Northland Dairy Development Trust
&
Northland Agricultural Research Farm

'Future Farm Systems'

Results 2021/22

Project funders

Ministry for Primary Industries
Manatū Ahu Matua

DairyNZ

Northland Dairy NDDT Development Trust

Hine Rangi Trust

Thanks also to our sponsors and supporters for their continued support

Ballance agri-nutrients

New Zealand Farm Source

Fonterra

GEA engineering for a better world | FIL

Visit the Northland Dairy Development Trust website for further information and updates from these projects

www.nddt.nz

Follow us on Facebook – Northland Dairy Development Trust

For further information contact:
Chris Boom – chris.boom@agfirst.co.nz or Kim Robinson – kim.robinson@agfirst.co.nz

These on-farm trials are being run by the Northland Dairy Development Trust (NDDT) in conjunction with the Northland Agricultural Research Farm (NARF). The projects are funded by DairyNZ, Ministry of Primary Industries (Sustainable Farming Fund & Sustainable Food and Fibre Futures) and Hine Rangi Trust with support from commercial sponsors.

Future Dairy Farm Systems for Northland Project

Summary

This study compares a typical Northland dairy farm system (**Current farm** – kikuyu/ryegrass pastures, 3.1 cows/ha, 190 kg N/ha applied) with a farm that has 74% of land in tall fescue/cocksfoot-based pastures (**Alternative Pastures farm** - 3.1 cows/ha, 190 kg N/ha) and a farm designed to have significantly reduced greenhouse gas (GHG) emissions (**Low Emissions farm** – kikuyu/ryegrass pastures, 2.1 cows/ha, no nitrogen applied).

Pasture growth monitoring showed that with no nitrogen fertiliser application the Low Emissions farm grew 1,376 kg DM/ha less pasture than the Current farm. This indicates a response of 8 kg DM/kg N applied on the Current farm. The tall fescue/cocksfoot pastures on the Alternative Pastures farm had higher feed quality from summer to early winter, compared to the kikuyu/Italian ryegrass pastures on the other farms. However, low pasture growth rates during summer/autumn on the Alternative Pastures farm resulted in the need to dry off cows earlier than the other farms.

Milk production was highest on the Current farm:

Farm	Kg MS/ha	Kg MS/cow
Current Farm	1,284	409
Alternative Pastures Farm	1,213	397
Low Emissions Farm	794	370

Financial analysis of the farms, using a $9.30/kg MS milk price, shows the Current farm slightly ahead of the Alternative Pastures Farm, with the low production significantly dropping profit on the Low Emissions Farm.

Farm	Income $/ha	Expenses $/ha	Op Profit $/ha
Current Farm	$12,778	$7,739	**$5,040**
Alternative Pastures Farm	$12,256	$7,471	**$4,786**
Low Emissions Farm	$8,076	$5,055	**$3,021**

Sowing alternative pasture species did not result in increased full season production or profit. However, this was within the context where some of these pastures did not establish well. It must also be noted that they were competing against a relatively productive regime on the other farms where all kikuyu is mulched and reseeded with Italian ryegrass annually.

The removal of applied nitrogen on the Low Emissions farm did not result in as much of a reduction in pasture growth rate as was expected, likely diminished by the high clover presence on this farm

and the relatively longer grazing rotation lengths during winter and spring. In hindsight, this farm was stocked conservatively at 2.1 cows/ha and at times, pasture control was compromised.

The Low Emissions farm had a 33% reduction in methane emissions and a 47% reduction in nitrous oxide emissions compared to the Current farm, and $2,019 lower profit. Milk price would have to be as low as $5.00/kg MS before these two farms showed a similar profit. The pricing mechanism to encourage farmers to reduce emissions has yet to be confirmed, however it is unlikely the initial emissions pricing will be enough to compensate for the significant loss in profit shown in this study.

Three further years of this study will allow testing of these regimes over different climatic conditions and display any compounding of treatment effects over time.

Background

Northland farm systems are at the forefront of the effects of a warming climate and demonstrate the challenges that the rest of New Zealand will experience over time. In Northland, ryegrass persistence is relatively poor, rust and pest damage are increasing and regression to kikuyu often occurs within three years after sowing new pasture. Kikuyu is productive during summer/autumn, however it is has poorer nutritive value, is difficult to manage and has low winter/spring growth. The performance of alternate pasture species such as tall fescue, cocksfoot, legumes, and herbs seem to be better and the reinvasion of kikuyu considerably slower with these species than ryegrass sown pastures.

