Leading Innovation for
Southern farmers' propserity

SOUTHERN DAIRY HUB

June Field Day 2023

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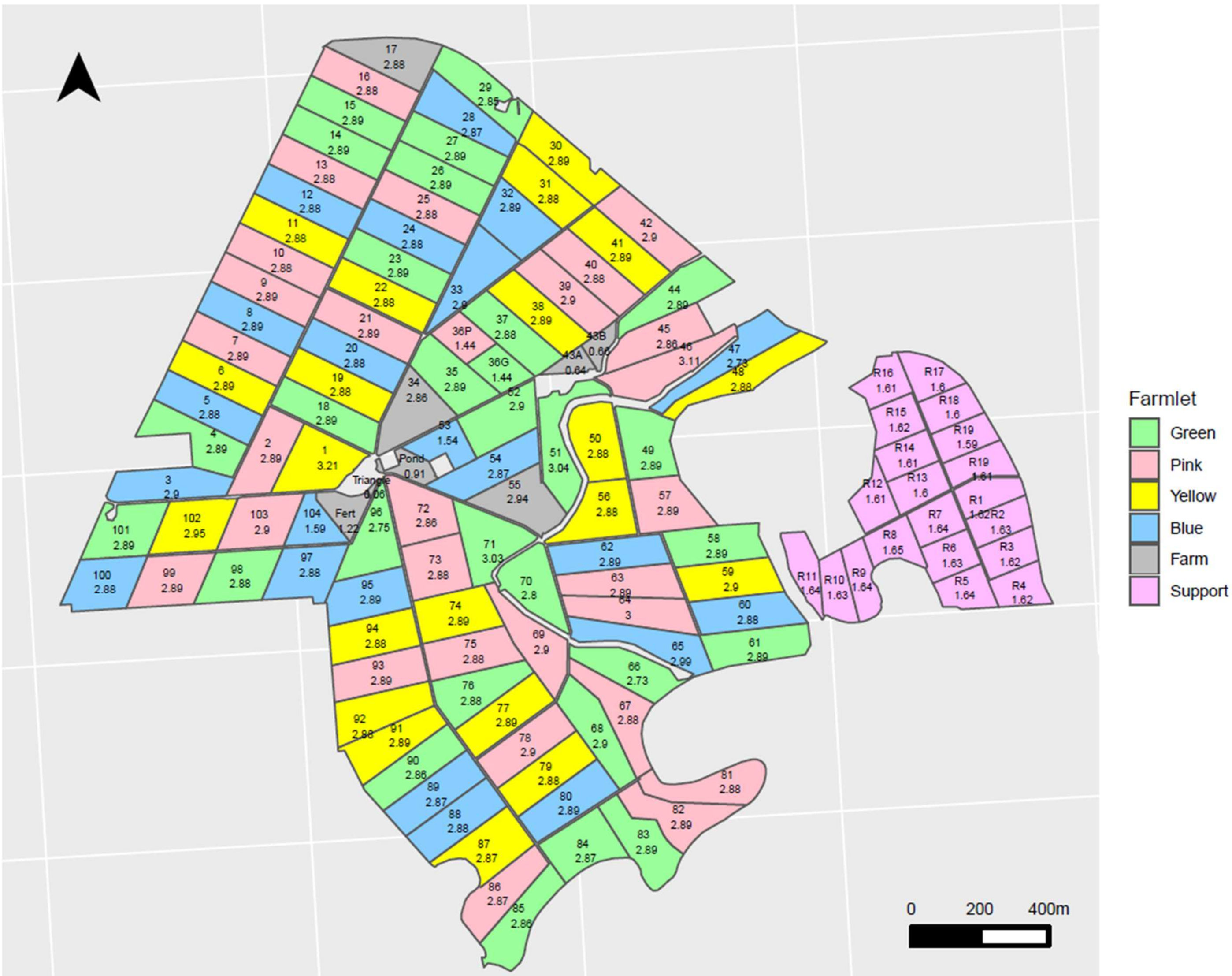
Farm Map



Visitor Health and Safety Requirements

Entry onto property by permission and appointment only.

Contact either:

Acting General Manager Richard Kyte 027 564 5595 or

Farm Manager Billy Singh 021 115 5658

All visitors required to sign in and out accepting farm rules

A farm map will be provided showing any general hazards on the farm; the manager will instruct you of any new hazards

General Rules

- Children on farm – must be under constant adult supervision and only with express permission of manager
- Reporting – Please notify manager immediately any accidents or near miss events/hazards
- Drive to the conditions – Max speed of 30km/hr 

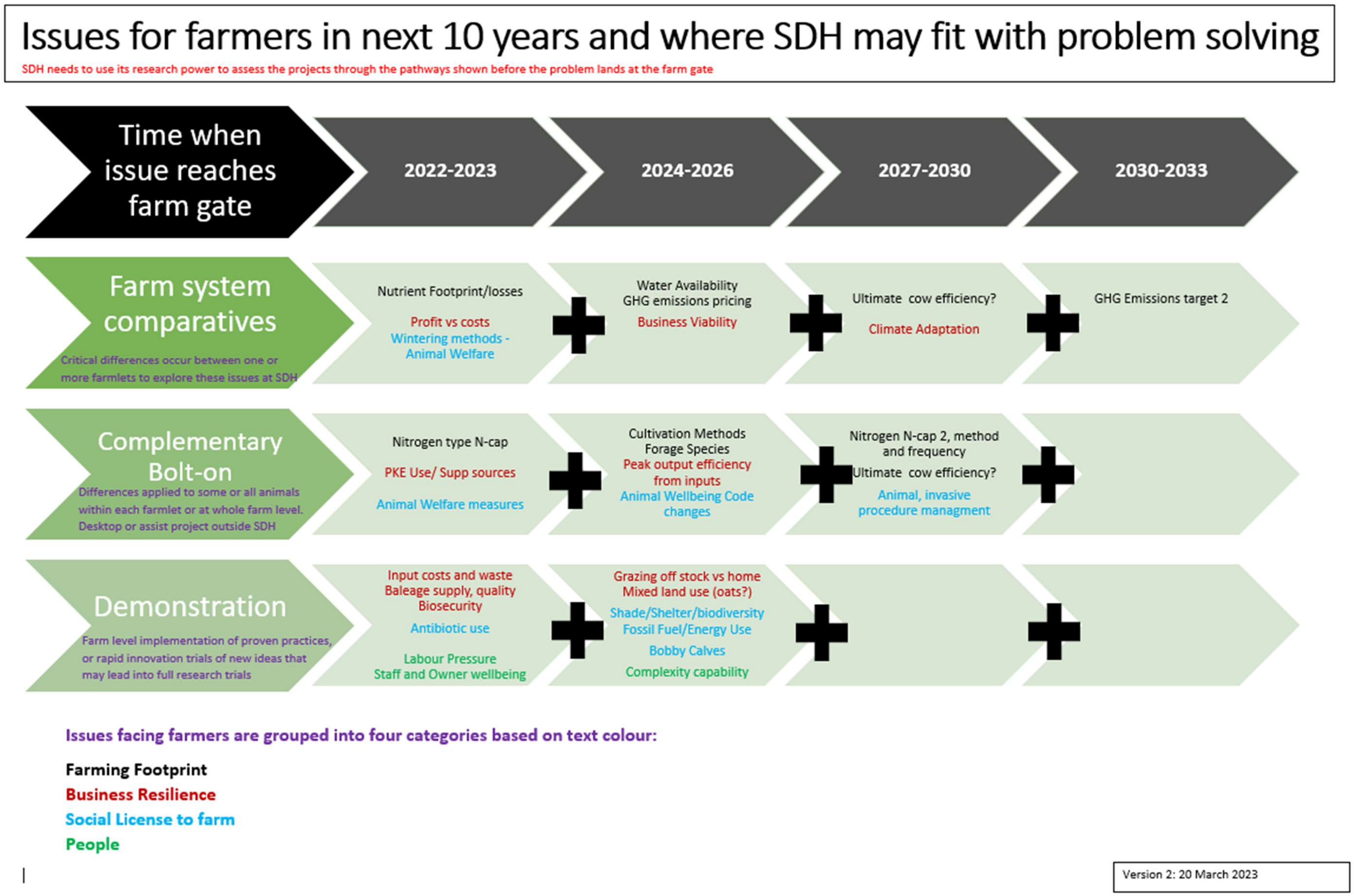
- Vehicles – no one to operate farm vehicles without manager's permission
- Water ponds/troughs – Keep a close eye on children around water sources – do not drink from farm taps, troughs, water ways
- In emergency – Please report back to farm manager at Assembly point in front of cowshed
- Fire extinguishers – found in farm houses, dairy shed, vehicles, and woolshed
- No smoking in cowshed, buildings, or vehicles

Biosecurity Requirements for Southern Dairy Hub (SDH)

All visitors must comply with Biosecurity Requirements when visiting SDH

- All footwear must be disinfected with materials supplied, upon arrival at and departure from the SDH farm site.
- All visitors are expected to wear clean protective clothing, including wet weather gear if necessary when on the farm(s).
- No farm visits will be allowed, from anyone within five days of their arrival in New Zealand from overseas.
- SDH retains the right at any time to refuse access to any person or persons deemed not to be complying with these requirements.

