



STEP CHANGE 2.0

- TESTING THE MODEL

REDUCING ENVIRONMENTAL FOOTPRINT WHILE STAYING PROFITABLE



Funded by

Ministry for Primary Industries
Manatū Ahu Matua



and New Zealand Dairy Farmers through



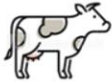
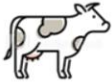
TRIAL OBJECTIVE AND OVERVIEW

The purpose of the Step Change Trial was to create change and to help all dairy farmers focus on reducing environmental footprint (GHG emissions and water quality) while maintaining profit. New Zealand farmers are facing increasing regulations around their environmental footprint. They may be required to reduce their N-loss and GHG emissions to comply with national and local regulations along with dairy company requirements.

The study compared two farmlets, one based on current farming practices (control farmlet = current) and the other (trial farmlet = future) expected to achieve reduced GHG emissions and N-surplus targets likely to be required by the Zero Carbon Bill and the Essential Freshwater Accord.

The Step Change 2.0 project is a continuation of Dairy Trust Taranaki's original Step Change trial, which started in the 2020/2021 season. In addition to testing the performance of the future farmlet under a variety of different climatic conditions, the Step Change 2.0 trial also includes N-leaching measurements through suction cups and lysimeters to test modelled N-leaching numbers from Overseer, as well as a plot trial to investigate the impact of reduced amounts of N and varying amounts of clover on total pasture yield.

FARMLET SET UP

Current Herd 54 hectares	Future Herd 54 hectares
 3.1 cows/ha	 2.5 cows/ha
 190 kgN/ha	 75 kgN/ha
 up to 700 kgDM/cow	 up to 300 kgDM/cow

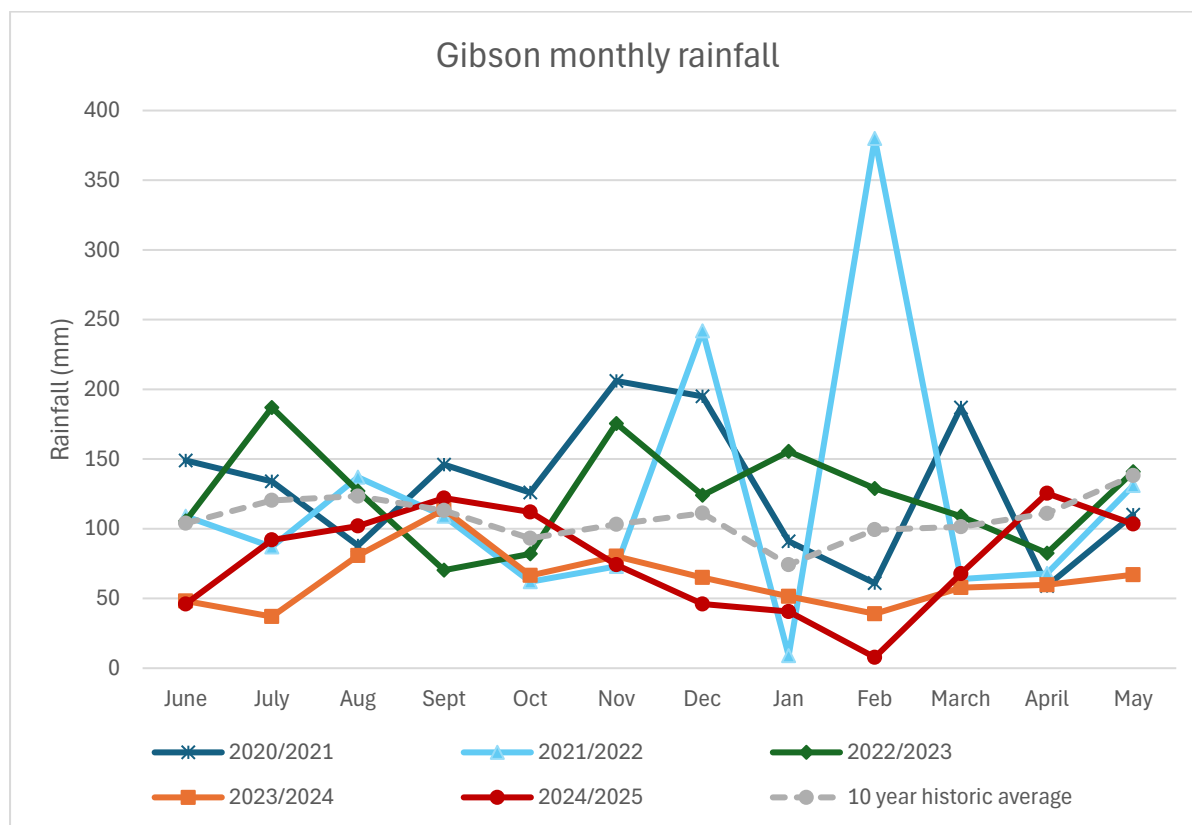
There were three key differences between the two farmlets:

Compared to the Current farmlet the Future farmlet had a reduced stocking rate (3.1 vs. 2.5 cows/ha), a reduced N-fertiliser cap (190 kg N/ha/yr vs. 75 kg N/ha/yr) and reduced supplement inputs (700 kg vs. 300 kg DM/cow/yr).

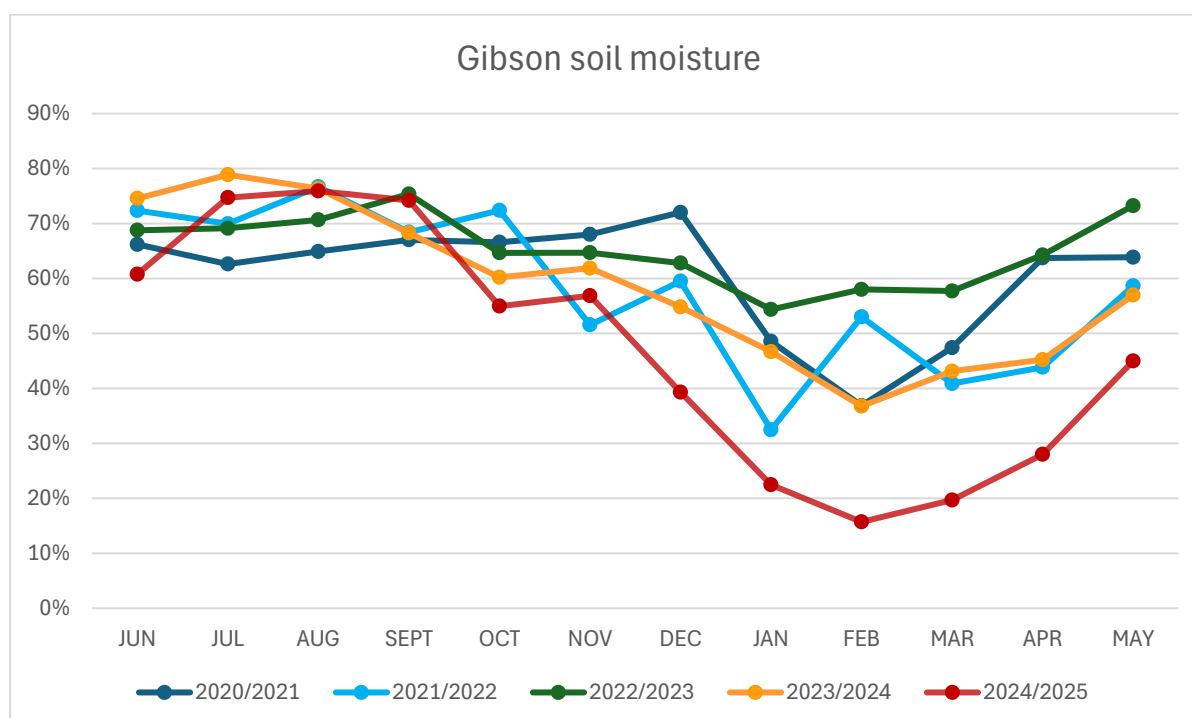
To offset some of the reduced N-inputs and further help with reduction of N-loss, the future farmlet has been undersown with clover and plantain.

The two-farmlet trial was set up in 2020 and inputs (e.g., pasture offered, feed and N-fertiliser purchased), and outputs (milk production) were measured, and GHG emissions and N-leaching were estimated using Overseer and profitability calculated.

