

The Northland Dairy Development Trust
&
The Northland Agricultural Research Farm

‘Resilient Farm Systems’
Field Day – 20th June 2019

Project funders

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Dairying in a Variable Climate Project – NARF

Chris Boom (NDDT Science Manager, AgFirst Northland) – June 2019

This trial is being run by the Northland Dairy Development Trust (NDDT) in conjunction with the Northland Agricultural Research Farm (NARF). The project is funded by DairyNZ, Ministry of Primary Industries (Sustainable Farming Fund) and Hine Rangi Trust with support from commercial sponsors.

Summary

A farm systems experiment conducted at the Northland Agricultural Research Farm (NARF) has been investigating the use of palm kernel extract (PKE) and other supplements on farm production, profitability and environmental measures. This project compares a farm that does not import any supplement (**Pasture Only farm**, 2.7 cows/ha) with a farm that only imports PKE (**PKE Only farm**, 3.1 cows/ha) and a farm that imports PKE and other supplements (**PKE Plus Farm**, 3.1 cows/ha). PKE is fed on the PKE Only and PKE Plus farms when pasture supply is limiting. Other supplements are fed to the PKE Plus farm when milk fat evaluation index (FEI) levels indicate no further PKE can be fed.

The first season of this three-year project is now complete. Climatic conditions were considered average with some challenge from wet conditions during early spring and dry conditions during late summer/autumn.

Milk production was 1,008, 1,238 & 1,314 kg MS/ha for the Pasture Only, PKE Only and PKE Plus treatments respectively. Feeding of PKE was constrained by milk FEI during summer and autumn, but not during spring. PKE fed totalled 748 and 769 kg DM/cow on the PKE Only and PKE Plus farms respectively. In addition to PKE, PKE Plus cows received 228 kg/cow DDG and 54 kg DM/cow baleage (purchased). Comparing milk production and supplementation between farms provides a calculation of the response rate to supplements. This shows a response of 100 g MS/kg DM PKE fed on the PKE Only farm and a response rate of 94 g MS/kg PKE, DDG & baleage fed on the PKE Plus farm.

Preliminary financial analysis for the 2018/19 season has been undertaken. This takes into account labour and other costs associated with each farm. Using a milk price of \$6.35/kg MS, farm operating profit (EBIRT) was \$3,011, \$3,323 and \$3,018/ha for the Pasture Only, PKE Only and PKE Plus farms respectively. These results show a financial advantage to putting PKE into the farm system, however this advantage disappeared when other higher priced supplements were added when milk FEI constrained feeding more PKE.

Background

This project is conducting a farm systems experiment that measures the economic and environmental impacts of three different management strategies for producing milk within a variable climate and constraints of milk fat evaluation index (FEI). The farm systems study is being conducted at the Northland Agricultural Research Farm (NARF) and commenced in June 2018. The study will run for three years.

Data collected will allow examination of the effects of these systems on milk production, profitability, environmental sustainability, cow welfare, labour, and capital requirements. This project will assist farmers in developing more profitable, less vulnerable, and lower impact farming systems.

Farmlet structure

All farms are self-contained farm systems. Land area allocated to each farm is 28 ha with paddocks allocated so pasture growth potential is similar across farms. Silage can be made when there is a pasture surplus and fed when pasture supply below feed demand.

The three farm systems are:

1. Pasture Only – 2.7 cows/ha

A simple pasture only farm system. Silage is made when pasture surpluses occur and fed back as required.

2. PKE Only – 3.1 cows/ha

PKE is fed when pasture grazing residuals fall below acceptable pasture feeding levels while maintaining ideal grazing rotation length. PKE is not used to create a pasture surplus for conservation. PKE use is constrained by the need to keep the milk fat evaluation index (FEI) within the acceptable limits set by Fonterra.

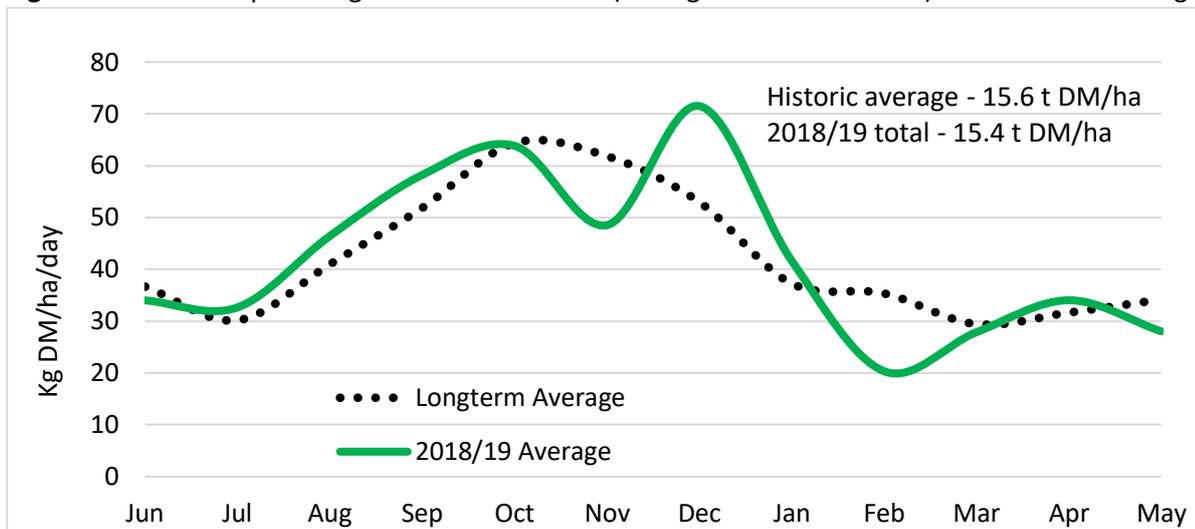
3. PKE Plus – 3.1 cows/ha

Supplements are fed when pasture grazing residuals fall below acceptable pasture feeding levels. PKE is used first until milk FEI limits are reached and then an alternative spot market feed sources are used.

Pasture Growth

Pasture growth during the 2018/19 season is shown in the graph below. It was dry during the first part of November and again during February and March. Overall pasture growth to date has been similar to historical average.

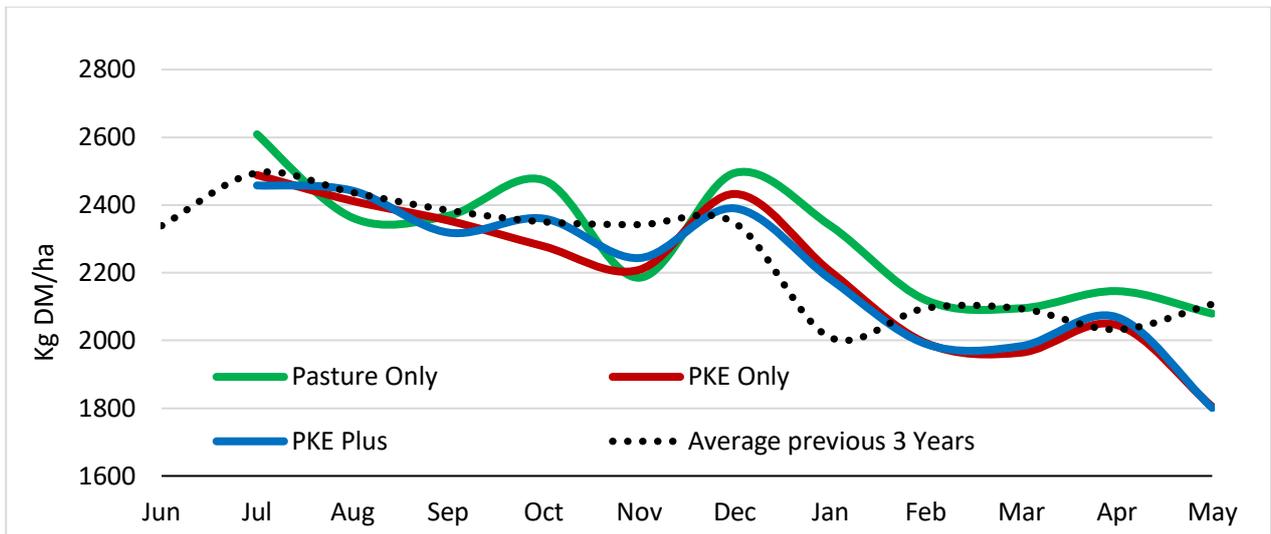
Figure 1. Calculated pasture growth rates at NARF (average of three farmlets) and historical average.



Pasture Covers

Average farm pasture covers are shown in Figure 2. Pasture cover was higher on the Pasture Only farm than the other farms right through summer and autumn, likely due to the lower stocking rate. Higher covers in October also allowed more area to be closed-up for silage on the Pasture Only farm than the other farms. Pasture cover was higher on the Pasture Only farm than the other farms through most of summer and autumn, due to lower stocking rate and earlier drying off.

Figure 2. Average farm pasture cover for the 2018/19 season compared with the average of the previous three seasons.



Supplement Use

Table 1 shows the supplement fed to date and area cut for silage. The PKE feeding level was constrained by milk FEI through much of summer and autumn. During this period, feeding was generally 2 – 3.5 kg DM PKE/cow/day.

Table 1. Supplements fed during 2018/19 season (kg DM/cow), price of supplements landed (¢/kg DM) and % of farm cut for silage and calculated pasture eaten (t DM/ha)

	Supplement	Kg DM/cow	Cost of Supplement ¢/kg DM	% of Farm Cut for Silage
Pasture Only Farm	Grass Silage (home-made)	567	14.7	38%
PKE Only Farm	Grass Silage (home-made)	249	14.7	24%
	PKE	748	26.2	
	Total	997		
PKE Plus Farm	Grass Silage (home-made)	166	14.7	26%
	PKE	769	26.2	
	DDG	228	61.9	
	Grass Silage (purchased)	49	31.1	
	Total	1,212		

Milk Production and Mating

Table 2 shows the milk production and mating results. Submission and empty rate differences are not considered significant.

Table 2. Milk solids production per ha and per cow for 2018/19 season, mating 3-week submission and empty rate.

	Kg MS/ha	Kg MS/cow	3-week submission rate	Empty Rate
Pasture Only Farm	1,008	376	93%	9%
PKE Only Farm	1,238	408	84%	11%
PKE Plus Farm	1,314	428	91%	6%

Responses to PKE

Comparing milk production on the two PKE supplemented farms to the Pasture Only farm provides a calculation of response to supplement. This shows a response to PKE feeding on the PKE Only farm of 100 g/kg DM PKE fed. This compares to an average of 122 g/kg DM PKE fed on the previous three seasons. The PKE Plus farm showed a response of 94 g MS/kg supplement (mostly PKE) when compared to the Pasture Only farm, however the response to the additional supplement used compared to the PKE Only farm is only 80 g MS/kg DM additional supplement.

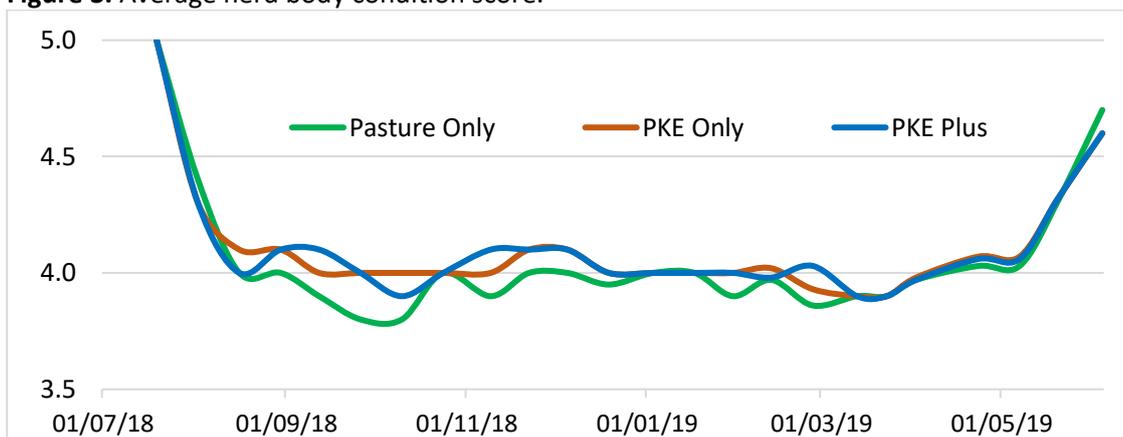
Table 3. Supplement response calculation

	Pasture Only farm	PKE Only farm	PKE Plus farm
Total Milk Production (kg MS)	28,235	34,678	36,789
Total PKE fed (t DM)	-	64.3	66.2
Other purchased supplements (t DM)	-	-	24.7
Supplement Response g/kg DM supplement		100	94

Body Condition Score

Body condition score (BSC) has been assessed fortnightly. The Pasture Only farm tended to have a lower condition score during spring and summer than the other farms. Earlier drying off led to the Pasture Only farm having a higher condition score by the end of the season. Any cows at 3.5 BSC are placed on Once a Day (OAD) milking. Prior and during mating a significant portion of Pasture Only farm cows were on OAD.

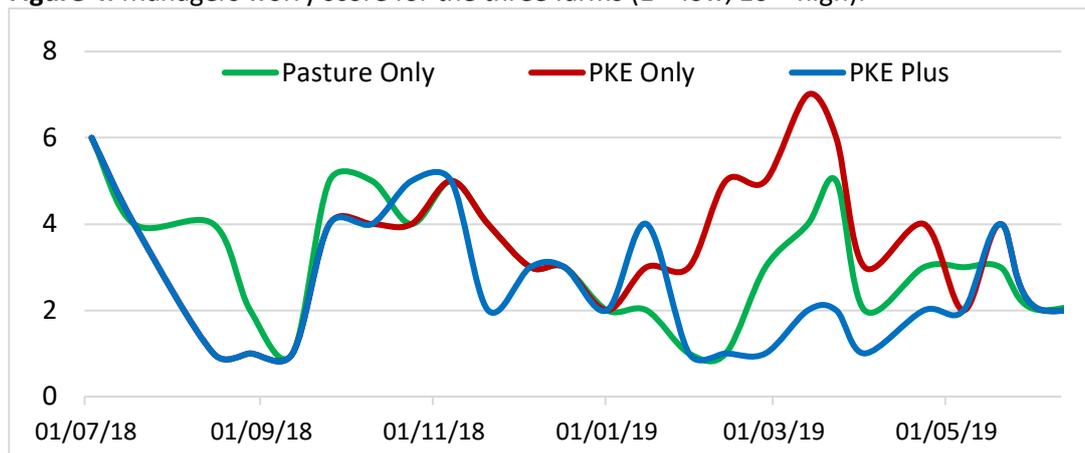
Figure 3. Average herd body condition score.



Worry Score

A worry score has been assessed fortnightly. This relates to the concern the manager has about cows and feed supply. The Pasture Only farm had a higher worry score during late winter/spring when there was no ability to bring in additional feed. In contrast the PKE Only farm had the higher score during summer/autumn due to milk FEI limits constraining feeding of PKE during this period.

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



Differences in Labour & Machinery

Time spent doing tasks on each individual farm has been recorded, over and above farm operations that are common to all farms. The table below shows this additional time required by NARF staff for feeding out, moving cows to and from the feed pad. It should be recognized that additional time spent feeding and shifting cows was based on mobs of 75 – 90 cows, this may be different with larger mobs. These results have been used to adjust the allocation of labour and vehicle expenses within the financial analysis.

Table 4. Additional labour and tractor time for each farm for feeding supplements in the 2018/19 season.

	Additional Tractor Hours	Additional Labour Hours
Pasture Only farm	55	55
PKE Only farm	90	247
PKE Plus farm	100	338

Financial Results

The financial results for the three farms have been calculated and are shown in the table 5. The income is based on the full milk price of the season being \$6.35/kg MS. Fonterra share dividend is not included. 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 has been used to adjust the vehicle, R&M and depreciation expenses.

Farm operating expenses/kg MS were lowest on the Pasture Only farm and highest on the PKE Plus farm. Using a milk price of \$6.35/kg MS the farm operating profit was highest on the PKE Only farm, while being similar on the other two farms. If milk price was below \$5.00/kg MS then the Pasture Only farm would have the highest operating profit. With a milk price between \$5.00/kg MS and \$10.40/kg MS the PKE Only farm would have been the most profitable. Over \$10.40/kg MS the PKE Plus farm would have been the most profitable.

For the PKE Only farm, for each dollar spent on purchasing PKE an additional \$0.83 was added to farm expenses. On the PKE Plus farm this was \$0.70 on top of each dollar spent on purchasing supplement.

Financial results from the 2018/19 season indicate that there was an advantage to putting PKE into the farm system, however this advantage disappeared when PKE was substituted with higher priced supplements due to milk FEI constraining PKE feeding levels.

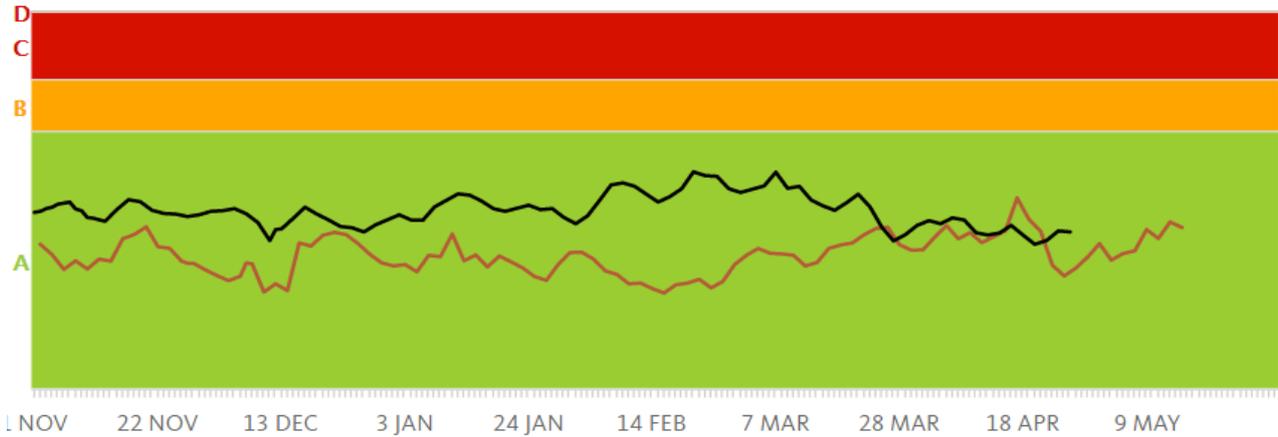
Table 5. Income, expenses and operating profit for the three farms with alternative milk pricing.

Financial Summary 2018/19	Pasture Only Farm	PKE Only Farm	PKE Plus Farm
Income	\$/ha	\$/ha	\$/ha
Income from milk (\$6.35/kg MS)	\$6,403	\$7,864	\$8,343
Dividends	\$34	\$34	\$34
Income from stock sales	\$587	\$666	\$674
Total Income	\$7,024	\$8,564	\$9,051
Expenses			
Wages	\$1,221	\$1,427	\$1,638
Animal Health	\$201	\$225	\$227
Breeding Expenses	\$226	\$255	\$258
Shed expenses	\$92	\$101	\$102
Electricity	\$203	\$226	\$228
Grazing	\$420	\$476	\$482
Calf rearing	\$121	\$137	\$138
Silage Making	\$185	\$109	\$100
PKE		\$671	\$690
DDG			\$444
Purchased Silage			\$51
Nitrogen/Fert	\$195	\$207	\$207
Regrassing	\$93	\$93	\$93
Weed and Pest	\$64	\$64	\$64
Vehicle Expenses	\$156	\$210	\$225
Depreciation	\$330	\$445	\$476
R&M General	\$146	\$197	\$210
R&M Effluent	\$52	\$82	\$82
Administration	\$129	\$132	\$132
Rates and Insurance	\$180	\$185	\$185
Total Operating Expenses	\$4,014	\$5,241	\$6,033
Operating Expenses/kg MS	\$3.98	\$4.22	\$4.59
Operating Profit			
Operating Profit at \$6.35	\$3,011	\$3,323	\$3,018
Alternative Milk Prices			
Operating Profit at \$4.00	\$607	\$379	-\$104
Operating Profit at \$6.00	\$2,624	\$2,856	\$2,524
Operating Profit at \$8.00	\$4,641	\$5,333	\$5,152

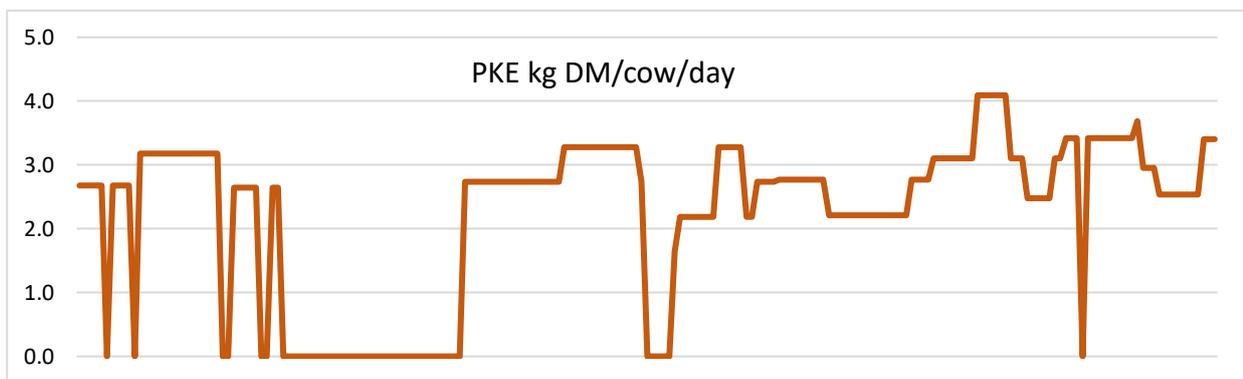
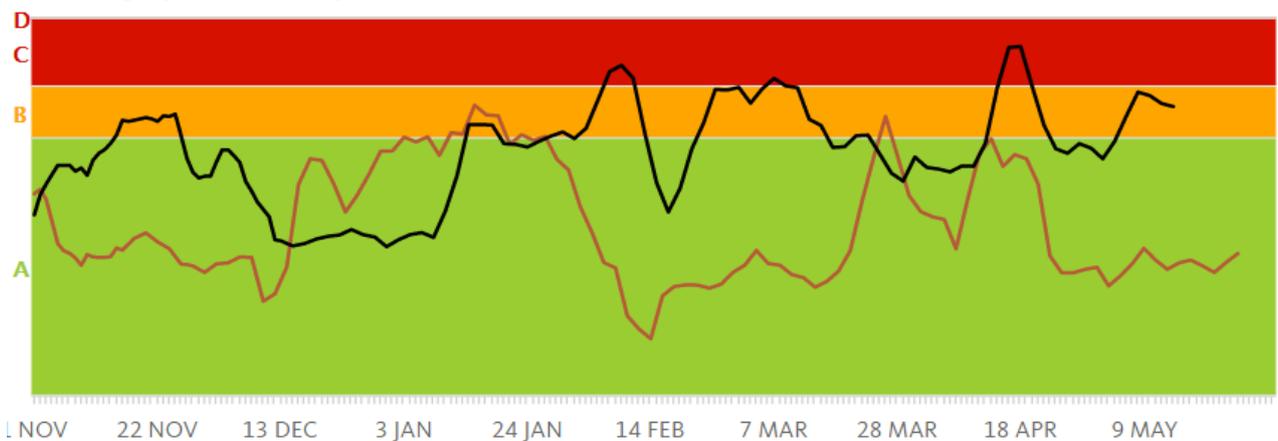
NARF Milk FEI Graphs

The graphs below show the milk FEI and the associated PKE feeding level. At times 3 kg DM/cow/day was too much to keep milk FEI under the C grade. Variation in milk FEI levels despite constant PKE levels are likely due to changes in pasture availability.

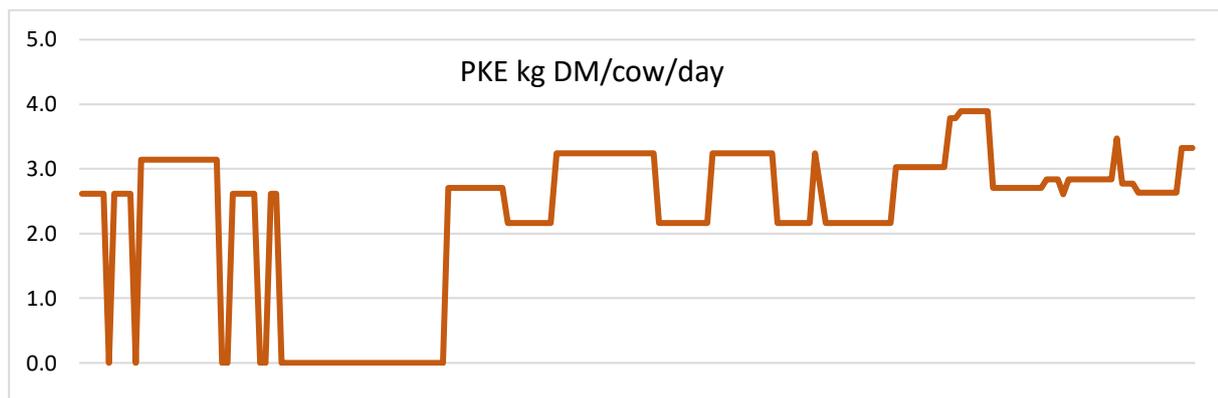
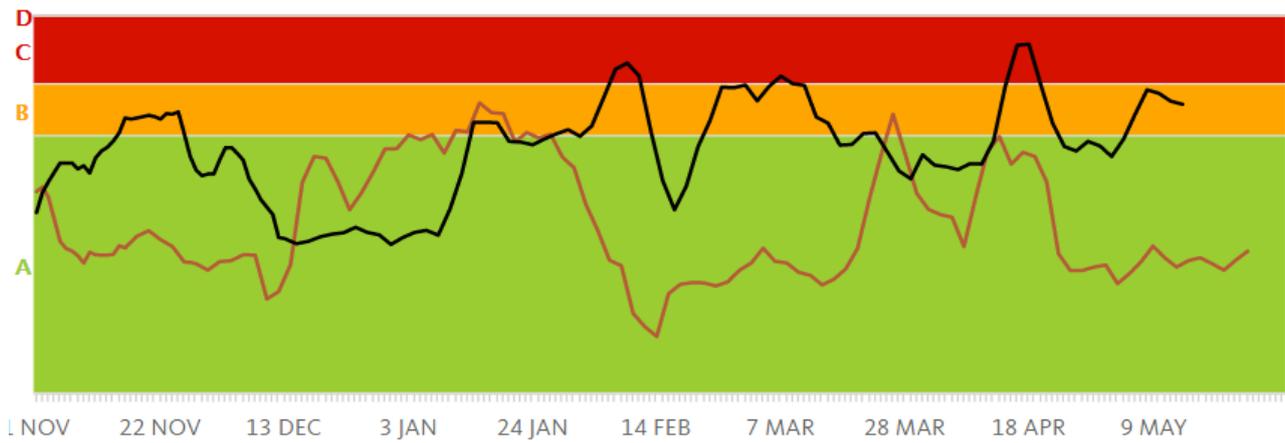
Milk FEI graph - Pasture Only farm



Milk FEI graph – PKE Only farm



Milk FEI graph – PKE Plus farm



Thanks to the NARF staff for making this project happen, being Kate Reed, Kelvin Horton and Johan Van den Berg. Special thanks to NDDT trustees and NARF committee members for their support and commitment to propose and oversee this project.

