

The BNZ - Northland Dairy Development Trust &

The Northland Agricultural Research Farm

‘Farm Systems for Profit’

Field Day – 24th May 2018

Project funders

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Reducing Reliance on Imported Feed Trial Update

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This trial has been conducted 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

For three years a farm systems trial located at Dargaville has been testing how two farms using all 'home grown' feed (Grass Only farm and Cropping farm) compare to a farm importing Palm Kernel Expeller (PKE farm). Stocking rate averaged 2.6 cows/ha on the Grass Only farm and 2.8 cows/ha on the other two farms.

Weather conditions were relatively kind during the first two seasons, resulting in good pasture growth and pasture covers on all farms. The late winter and early spring of the third season was challenging due to prolonged wet conditions. Pasture production totalled 17.4, 18.8 and 17.4 t DM/ha for the 2015/16, 2016/17 and 2017/18 seasons respectively. None of these seasons had a prolonged summer/autumn dry.

Supplement use on the PKE farm was 469, 513 and 544 kg DM PKE/cow for the three seasons respectively. Crops were established on the Cropping farm totalling 23%, 21% and 25% of the farm area for the three seasons respectively. Crops sown were turnips (average yield 8.4 t DM/ha), fodder beet (during the first two seasons only - 15.6 t DM/ha) and maize silage (18.2 t DM/ha).

In the 2015/16 season milk production was highest on the Cropping farm at 1,049 kg MS/ha compared with 870 kg MS/ha on the Grass Only and 1,028 kg MS/ha on the PKE farm. For the 2016/17 season production was highest on the PKE farm at 1118 kg MS/ha compared to 965 kg and 1053 kg MS/ha for the Grass Only and Cropping farms respectively. The challenging spring during the 2017/18 season resulted in cows on the Grass Only and Cropping farms being put on once a day milking whilst the PKE farm continued through with twice a day milking. This resulted in a significant advantage to the PKE farm production with 1128 kg MS/ha on the PKE farm compared with 893 and 887 kg MS/ha on the Grass Only and Cropping farms respectively. Poor soil structure on ex-crop paddocks was a significant challenge for the Cropping farm.

In-calf rates averaged 9% across all farms and all seasons. There was no consistent trend between farms as cow condition was carefully managed on all farms.

Costs were calculated for each farm, including differential labour requirements. Over the three seasons farm working expenses/kg MS averaged \$3.97, \$4.52 and \$4.03 for the Grass Only, Cropping and PKE farms respectively. In 2015/16 with a \$3.90/kg MS price, the Grass Only farm had the highest operating profit at \$787/ha followed by the PKE farm at \$733/ha and the Cropping farm at \$433/ha. For the 2016/17 season at a \$6.12/kg MS price the PKE farm had the highest operating profit at \$2,887/ha followed by the Grass Only farm at \$2,761/ha and the Cropping farm at \$2,300/ha. For the 2017/18 season at a forecast \$6.55/kg MS the PKE farm again had the highest operating profit at \$3,224/ha compared with the Grass Only farm at \$2,470/ha and the Cropping farm at \$1,928/ha.

The first two years of this study showed that when costs associated with supplementary feeding and cropping are considered, a Grass Only farm system may have similar or better profitability to a system using PKE. However, the third season showed a significant advantage to the PKE farm due to a challenging late winter/spring impacting the other farms to a greater extent. The use of cropping on heavy clay soils to replace imported supplements has not proved to be an effective strategy.

Background

New Zealand dairy farms have come to rely heavily on importing feed onto the farm, largely PKE. There is concern in the farming community as to the impact on farms if this feed was not available due to lack of supply, market pressures, milk composition requirements or food safety concerns. Increased levels of imported feed have also driven up farm working expenses, making farm systems vulnerable during seasons with lower milk price.

Removal of imported feed would have significant impact on the productivity of New Zealand dairy farms in the short to medium term. A three year farm systems trial was established at the Northland Agricultural Research Farm (NARF), located at Dargaville, to test and demonstrate how dairy systems might maintain production and/or profit without imported feed. The trial has been run for three years to ensure a range of climatic challenges.

Trial Structure

The trial compares three farms:

1. **Grass Only Farm** - No imported supplement, home grown grass silage may be used. Stocking rate of 2.6 cows/ha (73 cows calving on 28 ha)
2. **Cropping Farm** - No imported supplement, crops grown on farm (turnips, fodder beet and maize silage). Stocking rate of 2.8 cows/ha (80 cows calving on 28 ha)
3. **PKE Farm** - Importing of PKE as required to fill in feed gaps. Stocking rate of 2.8 cows/ha (80 cows calving on 28 ha)

This trial is run at NARF where paddocks are evenly allocated to each trial farmlet.

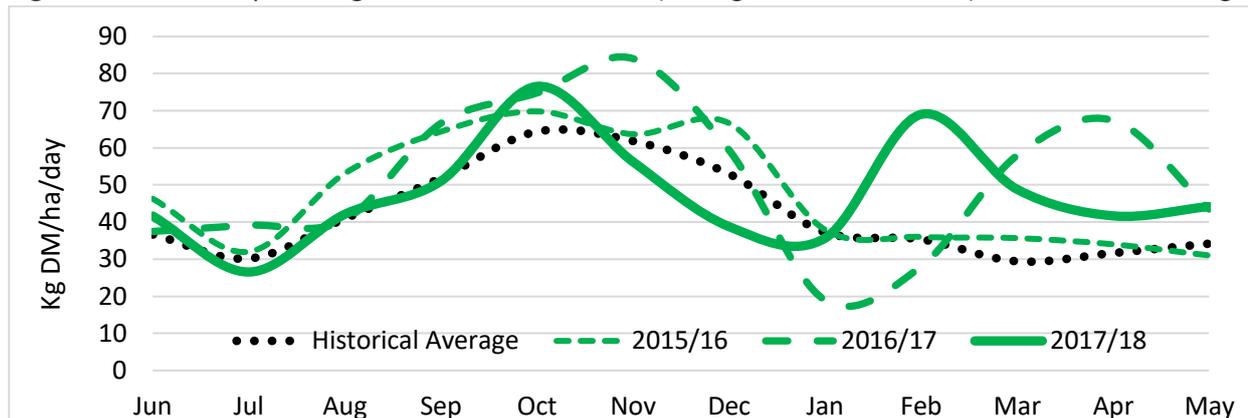
Pasture Growth

Relatively good pasture growing conditions have prevailed through most this three-year study. Calculated pasture growth (based on post and pre-grazing rising plate assessments) totaled 17.4 t DM/ha for the 2015/16 season, 18.8 t DM/ha for the 2016/17 season and 17.4 t DM/ha for the 2017/18 season. This compares with a historical annual production of 15.4 t DM/ha. Average monthly pasture growth rates are shown in Figure 1.

The first two winters and early springs were relatively dry and pasture utilisation relatively good. Challenging periods have been in late spring 2016 when soils got wet, pasture utilisation declined and crop establishment was delayed. Then early summer 2017 was dry, however this was followed by a kind late summer/autumn. Late winter and early spring 2017 was wet for a prolonged period and pasture utilisation was very poor, though pasture growth was still average due to additional nitrogen being applied. This study did not experience a prolonged summer/autumn dry.

Nitrogen was applied totaling 143, 154 and 224 kg N/ha for the three seasons respectively. Nitrogen use was higher during the 2017/18 season due to additional applications during spring 2017 and autumn 2018. Nitrogen use has been similar between farms.

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



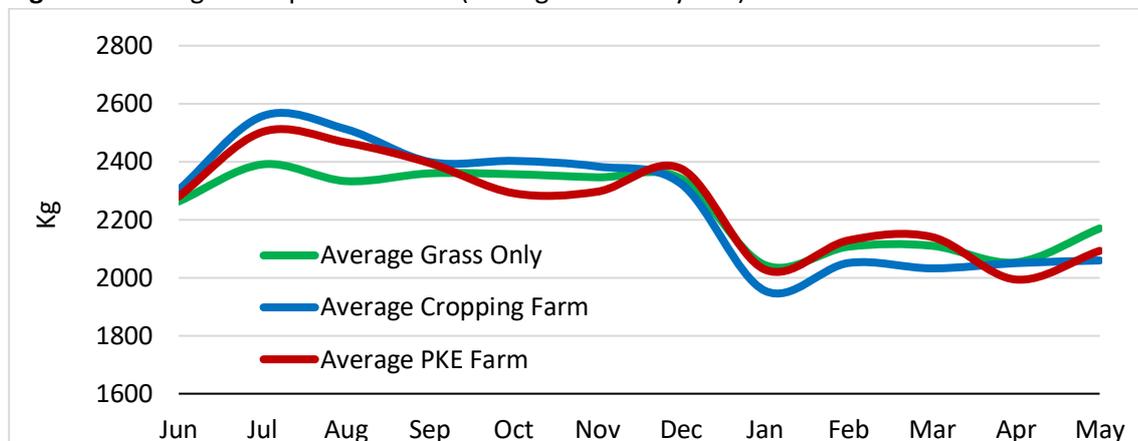
Pasture Covers

Average of farm pasture covers are shown in Figure 2. Overall, pasture supply was not extremely challenging at any time on the Grass Only farm. High covers allowed 20%, 47% and 55% of the farm to be cut for silage for the three seasons respectively. Some of this area was cut during autumn due to strong kikuyu growth.

The Cropping farm tended to hold higher covers than the other farms during late winter and/or early spring. Some of this effect may be due to the farm having less kikuyu and more perennial ryegrass as a result of the cropping regime. In addition, at times ex-crop paddocks held high pasture covers because they were difficult to utilise during wet periods due to very soft soils. Area taken out of grazing for cropping from October resulted in lower pasture covers on the Cropping farm during summer. No pasture silage was conserved on the Cropping farm in the first two years while 17% of the farm was conserved in the third season.

The PKE farm has had more flexible supplement use to control pasture cover. Pasture silage was harvested on 21%, 50% and 41% of the farm during the three seasons respectively. Some of this area was cut in autumn during the latter two seasons.

Figure 2. Average farm pasture cover (average of three years).



Supplement and Crop Use

Table 1 shows the crop areas, yields and costs. As a general rule, supplements were only fed when pasture grazing residuals were predicted to be below the target of 1500 – 1600 kg DM/ha, under optimal grazing rotation length. None of the farms started the study with pasture silage on hand, though some was carried over from one season to the next in subsequent years.

Crops were established on 23%, 22% and 25% of land area on the Cropping farm for the three seasons respectively. Crops grown were turnips, fodder beet and maize silage. However, during 2017/18 fodder beet was not included due to a loss in confidence of growing a cost effective crop. In general, conditions were good for growing crops during 2015/16. In both the 2016/17 and 2017/18 seasons, wet weather in spring delayed crop establishment and then dry conditions during early summer likely impacted yields. Turnips were fed to the Cropping cows January – March and fodder beet from late February – June. Cropped paddocks were sown into either perennial or annual ryegrass after harvest.

As with pasture silage feeding, PKE use on the PKE farm was limited to when pasture grazing residuals were predicted to be below 1500 -1600 kg DM/ha under what was considered optimal grazing rotation lengths, other than a few periods when PKE was fed to support cow condition at strategic times. With relatively good pasture supply during all three years of this trial, the use of PKE on the PKE farm was below what was expected to be used during an ‘average’ season. Total PKE use was been 469, 513 and 544 kg DM PKE/cow for the three seasons respectively.

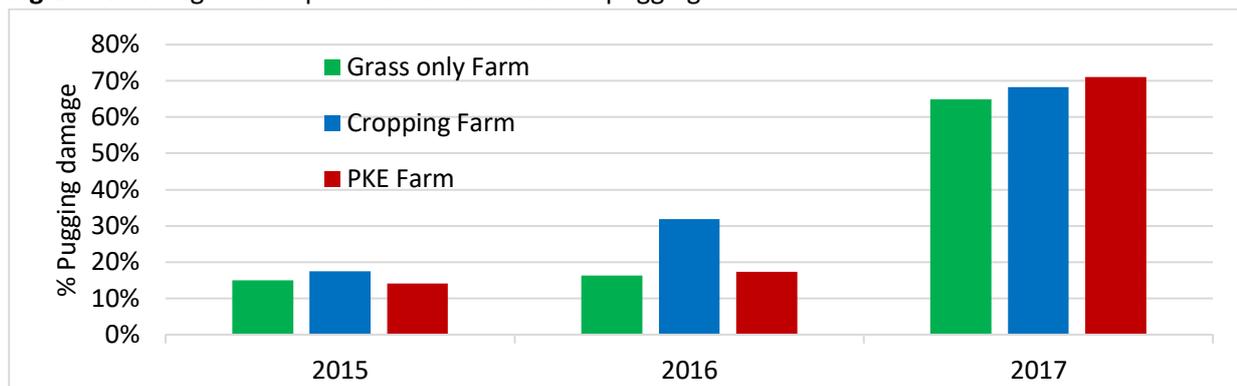
Table 1. Crop production, cost and supplement fed (kg DM/cow). 2017/18 numbers are for the season to date (20th May). Crop costs include the cost of regrassing but not the farm tractor or labour costs.

	Supplement	% of Farm in Crop			Estimated crop t/ha			Growing & Harvesting Cost c/kg DM			Fed kg DM/cow		
		15/16	16/17	17/18	15/16	16/17	17/18	15/16	16/17	17/18	15/16	16/17	17/18
Grass Only Farm	Grass Silage	20%	47%	55%				12.1	13.5	8.7	99	321	513
Cropping Farm	Maize Silage	9%	7%	9%	22.0	14.5	18.0	13.1	30.1	20.3	630	536	375
	Turnips	7%	9%	16%	9.0	9.5	6.8	7.7	11.9	11.9	217	309	340
	Fodder Beet	7%	6%		15.5	16.0		26.2	26.4		404	199	73
	Grass Silage			17%						8.7			174
PKE Farm	Grass Silage	21%	50%	41%				12.1	13.5	8.7	123	278	326
	PKE							28.9	29.7	29.9	469	513	544

Pugging Damage

Soils at NARF are predominantly marine clay which is subject to waterlogging and treading damage (pugging) when conditions are wet. To understand the effect of the different farm systems on soil and plant damage, all paddocks were surveyed for pugging damage. Figure 3 shows how damage levels have been significantly higher during 2017/18 than the previous two seasons. The Cropping farm had higher levels of pugging damage than the other farms during winter 2016. This was due to the ex-crop paddocks having very high levels of pugging. The cultivation process has a negative effect on soil structure and provides a challenge for the Cropping farm resulting in paddocks either being unable to be grazed or sustaining high levels of damage when grazed.

Figure 3. Average soil or plant disturbance due to pugging.



Feed Eaten

Cows on the Grass Only farm ate less feed than the other two farms during the first two seasons (see table 2), however during the third season a similar amount was eaten on the Cropping farm when this farm reduced stocking rate due to very poor pasture utilisation. Feed eaten during the 2015/16 season was similar between the Cropping and PKE farms, however the PKE farm was higher in the following seasons.

Table 2. Calculated feed eaten (t DM/ha).

Tonnes DM/ha	Total Feed Eaten			Home Grown Pasture & Crop Eaten			Imported Supplement Eaten		
	2015/16	2016/17	2017/18	2015/16	2016/17	2017/18	2015/16	2016/17	2017/18
Grass Only Farm	11.7	12.1	11.5	11.7	12.1	11.5	0	0	0
Cropping Farm	13.3	13.2	11.5	13.3	13.2	11.5	0	0	0
PKE Farm	13.3	13.7	13.8	12.0	12.3	12.4	1.3	1.4	1.4

Management during the wet 2017 spring

The very wet early spring of 2017 impacted the Grass Only and Cropping farms more than the PKE farm. With only grass silage on hand, the Grass Only farm had limited options for feeding. Silage was fed out to the Grass Only cows on paddocks when possible, otherwise on a stand-off area. The Cropping cows had a relatively low level of maize silage available to them due to poor crop production the previous season. This was used up by the 22nd September. With no more supplement and deteriorating cow condition, 25% of the cows were grazed out on a neighbouring farm from 21st September. Over half of these cows (15% of the herd) were returned on 24th October while the others remained off for the rest of the season.

To manage cow condition, all cows on the Grass Only and Cropping farms were put on once a day milking (OAD) between 15th September and 27th October. PKE farm cows remained on twice a day milking throughout, apart from young cows and low conditioned cows which were put on OAD prior to mating.

Milk Production

The Cropping farm had the highest milk production, and Grass Only the lowest during 2015/16 season, as shown in Table 3. In the 2016/17 season the PKE farm had the highest production while the Grass Only farm had the lowest. During 2017/18, the Cropping farm, and to a lesser extent the Grass Only farm, were significantly impacted during the wet winter/early spring. This resulted in the Cropping farm having slightly lower production than the Grass Only farm, while the PKE farm maintained similar production to the previous season.

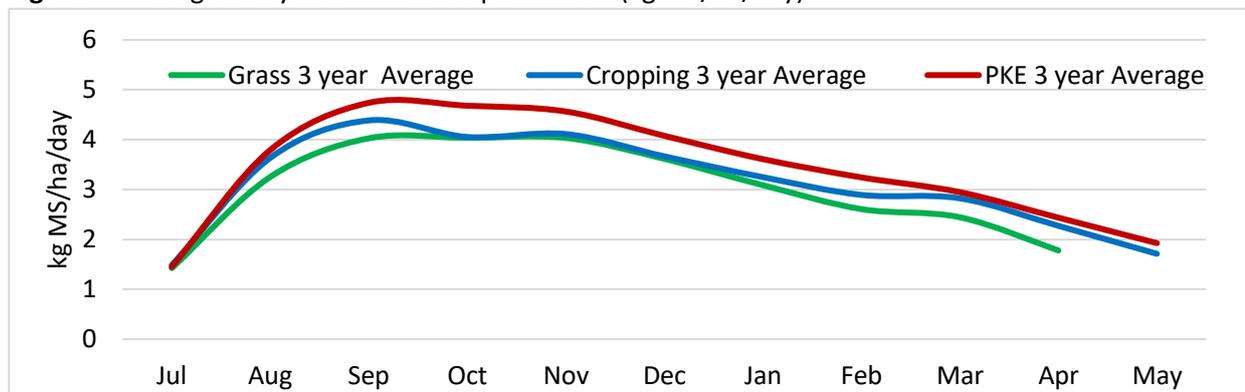
2017/18 production on the Cropping farm production was 16% down on the average of the previous two seasons, while the Grass Only farm was 3% down and the PKE farm 5% up. This season illustrates the vulnerability of farming systems that have no imported feed options when challenges come.

Table 3. Milk solids production per ha and per cow.

	Kg MS/ha			Kg MS/cow		
	15/16	16/17	17/18	15/16	16/17	17/18
Grass Only Farm	870	965	893	347	381	342
Cropping Farm	1,049	1,053	887	384	378	340
PKE Farm	1,028	1,118	1128 (predict)	379	401	385 (predict)

Figure 4 shows the daily milk production for the three farms, averaged over the three years. In the first two years the Grass Only cows were dried off approximately two weeks earlier than the other farms. The lower production on the Grass only farmlet on a per ha basis can be largely explained by the lower stocking rate compared to the other farms. Lower production on the Cropping farm compared with the PKE farm is mainly a result of poor production in the third season on the Cropping farm.

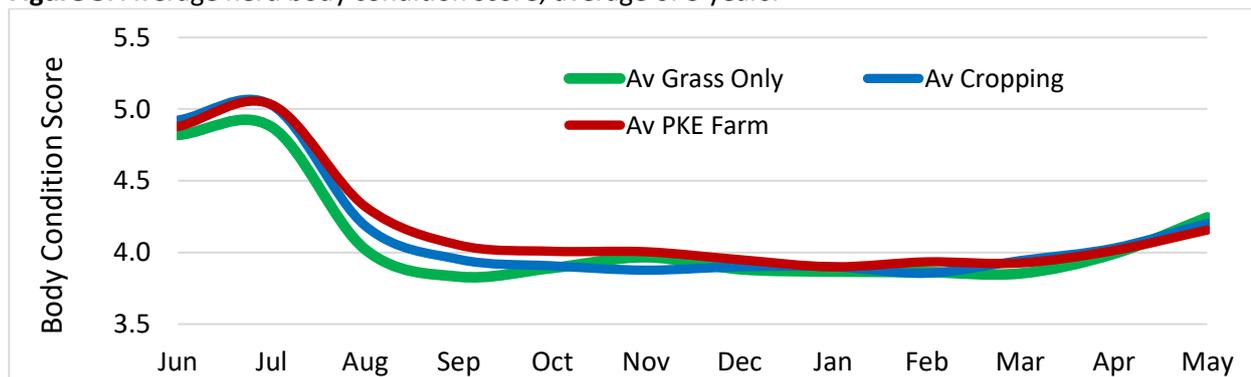
Figure 4. Average of 3 years milk solids production (kg MS/ha/day).



Body Condition Score

Body condition score (BCS) has been assessed fortnightly. The Grass Only farm had lower BCS during winter/early spring for two of the three seasons. Other than this period BCS has been similar across the farms. During the first two seasons cows on the Grass Only farm were dried off 2 weeks earlier than the other farms, endeavouring to ensure they achieved the 5.0+ target at calving.

Figure 5. Average herd body condition score, average of 3 years.



Mating Results

Overall, the in-calf rates have been relatively good (table 4) with an average empty rate of 9% over the three seasons. Mating results have varied between farms within a season, however these differences are not considered significant as there is no consistent trend across the three seasons.

NARF has a management regime of once-a-day milking for cows with BCS of 3.5 or under from 2 weeks prior to mating through to the end of mating.

Table 4. Mating results.

	3 Week Submission			Non-return Rate			Empty Rate		
	2015/16	2016/17	2017/18	2015/16	2016/17	2017/18	2015/16	2016/17	2017/18
Grass Only Farm	96%	79%	89%	83%	72%	79%	6%	10%	8%
Cropping Farm	83%	85%	92%	63%	84%	74%	13%	7%	12%
PKE Farm	87%	79%	85%	78%	80%	71%	9%	1%	12%

Responses to PKE

Comparing the PKE farm to the Grass Only farm provides a calculation of response to PKE, shown in table 5. Differences in response to PKE over the three seasons are somewhat due to using PKE to improve farm production from pasture. The high response in the 2017/18 season was mainly due to being able to maintain twice a day milking for the cows on the PKE farm during the challenging spring, while cows on the Grass Only farm were milked once a day due to poor cow condition.

Table 5. PKE response calculation

	2015/16	2016/17	2017/18
Grass Only Farm Production (kg MS)	24,346	27,032	24,994
PKE farm production (kg MS)	28,810	31,316	31,693
PKE Fed tonne (wet)	39.6	44.5	51.1
Kg Milk Response/kg PKE Fed (wet)	0.113	0.096	0.131

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 or crops, and crop establishment. It should be recognized that additional time spent shifting cows was based on mobs of 70 – 80 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 6. Additional labour and tractor time for cropping and feeding of crops and supplements.

