Contents

Lincoln University Dairy Farm - Farm Walk Notes - Tuesday 2nd July 2013

Critical issues for the short term

1. Use dry cows to manage pasture cover and graze out paddock which need tidying up.
2. Use back-fences on all herds whenever paddock grazing takes more than 36 hours.
3. Manage ground conditions minimise damage to soil and pastures.
4. Ensure cows at grazing are all in good health and on track to meet pre calving BCS targets.
5. Get programmed winter maintenance done.

Herd Management

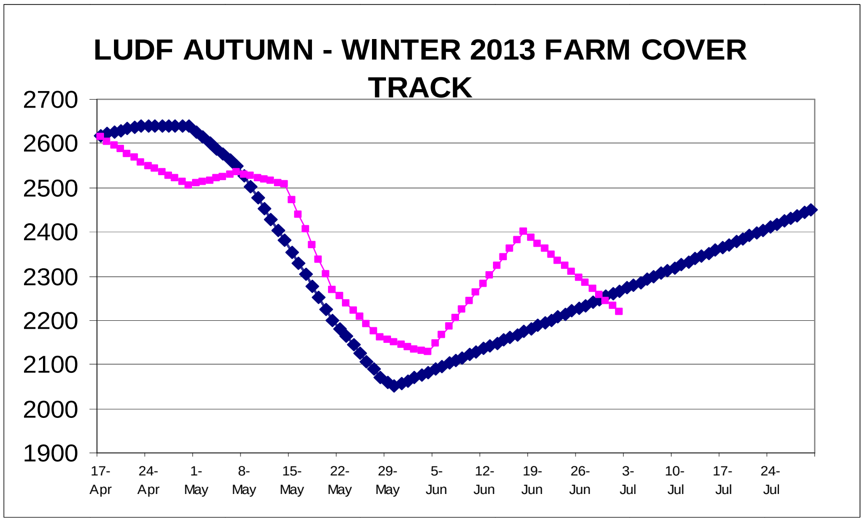
1. All cows are now dried off, the last 394 were dried off on 27th May. All cows were teat sealed at dry off, cows which have had a high cell count from herd test or been treated for mastitis received long acting dry cow therapy while all others were given short acting therapy.
2. The 94 higher condition score cows are back on the platform having been removed to grazing near the farm because ground conditions were very wet after the recent rains.
3. The R2s which are grazing at Macleans Island were teat sealed on the 27th of June.
4. The R1s are all back on the platform [since 26th June], we brought them back because of extremely wet conditions at the graziers property. They are set to return to grazing this Friday. This has worked out quite well as we have had adequate pasture to offer.

Growing Conditions

5. Pasture growth has been 3 kg DM/ha day over the last 2 weeks.
6. Soil temperatures at 9 am have averaged 7.9 degrees; a little [0.7 degrees] cooler than the last period.
7. There has been 42 mm rain this last fortnight. The farm has dried out quite well. Ground conditions are much firmer, there has been some small areas of pasture damage despite careful on-off grazing. There are a number of patches where pasture has died back due to spending a prolonged period under water.

Pasture Production and Management

8. The average cover is 2219 kg DM/ha. This is close to the average pasture cover target for this stage of winter. We are happy with this state and will see what the rest of the winter brings and continue to respond to the conditions.

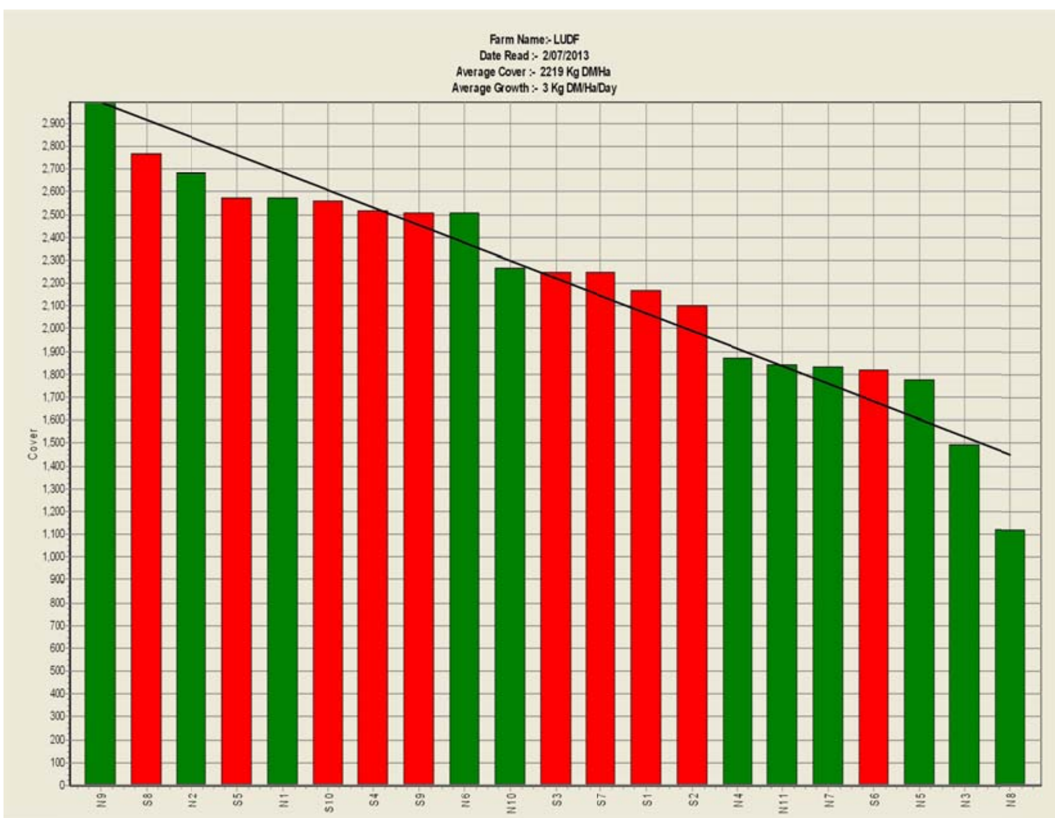


9. Our plan is to use the 94 high BCS cows to manage the shape of our wedge and cover track through to calving, and to make sure make sure paddocks are well grazed out: all without damaging soil and pastures.

Feeding Management

10. The plan is that all dry cows on the platform are fed on pasture only, their intakes are about 10 kg DM/cow. We are looking to get back to lower post grazing residuals of 6 – 7 clicks as the farm dries out.