Supplement use in a variable climate

Jane Kay, Senior Scientist, DairyNZ

Main points:

- Marginal milk is the additional milksolids produced when changes are made to a farm system (e.g. increased stocking rate or more supplementary feeds fed).
- The cost of the marginal milk produced determines whether the changes made to the system generate more profit
 - If the cost of the marginal milk is less than the milk price – they ARE increasing profit
 - If the cost of the marginal milk is more than the milk price – they are NOT increasing profit
- The cost of the marginal milk depends on:
 - The milksolids response to the system change(s)
 - The costs associated with the system change(s) For example: buying and feeding supplement, increasing cow numbers, AND additional system-level costs that are rarely accounted for in incomplete marginal analyses.
- In 2018/19 at NARF increasing stocking rate and feeding supplements increased milk production by:
 - 231 kg MS/ha for the PKE farm compared with the Pasture Only farm
 - 306 kg MS/ha for the PKE PLUS farm compared with the Pasture Only farm
 - 75 kg MS/ha for the PKE PLUS farm compared with the PKE farm
- The milksolids response was:
 - 100 g MS/kg DM PKE for the PKE farm compared with the Pasture Only farm
 - 94 g MS/kg DM supplement for the PKE PLUS farm compared with the Pasture Only farm
 - 80 g MS/kg DM supplement for the PKE PLUS farm compared with the PKE farm
- The cost of the marginal milk was:
 - \$5.33 /kg MS for the extra milk produced in the PKE farm compared with Pasture Only farm
 - \$6.61/kg MS for the extra milk produced in the PKE PLUS farm compared with the Pasture Only farm
 - \$10.51/kg MS for the extra milk produced in the PKE PLUS farm compared with the PKE farm

Summary:

Supplement use in a variable climate is a three-year research programme funded by DairyNZ and the Ministry for Primary Industries through their *Sustainable Food and Fibres Futures* programme. The project will compare three farm systems with different supplement use on production, profit and environmental impact. The three farm systems are:

1. **Pasture-Only Farm** - No imported supplement - 2.7 cows/ha
2. **PKE Only Farm** - PKE fed to fill feed deficits within milk FEI limits - 3.1 cows/ha
3. **PKE Plus Farm** - PKE fed until milk FEI limits and then alternative supplements fed to fill feed deficits - 3.1 cows/ha.

Preliminary results from the 2018-19 season (Year 1) have been collated to provide preliminary estimates for the milksolids response to supplementary feeds, the cost of marginal milk, and the profitability of feeding PKE to within the FEI limits or feeding PKE to within the FEI limits and then feeding alternative supplements. The alternative supplements included pasture silage and Dried Distillers Grain (DDG).

Milksolids response:

For the 2018/19 season, the Pasture Only treatment produced 1,008 kg MS per ha (Table 1).

Increasing stocking rate from 2.7 to 3.1 cow/ha and feeding PKE to fill feed deficits resulted in:

- greater per cow production (32 kg MS/cow) and
- greater per ha production (231 kg MS/ha; Table 1).

Increasing stocking rate from 2.7 to 3.1 cow/ha and feeding PKE plus alternative supplementary feeds (pasture silage and DDG) to fill feed deficits resulted in:

- greater per cow production (52 kg MS/cow) and
- greater per ha production (306 kg MS/ha; Table 1).

Maintaining stocking rate at 3.1 cows/ha but increasing the allowance of supplementary feed/cow by purchasing alternative supplements (pasture silage and DDG) in addition to PKE resulted in:

- greater per cow production (20 kg MS/cow) and
- greater per ha production (75 kg MS/ha; Table 1).

Table 1. Milksolids production for 2018/19 season for the Pasture Only, Pasture and PKE, and Pasture and PKE PLUS alternative supplements farms.

	Pasture Only	PKE	PKE PLUS
Per hectare (kg MS/ha)	1,008	1,239	1,314
Per cow (kg MS/cow)	376	408	428

The Pasture Only farm harvested silage but did not purchase any supplements.

The PKE farm fed 2.3 t DM PKE/ha (748 kg DM/cow or 813 kg PKE fresh/cow).

The PKE PLUS farm fed 2.4 t DM PKE/ha (769 kg DM/cow or 836 kg PKE fresh/cow), 0.7 t DM DDG (228 kg DM/cow or 251 kg DDG fresh/cow) and 0.2 t DM pasture silage (49 kg DM/cow).

Based on these feed inputs, the milksolids response to the increased supplement fed in the PKE and PKE PLUS farms compared with the Pasture Only farm was 100 g MS/kg DM for the PKE farm, and 94 g MS/kg DM for the PKE PLUS farm (Table 2 and Figure 1). When we compare the milksolids response of offering additional supplements in the PKE PLUS compared with the PKE farm, the milksolids response was 80 g MS/kg DM (Table 2 and Figure 1).

Table 2. Milksolids response to additional supplement fed in the PKE and PKE PLUS farms.

	PKE vs. Pasture Only	PKE PLUS vs. Pasture Only	PKE PLUS vs PKE
Milksolids response to supplement (g MS/kg DM)	100	94	80

Cost of marginal milk

Operating expenses per hectare increased when supplementary feeds were incorporated into the system.

