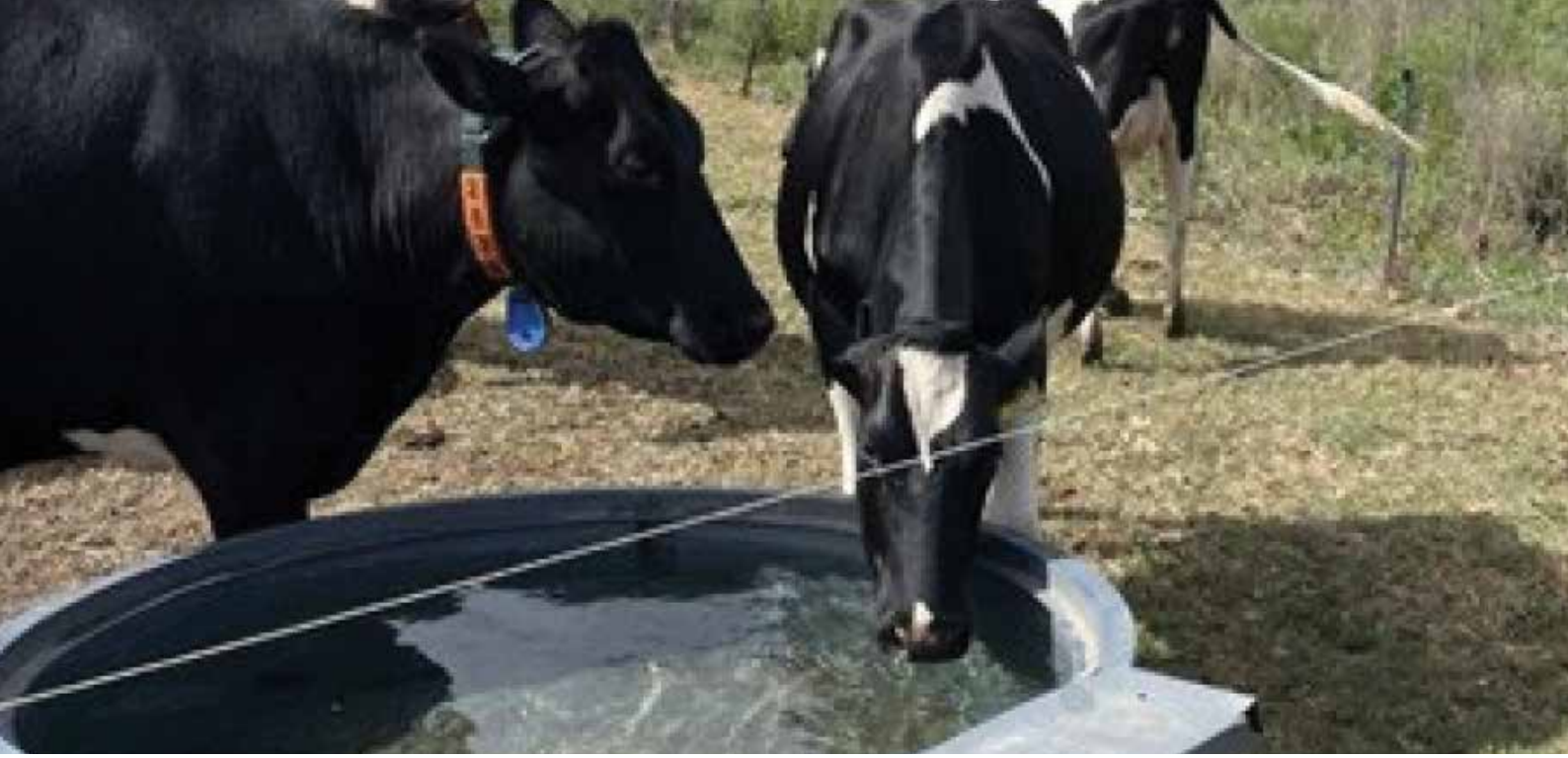


Project Update

P6a Resilient cattle (heat tolerance)

Managing dairy cattle in hot, humid conditions is an increasing issue for the Australian dairy industry, with climate change and the trend towards intensification. Improving heat tolerance in dairy cattle has benefits for both the business (maintaining production and reproductive performance in hot months) and animal welfare (improved cow comfort in hot conditions).

Under the supervision of Dr Anna Chlingaryan, Dairy UP PhD student, Alice Shirley, explored the diversity in dairy cattle responses to heat events. By collaborating with DairyBio and DataGene, the outcomes of this work will contribute to developing an improved tool for breeding dairy cattle with improved heat tolerance.

Heat Tolerance ABV

Published by DataGene, the Heat Tolerance Australian Breeding Value allows farmers to identify and breed animals with greater ability to tolerate hot, humid conditions with less impact on milk production.

The current Heat Tolerance ABV is derived from genomics only – the DNA testing of animals. It has a relatively low reliability which has contributed to slow uptake by farmers.

This Dairy UP project aimed to develop phenotypes for heat tolerance to add to the model for the Heat Tolerance ABV. Phenotypes are indicators of animal performance that can be measured in commercial animals. Combining genomics with traditional and new measures of heat tolerance should improve the reliability (accuracy) of the Heat Tolerance ABV.

Collecting phenotypes with sensor technology (Dairy UP)

The Dairy UP team analysed data from innovative sensor technologies (core body temperature) through advanced statistical methods.

Data automatically downloaded via API were used to build animal-level datasets to improve our understanding about which animals are more susceptible to heat.

Data, Advanced Technology and Automation (DATA)

Dairy UP's P6 project is exploring ways to use existing farm, climate and industry data to develop ways to monitor cows and systems. Reports and tools based on this data could be used by farmers to make better decisions, for example about heat management, health and feeding.