11. This week's wedge is printed below

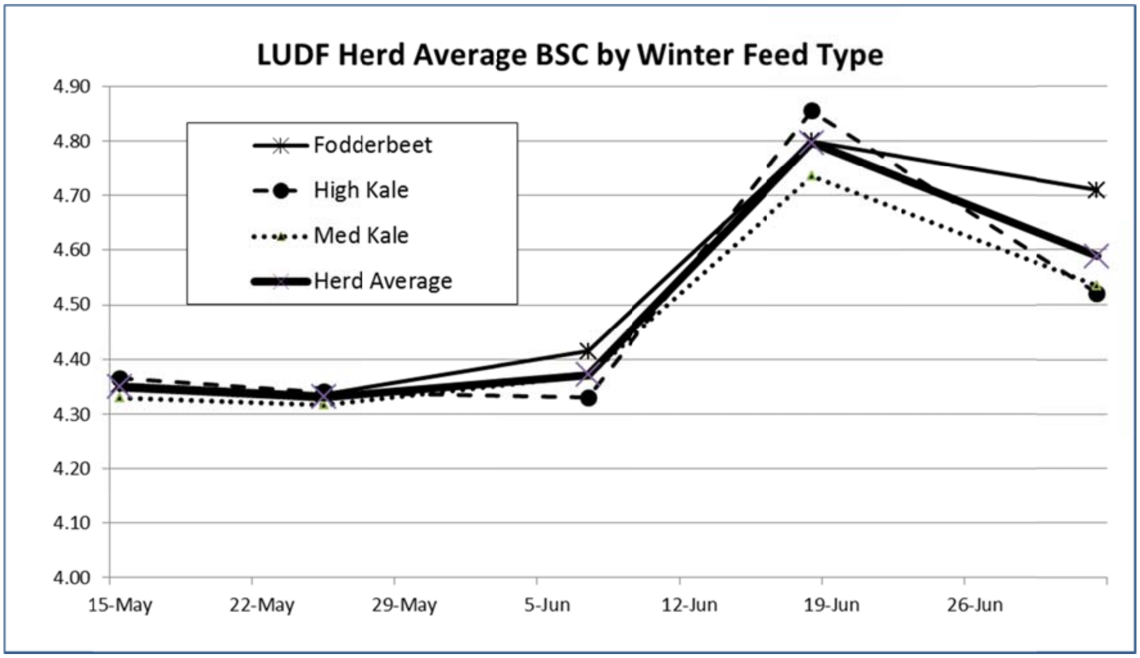


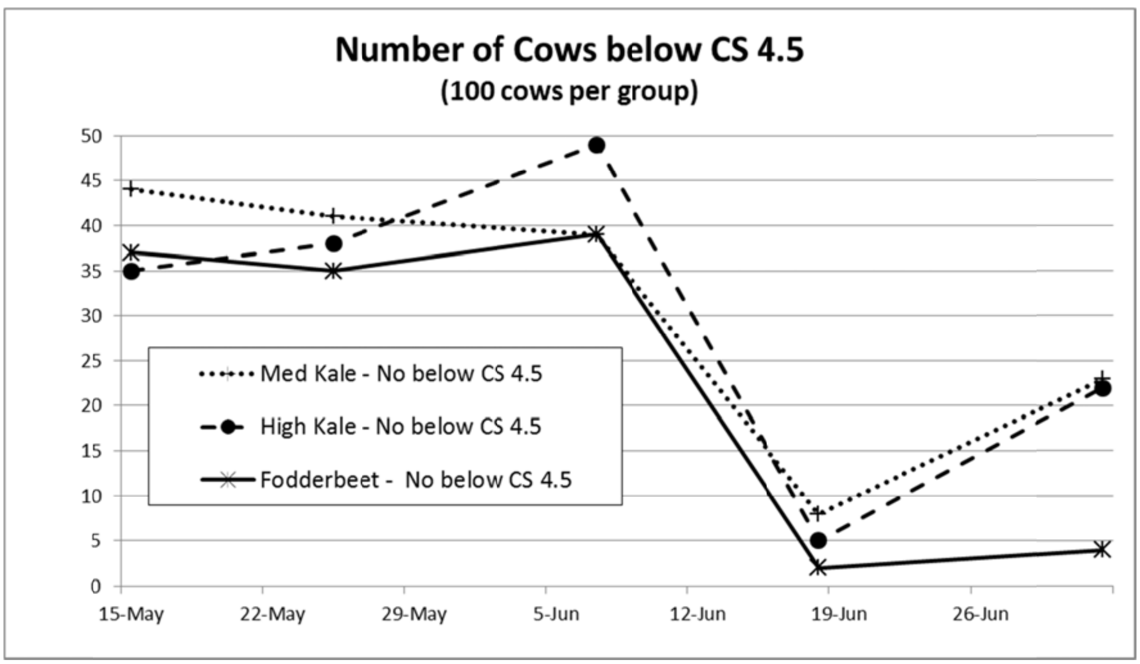
12. **Data sheet**

LUDF Weekly Report	28-May-13	4-Jun-13	18-Jun-13	2-Jul-13
Farm grazing ha (available to milkers)	160	160	160	160
Dry Cows on farm / East blk / other	395	94/0/0/0/556	4/0/91/555	94/0/0/556
Culls (Includes culls put down & empties)	0	0	0	0
Culls total to date	108	0	0	0
Deaths (Includes cows put down)	0	0	0	0
Deaths total to date	11	0	0	0
Calved Cows available (Peak Number 632…)	0	0	0	0
Treatment / Sick mob total	0	3	0	4
Mastitis clinical treatment	0	0	0	0
Mastitis clinical YTD (tgt below 64 year end)	76	0	0	0
Bulk milk SCC (tgt Ave below 150)	0	0	0	0
Lame new cases	3	0	0	0
Lame year-to-date	357	0	0	0
Lame days YTD (Tgt below 1000 year end)	5756	0	0	0
Other/Colostrum	0	0	0	0
Milking twice a day into vat	0	0	0	0
Milking once a day into vat	0	0	0	0
Small herd	0	0	0	0
Main Herd	0	0	0	0
MS/cow/day (Actual kg / Cows into vat only)	0.80	0.00	0	0.00
MS/cow to date (total kgs / Peak Cows 632	475	0	0	0
MS/ha/day (total kgs / ha used	1.66	0.0	0	0.0
Herd Average Cond'n Score	0.00	0.00	0	0.00
Monitor grp LW kg WOW 157 early MA calvers	0	0	0	0
Soil Temp Ave Aquaflex	9.1	7.6	8.6	7.9
Growth Rate (kgDM/ha/day)	22	13	23	3
Plate meter height - ave half-cms	11.9	0.0	13.6	12.3
Ave Pasture Cover (x140 + 500)	2160	2127	2400	2219
Surplus/[deficit] on feed wedge- tonnes	0	0	34	[1]
Pre Grazing cover (ave for week)	3200	3200	3200	3200
Post Grazing cover (ave for week)	1650	1300	1700	1450
Highest pre-grazing cover	3400	3200	3200	3200
Area grazed / day (ave for week)	0.00	0.00	0	0.00
Grazing Interval	0	0	0	0
Milkers Offered/grazed kg DM pasture	0.0	0.0	0	0.0
Estimated intake pasture MJME	0	0	0	0
Milkers offered kg DM Grass silage	0	0	0	0
Silage MJME/cow offered	0	0	0	0
Estimated intake Silage MJME	0	0	0	0
Estimated total intake MJME	0	0	0	0
Tgt total MJME Offered/eaten (incls 6% waste)	0	0	0	0
Pasture ME (pre grazing sample)	0.0	0.0	0	0.0
Pasture % Protein	0.0	0.0	0	0.0
Pasture % DM - Concern below 16%	0.0	0.0	0	0.0
Pasture % NDF Concern < 33	0.0	0.0	0	0.0

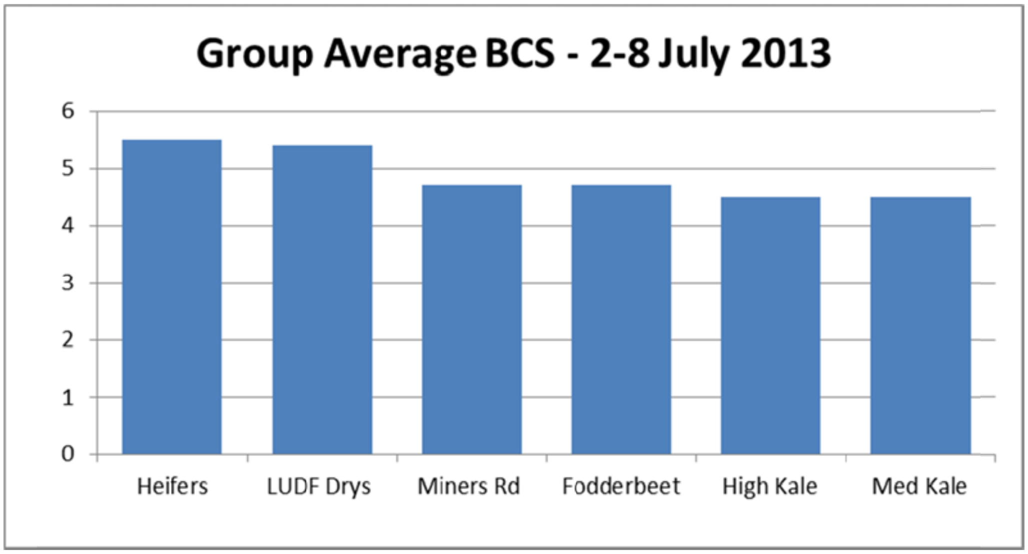
LUDF Weekly Report cont.	28-May-13	4-Jun-13	18-Jun-13	2-Jul-13
Mowed pre or post grazing YTD	711.7	0	0	0
Total area mowed YTD	749.6	0	0	0
Supplements fed to date kg per cow (632 peak)	527.0	0.0	0	0.0
Supplements Made Kg DM / ha cumulative	368.17	0	0	0
Units N applied/ha and % of farm	0	0	0	0
Kgs N to Date (whole farm)	351	0	0	0
Rainfall (mm)	14	18	95	42
Aquaflex topsoil rel. to fill point tgt 60 - 80%	100-100	100-110	100-120	0

Cow Condition Score – Cows on Crops at Ashley Dene



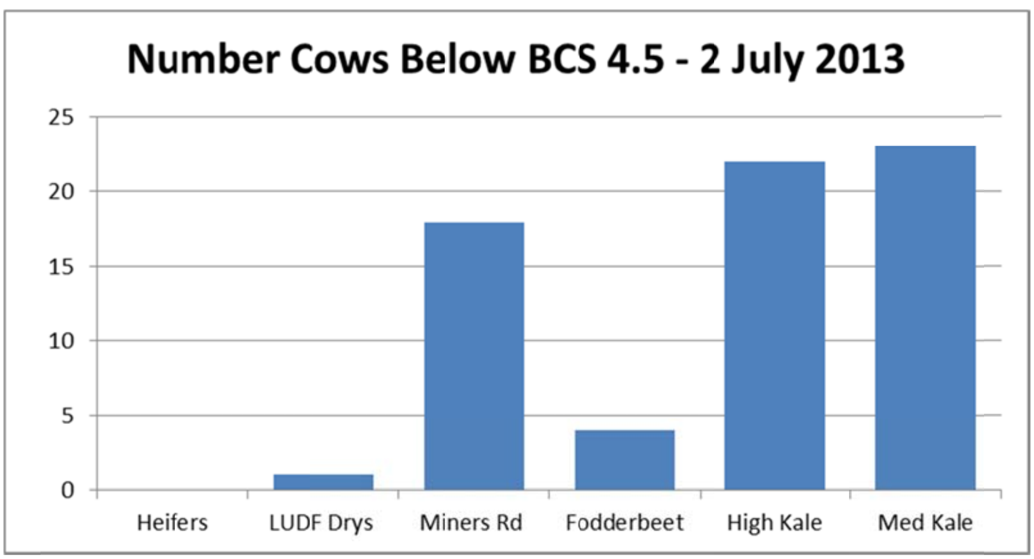


Cow Condition Score – All LUDF Cows



Note:
The condition score data above for the heifers, LUDF Drys and Miners Road groups were condition scored in the paddock, with the average score above representing the herd average for all cows in the group. Cows on Crops at Ashley Dene have been individually condition scored each two weeks. (see above for further details on these cows). Similarly for the data below.

