Crying over spilt milk…

The efficacy and cost of farm-level N loss mitigations applicable to the Lake Rotorua catchment

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Background

- Since 2010, Perrin Ag Consultants Ltd has been heavily involved with assessing the farm-level economic impact of meeting environmental limits in the wider Rotorua and Upper Waikato regions.
- To date we have published four publically available reports (the last to be released in March) on the topic and completed a significant amount of analysis work for regional government and famer groups alike.
- This includes all of the farm level modelling work used in the catchment scale analysis of allocation frameworks being prepared for the Sec 32 analysis for Lake Rotorua.

Methodology

- Across all of the work, methodology has been relatively consistent, with Farmax and Overseer software used to model baseline/current/status quo farm systems and then subsequent scenarios to test the efficacy and farm-gate profit impact on system change;
- “Cost” of mitigation has consistently been considered as the reduction in annual farm operating profit (as measured by EBIT) between any two status quo systems. The cost of transition has not been considered. This maintains the “annual average” concept embedded within Overseer.
- Focus has largely been on the impact of sequential/cumulative change in farm systems, rather than quantifying singular mitigation options.

Methodology

- All modelling directly or indirectly based on real farm case studies
- Terms of references dictated that all but one study assumed no increase in farm-level "productivity" derived from management skill. This has often been contentious, but we consider it to be a reasonable assumption:
  - ❖ prevents the effect of changes in farm system design being confounded with the effect of management ability;
  - ❖ use of case study farms typically sets the inherent boundaries of farm productivity for any given farm business;
  - ❖ potential extrapolation/application of results to catchment scale probably needs to capture an expected continued range in farmer capability;
  - ❖ the potential for most farm systems to lift productivity means "cost" estimates will tend to be conservative

What we found

- In general, reducing farm-gate N loss from farm systems tends to result in losses of farm profitability.
- Most pastoral farming systems analyzed have the capacity to achieve some reduction (in the order of 5%-10%) in N losses through system change for little or no loss in profitability.
- Greater reductions than this were generally assessed as resulting in significant reductions in status quo farm profitability.
- The overall “cost” of reducing N losses for individual farms depended greatly on underlying system productivity.
- Where productivity changes might be achieved, “cost” was able to be reduced.

What we found

- EBIT based cost excellent for comparing system/mitigation efficacy, not necessarily so for individual impact (given farmer preferences, extent of leverage, potential for equity losses);

and

- No matter what assumptions one makes, they will always be challenged as unreasonable.