CLIMATE



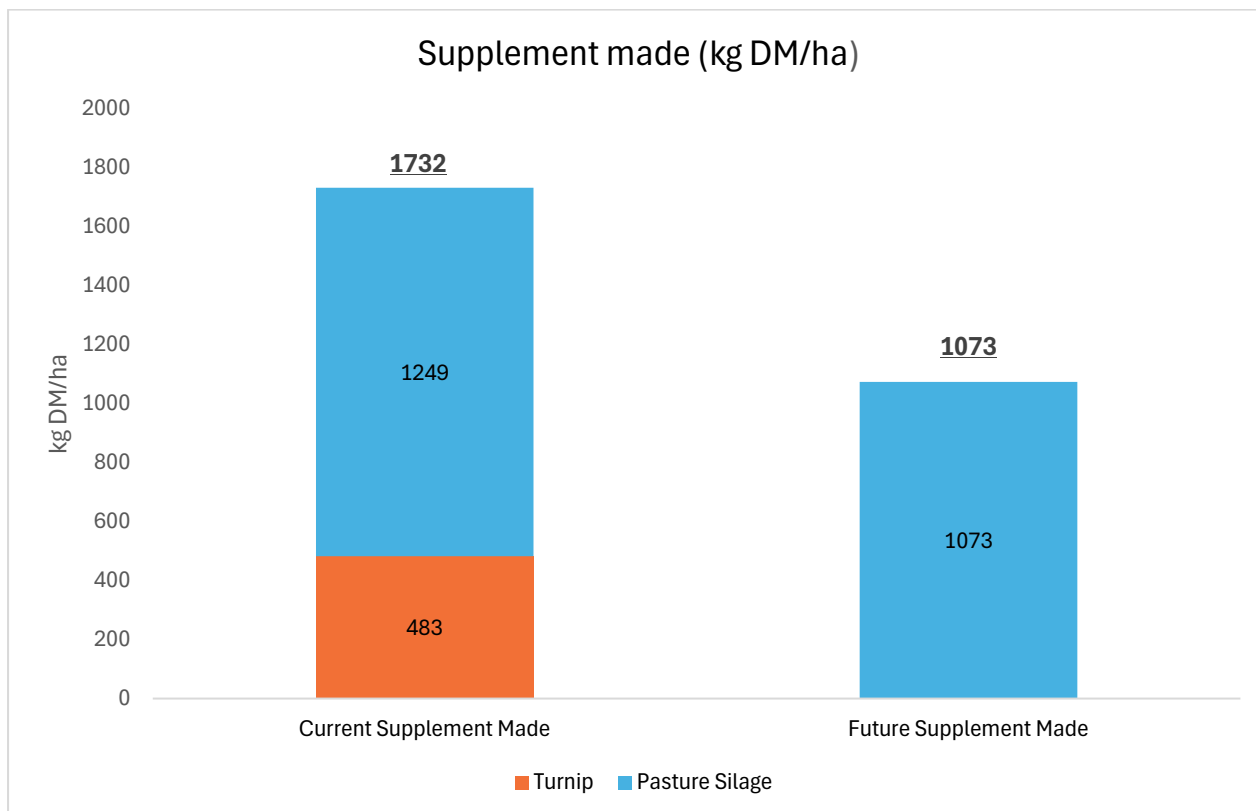
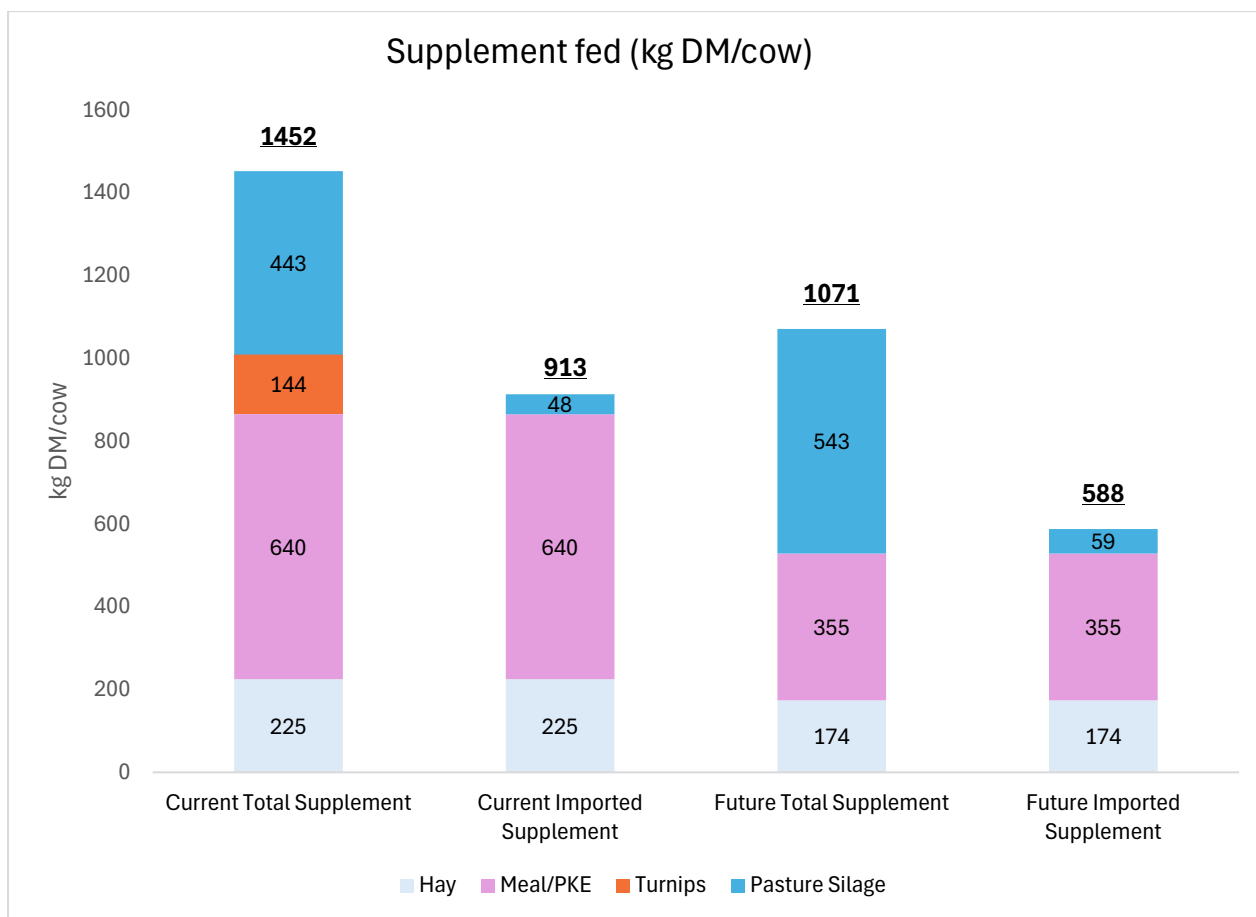
Annual rainfall	2020/2021	2021/2022	2022/2023	2023/2024	2024/2025	10 year historic average
mm	1552	1471	1488	767	939	1292

