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"Win/Win. Improving farm profit and the environment through the application of Farm Management principles."

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“Win/Win. Improving farm profit and the environment through the application of Farm Management principles.”

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Farmers expect to make profits but the community demands “swimmable” rivers.

Measuring farm performance is now more precise, but data averaging and the resultant use of ratios, benchmarks and KPI’s to create “Farm Standards” has become widespread despite this methodology having previously been shown to be incorrect.

Marginal analysis using a linear programming model demonstrates the physical and financial impact of changing a farm’s leaching of soil nitrogen (N) into ground water.

Increased profit and reduced N leach will be achieved on many farms if more efficient resource allocation is achieved. It also makes the concept of “Grand parenting” appear misguided.

Introduction:

Farmers expect to make profits to ensure farm business survival but increasingly the community expects environmental standards to be enforced that will ensure “Swimmable” rivers.

As the measurement of farm and environmental performance has expanded, the manner in which such data are now used is failing to accurately predict future responses to resource use.

The quantity of data has increased but not the quality of analysis.

Specific software will now perform many different computations of data without the operator requiring to understand the underlying principles involved. This easy manipulation has resulted in the revival of farm standards (comparison between farms using averaged ratios such as milk solids/cow or /hectare; feed used /cow; pasture grown and/or utilised / hectare) as a means to compare *between* farms despite the methodology having previously been shown to be incorrect for this purpose. Such data will however be useful for analysis *within* an individual farm system.

This reversion to farm standards has in turn been used to incorrectly justify an overuse of resources to the detriment of farm profits and increased nitrate leaching levels. The application of Farm Management analysis which includes marginal analysis, can better define the physical and financial limits when investigating intensification of dairy farming systems.

When integrated into a linear programming model, this approach demonstrates how increased profit and reduced N leach can be achieved on many farms from more efficient resource allocation. It also provides a better understanding of farm systems than the confused farm standards approach currently being used throughout the industry:

"In general, farm-to-farm variations in operating profit per hectare are not usually well linked to farm-to-farm variations in milk production per hectare." (Page *36 DairyNZ Economic Survey 2012-13)*

This is an example of the uncertainty generated when the principles of Farm Management (a discipline that encompasses agricultural economics, agricultural science, risk, the farm and the farm people; Hardaker, 2011), are either overlooked or ignored. There can be no "well linked" association when data from individual farms with quite different combinations of resources and management objectives are combined. Compounding the problem are the associations made between such data using averages, ratios and benchmarks when none actually exist.

With the advent of more extensive data capture and the ability to "analyse" such data rapidly and without much thought required, a range of such "comparative" measures, ratios and benchmarks have been produced and used to promote expansion of the dairy industry.

Calculations using such averaged data and ratios suffer from the disadvantage of no longer retaining the detail required to identify the point at which diminishing returns result in the marginal cost (MC) of the additional production being greater than the marginal return (MR) from the additional production (MC>MR). This has resulted in excessive resources being used to the detriment of both farm profits and the environment.

An indicator that such comparative techniques are of dubious value is the fact that in one large study, not only were technical performance indicators found to be poor indicators of operating profit but also that few farms in the study were found to be in the "top 25%" of farms in successive years. (Ho, 2012). There appears to be no recognition that the methodology being used is preventing better understanding of the important association between feed consumed, increasing production per cow and profit, the impact of these factors on environmental nutrients, the possible improvements to quality of farms and the land being compared, differences in feeding regimes and profit and the varying objectives of the managers.
Put simply, farms cannot be lumped together and compared in the manner that currently passes as "analysis".

Candler (Candler 1962) makes this statement:
"In large measure, record collection implies a total disregard for the research worker's technical knowledge of agriculture. It is assumed that records from, say, sixty farms in an area can indicate the key to successful farming in the region, but no knowledge of agriculture is required to collect the data, analyse it, and interpret it. The apparent simplicity of this procedure, which can be followed without any *a priori* hypothesis as to the key to successful farming, should make one suspicious."

Such data ignore the reality of diminishing returns and the marginality of agricultural production systems.