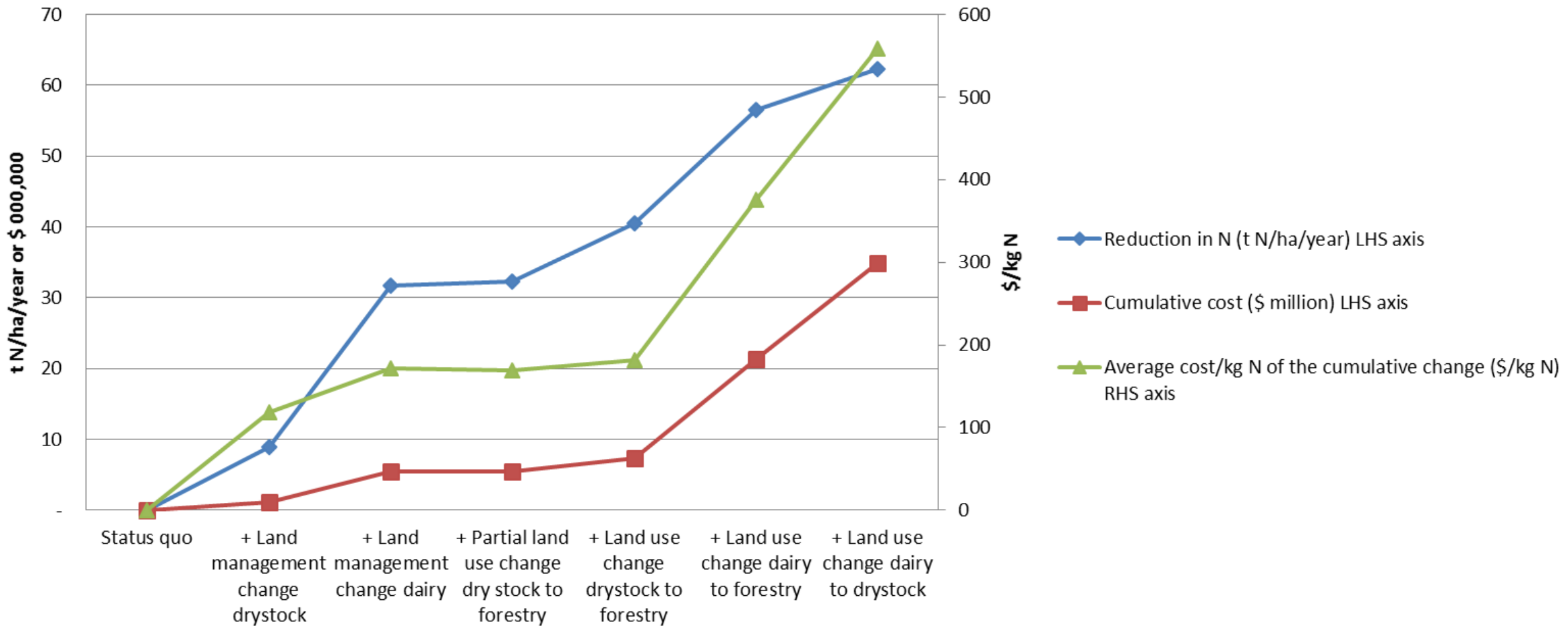
Some numbers and pictures….

- Numbers between studies often difficult to aggregate due to varied terms of references, modelling protocols engaged and assumptions of input/out put pricing
- Trends probably more important, but we have tried to satisfy an expected demand for relevant data/numbers from applicable bodies of work in the Rotorua and neighbouring catchments

