# Northland Dairy Development Trust
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# Future Farm Systems Trial

# 20th June 2024

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# Future Dairy Farm Systems for Northland Project

Chris Boom and Kim Robinson
June 2024

## Summary

This study compares a typical Northland dairy farm system (**Baseline Farm** – kikuyu/ryegrass pastures, 3.1 cows/ha, up to 190 kg N/ha applied) with a farm that has over 70% of land in tall fescue/cocksfoot/chicory-based pastures (**Alternative Pastures Farm** - 3.1 cows/ha, up to 190 kg N/ha), and a farm designed to have significantly reduced greenhouse gas (GHG) emissions (**Low Emissions Farm** – kikuyu/ryegrass pastures, 2.2 cows/ha, no N applied).

The three completed seasons of this study have shown quite different results. Milk production was highest on the Baseline Farm in the first season (2021/22) which featured a particularly dry summer. In the second and third seasons production was highest on the Alternative Pastures Farm. Milk production/ha on the lower stocked Low Emissions Farm has ranged between 25% and 39% lower than the Baseline Farm. The variation in milk production on the Low Emissions Farm appears to be related to variance in clover presence.

Financial analysis of each farm (using actual milk price) shows the Alternative Pastures Farm has been the most profitable in two of the three seasons. Profit on the Low Emissions Farm has been lowest except for the 2022/23 season, when better production and significant inflation in input costs combined to boost profit above that of the Baseline Farm.

| | Milk Solids kg/ha | | | Farm Operating Profit $/ha | | |
|---|---|---|---|---|---|---|
| | 2021/22 | 2022/23 | 2023/24 | 2021/22 | 2022/23 | 2023/24 |
| **Baseline Farm** | 1,284 | 1,204 | 1,112 | $4,952 | $1,906 | $171 |
| **Alternative Pastures Farm** | 1,213 | 1,269 | 1,178 | $4,699 | $2,669 | $459 |
| **Low Emissions Farm** | 794 | 910 | 790 | $2,974 | $2,234 | -$463 |

Averaged across the three seasons to date, the Low Emissions Farm has shown GHG reductions close to targets compared to the Baseline Farm. The methane reductions have been more variable, partly due to fluctuating milk production per cow. Emissions intensity (GHG/kg MS) has improved, primarily through a reduction in the embedded emissions in imported feed and nitrogen fertiliser.

| Low Emissions Farm vs Baseline Farm | Methane | Nitrous Oxide | GHG/kg MS |
|---|---|---|---|
| **Targeted Reduction** | 25% | 50% | 0% |
| **Actual Reduction** | 28% | 48% | 12% |

This study has provided results under contrasting climatic conditions. So far, extended dry summers appear to favour kikuyu/Italian ryegrass-based pastures, whereas the Alternative Pastures Farm performed well in the normal to wetter summer rainfall seasons.

Removing nitrogen fertiliser on the Low Emissions Farm quickly resulted in a significant increase in clover presence, particularly in the 2022/23 season until flooding from cyclone Gabrielle eliminated clover from much of the farm. Variation in performance of this farm indicates how dependent no-nitrogen systems are on clover presence.

This project will continue for two more seasons allowing testing of these regimes over further variable climatic conditions and display any compounding 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 two to three years after sowing new ryegrass pastures. Kikuyu is productive during summer/autumn, however it is has poorer nutritive value, is difficult to manage and has low winter/spring growth. Farmers are looking for alternative pasture species which may be more persistent and resilient in the face of climate change.

Farmers are also being encouraged to lower GHG emissions on dairy farms. Despite an abundance of modelled information farmers are uncertain as to whether the strategies to reduce emissions are physically or financially sustainable, particularly the lowering of stocking rate on kikuyu pastures.

This farm systems trial, conducted at Northland Agricultural Research Farm near Dargaville, is designed to test and compare 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. **Baseline Farm** – existing ryegrass/kikuyu pastures with imported feed (mainly PKE) to fill feed deficits. Stocking rate 3.1 cows/ha and up to 190 kg applied N/ha
2. **Alternative Pastures Farm** – target 70% of pastures in alternative pasture species to ryegrass/kikuyu – currently tall fescue, cocksfoot, legumes & herbs - with imported feed (PKE) to fill feed deficits. Stocking rate 3.1 cows/ha and up to 190 kg applied N/ha
3. **Low Emissions Farm** – existing ryegrass/kikuyu pastures. Targeting a 25% reduction in methane emissions and 50% reduction in nitrous oxide emissions (compared to the Baseline Farm). Stocking rate 2.2 cows/ha, no nitrogen application. Little or no imported feed

The trial commenced in June 2021 and will run for five seasons to test these systems under a range of climatic conditions. Trial measures capture pasture and milk production and composition, profit, labour input and management difficulty and environmental impact.

