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NITROGEN FERTILISER: A NEED FOR CAUTION?

With low prices for fertiliser nitrogen (N) it is tempting for farmers to over indulge. I advise caution for the following reasons.

1. With our grass/clover pastures it costs about 2-3 cents to grow a kg of DM. For an all-grass-fertiliser-N system, (ie as practiced in the Northern Hemisphere) the cost is about 10-12 cents/kg. The difference is because atmospheric N put into the system via clover N fixation is much cheaper than fertiliser N, even at to-days prices.

2. To compete effectively internationally it makes sense to maintain, and if possible, enhance this competitive advantage relative to our Northern Hemisphere competitors.

3. Applying more and more fertiliser N, will increase production but it will also increase costs and erode this competitive advantage. In other words, the efficiency of the clover-based production system decreases. It costs more to produce a unit of output.

4. Not only is there the direct cost of the fertiliser N, but also, the more fertiliser N applied the less atmospheric N is fixed by the clover – an indirect cost. It is a double whammy!

5. To optimise efficiency (maximum output for minimum cost) all farm practices, particularly the fertiliser policy and the grazing management, should be directed towards maximising clover growth and hence N fixation.

6. This means minimises the use of fertiliser N and optimising the inputs of P, K, S Mg, lime and trace elements. Clovers require greater fertility than grasses.

For these reasons my advice on fertiliser N is as follows, although I appreciate that opinions do vary:

1. N is a tactical weapon to be used if and when required depending on the season. The other nutrients P, K, S, Mg, lime and trace elements are a strategic necessity and are always required.

2. Once the soil nutrient levels are optimal, the strategic nutrients can be applied at any time, but the timing of fertiliser N must be flexible depending on weather conditions and likely periods of feed deficit, if it is to be economic.

3. Thus, it make sense financially, and in terms of retaining management flexibility, to separate fertiliser N inputs from the inputs of the other strategic nutrients.

4. The science tells us that the best responses to N (ie greatest kg DM/unit N applied) occur when single applications of not more than 20-25 kg N/ha are applied during the months May through August. Six weeks between applications is about optimum. Higher rates, applied more frequently, simply replace N that would otherwise be fixed by the clover.

5. Thus for the best financial return, my view is to restrict N to say 3-4 applications of not more than 25 kg N/ha applied as urea (50 kg urea/ha) during this period (ie a total of 150 –200 kg urea/ha/yr).

SOIL ACIDIFICATION DUE TO FERTILISERS

It is frequently believed and often asserted that chemical fertilisers are bad for the environment because they acidify the soil. What are the facts.

It is true that some fertiliser products react in the soil and produce acid. The common examples are the nitrogen (N) fertiliser which contain ammonium, such as ammonium sulphate (sulphate of ammonia) and those which produce ammonium when applied to soil such as urea. Some phosphate (P) fertilisers also produce acid including DAP and MAP. The only sulphur fertiliser which acidifies the soil is elemental S and none of the potassium (K) fertilisers are acidifying. These facts have been known for many years but the real question is - how large are these effects?

To provide this practical context the Table below shows how many years it would take to reduce the soil pH by 0.1 of a pH unit if some of these common fertiliser were applied at typical rates.

The first point to note is that properly made and cured superphosphate does not acidify the soil. Even if there is some free acid left after manufacture it would take 60-90 years of annual applications of 50 kg P/ha (ie 500 kg super/yr) before the acidity was reduced by 0.1 pH unit. This is why, even in long-term trials no decrease in soil pH is measured.

Other fertilisers which have no effect on soil ph include triple superphosphate, gypsum and potash.

The two products that have the greatest effect on soil pH are ammonium sulphate and elemental S, but even for these extreme cases it would take about 50 years to lower the pH by 1 unit, say from 6.0 to 5.0. The other products such as urea, DAP, MAP and Calcium Ammonium Nitrate (CAN) have intermediate effects on soil pH.

Note that in theory RPRs increase the soil pH. But this effect is so small that RPRs cannot be regarded as liming materials. Many tonnes of RPR over many years would be required to have a measurable effect on soil pH. In any case elemental S is generally added to RPR to provide the source of S and this has an acidifying effect which exactly cancels out any liming effect from the RPR.