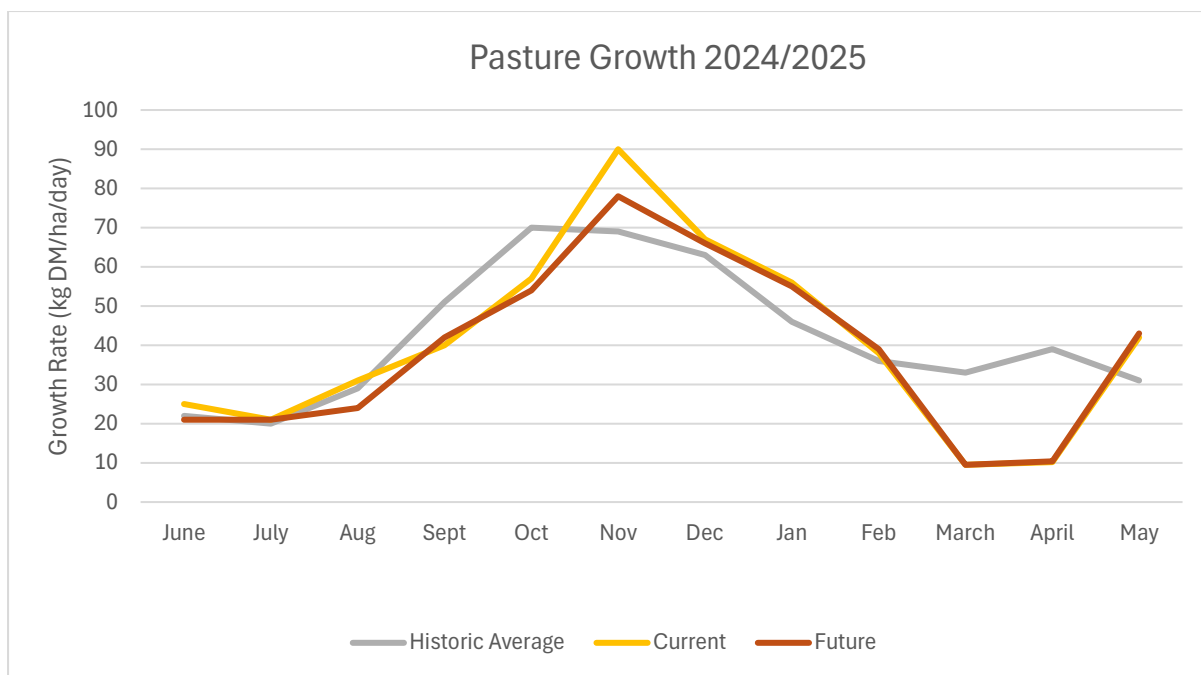


RESULTS 2024 – 2025 SEASON

PRODUCTION	CURRENT	FUTURE
kgMS/ha	1159	1015
kgMS/cow	378	407
Days in milk	265	272
Average kgMS/cow/day	1.43	1.50
kgLWT (Dec)	511	512
kgMS as % liveweight	74	79
Comparative stocking rate (kgLWT/tDM)	87	80

FEED	CURRENT	FUTURE
Cows/ha	3.1	2.5
KgN/ha	153	74
Pasture grown (tDM/ha)	15.22	14.54
Imported feed (tDM/ha)	2.80	1.41
Total feed offered (tDM/ha)	18.02	15.95
Estimated feed eaten (tDM/ha)	15.5	13.0
Utilisation (%)	86	82





ECONOMICS

	Current	per ha	Future	per ha
Milk Solid Production kgMS	63,139	1159	55,320	1015

Income

Milk solids income \$10.00	631,391	11,585	553,202	10,150
Stock sales	49,970	917	39,080	717
Total income	681,361	12,502	592,282	10,868

Expenses

Wages	127,500	2,361	90,000	1,667
Animal health	24,728	458	20,138	373
Breeding	14,823	275	14,909	276
Farm dairy	6,141	114	5,380	100
Electricity	19,723	365	17,281	320
Silage on farm	2,518	47	2,169	40
Hay + silage Brought in	19,031	352	13,086	242
Turnips - 2 ha	3,754	70	0	0
pasture renewal/plantain	3,823	71	6,635	123
In shed Feeding	51,883	961	23,404	433
Grazing - heifers 52 weeks, calves 26 weeks	39,037	723	32,909	609
Nitrogen	12,296	228	4,774	88
capital fertiliser	17,769	329	16,844	312
Weed & Pest	2,164	40	2,164	40
R & M	23,913	443	23,913	443
Vehicle & fuel	13,193	244	13,193	244
Calf rearing	15,932	295	13,277	246
Admin and Insurance	8,033	149	8,033	149
Other Farm Working Expenses	7,793	144	7,793	144
Depreciation	28,451	527	28,451	527
Total expenses	442,505	8,119	344,354	6,318

income - expenses	238,856		247,928	
EFS/ha (EBITA)	4,383		4,549	+3.8%
FWE/kg MS	7.01		6.22	-11.2%

GREENHOUSE GASES AND N-LOSS ANALYSIS

Numbers are modelled in Overseer.