SDH Research Strategy and pipeline



2022-23 Season update

The farm had a strong season in 2022-23, with several years of cumulative work on herd BCS at calving to improve our reproductive performance and calving spread. In addition, the kind spring weather in August and September, good pasture utilisation and quality and access to high-quality supplements for all herds has seen cows milking better on a per-cow basis.

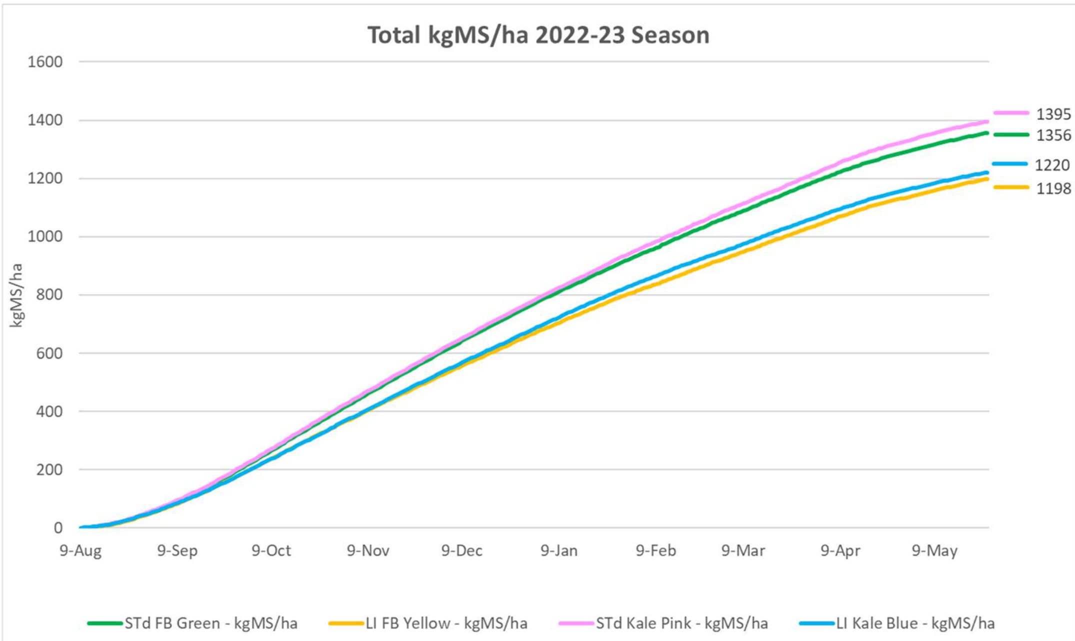
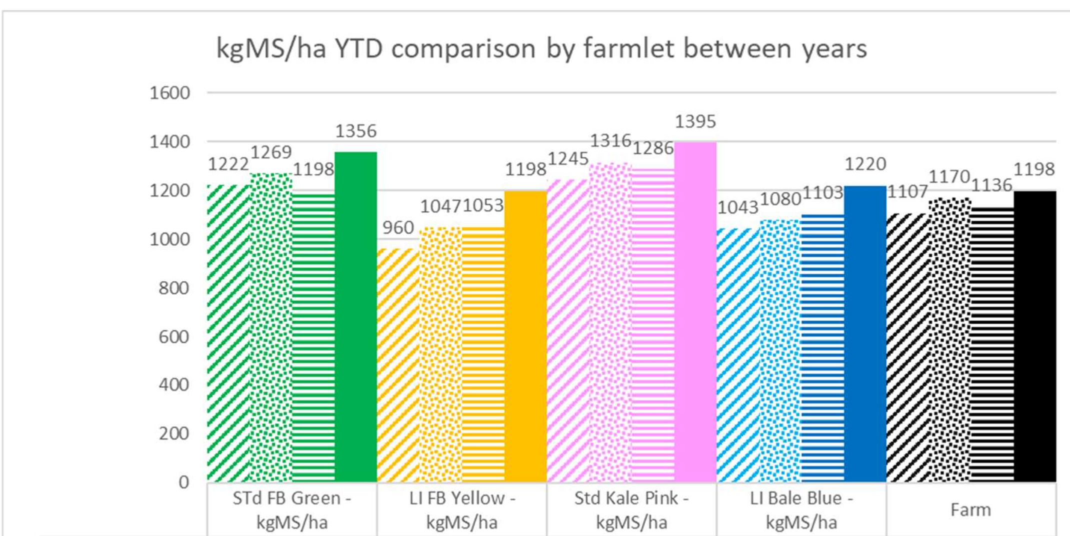


Figure 1: *Cumulative season milk solids production (kg/ha) for the 2022-23 season*



	STd FB Green - kgMS/ha	LI FB Yellow - kgMS/ha	Std Kale Pink - kgMS/ha	LI Bale Blue - kgMS/ha	Farm
2019-20 to 24 May	1222	960	1245	1043	1107
2020-21 to 24 May	1269	1047	1316	1080	1170
2021-22 to 24 May	1198	1053	1286	1103	1136
2022-23 to 24 May	1356	1198	1395	1220	1198

Figure 2: *Annual milk solids production per hectare for the last four seasons*

Per cow milk production ranged from 455 kg/cow for the Std FB to 489 kg/cow for the LI FB with the Std Kale (462 kg/cow) and LI Baleage (487 kg/cow) being intermediate.

The 2022-23 season saw another dry period through January and February that significantly impacted pasture growth. Thankfully the rain came earlier than autumn 2022 results in strong pasture growth through May. As a result we did not achieve our pre-winter average pasture cover for each farmlet.

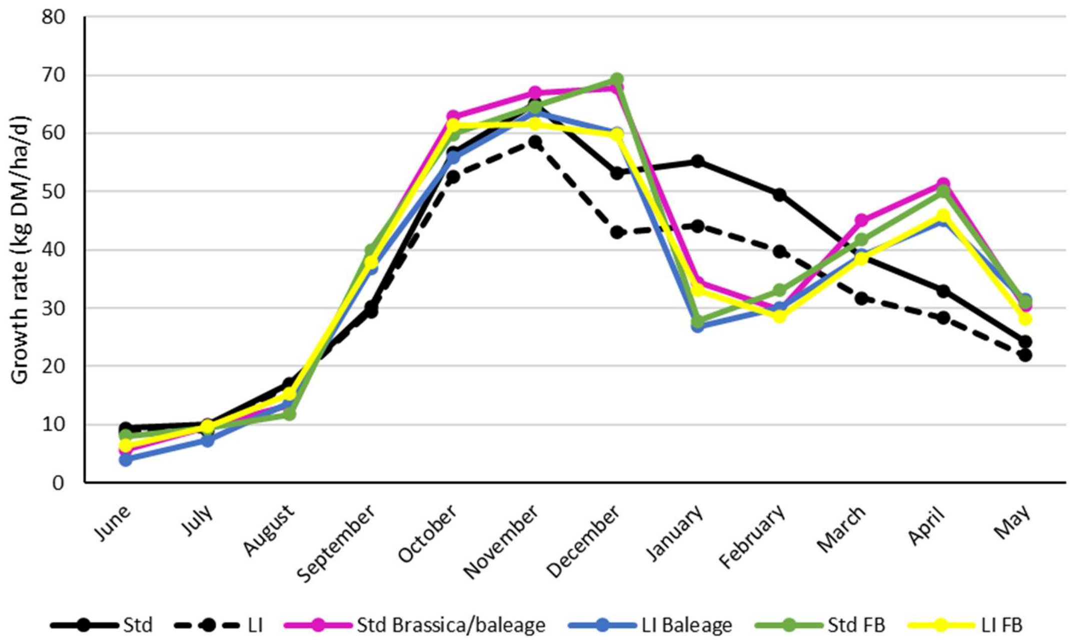


Figure 3: *Farmlet monthly average pasture growth rate compared to the 2019-2022 average*

Current On-farm situation

High average pasture cover at end of lactation has delayed some animals going onto their winter diets. Early dried off Std baleage cows plus heifers stayed on the milking platform until the 6th June taking the top out of high mass paddocks. The LI baleage heifers and lights spent a week off baleage also grazing long paddocks.