	Task	2015/16 Hours	2016/17 Hours	2017/18 Hours
Grass Only Farm	Tractor Hours	14	51	97
	Man Hours	14	63	97
Cropping Farm	Tractor Hours	98	101	96
	Man Hours	216	211	180
PKE Farm	Tractor Hours	45	88	102
	Man Hours	86	120	177

Financial Results

The financial results for the three farms have been calculated and are shown in the table 7. The income is based on the full milk price of the season, being \$3.90/kg MS for 2015/16, \$6.12/kg MS for 2016/17 and \$6.55/kg MS (forecast) for the 2017/18 season. Fonterra share dividend is not included. Actual income from livestock sales is 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.

Farm working expenses were the highest on the Cropping farm for all three seasons, while they were the lowest on the Grass Only farm for the first two seasons and lowest on the PKE farm in the third season.

The Grass Only farm was the most profitable in 2015/16 season, while the PKE farm was the most profitable for the 2016/17 and 2017/18 seasons. These differences were due to changes in milk price. If a constant milk price of \$4.00/kg MS is used across all seasons, then the Grass Only farm would have been the most profitable in the first two seasons. Likewise, if a \$6.00/kg MS is used then the PKE farm would have been most profitable in all seasons. The Cropping farm was the least profitable all seasons, though the difference was especially great in the third season when farm production took a real hit due to the challenging spring.

In practice, additional capital is required to develop infrastructure, machinery and additional cows for more intensive systems. Assumptions were made, and adjusted operating profit is shown in the table below based on servicing the additional capital required for the Cropping and PKE farms. Taking the additional capital requirement into account favours the Grass Only farm which made it the most profitable during the first two seasons.

Table 7. Summary of the three years income, expenses and operating profit for the three farms with alternative milk price and adjustment for additional capital required.

Financial Summary	Grass Only Farm			Cropping Farm			PKE Farm		
\$/ha	2015/16	2016/17	2017/18	2015/16	2016/17	2017/18	2015/16	2016/17	2017/18
\$/kg MS used in analysis	\$3.90	\$6.12	\$6.55	\$3.90	\$6.12	\$6.55	\$3.90	\$6.12	\$6.55
	\$/ha	\$/ha	\$/ha	\$/ha	\$/ha	\$/ha	\$/ha	\$/ha	\$/ha
Income from milk	\$3,391	\$5,908	\$5,854	\$4,071	\$6,446	\$5,807	\$4,013	\$6,845	\$7,431
Other Income	\$707	\$381	\$581	\$754	\$418	\$581	\$754	\$418	\$635
Total Income	\$4,098	\$6,289	\$6,435	\$4,825	\$6,863	\$6,388	\$4,766	\$7,262	\$8,065
FWE/kg MS	\$3.81	\$3.65	\$4.44	\$4.21	\$4.33	\$5.03	\$3.92	\$3.91	\$4.27
Total Working Expenses	\$3,311	\$3,528	\$3,965	\$4,392	\$4,563	\$4,460	\$4,033	\$4,375	\$4,849
Operating Profit/ha	\$787	\$2,761	\$2,470	\$433	\$2,300	\$1,928	\$733	\$2,887	\$3,224
Alternative Milk Price Analysis									
Op Profit/ha @ \$4.00	\$842	\$707	\$139	\$391	\$60	-\$352	\$675	\$438	\$150
Op Profit/ha @ \$6.00	\$2,581	\$2,645	\$1,979	\$2,479	\$2,173	\$1,441	\$2,733	\$2,753	\$2,600
Op Profit/ha @ \$8.00	\$4,320	\$4,569	\$3,714	\$4,567	\$4,273	\$3,194	\$4,791	\$4,912	\$4,687
Adjustment for Cost of Additional Capital Required									
Additional Capital/ha	\$500			\$2,242			\$2,483		
Cost of Capital at 6.5%	\$33			\$146			\$161		
Adjusted Op Profit/ha	\$755	\$2,728	\$2,438	\$287	\$2,154	\$1,783	\$572	\$2,726	3,063
3yr Average Profit/ha	\$1,974			\$1,408			\$2,120		