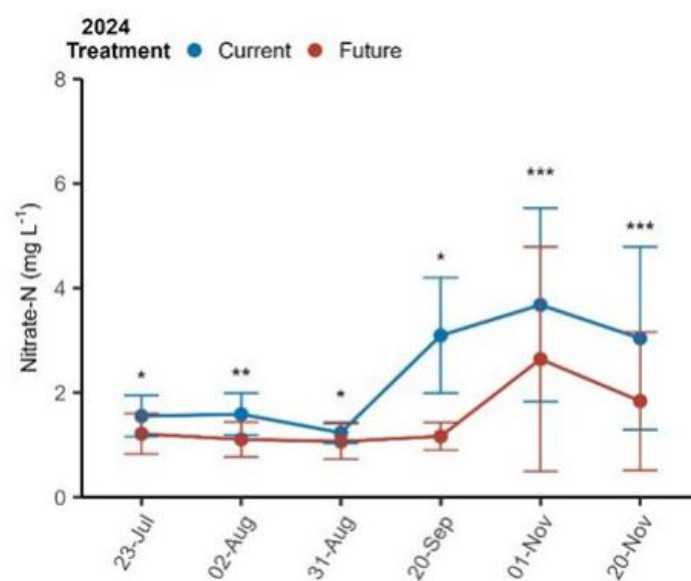
NITROGEN	CURRENT	FUTURE	DIFFERENCE
Total N-Loss (Kg)	2092	1549	-26.0%
N-loss/ha (kg/ha)	38	29	-23.7%
NCE (%)	28	30	+7.1%
N-surplus (kg/ha)	206	162	-21.4%

GREENHOUSE GASES (GHG)	CURRENT	FUTURE	DIFFERENCE
Total GHG (t CO ₂ -Eq/Yr)	727.7	569.0	-21.8%
Total GHG/Ha (t CO ₂ -Eq/Ha)	12.99	10.54	-18.9%
Methane (t CO ₂ -Eq/Yr)	477.3	401.5	-15.9%
Methane/Ha (t CO ₂ -Eq/Ha)	8.52	7.43	-12.8%
Nitrous Oxide (t CO ₂ -eq/yr)	132.2	102.3	-22.6%
Nitrous Oxide/ha (t CO ₂ -eq/ha)	2.36	1.89	-19.9%
Carbon Dioxide (t CO ₂ -eq/yr)	118.2	65.2	-44.8%
Carbon Dioxide/ha (t CO ₂ -eq/ha)	2.11	1.21	-42.7%

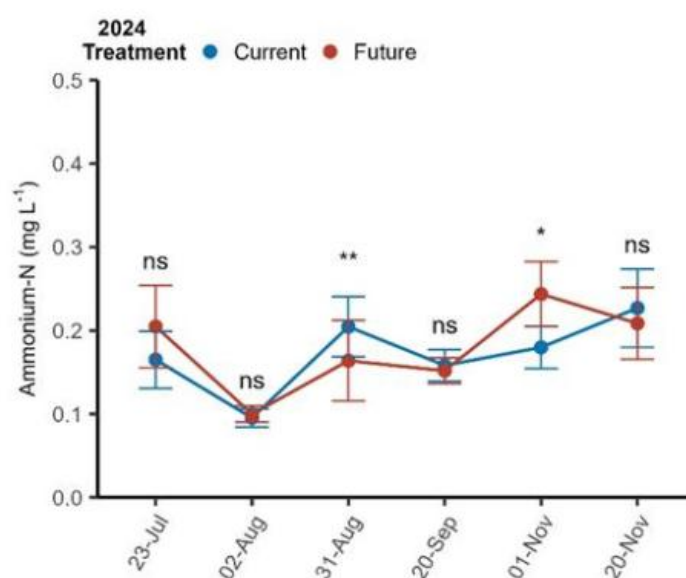
Measured N-leaching (winter/spring 2024):

Nitrogen (N) leaching is estimated by measuring the nitrate and ammonium concentrations in soil water below plant rooting depth by sampling leachate from the ceramic suction cups that were installed at the start of the project. The concentrations of nitrate and ammonium are multiplied by the amount of water drained beyond this depth to calculate the total amount of N leached (kg N/ha). Drainage amounts are measured using intact soil cores in lysimeters.

The initial nitrate-N concentrations (a) were low on both farmlets but increased over spring as drainage increased. The samples from the future farmlet had significantly lower nitrate-N concentrations than the samples from the current farmlet at all sampling timepoints. The ammonium-N concentrations (b) were low for all the samplings. A significant difference between the two farmlets was only found for two of the samplings in August and November.



(a)



It was found that the future farmlet had a significantly lower total N loss than the current farmlet (Figure 10). This is in accordance with the theory and the modelling results from the original StepChange trial.