There are currently 8 main wintering mob plus a small group that have been pulled out of their wintering system due to lameness and pink eye. Calves are wintering at the grazier and have been on grass until this week but are now transitioning onto swedes.

Our first winter BCS assessment was done the week of the 19th June with results summarised below. Average and individual BCS is tracking well although we are closely monitoring the LI Baleage mobs as they have the highest proportion in both age groups below their pre-calving targets. Our plan is to put BCS on early so we can then hold allocations in the later stages of winter.

Table 1: Summary of wintering mob size, diet and current BCS

Herd	Mob size	Diet	Crop	Baleage	BCS
Std Baleage – cows	109	Baleage	0	12	4.9
Std Baleage – heifers & lights	109	Baleage	0	12	5.2
LI Baleage – cows	67	Baleage	0	12	5.1
LI Baleage – heifers & lights	74	Baleage	0	12	5.0
Std FB – cows	98	Beet + Baleage	9.5	3.5	5.1
Std FB – heifers & lights	100	Beet + Baleage	9.5	3.5	5.2
LI FB – cows	98	Beet + Baleage	9.5	3.5	5.1
Grellows – LI FB heifers & Std FB Cows	83	Beet + Baleage	9.5	3.5	5.2

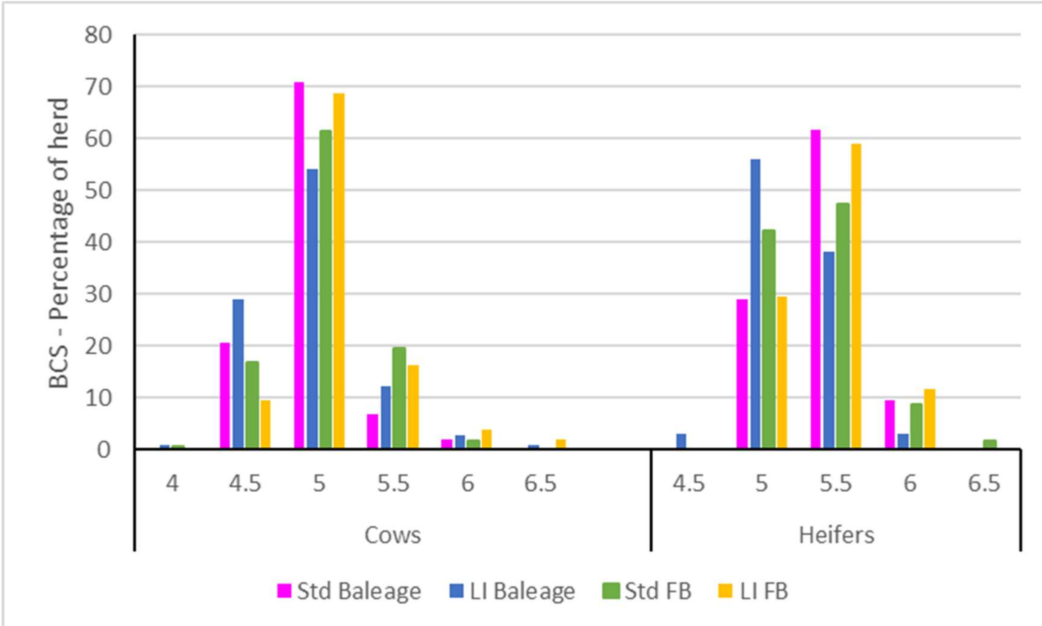


Figure 4: *Current range in BCS for the four farm systems*

<u>Crop yields</u>

This year most of the fodder beet crops have been established with conventional cultivation. Half a paddock was direct drilled and as in the first year pest pressure resulted in it having to be redrilled on the 27th November. While not yielding as high as the conventionally established crop it is currently yielding 21.4 T DM/ha and has held its leaf better (34% at the start of June compared to 20% in the other paddocks)

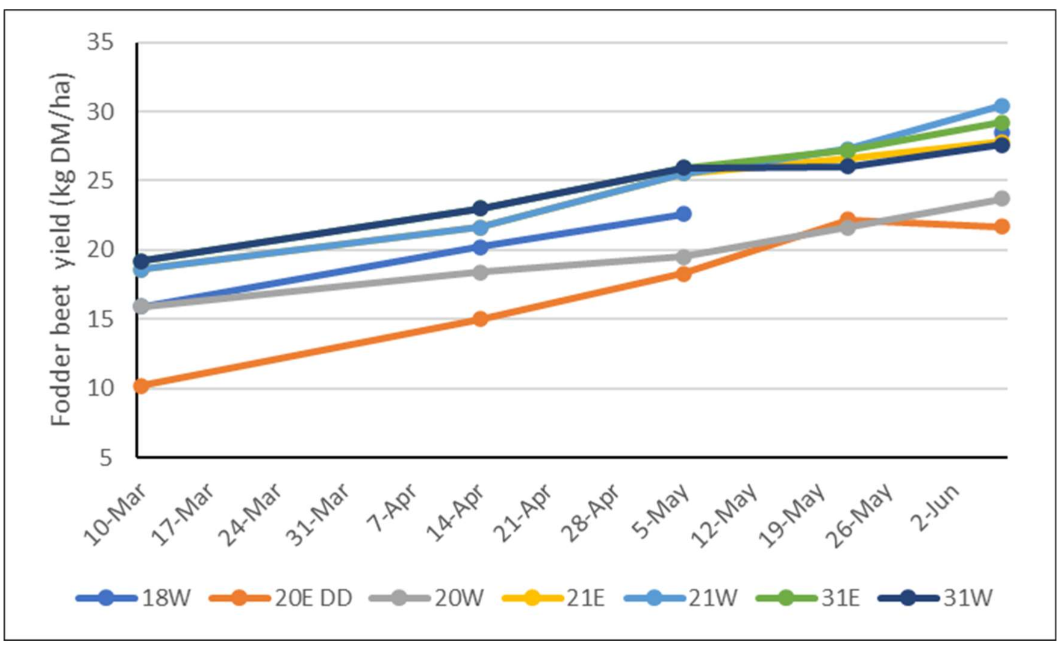


Figure 5: *Fodder beet crop yield trends*

Kale vs Fodder beet 2018-2022 Farm systems comparison

Background

Research priorities for the southern regions of the South Island, identified by farmers in 2017 included wintering, fodder beet, achieving nutrient loss reduction targets and integration of off paddock infrastructure into southern systems. The resulting farm systems comparison was a 2x2 factorial with two crops (kale and fodder beet) for wintering and two levels of system intensity. The lower intensity systems were formulated based on modelling to achieve a 30% reduction in nitrate leaching. Key mitigations for these farmlets were less N fertiliser (180 vs 50 kg N/ha/annum) and lactation supplement type (barley/PKE blend vs fodder beet) and amount 800 vs 500 kg/cow for Std and LI farmlets respectively. With less total feed in the LI systems the stocking rate was reduced from 3.1 to 2.6 cows/ha.