A relevant example is that of nitrogen application where an "average" response of 10 kg DM/kg nitrogen applied is typically used. Few (if any) farmers actually measure response rates to nitrogen, none measure responses at varying application rates, yet this is critical to knowing how economic such applications are. The cost of the nitrogen and use of the extra feed grown to produce a financial return provide figures for the return from this feed. **Appendix 1** is an example of this association.

Although the data shows that (for this example) nitrogen application should cease at about 40 kg nitrogen, many productionists argue that the total $returns (TR) are still more than the total $costs (TC) even up to 100 kg nitrogen per hectare. This ignores the concept of marginal analysis.

Table 1 illustrates a 240 ha. dairy farm milking 600 cows with an "average" per cow production of 350 kgMS/cow and could be described as feeding an average of 867 kg DM of bought in feed per cow and producing a $592,200 "profit" (in this case cash income *less* cash expenditure as the farm system has similar additional inputs and capital expenditure throughout all iterations).

However in a Farm Management marginal analysis sense the same farm would be regarded as a combination of profitably milking 494 cows predominantly on pasture, producing a profit of $627,875; and an additional "marginal herd" of (600-494) 106 cows being fed solely bought in feeds. This 106 cow marginal herd reduces the profit from the 494 cow herd by $35,675 due to the costs of the extra feed and the per cow costs associated with the extra 106 cows (animal health, breeding, labour, grazing, some direct farm expenses. See Appendix 2 for explanation.) Further, this 106 cow herd incurs a 6% drop in profit and a 20% increase in N leaching.

If the per cow production is also then improved to 384 kg MS /cow model by altering replacement rate (25% to 18% and improved young stock feeding to increase heifers and 3 year old MS production) and resource allocation optimised, Run 3 and 4 provide about +$124,000 (+21% profit) and a drop of 2 kg N leached /ha/year (11% reduction) compared to the Base Farm (Table 1.)

Table 1. 240 ha Dairy Farm. Imports 20% of feed and would be designated a System 3 DairyNZ farm.

	Base Farm	Run 2	Run 3	Run 4	Run 5	Run 6
	600 cows 350MS/cow	Optcows 350MS/cow	Optcows 384MS/cow	Optcows 384MS/cow	Optcows 384MS/cow	Optcows 384MS/cow
Nx Kg (1)	Base 84,590kgNx	71,955kgNx	76,710kgNx	90%Base Nx level	80%Base Nx level	70%Base Nx level
Herd No.	600 cows	494 cows	505 cows	496 cows	446 cows	395 cows
Milk solids	210,350 kg	172,900	193,920 kg	190,460 kg	171,264 kg	151,680 kg
$Profit	**$592,200**	**$627,875**	**$717,420**	**$715,820**	**$701,890**	**$603,620**
kgDM bought in feeds	520,000 Kg	18,400 kg	109,000 kg	86,500 kg	0	0
Farm suppl madekgDM	0	14,000 kg	7,500 kg	0	7,000 kg	23,000 kg
Total Farm Kg DM used	2,515,800 kg DM	2,046920 Kg DM	2,751,000 Kg DM	2,200,800 Kg DM	1,922,900 Kg DM	1,697,950 Kg DM
R 1yr graze off	All. 158 Nov-July	All. 130 Nov-July	All. 106 Nov-July	All. 104 Nov-July	All. 94 Nov-July	All. 83 Nov-July
R 2yr graze off	All. 153 July-July	All. 126 July-July	All. 103 July-July	All. 101 July-July	All. 90 July-July	All. 80 July-July
Cows graze off	All. 8 weeks	All. 8 weeks	All. 8 weeks.	All. 8 weeks	All. 8 weeks.	All. 8 weeks.
N leached /ha/year	**18**	**15**	**16**	**16**	**13**	**11**

Note (1) Nx is an output function of the model and can be limited to reduce final N leach figures.

The Base Farm can then be viewed as a combination of an Optimal Herd and a Marginal Herd:

Base Farm (Run 1)

600 cows. 350 kg MS /cow 210,350 kg MS
Buy and Feed 520,000 kg DM; 867 kg DM /cow
Profit $592,200
N leach 18 kg N/ha/year.