Copious volumes of data are collected across the Australian dairy industry. Until now this has been stored in numerous, separate data bases.

This project aims to utilise data, advanced technologies and automation to integrate information from multiple sources to enable the creation of tools that support on-farm decisions.

P6 is a suite of three projects that combine animal science and data science. Each project is being undertaken by a PhD student.

P6a: Resilient Cattle (heat tolerance).

P6b: Resilient Cattle (health): early intervention for improved animal health, enabled by advanced sensing.

P6c: Digital Feeding – data-driven feeding to optimise grain allocation in pasture-based herds.

This document provides an overview of Project P6a Resilient Cattle (heat tolerance).

Data was collected from cows on three Australian pasture-based dairy farms fitted with rumen sensors (reticuloruminal boluses) to monitor core body temperature, every 10 minutes, 24 hours a day. A total of 1429 animals were involved in this research, plus 28 heifers from the University of Sydney farm in NSW.

In addition, climate data from the past 20 years was obtained from the Bureau of Meteorology to match the observations from the cows.

A water threshold model was developed to account for water intake, isolating the impact of drinking events on core body temperature.

Drinking behaviour

Analysis of the sensor data confirmed significant variation between individual animals' reticulorumen temperature (core body temperature) and their drinking behaviour over time. This work also demonstrated the core body temperature of cattle increased at lower Temperature and Humidity Index (THI) levels than previously thought.

For example, the rumen sensors were indicating a rise in core body temperature at 67 THI. Until now, it has been recommended that herd managers prepare for a heat stress event at 70 THI, with negative effects on production expected at 75 THI.

The research also confirmed that cows drink more often during summer and less in winter. As expected, cows in herds in warmer regions also returned to the trough to drink more times, on average, in a day compared to those in cooler climates.

Further analysis found that drinking behaviour can be used as a reliable indicator of heat stress. Drinking was a consistent behavioural response to cope with internal and external heat. Those animals that drank more often during rising THI displayed a decline in reticuloruminal temperature. They were also able to maintain production under higher internal temperature. These findings open up new opportunities to integrate additional phenotypic indicators into the genomic-only model currently used to calculate the Heat Tolerance ABV, thereby improving its reliability.

Enhancing phenotype calculation (Dairy UP)

The Dairy UP team developed a hybrid artificial intelligence (AI)-based model (HAIM) to improve the assessment of heat tolerance in dairy cattle.

They used machine learning techniques and 20 years of historical climate and dairy cattle production data to enhance the heat tolerance phenotype calculation.

Traditional methods for determining heat tolerance in dairy cattle involve statistical models that use the rate of decline in milk yield as Temperature-Humidity Index rises above 60. Dairy UP's HAIM combines the predictive capabilities of machine learning algorithms with these established statistical models, allowing for the detection of intricate relationships within the extensive data.

The HAIM revealed patterns that might remain hidden when using traditional models alone, enhancing the understanding of heat tolerance in dairy cattle and the identification of more heat-tolerant animals.

The traditional statistical method and HAIM model overlapped in identifying 84% of heat tolerant animals, but the HAIM replaced about 8% of the cows that weren't identified with the statistical method, while accounting for a greater proportion of the total observed variability (i.e. increasing accuracy).

Combining phenotypes and genotypes (DairyBio)

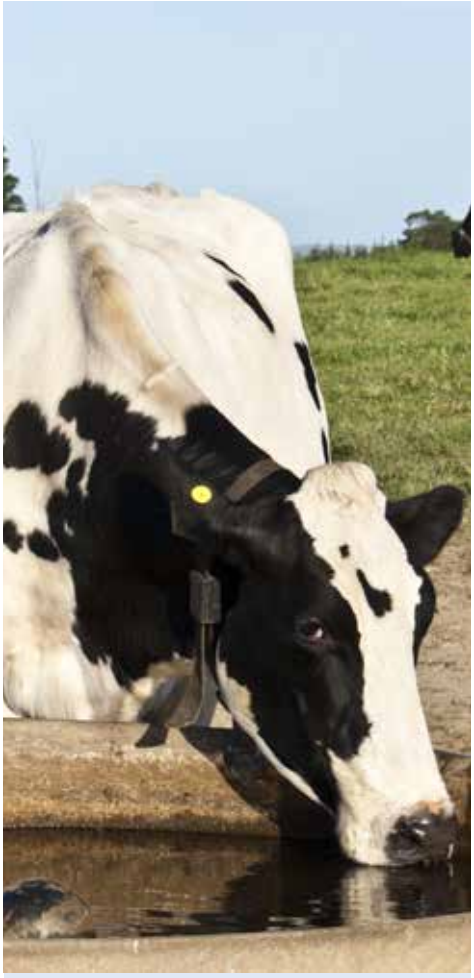
This collaborative project is being undertaken by DairyBio and La Trobe University PhD student, Laura Jensen under the supervision of Professor Jennie Pryce.

This project combines the genetic and performance data from animals with a variety of approaches including the sensor technologies from the Dairy UP project.

This information may allow the model for the Heat Tolerance ABV to be extended to incorporate sensor phenotypes which could help to identify animals that better tolerate hot and humid conditions with less impact on their milk production.

Sensors are one example of new research methods that could improve how we select for heat tolerance, capturing its full complexity.

Success in this area will come from collaboration among animal scientists, combining genomics with traditional and new measures of heat tolerance.



Collaboration

Dairy UP

DairyBio (Dairy Australia, Gardiner Foundation & Victorian Government)

DataGene

Charles Sturt University

SmaXtec

University of Sydney

More info

Project lead

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Published articles

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Shirley A. K. et al (2024) Review: Ruminant heat- stress terminology. Animal Volume 18, Issue 9.

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