The LUDF drys entered the winter as the cows at or close to target CS at calving and have largely been grazed on the platform throughout winter. The heifers and Miners Rd cows have been well fed on greenfeed and silage; Miners Road cows were the lightest cows at the start of winter.



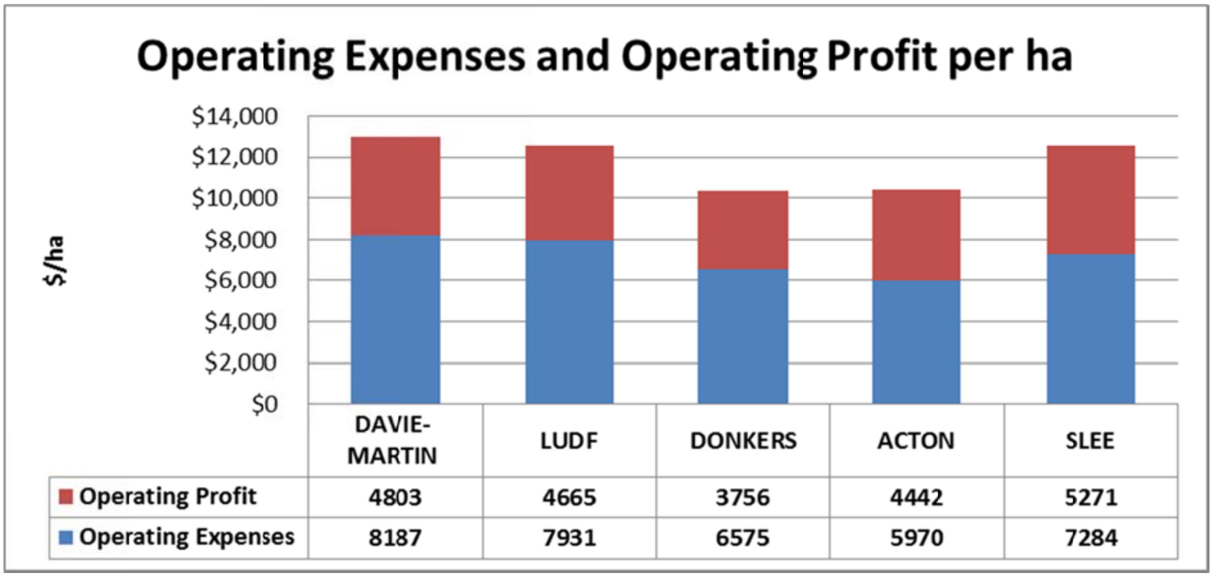
LUDF Profit Analysis and Comparison with other farms

This year we continue the annual farm profitability comparison. We are fortunate to have the same five participants this as last year. We thank all participants, past and present, for their generous sharing and contribution to South island dairying.

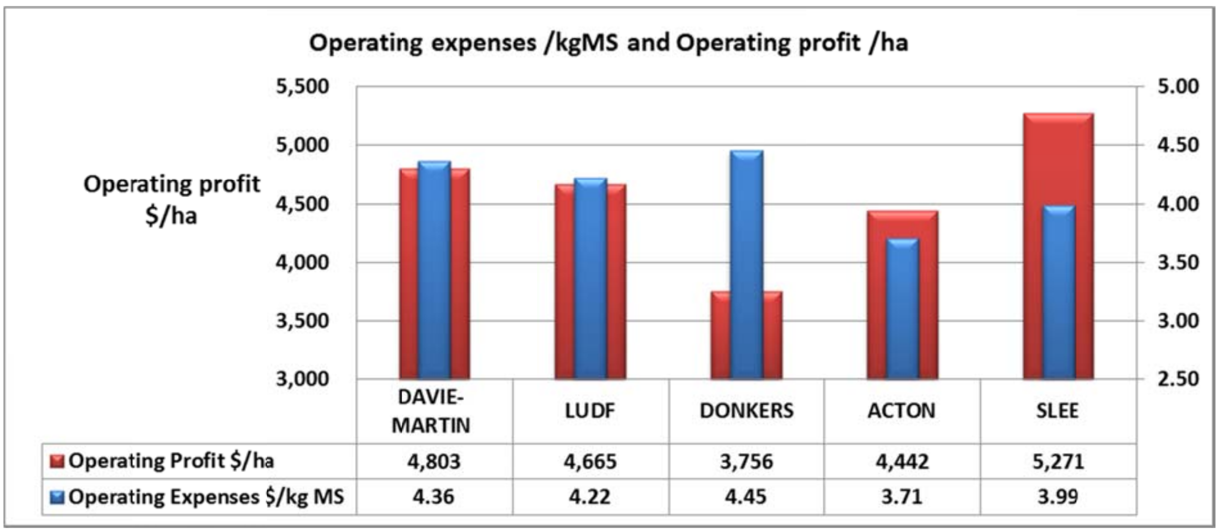
The profitability analyses set out to compare farms down to operating profit level. We have a good range of farm systems and pasture growth potential across this group of very good farms. Whilst it is interesting to see who is most profitable, the greatest value is in understanding how profitability is attained and taking that knowledge to Improve our own business performance. There are some quite large changes in financial performance within the group largely as a result of how the challenging 2012 -13 season impacted on different farms and the reactions of the individual managers to the season.

A brief overview of the participating farms

SEASON 2012-13	DAVIE -MARTIN	LUDF	DONKERS	ACTON	SLEE
Effective ha (MP)	141	160	306	173	663
Run Off	90				260
Cows	550	630	1036	720	2548
Kg MS	264,503	300484	451682	278528	1210990
KG MS/Cow	481	477	436	387	475
kg MS/ha	1,876	1,878	1,476	1,610	1,827
SR	3.90	3.94	3.39	4.16	3.84
Imported feed t/ha	3.7	1.6	3.3	1.58	2.3
N use kg/ha	368	350	268	346	225



	DAVIE-MARTIN	LUDF	DONKERS	ACTON	SLEE
Operating Profit	4803	4665	3756	4442	5271
Operating Expenses	8187	7931	6575	5970	7284



	DAVIE-MARTIN	LUDF	DONKERS	ACTON	SLEE
Operating Profit $/ha	4,803	4,665	3,756	4,442	5,271
Operating Expenses $/kg MS	4.36	4.22	4.45	3.71	3.99

Comparison to last season

SEASON 2011 2012	DAVIE MARTIN	LUDF	DONKERS	ACTON	SLEE
Effective ha (MP)	141	160	306	193	624
Run Off	0				175
Cows	520	632	1060	725	2507
Kg MS	258301	297720	458417	309782	1213777
KG MS/Cow	497	471	432	427	484
kg MS/ha	1832	1861	1498	1605	1945
SR	3.7	3.95	3.5	3.8	4.02
Imported feed t/ha	1.9	1.5	2.2	0.3	3.10
N use kg/ha	350	350	261	323	195
Op Exps $/kg MS	3.77	4.30	4.01	3.29	3.77
OP Profit/ha	5219	4553	4301	5249	5696

Changes season to season

Changes season to season	DAVIE MARTIN	LUDF	DONKERS	ACTON	SLEE
Effective area	**0**	**0**	**0**	**-20**	**39**
run off	**90**	**0**	**0**	**0**	**85**
Cows	**30**	**-2**	**-24**	**-5**	**41**
kgMS	**6202**	**2764**	**-6735**	**-31254**	**-2787**
kg MS/cow	**-16**	**6**	**4**	**-40**	**-9**
Kg MS/ha	**44**	**17**	**-22**	**5**	**-119**
SR	**0.21**	**-0.01**	**-0.08**	**0.41**	**-0.17**
Imported feed T/ha	**1.84**	**0.06**	**1.10**	**1.27**	**-0.80**
N use Kg/ha	**18**	**0**	**7**	**23**	**30**
Operating costs change $/kg MS	**0.60**	**-0.08**	**0.45**	**0.42**	**0.22**
Operating Profit change $/ha	**-417**	**112**	**-545**	**-807**	**-425**

Per ha income for 2012 -2013

INCOME (Season 2012-13)	DAVIE MARTIN	LUDF	DONKERS	ACTON	SLEE
Milk income [$5-80] -levy	10813	10825	8508	9280	10528
share income [$0.32 est]	600	601	472	515	584
Stock Sales	522	1140	879	800	1181
Stock Purchased	144	161	0	131	0
Stock Adjustment	1172	192	343	-52	136
Net Stock Income	1551	1170	1222	617	1317
Other Income	25	0	128	0	125
Total Income	12989	12596	10331	10412	12555