We are also being given a message from government to lower GHG emissions on dairy farms. There is plenty of modelling information, however farmers are uncertain as to whether the strategies to reduce emissions are physically or financially sustainable, particularly the lowering of stocking rate on pastures containing kikuyu.

This project is conducting a farm systems trial at NARF to test and compare three farm systems which may be used in the future to mitigate and adapt to the effects of a warming climate.

Trial Design

This project compares three farm systems:

1. **Current farm** (Red) – existing ryegrass/kikuyu pasture farm system with imported feed (likely PKE) to fill feed deficits. Stocking rate 3.0 cows/ha and up to 190 kg applied N/ha
2. **Alternative Pastures farm** (Blue) – at least 75% of pastures in alternative species to ryegrass - including fescue, cocksfoot, legumes & herbs with imported feed (PKE) to fill feed deficits. Stocking rate 3.0 cows/ha and up to 190 kg applied N/ha
3. **Low Emissions farm** (Green) – existing ryegrass/kikuyu pasture farm system that targets a 25% reduction in methane emissions and 50% reduction in nitrous oxide emissions (compared to the Current farm). Stocking rate 2.1 cows/ha, no nitrogen application. Little or no imported feed

This farm systems trial commenced June 2021 and will run for four years to test these systems under a range of climatic conditions. Trial measures capture pasture and milk production, milk composition, profit, and people (labour input and management difficulty) data on the three systems.

Introduction of New Pastures

To set up the Alternative Pastures farm, 9 ha of new pastures were sown in May 2020. Grass species sown were tall fescue or tall fescue and cocksfoot. These were sown with white clover, red clover, and Persian clover. Another 11.6 ha was sown in March 2021 either fescue or fescue and cocksfoot or cocksfoot with white clover, red clover, and 1kg/ha chicory. The farm was a total of 27.8 ha, so these new pastures represent 74% of the farm.

Establishment of pastures sown in 2020 was excellent, whereas establishment of 2021 sown pastures was variable with some poor establishment, mainly due to competition from poa annua. As a result, 4.2 ha was resown in autumn 2022.

Costs of the pasture introduction were similar across the three years, averaging $1,138/ha. This includes tractor and man hours associated with this introduction as well as contractor costs for drilling.

The other two farms (Current farm and Low Emissions farm), and the 25% of the Alternative Pastures farm that was not sown in new species, have older pastures with approximately 70% kikuyu presence. All kikuyu-based paddocks are mulched each autumn and drilled with Italian ryegrass. This provides control of kikuyu stolon and also a winter/spring active ryegrass to complement the summer/autumn active kikuyu.

Pasture Growth and Quality Monitoring

Pasture growth, composition and quality has been compared between the resident kikuyu/Italian ryegrass pastures with and without nitrogen, and the fescue/cocksfoot based pastures with nitrogen, since July 2021.

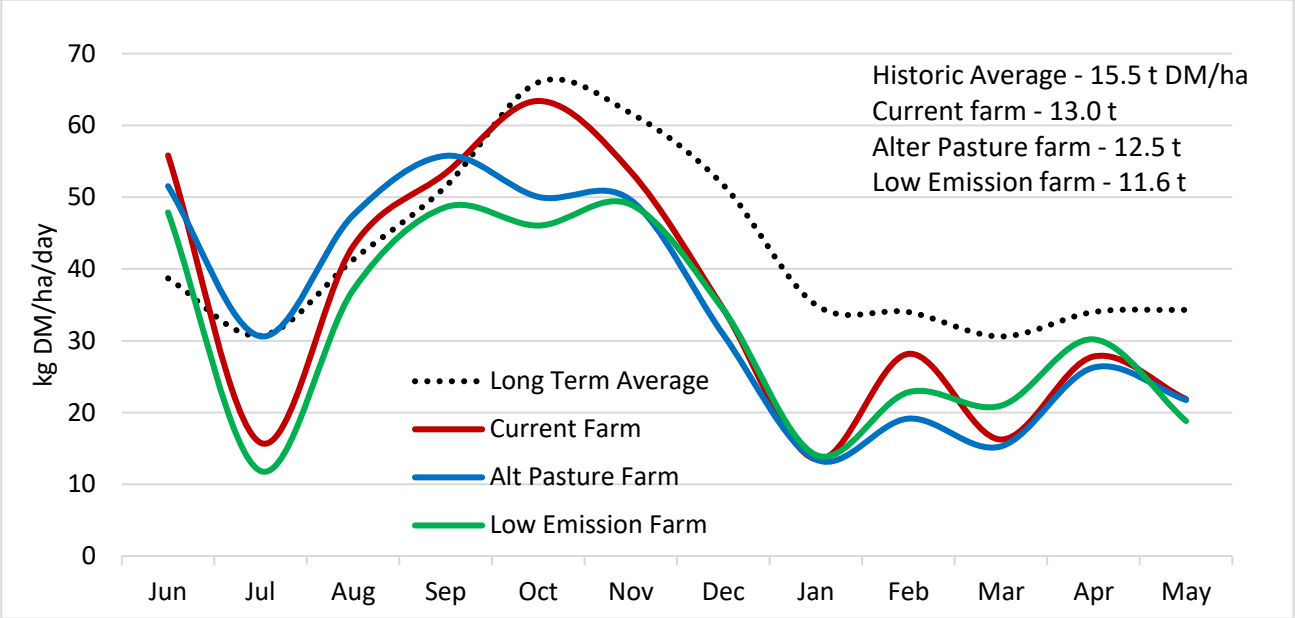
Figure 1 shows the pasture growth differences between these pastures as calculated by weekly platemeter assessments. Growth on all farms was considerably below the historic average, due to dry conditions during summer/autumn.