From Marginal Analysis the 600 cow herd is made up of two herds.

Optimal Base Herd	**PLUS Additional or Marginal Herd**
494 cows producing 172,900 kg MS	106 cows producing 37,450 kgMS
Buy and Feed 18,400 kg DM 37 kg DM /cow fed	Buy and Feed 501,600 kg DM 4740 kg DM /cow fed
Profit +$627,875	**Loss -$35,675**
N leach **15kg** N/ha/year	N leach **+3kg** N/ha/year

From LP optimisation and production per cow at 384 MS/cow (Run 5)

446 cows 171,264 kg MS
Profit $701,890
N leach 13 kg N/ha/year
Compared to Base Farm: Profit +$109,690 or **18.5% profit increase**
13kgN vs 18 kgN or **28% N leach reduction**

The clarity of this example is due to a number of factors.

1) The use of a resource allocation model (GSL model) which through a number of associated production data inputs allows a series of simple production functions to be formed.
2) These are “tagged” with information specific to each function and a database system enables each of these to be assembled in a manner which can allow optimisation or varying levels of constraints to be applied.
3) These are then “entered” into a linear programming (LP) routine which undertakes as many iterations as required to reach an objective function, normally maximising the financial return.
4) The process of data iteration allows marginal analysis of additional inputs, both for timing and quantity and ensures a proper continuing financial analysis is undertaken. Effectively this means that all inputs are scrutinised and adjusted in a continuous process until the best combinations are found.
5) The LP routine allows the *substitution* of resources whereas input output models define resource selection and the rate of such input or output, LP enables marginal analysis and

substitution to select *different ways of allocating resources* which also incorporates the best timing, amount and mix of available resources to achieve the best economic output.

6) Due to the LP, although quality of input data is important, any discrepancies that may occur are revealed as each Run is completed. As the input and output data and associations are linked mathematically, the output can provide guidance on data required and options for farm system improvement.
7) The model solves quickly, allows multiple runs to be compared, adjustments to be made, and further comparative runs to be completed. This provides the unique benefit of creating an understanding of the integration of resources, the ability to identify constraints within the system and to ascertain the value of overcoming those constraints.
8) Such a model ensures that inputs (unless constrained) will be used only up to the point where MC=MR and that resources must fit into the resource allocation system in a balanced way. (This is a function that averaging precludes.)
9) The GSL model allows specific resources to be constrained and others to be optimised. This ensures a consistent base for comparative purposes between differing input quantities and/or costs and output prices.
10) This system enables rapid and very precise comparisons between varying combinations of resources and provides extensive data that can be used to better formulate and understand alternative production system options.

The results can be used as a precise implementation plan for specific farms or for more research orientated purposes.

By contrast, farm data is typically less well resolved due to the physical and financial outcomes being disconnected through time and accountancy requirements. Throughout a season there is the need to just “do something” as the need arises. If a farm is “overstocked” in that animal demands are continually greater than the feed available, the simple relationship between feeding level, production per animal, profit and buying in deficit feeds is confounded. Any link between bought in feeds (due to not enough pasture), stock number and demand, cost, return and ‘best” production level is blurred between immediate physical factors and delayed financial impacts.

If an individual farm runs at a good profit each year, specific analysis to improve the system by reducing animal numbers is unlikely to be considered and even less likely to be implemented. Instead farmers are encouraged to intensify and feed more bought in feeds to reach the potential production that their stock are capable of. In this way the line between biological and economic efficiencies becomes more blurred and with it, the most logical options to reduce Nitrogen leaching.

A number of major considerations are being ignored in the current averaged evaluation process:

1) Establishing a correct comparative base.
2) The importance of applying efficient resource allocation.
3) Attributing benefits correctly.
4) **Recognising the marginal value of any change**.
5) The level of technical efficiency required for the overall system changes.
6) The economic efficiency that can be determined from assessing points 1-5 on any farm.

The decisions and marginal responses that occur within one system are highly unlikely to be the same as those that will occur within another. These include those data that may help define the technical efficiency of a farm. Merging or ignoring data from farms, such as averaging input costs, feed grown to eaten, feed eaten and animal performance, replacement rates, loss rates and longevity of the herd all contribute to a reduction in the fidelity of such data.