2012 -2013 Profitability analysis per effective milking ha

2012 2013 Analysis $/ha effective milking area	DAVIE MARTIN	LUDF	DONKERS	ACTON	SLEE
Total income/ha	12989	12596	10331	10412	12555
Cow Costs					
Animal Health	409	381	201	153	425
Breeding/testing	32	323	187	152	164
Dry cows / Young stock grazing	862	1886	1452	924	387
Feed					
Net Feed (made +purch +calf feed)	1229	641	986	769	1361
Run Off Adjustment /lease	426	0	0	0	447
Fertilizers (inc N)	1322	1080	677	788	897
Irrigation	88	347	617	354	319
Regrassing	211	92	76	23	113
Wages	1388	1362	1035	1205	1324
Land					
Electricity	341	169	63	128	105
Administration	227	135	215	228	93
Freight General	40	0	2	32	7
Rates and Insurance	116	131	136	123	117
R&M	495	386	199	342	287
Shed Expenses	57	47	88	124	132
Vehicle Expenses	326	218	122	281	149
Weed and pest/spraying	16	8	25	11	131
Depreciation	603	725	494	332	824
Operating Expenses	**8187**	**7931**	**6575**	**5970**	**7284**
F.W.E	**7248**	**7206**	**6145**	**5161**	**6249**
Operating Profit	**4803**	**4665**	**3756**	**4442**	**5271**

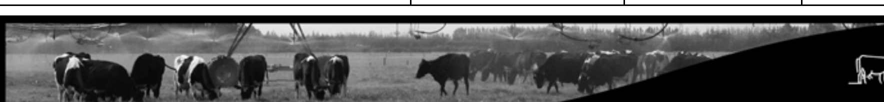
Summary by Cost Category					
Cow Costs	1303	2589	1840	1230	976
Feed	3275	2160	2356	1935	3138
Staff	1388	1362	1035	1205	1324
Land	2221	1820	1344	1601	1846
Total operating expenses /ha	**8187**	**7931**	**6575**	**5970**	**7284**

2012 2013 Profitability analysis expressed per kg Milk solids

Analysis $/kg MS	DAVIE MARTIN	LUDF	DONKERS	ACTON	SLEE
Total income/kgMS	6.92	6.71	7.00	6.47	6.87
Cow Costs					
Animal Health	0.22	0.20	0.14	0.10	0.23
Breeding/testing	0.02	0.17	0.13	0.09	0.09
Dry cows / Young stock grazing	0.46	1.00	0.98	0.57	0.21
Feed					
Net Feed (made+purch + calf feed)	0.66	0.34	0.67	0.48	0.75
Run Off Adjustment /lease	0.23	0.00	0.00	0.00	0.24
Fertilizers (inc N)	0.70	0.58	0.46	0.49	0.49
Irrigation	0.05	0.18	0.42	0.22	0.17
Regrassing	0.11	0.05	0.05	0.01	0.06
Wages	0.74	0.73	0.70	0.75	0.72
Land					
Electricity	0.18	0.09	0.04	0.08	0.06
Administration	0.12	0.07	0.15	0.14	0.05
Freight General	0.02	0.00	0.00	0.02	0.00
Rates and Insurance	0.06	0.07	0.09	0.08	0.06
R&M	0.26	0.21	0.13	0.21	0.16
Shed Expenses	0.03	0.03	0.06	0.08	0.07
Vehicle Expenses	0.17	0.12	0.08	0.17	0.08
Weed and pest/spraying	0.01	0.00	0.02	0.01	0.07
Depreciation	0.32	0.39	0.33	0.21	0.45
Operating Expenses	**4.36**	**4.22**	**4.45**	**3.71**	**3.99**
F.W.E	**3.86**	**3.84**	**4.16**	**3.21**	**3.42**
Operating Profit	**2.56**	**2.48**	**2.54**	**2.76**	**2.89**

Summary by Cost Category

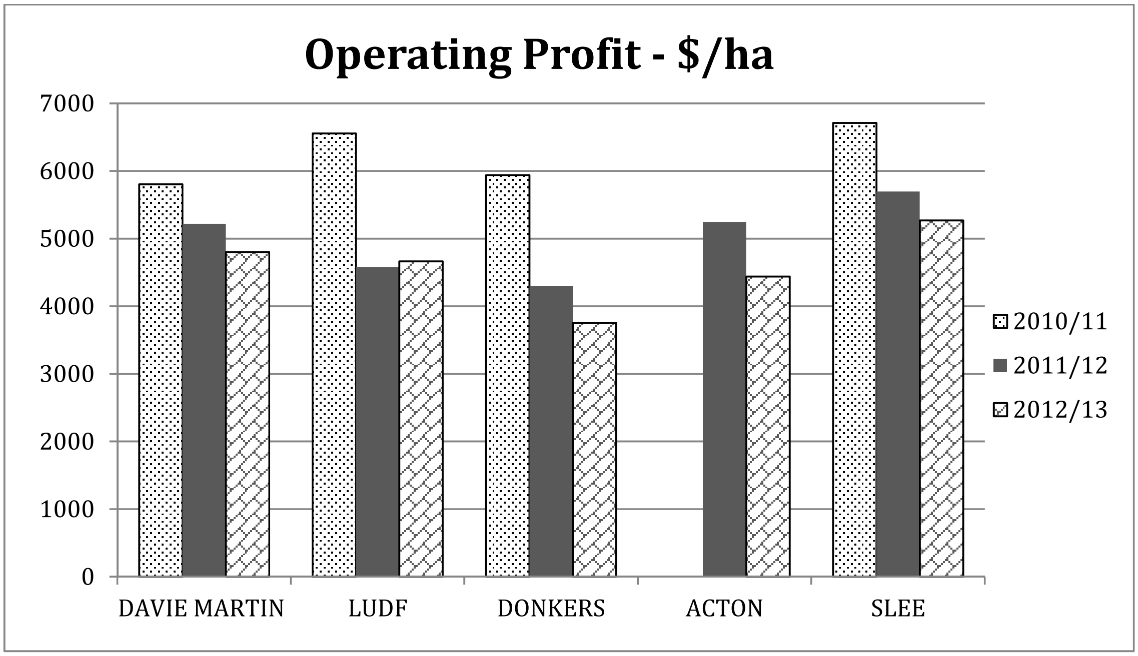
Summary by Cost Category					
Cow Costs	0.69	1.38	1.25	0.76	0.53
Feed	1.75	1.15	1.60	1.20	1.72
Staff	0.74	0.73	0.70	0.75	0.72
Land	1.18	0.97	0.91	0.99	1.01
Total Operating Expenses /kgMS	**4.36**	**4.22**	**4.45**	**3.71**	**3.99**