- The Pasture Only farm had operating expenses of \$4,014 (\$3.98/kg MS).
- Feeding 2.3 t DM PKE to the PKE farm increased operating expenses by \$1,226/ha to \$5,241/ha (\$4.25/kg MS).
- Feeding the alternative supplements to the PKE PLUS farm increased operating expenses by an additional \$792/ha to \$6,033/ha (\$4.63/kg MS).

The cost of the additional (marginal) milk can be calculated from the extra milk produced divided by the extra cost of producing this milk.

- For the PKE farm, the average cost of the marginal milk was \$5.33, so at a milk price of \$6.35, the extra milk produced from increasing stocking rate and feeding PKE to fill feed deficits returned approximately \$1/kg MS.
- For the PKE PLUS farm, the cost of the marginal milk produced compared with the Pasture Only farm was \$6.61, so at a milk price of \$6.35, the extra milk was not adding to profit.
- When we compare the marginal milk produced by the PLE PLUS farm above that produced by the PKE farm, the cost was \$10.51/kg MS. This means at a milk price of \$6.35, the extra milk produced from feeding the alternative supplements (PKE, DDG and pasture silage) was not adding to profit and actually cost the business \$4.16 for every kg MS produced. For this additional milk to be profitable (i.e. cost less than \$6/kg MS), it would require a milksolids response of greater than 140 g MS/kg DM, almost double what was achieved in this study.

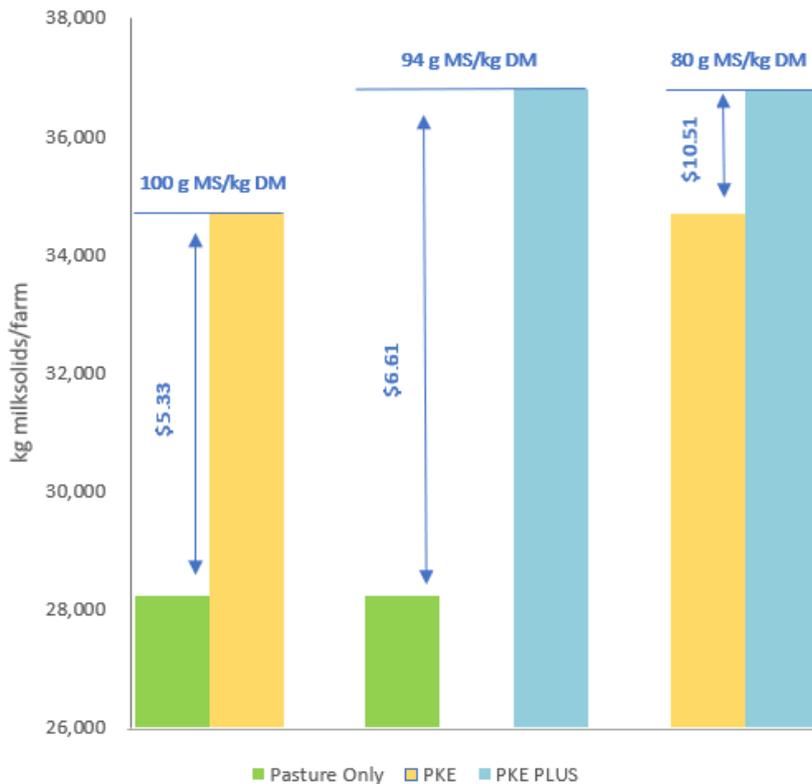


Figure 1. Milksolids response (kg MS/kg DM fed) and cost of marginal milk (\$/kg MS) for Pasture Only vs. PKE, Pasture Only vs. PKE PLUS and PKE vs PKE PLUS.

Summary:

The 100 g MS/kg DM response to increased stocking rate and feeding PKE in 2018/19 is less than previous years at NARF, which ranged from 106 g MS/kg DM to 140 g MS/kg DM, and averaged 122 g MS/kg DM. These high milksolids responses (compared with a national average from the last 12 years of DairyBase of 80 g MS/kg DM supplement) are potentially due to greater responses from feeding supplement when pastures are kikuyu-dominant (i.e., lower energy) compared with ryegrass-dominant systems, and due to very good decision rules being followed in the farms (i.e., no pasture wasted).

The lower MS response with the additional supplement fed; 80 g MS/kg DM in the PKE PLUS farm, is consistent with a diminishing response to supplements, as more supplementary feeds are incorporated into the system without increasing stocking rate. The high cost of the marginal milk in the PKE PLUS farm reflects the lower milksolids response and the high cost of DDGs, making this system the least profitable of the three farms

At a \$6.35 milk price, and with a higher than average MS response of 100 g kg DM, the PKE Only farm was slightly more profitable than the Pasture Only and PKE Plus farms (\$3,323/ha vs. \$3,011/ha and \$3,018/ha respectively).