The fescue/cocksfoot pastures on the Alternative Pastures farm appeared to show higher growth rates during late winter/early spring. This was supported by lower requirement for supplement on this farm during that period.

These platemeter assessments used a constant calibration across pasture types and likely underestimated the pasture growth on the kikuyu pastures during late summer/autumn. This suspicion is supported by several calibration cuts taken during the season, also that the Alternative Pastures farm was short of pasture from January through to May compared to the other farms. Accurately estimating pasture DM over a range of species can be challenging.

The difference between the Current farm and the Low Emissions farm shows the effect of nitrogen and indicates the Current farm grew 1376 kg DM/ha more than the Low Emissions farm. With 172 kg N/ha applied to the Current farm between June and December, this calculates to a full farm systems response of 8 kg DM/kg N. This is lower than expected, possibly due to longer grazing rotations and good white clover presence on the Low Emissions farm.

Figure 1. *Pasture growth rates for 2021/22 season as calculated by pre – post grazing platemeter assessments.*



Pasture samples were collected monthly from the next three paddocks to be grazed on each farm and analysed for feed quality and species presence. Pasture ME (see figure 2) indicates that the fescue/cocksfoot pastures had higher feed quality through most of the year, apart from during spring. The 2021 sown pastures had 1 kg of chicory in the seed mix and these pastures became chicory dominant over the summer/autumn period, contributing to the improved pasture quality seen in this data.

There was very little feed quality difference between the kikuyu ryegrass pastures that received nitrogen (Current farm) and those that did not (Low Emissions farm).

Figure 2. *Pasture metabolisable energy content (MJ ME/kg DM).*

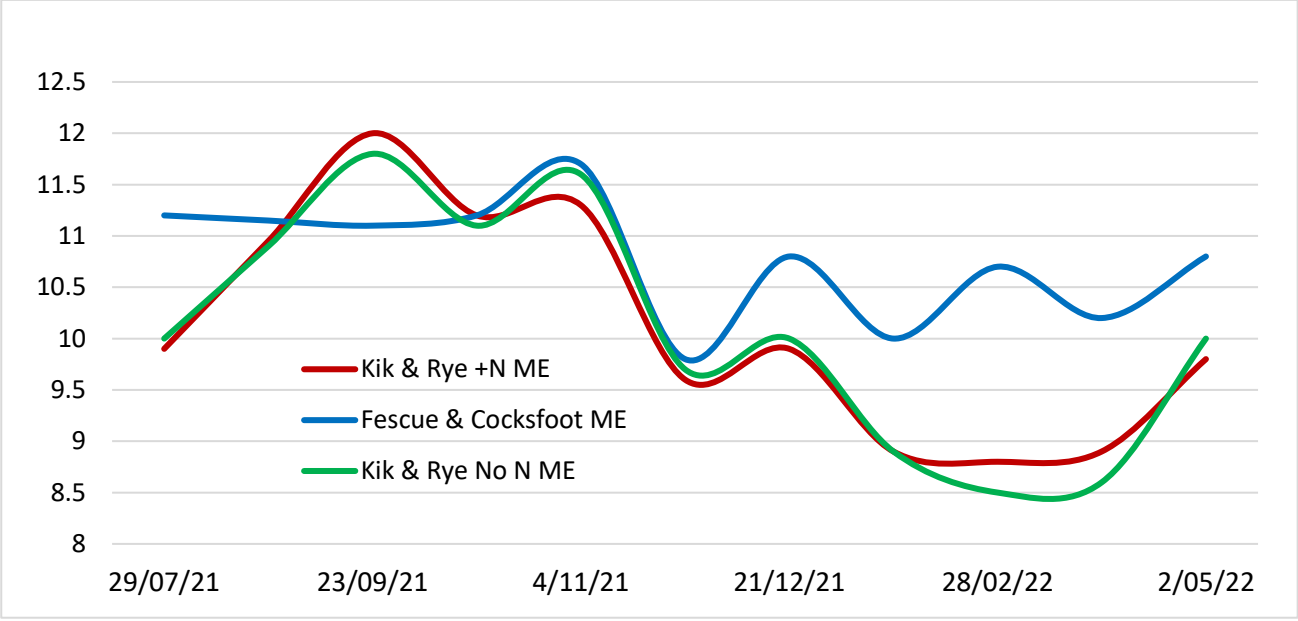


Figure 3 indicates that the crude protein level of the pastures that had not received nitrogen was lower during late winter/early spring. This coincided with a period when the Low Emissions farm cows had lower milk production than the other farms. The lower protein levels may have been due to the longer rotation length (older material in the sward), no applied nitrogen, or a combination of those two factors. The fescue/cocksfoot pastures had higher protein during summer/autumn, again likely partially due to chicory presence.

Figure 3. *Pasture crude protein content (%).*

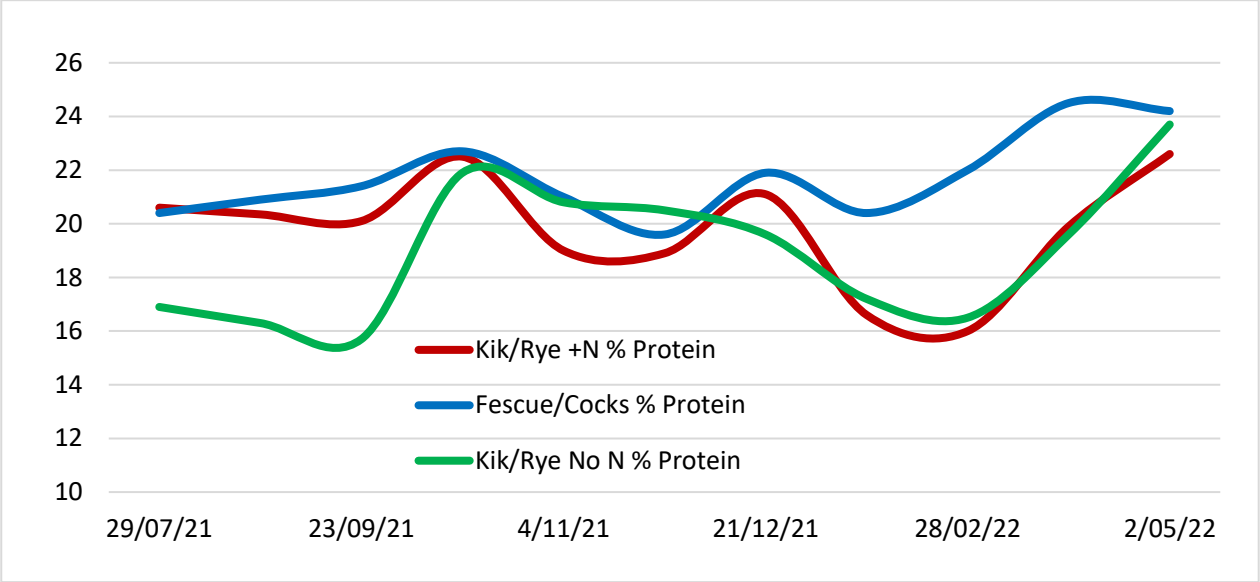
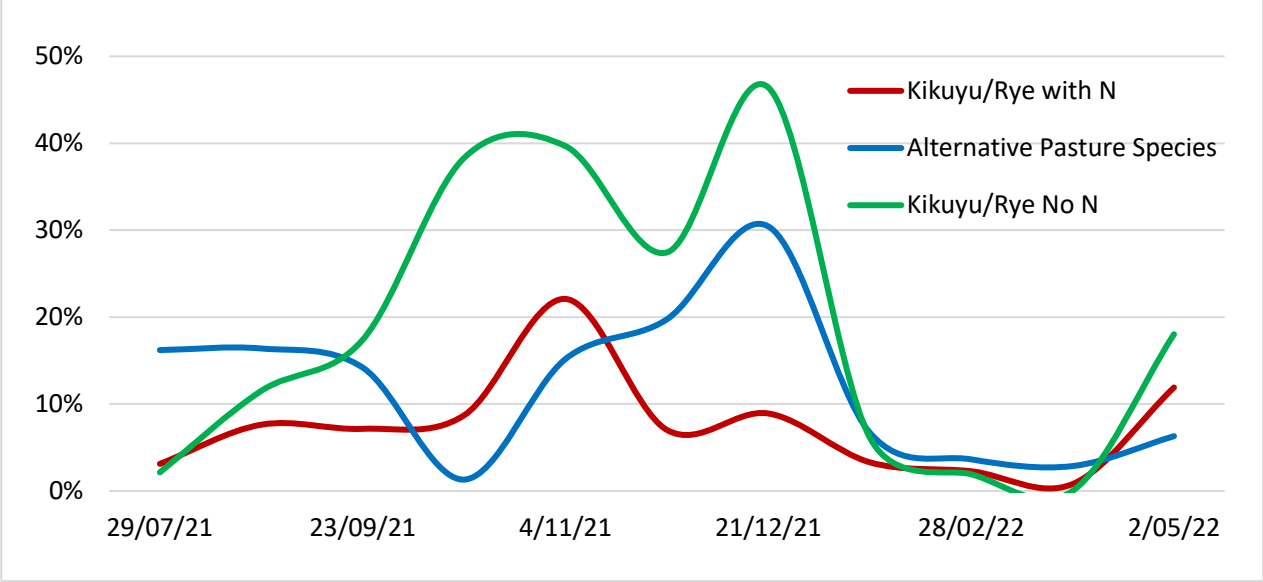


Figure 4 shows the presence of clover in the pre-graze pasture samples collected through the season. This was entirely white clover on the Current and Low Emissions Farms, with some red clover present in the Alternative Pastures farm. The graph indicates that the Low Emissions farm rapidly showed a higher clover presence through much of the season, assumed to be in response to no nitrogen applications.

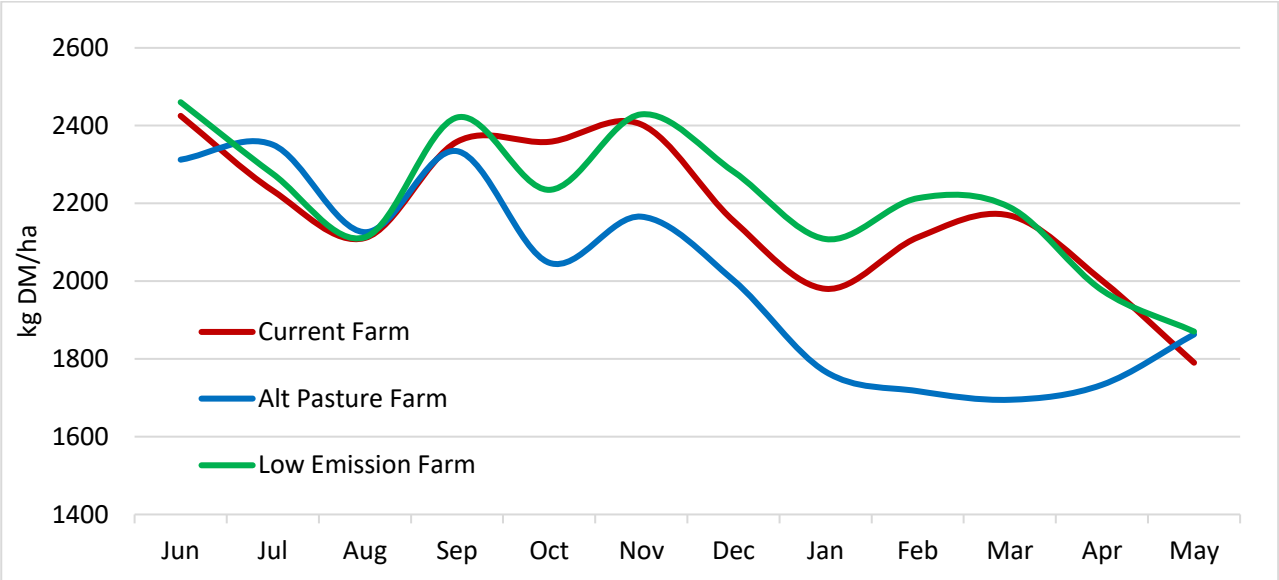
Figure 4. *Clover presence in pasture samples (% clover).*



Pasture Covers

Figure 5 shows the pasture cover on the farms through the season. The Alternative Pastures farm had significantly lower pasture covers from late spring through to autumn. The Low Emissions farm tended to have higher covers during summer, likely in response to the lower stocking rates on this farm.

Figure 5. *Average pasture cover on farms – monthly average.*



Supplement Fed & Pasture Eaten

Table 1 shows the supplement fed during the 2021/22 season, the cost of those supplements, and the calculated feed eaten for each of the farms. The differing cost of homemade silage/kg DM was due to differing bale weights.

Both the Current and Alternative Pastures farms purchased around 800 kg DM/cow of supplement, whereas the Low Emissions farm purchased only 67 kg DM/cow. The lower stocking rate on the Low Emissions farm allowed a greater quantity of silage to be conserved which was mainly fed out during the late summer/autumn period and eliminated the need for imported supplements.

The calculated pasture eaten data indicates that the Low Emissions farm cows consumed 3tDM/ha less pasture than the Current farm. This does not mean that the Low Emissions farm grew that much less, rather, grazing residuals were generally higher on the farm and more mulching was required.

Table 1. *Supplement made and purchased during 2020/21 season*

Farm	Supplement	Kg DM/cow fed	Cost of Supplement (incl Freight)	Total Cost of Supplement ¢/kg DM	Calculated Pasture Eaten t/ha
Current Farm	Home-made Silage PKE Purchased Silage **Total**	176 617 192 **986**	$53/bale $422/t $90/bale	22.6 46.4 36.0	13.4
Alternative Pastures Farm	Home-made Silage PKE Purchased Silage **Total**	104 528 276 **908**	$53/b $422/t $90/b	27.3 46.4 36.0	13.0
Low Emissions Farm	Home-made Silage PKE **Total**	400 67 **336**	$53/bale $422/t **468**	25.8 46.4	10.4

Milk Production

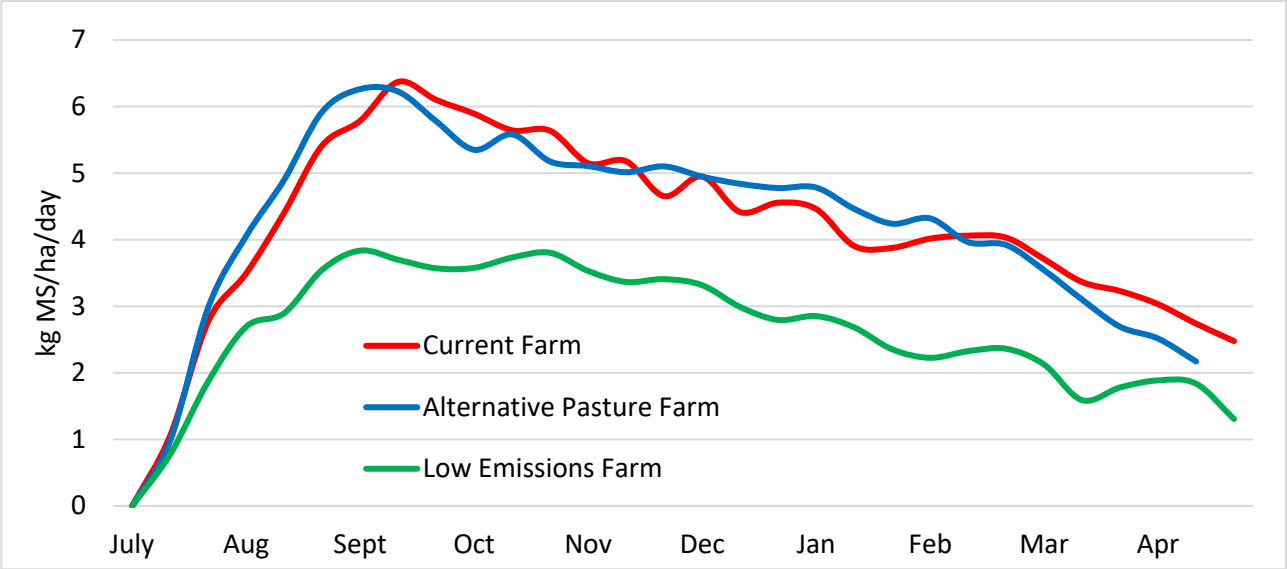
Milk production is shown in table 2 and figure 6. This was highest on the Alternative Pastures farm during early spring and summer, likely due to higher quality pasture. However, by late summer low pasture covers caused production and cow condition to drop and cows were therefore dried off in mid-April. Higher pasture covers on the other two farm enabled cows to be milked through to early May.

Over the whole season the Current Farm had the highest milk production. Milk production on the Low Emissions farm was always expected to be lower than the other farms due to the lower stocking rate, however milk production per cow was also lowest on this farm. The Low Emissions cows had a lower peak during spring despite all farms being on pasture only diets during that period and pasture covers being similar. As mentioned previously, this may have been due to lower protein levels in the pasture.

Table 2. *2021/22 Season Milk Production (kg MS/ha & kg MS/cow).*

Farm	Kg MS/ha	Kg MS/cow
Current Farm	1,284	409
Alternative Pastures Farm	1,213	397
Low Emissions Farm	794	370

Figure 6. *Milk Production – kg MS/ha/day (10 day average).*



Mating Results

Table 3 shows the mating results for the 2021/22 season. Overall, there were no significant differences between farms.

Table 3. *2021/22 Season Milk Production (kg MS/ha & kg MS/cow).*

Farm	6 Week In-calf Rate	Empty Rate
Current Farm	79%	11%
Alternative Pastures Farm	74%	9%
Low Emissions Farm	75%	3%

Greenhouse Gas Emissions

Greenhouse gas (GHG) emissions were calculated using the Overseer model. The Current farm and Alternative Pastures farm had similar emissions. The Low Emissions farm showed significant reductions in GHG emissions compared to the Current farm, especially in the CO_2 profile of the farm inputs which on the other farms were mainly made up by nitrogen fertiliser and supplements. Surprisingly, the calculated CO_2 emissions/kg product was also lower on the Low Emissions farm despite it having a 38% reduction in milk production compared to the Current farm.

Table 4. *Calculated GHG Emissions – kg CO_2 equivalent/ha and CO_2/kg milk solids using Overseer model.*

	Methane (CO_2 equivalent)	Nitrous Oxide (CO_2 equivalent)	Input CO_2	CO_2/kg MS
Current Farm	9,626	2,787	2,097	10.3
Alternative Pastures Farm	9,369	2,744	2,048	10.4
Low Emissions Farm	6,411	1,484	335	9.2
Compared to Current farm	33% reduction	47% reduction	84% reduction	9% reduction

Financial Analysis

The financial results for the three farms have been analysed and shown in Table 5. Expenses are based on actual expenses with some adjustments for labour and administration to compensate for extraordinary expenses involved in running the research trial. Records of additional labour and tractor time for each farm have been used to adjust the vehicle, R&M, and depreciation expenses. The initial cost of establishing the alternative pastures has not been considered in this analysis, however resowing of pastures this season and all mulching/drilling of kikuyu pastures is included.

Farm working expenses per kg milk solids were similar across all farms at around $5.70/kg MS. The Low Emissions farm had 35% lower expenses on a per ha basis, due to reduced stock numbers, no nitrogen inputs, and little imported supplementary feed. However, it also had 38% lower milk production.

With a $9.30/kg MS milk price, farm operating profit per ha was highest on the Current farm at $5,040, followed closely by the Alternative Pastures farm at $4,786, while the Low Emissions farm was significantly lower at $3,021. Alternative milk prices are overlayed in this analysis and show that the Low Emissions farm would continue to have the lowest farm profit until milk price was reduced to around $5.00/kg MS, (all other things being equal).

The cost of nitrogen within this season averaged $894/tonne urea (Sustain) delivered. The price of Sustain is currently significantly higher than this at around $1,340/tonne delivered. If this price was used in the analysis, it would reduce the profit of the Current and Alternative Pasture farms by $183/ha, still significantly more profitable than the Low Emissions farm.

Table 5. *Income, expenses, and operating profit for the three farms ($/ha).*

Financial Summary 2021/22 Season	Current Farm	Alternative Pastures Farm	Low Emissions Farm
Income	**$/ha**	**$/ha**	**$/ha**
Income from milk ($9.30/kg MS)	$11,793	$11,284	$7,386
Income from stock sales	$24	$24	$24
Dividends and other income	$962	$949	$666
Total Income/ha	**$12,778**	**$12,256**	**$8,076**
Expenses			
Wages	$1,925	$1,762	$1,314
Animal Health	$306	$302	$221
Breeding Expenses	$474	$468	$335
Shed expenses	$188	$186	$144
Electricity	$281	$277	$207
Grazing	$402	$396	$278
Calf rearing	$46	$45	$32
Silage Making	$126	$86	$198
PKE	$875	$748	$66
Purchased Silage	$198	$311	$0
General Fert	$119	$117	$118
Nitrogen Fert	$365	$369	$5
Regrassing	$300	$365	$326
Weed and Pest	$19	$19	$19
Vehicle Expenses	$266	$241	$219
R&M General	$837	$826	$701
R&M Effluent	$56	$55	$35
Administration	$161	$159	$150
Insurance	$93	$92	$84
Rates	$143	$141	$143
Depreciation	$557	$505	$460
Total Operating Expenses/ha	**$7,739**	**$7,471**	**$5,055**
Farm Working Expenses/kg MS	**$5.68**	**$5.74**	**$5.76**
Operating Profit (at $9.30/kg MS)	**$5,040**	**$4,786**	**$3,021**
Alternative Milk Prices			
Operating Profit at $5.00/kg MS	**-$413**	**-$432**	**-$394**
Operating Profit at $7.00/kg MS	**$2,123**	**$1,995**	**$1,194**
Operating Profit at $10.00/kg MS	**$5,927**	**$5,635**	**$3,577**

Discussion & Learnings

This study has shown that there was little difference in profitability between a kikuyu/Italian ryegrass-based farm and a farm that had 74% of pasture sown with tall fescue and/or cocksfoot pastures. This was despite these alternative species pastures having variable establishment success. The better feed quality of the alternative pastures species pastures provided better milk production in early spring and summer, however during what was a reasonably dry summer/autumn, those pastures did not produce as much feed as the kikuyu pasture and cows had to be dried off earlier than the other farms.

The removal of nitrogen fertiliser within the Low Emissions farm resulted in a fairly consistent reduction in pasture growth during winter and spring. Overall, the response to nitrogen on the

Current farm appeared to be around 8 kg/kg N applied. This was lower than expected. The lack of applied nitrogen may have been compensated by the longer grazing rotations on the Low Emissions farm as well as the higher clover content which would have fixed additional nitrogen. It will be interesting to see the impact of no nitrogen applications on clover presence in future seasons.

This project expected to reduce methane emissions 25% and nitrous oxide emissions by 50% on the Low Emissions farm. This was to be achieved through reducing stocking rate, the removal of nitrogen fertiliser, and minimal imported supplements. Compared to the Current farm, the Low Emissions farm showed a reduction of methane emissions of 33% and nitrous oxide 47%. In addition, CO_2 emissions associated with farm inputs were reduced by 84%, though these emissions are not accounted for on-farm.

The cost of achieving these emissions targets was a reduction in farm profit of $2,019/ha. This was in a record milk price season. In a lower milk price season this loss in profit would be reduced. Regardless, the cost of reducing emissions through reducing stocking rate and removing nitrogen applications and imported supplement was significant. The pricing mechanism to encourage farmers to reduce emissions has yet to be confirmed, however it is unlikely the emissions pricing will be high enough to compensate for the significant loss in profit shown in this study.

There are three further years of this study to run, which will allow the testing of these regimes over different climatic conditions and to see if any of these effects compound over time (such as clover presence). We consider we may have understocked the Low Emissions farm and plan to increase the stocking rate by 0.15 cows/ha in this coming season.

Acknowledgements

Thanks to NARF staff for making this project happen on the ground. Special thanks to NDDT trustees and NARF committee members for their support and commitment in proposing, overseeing, and managing this project.

For more information go to nddt.nz or to receive fortnightly email updates, contact info@nddt.nz.

Contacts

Terence Brocx – NDDT Chair, roundtuit@slingshot.co.nz
Kim Robinson – NDDT Coordinator, kim.robinson@agfirst.co.nz
Chris Boom – NDDT Science Manager, chris.boom@agfirst.co.nz