Leading Innovation for
Southern farmers' propserity

SOUTHERN DAIRY HUB

March Field Day 2022

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Contents

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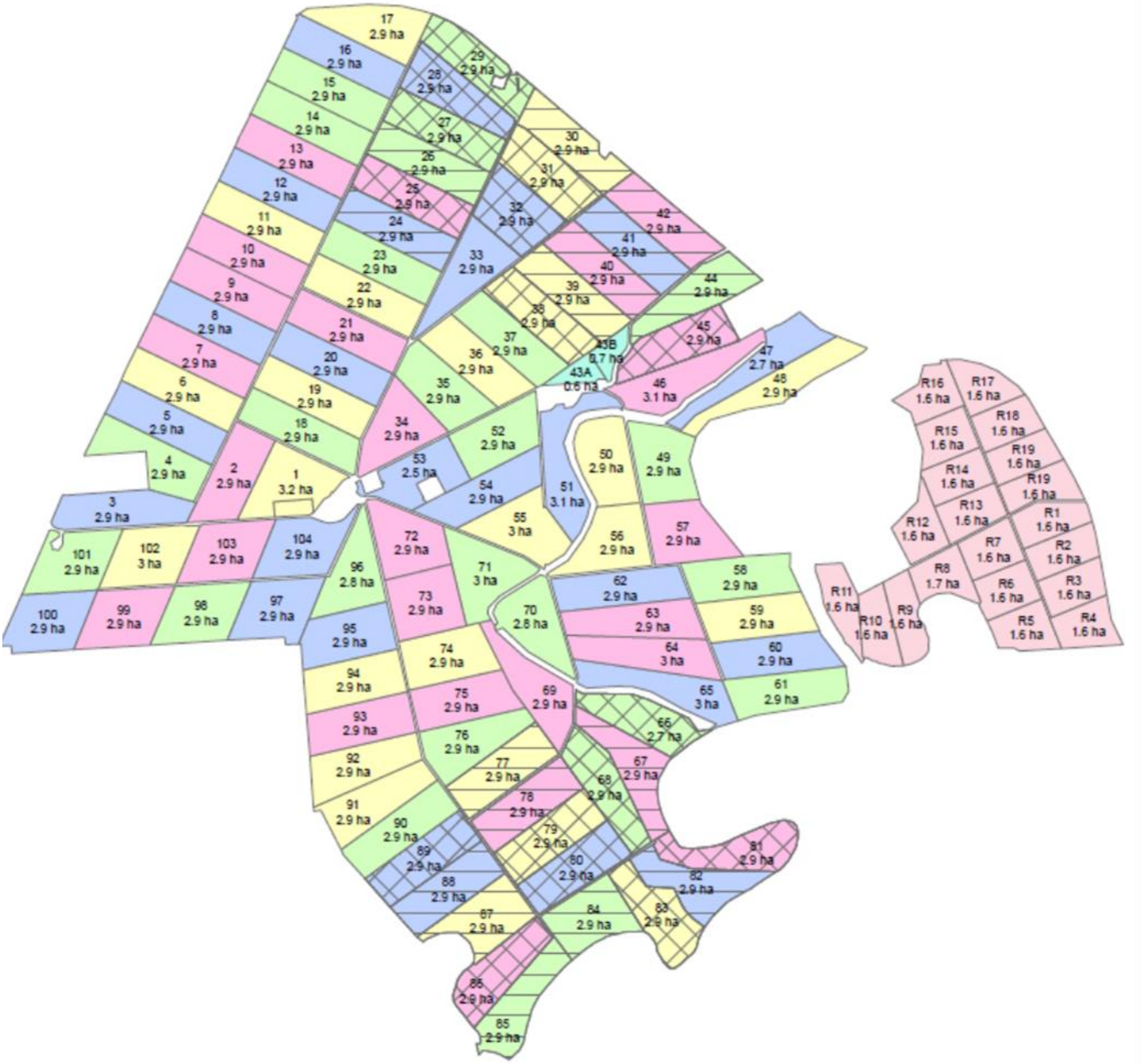
Farm Map



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Covid-19 Information:

- All attendees must maintain 1 metre physical distancing at all times
- Good health and hygiene standards must be maintained throughout the event and use of a face mask is compulsory for all attendees
- Attendees must record their attendance to enable contact tracing and scan the COVID QR code upon arrival
- Please do not attend this event if you are unwell or suspect you may have been exposed to COVID-19

Please note: The above requirements may be subject to change in accordance with COVID alert levels and Government requirements at the time of the event.

Visitor Health and Safety Requirements

Entry onto property by permission and appointment only.

Contact either:

General Manager Louise Cook 027 564 5595 or

Ops Manager Charlie McGregor 027 207 6012

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

- Communication – sign in and out
- 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
- Farm bikes – trained operators only, helmet with strap done up at all times, never operate if under 16 years old
- Vehicles – no one to operate farm vehicles without manager's permission

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- 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
- Firearms – only with approval of farm manager, must hold current licence

Biosecurity Requirements for Southern Dairy Hub (SDH)

All visitors must comply with the Biosecurity Requirements when visiting the SDH

- Visitors must comply with MOH guidelines regarding COVID-19, including wearing of masks indoors and presenting a valid vaccine passport.
- All footwear must be disinfected with materials supplied, upon arrival at and departure from the SDH farm site.
- Protective footwear may be borrowed from the SDH upon request, and must be cleaned thoroughly before its return. People wearing inappropriate (or no) footwear will not be allowed onto the SDH premises.
- 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, under any circumstances, from anyone within five days of their arrival in New Zealand from Central or South America, any part of Asia or any part of Africa. Further restrictions may be applied at any time, dependent upon international disease status.
- On farm, visiting vehicles must be parked in designated visitor parking areas. Approved vehicles may only access the farm after washing the undercarriage. This may be repeated prior to departure but this is up to the operator concerned.
- SDH retains the right at any time to refuse access to any person or persons deemed not to be complying with these requirements.

SDH 2021- 2022 Season To Date Summary

Feed supply and growth rates

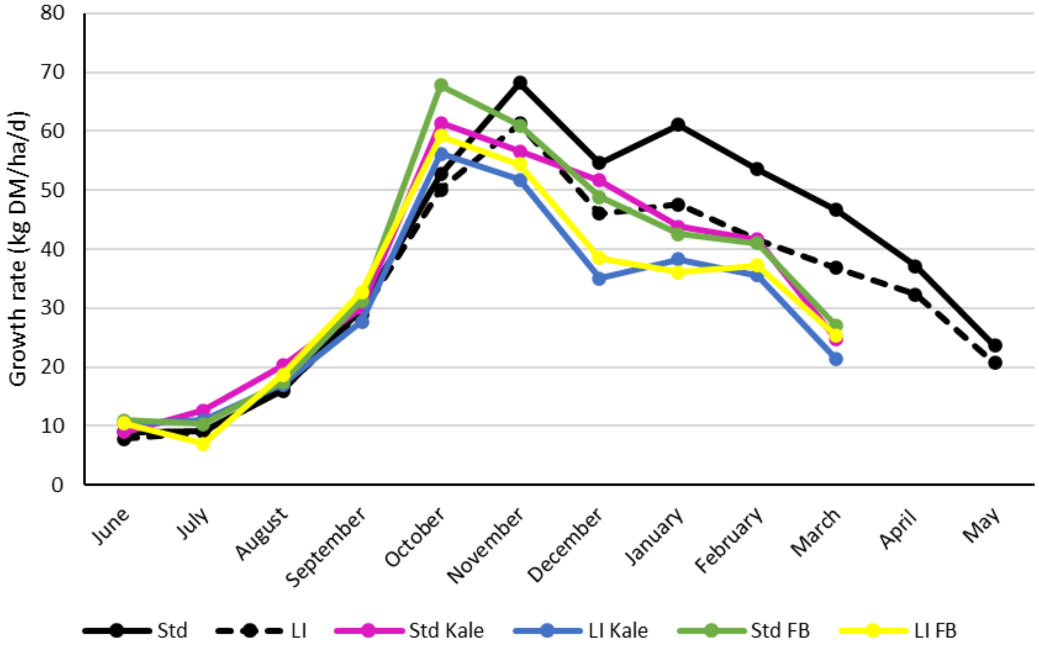

Figure 1: *Season to monthly pasture growth rate comparison for all the herds*

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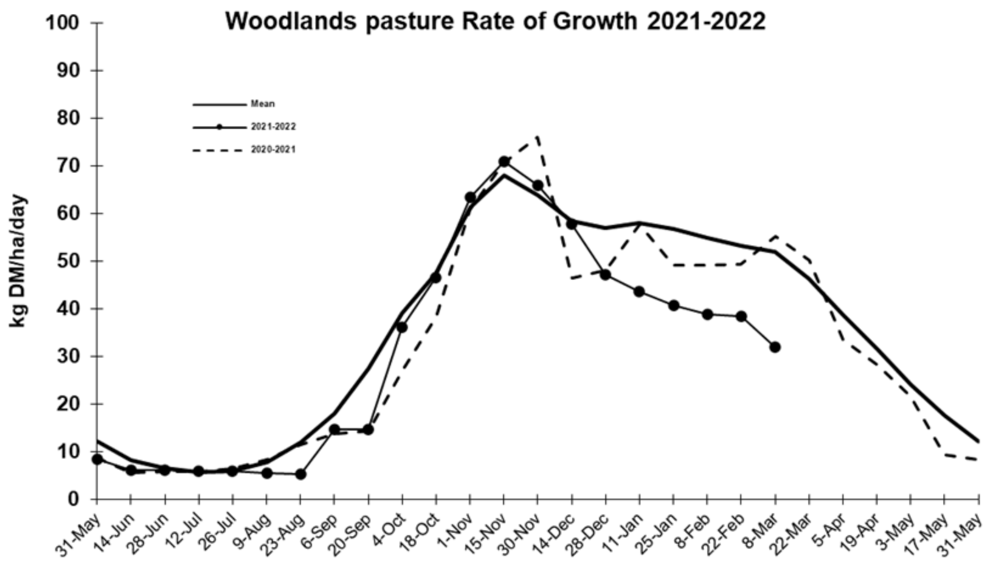

beef+lamb new zealand

Ballance agri-nutrients

Figure 2: *Woodlands average pasture growth rate (2021-22) relative to the long-term average*

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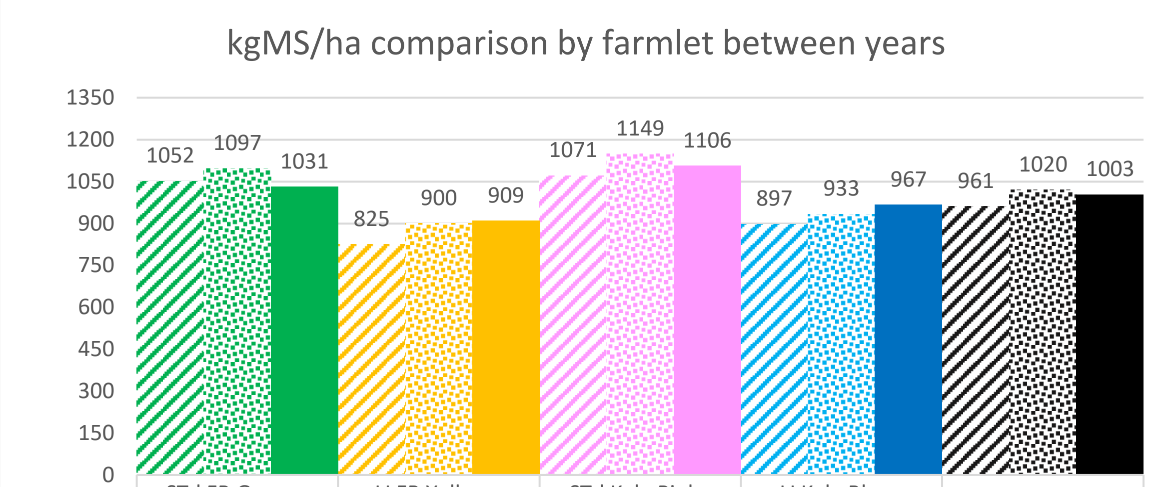
Milk production



	STd FB Green - kgMS/ha	LI FB Yellow - kgMS/ha	STd Kale Pink - kgMS/ha	LI Kale Blue - kgMS/ha	Farm
2019-20	1052	825	1071	897	961
2020-21	1097	900	1149	933	1020
2021-22	1031	909	1106	967	1003

Figure 3: *Season to date production comparison for all the herds*

Summer/Autumn decision making summary

- Early February - Started extending rotation to 30-32 days
- 20th February – exited 39 in-milk culls
- 1st March – exited 20 in-milk culls
- 3rd March – revised autumn feed budgets
- 3rd March – purchased additional milking quality baleage for autumn
- 3rd March – introduced lucerne baleage and increased supplementary feeding
- 6th March – all herds to 3 n 2 milking
- 6th March – started extending rotation to 40-42 days
- 11th March – rotation length out to 40-42 days
- 27th March – all herds to OAD milking
- 27th March – started feeding fodder beet to Std & LI FB herds

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Spotlight on herd improvement and production efficiency

Introduction:

With the reduction in cow numbers and the increased focus on the environment, cow efficiency needs to come to the forefront of herd improvement and the breeding decisions we make on farm.

The projection presented in the Climate Change Commission Report showed we should be expecting the same level of production but from fewer cows. To achieve this, we need to ensure we are breeding and keeping the best, most efficient cows coming through the system.

Production efficiency:

Breeding Worth (BW) is the index that ranks cows and bulls on their expected ability to breed profitable, efficient replacements. Liveweight is included in BW as the 'efficiency' part of production efficiency.

The representation of "kgMS per kgLWT" is often used as a key performance indictor on many diary farms across New Zealand.

Phenotypic records:

It is common practice for farmers to Herd Test their cows to obtain information on their productive ability. Last season (2020-21) 76.2% of cows in the national herd were herd tested (Dairy Statistics, 2020-21).

Just as important is the recording of liveweight records, to obtain a more accurate estimate of cow efficiency. Unfortunately, the recording of liveweight data is less frequent, with only 2.5% of all herd tested cows being weighed during 2020-21.

Impact of recording liveweight for all SDH animals:

Table 1 shows the movement in Breeding Worth and Production Worth for the four farmlets, following the recording of liveweight records at the end of last year.

Table 1: analysis of indices post recording of Liveweights

Measure	RKLX	TBGG	TBGH	TBGL
Expected LWT	514	509	510	509
Actual LWT	481	483	470	464
Herd Prev BW	122.86	129.78	122.21	134.31
Herd New BW	122.91	129.69	122.30	134.31
Change BW	0.05	-0.09	0.10	0.00
Highest BW now	248	230	240	291
Lowest BW Now	-26	-6	-53	-97
Max BW inc	25	22	40	26
Max BW Dec	-37	-20	-37	-23
Pre PW	147.21	156.14	137.88	164.24
New PW	147.09	156.02	137.93	164.22
Change PW	-0.12	-0.12	0.05	-0.02
Highest PW now	511	506	518	545
Lowest PW Now	-330	-332	-271	-566
Max PW Inc	85	63	66	76
Max PW Dec	-101	-58	-98	-78

Actual weights can vary significantly from ancestry liveweight information and will result in some reranking of animals within the herd.

For example, the extreme movements observed in the RKLX herd was +$25 and -$37 for BW and +$85 and -$101 for PW. This could be the difference between an animal being culled or not.

Weighing the herd will improve the accuracy of an animal's indices, allowing you to make more informed breeding and culling decisions.

Not only that, but it will also increase the accuracy of the production efficiency measure, which is a key component of an animal's environmental footprint.

Environment, HoofPrint® & Genetic Gain

Tony Fransen, LIC – Environment & Welfare Manager

There is now a greater focus on farm efficiency to assist with achieving environmental reductions while maintaining productive and profitable systems. The two main areas of concern are greenhouse gas emissions and water quality outcomes. While regulators are imposing overall limits and reduction targets, we as an industry need to be maximising our efficiency to enable production and profitability to be maximised under the regulatory measures.

The dairy cow is a central part to the level of environmental risk and production efficiency. Improved dairy genetics leads to greater production efficiency of dairy cows. Breeding worth (BW) is measure of production efficiency calculating the economic potential of the animal relative to a quantity of feed consumed.

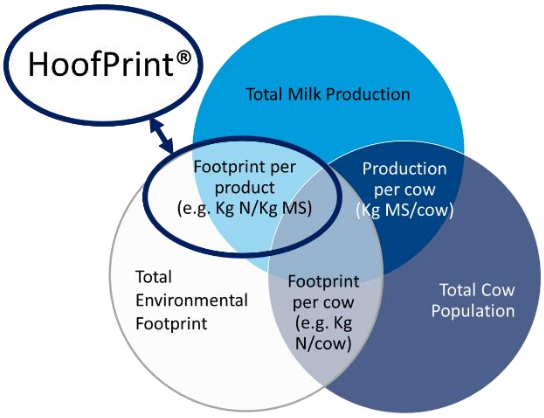
Dairy animals contribute to environmental risk in two main forms: enteric methane, burped or belched from the cow during digestion process; and urinary nitrogen excreted in the urine. LIC has a strong desire to see how genetics can further contribute to reducing the levels of methane and nitrogen deposited to the environment by dairy animals.

LIC is working on these in two parts:

1. Improved animal performance and efficiency (e.g. tools like BW and HoofPrint®)
2. Measuring new phenotypic traits (e.g. measuring methane emissions from breeding bulls)

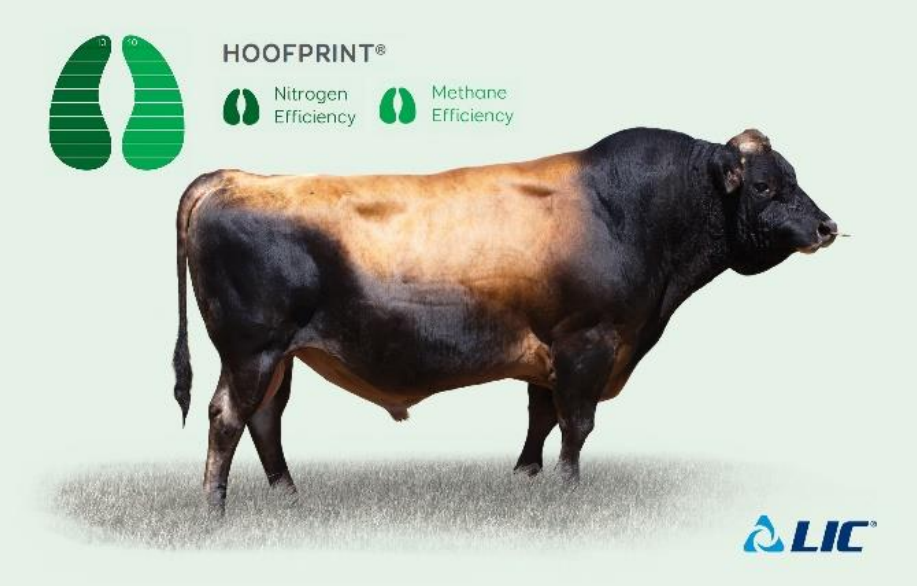
HoofPrint®

HoofPrint index has been generated to help quantify the environmental efficiency of available dairy genetics. Its purpose is to show farmers how genetics may help them achieve their environmental targets and enable them to make informed decisions.



HoofPrint index is a 10 point rating system based on the modelled lifetime production relative to the lifetime emissions and excretion generated. The methane and nitrogen ratings are measured in:

- Nitrogen - Lifetime urinary nitrogen per lifetime milksolid production (kg N/kg MS) and
- Methane - Lifetime enteric methane per lifetime milksolid production (kg CH_4/kg MS)

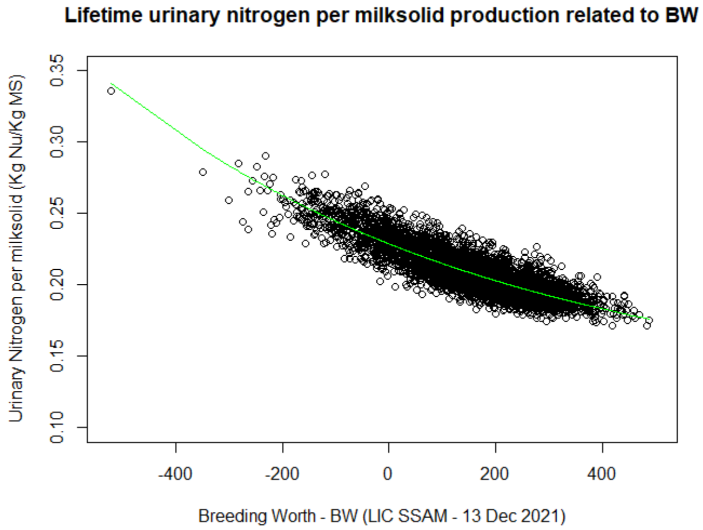


HoofPrint is calculated using animals breeding values (BV) and an energy and partitioning model based on the calculations used in the ‘Methodology for calculation of New Zealand’s agricultural greenhouse gas emissions’.

HoofPrint® modelling results

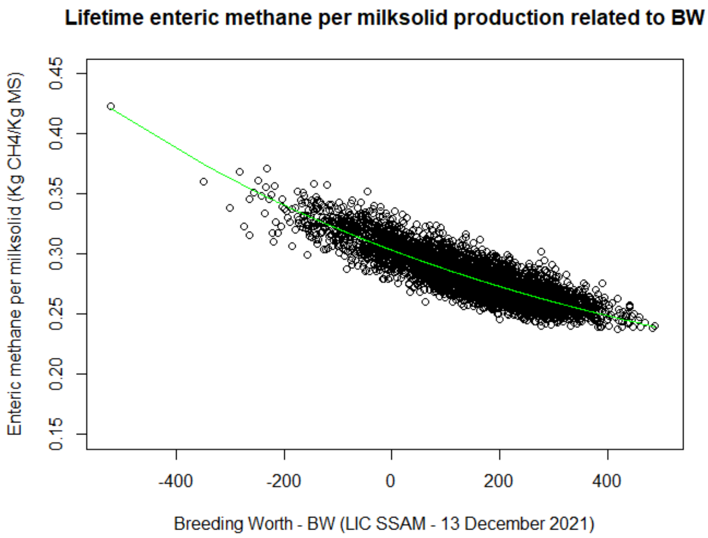
Using the reference population of mature dairy bulls, registered with NZAEL, born since 2011. We can see there is a strong relationship between BW and environmental efficiency.

The results for urinary nitrogen per milksolid over the animals lifetime shows for every $10BW higher the animal is there will be on average 1.3g less urinary nitrogen per milksolid. Over 30 years the Premier Sires® Daughter Proven team had a 16% reduction in urinary nitrogen per milksolid.



The results for enteric methane per milksolid over the animals lifetime shows for every $10BW higher the animal is there will be on average 1.5g less enteric methane per milksolid.

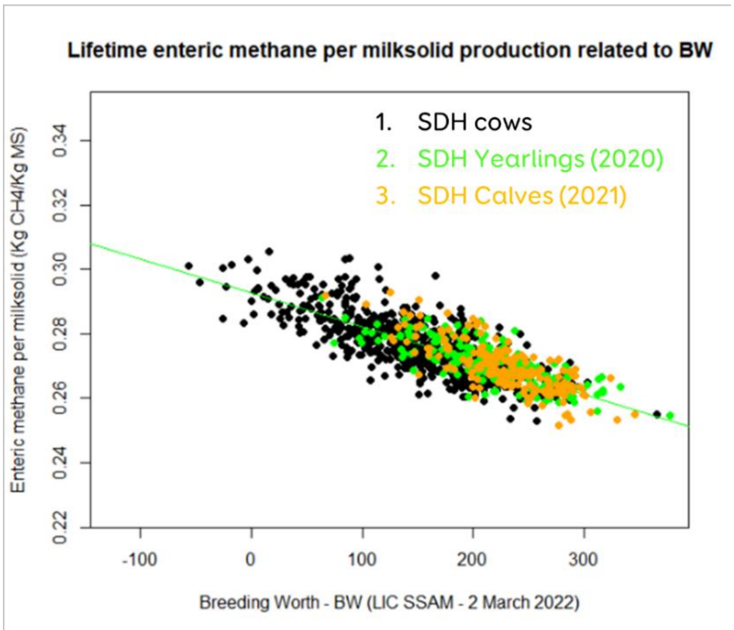
Over 30 years the Premier Sires® Daughter Proven team had a 13% reduction in enteric methane per milksolid.



When the Southern Dairy Hub herd is modelled through HoofPrint we can see the same relationship exists, in the graph shown for enteric methane specifically but similarly for urinary nitrogen.

The higher genetic merit (BW) animals have the lowest environmental foot print per kilogram of product.

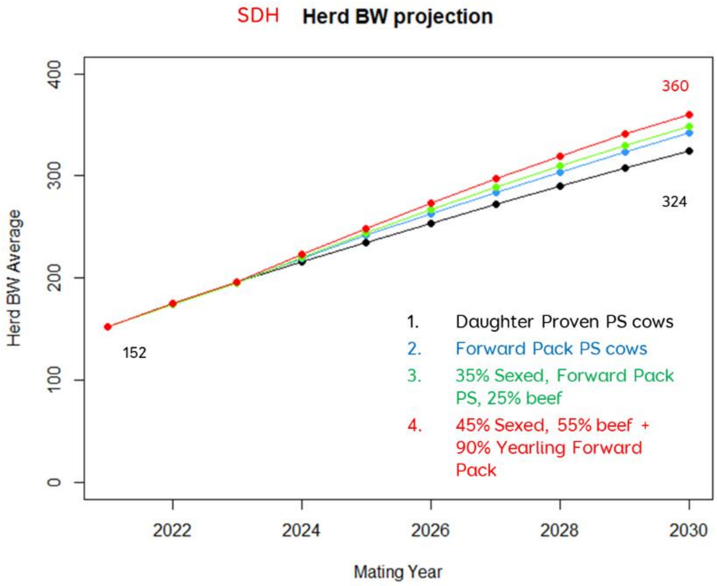
The 2020 and 2021 replacements have been overlaid onto the graph showing both the BW and HoofPrint improvements that are being made with breeding.



Projecting the future herd at SDH

LIC has also been undertaking modelling looking at how various mating plans delivered on farm could result in the herd genetics and performance in 2030. All the graphs provided below use the same four example mating plans:

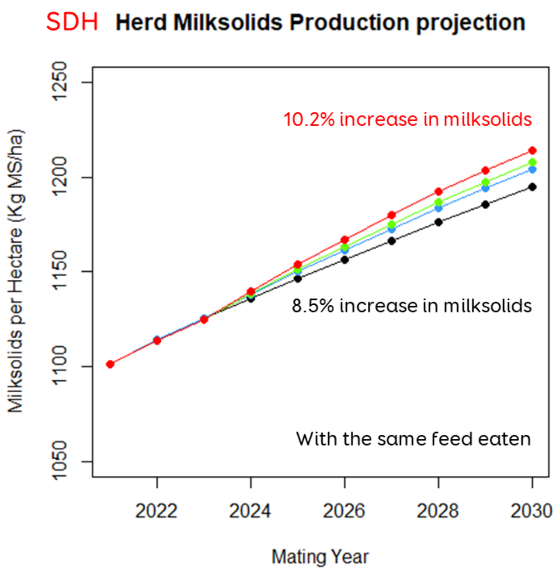
1. Cows all to Premier Sires Daughter Proven (black)
2. Cows all to Premier Sires Forward Pack (blue)
3. 35% of cows to Premier Sires Sexed, 40% Premier Sires Forward Pack, and 25% to beef (green)
4. 45% of cows to Premier Sires Sexed, 55% to beef, 90% of yearlings to Premier sires Forward Pack (red)

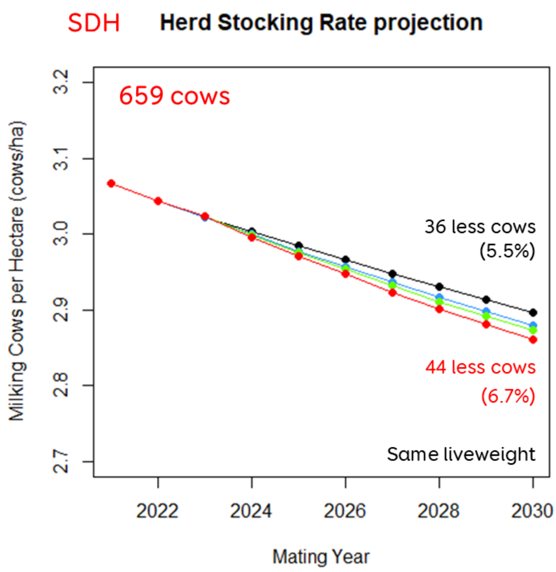


The modelling using BW at March 2022 predicts that the Herd BW could reach 360 with a more intensive mating program or 324 with a Premier Sires Daughter Proven plan. The higher BW will also enable additional milksolids to be produced.

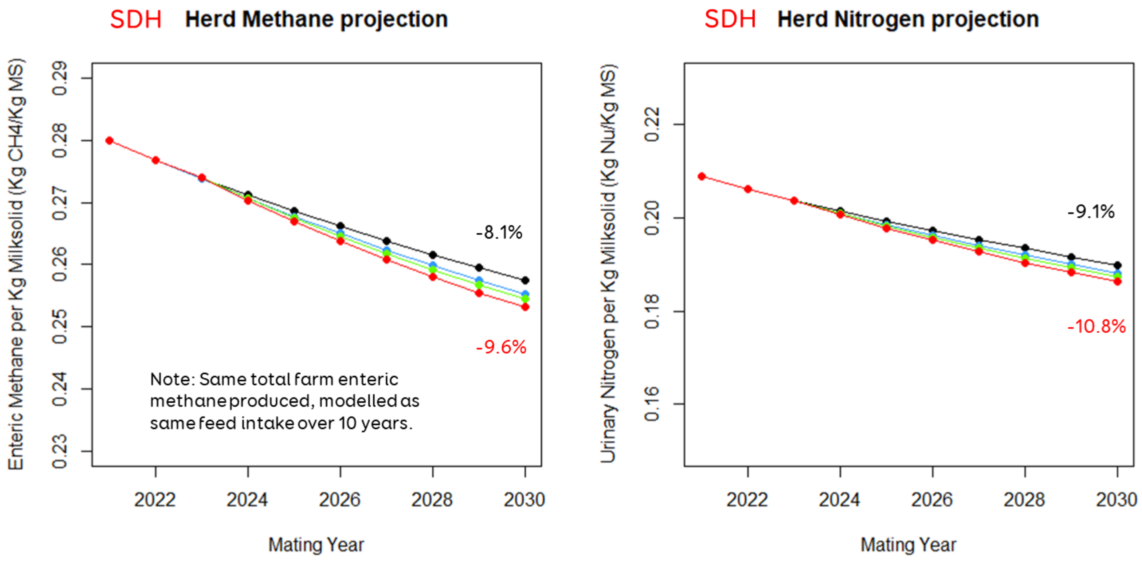
The per hectare modelling includes all grazed area for the milking herd and herd replacements, with an assumed 14 tonnes of dry matter consumed. This also doesn't account for the different management of the farmlet studies undertaken at the Southern Dairy Hub. The value in this modelling is to show the relative difference in the genetic merit of the herd over time with the different mating plans.

To achieve the additional production shown it is important that the stocking rate is adjusted to always enable the higher genetic merit cows to be fed to their high producing requirements. Reducing the stocking rate, while maintaining the same cow liveweight, means a lower total maintenance energy requirement of the herd and therefore a higher amount of feed available for energy to produce milk.
The lower herd size will also enable less replacements being reared, again meaning relatively more feed available to lactating cows.
The increase in milk production per hectare relative to feed consumed means that the enteric methane emitted, and urinary nitrogen excreted per kilogram of milksolid will become less. Urinary nitrogen has a





greater drop per kilogram of milksolid, as the increased production of milk protein will prevent more nitrogen needing to be excreted as urine. On a per hectare basis slightly less urinary nitrogen would be excreted with the higher production levels on the same quantity of feed.



Note that the total enteric methane emissions from the herd remains constant in this modelling. New Zealand legislation and proposed emissions pricing is not currently setting individual farm methane reduction targets. Should the farm have to reduce methane emissions to a specific value, to enable production to be maximised within the current system, the higher genetic merit and efficient animals are best going to allow this to be achieved.

Reproduction analysis and case study

Following the reproductive performance of the herds for the last 4 years, has been an interesting journey.

Overall, we've seen the farm; improve submission rates, improve 6-week in calf rates and reduce the empty rate on the property, all whilst maintaining the same mating length – 5.5 weeks of AB and 5 weeks of Bulls at the end.

With submission rates in Spring 2019 averaging 81%, it's fair to say that there was room for improvement and some laser focus was applied to critical areas of the farm for the next season.

At mating, we had 240 of 713 cows on OAD milking, as they had:

- Shown no heat, or only a very weak heat from pre-mating heat detection and/or
- Had BCS at mating of 4.0 or below or
- Had recorded a BCS at calving below target or
- Had significant health challenges in spring.

We assessed several simple metrics, calving spread before the 2019 mating, and BCS of cows at calving, as days post calving and BCS at calving are the two strongest determinants of reproductive performance. The individual BCS of cows left something to be desired. The Fodder beet herd averages were close to target, but the Kales were short of target, and there were cows in each herd at BCS 4.0 at calving.

What did we change?

We focussed on giving every cow the right chance to get in-calf by working on individual cow BCS. This controversially meant that in March 2020, we had dried off some Kale cows! 😊

In April we dried off more, to ensure when we worked backwards from BCS target (higher for first AND second calvers at 5.5), looked at calving date, and adjusted for expected winter weight gain, that all cows could meet their BCS targets.

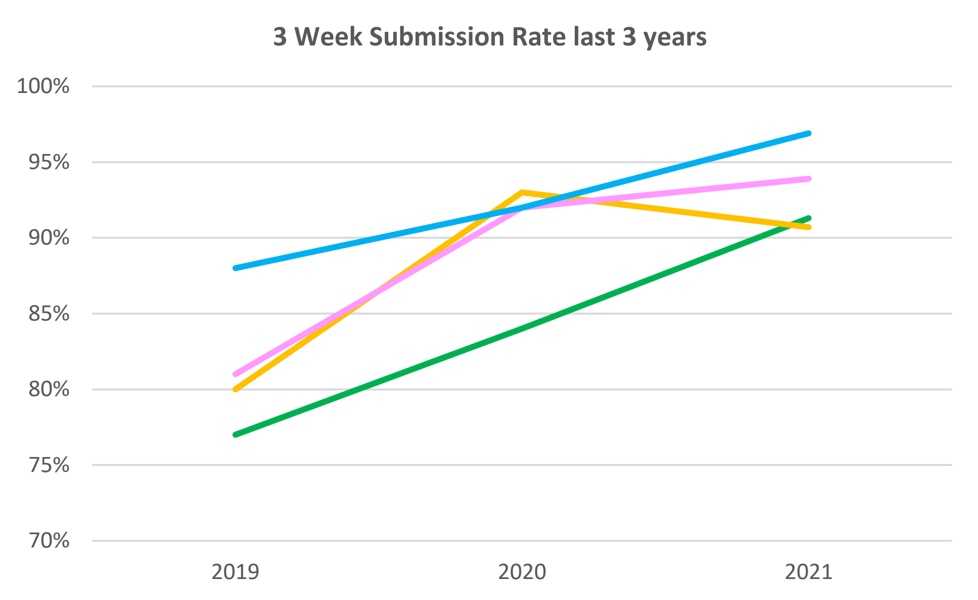
What results did we see?

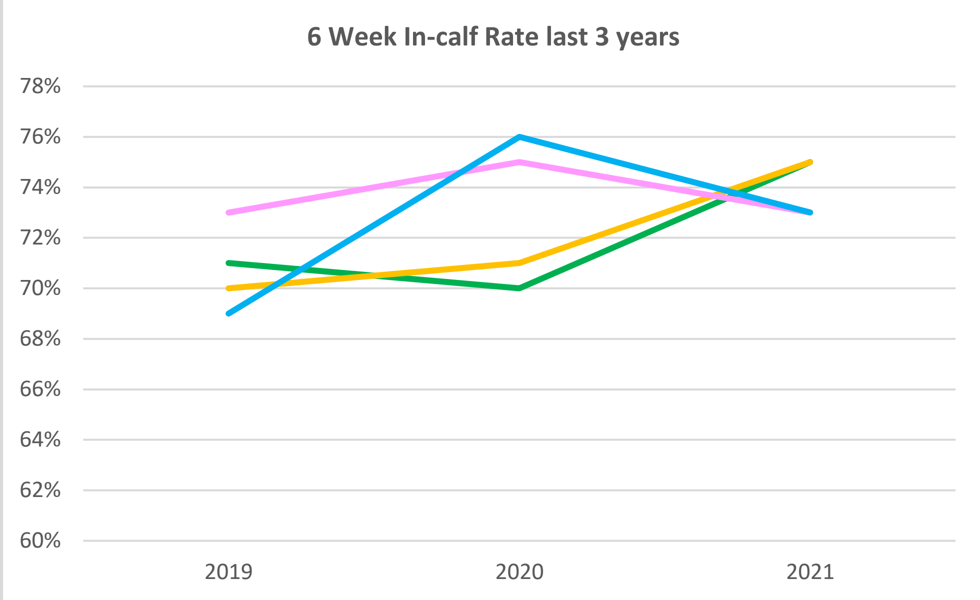
KPI	2019	2020	2021
Cows on OAD at start of Mating	240	170	110
Submission rate	81%	90%	93%
6 week in calf rate	71.0%	72.7%	73.8%
Empty Rate	12.9%	9.0%	9.1%

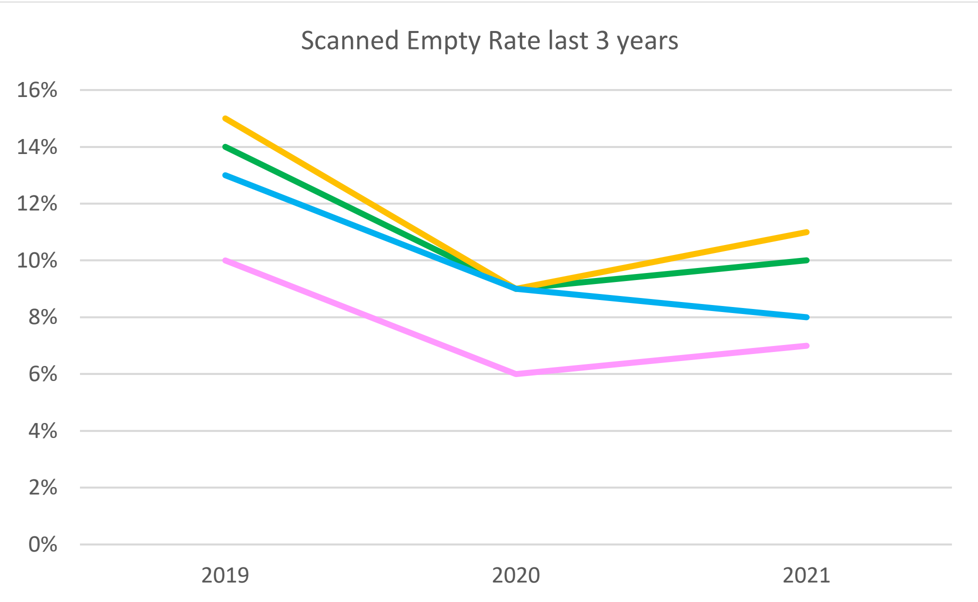
So we've definitely seen improvement across the farm, by focussing on the individual cow BCS, we still don't have all cows at target BCS, but we have all cows within half a BCS of target, and a lot fewer cows missing target. Overall, improving reproductive performance has converted to faster calving herds, and more milk out the gate in Spring adding to profitability.

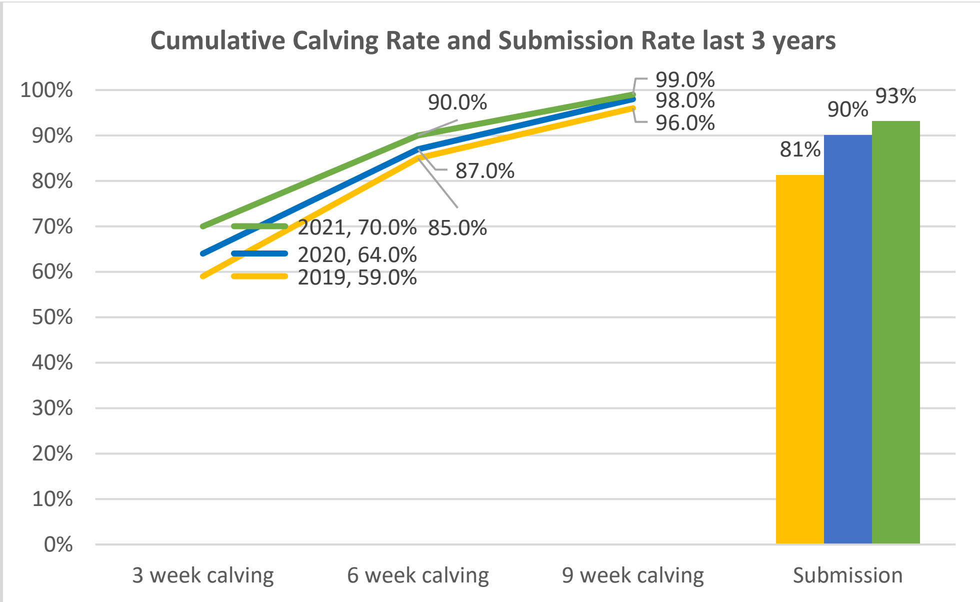
In terms of progress, we've probably not made as much as we would have expected though. However, when we break it down from "farm" to "farmlet", it starts to paint a clearer picture.
The Std Kale – Pink herd, has been normal 😊. The tools improved BCS, and when 6 week in-calf rates went up, empty rate went down. The other three herds have bucked this trend, especially this year.
The Fodder beet herds have the least BCS issues, and the most unpredictable (often worst) reproductive results. The LI Kale, went from best in class last year, to worst in class this year!

Same people picking for AB all herds, same rules about OAD and dry off based on BCS, same bull ratio and bulls between all herds, Bulls cycle around between herds in different teams throughout. Why the differences? We aren't sure yet – but the data tells us that farm system IS having an impact









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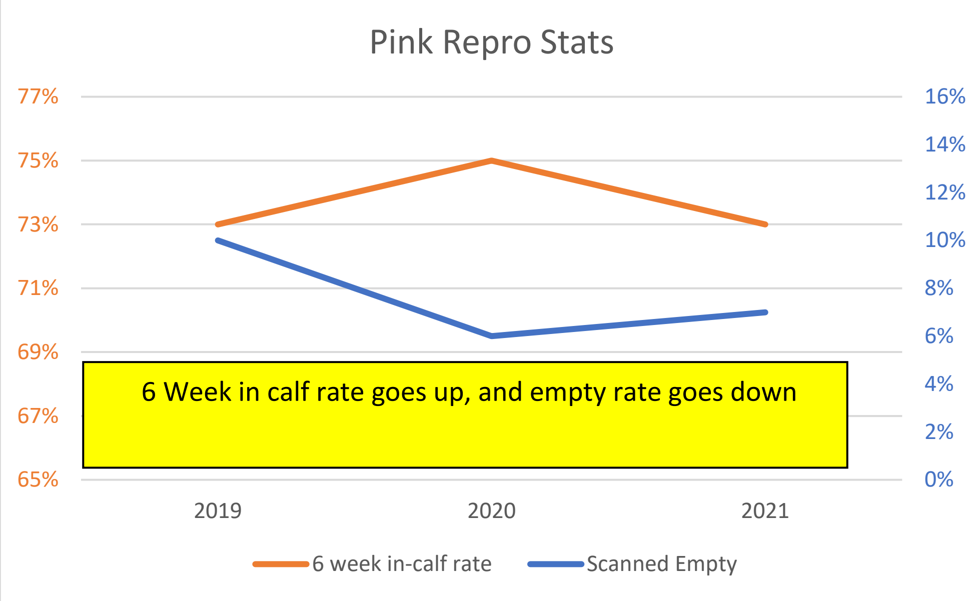
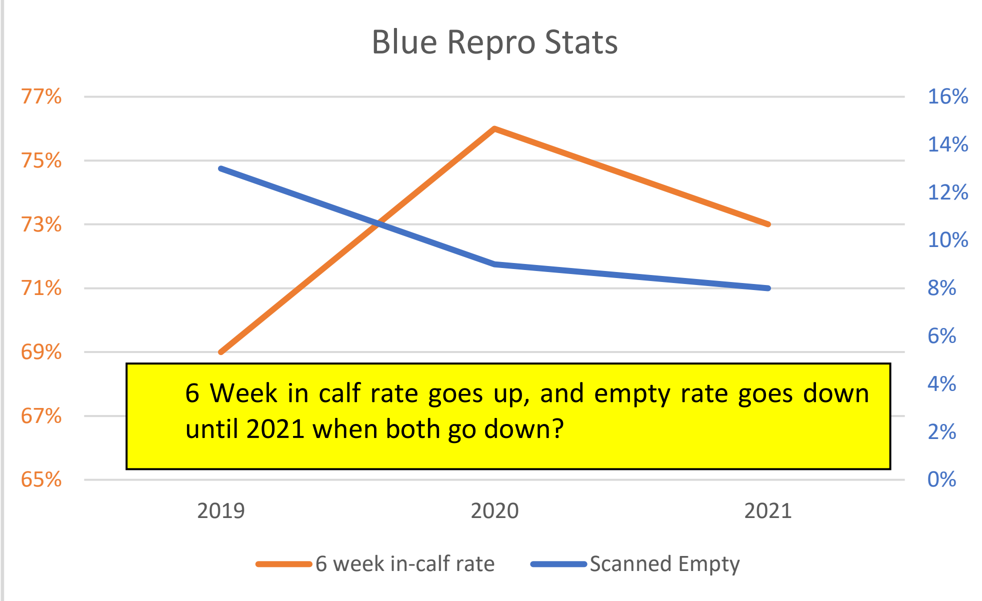
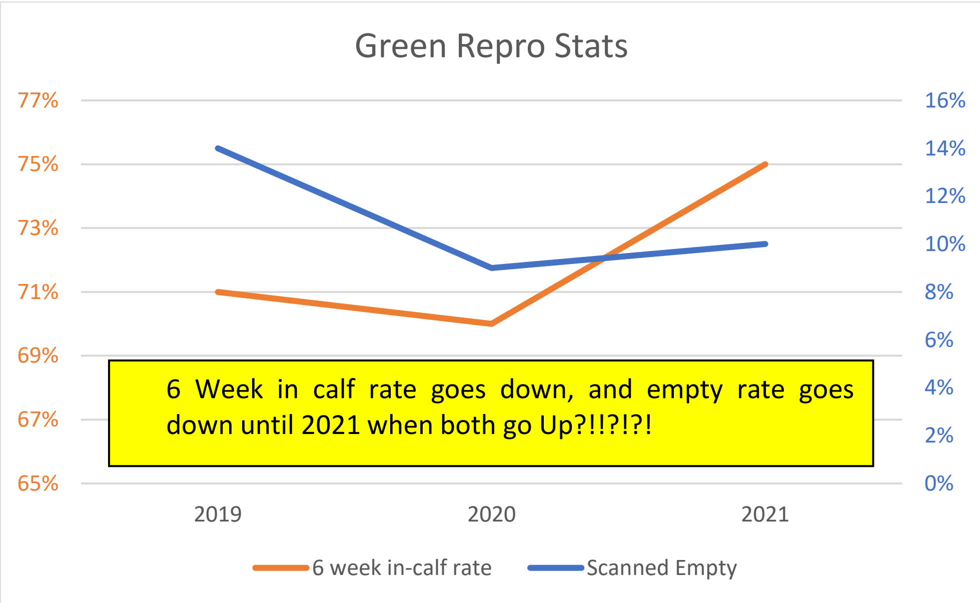
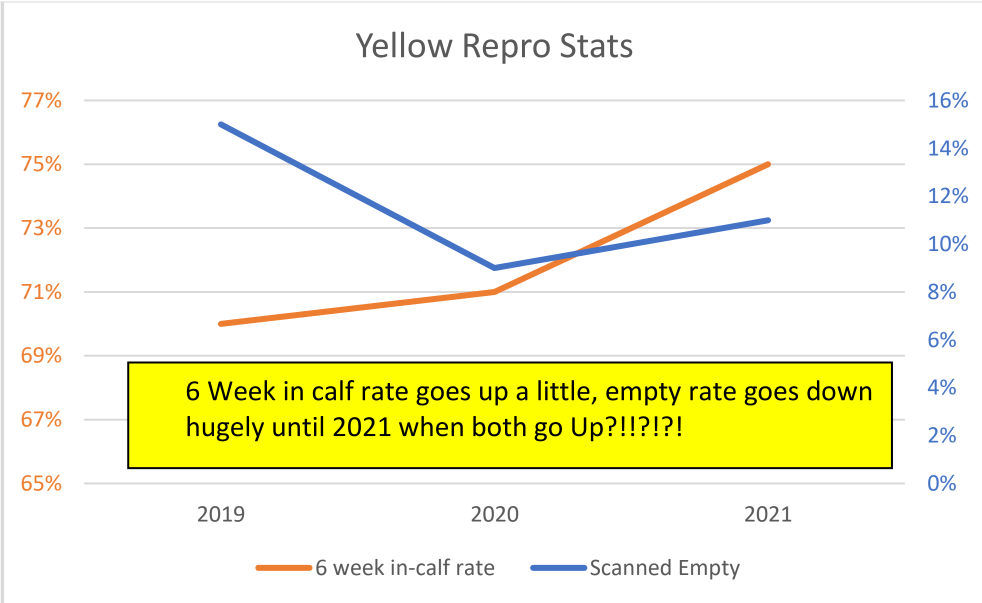








Synopsis of the Current Farm Systems

Objective of the 2018-2022 farm systems comparison

To demonstrate farm systems including a suite of farm management interventions that will increase farm profit and lower the environmental footprint by at least 30%.

What have we learnt from the current farm systems comparison so far?

- Higher profitability has been achieved from the kale systems at both intensity levels
- Reducing N fertiliser reduced pasture DM production (as predicted in the modelling)
- Achieving BCS gain over winter is easier with fodder beet feeding, requiring less animals to be dried off early to achieve calving BCS targets
- Feeding fodder beet during lactation and wintering creates a more complex systems with additional mineral requirements, crop management and labour for risk minimisation
- Reducing N fertiliser inputs reduced purchased N surplus and leaching risk
- Wintering on fodder beet reduced N leaching risk
- Milking less cows with few inputs reduced greenhouse gas emissions
- Our lower impact (fewer cows, less N) systems were more difficult to manage especially when fodder beet was used as the lactation supplement

Opportunities for optimization

1. Align herd sizes and paddock numbers to enable easier implementation of sensible rotation lengths
2. Revisit application rates and timing of nitrogen fertilizer for lower impact (LI) farmlets to promote better pasture quality through late spring, early summer
3. Split applications of maintenance fertilizer, aligned with N applications to LI farmlets
4. Reduce comparative stocking rate for lower impact farmlets to drive higher per cow production i.e increase supplementary feeding to compensate for less pasture grown
5. No fodder beet for lactation feeding, all herds have access to inshed feeding
6. 'Spare' paddocks outside the farmlets for managing cows out of their farmlet mob

The wagon wheel chart below allows us to compare the farm systems in each of the farmlets.
In this format, we can view each farmlet's score out of 100% in multiple areas at once.

- The closer to the outside of the graph, the better a farmlet did in each area.
- Where the farmet score is outside the graph, we overshot the and exceeded the target.

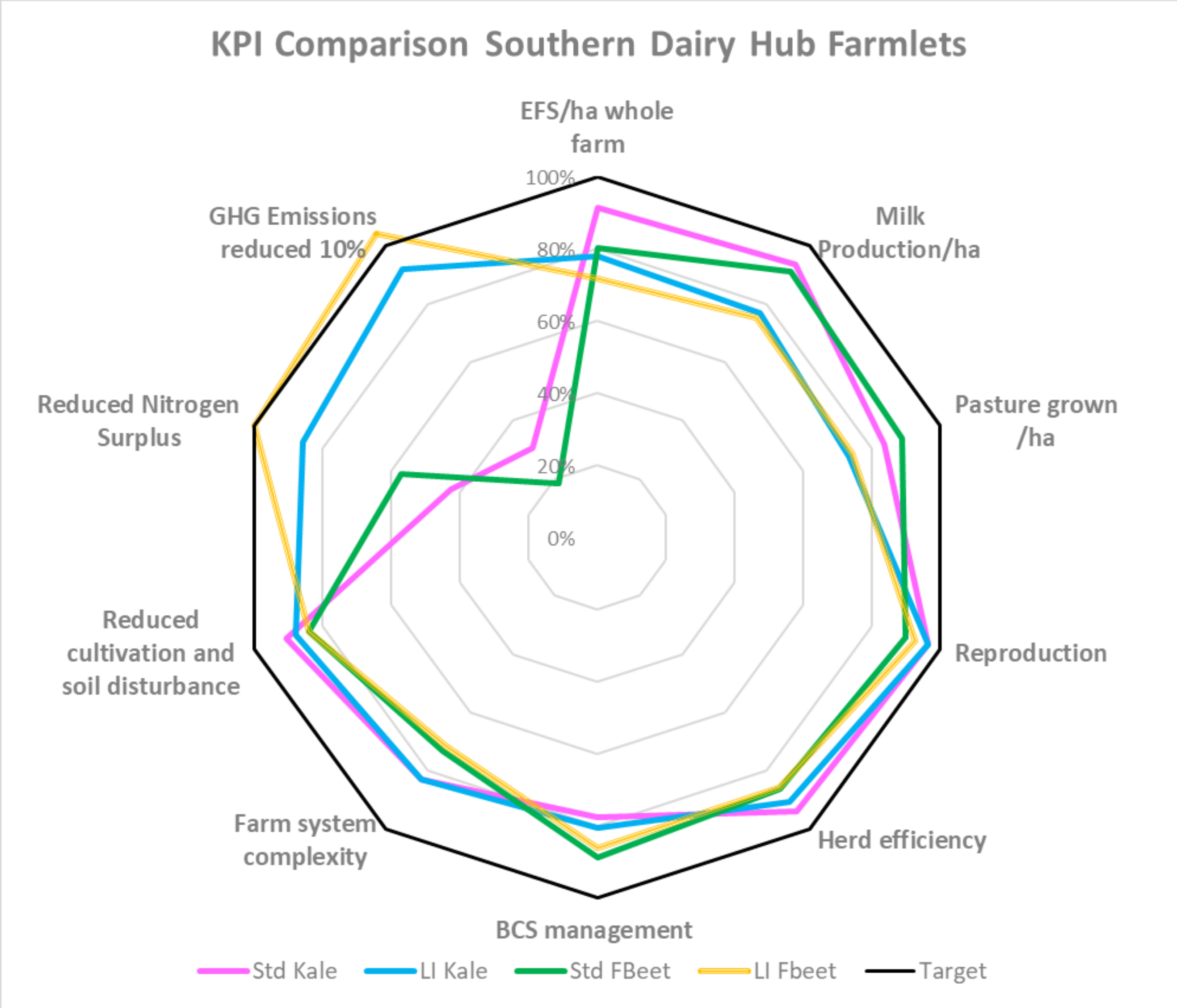


Figure 4: *Farm system comparison of farmlet performance for the 2020-21 season using wagon wheel analysis*

SDH Future Farm Systems – wintering by intensity

Outcome

Provide a range of farm system options that meet the future environmental (nutrient loss to water AND greenhouse gases), animal welfare, public perception and profitablity requirements for Southern farmers.

Objectives

Wintering

To evaluate the impact of off-paddock infrastructure compared to optimised forage systems (crop and baleage/grass) on animal performance and welfare, forage production and utilisation, profit, and emissions to air (greenhouse gases) and water (N leaching, P, sediment & e-coli)

Lower footprint farming

To evaluate the impact of optimised lower input intensity farming systems on animal performance and welfare, forage production and utilisation, profit, and emissions to air (greenhouse gases) and water (N leaching, P, sediment & e-coli).

Hypotheses:

Ho: that a lower intensity system wintering on crop has a lower environmental footprint than a high intensity system wintering on crop and can be as profitable

Ho: that wintering cows off paddock will provide better animal welfare and water quality outcomes than wintering on crop.

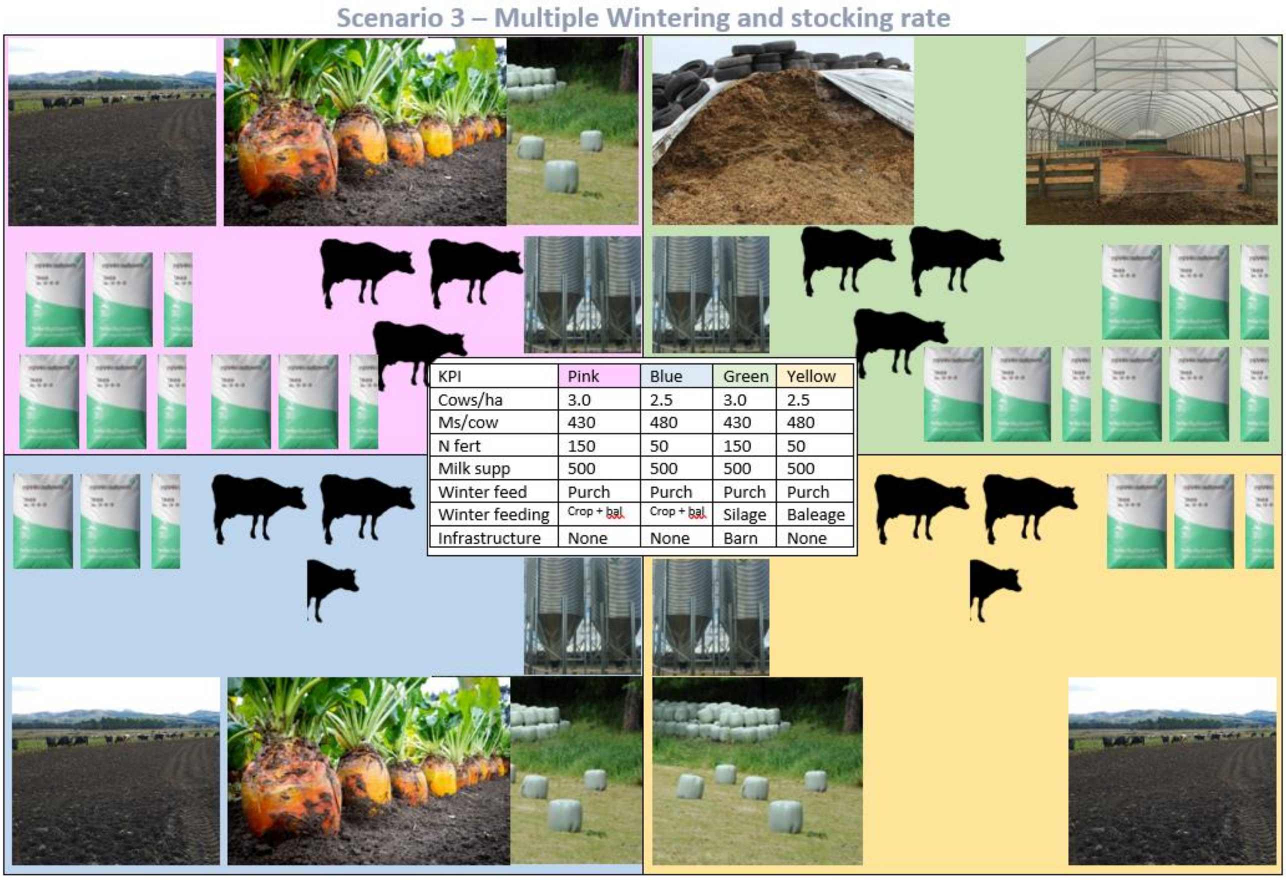
Ho: That off paddock silage/baleage wintering will have a lower environmental footprint than on paddock baleage wintering

Ho: That on paddock baleage wintering has a lower environmental footprint than optimized crop wintering and is more profitable (at low intensity)

Ho: That a hybrid wintering system (partial off paddock) that achieves animal welfare and environmental targets can be successfully implemented

Table 2: Proposed Future Farm systems

	Crop based wintering	Bale/Silage wintering
Intensity 1 150-180 kg N/ha 3 cows/ha 500 kg lactation supp 450 kg MS/cow 20% replacements	Optimised crop & baleage/kale 83 ha milking platform 230 cows peak milked Fodder beet for 6 weeks followed by baleage (12 kg DM) Winter baleage imported	Fully off paddock 83 ha milking platform 230 cows peak milked Silage wintering - 12 kg DM/cow Winter silage home grown & imported
Intensity 2 50-60 kg N/ha 2.5 cows/ha 500 kg lactation supp 480 kg MS/cow 20% replacements	Optimised crop & baleage/kale 61 ha milking platform 137 cows peak milked Fodder beet for 6 weeks followed by baleage (12 kg DM) Winter baleage imported	Baleage wintering 61 ha milking platform 137 cows peak milked Cows wintered on 12 kg DM baleage (some imported) off paddock option for adverse weather



KPI	Pink	Blue	Green	Yellow
Cows/ha	3.0	2.5	3.0	2.5
Ms/cow	430	480	430	480
N fert	150	50	150	50
Milk supp	500	500	500	500
Winter feed	Purch	Purch	Purch	Purch
Winter feeding	Crop + bal	Crop + bal	Silage	Baleage
Infrastructure	None	None	Barn	None

Figure 5: *Schematic of proposed future farm systems commencing August 2022*

Infrastructure Development

Outcomes

1. Provide a range of options to reduce the negative impact of cattle wintering on water quality, greenhouse gas emissions, animal welfare and public perception in Southern NZ.
2. Development of 'fit for purpose' infrastructure alternatives to forage crop grazed in situ. This requires facilitated collaboration between engineers, water, animal and farm-systems experts and farmers to design and test options.

Concepts

Design 1

- Covered for maximum cow comfort and effluent minimisation
- Use of technology to manage woodchip bedding surface
- Separate loafing and feeding surfaces
- Multi-purpose
    - Wintering
    - Calving
    - Feed pad for milkers

Design 2

- Uncovered but with shelter from prevailing wind
- Innovative all-weather surface
- Integrated loafing and feeding
- Greenwash for cleaning
- Lower cost construction?
- Lower operating costs?

Process to date

1. Series of workshops with farmers starting in January 2019
2. Project steering group of local Southland farmers
3. Testing of surfaces for cow comfort – May 2021
4. Development of concepts and testing with farmers

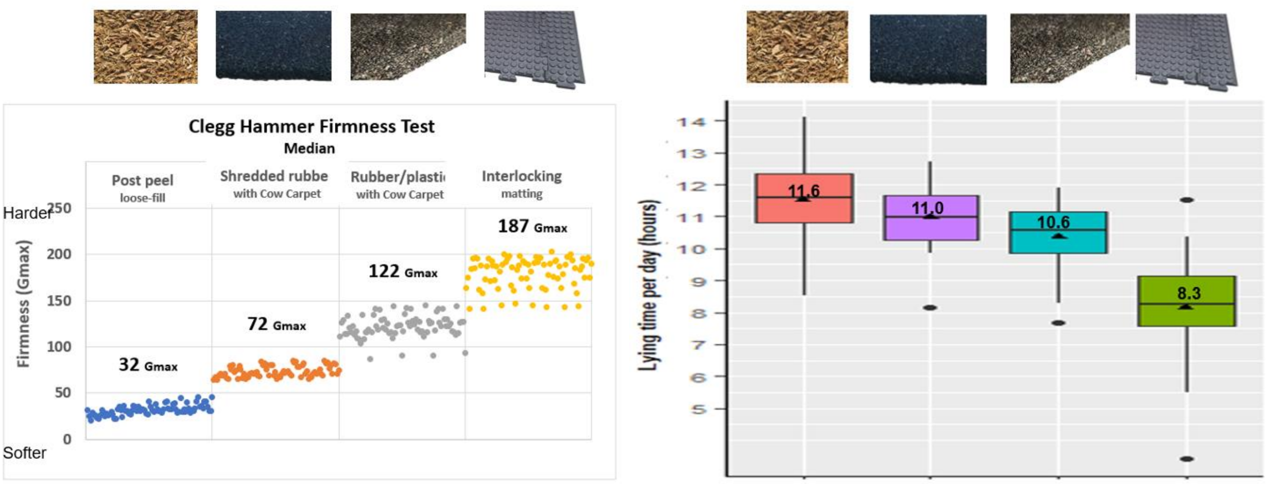


Figure 6: *Relationship between surface hardness and lying time for surface testing research*

Next steps

1. Convene a small group of farmers to help finalise the design details
2. Test the all-weather surface in Southland during winter 2022 – looking for potential sites
3. Finalise the location at SDH
4. Convert concept drawings into plans for costing
5. Engage with builders
6. Consenting
7. Build by May 2023

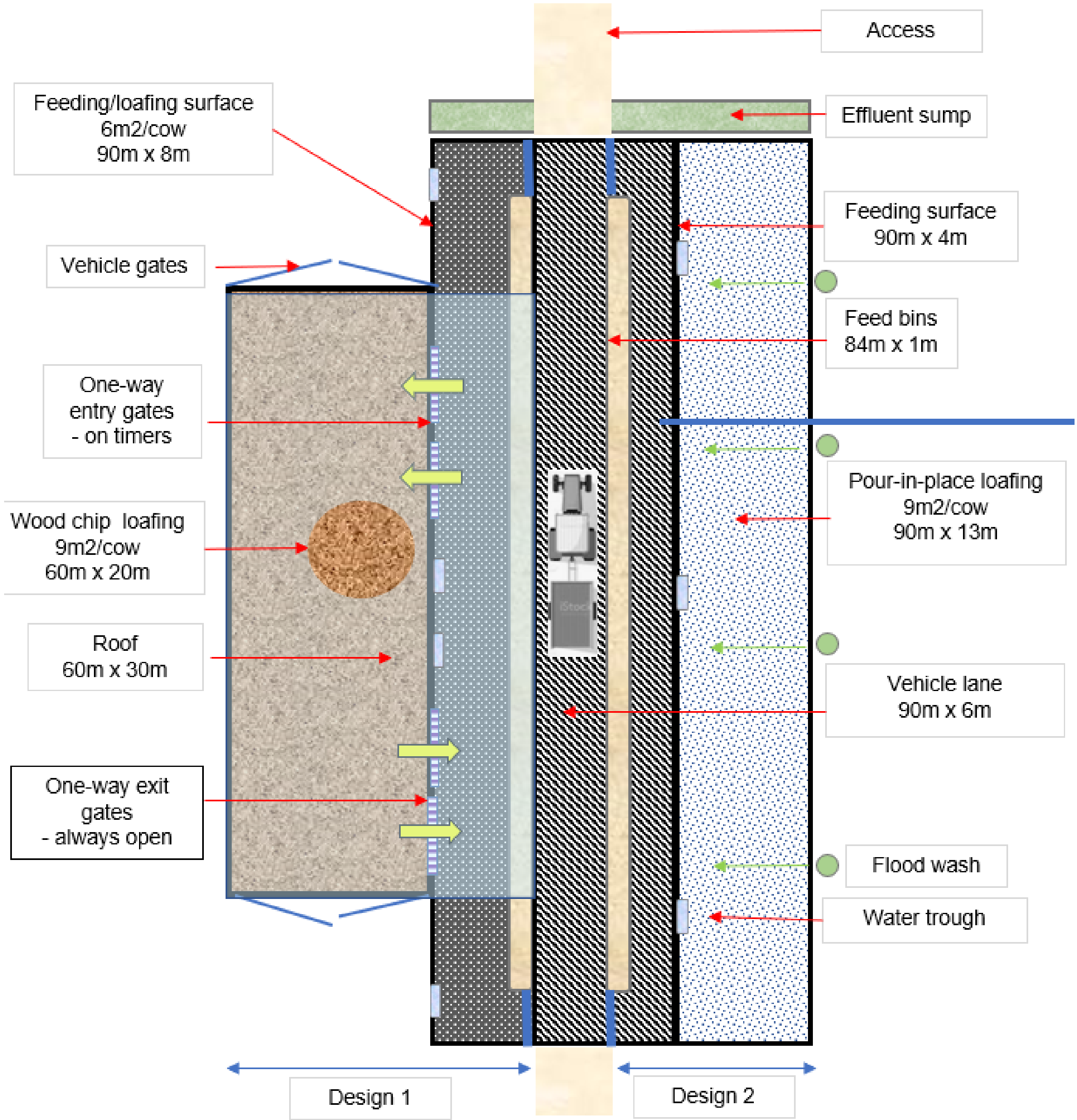


Figure 7: *Schematic of proposed infrastructure as at March 2022*

SDH Participatory research project: what is the greenhouse gas footprint for the 4 different SDH farmlets?

Greenhouse gas emissions

As part of the SDH Participatory research project, the greenhouse gas (GHG) footprint for the four SDH farmlets was calculated (Table 1). 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 1: 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.

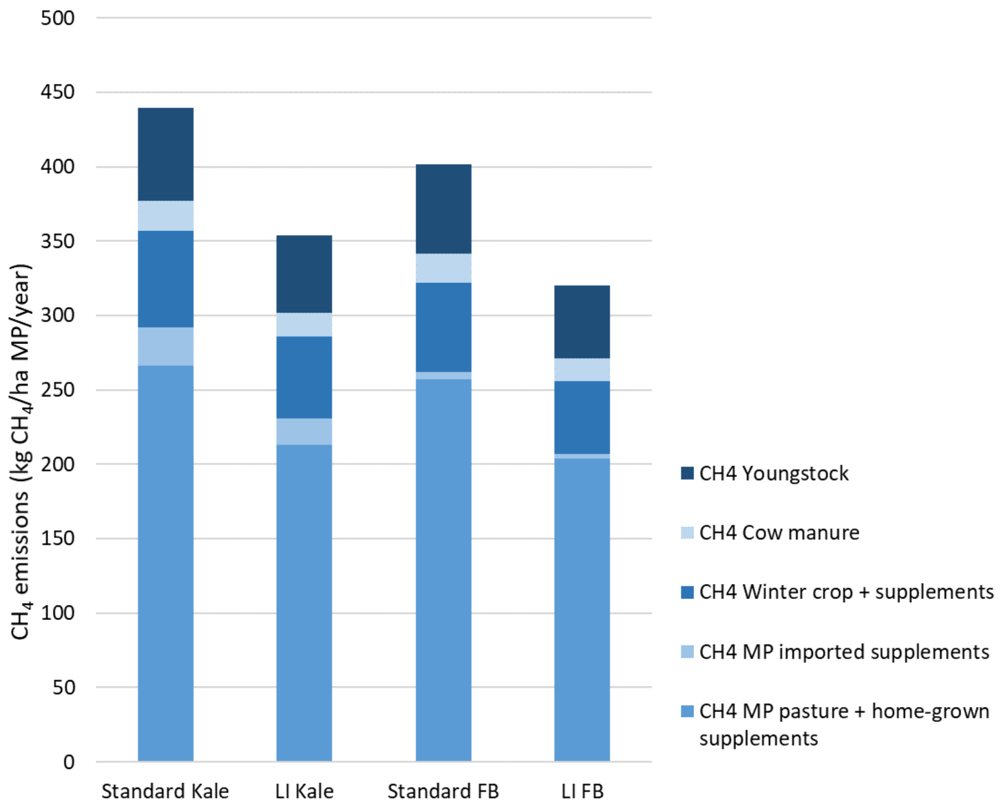


Figure 8: *Farmlet methane emissions by source*

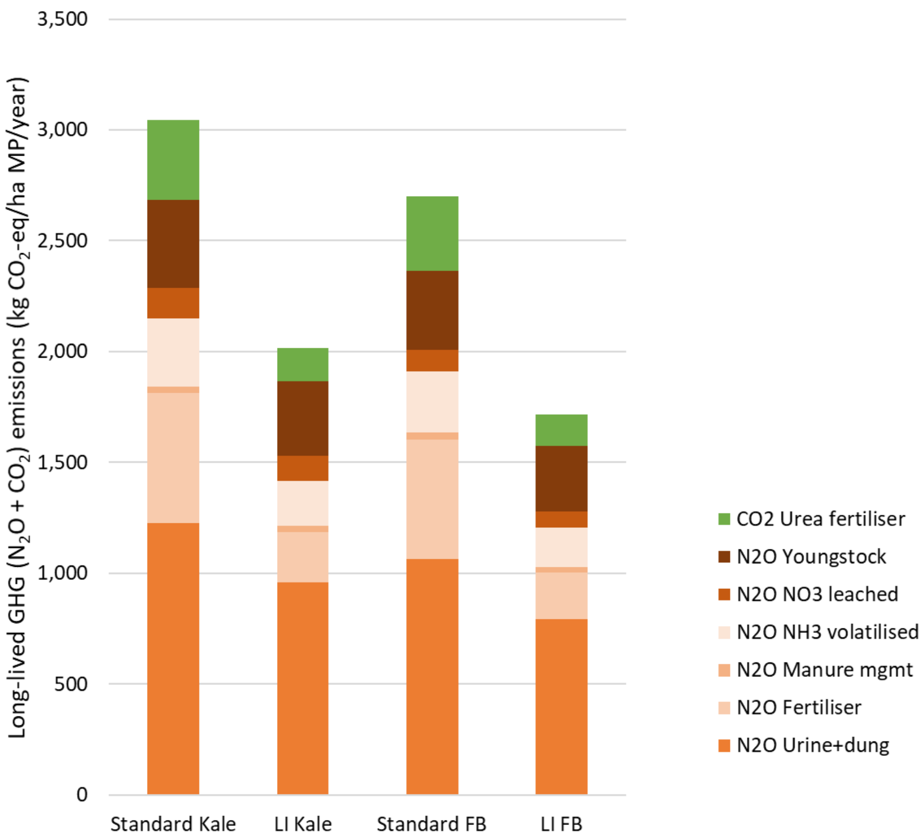


Figure 9: *Farmlet long lived greenhouse gas emissions by source*

GHG emissions – key results:
The effect of a Low 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.

Greenhouse Gas pricing
To illustrate the effect of pricing options for GHG emissions from agriculture, emissions were priced according to the options outlined in the He Waka Eke Noa Draft Farmer Engagement document (https://hewakaekenoa.nz/wp-content/uploads/2021/11/He-Waka-Eke-Noa-Draft-Engagement-Document-November-December-2021.pdf): ETS 'back-stop' and split-gas levy approach (Table 1).

For the ETS 'back-stop', total cost of emissions are priced at $85/t CO_2e, where all GHG emissions are converted to CO_2 equivalents based on GWP_{100} i.e. no split-gas approach. **For the first year of the ETS, farmers will only have to pay for 5% of the total cost of their emissions i.e. the pricing includes 95% discounting (free allocations). However, discounting is likely to decrease in future years, meaning farmers will need to pay for an increasing proportion of their emissions.**

For the split-gas levy approach, we used the current HWEN 'farm-level' option where the pricing of long-lived gases will be aligned with the ETS carbon price, while methane will have a unique price because of its short-lived nature. **The price has yet to be set, however we used the indicative price of $0.11/kg CH_4 that was used in the Draft Farmer Engagement document.**

GHG pricing – key points

- GHG pricing based on the ETS 'back-stop' and the He Waka Eke Noa farm-level split-gas levy across the four farmlets ranged from $41 to $61/ha MP.
- The LI farmlets had the lowest product cost, averaging 4.5 cents/kg MS, with the Standard farmlets having an average price of 4.8 cents/kg MS.
- Using the current price assumptions there was little difference in costs between the ETS 'back-stop' and the He Waka Eke Noa farm-level split-gas levy, but the latter would recognize any off-sets due to on-farm sequestration.

Acknowledgements
This research is funded by MPI through the Sustainable Food and Fibre Futures Fund, DairyNZ Inc and SIDE.

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 8 on 2 off, 8 on 3 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 28 March 2022

		BW	PW
Pink – Std Kale	**Cows (195)**	150	208
Blue – LI Kale	**Cows (156)**	158	212
Green - Std FB	**Cows (193)**	151	195
Yellow – LI Kale	**Cows (156)**	164	221
Grouped	**Youngstock**	244	270

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