## Introduction of New Pastures

The Alternative Pastures Farm was set up by sowing 74% of the farm area during 2020 and 2021. Species sown were tall fescue, cocksfoot, white and red clovers and chicory. Plantain and Persian clover were added in some paddocks.

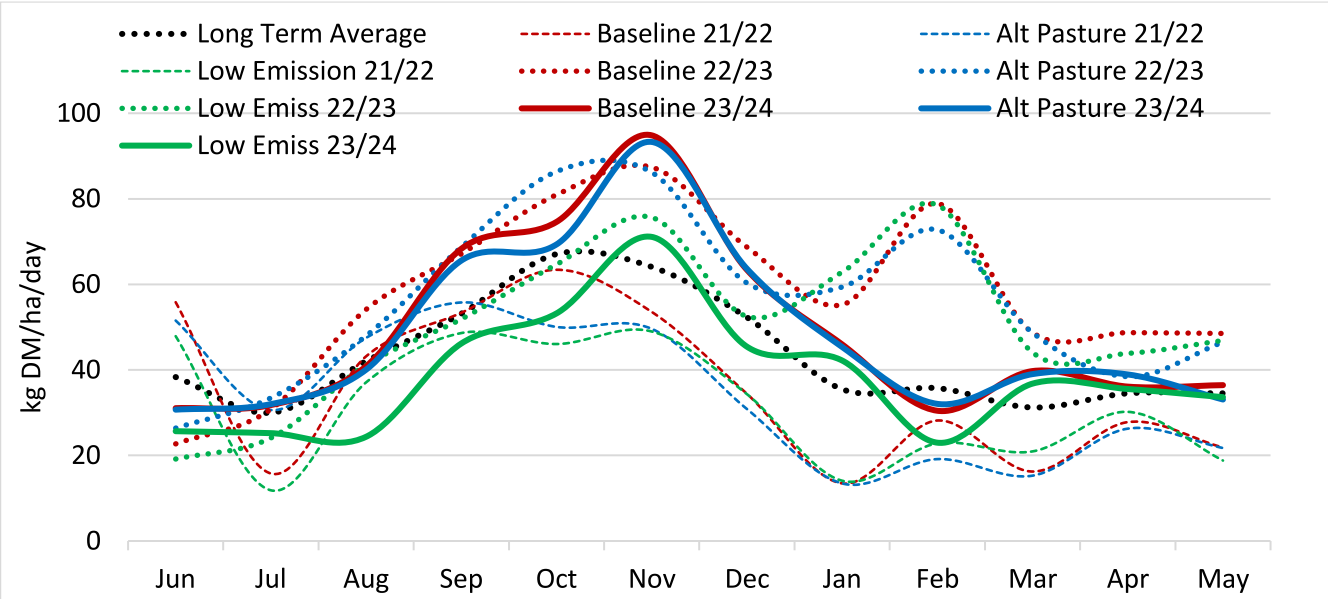
Between 15 - 20% of these alternative pastures have been resown each autumn, apart from autumn 2023 when 60% of these pastures were resown after damage from cyclone Gabrielle. Costs of the pasture introduction have been similar across each year, averaging $1,138/ha sown, including tractor time, man hours and contractor costs for drilling.

The other two farms (Baseline Farm and Low Emissions Farm), and the 26% portion of the Alternative Pastures Farm that was not sown in new species, have older pastures with approximately 70% kikuyu presence. All kikuyu-based paddocks on all three farms are mulched every autumn and under-sown with Italian ryegrass. This provides control of kikuyu stolon and boosts winter/spring growth and quality to complement the summer/autumn active kikuyu.

## Pasture Growth

Figure 1 shows the pasture growth differences between these pastures as calculated by weekly rising platemeter assessments. Pasture growth on the Baseline and Alternative Pasture Farms has generally been similar, with the Baseline Farm averaging 17.3 t DM/ha and the Alternative Pastures Farm 16.9 t DM/ha/annum.

***Figure 1.*** *Pasture growth rates for 2021/22, 2022/23 and 2023/24, as calculated by pre – post grazing platemeter assessments.*

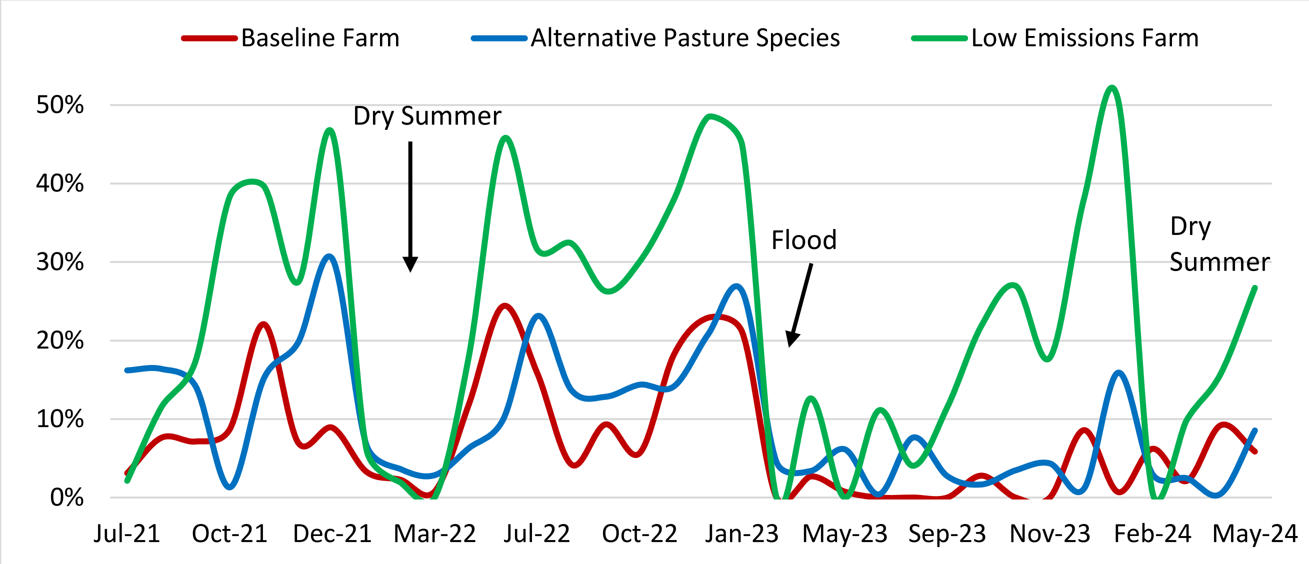



The pasture growth difference between the Baseline Farm and the Low Emissions Farm shows the impact of nitrogen applications. As expected, the differences are mostly confined to the period from June through to December when nitrogen is applied. During the 2023/24 season the Baseline Farm grew 3.9 t DM/ha more pasture than the Low Emissions Farm. With 188 kg N/ha applied to the Baseline Farm during this period, this calculates to a farm systems nitrogen response of 21.2 kg DM/kg N. This response to nitrogen is much higher than the previous two seasons, which were 8.0 and 15.5 kg DM/kg N applied respectively.

## Pasture Composition

Pasture samples are collected monthly from the next three paddocks to be grazed on each farm and analysed for feed quality and species present. Figure 2 shows the presence of clover for the three seasons. Clover present was entirely white clover on the Baseline and Low Emissions Farms and a small amount of red clover on the Alternative Pastures Farm.

***Figure 2.*** *Clover presence in pasture samples (% clover).*




The removal of fertiliser nitrogen on the Low Emissions Farm resulted in a rapid increase in clover presence at the start of the trial continuing through until the February 2023 when the flooding from cyclone Gabrielle wiped out clover on 90% of all three farms. The clover recovery was very slow, taking 10 months until it was fully recovered to pre flood levels. This lack of clover appeared to depress pasture and milk production on the Low Emissions Farm through the 2023/24 season.

## Calculated Clover Nitrogen Fixation

As shown above, the Low Emissions Farm has had significantly higher clover presence through most of the study to date. Based on these assessments the annual clover growth on each of the farms can be estimated (see table 1). This then allows an estimate of nitrogen fixation, based on a published study (Ledgard et al, Plant and Soil 229: 177-187, 2001).

Based on these estimates, the additional clover presence on the Low Emissions Farm has provided a significant contribution of nitrogen into the farm system, somewhat compensating for the lack of nitrogen application.

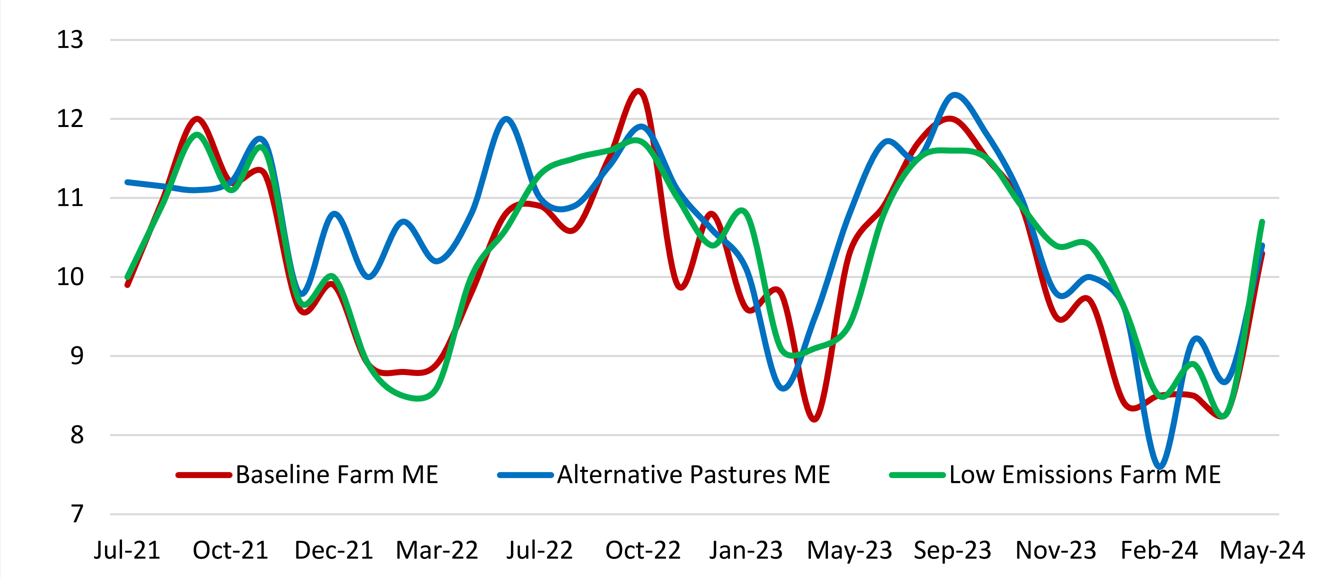
***Table 1.*** *Annual nitrogen application, calculated clover growth and estimated nitrogen fixation - average of three years.*

| Farm | Nitrogen Applied kg N/ha | Calculated Clover Growth kg DM/ha | Estimated Nitrogen Fixation kg N/ha | Total (kg N/ha) |
|---|---|---|---|---|
| **Baseline Farm** | 182 | 1,337 | 67 | 249 |
| **Alternative Pastures Farm** | 185 | 1,608 | 84 | 269 |
| **Low Emissions Farm** | 0 | 3,459 | 211 | 211 |

## Pasture Quality

Pasture ME as shown in Figure 3 indicates that the fescue/cocksfoot/chicory pastures can have higher feed quality through the summer/autumn periods, as seen in the first season.

***Figure 3.*** *Pasture metabolisable energy content (MJ ME/kg DM) over the three seasons.*




## Supplement Fed & Pasture Eaten

Farms are managed so that if pasture supply is inadequate then home grown or purchased supplement is provided to cows to keep pasture grazing residuals at the desired level (1500-1600 kg DM/ha). There is a limit of 800 kg DM/cow/annum purchased feed so that pasture system differences are not masked by very high supplement use.

Table 2 shows the average amount of supplement fed/annum over the three seasons, the cost of those supplements, and the calculated feed eaten for each of the farms. Due to greater pasture feed deficits, the Baseline Farm has fed more purchased supplement than the Alternative Pastures Farm during winter/spring in all three seasons.

***Table 2.*** *Supplement made and purchased, cost of that supplement and calculated pasture eaten – average of three seasons.*

| Farm | Supplement | Kg DM/cow fed | Cost of Supplement (incl Freight) | Total Cost of Supplement c/kg DM | Calculated Pasture Eaten t/ha |
|---|---|---|---|---|---|
| **Baseline Farm** | Home-made Silage | 223 | $54/bale | 20.3 | 12.9 |
| | PKE | 640 | $414/t | 46.0 | |
| | Purchased Silage | 135 | $96/bale | 37.6 | |
| | **Total** | **998** | | | |
| **Alternative Pastures Farm** | Home-made Silage | 238 | $54/bale | 20.3 | 13.4 |
| | PKE | 564 | $443/t | 46.0 | |
| | Purchased Silage | 163 | $96/bale | 37.6 | |
| | **Total** | **965** | | | |
| **Low Emissions Farm** | Home-made Silage | 426 | $54/bale | 20.3 | 10.2 |
| | PKE | 208 | $414/t | 46.0 | |
| | Purchased Silage | 23 | $96/bale | 37.6 | |
| | **Total** | **657** | | | |

Despite the lower stocking rate on the Low Emissions Farm, the low pasture growth rates and pasture covers during winter has resulted in some PKE being required to fill the feed gap and boost body condition score of cows.

The calculated pasture eaten data indicates that the Alternative Pastures Farm had the highest pasture eaten in all seasons to date while cows on the Low Emissions Farm consumed 2.7 t DM/ha less pasture than the Baseline Farm.

## Milk Production

Milk production is shown in Table 3 and Figure 5. In February 2023, flooding from cyclone Gabrielle caused this study to be disbanded while pastures were resown, therefore milk production for the latter part of that season was modelled (as if the flooding had not occurred).

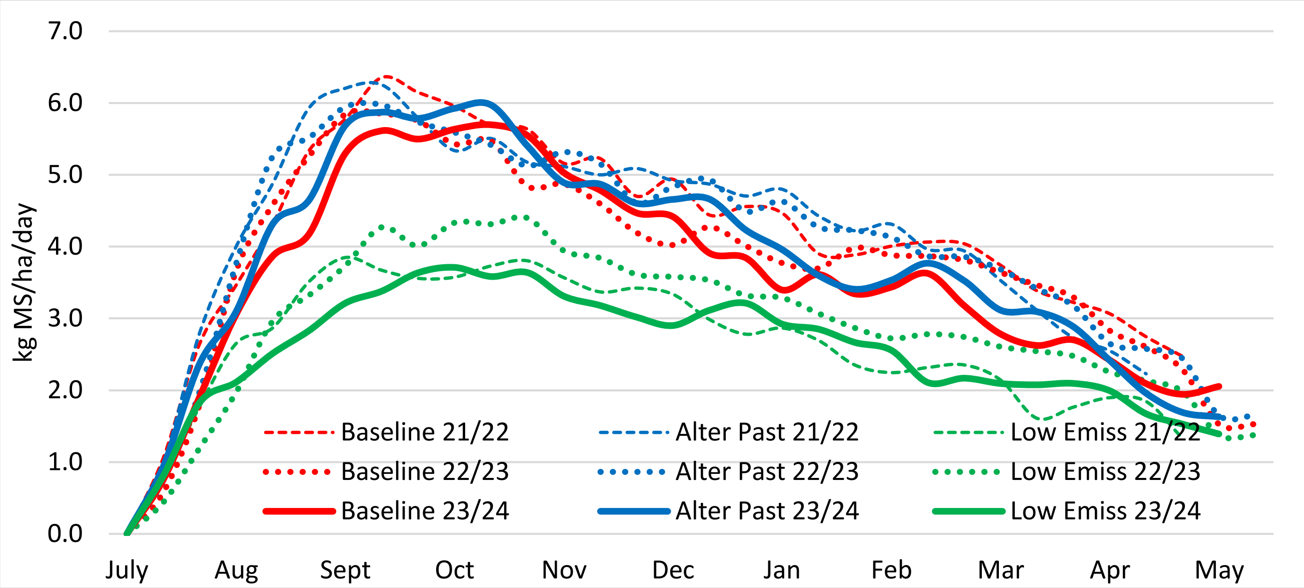
The Alternative Pastures Farm had higher milk production than the Baseline Farm during the 2022/23 and 2023/24 seasons. This is in contrast to the first season where the Baseline Farm had the highest production. Climatic differences between these seasons are responsible for this difference. The kikuyu pastures on the Baseline Farm supported milk production through a dry summer/autumn in 2022, while the Alternative Pastures Farm cows were dried off early. The following wetter seasons allowed the Alternative Pastures Farm to continue milking right through.

Milk production on the Low Emissions Farm was significantly higher during 2022/23 than the other two seasons. This is attributed largely to high clover levels and good summer pasture growth during this season, pre flood. Cows peaked at 2.0 kg MS/cow/day during that spring, when clover content was around 40% of pasture. This compares with 1.8 and 1.65 kg MS/cow/day in the first and third seasons, when clover content was lower.

***Table 3.*** *Seasonal Milk Production (kg MS/ha & kg MS/cow).*

| Farm | 2021/22 | | 2022/23 (part modelled) | | 2023/24 | |
|---|---|---|---|---|---|---|
| | MS/ha | MS/cow | MS/ha | MS/cow | MS/ha | MS/cow |
| **Baseline Farm** | 1,284 | 409 | 1,204 | 392 | 1,112 | 375 |
| **Alternative Pastures Farm** | 1,213 | 397 | 1,269 | 406 | 1,178 | 386 |
| **Low Emissions Farm** | 794 | 370 | 910 | 399 | 790 | 355 |

***Figure 5.*** *Milk Production – kg MS/ha/day (10 day average), modelled post-flood during the 2022/23 season.*




## Mating Results

Table 4 shows the mating results for the three seasons. Overall, there have been no consistent differences between farms.

***Table 4.*** *Six week in-calf and empty rates.*

| Farm | 2021/22 Season 6 week in-calf | 2021/22 Season Empty Rate | 2022/23 Season 6 week in-calf | 2022/23 Season Empty Rate | 2023/24 Season 6 week in-calf | 2023/24 Season Empty Rate |
|---|---|---|---|---|---|---|
| **Baseline Farm** | 79% | 11% | 81% | 10% | 81% | 8% |
| **Alternative Pastures Farm** | 74% | 9% | 82% | 11% | 85% | 4% |
| **Low Emissions Farm** | 75% | 3% | 82% | 12% | 73% | 10% |

## Greenhouse Gas Emissions

Greenhouse gas (GHG) emissions were calculated using the Overseer model and are shown in table 5. Averaged across the three seasons, emissions were relatively similar between the Baseline and Alternative Pastures Farms.

***Table 5.*** *Calculated GHG Emissions using Overseer Model, average of three seasons.*

| Farm | Methane ($CO_2$ eq) kg/ha | Nitrous Oxide ($CO_2$ eq) kg/ha | Input $CO_2$ kg/ha | kg $CO_2$/kg MS |
|---|---|---|---|---|
| **Baseline Farm** | 8,273 | 1,942 | 2,514 | 10.6 |
| **Alternative Pastures Farm** | 8,612 | 2,025 | 2,229 | 10.6 |
| **Low Emissions Farm** | 5,899 | 1,000 | 811 | 9.3 |
| Compared to Baseline Farm | 28% reduction | 48% reduction | 68% reduction | 12% reduction |

The Low Emissions Farm reduced methane and nitrous oxide relative to the Baseline Farm close to target levels. The methane levels fluctuated somewhat in line with milk production and stocking rate, as methane is closely related to feed eaten.

Despite the 31% drop in milk production, emissions intensity was also lowest on the Low Emissions Farm. This is due to the relatively high embedded emissions associated with the manufacture and transport of nitrogen fertiliser and PKE.

Emissions intensity on the Low Emissions farm varied over the three years from 8.6 kg $CO_2$/kg MS to 10.0 kg $CO_2$/kg MS, with the lowest intensity in the second year being driven by higher milk production per cow, and low imported feed. At high milk production per cow, the emissions associated with cow maintenance feed eaten are diluted over more kg MS. However, if high milk production is coming from high levels of imported PKE, then emissions intensity may be increased due to the relatively high embedded emissions associated with PKE inputs.

## Financial Analysis

Three-year average milk production and operating profit for the three farms is summarised in Table 6 and full financial results for the 2023/24 season are detailed in Table 7. Fonterra dividend income is excluded as shareholdings will vary between farms and does not necessarily reflect a treatment difference. Expenses are based on actual farm 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 allocate the vehicle, R&M, and depreciation expenses.

Averaged across all farms, 2023/24 season farm working expenses (FWE) at $7.77/kg MS were significantly higher than previous seasons, partially due to very high expenditure on R&M as a result of flood damage and catch up on deferred maintenance. These high costs combined with lower milk production resulted in low farm operating profits.

For the second year in a row, farm operating profit was highest on the Alternative Pastures Farm. The Low Emissions Farm showed lower operating profit than the other farms. This is different to the previous season when the farm had higher milk production and high input prices prevailed.

Averaged across the three years of this study, farm operating profit relative to the Baseline Farm has been 13% higher on the Alternative Pastures Farm and 31% lower on the Low Emissions Farm.

***Table 6.*** *Three-year average milk production and operating profit*

| Farm | Average Milk Production kgMS/ha | Change relative to Baseline % | Average Farm Operating Profit $/ha | Change relative to Baseline % |
|---|---|---|---|---|
| **Baseline Farm** | 1,200 | | $2,306 | |
| **Alternative Pastures Farm** | 1,220 | +2% | $2,605 | +13% |
| **Low Emissions Farm** | 831 | -31% | $1,590 | -31% |

***Table 7.*** *2023/24 Financial Results - income, expenses, and operating profit for the three farms ($/ha).*

| **Financial Summary 2023/24 Season** | **Baseline Farm** | **Alternative Pastures Farm** | **Low Emissions Farm** |
|---|---|---|---|
| **Income** | **$/ha** | **$/ha** | **$/ha** |
| Income from milk ($7.80/kg MS) | $8,676 | $9,190 | $6,164 |
| Other income (excl Fonterra Divid) | $78 | $77 | $78 |
| Income from stock & baleage sales | $586 | $605 | $441 |
| **Total Income/ha** | **$9,341** | **$9,871** | **$6,682** |
| **Expenses** | | | |
| Wages | $2,035 | $2,107 | $1,487 |
| Animal Health | $700 | $719 | $541 |
| Breeding Expenses | $279 | $287 | $212 |
| Shed expenses | $209 | $214 | $169 |
| Electricity | $361 | $370 | $283 |
| Grazing | $662 | $682 | $497 |
| Calf rearing | $118 | $121 | $88 |
| Silage Making | $111 | $116 | $41 |
| PKE | $1,026 | $1,007 | $380 |
| Purchased Silage | $0 | $40 | $395 |
| General Fert | $107 | $107 | $107 |
| Nitrogen Fert | $404 | $400 | $0 |
| Regrassing | $320 | $396 | $320 |
| Weed and Pest | $68 | $68 | $68 |
| Vehicle Expenses | $448 | $440 | $438 |
| R&M Buildings | $113 | $115 | $99 |
| R&M General | $1,114 | $1,132 | $970 |
| R&M Effluent | $33 | $33 | $21 |
| Administration | $185 | $186 | $175 |
| Insurance | $178 | $180 | $164 |
| Rates | $149 | $149 | $149 |
| Depreciation | $552 | $543 | $540 |
| **Total Operating Expenses/ha** | **$9,170** | **$9,412** | **$7,144** |
| **Farm Working Expenses $/kg MS** | **$7.76** | **$7.53** | **$8.03** |
| **Operating Profit (at $7.80/kg MS)** | **$171** | **$459** | **-$463** |
| **2023/24 Operating Profit with Alternative Milk Prices** | | | |
| **Operating Profit at $6.00/kg MS** | **-$1,859** | **-$1,690** | **-$1,906** |
| **Operating Profit at $10.00/kg MS** | **$2,591** | **$3,023** | **$1,255** |
| **Previous Seasons Operating Profit** | | | |
| **2021/22 Operating Profit (at $9.30/kg MS)** | **$4,952** | **$4,699** | **$2,974** |
| **2022/23 Operating Profit (at $8.22/kg MS)** | **$1,906** | **$2,669** | **$2,234** |

## Discussion & Learnings

The three seasons of this study have been climatically very different. The wetter summer of 2023 benefited the tall fescue and cocksfoot pastures on the Alternative Pastures Farm. These same pastures showed low growth rates during the previous 2022 dry summer/autumn resulting in cows drying off early. Kikuyu growth on the Baseline Farm supported this farm during that dry season. It should be noted that the kikuyu pastures are intensively managed with mulching and under-sowing of Italian ryegrass each autumn, making the Baseline Farm a relatively high production system. Kikuyu pastures have also proven highly resilient, with little plant death and a rapid recovery following Cyclone Gabrielle flooding in early 2023. Most other pasture species, including ryegrass, tall fescue, cocksfoot, chicory and clovers died as a result of the flooding and had to be resown.

The removal of nitrogen fertiliser within the Low Emissions Farm has resulted in a consistent reduction in pasture growth during winter and spring compared with the Baseline Farm, averaging 2.7 t DM/ha/annum less pasture across the three years of this study.

Clover levels on the Low Emissions Farm rapidly increased when nitrogen applications ceased on the Low Emissions Farm pastures, which had a long history of nitrogen applications prior to this study. However, this did not compensate for the lack of nitrogen applied. Calculations indicate an average total farm system response of 14.9 kg DM/kg N applied on the Baseline Farm over the three years. This response was greatest during the 2023/24 season when there were very low clover levels on the Low Emissions Farm following flood damage.

Averaging data over the three years of this project, the Low Emissions Farm showed 369 kg MS/ha lower milk production and $716/ha lower operating profit than the Baseline Farm. Variation between seasons shows how dependent the Low Emissions Farm is on clover presence to reduce the impacts of removing nitrogen applications.

This project expected to reduce methane emissions by 25% and nitrous oxide emissions by 50% on the Low Emissions Farm compared to the Baseline Farm. The actual (modelled) reduction so far has averaged 28% and 48% respectively, which is somewhat in line with the reduction in stocking rate and milk production. The reduction in emissions per kg milk solids (12%) indicates the potential for lower input systems like the Low Emissions Farm to be more efficient from a GHG emissions perspective.

This project will continue for a further two seasons allowing testing of these regimes over further variable climatic conditions and display any compounding treatment effects over time.

# NDDT Supplement Trial – Summary 2018-2021

*Chris Boom and Kim Robinson (NDDT, AgFirst Northland)*

This three year farm systems trial investigated the use of palm kernel extract (PKE) and other supplements on farm production and profitability by comparing three independent 28ha farms, being:

1. **Pasture Only Farm**, (2.7 cows/ha) no imported feed
2. **PKE Only Farm**, (3.1 cows/ha) imports palm kernel expeller (PKE) to fill pasture deficits
3. **PKE Plus Farm**, (3.1 cows/ha) imports PKE and other supplements to fill pasture deficits

PKE was fed on the PKE Only and PKE Plus farms when grazing residuals indicated that pasture supply was limiting. Other supplements (dried distillers grain (DDG), Soya Hulls or baled silage) were fed on the PKE Plus farm when milk fat evaluation index (FEI) levels indicated no further PKE can be fed without incurring penalties.

On average over the three years, the PKE Only Farm fed 836 kg PKE/cow/annum, while the PKE Plus Farm fed 1,253 kg/cow of PKE and other supplements (predominantly DDG).

As would be expected, milk production was highest on the PKE Plus Farm and lowest on the Pasture Only Farm in all three seasons (see table 1). A drought occurred during the 2019/20 season which reduced milk production on the Pasture Only and PKE Only farms but only had a minor effect on the PKE Plus Farm. Response to supplement on the PKE Only Farm averaged 113 g MS/kg DM supplement fed, while the PKE Plus Farm averaged 104 g MS/kg DM fed. These numbers are higher than those reported in other studies, possibly due to supplements only being fed when pasture supply was deficient.

**Table 1.** Milk Production (kg MS/ha) for the three seasons of the study.

| | 2018/19 | 2019/20 | 2020/21 | Three Year Average |
|---|---|---|---|---|
| **Pasture Only Farm** | 996 | 816 | 936 | **916** |
| **PKE Only Farm** | 1,225 | 1,129 | 1,272 | **1,209** |
| **PKE Plus Farm** | 1,300 | 1,279 | 1,405 | **1,328** |

Financial analysis of the individual farms considers labour and other variable costs. Farm operating profit (EBIT) was highest on the PKE Only Farm in two of the three seasons, while the PKE Plus farm was the most profitable in the 2019/20 season when a drought occurred and cows on the other farms were dried off early, and milk price was reasonable compared to the cost of supplement This illustrates the point that higher milk production does not necessarily lead to higher profit. This can be explained by calculating the marginal cost of the extra milk produced through supplement.

**Table 2.** Operating profit for the three seasons ($/ha).

| | Milk Price $6.35/kg MS | Milk Price $7.14/kg MS | Milk Price $7.55/kg MS | Three year Average |
|---|---|---|---|---|
| | 2018/19 | 2019/20 | 2020/21 | |
| **Pasture Only Farm** | $3,002 | $1,877 | $3,031 | **$2,636** |
| **PKE Only Farm** | $3,301 | $2,119 | $3,743 | **$3,054** |
| **PKE Plus Farm** | $2,991 | $2,336 | $3,488 | **$2,938** |

The marginal cost of the extra milk produced on the supplemented farms is calculated by comparing production and costs with the Pasture Only Farm. Over three seasons the average cost of the marginal milk was $5.86/kg MS for the PKE Only Farm and $6.56 for the PKE Plus farm. When comparing the PKE Plus Farm against the PKE Only Farm the cost of the marginal milk was $8.58/kg MS. Further analysis shows for each dollar spent on purchasing PKE on the PKE Only Farm, $0.86 was added to other farm expenses.

**Table 3.** Cost of additional milk produced (marginal milk) compared to the Pasture Only Farm.

| | Marginal milk cost - $/kg MS | | |
|---|---|---|---|
| | **2018/19** | **2019/20** | **2020/21** |
| **PKE Only Farm** | $5.39 | $6.54 | $5.65 |
| **PKE Plus Farm** | $6.67 | $6.27 | $6.73 |

This study shows the financial advantage to using imported supplements. However, it also illustrates that the use of higher priced supplements when milk FEI limits are reached, may not result in improved operating profit unless climatic conditions are severe, or milk price is very high.

Using average farm working expenses to calculate profitability can be misleading. Table 4 shows the three-year average farm working expenses for each farm. The marginal cost of the extra milk produced is then separated out in the PKE Only and PKE Plus farms. When the cost of the marginal milk is higher than milk price then profit will be reduced. This happened two years out of three in this trial.

**Table 4.** Farm working expenses and cost of additional milk due to supplementation. Average of three years.

| | Farm working expenses $/kg MS | Marginal cost of additional milk using PKE | Marginal cost of additional milk using other supplements |
|---|---|---|---|
| **Pasture Only Farm** | $4.55 | | |
| **PKE Only Farm** | $4.78 | $5.65 | |
| **PKE Plus Farm** | $5.51 | | $9.47 |

Imported supplements can have a role in improving farm production and profit, however care needs to be taken that costs are closely monitored and milk responses are maximised, otherwise production gains can be overcome by the increased costs associated with the supplementation.

## 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.**

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