (Asia Oceania Mass Spectrometry Conference) in Singapore. The mentoring program in the DFCRC also provided me the skills to network with research leaders and peers in the field.

DairyBio PhD students

In financial year 2018–19, 29 PhD students undertook graduate research in dairy science through the DairyBio PhD Program.

Successful PhD students

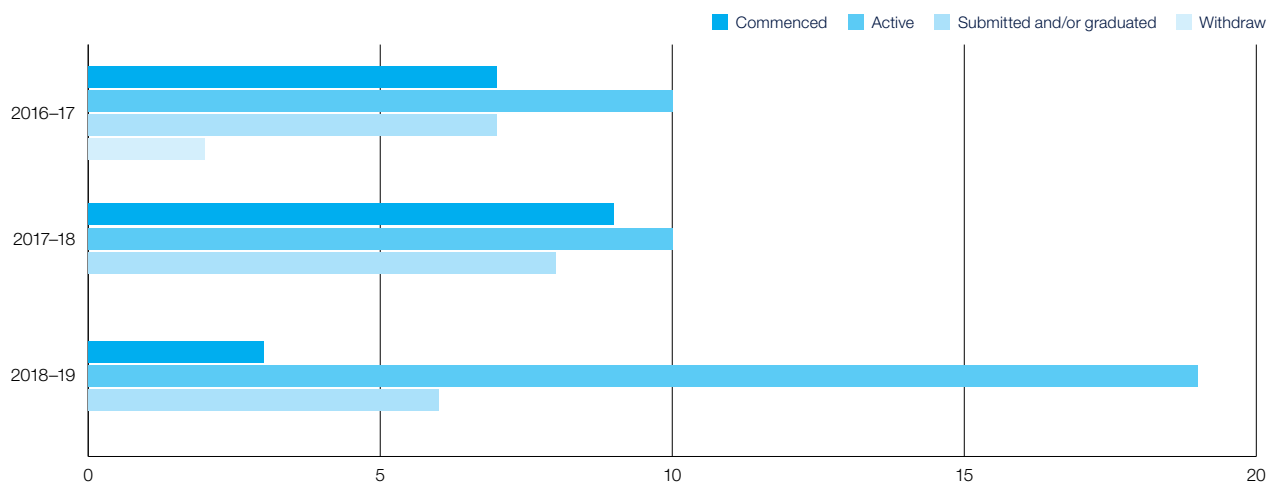
Name	Research topic	University	Academic supervisor	Dairy industry mentor
Min Wang	Using functional information to improve the accuracy of genomic prediction	School of Applied Systems Biology, La Trobe University	Prof Ben Cocks	Aubrey Pellett Gippsland dairy farmer
Natasha Brohier	Development and implementation of genome editing technology for modification of fungal endophytes of pasture grasses	School of Applied Systems Biology, La Trobe University	Dr Noel Cogan	Lee-Ann Monks DataGene Marketing and Communications Manager
Victoria Russo	The impact on dairy cow production during the transition between pasture and forage supplements in systems in Ireland and temperate Australia	The University of Melbourne	A/Prof Martin Auld	TBC

Current PhD students

Name	Research topic	University	Academic supervisor	Dairy industry mentor
Nicholas Collinson	Investigating tri-trophic interactions between insects, endophytic fungi and pasture grasses	School of Applied Systems Biology, La Trobe University	Dr Mallik Malipatil	Brian Anderson Gippsland dairy farmer
Ian Tannenbaum	Perennial ryegrass microbiome discovery and application	School of Applied Systems Biology, La Trobe University	Dr Tim Sawbridge	Peter Thurn, Breeding, Genetics Australia Genetics and Production Manager
Tongda Li	Molecularly characterise fungal and bacterial microbiome enhanced associations of perennial and short-term ryegrasses for improved pasture performance	School of Applied Systems Biology, La Trobe University	Dr Tim Sawbridge	Tim Humphries Tongala dairy farmer
Paula Giraldo	Field evaluation of transgenic high-energy ryegrass under grazing	The University of Melbourne	Dr Noel Cogan	Cath Lescun, Dairy Australia Feedbase and Animal Nutrition Development Manager
Meaghan Douglas	To determine optimal supplementary feeding strategies at four key stages of pasture growth for lactating dairy cows in pasture-based systems	University of Sydney	Prof Bill Wales	TBC
Alem Gebremedhin	Advanced phenomic tools for molecular breeding of yield improvement in ryegrass	The University of Melbourne	Prof Kevin Smith	Matt Reid Carlisle River dairy farmer
Jigme Dorji	Role of the X chromosome and mitochondrial DNA in the prediction of dairy traits and understanding cow families	School of Applied Systems Biology, La Trobe University	Dr Hans Daetwyler	Tony Francis formerly DataGene Software Services Manager
Caeli Richardson	Incorporation of international data in breeding programs for evaluation of novel traits: feed efficiency & methane emissions	School of Applied Systems Biology, La Trobe University	Dr Jennie Pryce	Craig Lister Calvil dairy farmer and DataGene director
Claire Prowse-Wilkins	Functional genomics to discover biologically relevant regulatory variation	The University of Melbourne	Prof Mike Goddard	Tony Francis formerly DataGene Software Services Manager
Evans Kiptoo	Genetic aspects of heat tolerance in Australian dairy cattle	School of Applied Systems Biology, La Trobe University	Dr Jennie Pryce	To be allocated