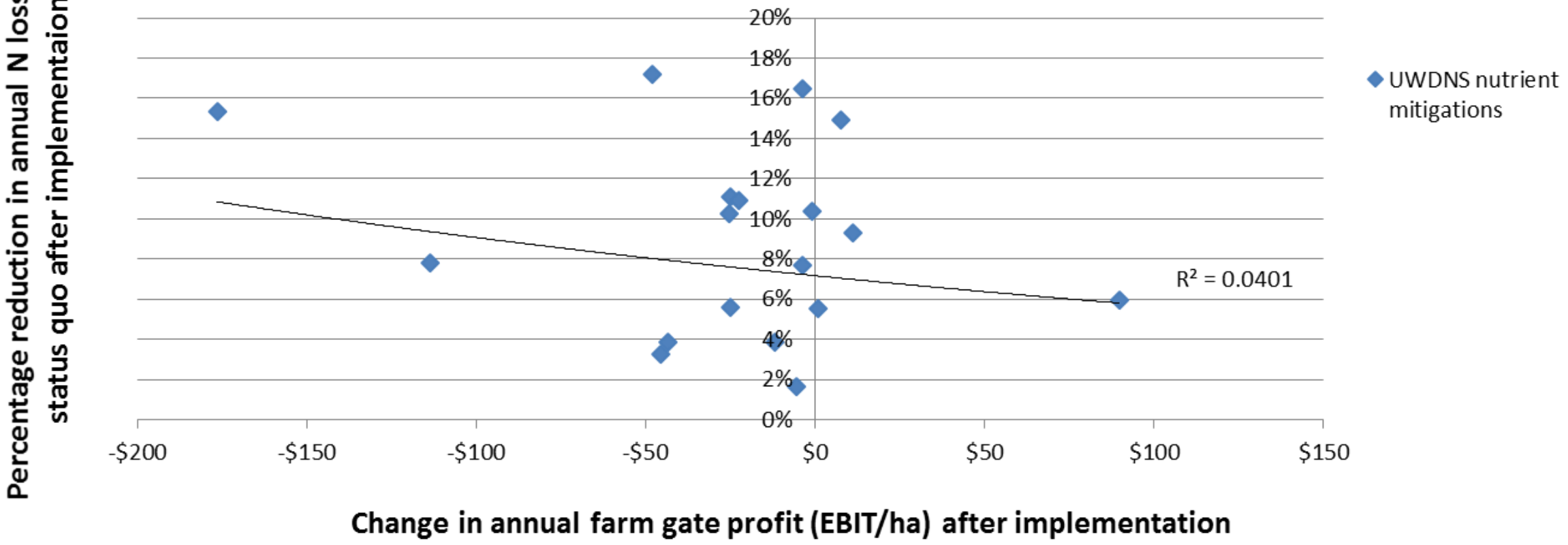
Mitigation	Average reduction in whole farm N losses	"Cost"	Comment	Reduction of comparable mitigation in the UWNES
Reduce milking cows, graze replacements on	-9%	N/A	This actually increased N losses. This would appear to be due to the reduced quantumn of N leaving the farm in product for no reduction in the number of female cattle liveweight wintered.	
Retirement of 5% of sheep & beef for forestry	4%	-$389	This is higher than the implied cost of total land use change. This probably reflects the relative weighting of the case studies within the "average" model. As it happens, this mitigation varied from extremely unprofitable to very profitable, depending on actual sytem and land retired.	3%
Swap PKE for Maize on feed pad	7%	-$454	Relatively low impact, despite the difference in protein levels between the feeds. High cost relative to the low impact.	3%
Use of wintering pad (uncovered) for half the herd	12%	-$405	The efficacy of seemed to vary depending on the underlying operating policies. More work on how to accurately model in Overseer needs to be done.	9%
Cease cropping (winter or maize)	24%	-$173	Note that impact of growing maize on effluent paddocks isn't captured using Overseer 5.4.11. This would need to be reassessed using Overseer 6.	n/a
Reduce to 100kg N/ha, replace feed with maize silage	26%	-$93	This mitigation actuallly led to an improvement in economic outcomes for one case study. Dependent on overall dairy system. Overall probably the best management mitigation, as the low N content of the maze leads to an overall improvement in system N efficiency.	n/a
Reduce N usage to 100kg N/ha (if currently above 150kg N/ha)	33%	-$292	The reduction in feed associated with this mitigation has been managed via reduction in stocking rate.	15%
Eliminate N Usage (10:1 response for last 100kg N)	42%	-$276	Complete cessation of fertiliser N may lead to sward compositional changes, with a lowering of overall pasture growth potential. On this basis the cost of N elimination is exacerbated (represented by a 15:1 assumed response rate). Reduction in growth managed by reduction in stocking rates.	n/a
Eliminate N Usage (15:1 response for last 100kg N)	43%	-$354		n/a
Dairy support to bull beef (cattle 70% SU)	49%	-$227	This is the shift from grazing heifer replacements to a conventional 15 month bull beef policy.	
Conversion from dairy to drystock	61%	-$966	This assumes a shift in land use from the average dairy scenario to the average sheep & beef scenario.	n/a
Complete land use change to forestry from drystock	81%	-$143	Use of NPV-based annuity of $315/ha for forestry implies that afforestation actually increase profitability. Gap between profit analysis & market price derived from land values	n/a
Complete land use change to forestry from dairy	93%	-$688	The "cost" not dissimilar to the market gap between dairy and forestry land values based on the average N loss figures used. The property market implies a value of $579/kg N	n/a

Cumulative economic impact, efficacy and reduction in annual N losses from the sequential adoption of willing farmer mitigations from the FSP sample group

(1,967ha dairy & 1,686 sheep & beef, Rotorua catchment)



Comparison of change in annual farm profit and extent of N loss reduction achieved across UWDNS case study farms



Mitigation	Average[1] reduction in N loss	Average impact on EBIT ($/kg N reduced)	*n*
Reduction in cash cropping	-4%	-$43.40	1
Elimination of N and/or targeted use of DCD	-6%	-$6.30	5
Afforestation (8% farm area)	-7%	-$1.40	2
Change to lower N livestock policies	-9%	-$3.50	6
Elimination of winter forage cropping for cows	-12%	-$58.60	2
Elimination of cash cropping	-15%	-$176.40	1
Wintering infrastructure	-17%	-$48.20	1

Dairy

1 Baseline

Contain production losses

2 Remove summer crop, replace with supplements

3 Reduce autumn N application (if any), replace with appropriate low(er) N feed

4 Cull early as feed demand allows (10% culls early Feb, 10% culls early March)

5 Replace high N feed (imported pasture, PKE) with low N feed (maize silage) as appropriate

Reduce supplement up to 20% reduction, targeting lower value feed and autumn feed first, reduce SR/production

6.1 20% autumn feed reduction

6.2 20% spring supplement reduction

6.3 Reduce spring fert to deliver annual N use to 100kg N/ha

6.4 Reduce winter supplement by 20%

7 Retire marginal land and decrease SR (assume 5% marginal)

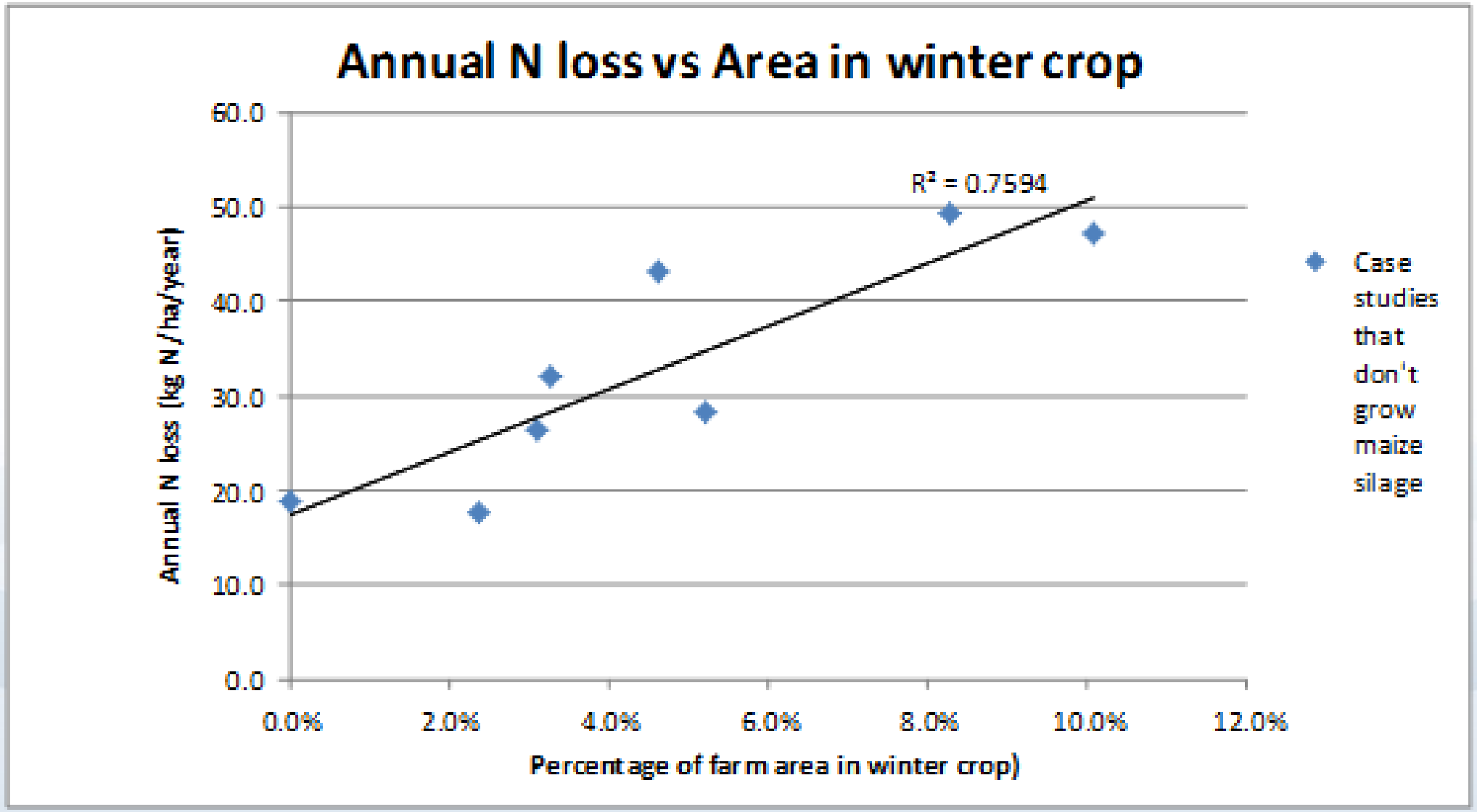
Drystock

1 Baseline

2 Reduce N that supports capital livestock (i.e. primarily maintenance feed demand)
3 Reduce winter cropping providing it doesn't affect dairy support enteprise (if any)
4 Lamb hoggets and decrease ewe numbers
5 Decrease dairy young stock (R1, R2), replace with bulls or steers as appropriate. For sole dairy support system, remove calf grazing (R1) only.
6 Remove wintering dairy cows. Increase other stock numbers
7 Graze any dry hoggets off
8 Increase sheep: cattle ratio - limit of 70% sheep

Recent dairy farm system modelling

Model	Baseline N loss	Reduction in N loss	% of baseline	Baseline EBIT ($/ha)	Reduction in EBIT ($/ha)	% baseline
Al1	77	-24	-31%	1366	-258	-19%
Po1Ha	86	-18	-21%	2602	22	1%
Po1Hb	76	-7	-9%	2011	-11	-1%
Po1L	62	-5	-8%	2011	-11	-1%
Pu1H	84	-11	-13%	932	-120	-13%
Pu1L	81	-17	-21%	1418	-175	-12%
Pu2	60	-13	-22%	661	-90	-14%
Re1	60	-16	-27%	1479	-295	-20%


Annual N loss vs Area in winter crop
60.0
50.0
40.0
30.0
20.0
10.0
0.0
R² = 0.7594
Annual N loss (kg N/ha/year)
0.0%
2.0%
4.0%
6.0%
8.0%
10.0%
12.0%
Percentage of farm area in winter crop)
Case studies that don't grow maize silage

Profit “neutral” dairy farm mitigations

- Elimination of losses associated with summer cropping;
- Replacement of high protein N-boosted pasture DM (and associated direct losses from N application) with low[er] N supplement;
- Improvement in productivity from culling early (same total production from less maintenance feed/N loss)
- Utilising maize silage (where it was deemed appropriate) in place of PKE/grass silage – at a per ha level, this actually had limited impact in Overseer. Using maize to replace N-boosted pasture seems to have the most efficacy in the modelling.

Other comments

- Dairy farm system profit losses minimised where productivity gains are achieved, combined with replacing high N feed sources (i.e. N boosted pasture, grass silage) with low protein alternatives and removing “leaky” management practices (like cropping).
- Wintering of dairy cows linked to higher N losses, and as a sole policy there is significant profit implications in a N capped environment.
- Keys to sheep & cattle systems being profitable at low levels of N loss hinge on combination of high productivity, limiting use of N fertiliser and accessing higher value land uses/markets.