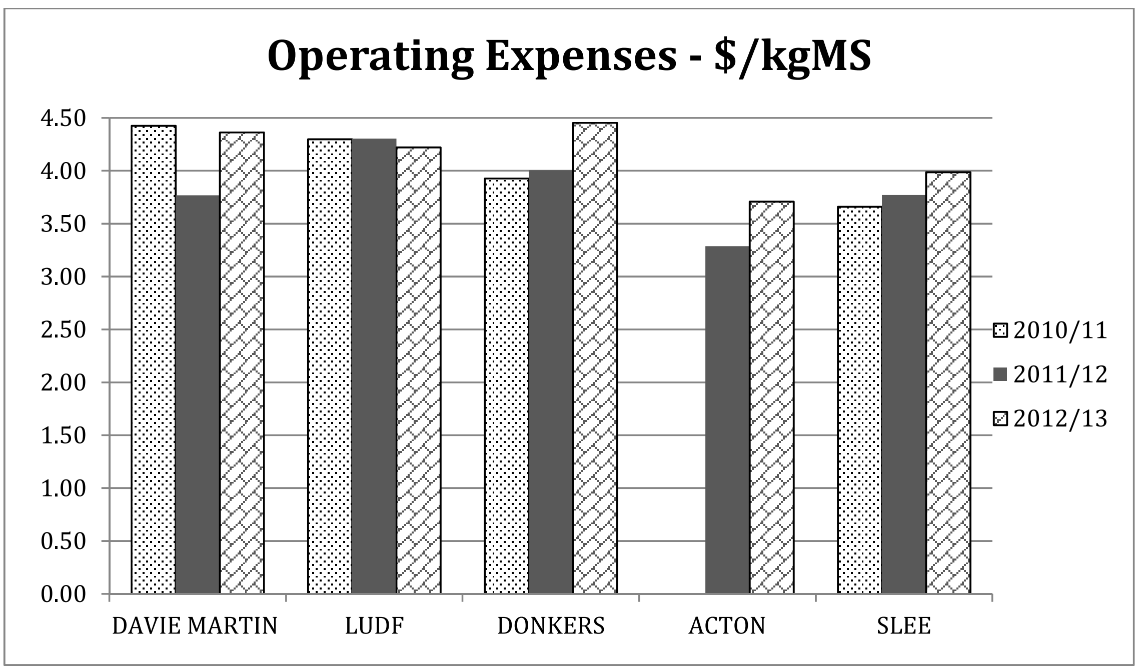


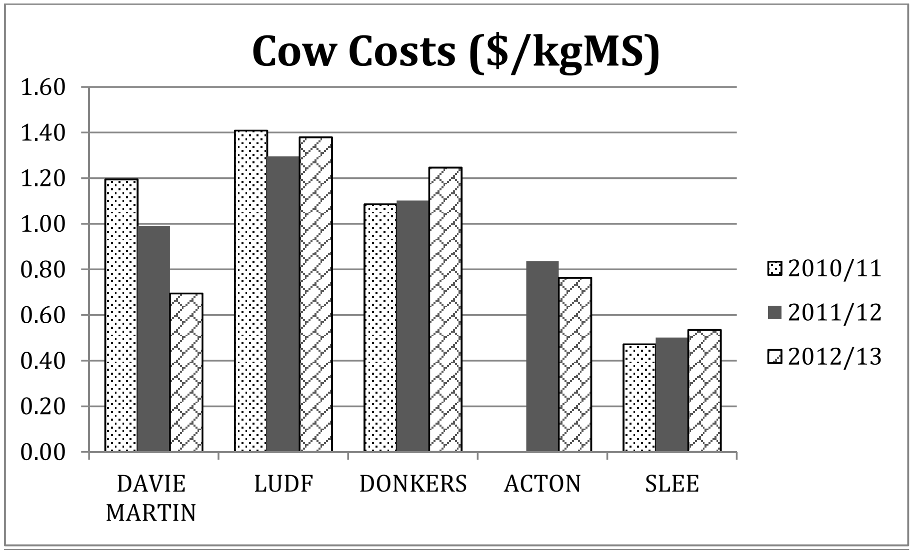
2012 2013 Profitability analysis expressed per cow

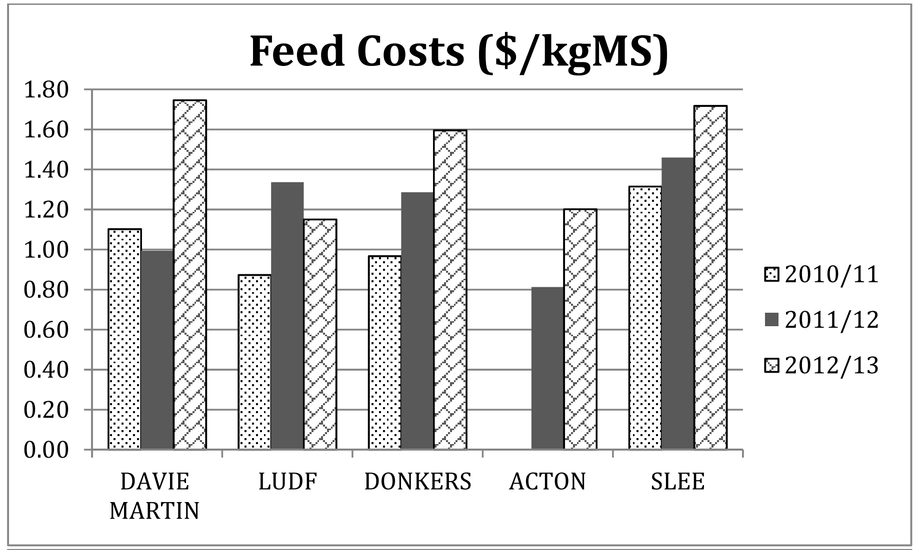
Analysis per cow	DAVIE MARTIN	LUDF	DONKERS	ACTON	SLEE
Total income/cow	3330	3199	3051	2502	3267
Cow Costs					
Animal Health	105	97	59	37	111
Breeding/testing	8	82	55	37	43
Dry cows / Young stock grazing	221	479	429	222	101
Feed					
Net Feed (made +purchased, incl calf feed)	315	163	291	185	354
Run Off Adjustment /lease	109	0	0	0	116
Fertilizers (inc N)	339	274	200	189	233
Irrigation	23	88	182	85	83
Regrassing	54	23	22	6	29
Wages	356	346	306	290	345
Land					
Electricity	87	43	19	31	27
Administration	58	34	64	55	24
Freight General	10	0	1	8	2
Rates and Insurance	30	33	40	30	31
R&M	127	98	59	82	75
Shed Expenses	15	12	26	30	34
Vehicle Expenses	84	55	36	68	39
Weed and pest/spraying	4	2	8	3	34
Depreciation	155	184	146	80	214
Operating Expenses	**2099**	**2014**	**1942**	**1435**	**1895**
F.W.E	**1858**	**1830**	**1815**	**1240**	**1626**
Operating Profit	**1231**	**1185**	**1109**	**1067**	**1372**

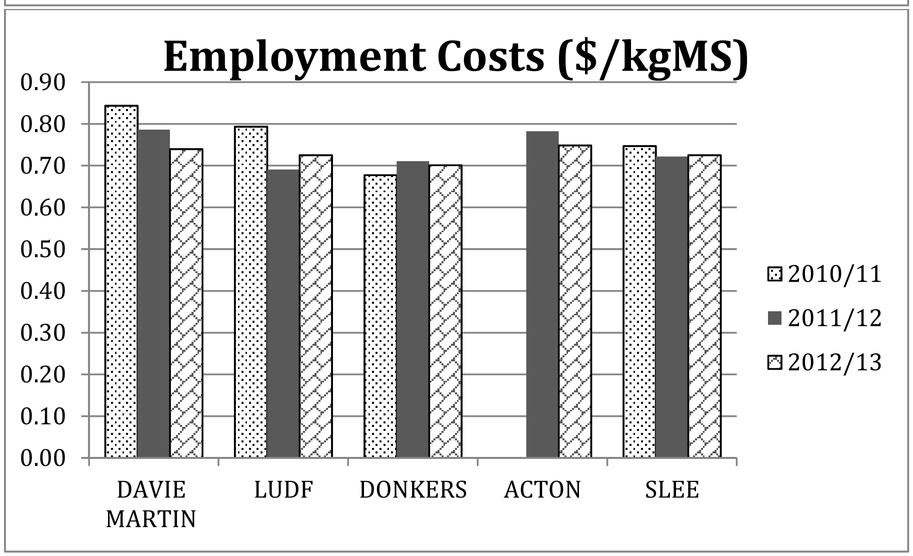
Summary by Cost Category					
Cow Costs	334	658	543	296	254
Feed	840	549	696	465	816
Staff	356	346	306	290	345
Land	569	462	397	385	480
Total Operating Expenses /cow	2099	2014	1942	1435	1895

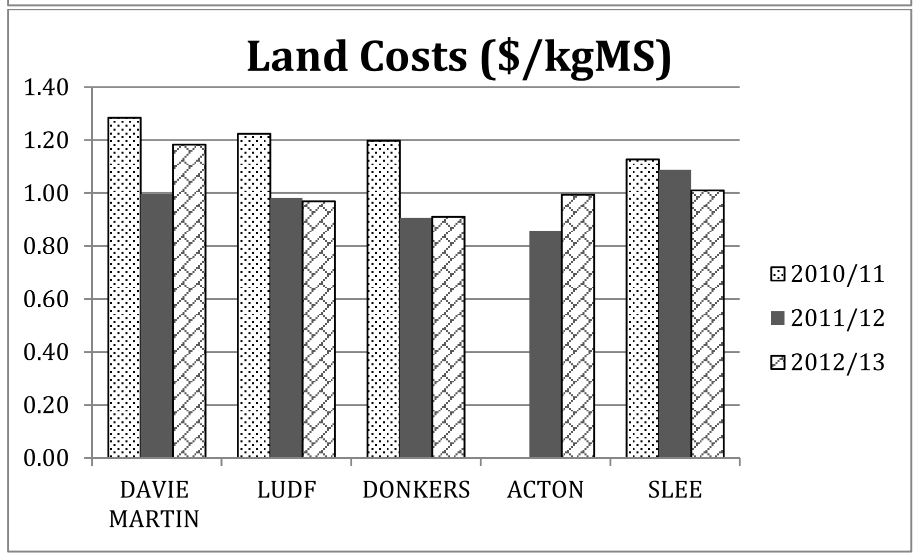

Operating Profit - $/ha
7000
6000
5000
4000
3000
2000
1000
0
DAVIE MARTIN
LUDF
DONKERS
ACTON
SLEE
2010/11
2011/12
2012/13


Operating Expenses - $/kgMS
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
DAVIE MARTIN
LUDF
DONKERS
ACTON
SLEE
2010/11
2011/12
2012/13


Cow Costs ($/kgMS)
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
DAVIE MARTIN
LUDF
DONKERS
ACTON
SLEE
2010/11
2011/12
2012/13


Feed Costs ($/kgMS)
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
DAVIE MARTIN
LUDF
DONKERS
ACTON
SLEE
2010/11
2011/12
2012/13


Employment Costs ($/kgMS)
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
DAVIE MARTIN
LUDF
DONKERS
ACTON
SLEE
2010/11
2011/12
2012/13


Land Costs ($/kgMS)
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
DAVIE MARTIN
LUDF
DONKERS
ACTON
SLEE
2010/11
2011/12
2012/13

P21 Dairy Systems Research - Dairy farming within nutrient limits

What does ‘farming within nutrient limits’ mean?

Regional Councils across New Zealand are currently setting nutrient limits for lakes and rivers in their catchments, as required by the NZ Government under the National Policy Statement on Freshwater.