Leaching losses (kg N/ha/yr)	Current	Future
Nitrate-N	3.96 ± 1.23 a	2.16 ± 0.58 b
Ammonium-N	0.32 ± 0.02	0.30 ± 0.04
Total N lost	4.28	2.46

Different letters indicate significant differences ($p < 0.01$).

SUMMARY

Milk production per hectare was consistently lower on the Future farmlet and the difference to the Current farmlet was largest in year one when both herds calved at the same time (Table 1). From year two on the Future herd calved ten days before the Current herd. In non-drought years the Future farmlet also achieves about an extra 10 DIM at the end of the season. As a result of more days in milk the annual milk production per cow was higher in the Future herd (Table 1).

Table 1: Milk solid production (kg MS) per ha and per cow of the Current the Future farm system in years 1-5 and the difference between systems.

	Current	Future	Change	Current	Future	Change
	KgMS/ha			KgMS/cow		
<u>Year 1</u>	1276	1060	-16.9%	412	419	+1.9%
<u>Year 2</u>	1249	1093	-12.5%	408	445	+9.3%
<u>Year 3</u>	1211	1093	-9.8%	408	445	+9.3%
<u>Year 4</u>	1144	1007	-12.0%	378	401	+6.2%
<u>Year 5</u>	1159	1013	-12.5%	378	407	+7.7%

Milk solid production per ha was consistently lower on the Future farmlet compared to the Current farmlet. Milk production per cow was higher on the Future farmlet, achieved through more days in milk, particularly in years 2-5, when the calving date had been adjusted forward. Both herds were dried off early in year 4 and 5 due to drought.

The Future system achieved reductions in GHG emissions and N-leaching in all five years of the trial (Table 2 and 4). Encouragingly, it also consistently achieved a reduction in emissions intensity (Table 3).

Table 2: Greenhouse Gas (GHG) and Methane (CH₄) emissions expressed as CO₂-equivalents from the Current and the Future farmlets and the difference between the systems in years 1-5.

	Current	Future	Change	Current	Future	Change
	GHG t CO ₂ -eq/ha			CH ₄ t CO ₂ -eq/ha		
<u>Year 1</u>	13.7	10.7	-21.6%	9.4	7.9	-15.4%
<u>Year 2</u>	13.7	10.9	-20.5%	9.2	7.9	-13.6%
<u>Year 3</u>	13.4	10.8	-19.2%	9.2	8.0	-13.0%
<u>Year 4</u>	12.6	10.6	-16.2%	8.4	7.6	-10.0%
<u>Year 5</u>	13.0	10.5	-18.9%	8.5	7.4	-12.8%

GHG and CH₄ emissions from the Future farmlet were lower than from the Current farmlet and achieved CH₄ 2030 emission reduction targets in all four seasons. Emissions were calculated using OVERSEER.

Table 3: Emissions intensity (kg CO₂-equivalent/kg MS) and the difference achieved between the Current and Future farmlet in years 1-5.

	Current	Future	Change
	GHG kg CO₂-eq/kg MS		
<u>Year 1</u>	10.8	10.0	-7.5%
<u>Year 2</u>	11.1	9.9	-10.9%
<u>Year 3</u>	11.2	9.8	-12.2%
<u>Year 4</u>	11.3	10.4	-8.4%
<u>Year 5</u>	11.5	10.3	-10.8%

In addition to a reduction in total emissions, the Future system also achieved a reduction of emissions intensity in all five years. Emissions intensity was highest on both farmlets in year 4 and 5 when milk production was reduced due to early dry off.

N-leaching was reduced in all five years (Table 4) as a results of lower stocking rate and reduced N-fertiliser inputs on the Future farmlet.

Table 4: Nitrogen loss (kg N/ha) from the Current and the Future farmlet and the difference between the two systems in year 1-5, calculated using OVERSEER.

	Current	Future	Change
	Kg N/ha		
<u>Year 1</u>	41	34	-17.1%
<u>Year 2</u>	43	33	-23.3%
<u>Year 3</u>	43	37	-14.0%
<u>Year 4</u>	35	28	-20.0%
<u>Year 5</u>	38	29	-23.7%

Nitrogen leaching was consistently lower on the Future farmlet as a result of lower stocking rate and reduced fertiliser and supplement inputs.

Profitability of the two systems varied between years. When milk payout was lower, and input costs higher, the Future farmlet was more profitable (Table 5).

