Northland Dairy Farmers Conference

'The Future Farm'

21st February 2023 - Whangarei

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Future Dairy Farm Systems for Northland Project

Update - February 2023

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 Food and Fibre Futures) and Hine Rangi Trust with support from commercial sponsors.

Summary

This study compares the normal (current) NARF dairy system (**Current Farm** - 3.1 cows/ha, 190 kg N/ha applied) with a farm that has 75% 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** - 2.2 cows/ha, no nitrogen applied). This project commenced in June 2021 and will run for 4 seasons.

Pasture growth monitoring showed that with no nitrogen fertiliser application the Low Emissions Farm grew 1,37 tDM/ha less pasture than the Current Farm in the 2021/22 season, and 2.3 tDM/ha less in the 2022/23 season (to date). This indicates a response of 8 and 15 kg DM/kg N applied on the Current Farm for each season respectively.

The tall fescue/cocksfoot pastures on the Alternative Pastures Farm have had similar annual pasture growth to the kikuyu/Italian ryegrass pastures on the Current Farm, however the seasonality has been different with the Alternative species pastures having higher growth in winter/spring and lower growth in summer/autumn. The Alternative Pastures Farm has also shown higher pasture quality during summer/autumn compared to the other farms.

To date, the proportion of clover in the pasture has averaged 10% on the Current Farm, 16% on the Alternative Pastures Farm and 26% on the Low Emissions Farm.

In the 2021/22 season, total milk production was highest on the Current farm (1,284 kg MS/ha) followed by the Alternative Pastures farm (1,213 kg MS/ha) with the Low Emissions farm significantly behind the other two (794 kg MS/ha).

Financial analysis for the 2021/22 season, using a $9.30/kg MS milk price, shows the Current farm was the most profitable with an operating profit of $5,040/ha followed closely by the Alternative Pastures farm with $4,876/ha and the Low Emissions farm with $3,021/ha.

Sowing alternative pasture species did not result in increased full season production or profit. However, it must be noted that they were competing against a relatively productive regime on the other farms where kikuyu is mulched and reseeded with Italian ryegrass annually.

Modelling of the 2021/22 season shows that the Low Emissions farm had a 33% reduction in methane emissions and a 47% reduction in nitrous oxide emissions compared to the Current farm, however farm profit was also 40% lower. Based on this the pricing mechanism to encourage farmers to reduce emissions is unlikely to be near enough to compensate for the significant loss in profit shown in this study for this season.

The 2022/23 season to date is indicating the difference in milk production between the Current and Low Emissions Farms will be less than the 2021/22 season, and when combined with increased on-farm costs it is likely that farm profit will be similar between these two farms.

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.

Dairy farmers are also being asked to lower GHG emissions. 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 pastures with imported feed (PKE & Baleage) to fill feed deficits. Stocking rate 3.1 cows/ha and up to 190 kg applied N/ha
2. **Alternative Pastures Farm** (Blue) – 75% of pastures in alternative species to ryegrass - including fescue, cocksfoot, legumes & herbs with imported feed to fill deficits. Stocking rate 3.1 cows/ha and up to 190 kg applied N/ha
3. **Low Emissions Farm** (Green) – existing ryegrass/kikuyu pasture with a target to reduce methane emissions by 25% and nitrous oxide emissions by 50% (compared to the Current Farm). Stocking rate 2.2 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, 11.6 ha in March 2021. Grass species sown were tall fescue or tall fescue and cocksfoot or cocksfoot, with white clover, red clover and persian clover. In the 2021 and 2022 sowings 1 kg/ha chicory was also added. 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 and 2022 sown pastures was variable with some poor establishment, mainly due to competition from poa annua. Due to this, 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. All sowings were grass to grass, no cropping.