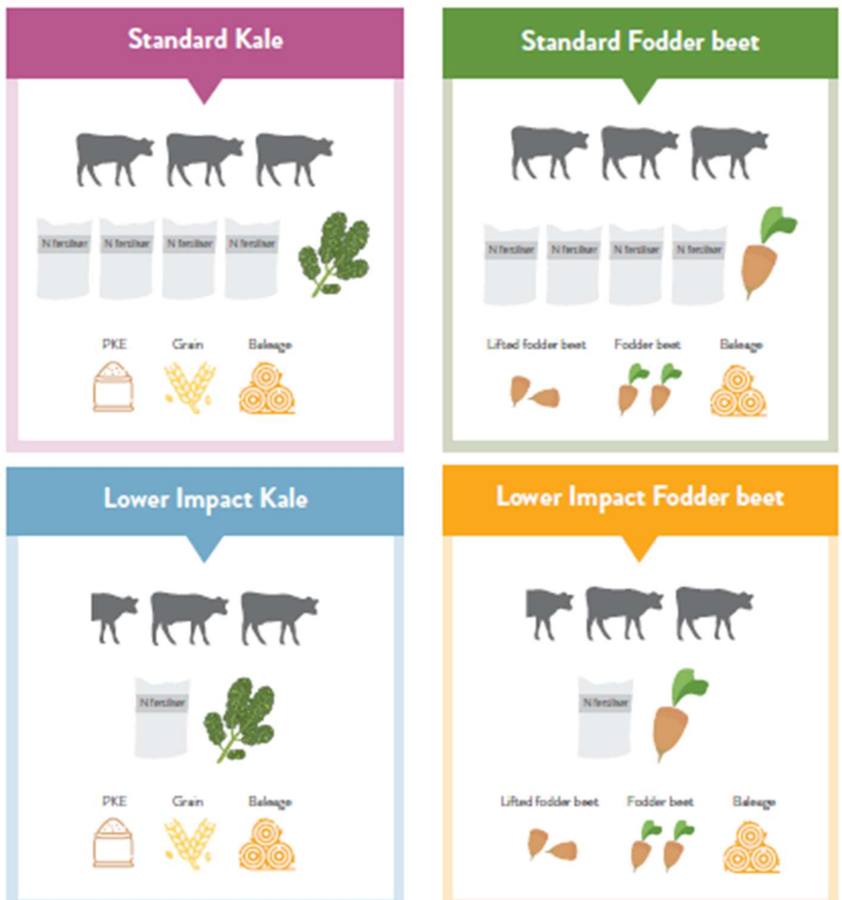


Figure 6: *Current farmlet feed wedges (measured 13th June 2023)*

Four farmlets with the same total area were set up in June 2018. Cows were randomised across the farmlets and each farmlet had to rear their own heifer replacements which remained within their farmlet for the duration of the study.

Kale herds received lactation supplement via inshed feeding and baleage while fodder beet and pasture baleage were the lactation supplements for the fodder beet herds. Each winter half of the paddocks were first year and other half second year crops. Except for early lactation cows only grazed the paddocks in their farmlet and feeding management was guided by a common set of decision rules.

Pasture production

Reducing nitrogen fertiliser input from approx. 180 to 50 kg N/ha/annum reduced annual pasture grown from 13.1 to 11.5 kg DM/ha with most of the difference in growth being observed between November and April (Figure 8). Estimated response rate to the additional nitrogen fertiliser of 11.8 kg DM/kg N applied. From year 1 of the study the LI farmlets have had a higher proportion of clover in their pastures 15.6% vs 8.6% in the standard farmlet paddocks. Average pasture quality has been similar although there has been a lot of variation between paddocks both within and between farm systems.

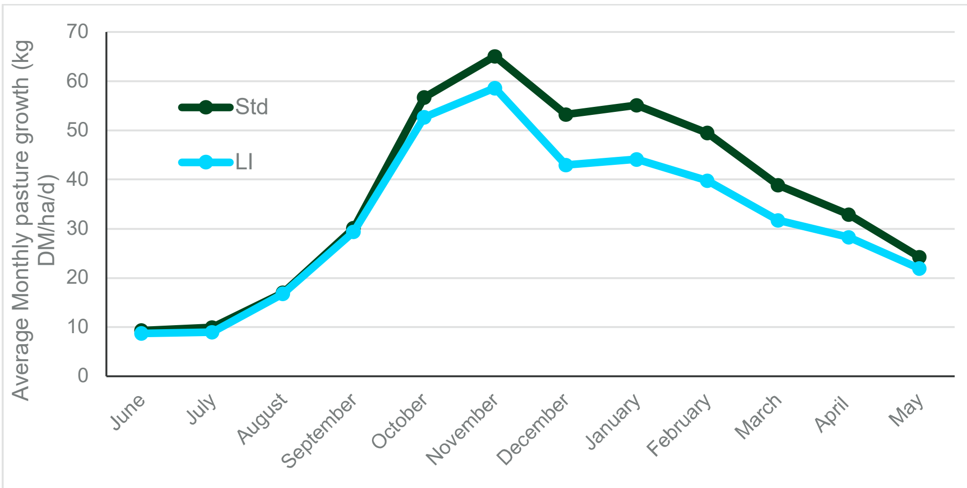


Figure 7: *Average monthly pasture growth for the Standard (185 kg N/ha/annum) and LI farmlets (50 kg N/ha/annum*

There were differences between the farmlets in the area topped to reset residuals/maintain pasture quality with the LI farmlets having more area topped than their corresponding standard farmlets. Area conserved as supplement was variable between years depending on seasonal growth. On average the fodder beet farmlets conserved more supplement/cow than the kale farmlets (Table 2). The fodder beet farmlets also tended to have more total area mown during the season than their paired kale farmlet.

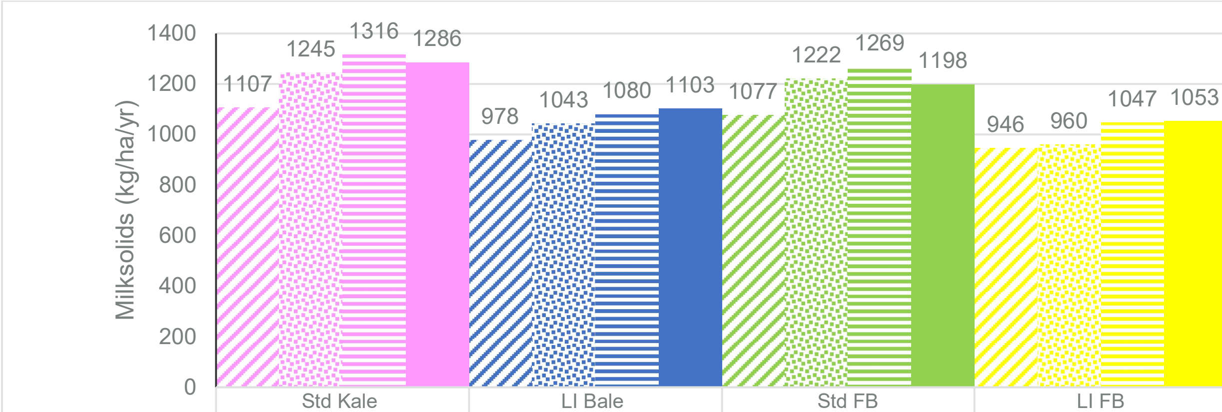
Table 2: Average proportion of the farm conserved for baleage or topped and amount of supplement conserved (kg DM/cow) from each farmlet.

	Farm area conserved (%)	Baleage made (kg DM/cow)	Farm area topped (%)	Total area mown (%)
Std Kale	56	212	62	118
LI Kale	53	231	73	126
Std FB	56	240	69	125
LI FB	58	246	85	143

Milk production

Except for the 2021-22 season, where both standard farmlets dropped production compared with the 2020-21 season, there was a steady increase in MS production per hectare year on year for all farmlets. This increase reflects better on farm management as well as consolidation of pasture growth post conversion in 2017.

Both kale systems outperformed their respective fodder beet systems on a per cow and per hectare basis (Figure 9).



	Std Kale	LI Bale	Std FB	LI FB
2018-19 to 22 May	1107	978	1077	946
2019-20 to 24 May	1245	1043	1222	960
2020-21 to 24 May	1316	1080	1269	1047
2021-22 to 24 May	1286	1103	1198	1053

Figure 8: *Annual milksolids production per hectare per farmlet for the 4 seasons*

Potential factors contributing to the higher per cow and per hectare production for the kale farmlets include:

a. Access to inshed feeding
b. Fewer metabolic issues at calving
c. More cows in milk at peak
d. Higher peak milk production and slower decline from peak
e. More opportunity for discretionary culling – better herd age structure

Only marginal increases in per cow production were achieved in the lower impact systems resulting in significantly lower per hectare production due to the lower stocking rate.

