Final Project Summary
P4: Feedbase – Maize for silage

May 2026

Unlocking the potential of maize

Dairy UP's P4 project aimed to unlock the potential of the dairy feed base, with a focus on growing maize for intensive systems.

P4 integrated precision agriculture with real-time monitoring of plants and soils as well as advanced modelling to grow better forage crops and increase water and land-use efficiency.

This document provides the final update on P4: Feedbase – Maize for silage.

On most Australian dairy farms, the costs associated with feed represent at least half of all expenses associated with producing milk. Feed costs can be even higher for those milking cows in intensive Total Mixed Ration (TMR) systems or housed-cow operations. That's why any refinements to the feed base of a dairy farm can have a huge effect on a business' profit.

Maize silage

Maize is a key component in the feed base of many TMR or partial mix ration (PMR) systems because it is high yielding and water efficient.

Several research studies, including projects through the FutureDairy program, proved the water and nitrogen efficiency of growing maize in Australia. Work with farmers across the country demonstrated that maize silage could consistently yield 25-28 tonnes of dry matter per hectare when good management was combined with good water and nitrogen availability.

In trials where maximum amounts of irrigation water were applied, maize silage yielded 5 tonnes of dry matter per megalitre of water – five-times greater than the average response to perennial pastures in the irrigation region of Northern Victoria. With no water limitation, maize for silage also yields an average of 150kg of DM per kg of nitrogen.

The quality challenge

The ingredients that determine profitable maize crop yields are clear but ensuring yield is converted to 'high quality' silage isn't as straight forward.

Maize silage is made from the entire plant. Each element has differing starch, fibre, and energy content.

Additionally, metabolisable energy (ME) – a traditional form of determining feed quality – isn't an accurate indication of the quality of maize silage, as the high ME of the grain (starch) can be diluted by the lower ME of the stem and leaves.

Project aim

This project aimed to provide the foundations for a future decision support tool to help dairy farmers with their maize silage production. The project investigated:

1. Predicting maize silage yield and quality using a modelling program called the Agricultural Production Systems sIMulator (APSIM).
2. Real-time monitoring of the maize crop using a combination of APISM and remote sensing.
3. Clearer indicators of maize silage energy content and nutritive value.
4. Performance of the highly digestible Brown midrib (BMR) maize variety under NSW dairying conditions.

Key findings

The APSIM model reliably predicts maize silage yield on commercial farms, across regions, sites, years and individual farms.

Harvest index (HI) can be used as a practical on-farm proxy for silage energy content, especially in well managed conditions.

Combining the APSIM model with satellite imagery (Sentinel-2) can help track how crops are growing across a paddock, but at this stage it didn't improve yield predictions compared to APSIM on its own.

A new framework for evaluating maize silage energy was developed, showing why silages with very different starch contents often deliver similar energy.

New generation BMR maize hybrids had only 10% less yield compared to conventional hybrids but lodged less and had improved fibre digestibility and comparable energy content.

Together, these outcomes provide practical pathways for farmers to:

- Improve feed planning and budgeting.
- Reduce uncertainty in silage supply and quality.
- Make better hybrid, density, and harvest decisions
- Support profitable and resilient intensive dairy systems.

Benefits

Managed well, maize silage is an efficient use of water and nitrogen on-farm, but it's an expensive crop to plant. Tools to improve management can have a big impact on maize yield and quality and therefore the return on investment in the crop.

Understanding the potential yield and quality of the final, harvested silage will also help dairy farmers to plan in advance for their feed requirements and should decrease costs.

This work could also benefit other livestock industries that use maize silage as a feed source.

More info

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Research and results

Yield and quality targets

A combination of a literature review and research established maize silage yield and quality targets while also identifying knowledge gaps.

Maize silage targets include:

- Dry matter yield: 25t DM/ha.
- Starch: at least 35% to dilute as much fibre as possible.
- Harvest index (ratio of grain to total dry matter): 40-50% can dilute the fibre in maize silage.

Knowledge gaps include:

- Uncertainty about how to accurately measure the dry matter percentage of maize silage and if a maize silage with 35 per cent or more dry matter ensures a lower NDF due to increase in starch content.
- How much does sowing time, plant density, water and nitrogen availability determine crop yield and quality? And how can this be monitored in real time?
- How are indicators of silage 'quality' and yield best monitored?

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Predicting maize yield and quality

The modelling tool, Agricultural Production Systems sIMulator (APSIM) was developed and calibrated for 90 crops including maize for grain (but not maize for silage). This study tested and calibrated it to predict the yield of maize crops grown in NSW for *silage*.

The initial calibration was done with data from FutureDairy. The subsequent validation used data from maize crops on research (FutureDairy feedbase data) and six commercial dairy farms. The farm data was collected through remote sensing and real-time on-site monitoring, which involved cutting and measuring plants at four stages (V6, flowering, grain-filling, and plant maturity (harvest)).

Overall APSIM predicted yield (biomass) of maize crops with reasonable accuracy.

The APSIM calibration has room for improvement in dryland conditions, but it provided reasonable predictions of yield and harvest index for irrigated crops across regions.

Figure 1: Data combined for 6 farms

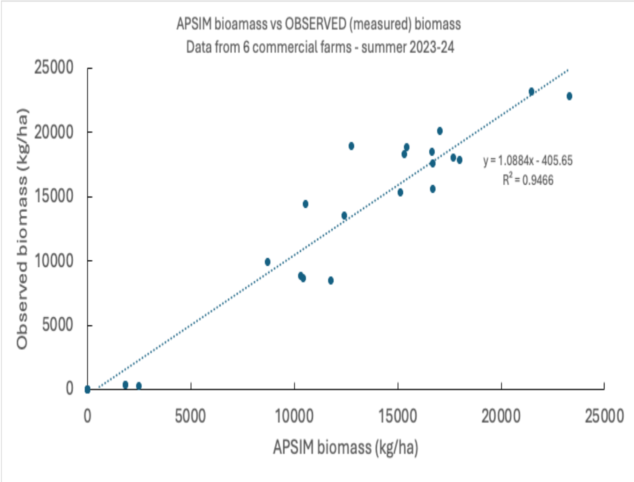


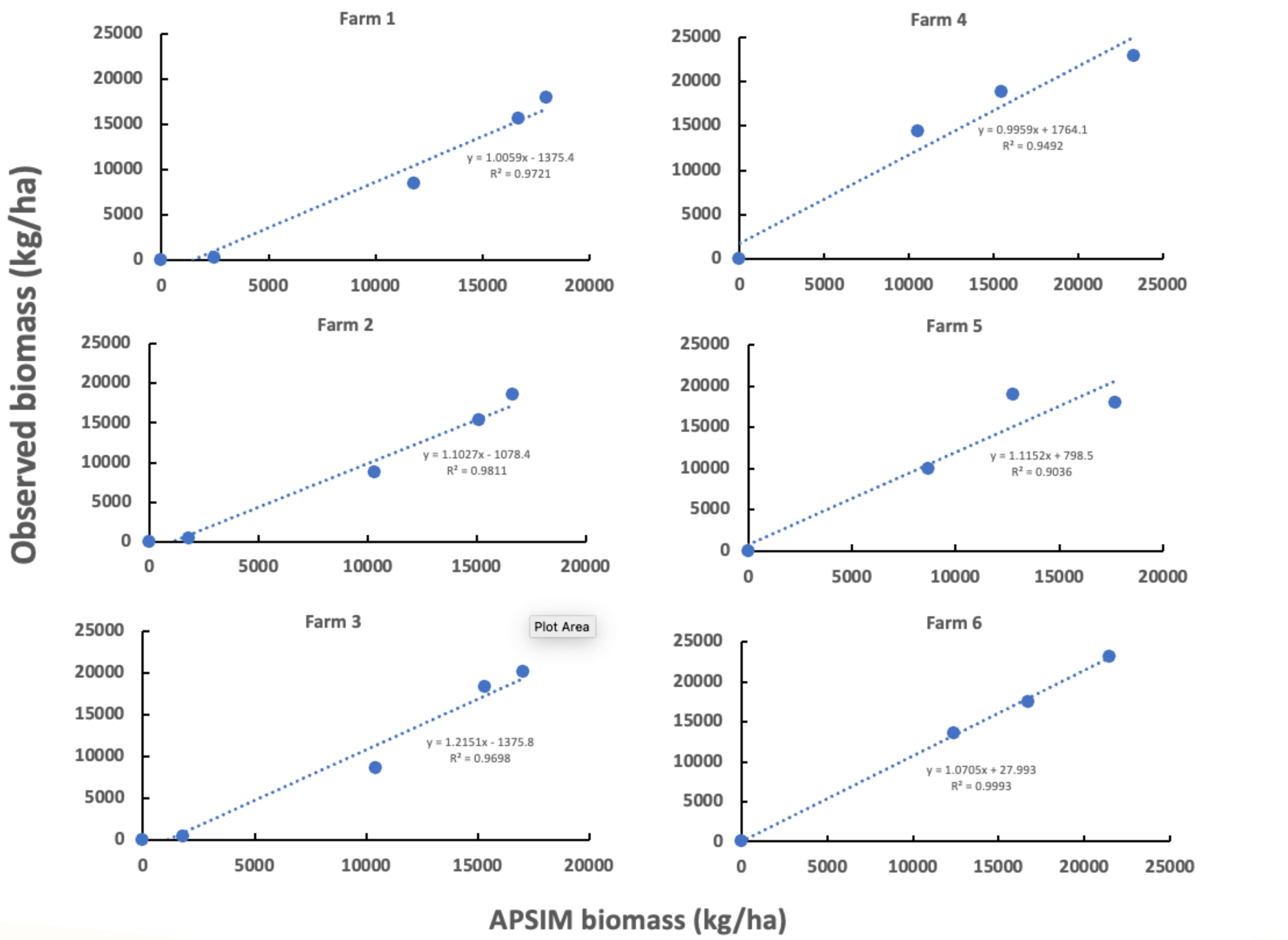
Figure 1 shows the combined data for the six farms.

Figure 2 shows the individual crop/farm data. It demonstrates good performance in all cases.

This was measured through cutting plants but variation with paddock yield was high.

Harvest index (HI) was identified as a useful proxy for silage nutritive value.

Figure 2: Individual crop/farm data



Real time monitoring of maize crop

While APSIM is provides a good overall prediction of crop growth, it doesn't pick up day-to-day differences across a paddock. Remote sensing fills that gap, using satellite and sensor data to give a full paddock view of crop condition and feed availability as it changes through the season. The Dairy UP team combined these two tools to improve real-time predictions of yield and energy for silage decisions.

On farm monitoring
Dairy UP researchers evaluated 12 different maize silages across various NSW dairy farms to determine biomass, grain yield and the quality of the crop.

On average, grain in the maize silage was 78% starch and 14 MJ/kg DM, however, there was variation between the different maize cultivars.

Neutral Detergent Fibre (NFD) percentages varied across the rest of the plant. The cob (without the grain) was 70% NDF, while the leaf and stem were at least 60% and the grain was 8%.

Metabolisable energy (ME) of the grain was 14 MJ/kg/DM, while the rest of the plant was 8 MJ/kg DM or less.

Both APSIM and the combined APSIM–remote sensing approach were able to reliably predict how much maize biomass was grown across a range of conditions.

APSIM also provided a good estimate of feed energy under well-managed conditions. This suggests these tools have the potential to be used in silage systems.

Being able to accurately predict both yield and energy helps farmers better plan how much silage they will have and its feed value — particularly important in intensive, housed systems where maize silage makes up a large part of the ration.

Maize silage nutritional quality

The Dairy UP team looked at the feed value of whole-crop maize silage and why crops with very different starch levels can still deliver similar overall energy.

The work showed that as starch increases, fibre digestion can drop. This happens because starch is broken down quickly in the rumen, lowering rumen pH and reducing the activity of the microbes that digest fibre. Starch itself is still well digested, but less fibre is used.

To better reflect how this works in the cow, the team developed a new approach that looks at grain (starch) and the rest of the plant (fibre) separately, rather than treating the silage as one uniform feed.

This gives a more accurate picture of silage quality and energy supply and improves the ability to predict feed value in real time.

This supports more precise ration planning and silage management, helping lift feeding efficiency and control costs in intensive systems.

BMR performance

In this study, the team compared a newer, short-season brown midrib (BMR) hybrid with a conventional hybrid under different planting rates at University of Sydney's "Landsdowne" farm at Camden, NSW. Crops were well managed, with adequate nitrogen and irrigation. Both yield and feed quality were measured over two seasons. Drone imagery was used to assess crop performance at flowering.

Both hybrids produced high yields (25–28 tonnes of dry matter per hectare), and importantly, the brown midrib hybrid showed no lodging, suggesting improved standability compared to older types.

The conventional hybrid produced slightly higher yields (about 2 tonnes of dry matter per hectare more) and higher starch levels. However, the brown midrib hybrid had better fibre digestibility. As a result, overall feed energy was similar between the two.

Planting rate influenced yield but not feed energy. The brown midrib hybrid performed best at moderate plant density, while the conventional hybrid achieved its highest yield at higher plant density.

Overall, these results show that newer brown midrib hybrids can close the yield gap while maintaining feed quality, giving farmers more flexibility when choosing hybrids and planting rates in intensive silage systems.

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Read more

P4 final report

Ojeda, JJ et a;. (2023) Field and in-silico analysis of harvest index variability in maize silage. Frontiers in Plant Science Volume 14

Islam et al. Revealing the real nutritional value for maize silage. J. Dairy Sci. Vol. 108, Suppl. 1, pp 174-175 (2025)

Islam et al. Integrating APSIM and remote sensing to predict maize silage biomass. Proc Precision Dairy Farming Conf, vpp 170-171 (2025)

Delivery organisations

The University of Sydney Dairy Research Foundation | NSW Government Department of Primary Industries and Regional Development | Scibus | Dairy Australia

Partner organisations

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

Additional program supporters, collaborations or partnerships

Charles Sturt University | DairyBio | DataGene | Eagle Direct | Entegra
Macquarie University | NSW EPA | smaXtec | UC Davis | University of Technology Sydney