The main nutrients of concern are nitrogen (N) and, in some situations, phosphorus (P). Nitrogen is a more widespread issue, since it moves freely through the soil into water whereas phosphorus usually stays bound to particles within the soil.

Regional nutrient plans will probably require dairy farmers to reduce N losses in several catchments. What could emerge from this is a ‘target’ nitrogen leaching limit to be achieved for different categories of farms, such as ‘x’ kg N per hectare per year.

Depending on the catchment, soil type, and farm system, ‘x’ could be a figure that is lower than many farms are currently achieving. In this situation, farm management will have to change. For the dairy industry, and for regional economies, it is important that any possible negative implications of these changes on milk production and farm profitability are avoided.

Nitrogen: a ‘slippery’ nutrient

Our ‘staple’ dairy cow feed, ryegrass/white clover pasture, requires high levels of soil nutrients, including nitrogen, to grow well and provide sufficient feed for high productivity. Ryegrass/clover pasture usually contains a higher concentration of N than cows need in their diet.

Each year, a lot more N is bought in to the dairy farm (through N fertiliser, biological fixation by legumes, and in supplementary feeds) than leaves the farm (in milk, or through animal sales).

Much of the surplus N is lost from the farm in the form of nitrate, which can leach below the plant root zone into sub-surface waters and eventually accumulate in surface water.

Only 25-30% of the N eaten by cows is retained for milk protein or other animal needs. The rest is excreted in dung or urine. It is the N in urine which is the main problem for freshwater quality in agricultural catchments.

Usually, there is a lot more N deposited in a urine patch than the pasture plants in that patch can take up for new growth. The excess N is a major source of emissions to freshwater via nitrate leaching.

The higher the concentration of N in the diet of the animal, the higher the concentration in the urine and the greater the risk of nitrate leaching.

The risk of N leaching from the urine patch is higher for urine deposited in late summer and autumn than for urine deposited at other times. This is because plant growth is often restricted in the following months and therefore plant N uptake is low, and because subsequent winter/spring rain usually exceeds the water holding capacity of the soil, so water will drain from the soil taking nitrate with it.

What can we do about nitrate leaching?

There are management practices available that help reduce the risk of nitrate leaching. These include:

- Maximising animal reproductive efficiency, to reduce total animal replacements. This reduces the total number of animals within the system, and therefore total urinary N output

- Lower stocking rate. This works for the same reasons outlined above – fewer total animals, less total urinary N being deposited on pastures or crops

- Reduce N fertiliser, and/or increase the efficiency of N fertiliser use by plants. Over-fertilising leads to high N concentrations in grass, therefore high N concentrations in the cows diet and urine

- Reduce dietary N concentration by using alternative feeds that have low N concentration eg maize silage, fodder beet, or forage herbs such as plantain

- Restrict the time that animals spend on pasture, and therefore reduce urinary N return to pasture during the 'risk' periods of late summer/autumn. This only works if the N excreted while animals are on stand-off areas is captured and cycled efficiently.

- Increase the genetic merit of the herd. Recent trials show that cows with high breeding worth/production worth (BW/PW) put more of the N they eat into milk, and also excrete less N in urine, than cows with low BW/PW

- Maximise pasture growth, so that: 1) as much as possible of the available soil nitrogen is taken up by plants; and 2) as much as possible of the rain or irrigation water hitting the soil is taken up by plants rather than draining below the plant roots, carrying N with it.

So, where to from here?

Many of these practices help improve the overall efficiency of production in the farm system, and should therefore also reduce costs and increase profit as well as reduce the risk of N leaching. Improving reproductive efficiency, N fertiliser use efficiency, and pasture growth are all examples. They are all good for business.

Other practices require substantial change to the system, and could therefore add more costs and/or reduce production and profitability. Examples include standing animals off pasture, or reducing stocking rate below the farms optimum.

For all of these practices, we need to work out:

- how effective they are for reducing N losses when implemented in a farm system
- how much production risk is involved; and
- the possible consequences for profitability.

We also need to identify the critical management decision rules for the different practices to help farmers implement changes.

<u>Hence, the P21 project seeks to develop</u>:

practical dairy farming systems that combine high production and profit with lower environmental emissions.

P21 Farmlet Research Targets

The P21 project has the following production, profit and environmental targets:

- Milksolids (MS) production 1,600 – 2,200 kg/ha/year (compared to Canterbury benchmark of 1,500 kg/ha/year)
- Operating profit $4,300 - $4,800/ha/year (compared to Canterbury benchmark of $3,300/ha/year)
- Nitrate-N leaching 25-35 kg N/ha (all hectares counted).

We compare two management <u>systems:</u>

The P21 farmlets compare two different systems, both with a strong focus on management efficiency: one based on the 'traditional' pathway of intensification through more cows and more inputs (called 'High Stocking Efficient', or HSE), and one based on reducing stocking rate, focussing on high per-cow production through increased pasture intake, and incorporating N loss mitigations such as diverse pastures ('Low Stocking Efficient', or LSE). They are summarised below. The experiment started in September 2011.

Low Stocking rate Efficient (LSE)	High Stocking rate Efficient (HSE)
Milking platform, Lincoln University Research Dairy Farm	
3.5 cows/ha	5.0 cows/ha
BW 140*	BW 133*
Up to 150 kg N/ha/year	Up to 400 kg N/ha/year
22 paddocks on milking platform. Mixtures of white clover and perennial ryegrass: 8 with diploid Arrow AR1, 8 with tetraploid AR37 and 6 with a diverse pasture mix, including chicory, plantain and prairie grass (sown April 2011)	18 paddocks on milking platform. Mixtures of white clover and perennial ryegrass: 8 paddocks with diploid Arrow AR1 sown April 2009, 8 with tetraploid AR37 and 2 with diploid Expo AR1, sown April 2011.
Wintering support block, Ashley Dene	
Kale + green chop silage	Fodder beet + pasture silage

*Actuals for 2012-2013 season

What are we looking at?

<u>Farm scale:</u>

- N and P balance at farm gate
- Nitrate leaching
- Water use efficiency
- Economics

<u>Pasture and crops:</u>

- Production
- Composition, quality
- Animal intake
- Soil structure
- Soil fertility
- Insect damage

<u>Animals</u>:

- Milksolids production
- Body condition, weight, health, fertility
- N partitioning (milk, faeces, urine and blood)

Our 'expectations': Results of modelling

Before starting the experiment, the DairyNZ Whole Farm Model was used to simulate the physical production, financial performance and environmental emissions of the HSE and LSE systems. Some key results of the modelling are shown in the table below. These results represent our expectations of how the two systems will perform. The farmlet experiment will test whether or not these expectations can be met.

Table 1. Results of pre-experimental modelling

Whole Farm Model Results	LSE	HSE
Milking platform		
Stocking rate (cows/ha)	3.5	5.0
N fertiliser application (kg N/ha/year)	150	400
Total pasture harvested (t DM/ha/year)	16.0	18.1
Grain supplement (kg/cow/year)	100	800
MS produced (kg/cow/year)	453	437
MS produced (kg/ha/year)	1,588	2,184
Operating profit ($/ha)	4,334	4,810
Farm gate N surplus (kg/ha)	154	339
N leached (kg N/ha)	24	38
Wintering		
Main winter crop	Kale	Fodder beet
Crop area / 100 cows	8.0	2.2
Other winter feed	Green-chop cereal silage	Pasture silage

Can we achieve these performance levels?

Table 2. Average of first two years: Milking platform, 2011/2012 and 2012/13

Milking platform	LSE	HSE
Cows/ha (Breeding Worth)	3.5 (131)	5.0 (126)
Comparative stocking rate (kg LWT/t feed)	84	87
N fertiliser on pasture (kg/ha)	160	324
Pasture eaten (t DM/ha)	15.3	18.3
Supplements eaten (t DM/cow)	0.27	0.87
MS (kg/c)	511	458
MS (kg/ha)	1789	2290
Operating costs ($/kg MS)	3.93	4.43
Operating profit ($/ha)	4860	5061
Nitrate leached (kg N/ha) [Overseer 6]	19	35

Summary points:

- While the two systems differed substantially in total inputs (cows/ha, N fertiliser, and supplementary feed), they operated at similar comparative stocking rate, indicating that the total amount of feed offered per cow was similar
- In the LSE system, N use exceeded expected usage by 10 kg N/ha. This is because, in 2011/12, pastures were visibly N-deficient in late summer/autumn, and an 'extra' round of fertiliser was used to ensure pasture cover targets at drying off were met. The notional target of 150 kg N/ha was met in 2012/13. (Note: neither system received any effluent in 2011/12, and both systems include new pastures on ex-cropping soils, which have lower soil organic N levels compared to soils that have been under pasture for many years).
- Total pasture harvest was similar to model projections (model projections are based on an average of 10 years climate data). Pasture eaten in HSE has exceeded LSE by 3 t DM/ha, which can be largely explained by the additional N fertiliser used in HSE (164 kg N/ha)
- Both systems have exceeded milk production targets, per cow and per hectare.
- Operating costs are lower in LSE, due mainly to lower feed costs
- Both systems have returned good operating profit, in excess of target.
- Nitrate leaching (as <u>estimated</u> by Overseer 6) was lower than target in LSE, and at the top end of the target range in HSE (as expected). Note, DCD was applied twice in 2011/12 (as planned), but only once in 2012/13 before DCD sales were suspended. Estimated nitrate leaching was therefore higher in 2012/13 than in 2011/12.