The other two farms (Current Farm and Low Emissions Farm), and the 26% 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

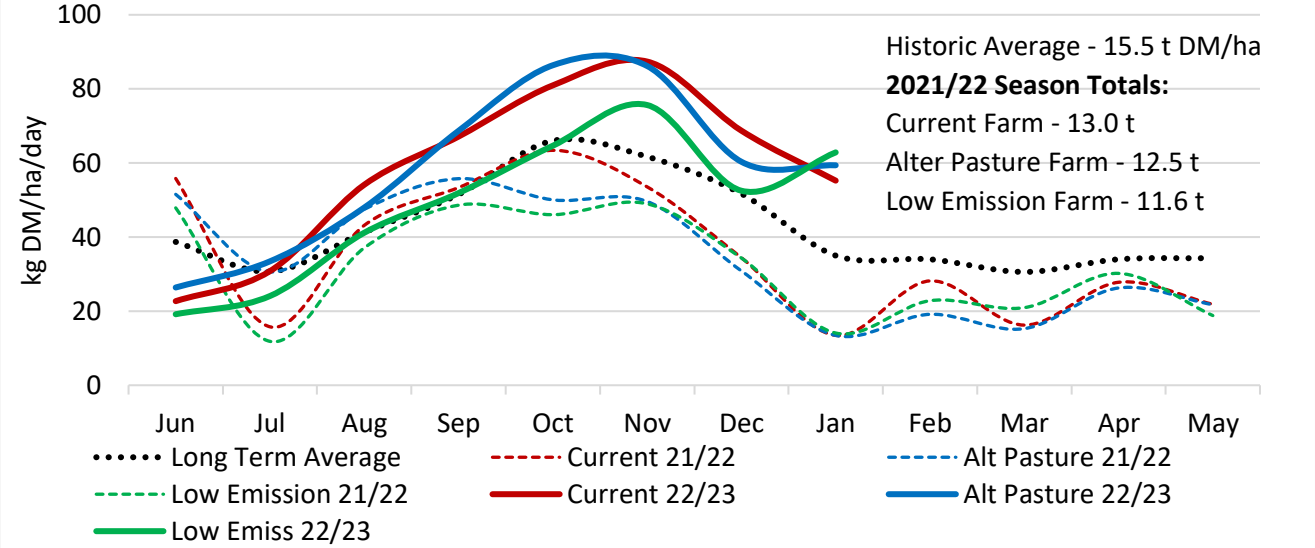
Pasture growth, composition and quality has been compared between the resident kikuyu/Italian ryegrass pastures with and without nitrogen, and the fescue/cocksfoot based pastures with nitrogen, since July 2021.

Figure 1 shows pasture growth differences between farms pastures as calculated by weekly platemeter assessments. During the 2021/22 season, growth on all farms was considerably below the historic average, due to dry conditions during summer/autumn. So far, pasture growth in the 2022/23 has generally been above the historic average.

Overall, the fescue/cocksfoot pastures on the Alternative Pastures Farm showed similar pasture growth to the pastures on the Current Farm.

The difference between the Current farm and the Low Emissions farm shows the effect of nitrogen application on the Current Farm, which grew 1,376 kg DM/ha more than the Low Emissions farm in 2021/22 and 2,297 kg DM more in 2022/23 (to date). With 172 kg N/ha applied to the Current farm in 2021 and 153 kg N/ha in 2022, all between June and December, this calculates to a farm systems response of 8 kg DM/kg N in 2021 and 15 kg DM/kg N in 2022.

Figure 1. *Pasture growth rates for 2021/22 and 2022/23 seasons to date, as calculated by pre – post grazing platemeter assessments.*



Pasture Quality

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 much of the first year, especially during

summer/autumn. The 2021 sown pastures had 1 kg of chicory in the seed mix and these pastures became chicory dominant over the summer/autumn period.