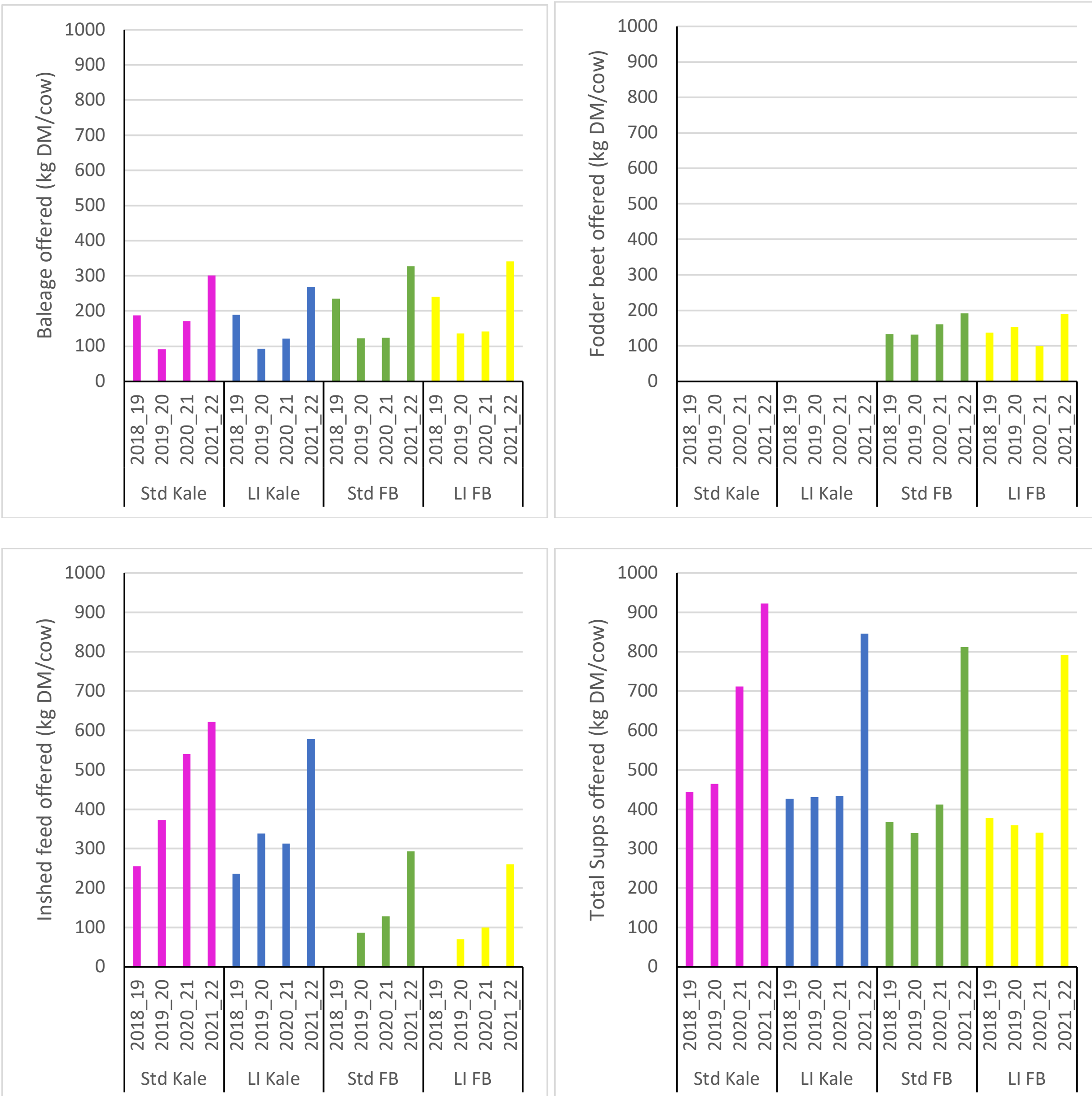
Supplementary Feeding

Seasonal variation in pasture growth resulted in variation in supplementary feed offered across the farmlets within and between years. On average the kale farmlets received more total supplement/cow during lactation than the fodder beet farmlet (Table 3). Fodder beet fed during lactation was a combination of lifted and grazed insitu depending on the season. Early lactation fodder beet only started once all cows had calved.

Table 3. Average annual supplementary feed offered per farmlet (kg DM/peak cow)

	Baleage (kg DM/cow)	Fodder beet (kg DM/cow)	Inshed feed (kg DM/cow)	Total supplement (kg DM/cow)
Std Kale	188	0	448	636
LI Kale	168	0	367	535
Std FB	202	154	127	483
LI FB	215	145	107	467

In the second two seasons inshed feed was only offered to cows in the fodder beet herds if they required priority feeding for BCS management and they only received PKE. In the dry of the 2021-22 season when up to half of the diet was required as supplementary feed the decision was made to allow the fodder beet herds access the PKE in the dairy at milking as it was not feasible to fill the feed gap with baleage. Group feeding in trailers in the paddock was considered however it was deemed more efficient to feed through the dairy.



Figures 9 a-d: *Annual average supplementary feed offered per cow for the four seasons a. baleage, b. fodder beet, c. Inshed feed and d. total supplements.*

<u>Reproductive performance</u>

Reproductive performance was variable between years and systems however the kale farmlets did outperform the fodder beet farmlets in several areas:

a. Used less CIDR's - 10.7 (kale) vs 14% (fodder beet) of animals
b. Had a higher average 3-week submission rate
c. 2 days shorter interval between calving to conception

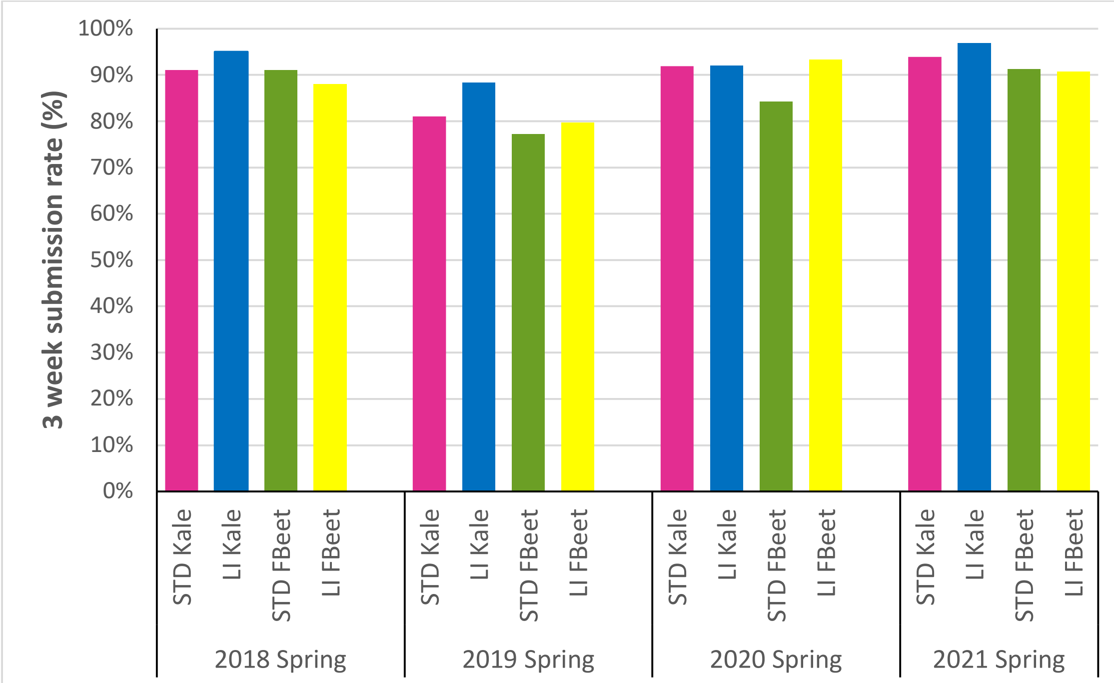


Figure 10: *3-week submission rate for the four farmlets for the 4 years of the study*

Animal Health

Cows wintered on fodder beet were more likely to experience metabolic issues at calving and lameness during lactation. Phosphorous was supplemented through out the winter period utilising both DCP (50 g/cow/day dusted on baleage) and a loose mineral mix (70 g/cow/day). DCP was also dusted onto pasture to the colostrum mob and any time that the fodder beet herds were consuming beet during lactation.

Despite proactive animal health management death rates were higher in the fodder beet herds resulting in less opportunity for discretionary culling. While there was an increased risk of metabolic disease there were more other random deaths in the fodder beet herds.

The fodder beet cows calved on average 0.9 days earlier than their expected calving date while the kale cows were more likely to calve after their predicted calving date.