It is for these reasons that farmers should not be unduly concerned about the effect of fertiliser on soil pH. Most liming programs will easily offset these sources of acidity, and as we will discuss in the next bulletin, there are far more important things to worry about in terms of soil acidification.

One final point though. Why is it the elemental S which has a relatively large negative effect on soil acidity is accepted as an organic fertiliser but superphosphate which has no effect is not?

Table 2: Time Required (Years) For Typical Annual Applications of Fertilisers To Decrease (or Increase) Soil pH by 0.1 Unit

The Suitability of Various Magnesium Fertiliser to Achieve Four Different Goals

Fertiliser	Annual Application Rate (kg nutrient/ha/yr)	Time (yrs) to Decrease (or Increase) Soil pH by 0.1 Unit[1]
P Fertilisers		
Superphosphate	50	∝[2]
Superphosphate (14% free acid)	50	60 - 90
Triple superphosphate	50	∝
Mono calcium phosphate	50	∝
DAP	50	33 - 50
MAP	50	12 - 18
RPR	50	(4) - (6)
N Fertilisers		
Urea	75	18 - 27
Ammonium sulphate	75	4 – 6
CAN	75	30 –44
S Fertilisers		
Gypsum	50	∝
Elemental S	50	4 - 6
K Fertilisers		
Potash	75	∝
Potassium sulphate	75	∝

Notes: 1) assuming that the buffer capacity of a typical soil is 0.10 – 0.15 pH units/1 tonne of lime
2) infinite – ie the product has no effect on acidification

PLANT NUTRIENT RATIOS: WHAT DO THEY MEAN?

When R J HILL Laboratories report results from plant analyses they also give a BLOAT RATIO, a HYPOMAGNESEAMIA INDEX and a DCAD ratio. What do these ratios mean? Do they have any interpretive value?

The answer, putting it succinctly is no. In fact they can be very misleading.

The so-called BLOAT RATIO is the concentration of sodium (Na) divided by the concentration of potassium (K). It has been claimed that the incidence of bloat is reduced by the application of Na and that the desirable ratio of Na/K in pasture is > 20. There is in fact no experimental data to support this. In fact a survey of over 300 farms conducted in the 1980's found that the incidence of bloat was not related to the concentration of Na or K, or the ratio Na/K in pasture.

Regretfully I have had farmers report to me that they have been advised not to apply any potash because the Na/K ratio was less than 20. The stupidity of this advice is that in some cases the soil and plant analyses indicated either an absolute deficiency in K, or an on going need for maintenance inputs of potash! Bloat is a complex disorder and to attribute it solely to an imbalance of Na and K is in the realms of fairyland!

Similarly the HYPOMAGNESEAMIA INDEX. This is the ratio of the concentrations of K to magnesium (Mg) plus calcium (Ca). It was first suggested by a Dutch scientist many years ago on the basis that the risk of hypomagneseamia increases with increasing amounts of K relative to Mg and Ca. In fact, much subsequent research has failed to establish the relevance of this ratio. Indeed the author himself is embarrassed by the way the original idea has been misused! Like bloat this disease is very complex and is not determined solely by the relative intake of K, Mg and Ca. This ratio also should be assigned to the rubbish heap.

The latest fashionable plant nutrient ratio is DCAD – the dietary cation anion difference. It is calculated by subtracting the amounts of the anions in the diet (ie sulphate and chloride) from the amounts of the cations (K plus Na). The theory is that if the DCAD is negative the blood will becomes more acidic and this will enable the animal to better utilise Ca, thereby preventing milk fever.

This theory was developed to design ratios for stall-feed animals but it has little application to pasture feed animal. As my colleague Dr Roberts (AgResearch, Ruakura) has pointed out, if there was any truth to the importance of this ratio for animal on pasture most of the dairy cows in New Zealand should be dead!

More seriously Dr Roach (DRC) has shown that the DCAD of most pastures is between +200 to + 1000. Further, he has found that it practically impossible to alter the DCAD of pasture-feed animals by feeding them specialist anionic salts of Ca and Mg. The amounts required are simply not feasible. He does note however that many of the reported instances of "success with DCAD" arise simply because the animal are being feed sufficient quantities of Ca and Mg. It has nothing to do with DCAD per se.