The apparent simplicity of averages and ratios provides a formidable barrier to more objective analysis. For example many in the dairy industry will argue that bought in feeds are profitable at up to 5% of the price of milk solids (5% of $7 in this case = 35 cents.). Appendix 2 shows that this simplistic ratio is quite wrong and the cost of feed by the time it is consumed by the cow will be at least 46 cents/kg DM for most feeds and therefore unaffordable when fed to the additional cows supported by this feed.

Some may then argue that such bought in feed will produce additional production (increase production per cow) and this will be at a profit, yet others using merged data from many farms state that increasing milk solids per cow does not correlate with higher profits (Dewes 2014).

This confusion exists due to an attempt to combine multiple farm's individual data which occurred only because of the farm's specific resources and managerial competency and consider the outcome factual.

The model exactly equates the animal production with pasture growth profile, identifies where a feed deficit of short duration will occur and buys in supplements to *supplement* that shortfall. Any additional feed use will be used to feed an additional cow with all the added fixed and variable costs associated with this marginal cow (or in the example farm case, 106 cows).

It is better to improve production per cow by reducing herd number (to a practical management level) than by purchasing any more feed than that required to fill true deficit periods (Anderson 2010; Ridler 2010) Of interest is that any decrease in profit from slight understocking has far less economic implications than the decrease in profit and increase in N leach when overstocking occurs.

The "breakeven" figure for bought in feeds will vary with a number of factors including production per cow (Appendix 2a.), normal pasture production profiles and other individual farm factors. This illustrates the importance of incorporating financial assumptions into each calculation to ensure any analysis responds to changes in relative costs of the feeds used and/or the prices of the system products.

Merging data from numerous farms cannot retain the level of detail required for such analysis. Additional feed inputs cannot be decided on the marginal return from the next input, nor can feeds or animals substituted in or out of the system on such margins. Instead, averages apply the same response to each additional input rather than a diminishing return for each added input. But this overuse of resources and reductions in profit are fudged due to time, accountancy and averaging of farm records.

Important also will be the willingness of the manager to believe that a change back to predominantly pasture feeding with reduced herd numbers is actually possible, despite the number of farmers who are already achieving this (Dewes 2014).

So why is the productionist's drive so strong in the Dairy Industry?

It may be due to the share milking legacy upon which many of todays "successful" farmers began their careers (higher cow numbers meant higher borrowing could be achieved to make the step up from share milking to farm ownership) combined with the incentive of tax free capital gains, again invariably measured by the number of cows per hectare and milk solids produced per hectare.

Farm sales and bank loans were (are) made on the basis of ratios such as kg MS/ha (per hectare, per cow or even per $debt/kgMS) or combinations of these calculated into even more meaningless ratios. So the whole industry is now structured around the concept of Farm Standards, ridiculous as these seem when it is obvious that profit must be the objective for financially challenged farmers.

Candler in 1962 also noted the flaws inherent in such a methodology:
"Secondly, there are an infinite number of ratios that can be calculated and there is no *a priori* way of telling which ratios are important and which unimportant. Most farm standards are of the output per unit of input type. **Certainly, there are many situations as with butterfat per cow and butterfat per acre where an improvement (or increase) in one ratio may involve a decline in the other."**

After this clear denunciation of the flawed "comparative analysis" in the 1960's it was thought that the matter would be closed and that farm management analysis would expand as technical abilities and computers allowed more in-depth farm specific analyses, which in turn would lead to greater understanding of farm systems.

Instead the use of "farm standards" has replaced the application of production economics and proper comparative analysis in every aspect of farming. Indeed the movement away from Farm Management as a discipline is now almost complete with few courses providing any real insight or understanding of the diminishing returns inherent in biological systems, the concept of marginal analysis and the importance of substitution within any comparative analysis. Ignored also is the importance of production economics as an overall decision implementation factor (Hardaker, 2011).

The more recent expansion of the dairy industry based on this poor methodology has been of dubious benefit to many farmers in terms of profit (2012-2013 DairyNZ Economic Survey shows milk solids have increased by 42% but liabilities have increased by 300% between 2003 and 2010) and has caused a major increase in nutrient levels, especially in areas where irrigation and intensified dairying have coincided (Refer Canterbury report).

There are now many commentators opining on how to best curb the increasing nutrient discharges with "mitigation" strategies such as large feed pads, housing cows indoors, changing feed mixes, reductions in nitrogen use and increased riparian plantings.

The answer however is far simpler than all, or any one of these. Just apply correct Farm Management principles and with these will come more sustainable stock numbers (and feed inputs), increases in farm profit, decreases in risk and decreased nutrient leaching. (Although riparian strips have other advantages than just curbing some nutrient run-off.)

What is also clear is that the marginal costs of such reductions in N leach will vary with each farm.

Marginal Cost of Nitrogen Reduction.

Table 1 puts this "mitigation" problem into perspective with Runs 3, 4, 5 and 6 using the GSL model to limit output of nitrates ("Nx") that is the equivalent of N leach per hectare.

This Table shows that by a combination of reducing herd number and bought in feeds (Run 1 and Run 2) then by improving per cow production from 350 to 384 kg MS/cow (Run 3) and applying a progressive N leach limit whilst optimising for profit (Runs 4, 5 and 6) N leaching can be reduced on this farm by 39% (N leach reduced from 18 to 11 kg N/ha/year) with no decrease in profit from the Base Farm (Run 1).

Similar work has been reported (Riden 2007; Ridler 2010) and evidence that this approach works comes from both a three year study on 25 upper Waikato Farms (Dewes 2014) and from Lincoln

University Dairy Farm (LUDF) where the GSL model was initially used (2010) to model the potential for improvement in overall profits but limit N leach to the current levels (Pellow 2013).

All New Zealand farms are able to make reductions of between 5-50% in nitrogen leaching yet maintain the same profit. No other costly mitigations are required. The ability of the LP model to reduce N leaching by limiting output allows a “mitigation” curve to be plotted for each farm. This then provides a clear indicator of the marginal cost for each reduction in N leach for that farm.

These data are presented in graphical form in Appendix 3 with explanation. What is clear from this is that farms with high inputs of supplement can readily reduce N leaching without penalty. But efficient farms cannot and will suffer increasingly large reductions in profit for each additional N leach unit reduction.

The policy of grand parenting to reduce N leach on each farm by a ***prescribed % reduction*** is misguided as there are few economic options for reducing N leach available for well run, pasture fed herds whereas improvement can be economically achieved from farms with higher levels of bought in feed .

This fixed % decrease per farm reduction in N leaching over catchment areas is another example of averages being used without understanding the implications or alternate possibilities. This anomaly was pointed out in a previous paper when Green House Gas was the target of choice. (Anderson 2010).

Summary:

Confused signals have been provided for farming that have resulted in poorer returns and higher nutrient discharges. Much of this is due to the misplaced belief in farm standards and ignorance of farm management principles. Change away from the productionist mantra of “more production equals more profit” is beginning to gain momentum but lacks quantitative rigour.

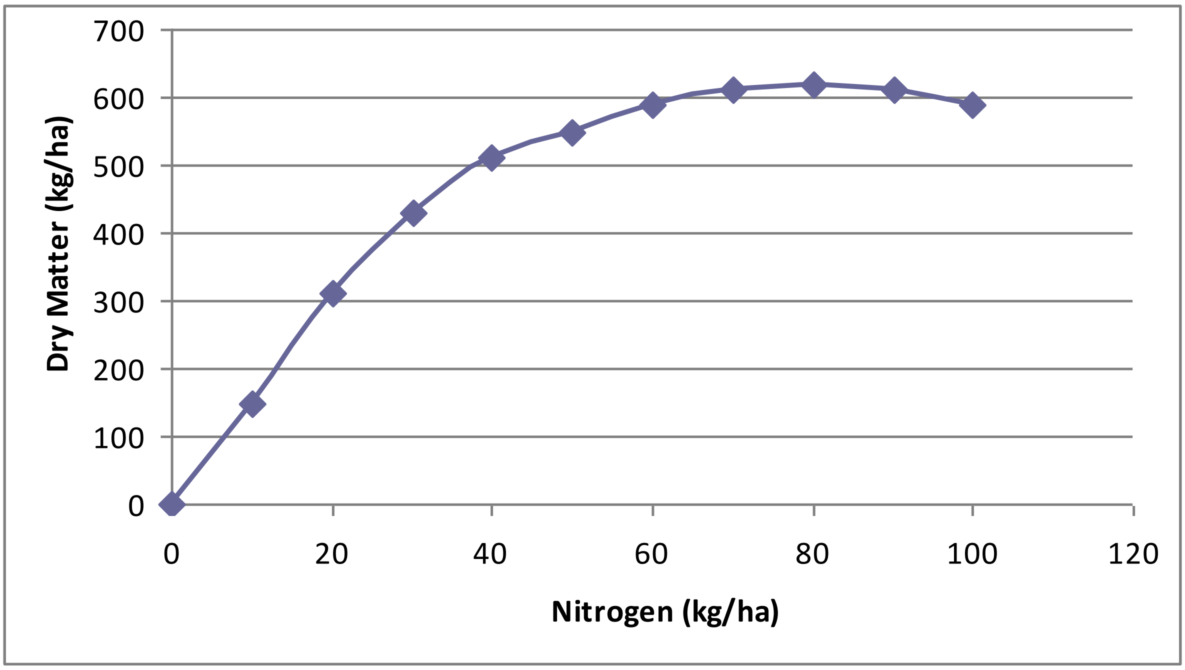
Modelling using resource allocation optimisation provides a clear implementation pathway for every individual farm to improve both profit and N leaching in a precise and economical manner. This methodology uses the detail of individual farm data and marginal analysis using LP; not averaging data and relying on perception.

In order to identify the “tipping point” where the next input returns no added value requires such marginal analysis. By definition, averages such as farm standards have no usefulness in determining the point of optimal resource allocation as they are not capable of substitution, nor indeed the efficient allocation of resources in any system. Averaged financial data provides no opportunity to differentiate between the marginal costs and returns within a system and assumes equal return for each additional input.

Such assumptions form the basis of poor policy whether in terms of deciding farm production systems or deciding on the manner in which N leaching will be reduced.

Both need to review the methodology being used and move forward using the principles of production economics and farm management that have been proven, but are now largely ignored.

Appendix 1. Response to Nitrogen applications. “Diminishing Returns Curve.”



Data for Diminishing Returns Graph (based on Ball 1980)

Units N applied	Total DM grown	Average Product AP/10kgN	**Total Cost $TC**	**Total Revenue $TR**	Av Revenue **TR/TC**	AddedDM /Added Unit N kg	Return/ Unit N $MR	Cost/ **Addtn Unit N**
0	0	0	0	0	0	0	0	0
10	150	150	16	40	2.5	15	4	1.60
20	310	155	32	82.7	2.6	16	4.27	1.60
30	430	143.3	48	114.7	2.39	12	3.2	1.60
40	510	127.5	64	136	2.13	8	***2.13***	***1.60***
50	550	110	80	146.7	1.83	4	***1.07***	***1.60***
60	590	98.3	96	157.3	**1.64**	4	1.07	**1.60**
70	610	87.1	112	162.7	1.45	2	0.53	1.60
80	620	77.5	128	165.3	1.29	1	0.27	1.60
90	610	67.8	**144**	**162.7**	1.13	-1	-0.27	1.60
100	590	59.0	**160**	**157.3**	.98	-2	-0.53	1.60

From the above Graph and associated Table: Productionists apply N to about 92 kg N/ha as Total Revenue-Total Cost is still positive.

Averaged figures allow application of N until about 63kg N/ha as Average Revenue is about same as added unit cost.

But application should cease at about 45 kg N/ha where **$1.64 additional revenue vs. $1.60 additional cost is still positive** or up to the point where Marginal Cost = Marginal Return (MC=MR).

To calculate this correctly requires marginal analysis which is difficult when averaged figures are used in an input/output format.

The same applies for bought in feeds (see below: Appendix 2 and 2a)

Appendix 2: Cost of bought in feeds.

Bought in feed combination costs $300 / tonne landed on farm at 90% DM. This is 33 cents per kg DM. Also the mega joules per kilogram of dry matter (MJME/kgDM) will vary in each feed as will the crude protein and other factors.

Feed out costs of this will vary depending on quantities and facilities. Assumed a "budget" tractor and feed out wagon on farm with dry area to feed when necessary. Costs for this will be from 4 cents upwards (machinery, labour time.) If higher amounts fed as per Run 1 where higher capacity machinery and a feed pad system plus in shed feeding will be required cost will be 7-10 cents per kgDM fed.

33 cents PLUS feed out costs = 37 cents /kgDM

Utilisation: If a reasonable dry paddock or area this will be about 85% utilisation so the costs will now be (37 cents x .85 utilised =) **44.5 cents** per kgDM utilised.

Feed pad etc. improves utilisation but the cost of the facilities have increased the feed out costs. Calculations can vary but now 33 cents + feed out costs of 8 cents x 95% utilisation = 43 **cents.**

Each step increases the real input cost compared to the original figure for the bought in feed.

Extra 106 cows are marginal cows and other fixed costs to run these cows must also be added to this sum. These include added labour (additional 106 cows will require ½ FTE) animal health and breeding expenses plus some additional per cow for added farm maintenance. DairyNZ Economic Survey 2012-2013 page 44 Table 5.8 per cow costs for these additional cows will total about **$400 per cow**. (This figure excludes the cost of additional capital required for the cow and part replacement, increased milk solids shares, plus any additional machinery and infrastructure.)

Appendix 2a: Varying costs per cow depending on per cow production.

Depending on the production per cow, the intake of feed at "normal" dairy farm pasture qualities (varying from 11.5-12.0 MJME/kgDM in a seasonal pattern) will be:

5480 kg DM for 330 kgMs cows with 25% replacement rates and about 5 years in the herd. (If there is a desire to make a ratio of this, this becomes about 16.6 kgDM/kgMS).

5725 kgDM for a 400 kgMS cow with 25% replacement rates and about 5 years in the herd. (If there is a desire to make a ratio of this, this becomes about 14.3 kgDM/kgMS).

6020 kgDM for a 450 kgMS cow with 25% replacement rates and about 5 years in the herd. (If there is a desire to make a ratio of this, this becomes about 13.4 kgDM/kgMS).

From this a more accurate figure for Marginal cost for these cows can be calculated.

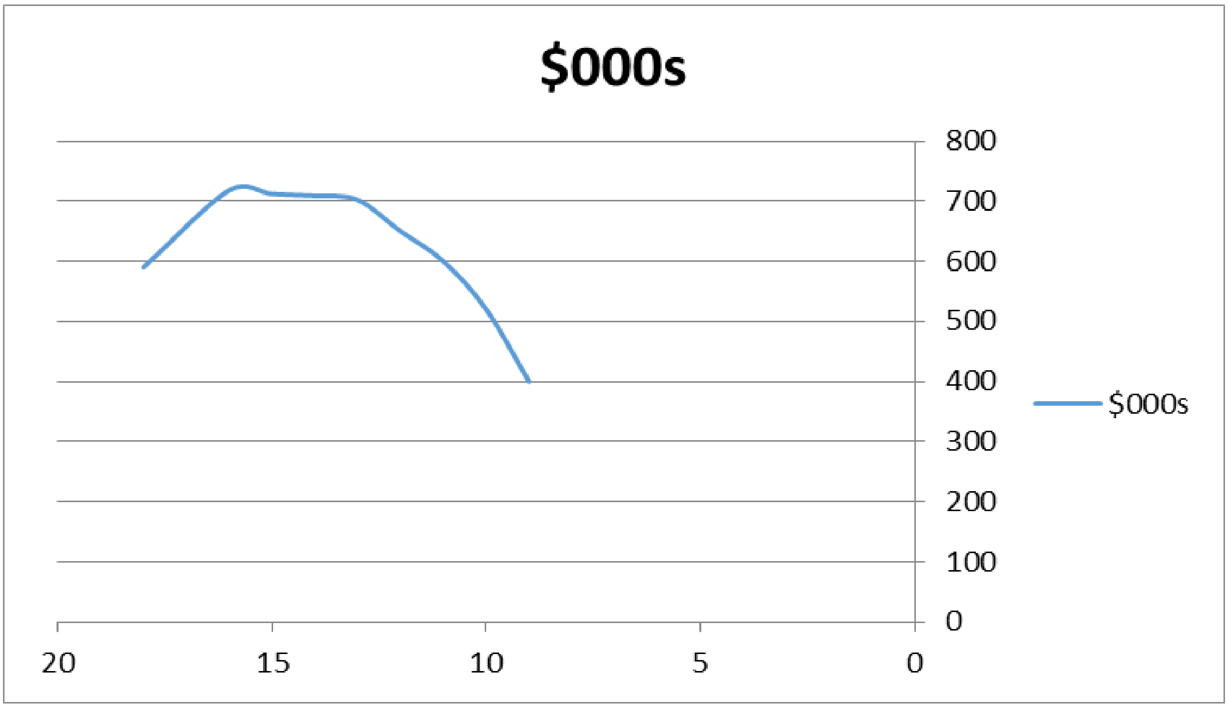
As the MJME of the cheaper bought in feeds is about 10.5-11.0 MJME/kgDM, the 43 cents must be equalised and this will make the cost of bought in feeds now about 46-48 cents per kgDM equivalent actually consumed by the cow.

Which makes cost of added feed per cow about (5600 x .47 =) $2600 per cow and the additional running costs per cow add $400 to total about **-$3,000 per additional cow.**

The additional MS in this case will be about 380 kgMS at $7 or about **+$2,670 per additional cow**. This leaves a deficit of about $330 per additional cow.

However once again, the GSL model shows it is not as simplistic as this with the MC/MR varying with each additional cow depending on how the additional cow unit fits the overall system. In reality, adding cows up to, then past the "optimal stocking rate" where pasture plus true supplement (to fill a genuine pasture feed gap) balances shows that the diminishing marginal value of adding cows is less BEFORE the optimal point than the marginal cost increases which increase at an increasing rate AFTER the optimal point is exceeded.

Appendix 3. **Marginal Cost of reducing Nitrogen leaching**.



The System 3 dairy farm produces at an N leach of 18 and profit of about $600,000.
Becoming more efficient in terms of economic resource allocation will also improve profit for such System 3 farmers and reduce their N leach to that of a more optimal farmer at about 14.
But from there on, the diminishing returns curve dips down at an increasing rate, meaning that any reduction in N leach for the efficient farmers will immediately reduce profits.
"Grand parenting" therefore results in the most efficient farmers (e.g. LUDF) immediately losing profit whereas the least efficient farmers may reduce N leach by up to 50% and be no worse off.

This policy unfairly targets efficient farmers but inadvertently benefits inefficient farmers.
("Inefficient" refers here to integrated economics and N leach. The higher input farms may however claim to be more *biologically efficient* if the high inputs result in higher production per cow.)

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(Extract from Executive Summary: (2007).

“The perceived relation between production and profit, which had some basis through the 20th Century, no longer holds for NZ dairy production.

In part, simple overproduction (allocative inefficiency) means that lower levels of production would provide dairy farms higher levels of income. Nationally, gains of $252 million in operating surplus would have accrued from dairy farms producing where MC=MR in 2006 – an average of 23 cents per Kg MS or 24% on a per farm basis.

These numbers are based on regional average farms. Averages tell us little about the distribution of performance within the sample. The numbers though are consistent with anecdotal evidence and commercial experience. They have a possible bias to understatement.”)

Ridler,BJ.; Anderson WJ.; Fraser P.; Milk, money, muck and metrics: inefficient resource allocation by New Zealand dairy farmers. NZARES 2010

Ridler, B., Anderson W., Importance of detailing all Influencers on per Cow Production. 2014 (in press) Proceedings of the 6th Australasian Dairy Science Symposium 2014.