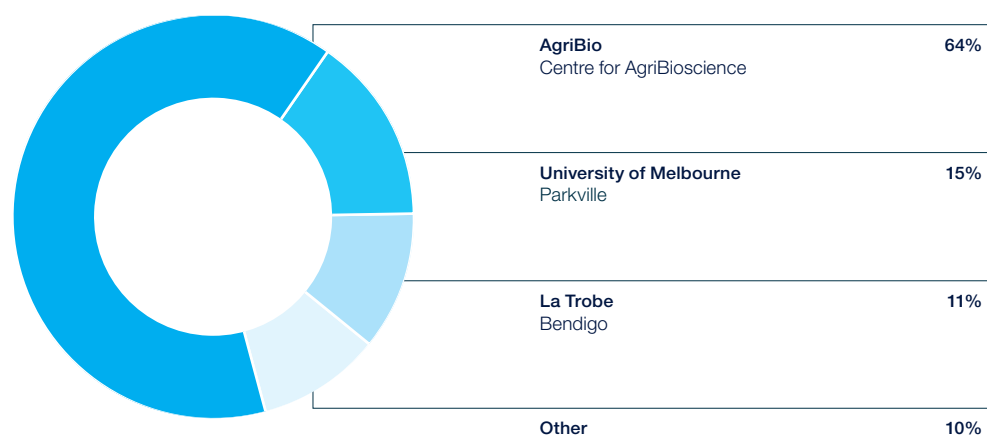
Name	Research topic	University	Academic supervisor	Dairy industry mentor
Tim Luke	Digestive microbiome in healthy, productive dairy cows	School of Applied Systems Biology, La Trobe University	Dr Jennie Pryce	To be allocated
Beth Scott	Optimising the use of genomics on-farm	School of Applied Systems Biology, La Trobe University	Dr Jennie Pryce	Richard Shephard Herd Health Managing Director
Sailajah Vishwanathan	Advancing genotyping – by-sequencing and genome resources for perennial ryegrass	School of Applied Systems Biology, La Trobe University	Dr Noel Cogan	Travis Wild Chobani CFO
Saba Rabab	Genomic selection using novel forage phenomics for perennial ryegrass	School of Applied Systems Biology, La Trobe University	Dr Hans Daetwyler	Cath Lescun, Dairy Australia Feedbase and Animal Nutrition Development Manager
Chaya Smith	Forage nutritive quality predictions using novel forage phenomics for perennial ryegrass	School of Applied Systems Biology, La Trobe University	Dr Noel Cogan	Naomi Pye Gardiner Dairy Foundation Director
Krishni Fernando	Metabolomics and bioactivity – the novel chemistry of endophyte – perennial ryegrass symbiota	School of Applied Systems Biology, La Trobe University	Dr Simone Rochfort	Ron Paynter Ellinbank dairy farmer
Chinthaka Jayasinghe	Genomic and phenomic indicators of persistence in perennial ryegrass cultivar evaluation	The University of Melbourne	Prof Kevin Smith	To be allocated
(Tan) Phat Nguyen	Phenome-informatics: Development of an integrated data acquisition and analysis system for a ground-based forage phenomics platform	School of Applied Systems Biology, La Trobe University	Dr Hans Daetwyler	To be allocated
Nima Norbu	Use of on-cow sensors for the measurement of dry matter intake of grazing cows	The University of Melbourne	Prof Brian Leury	To be allocated
Cheng Li	Dairy21 – Lipidomics of bovine milk and plasma	School of Applied Systems Biology, La Trobe University	Dr Simone Rochfort	To be allocated
Shilja Shaji	DairyFeedbase Feeding Cool Cows – Experiment 2: Effects of feeding different grains on body temperature and milk production of heat stressed dairy cows	University of Western Australia	Dr Leah Marett	NA as visiting Graduate Researcher

Higher degree by research student cohort overview



As at 31/12/2019, DairyBio/DairyFeedbase has engaged 48 Higher Degree Research students through it's program. To date 26 have graduated.

Participant location 2019



Get into Genes program workshops – Q1 2019

Location	Participants	Students	Teachers	Girls	Boys	Total sessions
Metropolitan	3428	3205	223	2102	1047	124
Regional	189	171	18	105	66	13
Total	3617	3376	241	2207	1113	137

The content of this publication including any statements regarding future matters (such as the performance of the dairy industry or initiatives of DairyBio) is based on information available to DairyBio at the time of preparation. DairyBio does not guarantee that the content is free from inadvertent errors or omissions and accepts no liability for your use of or reliance on this document. You should always make your own inquiries and obtain professional advice before using or relying on the information provided in this publication, as that information has not been prepared with your specific circumstances in mind and may not be current after the date of publication.

© DairyBio 2020. All rights reserved.

ISSN 2209-1424

DairyBio ABN 24 141 180 805

AgriBio, Centre for AgriBioscience
5 Ring Road, La Trobe University
Bundoora, Vic 3083
dairybio.com.au

