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Northland Agricultural Research Farm

‘Looking to the Future’

Field Day – 10th June 2021

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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.

Dairying in a Variable Climate Project – NARF

Chris Boom and Kim Robinson (NDDT, AgFirst Northland)

Summary

This was a 3 year farm systems trial investigating the use of palm kernel extract (PKE) and other supplements on farm production and profitability. There are three independent 28ha farmlets :

- **Pasture Only farm**, (2.7 cows/ha) no imported feed
- **PKE Only farm**, (3.1 cows/ha) imports PKE to fill pasture deficits
- **PKE Plus Farm**, (3.1 cows/ha) imports PKE and other supplements to fill pasture deficits.

PKE is fed on the PKE Only and PKE Plus farms only when grazing residuals indicate pasture supply is limiting. Other supplements (DDG and baled silage) are fed on the PKE Plus farm when milk FEI levels indicate no further PKE can be fed without incurring penalties.

Key results from the 3 years

- Milk production on the Pasture Only farm was more affected by weather

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, due to the ability to purchase extra supplement to counter the lower pasture growth.

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

	2018/19	2019/20	2020/21
Pasture Only Farm	996	816	936
PKE Only Farm	1,225	1,129	1,272
PKE Plus Farm	1,300	1,279	1,405

- Milksolids response to supplement feeding was higher on the PKE Only farm than the PKE Plus farm

Milk response to PKE fed on the PKE Only farm was higher than the combined response of feeding PKE, DDG and silage on the PKE Plus farm. This is probably be due to lower substitution in the PKE Only herd as they were often under more feed pressure.

The responses are higher than the 12 year Dairybase average (80gMS/kgDM) and those reported in other studies, probably due to strict adherence to decision rules on feeding supplement only when pasture residuals are too short.

Table 2. 3 year Average Purchased Feed and Milksolids Response compared with Pasture Only Farm

	Supplement kgDM/c	Milk response gMS/kgDM
Pasture Only Farm	-	
PKE Only Farm	836	113g
PKE Plus Farm	1,253	104g

- Profit was highest on the PKE Only farm except during the drought year

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.

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
	2018/19	2019/20	2020/21
Pasture Only Farm	$3,002	$1,877	$3,031
PKE Only Farm	$3,301	$2,119	$3,743
PKE Plus Farm	$2,991	$2,336	$3,488

- Marginal cost of extra milk is high on the PKE Plus farm

This study provides the opportunity to calculate the marginal cost of the extra milk produced by feeding the extra supplement. This is the minimum milk price needed to make the extra feed profitable. The marginal cost of feeding PKE is generally lower than the DDG and silage fed on the PKE Plus farm. This is primarily due to the lower milk response to the additional supplement, and the higher cost of the DDG and silage compared to the PKE. Further analysis shows for each dollar spent on purchasing supplement, $0.66-$0.86 was added to other farm expenses.

Table 3. Cost of additional milk produced (marginal milk, $/kg MS)

	Marginal milk cost - $/kg MS			
	2018/19	2019/20	2020/21	3 year average
PKE Only Farm over Pasture Only Farm (PKE fed)	$5.39	$6.54	$5.65	$5.86
PKE Plus Farm over PKE Only Farm (DDG, SBH, silage fed)	$10.57	$5.70	$9.47	$8.58

This study shows the potential financial advantage to using imported supplements during a true feed deficit. However, it also illustrates that the use of additional 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. In 2018/19, when neither of these factors were present, the PKE Plus farm was the least profitable of the three farms.

Though the Pasture Only farm was generally less profitable than the other farms, if the milk price was below $5.86/kg then this farm would have been the most profitable.

Imported supplements can have a role in improving farm production and profit if managed well and used when there is a true feed deficit and a good milk price. However, these systems do require additional time (e.g., feeding out, milkings), and care needs to be taken that costs are closely monitored and milk responses are maximised, otherwise production gains and increased revenue is overcome by the total cost of feeding supplements.

Background

This project conducted a farm systems experiment that compared three different management strategies within a variable climate and constraints of milk fat evaluation index (FEI). The project was conducted at the Northland Agricultural Research Farm (NARF) and ran from June 2018 to May 2021.

Data collected allowed examination of these systems on milk production, farm operating profit, environmental sustainability, cow welfare, labour, and capital requirements.

Farmlet structure

All farms were self-contained farm systems. Each farm was 28 ha with paddocks allocated so pasture growth potential was similar across farms. Silage was made when there was a pasture surplus and fed when pasture supply was below feed demand. The three farm systems were:

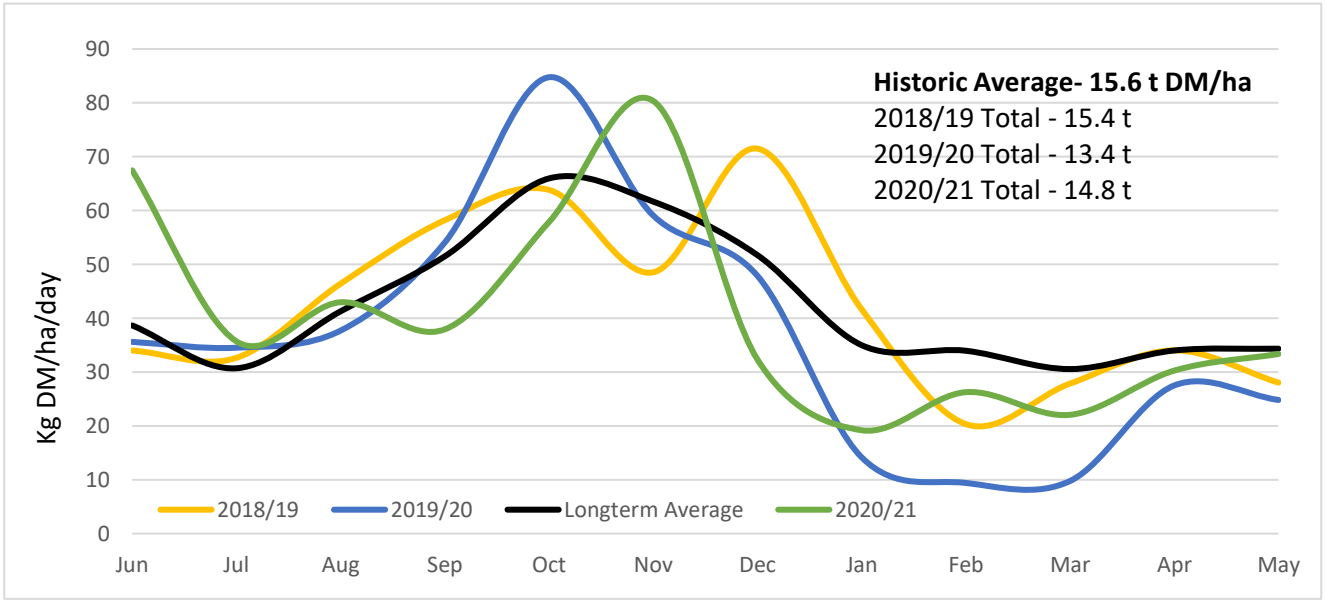
1. ***Pasture Only – 2.7 cows/ha***
   A simple pasture only system with no imported feed.
2. ***PKE Only – 3.1 cows/ha***
   PKE was fed when pasture grazing residuals fell below target levels while maintaining ideal grazing rotation length. PKE was not used to create a pasture surplus for pasture conservation. PKE use was constrained by the need to keep the milk FEI within the acceptable limits set by Fonterra.
3. ***PKE Plus – 3.1 cows/ha***
   Supplements were fed when pasture grazing residuals fell below target levels. PKE is used first until milk FEI limits are reached and then alternative spot market feed sources are used.

Trial Results

Pasture Growth

Pasture growth for the three seasons is shown in figure 1. The 2019/20 season was marked by a prolonged drought and 2020/21 also had a relatively dry summer/autumn. Total pasture production during the latter two seasons was lower than the historic average.

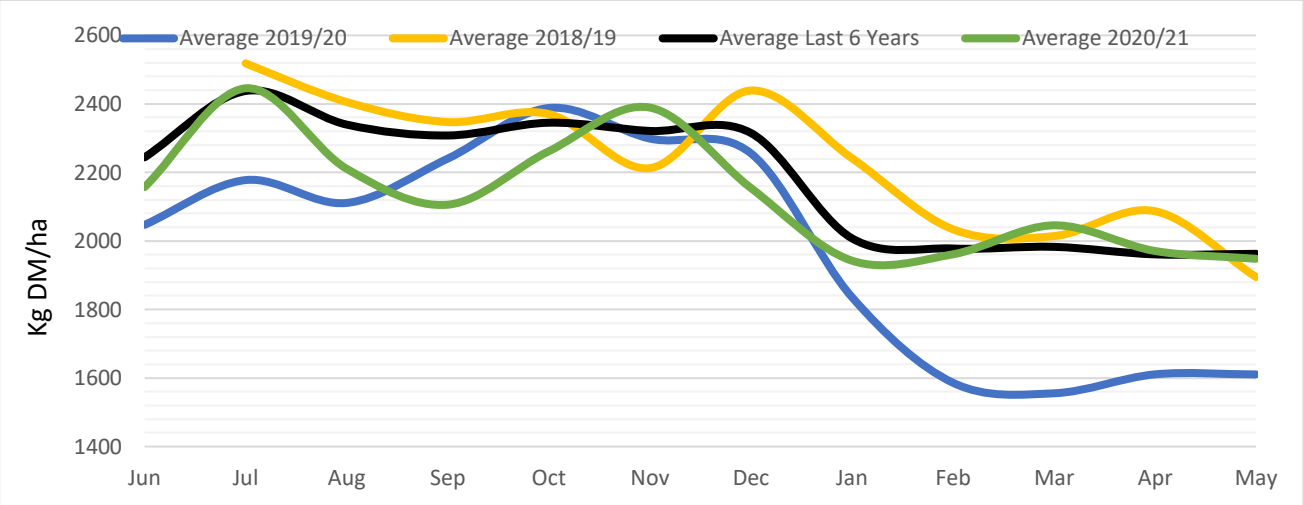
Figure 1. Calculated pasture growth rates at NARF (average of three farms)



Pasture Covers

Average farm pasture covers, as measured by rising plate meter, are shown in figure 2. Despite pasture covers being low during autumn 2020, very good pasture growth during June 2020 resulting in good average pasture cover on all three farms at calving. Differences between farms were small so not shown.

Figure 2. Average pasture cover on all three farms during the last three seasons.



Pasture Eaten

Table 4 shows the pasture eaten (including home-grown silage) calculated for the three seasons. The effect of the drought can be clearly seen in the large drop in Pasture Eaten across all farms during 2019/20 season. The Pasture Only farm tended to have a lower amount of feed eaten, possibly in due to a lower stocking rate and therefore poorer utilisation of pasture grown.

Table 4. Calculated pasture and home-grown silage eaten (t DM/ha/year)

	2018/19	2019/20	2020/21
Pasture Only farm	12.6	10.9	12.4
PKE Only farm	13.2	11.6	13.3
PKE Plus farm	12.6	11.4	12.9
Average across farms	12.8	11.3	12.9

Supplement Use

Table 5 shows the supplement fed during the 2020/21 season and the cost. Silage was made on all farms and fed back into that farm. PKE was fed on both PKE farms when residuals were below targets, and FEI allowed. Extra supplement was then purchased on the PKE Plus farm when FEI limits were reached and residuals were still below target. The choice of supplement was made on the basis of cost per unit of feed when allowing for nutritional requirements. Soya hulls were used when protein was not limiting in spring. DDG was used in both spring and summer, and good quality grass silage was purchased in autumn when the cost (per unit of energy and protein) was considerably lower than that of DDG.

Table 5. Supplement made and purchased during 2020/21 season

	Supplement	Kg DM/cow	Cost of Supplement (excl cart)	Total Cost of Supplement ¢/kg DM	% of Farm Cut for Silage
Pasture Only Farm	Grass Silage (home-made)	**336**	$52/b	15.7	46%
PKE Only Farm	Grass Silage (home-made) PKE **Total**	230 784 **1014**	$52/b $331/t	15.7 39.4	31%
PKE Plus Farm	Grass Silage (home-made) PKE DDG SBH Grass Silage (purchased) **Total**	170 845 181 104 174 **1,473**	$52/b $331/t $559/t $450/t $87/b	15.7 39.4 69.4 58.0 40.0	27%

Table 6 summarizes the supplement used over the three years of the trial. Supplement use was highest during the drought season of 2019/20. In each season the majority of supplement was fed during the summer/autumn period. The PKE feeding level has been constrained much of the time due to milk FEI limits, especially during summer/autumn. Alternative supplements were added on the PKE Plus farm when these milk FEI limits were reached. The additional supplement was chosen on the basis of price and quality, and was predominantly DDG in the summer and autumn.

Table 6. Imported supplements fed and the average cost of supplements during the three seasons.

	Imported Supplement kg DM/cow		
	2018/19	**2019/20**	**2020/21**
Pasture Only Farm	0	0	0
PKE Only Farm	748	978	784
PKE Plus Farm	1,046	1,410	1,303
	Cost of Supplement (excl cartage)		
PKE $/t	$245	$301	$331
DDG $/t	$498	$587	$559
SBH $/t			$450
Purchased Silage $/b	$80	$85	$87

Milk Production

Milk production was lowest during 2019/20 on all three farms due to summer/autumn drought. However, production on the PKE Plus farm was less affected by the drought than the other farms, as the other two farms used once-a-day milking to manage body condition score and then early culling and/or drying-off of cows to manage feed demand.

Table 7. Total milk solids production per ha and per cow

	Kg MS/ha			Kg MS/Cow		
	2018/19	**2019/20**	**2020/21**	**2018/19**	**2019/20**	**2020/21**
Pasture Only Farm	996	816	936	372	313	340
PKE Only Farm	1,225	1,129	1,272	403	359	405
PKE Plus Farm	1,300	1,279	1,405	423	407	447

Mating Results

Table 8 shows the mating results from the last three seasons. Overall, there are no significant differences between farms. Feed levels prior to mating have been challenging on the Pasture Only farm each year resulting in lower cow condition on this farm than the other farms during early spring. The impact of this was managed through using once-a-day milking every year for low condition cows and heifers and at times all cows. This appears to have been an effective tool in minimizing the impact of lower feeding levels pre-mating.

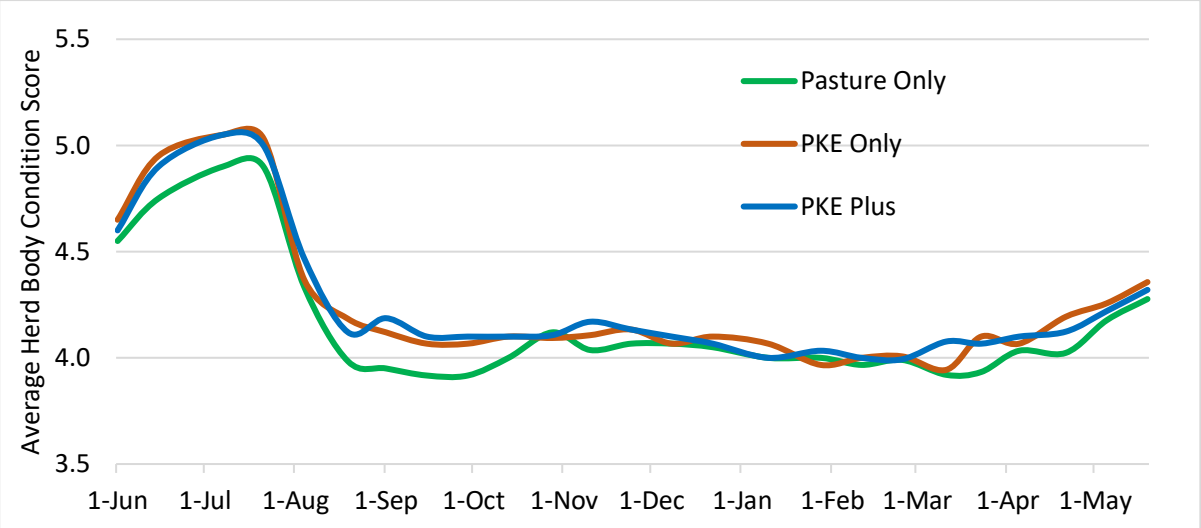
Table 8. Six week in-calf rate and empty rate (cows in calf/cows at mating).

	Six Week in Calf Rate (%)			Empty Rate (%)		
	2018/19	2019/20	2020/21	2018/19	2019/20	2020/21
Pasture Only Farm	79%	71%	76%	9%	6%	9%
PKE Only Farm	67%	76%	69%	11%	6%	13%
PKE Plus Farm	74%	76%	70%	6%	7%	7%

Body Condition Score

Body condition score was assessed fortnightly. The Pasture Only farm had lower condition score during spring and late autumn than the other farms in each of the three seasons. Earlier drying-off allowed the Pasture Only cows to regain condition during May to be near the condition of cows on the other farms.

Figure 3. Herd body condition score, average of 3 years.

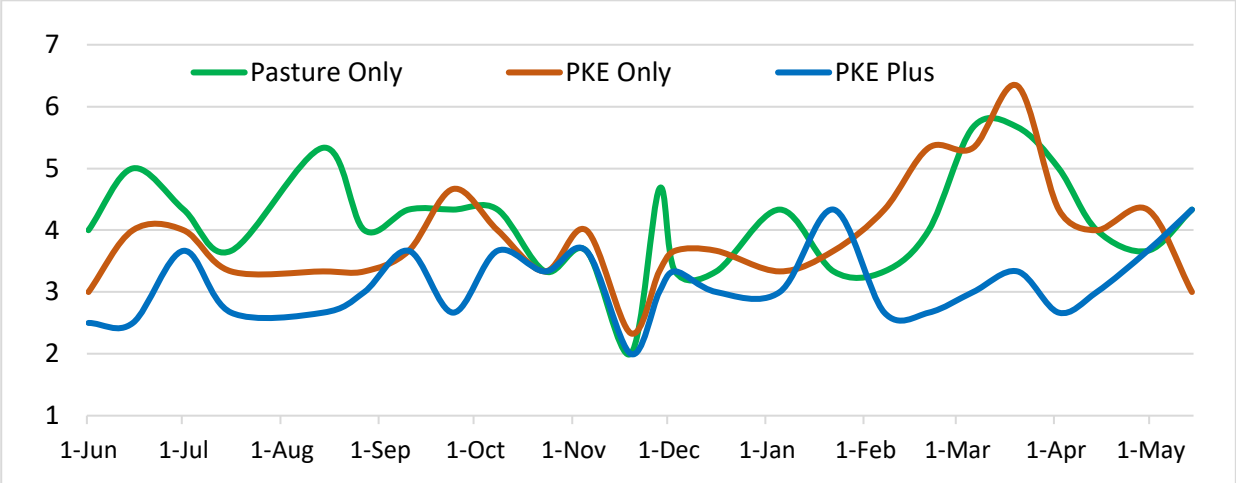


Worry Score

A worry score was assessed fortnightly. This relates to the concern the manager has about cows and feed supply. The Pasture Only farm tended to have a higher worry score during late winter, spring and early summer, largely due to the inability to bring in additional feed during these periods. The worry score for the PKE Only farm tended to be elevated during late summer/early autumn when milk FEI was challenging. The Pasture Plus farm tended to have the lowest worry score through all seasons.

Note the worry score does not take into account financial considerations. The score is based on farm management factors only.

Figure 4. Managers worry score for the three farms (1 = low, 10 = high), average of 3 years.



Responses to supplements

Comparing milk production of the two PKE supplemented farms with the Pasture Only farm provides a calculation of milk solids response to supplement on a whole farm system basis. These supplement response rates tend to be higher than those reported in other studies, possibly due to the strict controls on feeding supplement (only when pasture residuals were below target). Supplement responses have tended to be higher on the PKE Only farm than the PKE Plus farm, despite the additional supplement used on the PKE Plus farm mainly being DDG which has higher energy and protein levels than PKE. This may be due to lower substitution occurring in the PKE Only farm where there tends to be more feed pressure.

Table 9. Supplement response relative to the Pasture Only farm (g milk solids/kg DM supplement fed).

	PKE Only farm			PKE Plus farm		
	2018/19	2019/20	2020/21	2018/19	2019/20	2020/21
Milk Solids Response g/kg DM fed	**100**	**102**	**136**	**94**	**104**	**114**

Differences in Labour & Machinery

Time spent doing tasks on each individual farm was recorded, over and above farm operations that are common to all farms (see Table 10). This additional time was mainly due to feeding out or additional milkings (when other farms were on once-a-day or dried off). These results have been used to adjust the allocation of labour and vehicle expenses within the financial analysis.

Table 10. Additional labour and tractor time required per season for each farm (on top of farm operations common to all farms), average of three years.

	Additional Tractor Hours	Additional Labour Hours
Pasture Only farm	45	45
PKE Only farm	85	355
PKE Plus farm	112	483

Financial Analysis

The financial results for the three farms have been analysed. Table 11 shows the average of three years. 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.

Averaged over the three seasons, farm working expenses/kg MS were lowest on the Pasture Only farm and highest on the PKE Plus farm. The PKE Only farm had the highest operating profit/ha for two out of the three years of the study. However, during the 2019/20 drought year, the PKE Plus farm had a higher operating profit due to the PKE Only farm having to dry cows off early when milk FEI constrained PKE feeding.

When averaged over the three seasons and a milk price of $7.01, the PKE Only farm showed a slightly higher operating profit ($3,058/ha) than the PKE Plus farm ($2,934/ha), while the Pasture Only farm showed the lowest operating profit ($2,634/ha). At a milk price of $6.00/kg MS the PKE Only farm would have had the highest profit, and the Pasture Only Farm would have been more profitable than the PKE Plus farm.

The price of PKE would have to be around $500/tonne PKE (delivered) before the Pasture Only farm was more profitable than the PKE Only farm.

Feeding supplements increases farm costs in addition to the cost of the supplement itself. On the PKE Only farm, each dollar spent on purchasing PKE had an additional $0.86 of other farm expenses. For the PKE Plus farm this was $0.66 on top of each dollar spent purchasing supplement.

Table 11. Income, expenses and operating profit for the three NARF farms, average of three seasons ($/ha).

Financial Summary 2019-2021 Seasons	**Pasture Only Farm**	**PKE Only Farm**	**PKE Plus Farm**
Income	**$/ha**	**$/ha**	**$/ha**
Income from milk ($7.01/kg MS)	$6,424	$8,476	$9,314
Income from stock sales	$451	$523	$525
Dividends and other income	$38	$38	$38
Total Income/ha	**$6,914**	**$9,038**	**$9,877**
Expenses			
Wages	$1,111	$1,569	$1,749
Animal Health	$198	$226	$227
Breeding Expenses	$230	$265	$266
Shed expenses	$110	$123	$123
Electricity	$182	$206	$207
Grazing	$441	$512	$513
Calf rearing	$43	$50	$51
Silage Making	$174	$102	$87
PKE		$916	$989
DDG & Soya Hulls			$487
Purchased Silage			$128
Nitrogen/Fert	$311	$311	$311
Regrassing	$130	$130	$130
Weed and Pest	$83	$83	$83
Vehicle Expenses	$160	$215	$249
R&M General	$410	$435	$436
R&M Effluent	$36	$57	$57
Administration	$132	$136	$136
Rates and Insurance	$209	$214	$214
Depreciation	$320	$430	$499
Total Operating Expenses/ha	**$4,279**	**$5,980**	**$6,943**
Farm Working Expenses $/kg MS	**$4.32**	**$4.59**	**$4.85**

Operating Profit			
Operating Profit at $7.01/kg MS	**$2,634**	**$3,058**	**$2,934**
Alternative Milk Prices			
Operating Profit at $5.00/kg MS	**$790**	**$624**	**$261**
Operating Profit at $6.00/kg MS	**$1,706**	**$1,833**	**$1,589**
Operating Profit at $8.00/kg MS	**$3,538**	**$4,250**	**$4,245**
Alternative PKE Prices (incl $23/t cartage)			
Operating Profit at $200/t PKE	**$2,634**	**$3,427**	**$3,333**
Operating Profit at $300/t PKE	**$2,634**	**$3,153**	**$3,038**
Operating Profit at $400/t PKE	**$2,634**	**$2,879**	**$2,743**
Operating Profit at $500/t PKE	**$2,634**	**$2,605**	**$2,448**

The cost of the additional milk produced by the supplemented farms can be calculated compared to the Pasture Only farm. The cost of this marginal milk for the PKE Only farm averaged $5.86/kg MS over the three seasons. This means the milk price would need to be higher than $5.86/kg MS for the PKE Only farm to be more profitable than the Pasture Only farm. When comparing the PKE Plus farm against the PKE Only farm the cost of the marginal milk from the extra supplements was $8.58/kg MS.

This study shows the financial advantage to using imported supplements. It also illustrates that the use of higher priced supplement, such as substituting PKE for higher priced supplements (when milk FEI limits are reached) does not result in improved operating profit unless climatic conditions are severe or milk price is very high. Though the Pasture Only farm was consistently less profitable than the other farms, if the milk price was below $5.86/kg then this farm would have been the most profitable when averaged over the three years of the study.

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 (through careful monitoring of pasture residuals), otherwise production gains can be overcome by the increased costs associated with the supplementation.

Acknowledgements

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For more information contact info@nddt.nz

Future Dairy Farm Systems for Northland Project

Summary
Farmers are being given a clear message from government and society to lower their greenhouse gas emissions. This project will demonstrate strategies that may help farmers adapt their farm systems to mitigate the effects of climate change and comply with changing regulations. It will test the effectiveness of three dairy farm systems: one currently common to Northland dairy farms, one using pasture species better adapted to a warmer climate, and another designed to achieve future greenhouse gas emission targets.

Background
Recent farm systems trials at the Northland Agricultural Research Farm (NARF - Dargaville) have indicated that a pasture-based system with relatively small quantities of imported feed to fill deficits is a profitable and resilient farm system. However, there are questions over the ongoing productivity of ryegrass-based pastures in a warming climate. In addition, constraints on GHG emissions will demand changes to farm systems.

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 3 years. Kikuyu is productive during summer/autumn, however it is difficult to manage and has very poor 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.

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 are physically or financially sustainable, particularly the lowering of stocking rate on pastures containing kikuyu.

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

Trial Design
This project will compare three farm systems being:

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 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. Imported supplement and little or no imported feed

This farm systems trial commences on 1st June 2021 and runs for four years to test these systems under a range of climatic conditions. Pastures on the Alternative Pastures farm will have a mix of 15 month old and 3 month old pastures at the time of the trial commencement. Pasture sowing will continue in future seasons at 10% of the farm/annum to maintain over 75% of the farm in these pastures.

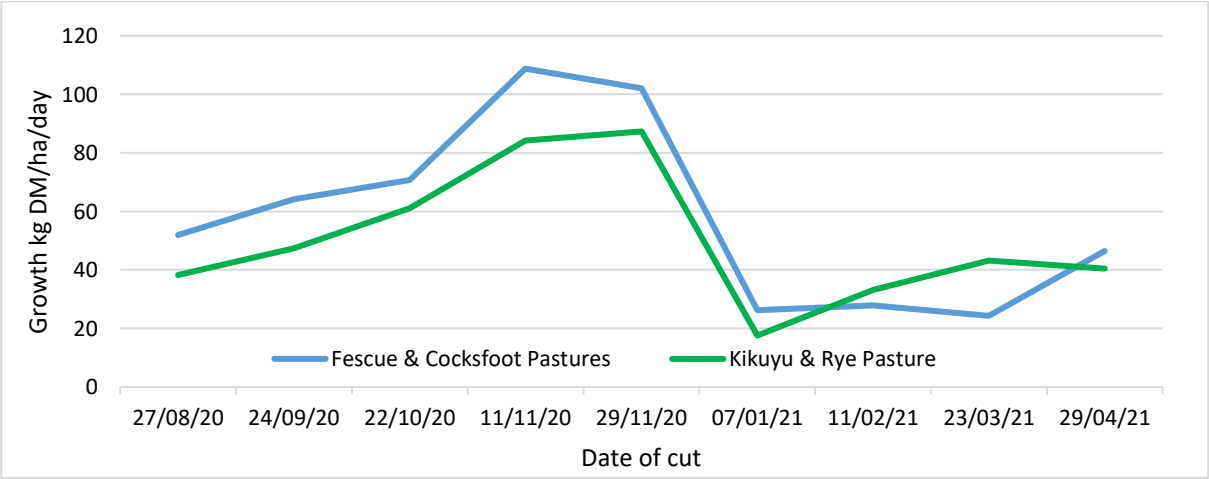
Trial measures will capture pasture and milk production, milk composition, profit and people (labour input and management difficulty) data on the three systems.

Pasture Introduction and Monitoring – so far

To set up the Alternative Pastures farm, 9 ha of new pastures were sown in May 2020. Grass species sown was fescue or fescue and cocksfoot, with white clover, red clover and Persian clover. Another 11 ha was sown in March 2021 either fescue or fescue and cocksfoot or cocksfoot with white clover, red clover and chicory (only 1 kg/ha).

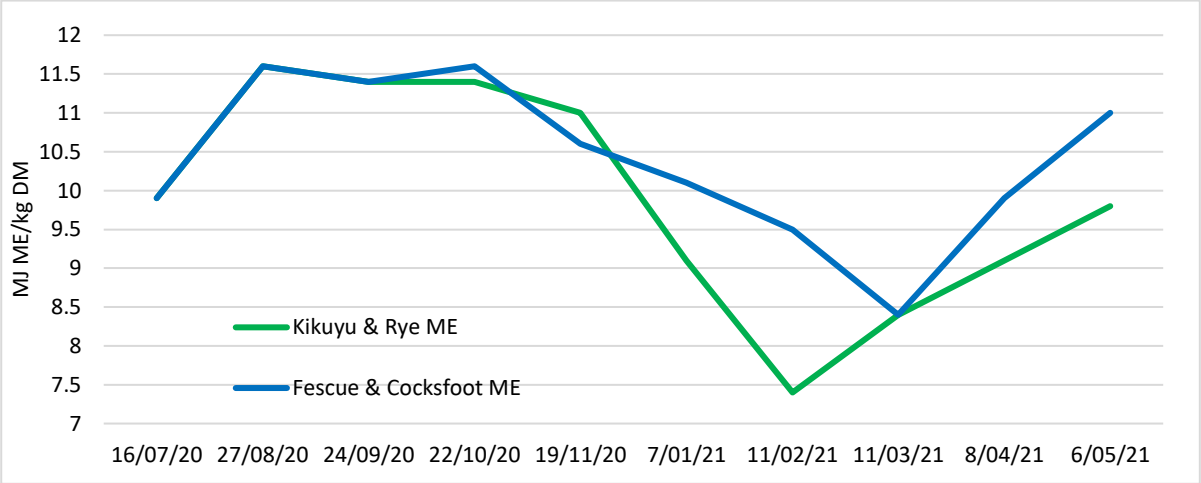
Pasture growth, composition and quality has been compared between the resident kikuyu/Italian ryegrass pastures and the Fescue/Cocksfoot based pastures since July 2020. Figure 1 shows the pasture growth differences between these pastures as measured by cutting cages. The newly sown fescue/cocksfoot pastures showed higher pasture growth rates during late winter through to early summer, while the kikuyu-based pastures showed higher growth rates through late summer/early autumn. This monitoring indicates that the fescue/cocksfoot based pastures have produced 1281 kg DM/ha more than the resident pastures.

Figure 1. *Pasture growth rates as measured by cage cuts.*



Pasture quality monitoring, as indicated by lab analysis of pasture ME (see figure 2), has shown that the two pasture types had similar pasture quality through late winter and spring, however the fescue/cocksfoot pastures showed higher pasture quality through most of summer and autumn.

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



Modelling of Farm Trial Systems

Farmax and Overseer computer modelling was used to establish stocking rates and management strategies, and to determine production, financial and environmental outputs. Farm systems were tested under three different climatic conditions, being an average season, a wet winter and a dry summer. Changes in milk price and feed costs were also examined.

Modelling shows that if no nitrogen is applied to the Low Emissions farm, little or no imported supplements are used and stocking rate is reduced by 26% then this farm will show a reduction of 24% in methane emissions, 47% in nitrous oxide emissions and 54% in nitrogen leaching, compared to the Current farm system.

Pasture growth rates used in the modelling are shown in figure 3. Anticipated response rates to nitrogen range from 10:1 to 15:1 depending on the season.

Figure 3. *Anticipated pasture growth rates used in modelling.*

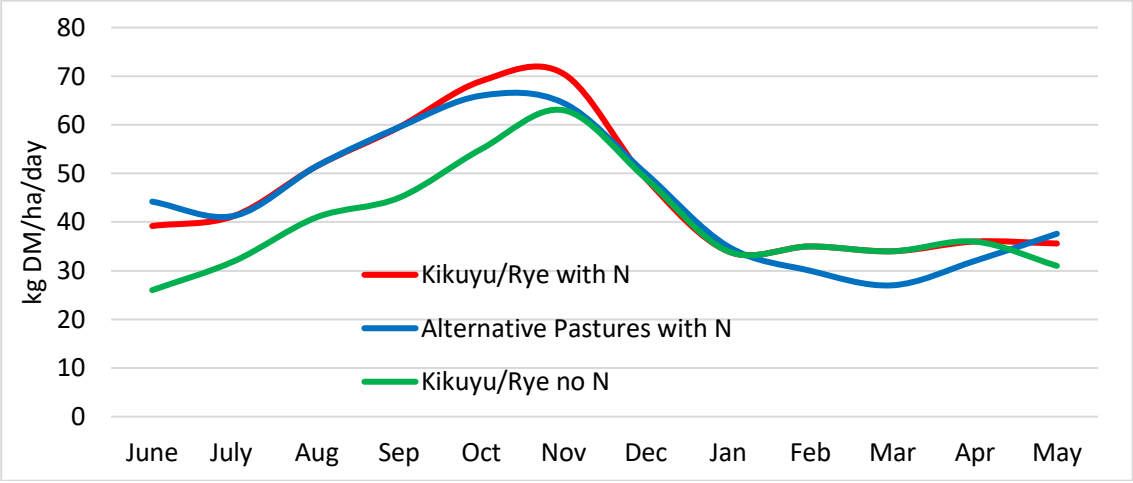


Table 1 shows the predicted milk production under three different climatic conditions: an average season, a dry summer/autumn and a wet winter/early spring. The Low Emissions farm is predicted to have significantly lower production than the other farms under all climatic conditions.

Table 1. *Predicted Milk Production (kg MS/ha) under variable climatic conditions.*

	Total Milk Production/ha		
	Average Season	Dry Summer	Wet Winter
Current Farm	**1,144**	976	1,122
Alternative Pastures Farm	**1,163**	997	1,128
Low Emissions Farm	**833**	659	744

Table 2 shows the predicted GHG emissions for the three farm systems. The Current Farm and Alternative Pastures farm are predicted to have similar emissions while the Low Emissions farm has lower emissions.

Table 2. *Predicted GHG Emissions* – kg CO_2 equivalent/ha and CO_2/kg milk solids for an average climatic season.

	Methane	Nitrous Oxide	CO_2/kg MS
Current Farm	8,848	3,196	10.4
Alternative Pastures Farm	8,623	3,126	10.0
Low Emissions Farm	6,706 (24% reduction)	1,696 (47% reduction)	9.9 (5% reduction)

Project Management and Funding

This project is initiated and managed by the Northland Dairy Development Trust (NDDT) with support from the Northland Agricultural Research Farm (NARF).

The two main funders of this project are the Ministry of Primary Industries (MPI – Sustainable Food and Fibre Fund) and New Zealand dairy farmers through DairyNZ. Additional support is provided by Fonterra, Hine Rangi Trust and NDDT. NDDT is also supported by Farm Source, Ballance Agrinutrients, Avoca Lime and FIL.

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

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Step Change & Knowing Your Numbers

The following page shows each farmlet on the DairyNZ Step Change graphs.

These compare the key environmental metrics of water quality and greenhouse gases (GHG) against operating profit per hectare.

Operating profit per hectare indicates the 'engine room' of the production system. How financially profitable is your current system? The more profitable the system, the more opportunity for financial progress. If you needed to adapt your system would you want to bring your cost of production per milksolid with you?

Enteric methane emissions vs Operating profit
As enteric methane is driven by dry matter intake there is a linear relationship to dry matter eaten i.e. the higher the dry matter intake per hectare the higher the enteric methane per hectare. Currently reducing dry matter eaten is the only mitigation farmers have to reduce methane. As growing and harvesting high amounts of pasture is strongly linked to farm profitability, the first area to review to reduce methane is to review purchased supplement.

Purchased N surplus vs Operating profit
The aim to be in quadrant A with low Purchased N surplus and high profit. If Purchased N surplus is high and profit is below average (quadrant D) this indicates there is an opportunity to review fertiliser and supplement use relative to production.

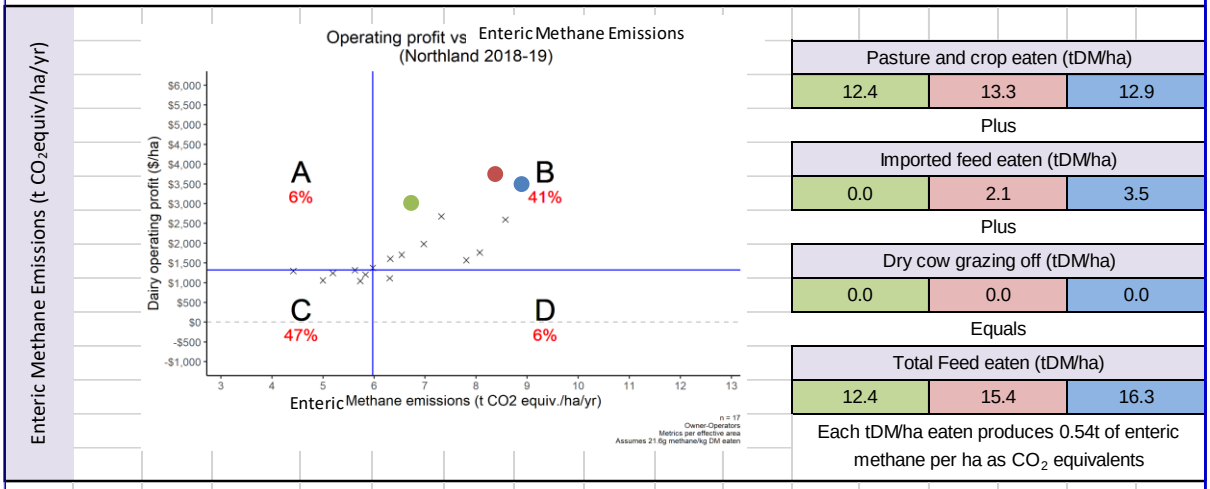
Purchased Nitrogen surplus is a key driver of nitrous oxide emissions (which make up 19 percent of New Zealand's biological emissions) and N loss to water (one of the four primary measures of water quality).
When making farm system changes, you need to consider not only profit but also how will methane and Purchased N surplus be affected. If the environmental measures increase, your farm will be more at risk to a financial cost for methane and may not comply with catchment limits for N loss or nitrous oxide emissions.

For more information or to calculate your own
https://www.dairynz.co.nz/environment/step-change/know-your-numbers/

Environmental KPIs

	Pasture Only (Green)	PKE (Red)	PKE Plus (Blue)
Imported N (fert and feed) kgN/ha	174	227	274
Exported N in milk (kgN/ha)	67	91	101
Estimated purchased N surplus	107	136	173
Estimated CH_4 emission($kgCO_2e$/ha/yr)	6.683	8.316	8.825

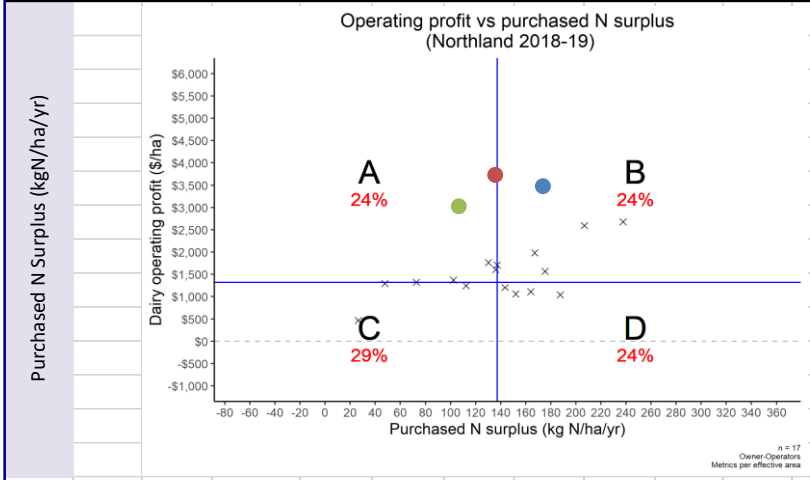
Note: The below graphs are built with DairyBase data. The blue lines creating the quadrants are set on the median (the middle value) of each metric. The blue dot is the host farm's performance based on the information entered. Numbers may differs slightly from Overseer or your Dairy Company figures due to detail of data entry and calculations



Pasture and crop eaten (tDM/ha)		
12.4	13.3	12.9
Plus		
Imported feed eaten (tDM/ha)		
0.0	2.1	3.5
Plus		
Dry cow grazing off (tDM/ha)		
0.0	0.0	0.0
Equals		
Total Feed eaten (tDM/ha)		
12.4	15.4	16.3

Each tDM/ha eaten produces 0.54t of enteric methane per ha as CO_2 equivalents

Enteric Methane Emissions (t CO_2equiv/ha/yr)



Purchased N Surplus (kgN/ha/yr)

N imported onto Blue farm (kgN/ha)	kgDM/ha	Prot %	kgN/ha
Fertiliser			168
PKE	2,655	14%	59
Maize silage	-	8%	0
Grass silage	-	17%	0
Baleage	546	14%	12
Hay	-	15%	0
DDG	568	30%	27
Soya Hulls	325	14%	7
Molasses	-	4%	0
Other	-	14%	0
Total N imported			**274**

Minus

N exported as milk protein (kgN/ha)

631 kg Protein/ha

Protein is 16% N

631 x 0.16 =

Total N exported **101**

Equals

Purchased N surplus (kgN/ha)

173

On most farms surplus N is either lost as nitrate via leaching which effects water quality, or as nitrous oxide which is a greenhouse gas, or as ammonia gas via volatilisation.