Body condition score management

Winter body condition score gain was better on fodder beet than on kale, despite offering similar daily metabolisable energy allocations and accounting for differences in crop utilisation between the kale and fodder beet crops. Because of the improved ability for winter BCS gain in the fodder beet systems fewer cows were required to be dried off earlier in the autumn to ensure that pre-calving BCS targets were met.

OAD milking and priority inshed feeding were used to manage BCS during lactation. Cows on OAD stayed within their herds but were not milked in the afternoon but did receive inshed supplement. This in season management reduced the number of cows across the farm requiring early autumn dry off in the later years of the project.

Nitrogen leaching losses – Research undertaken by AgResearch

To increase knowledge of the environmental impacts of these grazed forage crops, N leaching losses were measured in selected treatments during 2018, 2019 and 2020 to provide

- Quantitative N leaching data for the crops, soils and climate of SDH.

- N leaching comparisons between:
    - autumn-grazed v lifted FB,
    - winter-grazed kale v winter-grazed FB, and
    - selected pastures on the milking platform.

Average N leaching losses for the 3 years of measurements are presented in Figure 11 below. These results show that N leaching under the winter-grazed fodder beet crops was on average only 50% of that under the winter-grazed kale crops, while the autumn harvested FB leached a similar amount to the winter grazed kale.

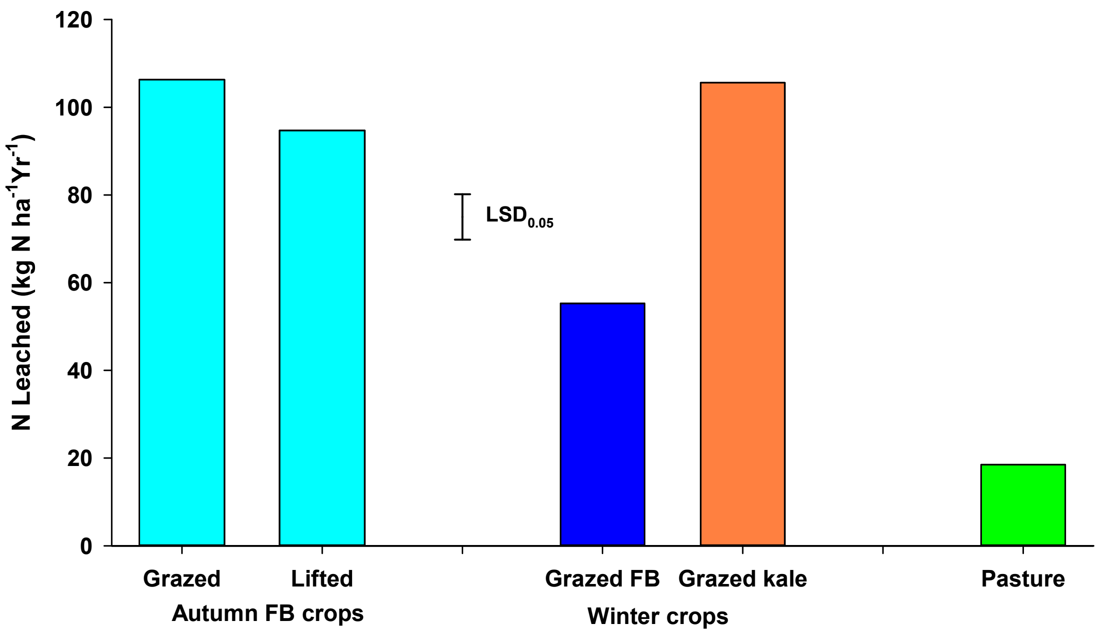


Figure 11. *Average annual N leaching losses (2018, 2019 and 2020) from autumn-grazed or -lifted FB, and winter-grazed FB or kale treatments. Average N loss from 3 pasture paddocks (Standard farmlet) is also shown (in green). The LSD bar represents a significant difference between the forage crop treatments at a 95% confidence level.*

Likely N losses per cow wintered were calculated using the yields of the FB and kale treatments, cow daily feed allocations and adjusting the areas required for each crop. These results, shown in Table 4, indicate that using FB as a winter grazing option is likely to result in 60% less N leached per cow wintered.

Table 4. N leaching losses from winter-grazed crops (average of 3 years of data).

	Kale	Fodder beet
Kg N leached per ha per year	106	55
Kg N leached per cow wintered	5.6	2.0

Using the losses calculated by Overseer for the pasture areas of the milking platform combined with the measured N losses from the winter crop areas, it is possible to estimate the total N losses from each of the 4 farmlets. These results, presented in Figure 12, indicated that the change in fertiliser N inputs resulted in about

22% less N leached. Similarly changing from kale to fodder beet as the winter crop lowered N leaching losses by about 16%. The low impact (N) FB treatment leached 34% less than the standard kale farmlet.

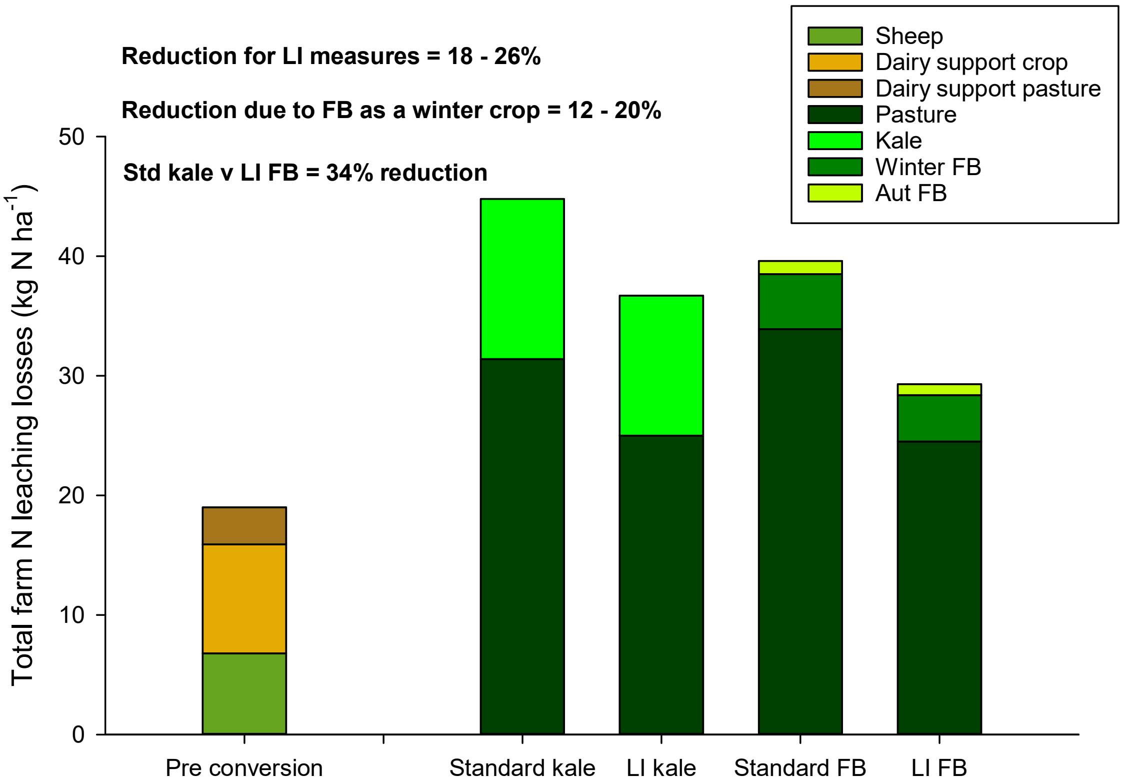


Figure 12. *Comparison of the calculated and measured N losses pre conversion and from the four farmlets. Note that the low impact (LI) treatments indicate lower N inputs*.

Summary

- Autumn grazing of FB resulted in significantly greater N leaching losses than observed for winter-grazed fodder beet. Differences are likely due to two effects:
  - Timing: removal of plant cover and deposition of urinary N in autumn increases the potential for N loss in subsequent drainage, because no N is captured by plant growth; and
  - Animal N intake: slightly less plant N was consumed by the herd that grazed the winter crop of FB. Urinary N returns would thus also be reduced, leading to lower N leaching losses.
- Leaching losses from winter-grazed kale were greater than estimated for winter-grazed FB.
- Leaching losses of N from autumn-lifted FB were relatively large, and similar to losses from autumn-grazed FB. This was unexpected and may be due to high mineralisation of soil N following the dry summer of 2018.
- Measured losses of N from the pasture paddocks were relatively low, and similar to modelled expectations.
- Lower N inputs resulted in 16 to 24% lower N leaching losses while changing from kale to fodder beet lowered N leaching losses by 12 to 20%.

