Final Project Summary
P9a Producing milk with less lactose

May 2026

Climate change is increasing pressure to produce food with less water. As milk is 87% water, producing milk with less water is an opportunity for the dairy industry to improve its carbon footprint, reduce energy costs and improve water use efficiency. This could create more value and profit along the supply chain.

This project aimed to find ways to produce cows' milk with high concentrations of solids.

Lactose was the focus of this work as it plays a key role in determining milk's water content.

The project investigated the theory that those cows that produce less lactose would produce milk with less water and higher concentrations of solids (fat and protein), reducing transport, processing costs, and resource use.

Potential benefits

Lactose has broad roles in the physiology of the dairy cow, which means the potential to influence lactose production has a wide range of potential benefits.

Unlocking the potential of cows

Milk underpins the dairy industry. Getting more from this precious commodity has the potential to increase its value throughout the supply chain.

The Dairy UP team investigated novel ways to get more value from milk.

There were three elements to this research:

- P9a: Producing milk with less lactose
- P9b: Milk as an indicator of heat load
- P9c: Adding value to dairy waste

This document provides an overview of P9

Animal performance, health and welfare
It takes a lot of energy for a cow to produce lactose so reducing the production of lactose could improve the energy balance of the cow, especially during the transition period. Improved energy balance could also have a role in reproduction and fertility.

Lactose is also associated with some animal health traits. For example, milk lactose content could be used to monitor or detect mastitis and ketosis in dairy cows.

Farm labour
If reducing lactose production means cows produce milk containing less water, it may be possible to reduce the frequency of milking. This could provide a labour-saving opportunity.

Processing and transport
A reduction in milk volume could also lead to more efficient transport – carting less water or volume overall – and gains in the processing sector.

Key findings

Out of a dataset of more than 30,000 cows, researchers identified 80 individuals that consistently produced milk with about 15% less water and lactose content or lactose yield while maintaining similar fat and protein levels.

Heritability estimates suggest the trait has a meaningful genetic component, indicating that breeding selection is feasible.

The potential scale of impact is substantial: a 1% reduction in lactose across the national herd could reduce milk transport volumes by about 80 million litres annually — saving an estimated 2,700 truck trips and 20,000 litres of water per farm per year.

Although the underlying molecular mechanisms have not been confirmed, the work established an evidence-based foundation for a genetic selection program.

The findings also highlight the potential to develop management strategies to influence lactose production and enhance the milk production efficiency of cows and potentially reduce their environmental impact.

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P9 final report

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Research and results

This project built on earlier work in California led by Dairy UP collaborator Prof Russ Hovey that demonstrated it is possible to reduce the lactose in milk production without negatively affecting the total milk solids output. To identify potential management interventions to reduce lactose production, Dairy UP researchers investigated the factors that influence lactose secretion in the cow, for example milk composition, genetics and environmental conditions.

There were two elements of this project. The first project investigated the impact of genetics and other management or environmental influences. It involved creating and analysing a large-scale dataset from Dairy UP monitor farms, NSW herd test results and DataGene's Central Data Repository.

The second was research to better understand lactose synthesis in the dairy cow and how it is regulated. This work was being undertaken at the University of California, Davis, USA.

What influences milk lactose levels?
To understand the factors affecting lactose production the team examined datasets of herd records, genetic data for dairy sires and meteorological records. Spanning 14 years (2008-2022) the dataset included 393,772 herd records from 33,280 cows in 85 herds, representing 5% of the NSW herd records.

The following summarises some of the high-level findings about the factors affecting lactose production in Australian dairy cows.

Parity (number of calvings)
The lactose percentage was higher for heifers throughout their lactation but their total lactose yield wasn't (because heifers' total milk yield per lactation is less than mature cows).

Stage of lactation
Stage of lactation had a strong impact on lactose output, peaking in early lactation and decreasing as the lactation progressed (similar to the milk yield curve).

Seasonal conditions
Hot, humid weather negatively affected yield of milk, lactose and milk solids but it did not affect lactose percentage or other milk components. A decline in milk yield, lactose yield and protein

yield coincided with severe drought conditions from 2016.

Breed

Holsteins had the highest lactose yields. Jerseys had the lowest lactose yields and produced more milk solids per unit of lactose. This finding wasn't surprising given that Jerseys are well recognised for producing milk with higher concentrations of solids for a given volume of milk compared with other dairy breeds like Holsteins.

Genetic link

Building on these findings, DairyUP researchers determined that lactose traits have a meaningful genetic component.

Heritability estimates for lactose yield and lactose percentage ranged from 0.24 to 0.33. This suggests that genetic selection for improved lactose efficiency is feasible.

A cohort of 80 high-efficiency cows was identified. These cows consistently produced milk with a high ratio of milk solids yield to lactose yield, delivering equivalent milk solids output to the broader population with approximately 15% less lactose and water volume.

These animals were descendants of 13 sires spanning Jersey, Holstein, and crossbred lines, suggesting that the relevant genetic variation is already present within the commercial population.

All the female descendants of these sires produced a similar milk yield, but with more fat, and showed a trend towards lower protein production. There was no difference in daughter fertility.

An enhanced methodology for identifying high-efficiency cows was subsequently developed and validated on a Dairy UP dataset, identifying a cohort of 90 cows. Blood and milk samples have been collected from some of these animals. DNA and milk LALBA concentrations are being analysed to identify genetic variants associated with the high-efficiency phenotypes.

Lactose synthesis

A 'proof of concept' study showed it is possible to change the proportion of lactose in milk without affecting fat and protein production.

The study involved Holsteins in a total mixed ration farming system that were on their second calf and at peak lactation.

It demonstrated that a single treatment with the drug dexamethasone temporarily reduced the amount of lactose in the cow's udder. Fat and protein production increased in response to the treatment as milk volume decreased.

Blood and milk samples were collected from some of these animals. DNA and milk alpha-lactalbumin concentrations were analysed to identify genetic variants associated with the high-efficiency animals.

The team uncovered a possible explanation for this finding. Advanced genetic testing pointed to a regulatory molecule involved in lactose synthesis (alpha-lactalbumin) that was suppressed by the dexamethasone treatment.

This finding offers new insights for researchers to better understand the factors regulating milk yield (volume) relative to the fat and protein content which could lead to interventions.

Priorities for future research

Priorities for future research could include:

- Genetic marker discovery: associated with elevated ratio of milk solid yield to lactose yield.
- Molecular characterisation: to confirm the proposed biological mechanism.
- Early-life predictors of long-term lactose efficiency.
- Economic and systems modelling of on-farm and industry impact of selecting for lower lactose production.

DairyUP
Unlocking potential

Collaborators

This project was a collaboration between Dairy UP researchers based at the University of California Davis (USA), DPI NSW and the University of Sydney. A large proportion of the herd records were provided by DataGene.

Read more

J.I. Gargiulo, et. al., Sources of variation underlying the production of lactose by dairy cows, Journal of Dairy Science, Volume 108, Issue 4, 2025, Pages 4403-4421.

Sadovnikova A, et. al. Transcriptomic changes underlying glucocorticoid-induced suppression of milk production by dairy cows *Frontiers in Genetics* Volume 13 - 2022

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Delivery organisations

The University of Sydney Dairy Research Foundation | NSW Department of Primary Industries | Scibus | Dairy Australia

Partner organisations

NSW Farmers Growing the best | eastAUSmilk | Dairy NSW | Dairy Australia | AFMH | Leppington Pastoral Company Pty Ltd | NSW Local Land Services | Norco

Additional program supporters, collaborations or partnerships

Charles Sturt University | DairyBio | DataGene | Eagle Direct | Entegra
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