What have we learnt so far?

- The success of LSE rests heavily on achieving high per-cow production from home-grown forage
- Good cow genetics, pasture quality, and pasture intake rates are critical for this
    - Hence, LSE requires a higher intensity of management information and decision-making than HSE – it is more challenging from a management perspective
- LSE and HSE have different footprints. With the advent of nutrient limits, we need to understand the **TOTAL** footprint of each system by accounting for all land used to support dairy production – since limits will apply to **all** land uses in catchments. This analysis is presented in Table 3, below.

Table 3. Average of first two years: ALL HECTARES COUNTED, 2011/2012 and 2012/13

All hectares counted (*Excluding replacements)	LSE		HSE	
	Kale	F Beet	Kale	F Beet
(Milking platform hectares)	(150)	(150)	(150)	(150)
Herd size (cows)	525	525	750	750
Total hectares[1]	216	216	287	296
Milksolids (kg/ha)	1245	1246	1201	1161
N surplus (kg/ha)[2]	103	94	208	201
N conversion efficiency (%)[3]	46	48	29	29
Nitrate leached (kg N/ha)[4]	33	24	49	38
Milk Production (kgMS/kgN leached)	38	52	24	31
Profit ($/kgN leached)	$102	$141	$54	$67

**All hectares counted for annual feed requirements of the milking herd (lactation and dry period). Area required for replacements is not included.*

[1] Based on 150 ha milking platform and scaling for wintering area (crop plus grass) + area used for growing imported feed (grain and silage)
[2] (total fertiliser N + N imported in purchased feed) – (N exported in milk) / total hectares
[3] (N exported in milk) / (total fertiliser N plus N imported in purchased feed) x 100
[4] Overseer for milking platform and arable area; lysimeter data for wintering area, scaled for % grazed area covered by urine patch

Summary points:

- Milksolids production per hectare is much lower when all hectares are counted compared to just milking platform hectares – and similar to other regions of New Zealand, eg Waikato
- Estimated nitrate-N leached per hectare is higher when all hectares are counted, because the winter support land makes a disproportionate contribution to total leaching (largely because it occurs on free-draining soils, and involves a high stocking density during the winter months leading to a heavy urinary N load being returned to the soil at the time of the year when drainage is occurring)
- Wintering systems differ in area of crop required per cow, area required to grow forage supplements for winter (pasture or green-chop silage), stocking density, urinary nitrate concentration, and overlap of urine patches – all of which affect the intensity of nitrate leaching
- Estimated nitrate leaching across all winter support land used is in the range 75-85 kg N/ha for kale and 55-60 kg N/ha for fodder beet
- Estimated nitrate leaching (all hectares counted) is lowest for the LSE-type system using fodder beet for wintering
- When all hectares are counted, an LSE-type system does not necessarily mean that milk volume is foregone – this depends on how land that is 'spared' is used
- 'LSE' system could allow industry to grow in catchments that are 'fully allocated' for nutrient load
- 'HSE' system can drive milk volume if land is available, catchments can absorb more nitrate-N, and communities judge the impacts to be acceptable

Pastoral 21 is a collaborative venture among DairyNZ, Fonterra, Dairy Companies Association of New Zealand, Beef + Lamb New Zealand and the Ministry of Science & Innovation. Its twin goals are: (1) a $110/ha/year increase in average profitability from dairy production, with a 30% reduction in nitrogen and phosphorous losses to water; (2) a 3% annual meat productivity increase, while containing or reducing environmental footprint. The collaborating research organisations in the various projects include AgResearch, DairyNZ, Massey University, Lincoln University/Telford Rural Polytechnic, NIWA, Plant & Food Research, Landcare Research and On-farm Research.

Pasture mixture, grazing residuals and supplements for dairy systems: recent insights from Lincoln University Research Dairy Farm

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Summary

- Diverse pastures containing herbs (chicory and plantain) and legumes (lucerne and red clover) in addition to perennial ryegrass and white clover have been compared with perennial ryegrass-clover pastures. DM production from diverse pastures was comparable to that from perennial ryegrass-white clover pastures under full irrigation; diverse pastures were less affected by temporary restrictions of water supply in summer. MS production was similar between diverse and perennial ryegrass-white clover pastures when offered at the same allowance; however, the N concentration in urine and estimated total N excretion were lower in diverse pastures offering potential benefits to mitigate nitrate leaching.
- Irirgated lucerne has been compared with a tetraploid perennial ryegrass-white clover pasture for DM production and MS production. Irrigated lucerne produced more DM (17.5 to 19 t DM/ha) than perennial ryegrass-white clover pastures (14.5-16.5 t DM/ha) grown with 200 kg N/ha. In experiments lasting 14-21 days, MS production from cows grazing lucerne was greater than cows grazing tetraploid perennial ryegrass-white clover mixtures in summer but similar in spring or early autumn.
- Alternative grazing residual strategies to increase DM production have been examined. Greater summer, autumn and annual DM production was found where pastures were grazed laxly (10 clicks RPM) in spring with some tillers allowed to proceed to the early flowerhead stage before switching to hard grazing (8 clicks) than those that were grazed hard (8 clicks) or laxly (10 clicks) all year.
- High and low grazing residual grazing systems with and without supplement (3.5 to 4 kg concentrate/cow/day) have been compared for MS production in a farmlet trial. MS production per ha from low and high residual systems without supplements was similar (1898 and 1860 kg MS/ha). MS production with supplement was 2414 and 2395 for low and high residual systems, respectively.

Purpose

The purpose of this session is to address recent research on Lincoln University Research Dairy Farm (LURDF) directed toward strategies to increase or maintain milksolids (MS) production under nutrient constraints, lower nitrogen (N) fertilizer use and water restrictions. Specifically, the session will address:

1. Use of pastures containing additional herbs (chicory and plantain) and legumes (lucerne, and red clover) under full irrigation and restricted irrigation to improve DM, milksolids and reduce N excretion of cows.
2. Potential role of lucerne as grazed forage in dairy systems.
3. Grazing management (residual) interactions with supplement use to increase DM production and MS production.

1. Pasture species

Background

The production focus of dairy farming has led to a limited range of plants being used; predominantly perennial ryegrass-white clover pastures with some brassicas and maize. There has been a relatively low use of pure swards or mixtures of alternative legumes such as red clover and lucerne, or forage herbs such as chicory and plantain. With concerns around the poor persistence of perennial ryegrass, and growing awareness of the role that plant species may play in reducing the environmental impacts of dairy farming, there has been increased interest in alternative plant species.

LURDF research

DM production and MS production have been measured over 2 years for perennial ryegrass-white clover and diverse pastures also containing additional red clover, chicory and plantain. All pasture mixtures were irrigated, fertilised with 200 kg N/ha/year and grazed by dairy cows under typical perennial ryegrass-white clover pasture grazing management[1]. The key points to emerge from this work, and outlined at the February 2013 focus day, were:

- Annual DM production was higher in diverse (16.8 t DM/ha) than perennial ryegrass-white clover pastures (15.2 t DM/ha), primarily reflecting 0.8 t DM/ha greater summer DM production.
- ME was similar across pasture mixtures (average = 11.7 MJ ME/kg DM).
- Diverse pastures retained a high proportion of herbs after two years, with chicory and plantain making up approximately 40% of the total herbage in summer in the second year.
- MS production was similar between diverse and perennial ryegrass-white clover pastures when averaged across experiments that ran for 14-21 day periods throughout the year (1.53 vs. 1.61 kg MS/cow/day)
- Urine N concentration and estimated total N excretion were lower in diverse than perennial ryegrass white clover pastures (3.4 g N/l vs 5.8 g N/l; 354 g N/cow/day vs 426 g N/cow/day)[2].

More specific work has measured water use and DM production of perennial ryegrass-white clover pastures and mixtures with additional herbs (chicory and plantain) or legumes (lucerne and red clover) (Table 1). The key points to emerge from this work were:

- Diverse pastures, particularly those containing lucerne and red clover extracted water from deeper (0 to 1.5 m) in the soil profile than perennial ryegrass-white clover pastures (0 to 0.85 m) and

- DM production was at least as high in the diverse as standard pastures under full irrigation, and grass-clover-lucerne-red clover mixtures were less affected by stopping irrigation for 2.5 months in mid-summer (-2.8 and -5.5 t DM/ha for grass-clover-lucerne, grass-clover respectively).

Table 1. *DM production, ME (MJ ME/kg DM), crude protein (%) of grass-legume-herb mixtures subject to full or partial irrigation (ceased for 2.5 months in mid summer). Pastures were grown with 160 kg N/ha/year. Data average of two years.*

Pasture	Annual DM yield (t DM/ha)		Summer-autumn DM yield (t DM/ha)		ME	Crude Protein
	Irrigated	Partial	Irrigated	Partial		
Grass-white clover	17.8	12.3	9.1	5.2	11.37	18.0
Grass-white clover –herbs	16.7	12.6	9.8	6.5	11.25	19.3
Grass-white clover-lucerne-red clover	18.2	15.4	10.2	8.4	11.11	21.4

Combined, these data highlight that the diverse pastures grew at least to comparable levels as standard perennial ryegrass-white clover pastures, and that they may offer benefits for DM production in dryland pastures or in irrigated situations where temporary water restrictions occur; further the diverse pastures may be a useful tool to reduce urine N excretion and N loading associated with urine patches.