Greenhouse gas emissions – Research undertaken by AgResearch

As part of the SDH Participatory research project, the greenhouse gas (GHG) footprint for the four SDH farmlets was calculated (Table 5). On-farm emission sources included rumen-derived enteric methane (CH_4) from livestock, nitrous oxide (N_2O) and CH_4 emissions from animal excreta, and N_2O and carbon dioxide (CO_2) emissions from N fertiliser applied to pasture and crop. These sources align with those included in the current He Waka Eke Noa requirements for reporting on-farm GHG emissions. For each farmlet, emissions were split into short-lived and long-lived GHGs:

- Short-lived: CH_4. Units = kg CH_4
- Long-lived: N_2O and CO_2. Units = kg CO_2 equivalents (CO_2e), based on Global Warming Potential over a 100-year time horizon (GWP_{100}).

Table 5: Milking platform (MP) area, milk production (kg milk solids), greenhouse gas emissions (kg of methane/ha MP and N_2O+CO_2 as kg CO_2e/ha MP) and GHG pricing (discounted cost) for the four Southern Dairy Hub farmlets for the 2019-20 season. LI=low input; FB=Fodder beet

	Standard Kale	LI Kale	Standard FB	LI FB
Farmlet information				
Area of MP (pasture + lactation crop, ha)	62.4	63.2	65.3	66.5
N fertiliser rate (kg N/ha pasture)	180	56	175	57
N fertiliser rate (kg N/ha crop)	151	145	149	155
MS production (total kg MS)	77688	65854	77104	62400
Profitability ($/ha)	2,746	2,460	2,571	1,712
Greenhouse gas sources and emissions				
Methane (kg CH_4/ha MP)				
Enteric fermentation	419	338	382	306
Manure management	20	16	20	15
Total methane	**440**	**354**	**402**	**320**
Nitrous oxide (kg CO_2e/ha MP)				
Urine and dung	2,068	1,608	1,792	1,339
Manure management	32	28	29	26
N fertiliser on soil	584	228	541	210
Total nitrous oxide	**2,684**	**1,865**	**2,363**	**1,575**
Carbon dioxide (kg CO_2e/ha MP)				
Urea fertiliser on soil (on-farm[1])	360	151	337	142
Total carbon dioxide	**360**	**151**	**337**	**142**
GHG pricing (for 2019-20 season) (discounted cost)				
ETS back-stop ($/ha MP)	$59.65	$46.13	$54.15	$41.35
He Waka Eke Noa split-gas level				
$/ha MP	$61.30	$47.46	$55.66	$42.55
cents/kg MS	4.9c	4.6c	4.7c	4.5c

[1]He Waka Eke Noa GHG reporting does not include embedded emissions associated with supplements brought onto farms e.g. emissions from N fertiliser used for PKE production. However, embedded emissions may impact global market access of NZ products.

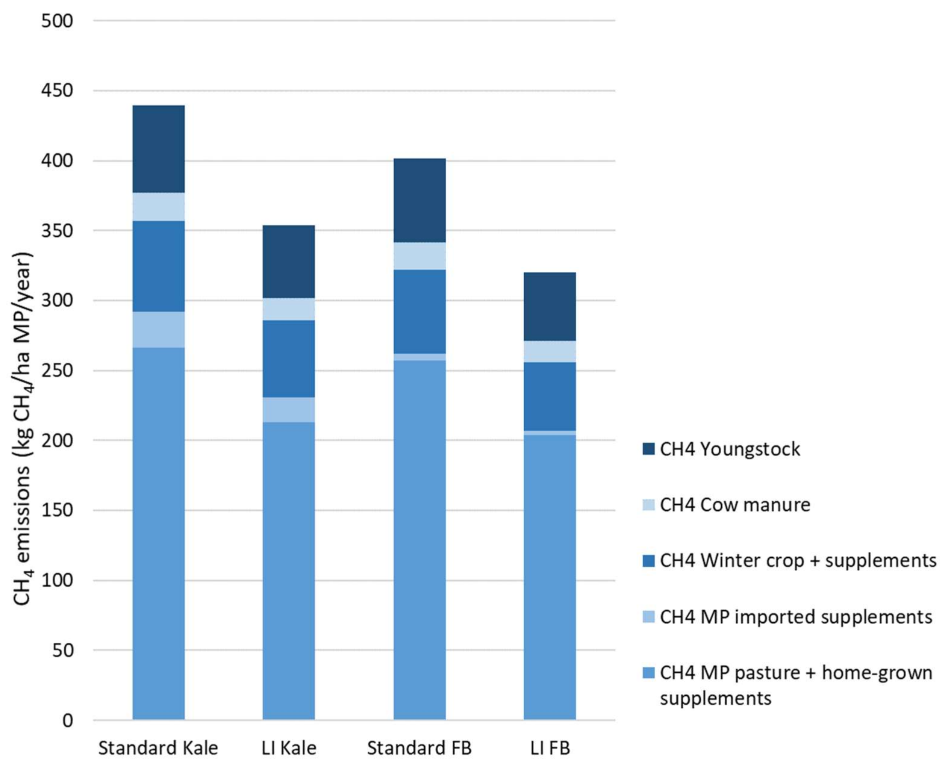


Figure 13: *Farmlet methane emissions by source*

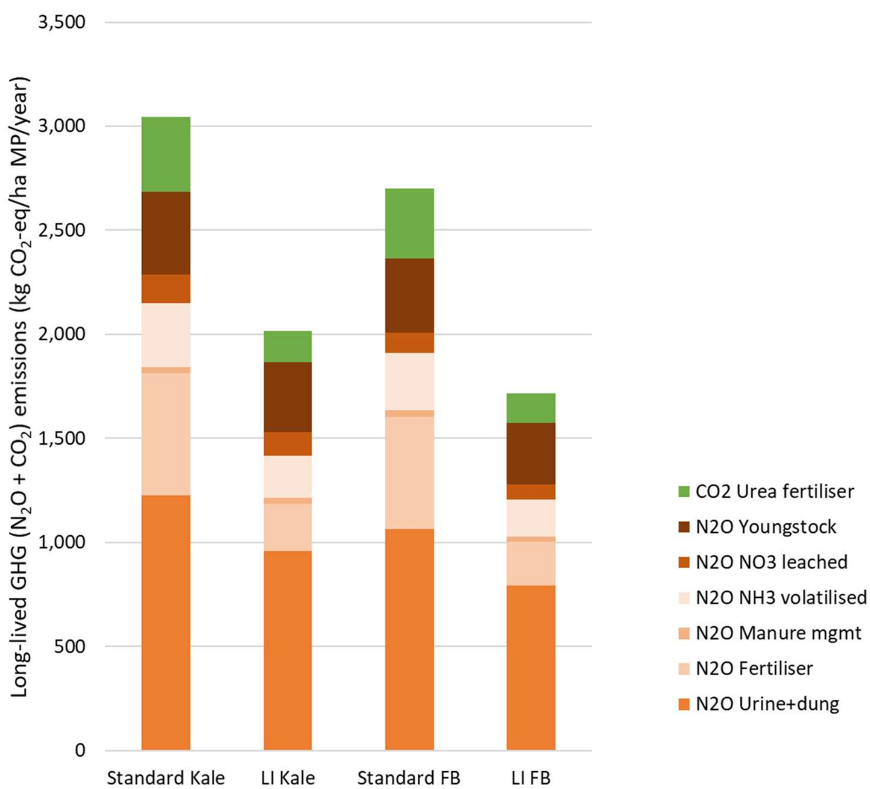


Figure 14: *Farmlet long lived greenhouse gas emissions by source*

GHG emissions – key results:
The effect of a Lower Input system (reduced N fertiliser and supplement use and thus lower stocking rate) had a much larger effect on GHG footprints than the choice of crop type:

- The LI systems had 20% lower methane footprint and 35% lower long-lived gas footprint than the Standard farmlet systems.
- The Fodder beet systems had a 9% lower methane footprint and 13% lower long-lived gas footprint than the Kale systems.
- The reduced N inputs in the LI systems also resulted in a reduction in direct and indirect N2O emissions from fertiliser use and from urine and dung deposition.

Enteric CH_4 from ruminants grazing pasture grown on farm was the largest methane source, representing 95% of methane footprints.

