DairyNZ

Emissions & Profitability

Understanding the relationship between greenhouse gas emissions and farm profitability.

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DairyNZ

Disclaimer

This study describes relationships found across many farms but does not guarantee specific outcomes for individual farms. Farm-specific factors such as pasture potential, climate, and management capability will influence what can be achieved. Always consider your specific circumstances and seek professional advice when making farm system changes. Factors beyond the farmer's control—such as pasture potential—may limit the outcomes that can be achieved on a given farm.

For more information on managing greenhouse gas emissions and what DairyNZ and others are doing to assist farmers in reducing their emissions visit **dairynz.co.nz/managing-ghg**

For more details on the information provided in this guide, visit **dairynz.co.nz/emissions-profit**, email info@dairynz.co.nz, or phone 0800 4 DAIRYNZ (0800 4 324 7969).

About this study

Background

Customers buying products directly from New Zealand milk processing companies are setting targets to reduce their greenhouse gas emissions, focusing on emissions per unit of product.

This is usually expressed as kilograms of carbon dioxide equivalent or kgCO_2-e and is also known as 'emissions intensity'.

This metric is important because it is the basis customers use for comparing different sources of milk when purchasing our dairy products.

Some New Zealand dairy companies are now offering incentives to farmers for low emissions intensity milk. However, **emissions intensity** is only one of several important considerations for farmers.

Other key farm-level outputs include:

Total greenhouse gas emissions: this is important because government climate targets are based on reducing total emissions, not emissions intensity.

Profitability: any changes to reduce emission intensity should be considered in the context of profitability.

Other sustainability indicators e.g. purchased nitrogen surplus: as a measure of nitrogen loss, which can be a focus for dairy companies and regional councils.

Pasture-based farm systems are complex and dynamic. There is a risk when pursuing one goal, it can be at the expense of other goals, if not carefully considered.

About the Emissions and Profitability project

This study aimed to better understand the relationships between physical and financial performance on a farm by connecting large industry datasets. DairyNZ, Fonterra and LIC worked together to create a single, anonymised dataset of around 8,000 farms, enabling detailed analysis of these relationships.

This document explains findings from the study and what it means from a farm performance and profit perspective. Two important factors should be considered when reviewing the findings:

1 Farm data is informative; this study was not a controlled experiment

Data describes the current situation across farms in the study, but not necessarily what each individual farmer could do. It describes relationships and associations, but it can't be assumed that by simply changing one variable by a certain amount (e.g. stocking rate) it will lead to a certain change in another variable (e.g. MS/ha). When farmers change multiple aspects of their farm system at the same time, they do so with knowledge we don't have - such as an understanding of their pasture potential.

2 Scope of the study

The study considered data from 2020/21 to 2023/24. The milk price during this period had a major effect on the return on feeding levels. The last four years had higher milk prices and high-cost inflation. The last 3-4 years were not consistently high or low for pasture harvested. Waikato and Canterbury were chosen as example regions due to the volume of available data; however, we have looked at other regions and have generally found similar effects.

Findings

Farms with higher profit and lower emissions intensity had:

Proportion of homegrown feed

Purchased N surplus

Purchased feed with high-embedded emissions

Relative to farms with higher profit and higher emissions intensity.

*Life Cycle Analysis (LCA) is used to calculate emissions across the full dairy production chain, including on-farm sources and off-farm inputs like feed, fertiliser and fuel, as well as emissions associated with milk processing.

At a glance

1. We found no significant relationship between profit and emissions intensity, which included LCA* emissions. High profit can be generated in systems with either low or high emissions intensity.

2. The key to high profit and low emission intensity is using low footprint feed to achieve good, but not exceptional, milk production per kg liveweight.

3. Low footprint feed is homegrown, using nitrogen efficiently, and supplements with lower embedded CO_2 emissions.

4. Aiming for low emissions intensity through increased production per cow without focusing on the footprint of the feed, is likely to have undesirable consequences on other key outputs e.g., profitability, total emissions, PNS.

5. High profit farms with low emissions intensity can be found anywhere within each region.

6. All farms have opportunities to lower emission intensity, without compromising other outputs.

Where there was high variation in data, individual farm results will differ, and other factors may be more important to farmers. Limitations from factors outside of farmers' control (such as pasture potential) may limit what can be achieved on each farm.

It is possible to be a highly profitable farm with either low OR high emissions intensity.

Another key finding was **high profit farms with low emissions intensity can be found anywhere within each region**. All farms have opportunities to lower emissions intensity, without compromising other outputs.

This shows it doesn't necessarily matter where in the region your farm is, there will still be farm system opportunities to increase profitability while reducing emissions intensity and managing other outcomes, such as total emissions or purchased nitrogen surplus.

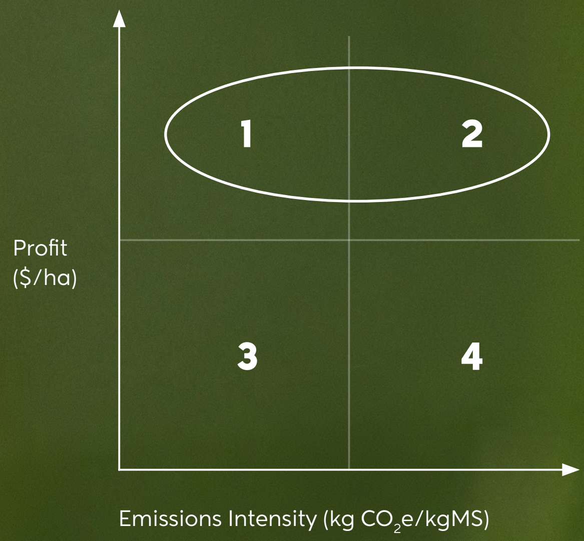
In each region, high profit farms with low emissions intensity can be found everywhere.

- High profit farms with low emissions
- Other

You or your neighbour might be one.

Quadrant analysis

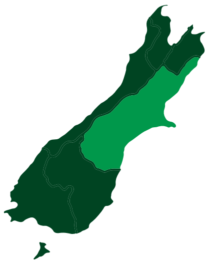
The key to high profit and low emissions intensity is using low footprint feed to achieve good, but not exceptional, milk production per kg liveweight. Low footprint feed is homegrown, using nitrogen efficiently, and supplements with lower embedded CO_2 emissions.



Aiming for low emissions intensity through production per cow without focusing on the footprint of the feed, is likely to have undesirable consequences on other key measures e.g., profitability, total emissions, purchased N surplus.

This study grouped farms into quadrants based on profit and emissions intensity. Quadrants 1 and 2 represent the top 50% of farms for operating profit/ha and either high or low emissions intensity – Quadrant 1 representing lower emissions intensity farms and Quadrant 2 consisting of higher emissions intensity farms.

Canterbury findings

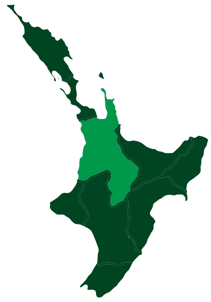


Within the top 50% for profit (Quadrant 1 and 2), the data shows around **12% lower emissions intensity** for Quadrant 1 farms.

This was mostly due to **lower embedded emissions in the supplementary feed**. We found these farms had 1.8% of all feed coming from high embedded emissions feeds, vs 8.0% for Quadrant 2 farms. Quadrant 1 farms also had **14% lower purchased nitrogen surplus**.

The lower emissions intensity was partly due to a slightly higher proportion of homegrown feed. There was also slightly higher total feed eaten.

Waikato findings



Within the top 50% for profit (Quadrant 1 & 2), the data shows around **14% lower emissions intensity** for Quadrant 1 farms. This was primarily due to a **higher proportion of homegrown feed.**

It's partly due to lower embedded emissions in the supplementary feed. We found these Quadrant 1 farms had 5.4% of all feed coming from high embedded emissions feeds vs 10.7% for Quadrant 2 farms, similar to Canterbury farms.

However, unlike Canterbury, there was a slightly lower total feed eaten (-3%), driven by lower imported supplement per hectare. There was **a 40% lower purchased nitrogen surplus** on Quadrant 1 farms.

Compare emissions across high-profit farms

	Canterbury Farms		Waikato Farms	
	Higher profit, **lower** emissions intensity	Higher profit, **higher** emissions intensity	Higher profit, **lower** emissions intensity	Higher profit, **higher** emissions intensity
Emissions Intensity ($kgCO_2e/kgMS$)	**9.31**	**10.58**	**11.05**	**12.81**
Absolute Biological Emissions ($kgCO_2e/ha$)	15,628	15,233	**12,472**	**13,310**
Purchased Nitrogen Surplus - PNS (kgN/ha)	**112**	**130**	**73**	**120**
Operating Profit ($/ha)	5,960	6,369	4,829	4,774
Total Feed Eaten (tDM/ha)	19.9	19.6	15.8	16.3
Homegrown Feed Eaten* (tDM/ha)	**16.3**	**15.7**	13.8	13.6
Stocking Rate (cows/ha)	3.6	3.6	2.9	3.1
Production (kgMS/cow)	448	441	414	402
Production (kgMS/ha)	1,614	1,574	1,215	1,242
Production Efficiency (kgMS/kgLW)	0.96	0.95	0.89	0.87

Notes: Higher profit is defined as the top 50% of farms for operating profit ($/ha) in each region.
Those marked in bold are statistically significant within the region.
*Wintering is not included in homegrown feed.

A deeper look at cow efficiency

Cow efficiency was one difference identified between Quadrant 1 and Quadrant 2 farms. The study found both opportunities and risks when focusing on cow efficiency. Production per kg liveweight describes individual cow performance, and the study showed a mix of positive and negative correlations.

Increased production per kg liveweight is associated with:

A

Lower emissions intensity – with a variation of 14% across farms.

B

Higher biological emissions (kgCO_2e) per hectare with a variation of 21% across farms.

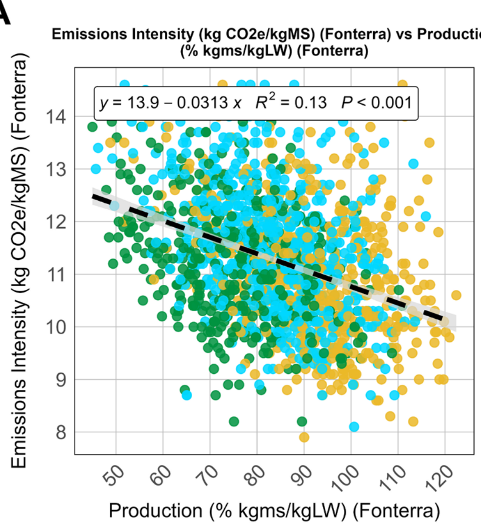
C

Higher purchased nitrogen surplus – with a variation of 12% across farms.

D

Higher profit per hectare – with a variation of 8% across farms.

A



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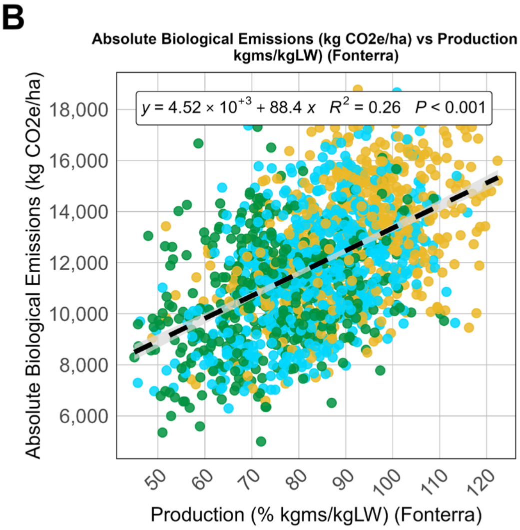

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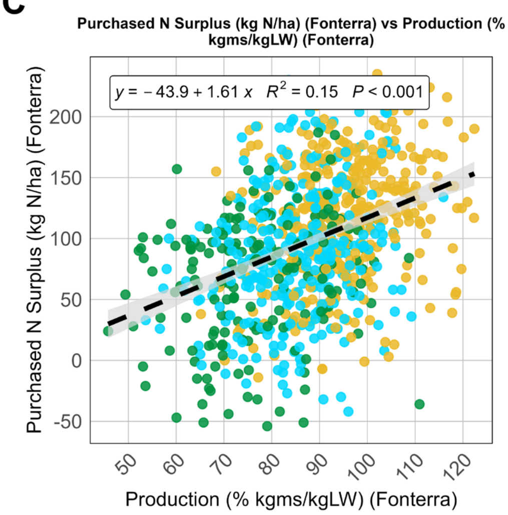

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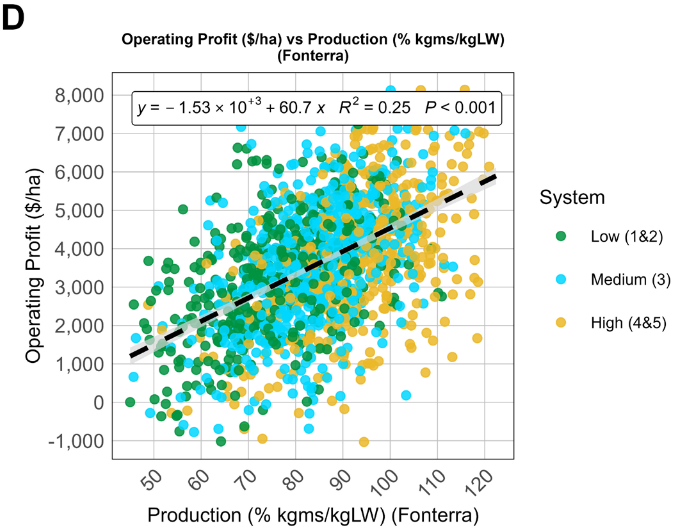


NB: Profit relationships are not necessarily linear and could be influenced by the high payout over the last 4 seasons; diminishing and/or negative returns can occur.

Pathways to increase cow efficiency

Improving emissions intensity can be achieved by increasing kilograms of milk solids per kilogram of liveweight (kgMS/kgLWT). However, this only explains 14% of the variation between Quadrant 1 and Quadrant 2 farms, meaning there are other factors that also influence emissions intensity.

The primary driver for kgMS/kgLWT is increasing the amount of feed eaten per individual cow. There are three primary pathways to achieve this:

Increase homegrown feed: Harvesting more homegrown energy eaten per cow (yield, quality and utilisation).

Increase total feed: Importing more feed to the farm system through using supplements or grazing cows off-farm.

Reduce liveweight/ha: Maintain existing feed harvested with less liveweight, partitioning more energy to milk (e.g. smaller cows, or less cows).

These pathways have varying impacts on emissions intensity and other key measures such as profitability, total emissions, and purchased nitrogen surplus.

The effect of feed

Emissions intensity

The study found that focusing on feed management to support increased kgMS/kgLWT had positive outcomes on emissions intensity.

It also found that higher total feed intake or homegrown feed intake per kgLWT is associated with lower emissions intensity.

These are the only times that both 'total' and 'homegrown' feed eaten metrics give a positive outcome on emissions intensity, which means there is a risk of unintended consequences.

Total emissions

The study found that increased production per kgLWT, either from increasing total feed, through imported feed or through increased homegrown feed eaten while retaining existing supplements, leads to **higher total emissions.**

However, in comparison, higher homegrown feed eaten per kgLWT has a limited association with higher total emissions. Increasing homegrown feed eaten and removing supplements or having smaller cows or maintaining homegrown feed with fewer cows leads to **less of an increase in total emissions.**

Purchased N surplus (PNS)

The study found that higher total feed intake per kgLWT is associated with **higher PNS per hectare**.

Increased production per kgLWT through increasing total feed supply from imported feeds is more likely to lead to **higher PNS.**

Conclusions

Profit from Pasture

Focusing on homegrown feed appears to be the most favourable pathway to higher profit and lower emissions intensity. Previous DairyNZ research showed that greater homegrown feed per hectare is associated with higher profitability of around $350 per tonne of dry matter. This study found the increase was $428 per tonne of dry matter, due to payout over the period of this study.

This study found:

- There is no relationship between profit per hectare and emissions intensity
- For farms in the top 50% for profit (Quadrants 1 and 2), those with lower emissions intensity had key system differences focused on feed management
- Eating more homegrown feed/ha is linked with higher profit/ha, lower emissions intensity, lower PNS, and minimises the risk of higher total emissions

For every extra tonne of homegrown feed eaten = $428 extra profit

Metric	Waikato region	Canterbury region
Stocking Rate	-6%	Similar
Production (kgMS/cow)	+3%	+1.5%
Production/Liveweight (kgMS/kgLWT)	+2.6%	+1.6%
Homegrown feed	+1.4%	+3.7%
Total supplements	-26%	-6.7%
Supplements from high embedded emission feed sources	-50%	-77%
Purchased Nitrogen Surplus (PNS)	-40%	-14%

Farm system opportunities

Farm systems opportunities to increase profitability and reduce emission intensity that align with this study are:

Know your data, and where your next opportunity is on farm. See how at **dairynz.co.nz/dairybase**

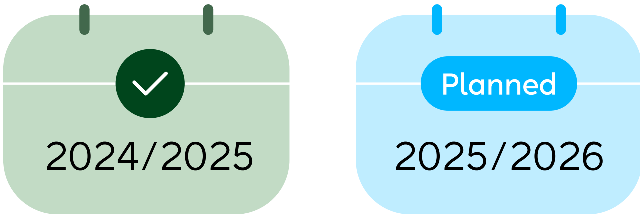
Drive more homegrown feed eaten per ha, from growing more, improving feed quality, and utilising what is grown. See more at **dairynz.co.nz/feed-management**

Optimise cow performance and plan for constant gains in reproductive success and calving pattern, cow quality and herd structure, and hitting BCS targets and managing cow health. See more at **dairynz.co.nz/repro-and-mating**

Ensure any imported feed is used to drive additional farm production, and is not contributing to substitution, wastage, or system and cost increases.

Further research

Results from this study are the first phase of analysis of the dataset. However, its scale and richness mean there are opportunities for further investigation.
A second phase of research is planned for the 2025/26 season.



We continue to work together to:

Investigate using liveweight breeding values to improve the estimates of liveweight.

Liveweight is a key assumption that affects both estimates of farm system metrics like feed eaten and kgMS/kg LW, as well as emissions estimates from life cycle assessment. Currently liveweight is based on breed defaults.

Use more complex statistical methods, such as causal interference*, to improve our understanding of the underlying drivers of associations that have been identified.

Current results describe linear relationships and associations, but we cannot assume that changing some variable (e.g. stocking rate) by some amount will lead to a certain change in another variable (e.g. kg MS/ha). Using causal interference may help with this.

*Causal interference is about figuring out whether one thing causes another, not just whether they happen at the same time.