Table 5: Operating profit per hectare generated from the Current and the Future system throughout the study period.

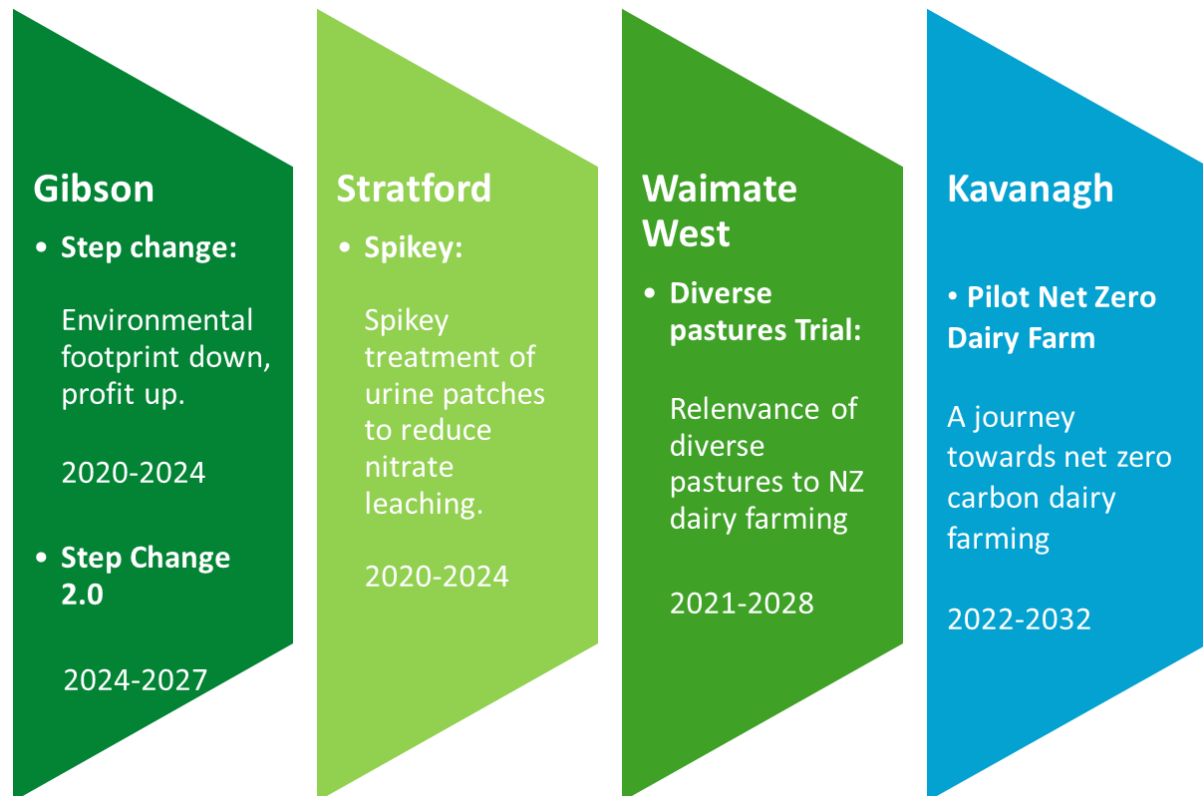
	Current	Future	Change
Operating profit/ha			
<u>Year 1</u>	\$5,357	\$4,700	-12.3%
<u>Year 2</u>	\$5,639	\$5,546	-1.6%
<u>Year 3</u>	\$2,961	\$3,066	+3.6%
<u>Year 4</u>	\$1,630	\$2,019	+23.9%
<u>Year 5</u>	\$4,383	\$4,549	+3.8%
<u>Average</u>	\$3,994	\$3,976	-0.4%

Profitability of the two systems varied between the years with the Future system being more profitable when input prices are high. Average profitability across the five years was the same across the five years of the trial.

CONCLUSION

This Step Change programme was able to achieve 2030 emissions reduction targets each season with varying impacts on profit. Lower payouts and high input costs are favouring the future farmlet. The challenge with the reduced stocking rate is to manage quality of pastures and harvest any surplus as supplement.

For more information on Step Change and on the trials that Dairy Trust Taranaki is running on its other three farms sign up to the weekly farm walk notes and follow us across our social media channels.



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