Nitrous oxide emissions from animal excreta represented 67-81% of total long-lived gas footprint, with the balance due to urea fertiliser.

Other research has measured a 39% lower nitrous oxide emissions from urine patches of cows grazing FB than from cows grazing kale despite both having the same rate of nitrogen deposition with the authors proposing the existence of inhibitors in both urine and soil of fodder beet paddocks.

Financials

Across all seasons the fodder beet farmlets were not as profitable as the kale farmlets.

Table 6: Average annual farm systems profitability ($/ha) and average operating expenses ($/kg MS)

	Std Kale	LI Kale	Std FB	LI FB
Net Operating profit $/ha	$3168	$2795	$2678	$2527
Profit differential cf Std Kale		$ -373	$ -490	$ -670
Operating expenses $/kg MS	$5.42	$5.30	$5.72	$5.63

Key drivers of the differences were:
Income:

- better milksolids production per cow & per hectare in both kale herds compared to their fodder beet counterparts
- lower stock sales for the fodder beet herds (less discretionary culls)

Expenditure

- higher animal health costs for the fodder beet farmlets
- higher supplementary feeding costs for fodder beet farmlets
- higher cropping costs for fodder beet farmlets
- higher staff costs for fodder beet farmlets
    - extra fences to set up in crop paddocks
    - feeding fodder beet during lactation
    - more in paddock supplementary feeding

Overall System comparison

The farm systems comparison set out to identify farm systems with reduced environmental footprint and better understand the challenges with wintering on fodder beet and offering it as a lactation supplement. At the time the project was set up fodder beet feeding was at its peak for both winter and lactation feeding and farmers were concerned of potential negative effects on production and reproduction. This project has confirmed some of the negative impacts but has also highlighted some opportunities for fodder beet with regards winter BCS management and reducing environmental footprint. The results highlight the tension between environmental benefits and profitability.

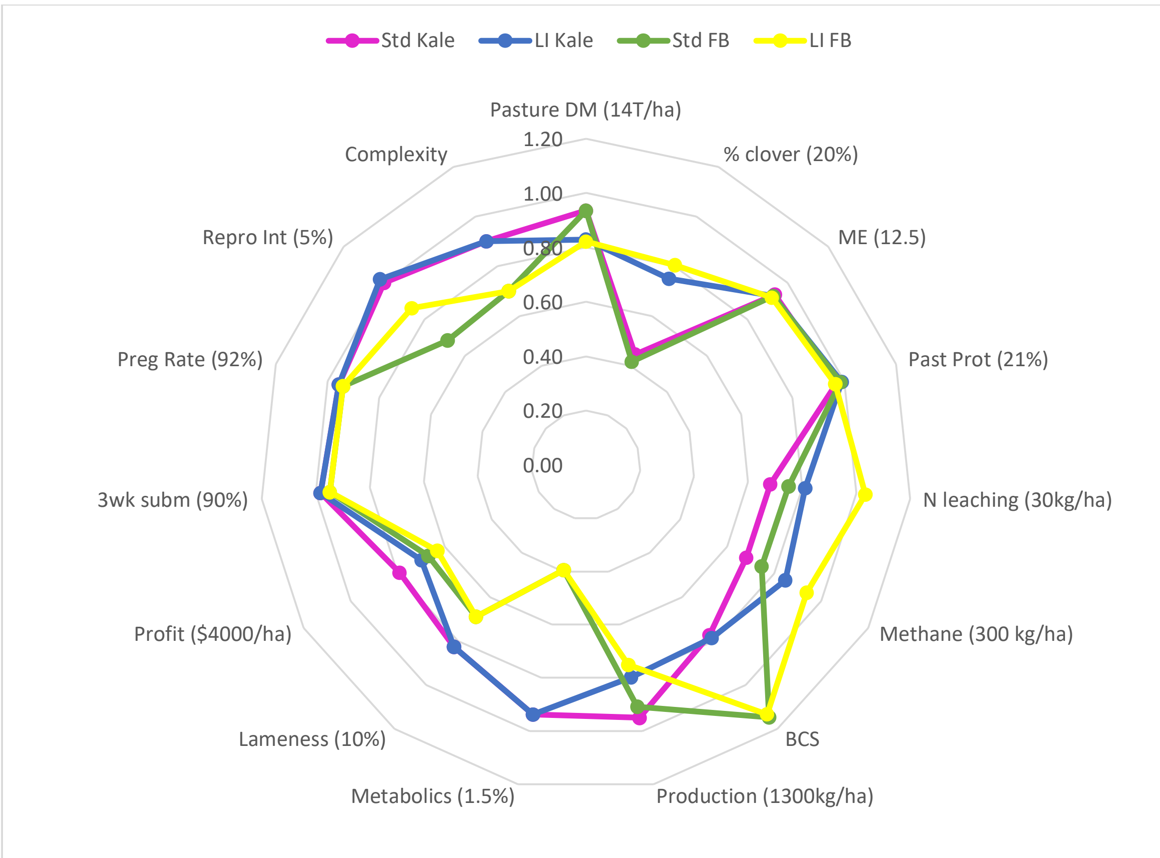


Figure 15: *Farmlet performance relative to industry benchmarks for a range of system KPI's*

Future fodder beet systems need to maximise the environmental and BCS benefits while maintaining production and profitability. We believe this is possible but will require a reset of feeding levels and length of feeding.

Research in aligned projects has helped define boundaries for fodder beet feeding for optimal results. Based on these results the current fodder beet feeding recommendations to minimise nutrient imbalances include:

- Testing all feeds to determine their nutritional value and develop feeding strategies based on results

Growing R1 cattle:

- A maximum of 60% fodder beet in the diet DM.
- Supplementation with pasture silage with adequate crude protein
- Supplement Ca and P when feeding more than 40% fodder beet.

Dry cows:

- A maximum of 60% fodder beet in the diet DM
- Supplementation with pasture or cereal silages with adequate crude protein.
- Supplement P throughout the dry period, Mg for at least 14 days before calving and Ca, P and Mg following calving.
- Increase dietary protein intake in the last 4 weeks of gestation

Lactating cows:

- A maximum of 30% fodder beet in the diet DM
- Supplementation with pasture or supplements with adequate crude.
- Supplement P whenever feeding fodder beet

Successful feeding requires attention to detail throughout the planning and feeding process. Farmers feeding fodder beet successfully use the following guiding principles:

1. Plan – paddock selection and setup, feed budgeting, strategies for meeting nutrient requirements and minimising environmental risks
2. Measure – crop yield, feed quality, body condition score, animal mineral levels
3. Observe – animal health especially during transitioning, growth rates of youngstock

The Farm

Farm Area
Milking platform: 299 ha
Support Block: 39 ha
Unproductive land: 2 ha

Milking infrastructure
60 bale rotary dairy with DeLaval plant and Delpro Herd Management software
Automatic cup removers and on-platform teat spray, Automatic drafting and weighing
Greenwash on the backing gate

Climate
Mean Annual Maximum Temperature - 17.7 °C
Mean Annual Minimum Temperature - 5.4 °C
Average Annual Soil Temperature – 11.0 °C
Average Annual Rainfall – 785.4 mm

Soil Types
Table 4: Soil types, locations and characteristics on farm

Soil type	Location	Characteristics
Edendale	Top terrace	Well drained, high WHC, seldom dries out
Pukemutu	Through centre of farm	Poorly drained due to sub surface pan between 600 and 900 mm deep. Vulnerable to waterlogging.
Makarewa	Bottom terrace	Poor aeration during wet periods due to poor sub surface drainage and slow permeability. Severely vulnerable to waterlogging in wet periods.

Staffing and management
Roster System – Year-round 5 on 2 off
Milking Times – cups on at 5 am / 2.30 pm

Effluent System
Two receiving ponds with weeping walls, leading into a storage pond. Effluent applied by travelling irrigator. Solids cleared out November 2018. Some effluent applied by umbilical system in March 2019. Greenwash on the backing gate

Herd Details
Table 5: BW and PW as of 26 February 2023

		BW	PW
Pink – Std Swede/Baleage	**Cows (230)**	202	253
Blue – LI Baleage	**Cows (141)**	205	258
Green - Std FB	**Cows (230)**	203	254
Yellow – LI Kale	**Cows (141)**	217	271
Grouped	**Yearlings**	275	286

We would also like to recognise and thank the businesses who continue to support us, specifically: