agKnowledge
TNM™ "Total Nutrient Management"
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EFFICIENT FERTILISER USE

How much are you spending on fertiliser per unit of production? Do you know? I suggest you should, because it is an important measure of fertiliser use efficiency.

The long-term statistics from the pastoral sector show many trends indicating increasing productivity. For instance, consider the trends in the number of cows milked, or stock units carried, per labour unit. Without these efficiency gains many farmers would not be able to hold their heads above the financial water line.

The dairy industry has explicitly embodied this need for greater efficiency by setting a goal of 4% increase in productivity per year. Productivity in this sense does not mean and increase in production per se. It is far more precise. It is a measure of the production per unit of input. This goal urges dairy farmers to produce more with less, but this principle applies to all pastoral farmers, most of whom know, at least instinctively, that it is the key to their financial survival.

Most farmers also know that fertilisers are the single largest item of discretionary expenditure in the budget and that this cost has a large impact on bottom line. More specifically, the fertiliser spend per unit of production has a major impact on the overall financial efficiency - that is, the productivity - of the particular farming operation. Hence my question: what is your annual fertiliser spend per unit production?

I encourage you to do this calculation and compare your figures with the fertiliser costs for the average dairy farm and average sheep & beef farm for the season 2000/01 (Table 1).

Table 1: Average fertiliser costs on dairy and sheep and beef farms for the season 2000/01

	Average dairy farm	Average sheep & beef farm
Total fertiliser spend ($/farm)	36,400	25,000
Fertiliser spend per ha ($/ha)	367	44
Fertiliser spend per unit production ($/kg MS [dairy] or $/SU [sheep&beef])	0.46	6.5

These figures include all fertiliser and lime costs, including N, but do not include transport and spreading costs. Note also that fertiliser costs per unit production do change from year to year. So if you are using the figures above as the benchmark, you will need to use your year 2000/01 production and financial data.

If your fertiliser costs are above average you could do well to ask a few questions:

1. Are you applying capital inputs of fertiliser, as distinct from maintenance inputs – this could explain why your costs are higher than average?
2. Are you using too much fertiliser N – replacing free clover N with expensive fertiliser N.
3. Are you using the most cost effective products? Do you know which ones are the most cost effective?
4. Are you wasting your fertiliser dollar on unproven products or products which have been shown to be ineffective?
5. Are you getting sound independent fertiliser advice?

The chances are you may be able to reduce fertiliser costs for no loss in production and thereby squeeze a little more efficiency out of the farm. The good thing is that the money you save will go straight to your bottom line!

NUTRIENT BUDGETING

You will hear more and more about nutrient budgeting over the coming years. Environment Waikato, for instance, in planning to introduce nutrient budgeting by 2005 for all farmers using more than 60 kg N/ha/yr. Westland Dairy Co-op Ltd is thinking of making nutrient budgeting a condition of supply. And of course all the bureaucrats and policy makers are beginning to run around thinking that nutrient budgeting will solve the fertiliser-water quality issue.

What is Nutrient Budgeting?

Financial budgeting is familiar to most of us – it is a way of measuring and monitoring the flows of money into and out of a business. Importantly, it is a means of measuring the financial sustainability of the activity – is money accumulating (a profit) or being depleted (a loss). But budgeting has other practical benefits. Knowing where the money is going identifies inefficiencies and ensures that the income is efficiently deployed. In short, financial budgeting is a tool to ensure that money is used efficiently and that the activity is financially sustainable.

Nutrient budgeting is similar. It is a tool that helps farmers, horticulturalist and growers track the flows of nutrients into and from their land. If inputs are greater than outputs then soil nutrient levels will increase. Conversely, soil nutrient reserves will be depleted if inputs are less than outputs. Thus, nutrient budgets are a powerful indicator of the long-term sustainability of specific farm policies and practices.

Also, by knowing where the incoming nutrients are going – whether remaining in the soil or being removed as products from the farm, or lost by transfer to non-productive areas, leaching, runoff and as gases to the atmosphere – enables decisions to be made which ensure that nutrients are used efficiently and that avoidable losses of nutrients are minimized. Thus, nutrient budgeting makes sense for both financial and environmental reasons.

Table 2: Nutrient budgets for an average dairy farm and sheep and beef farm.

		Average dairy farm		Average sheep & beef farm	
		Nitrogen	Phosphorous	Nitrogen	Phosphorous
Inputs	Fertiliser	0	37	0	25
	Atmosphere	147	0	59	0
	Slow release	0	3	0	3
Outputs	Product	57	10	7	1
	Transfer	33	4	37	4
	Atmosphere	29	0	5	0
	Leaching/ runoff	27	1	10	0
	Immobilisation	1	25	0	10
Balance		0	0	0	+13

Some Examples

Examples of nutrient budgets for an average dairy farm and an average sheep and beef farm are given in Table 2. What do they mean?

Our average dairy farm (about 750 kg MS/ha) is applying no fertiliser N and about 40 kg of fertiliser P per year. In addition, the clovers are busy on his farm and 'fixing', from the atmosphere, about 150 kg N/ha/yr. There is also a small input of P because of the weathering of P minerals in the soil.

Where do these nutrient go? The largest output is in products - mainly milk- from the farm. But notice that large quantities of N, but not P, are 'lost'. Some is transferred to non-productive areas, such as around troughs, hedges, raceways and gateways. Some is lost as gases to the atmosphere and some is leached as nitrate into the ground water. For P a large amount is incorporated into the organic matter. [It is stored in this plant unavailable form until mineralised and so is not lost completely from the system].

Notice in particular for this example, the balance – that is the difference between inputs and outputs - is zero for both N and P. This means that the pools of plant available pool of N and P are not increasing or decreasing. The soil is in balance - at equilibrium - at maintenance. However, just because it is in balance does not mean there are no environmental consequences. For N there is a leaching loss of 30 kg N/ha/yr into the ground water, and for P, there is 1 kg P/ha/yr running off the land into waterways (see article 'Managing P Runoff' this issue).

So lesson number one: doing a nutrient budget and achieving a balance of zero does not in itself mean that your farm is not contributing to nitrate leaching or P runoff.

What nutrient budgeting does do is highlight where the leaks - the inefficiencies are occurring and get you to think about changing some management practices.

For the sheep and beef example the nutrient inputs are lower relative to the average dairy farm. This simply reflects the lower intensity of the farming system. Of more significance, under sheep and beef, the proportion of the total inputs of N and P going off the farm as product is smaller than under dairying but the proportion lost via transfer to non-productive area is greater, suggesting that greater stock control would increase nutrient use efficiency.

The final point is that for the sheep and beef farm there is a positive P balance. In other words we would expect that overtime the Olsen P level will increase. This is desirable in this case because the Olsen P level in this example has been set at 10 and we know that the economic optimal Olsen P is about 15, given current costs and prices. (see article 'Optimal

Olsen P' this issue). The outcome would be different if the current Olsen P level was above the economic optimal. It would make no sense financially or environmentally to increase the Olsen level above that which is economically optimal.

This article is intended simply to introduce you to the concept of nutrient budgeting. It is, and will become, a useful tool, which will ensure that fertilisers are used efficiently and economically (see article 'Efficient Fertiliser Use' this issue) and at the same time minimise avoidable environmental consequences

MANAGING NUTRIENT RUNOFF

One of the major environmental issues confronting farmers today is the issue of nutrient runoff. Specifically, the concern is about phosphorus (P) getting into waterways and there has been much said in the farming press recently proclaiming that RPR's cause less runoff than soluble fertilisers like superphosphate. What does science have to say on the topic?

But first some background:

1. About 90% of total P entering fresh waters comes from diffuse sources (ie runoff and sediment from agricultural land). The balance is from point sources (industrial and urban).

2. Total P losses (runoff P) from pasture land range from 0.11 to 1.67 kg P/ha/yr. Most (80%) is in the from of sediment (sedimentary P) and the balance as P dissolved in the runoff water (dissolved P).

3. The sources of runoff P (either as sediment or as dissolved P) can differ between catchments. Surface runoff (of dissolved P) and direct fertiliser application to waterways are the major sources of dissolved P into water bodies, but steam channels and hill slopes are the main sources of sediment P.

4. In most agricultural catchments, sediment P is the dominant source of runoff P. Hence, within a given catchment, runoff P can be reduced by reducing erosion. However, the proportional reduction in P runoff may be less than the decrease in sediment loading. It will depend on the P enrichment of the sediment.

5. Increasing the soil P status (as when applying any P fertiliser) increases the P concentration of both dissolved P and PAP

So far so good: The amounts of P lost via runoff are small agronomically but are significant in terms of affecting water quality. There are two forms of runoff P – the stuff in and on soil particles or otherwise present as particles (sediment P) and that dissolved in the water (dissolved P). The former is the dominant source of runoff P. Increasing the soil P status increases both sediment P and dissolved P.

Where does this leave us in terms of RPR and soluble P?

When a soluble P fertiliser, such as DAP, Triple P or superphosphate is applied, most of it is present initially as soluble P. A rainfall event at this time will carry some of this soluble P away in runoff. Given time (days and weeks) the soluble P interacts with the soil and becomes attached to soil particles (sediment P). A rainfall event at this time will carry away some of this as sediment P in runoff.

Things are slightly different when a slow release product such as RPR is appled. The P is added to the soil in insoluble particles some of which can be removed as sediment P. Given time the RPR dissolves and the P becomes attached to soil particles, once again subject to removal as sediment P.

And so the answer to the RPR or soluble P question is, it depends! It depends primarily on how the P is getting into the waterway. If it is primarily as sediment P, as is typically the case - and remember the primary source of sediment P is from soil erosion or the erosion of stream banks - then it matters little, in the long-term (months and years) if fertiliser was applied as soluble P or slow release P. This seems to be what the majority of the science is saying.

In the short term (ie within days and weeks following fertiliser application) there may be some differences. If the primary source of runoff P was as dissolved P then soluble fertiliser will contribute more to runoff initially but this will decline rapidly overtime (weeks). In other words in this situation the degree to which soluble P fertiliser contributes to runoff P declines in proportion to the time between the application and the runoff event. However, if the primary source of runoff P is as sediment - and remember this includes fertiliser particles – then there is unlikely to be much difference between these two forms of P even in the days and week following application.

What does all this reduce to in terms of practical management options for reducing runoff P? Here is my list in decreasing order of importance:

1. Eliminate remaining point-source discharges.

2. Reduce soil erosion at stream banks, drains and of topsoil from hill slopes – this minimises sediment P.

3. Fence ungrazed pasture buffer strips and eliminate stock access to streams – this minimise the possibility of sediment P as topsoil, dung and plant material getting into streams.

4. Avoid direct application of fertiliser to waterways – brief you spreader operator.
5. Avoid applying P fertiliser in late autumn or early spring – ie minimize the risk of getting heavy rainfall within weeks of fertiliser being applied.

Note that changing fertiliser type does not feature is this list for this simple reason that in the long-term it will have no net effect on P runoff.

WHAT IS THE OPTIMAL OLSEN P?

The one question I am most frequently asked is: what is the ideal Olsen P for my farm? It is an important question. Not only is P the most expensive nutrient it is also the main driver of pasture production in our legume-based system. Thus, the decision that every farmer must make - what Olsen P level - has a large impact on the farm production and productivity (see article this issue 'Efficient Fertiliser Use').

To answer the question we need to deal with some definitions and jargon.

Most will be familiar with the term 'biological optimum' in respect to the Olsen P test. It is the Olsen P level which gives the maximum yield. The 'economic optimal' Olsen P is the level required to optimise the long-term profitability of a given farming enterprise. They are not necessarily the same. For legume-based pastures the biological optimal Olsen P depends on the soil group – peats and pumice soils have higher biological optimum (35-40) than volcanic and sedimentary soils (25-30). The economic optimum depends, not only on the soil group, but also the profitability of the land use. As the profitability per unit area increases the economic optimal increases towards the biological optimal.

The graph below shows for sheep and beef farms, the relationship between the economic optimal Olsen P and farm gross margin per hectare (GM/ha) - a measure of profitability per unit area - for the five major soil groups in New Zealand. It is important to note that these calculations, and hence these relationships, are based on costs and prices for the season 2000/01.

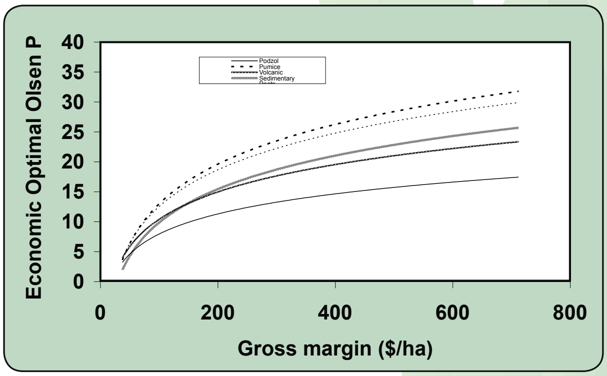
What do they tell us? Take for example the sedimentary soils – the middle line. For a farm with a GM/ha of $200, the economic optimal Olsen P is about 15. This is the Olsen P level which will maximise the profits from the farm in the long-term. At GM/ha $400, the economic Olsen P is 20-25 and it is over 25 for farms doing better than $600/ha.

The relationship for the volcanic soils is very similar but the peat and pumice soils have higher optimal levels, and the podsol lower optimal levels, for a given GM/ha.

Of course dairy farming is more intensive and the GM's from dairying, over the same period of time, were typically in the $1000-2000/ha region. This is why dairy farms are operated at higher soil fertility levels. The average dairy farm on a pumice soil is quite properly operating at an Olsen P of about 40 and, on volcanic or sedimentary soils, at about 30.

What happens when commodity prices fall? Well, if it is assumed that costs are static then income and profits will decline and with them GM's. And as shown in the figure above, as the GM/ha decreases, the economic optimal Olsen P declines. What the smart farmer does in these circumstances – and there is good evidence for this from the down turn during 1985-90 – is to tighten the belt and find ways of increasing productivity (production per unit cost) thereby maintaining the GM/ha.

He/she will therefore maintain fertiliser inputs to keep the Olsen P at the optimal level, knowing that when things come good again they are in a good position to harvest the rewards.



PHOSPHATE ROCK RESERVES

A question at a recent farmer meeting sent me scurrying to my books. What, the questioner asked, are the reserves of phosphate rock? When will we run out?

According to the International Fertiliser Development Centre the annual global consumption of phosphate rock (ie the raw material used to make all phosphate-based fertilisers) is about 150 m tonnes. New Zealand's consumes about $1.0m annually.

The known economic reserves (ie commercially exploitable given current mining processes and costs) are estimated at 14,000m tonnes. In other words the world has known currently available reserves for about 100 years.

The economic reserves do not include reserves that have not as yet be fully surveyed and quantified. These are estimated at a further 36,000 m tonnes.

In addition, new deposits are continually being discovered and improved extraction techniques mean that deposits currently not considered, will become viable. One such reserve lies off the New Zealand coast – the Chatham Rise deposit.

So, while we must accept that phosphate rock is a non-renewable resource the prognosis is that the world has sufficient reserves for at least 20 generations, plenty of time for mankind to learn new management practices that improve nutrient use efficiency (see article Efficient Fertiliser Use in this issue), find new reserves and develop new, more efficient, extraction techniques.

LIQUID FERTILISERS: AGAIN?

I was recently sent a report on a field trial in Otago examining the efficacy of the liquid fertiliser 'Reaction 9-5-6'. This product is claimed to increase pasture production and quality. The product when used as recommended supplied 0.9, 0.4 and 0.6 kg/ha of N, P and K, plus some trace elements, and cost $46.50/ha.

The results showed that the product was ineffective – it had not practical effect on pasture production and quality. This is a good example of a product that adds costs to your fertiliser bill for no increase in output. Your efficiency goes down! (see article 'Efficient Fertiliser Use' this issue).

This reminded me of the comprehensive trials conducted by Dr Alister Metherell (now of AgResearch) in Otago and Southland in the mid-eighties.

Table 1. Effect of Maxicrop on pasture and animal production at three sites in Otago and Southland (pasture production in kg DM/ha over 3 years; animal production lamb growth rate g/day over 3 years)

Site	Measurement	Response (%)	Confidence interval (95%)
Site A	Pasture	+ 2.6	-12.3% to +17.4%
	Animal	-3.6	-12.6% to +5.9%
Site B	Pasture	+2.7	-6.5% to +12.0%
	Animal	-8.2	-14.7% to -1.0%
Site C	Pasture	-1.5	-11.3% to +8.3%
	Animal	+6.9	+0.3% to +13.5%

The confidence interval above is a measure of the precision of the experiment and the fact that all the measured responses fall with the limits of the confidence interval is a good reason to conclude that this product is having no practical effect on either pasture or animal production.

These more recent trials are only the tip of the proverbial iceberg of scientific data these types of liquid fertilisers. There is something like 800 trials internationally with these products across a whole range of crops and the results show that these products are no better than the water they contain!

My advice: If you are concerned about your fertiliser costs pr unit production then these are not the products for you!

PRODUCTS AND SERVICES TO AVOID

I have received correspondence seeking further advice regarding Mainland Minerals Ltd and Quantum Laboratories Ltd. I have previously commented on both of these topics in detail (see The Fertiliser Review No 4 re Quantum Laboratories and No 5 re Mainland Minerals). This article serves just as a reminder.

The fertiliser advice offered by both companies is of doubtful value and in some of the examples I have reviewed, grossly misleading. Both companies place emphasis on the base saturation theory of soil nutrition, which is flawed, especially for use on our New Zealand soils. In both the examples sent to me recently the elements manganese (Mn) and iron (Fe) are recommended. This is nonsense. If we have a problem with these two elements it is because they are present in too high a concentration in our New Zealand soils!

My advice: These products and services are best avoided!

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PRICE WATCH

Nutrient	Product	Average cost ($/kg nutrient)[1]
Phosphorus	Superphosphate	1.47
	DAP	1.80
	RPR	1.51-1.76 (Ravensdown)
	Triple super	2.13 (only listed by Ballance)
Nitrogen	Urea	0.77
	DAP	1.14
	Ammonium sulphate	0.95 - 1.27 (Ravensdown)
Potassium	Potash (KCl)	0.83
	Potassium sulphate	1.52 (only listed by Ballance)
Magnesium	Calmag (MgO)	0.70
	Serpentine super	0.85-0.95 (Ballance)[2]

Notes: 1) based on ex-works prices (June 1 2002 for Ravensdown and July 1 2002 Balance) exclusive of GST and assuming the cost of S is $0.40/kg.
2) where prices differ by more than 0.10 cents / kg the range is given and the cheapest source indicated.

Points to note:

1. Apart from RPR, ammonium sulphate and serpentine super there is little difference in prices between the two companies.
2. Urea, superphosphate, potash and MgO are still the cheapest forms of N, P, K and Mg respectively
3. The ammonium sulphate listed by Ravensdown is for the standard product not the granulated product listed by Ballance. The former could present difficulties for transport and spreading.
4. Prices for all N fertiliser have decreased slightly since the last N Price Watch (September 2001).
5. Prices for all P fertilisers are very similar to those reported in the last P Price Watch (March 2001).
6. Prices for all Mg fertilisers are very similar to those reported in the last Mg Price Watch (October 2000).

YOUR QUERIES...

Do you have a topic, a product or issue relating to fertilisers that you would like discussed in **'The Fertiliser Review'**?

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