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).*

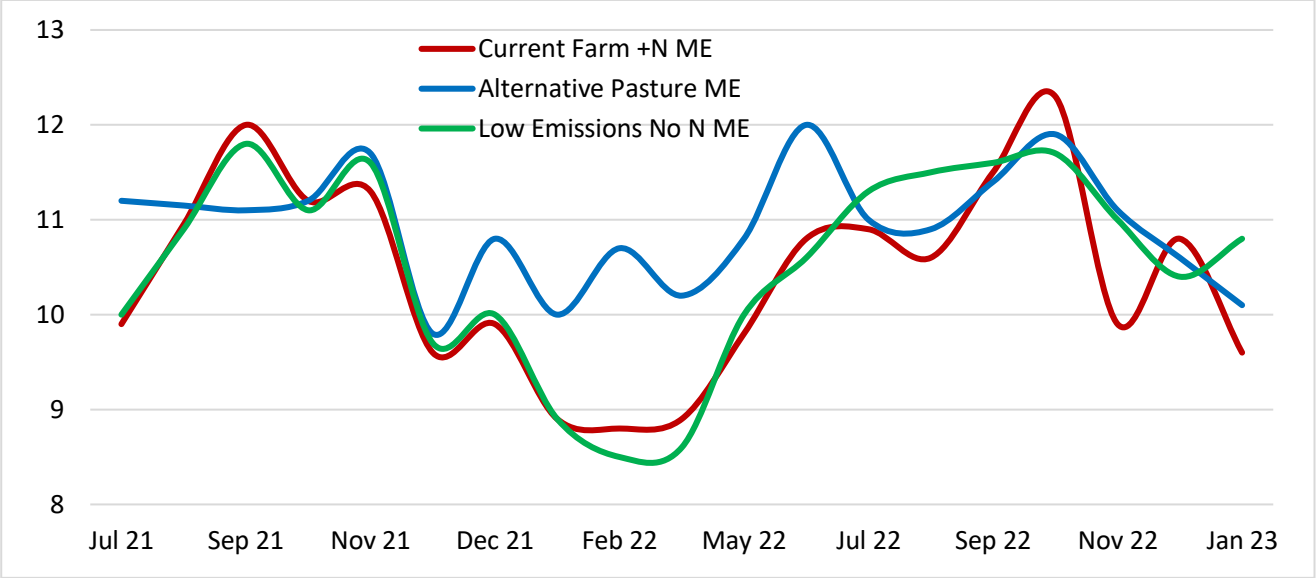
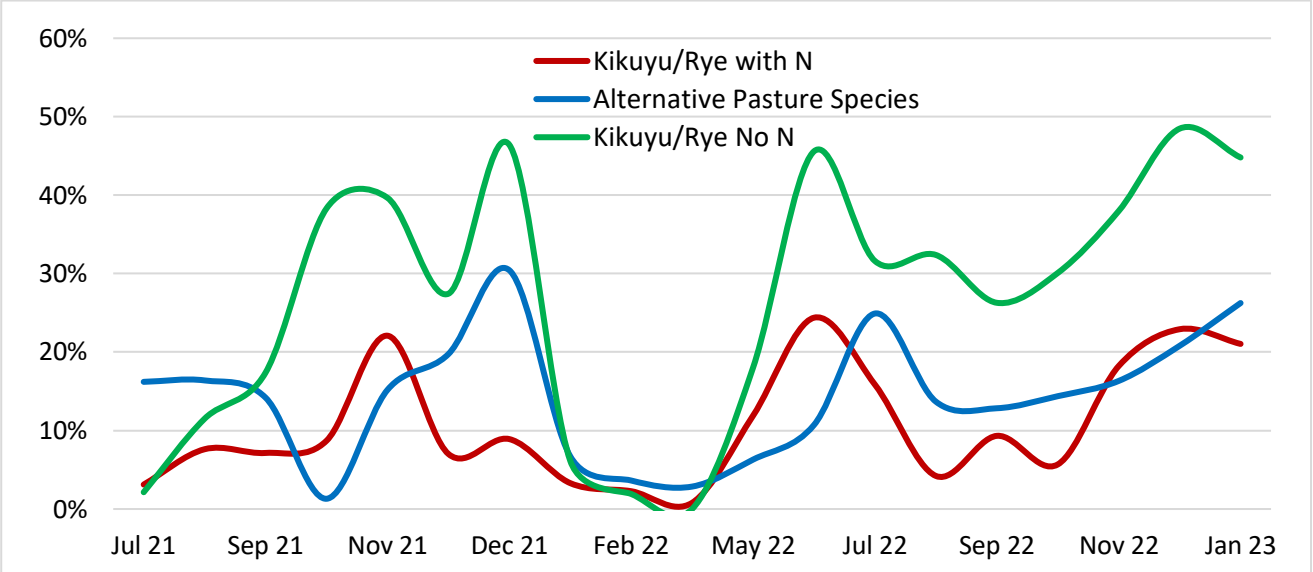


Figure 3 shows the presence of clover in the pre-graze pasture samples collected through the season. This was entirely white clover on the Current and Low Emissions Farms, with some red clover present in the Alternative Pastures Farm. The graph indicates that no applied nitrogen on the Low Emissions farm rapidly resulted in a higher clover presence throughout the study to date, apart from the dry period 2022 summer period.

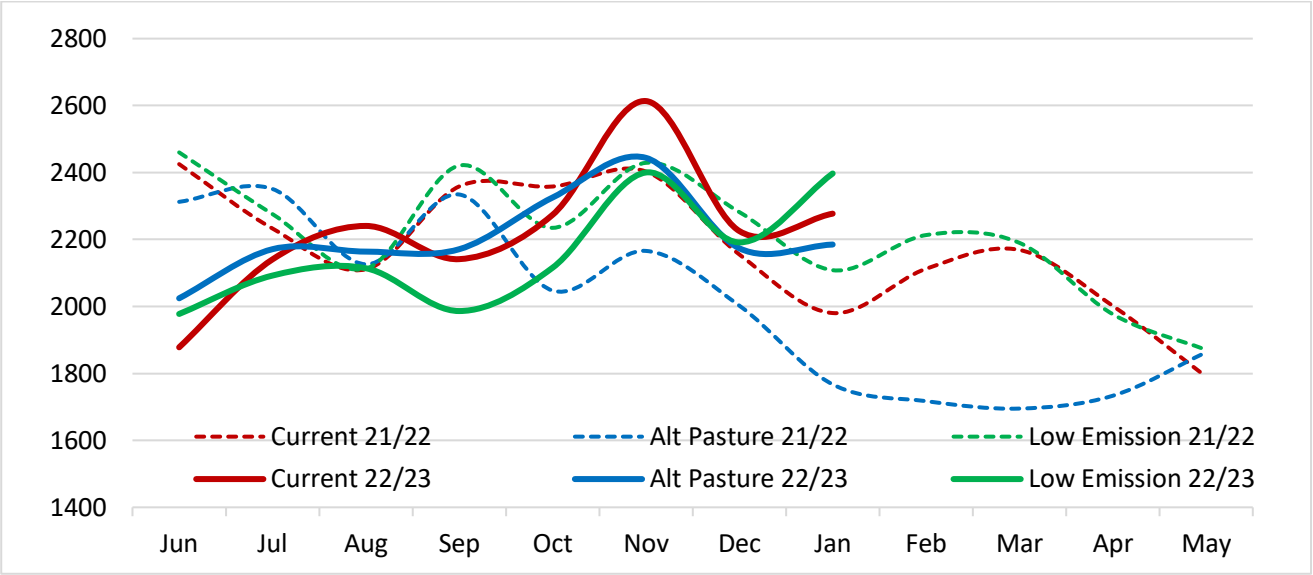
Figure 3. *Clover presence in pre-graze pasture samples (% clover).*



Pasture Covers

Figure 4 shows the pasture cover on the farms to date. The Alternative Pastures Farm had significantly lower pasture covers from late spring through to autumn in the 2021/22 season. The Low Emissions Farm tended to have higher covers during summer, likely in response to the lower stocking rates on this farm.

Figure 4. *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.

In the 2021/22 season 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 three tonnes 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 2021/22 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

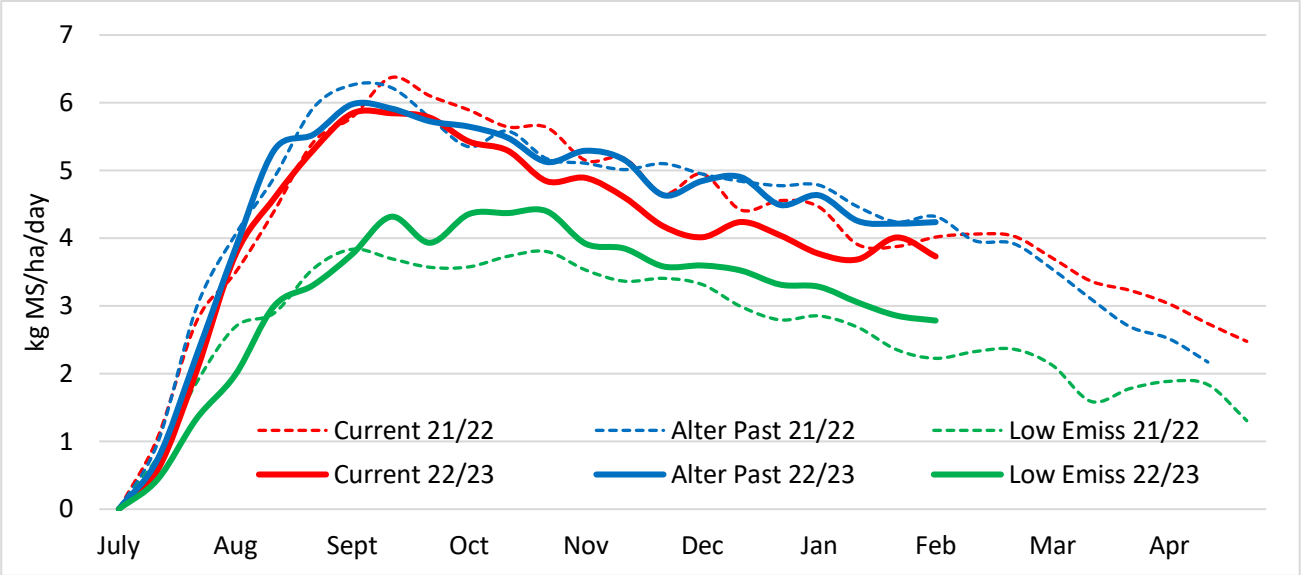
Milk production is shown in table 2 and figure 6. In both seasons milk production was highest on the Alternative Pastures Farm during early spring and summer, likely due to higher quality pasture. However, by late summer 2022 low pasture covers caused production and cow condition to drop and cows were therefore dried off in mid-April 2022. Higher pasture covers on the other two farm enabled cows to be milked through to early May.

The Current Farm had the highest milk production for the 2021/22 season. 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 in the 2021/22 season.

Table 2. *Milk Production for 2021/22 season and 2022/23 up to 4th February (kg MS/ha & kg MS/cow).*

	2021/22 Kg MS/ha	2021/22 Kg MS/cow	2022/23 to 4th Feb Kg MS/ha	2022/23 To 4th Feb Kg MS/cow
Current Farm	1,268	409	894	292
Alternative Pastures Farm	1,213	397	953	308
Low Emissions Farm	794	370	681	297

Figure 6. *Milk Production to 4th February 2023 – kg MS/ha/day (10 day average).*



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 imported 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 3. *Calculated GHG Emissions – kg CO_2 equivalent/ha and CO_2/kg milk solids using Overseer model for the 2021/22 season.*

	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 2021/22 financial results for the three farms have been analysed and shown in Table 4. Expenses are based on actual expenses with some adjustments for labour and administration to compensate for extraordinary expenses involved in running the research farm. 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 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.

Table 4. *Income, expenses, and operating profit for the 2021/22 season on 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 during the 2021/22 season. 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. The response to nitrogen on the Current Farm was 8 kg/kg N applied during the 2021/22 season and 15 kg DM/kg N during the 2022/23 season (to date). The removal of applied nitrogen from the Low Emissions Farm pastures quickly resulted in significantly higher clover content, which would have fixed additional nitrogen, somewhat compensating for the lack of nitrogen application.

The Low Emissions Farm was designed to reduce methane emissions 25% and nitrous oxide emissions by 50% compared to the Current Farm. For the 2021/22 season, 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. This reduction was achieved through reducing stocking rate, the removal of nitrogen inputs, and minimal imported supplements.

The relative cost of achieving these emissions targets was a reduction in farm profit of $2,019/ha for the 2021/22 season. This was in a record milk price season. In a lower milk price season this loss in profit would be reduced, however milk price would need to be as low as $5/kg MS before all farms would have had a similar profit. The cost of reducing emissions through reducing stocking rate and removing nitrogen applications and imported supplement was significant and it is unlikely the emissions pricing will be high enough to compensate for the significant loss in profit shown in the 2021/22 season.

The 2022/23 season to date is indicating the difference in milk production between the Current and Low Emissions Farms will be less than the 2021/22 season. On farm costs are also higher, especially nitrogen fertiliser and labour costs which will affect the Current and Alternative Pastures Farms more than the Low Emissions Farm, and therefore farm profit will likely being more similar between farms for the 2022/23 season.

This study will continue until May 2025, allowing the testing of these regimes over different climatic conditions and to see if any of these effects compound over time.

Acknowledgements

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

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