2. Lucerne

Background

The value of lucerne as a forage for dryland or restricted irrigated systems is well documented. On dryland Wakanui silt loam soils at Lincoln, lucerne annual DM yield (14 t DM/ha) was at least 40% higher than ryegrass-white clover pastures (c. 8 t DM/ha)[3]. Previous research also confirms the high production potential of lucerne under irrigation. Under irrigated conditions on Wakanui silt loams at Lincoln, measured annual DM yields of lucerne ranged from 16–28 t DM/ha over a 6 year period[4]; these numbers compare very favourably with the 17 to 25 t DM/ha estimated from pasture coach to be grown under irrigation on LUDF in 2012/2013 with inputs 330 kg N/ha and two applications of gibberellic acid.

LURDF research

Current work on LURDF[5] is comparing irrigated lucerne for dairy production with a high quality tetraploid perennial ryegrass-white clover based pasture maintained under irrigation and fertilized with 200 kg N/ha. Data from initial year show:

- Higher annual DM production from irrigated lucerne (17.5 to 19 t DM/ha) than irrigated perennial ryegrass-white clover pastures (14.5-16.5 t DM/ha), although lower growth rate in lucerne in early spring (e.g. September: 25 kg DM/ha versus 40 kg DM/ha).
- Similar milksolids production to perennial ryegrass-white clover pastures when the cows were offered the same herbage allowance in spring and autumn; higher milksolids production in summer from lucerne (Table 2)
- Similar fat and protein % of milk (Table 2)
- No dip in milksolids production when transitioned from pure grass to pure lucerne over 3-4 day period.
- Increased concentration of N in urine; averaged across three periods, urinary N concentration was 4.9 g N/l in perennial ryegrass-white clover pastures and 3.6 g N/L in lucerne pastures.

Table 2. *MS production, % fat and % protein of milk, and urine N concentration of dairy cows grazing, a ryegrass-white clover pasture, pure lucerne and a sequence of lucerne in the morning and ryegrass in the afternoon (50% of each).*

	kg MS/cow/day	% Protein	% Fat	g N/L urine
September				
Ryegrass	2.23	3.8	4.9	3.8
Lucerne	2.20	3.6	5.1	4.8
Lucerne-Ryegrass	2.28	3.7	5.0	4.2
December				
Ryegrass	1.81	3.9	5.3	3.1
Lucerne	1.93	3.6	5.2	5.4
Lucerne-Ryegrass	1.96	3.8	5.7	5.0
February				
Ryegrass	1.68	3.8	5.3	3.8
Lucerne	1.61	3.7	5.3	4.7
Lucerne-Ryegrass	1.71	3.9	5.6	5.1

Combined, these data highlight that lucerne pastures grew more than perennial ryegrass, and that lucerne use should be considered across the range of dairy farms in Canterbury from dryland, partially irrigated to fully irrigated. The high N concentration of urine, combined with low winter growth, leads to concerns around lucerne pastures being prone to nitrate leaching. The limited information from cut and carry systems to date[6] reports nitrate leaching to be greater from lucerne (19 kg N/ha/year) than pasture (12 kg N/ha/year), with both having similar DM production.

3. Grazing residuals and supplements

Background

The case for low, consistent post-grazing residuals (7-8 clicks on RPM, 3.5 cm compressed pasture height) as a basis for ensuring high pasture quality (ME) and a high quantity of ME harvested per ha was championed by LUDF over the years until 2011. The last two seasons (2011/2012, 2012/2013) has seen higher, but consistent, residuals used (8-10 clicks). At the February 2012 focus day, it was outlined how slightly higher residuals may promote greater DM intake or reduce the energy costs associated with grazing, thereby contributing with a range of other factors (lower stocking rate, split herds, increased N fertilizer, mowing) to the higher MS production and profit observed on LUDF.

There are various schools of thought on the role of grazing management in spring in promoting DM production, pasture persistence and quality[7].

One line of thinking is that hard consistent grazing is needed to prevent the expression of flowering in the grass plant in spring, and so the decline in quality and DM production. This is based on the premise that vegetative tillers that become reproductive are more likely to die than those that remain vegetative, and if defoliation of the reproductive parent tiller is left too late (e.g. late flower stage), competition for nutrients from the developing seedhead has a negative effect on daughter tiller survival.

An alternative line of thinking[8] is that more lax grazing allows better provisioning of daughter tillers with the consequence of improved DM production. This is based on the premise that daughter tiller development is inhibited by severe or early defoliation, with daughter tiller development and summer growth enhanced by allowing the reproductive parent tiller to develop to the early flower stage before being removed by defoliation.

LURDF research

Two pieces of work at LURDF are addressing the implications of the higher residuals for pasture grown, pasture quality, milksolids production, and potential implications with supplement use.

In the first piece of work, DM production, botanical composition pasture quality is being measured from ryegrass-white clover and ryegrass-white clover-herb pastures that have been (i) hard grazed all year (8 clicks on RPM), (ii) laxly grazed all year (10 clicks on RPM), and (iii) laxly grazed in spring with tillers allow to move to anthesis (10 clicks) before hard grazing for rest of year (8 clicks on RPM). Data from ongoing work shows greater DM production from the lax to hard treatment than the lax and hard treatments in the first year, with little difference in ME and CP of samples collected to ground level. This confirms work in Manawata[9] where the lax to hard treatment (8-10 cm, then 3-5 cm) resulted in 22% more herbage DM production from January to April compared to hard grazing (3-5 cm) all the time.

Table 3. *Total accumulated DM yield (August 2011 to May 2012), and metabolisable energy (MJ ME/kg DM) and crude protein (CP) concentrations of pastures sampled to ground level in summer (January 2012) and autumn (April 2012) for grazing treatments applied to simple and diverse pastures.*

Pasture Mixture	*Grazing severity*	*DM yield spring-autumn*	*ME summer*	*ME autumn*	*CP% summer*	*CP% autumn*
Ryegrass, white clover						
	Hard	14.8	10.55	10.98	14.08	15.27
	Lax+Hard	18.6	10.58	11.05	13.00	15.17
	Lax	14.4	10.26	10.99	10.31	15.30
Ryegrass, white, chicory, plantain						
	Hard	17.6	10.52	10.89	15.21	14.94
	Lax+Hard	18.6	10.52	10.92	14.81	16.11
	Lax	15.5	10.30	10.99	12.95	15.68

In a second piece of work, a farm systems (farmlet) trial is being carried out[10] with four grazing and supplement treatments. Groups of cows are stocked throughout the year at low (7-8 clicks RPM) and high residuals (9-11 clicks RPM) with and without supplement (3.5 to 4 kg wheat based concentrate/cow/day for total lactation; ME 13.9 MJ ME/kg DM; 18% CP, 17% NDF). Cows are assigned to 17 to 19 paddocks and moved to next paddock when residual targets are met; standard decision rules around pasture conservation and drying off are applied. Pastures are fertilized with 320 kg N/ha as urea per year, with two applications of gibberellic acid. Results from the first year (Table 4) show:

- MS production per ha from low and high residual groups without supplements similar to LUDF in 2012-13 (LUDF - 1878 kg MS/ha achieved from 3.9 cows/ha producing 476 kg MS/cow with 350 kg N/ha)
- MS production per ha from low and high residual groups with supplements was similar to HSE farmlet in Pastoral 21 trial (2369 kg MS/ha from 5 cows/ha; 330 kg N/ha; 1093 kg supplement (grain + silage) per cow).
- Little difference in MS production per cow or per ha between low and high residual systems without supplement.
- Supplementation increased MS per cow and per ha by 90 and 554 kg MS respectively for high residual and 66 and 447 kg MS for low residual.
- Average MS response to the additional supplement and higher stocking rate was c. 104 g MS/ kg DM supplement across the entire season, with tentative evidence of greater response at high (115 g MS/kg DM) than low (93 g MS/kg DM) residual.

Table 4 Pasture characteristics and milksolids production from pastures grazed to low and high residual with and without supplement feeding.

Residual	Supp	cows/ha	Pre-grazing residual (RPM clicks)	Post grazing (RPM clicks)	kg MS/cow	kg MS/ha	MJ ME/ kg DM	%Crude protein
High	No	4.5	16.3	9.2	413	1860	11.7	22
High	Yes	4.8	16.6	9.2	503	2414	11.7	20
Low	No	4.5	15.5	7.1	422	1898	11.8	20
Low	Yes	4.8	15.4	7.3	488	2345	11.8	23

The use of higher residuals or changing from low to high residuals remains one of only a few examples of the application of ecophysiological information to the solution of practical problems of production and persistence in grazed pastures. Studies indicate greater DM production with a system of lax combined hard grazing, although any additional growth associated with lax grazing has not been captured at farm systems level in terms of additional milksolids production. The milk production trial was constructed with minimal pre-grazing mowing intervention; greater use at critical periods around early flowering stage may have prevented some of the declines in the production that were evident post flowering.

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