The point is this. The key to healthy well feed animals grazing pasture is the intake (the amount of pasture DM consumed times the nutrient concentration) of each nutrient – the absolute amount, not the ratio of one nutrient to another. And there are good scientifically defined guidelines available for all the key nutrients for all classes of animals. This is most likely to be a cheaper option relative to using proprietary brews.

My advice: ignore all pasture nutrient ratios. At best a humbug, at worst misleading.

MAINLAND MINERALS: BE AWARE!

A correspondent has sought my advice regarding Mainland Minerals, a small fertiliser company that, according to a recent press statement, is growing rapidly throughout New Zealand. What does this company offer and what claims does it make for its products and services?

Mainland Minerals offers Fine Particle Application (FPA) of fertiliser nutrients, trace elements and lime. FPA involves grinding normal fertiliser and lime products and making a suspension of this fine material in water. The suspension is then sprayed onto the crop or pasture.

The essential claim made for FPA is that it results in more even and accurate application of nutrients and lime, relative to applying solid fertiliser, and that as a result it more cost effective. The advertising relies heavily on anecdotal comment from users and specifically it is claimed that FPA increases pasture production, increases livestock returns and improves fertiliser utilisation.

An Example

An example of what Mainland Minerals offers has been provided to me by my correspondent. It includes a soil test from Perry Agricultural Laboratories and a fertiliser recommendation signed by Dr Tim Jenkins an employee of Soil Tech Ltd.

For this Southland sheep farm the key soil tests were:

- Olsen P = 12, below optimal, indicating that a least a maintenance input of P was required and depending on the farmers goal a capital input of P should be considered.
- Soil pH = 6.3, above the optimal for pastures indicating no lime required at this stage.
- Soil K = 9 indicating that possibly K inputs could be withheld. This would depend on other information.
- Soil sulphate S = 28, indicating that there was adequate soil S.

Based on this, and the other soil test results, Dr Tim Jenkins recommended the following; 70 kg/ha of a mix comprising DAP (60%), Elemental S (10%), Lime flour (15%), Magnesium sulphate (5%) and Sodium chloride (10%). A quantity of the trace elements including boron, copper, manganese, zinc, iron, iodine, and selenium was also recommended but the rates of application were not given. This mix was to be applied as a FPA suspension at a cost, including application by helicopter, of about $78/ha.

From this information the rate of application of each of the major nutrients can be calculated. These are compared below in Table 1 with a typical maintenance input based on scientific facts.

Table 1: Nutrient inputs recommended by Mainland Minerals compared to a science –based maintenance input.

	Amounts of Nutrients Recommended (kg/ha)						
	N	P	K	S	Ca	Mg	Na
Mainland Minerals	8.4	8.4	0	7	4	0.4	2
Maintenance (at 16 SU/ha)[1]	0	20-30	0-40	10-30	-	15-20	-

Notes: 1) Actual nutrient inputs would depend on other factors including topography, reserve K etc

It is clear that if the farmer followed the advice offered by Mainland Minerals his soil fertility and hence pasture and animal production would decline over time. The rates of nutrient input are insufficient to make good the nutrient losses and hence maintain soil fertility and production.

Furthermore, the major nutrients in the Mainland Mineral mix could be purchased from a normal fertiliser retailer for about $25! Allowing, generously, say $20 per tonne for transport, and aerial application at $50 per tonne would add a further $5.0 (remember the application rate is 70 kg/ha), bringing the total on ground cost to about $30/ha. Compared this with Mainland Mineral's price of $76/ha.

This could perhaps be justified if FPA was a more efficient means of applying nutrients, as the company claims. But what is the scientific evidence for this?

The results below are from 3 trials in the Hawkes Bay that compared DAP applied in a solid form and as a FPA suspension. If the company's claim was true then one would expect that the pasture production from the FPA treatments to be higher than where solid fertiliser was applied. This would be true particularly at low application rates using the company's argument that FPA is more efficient and therefore a little goes a long way. Obviously this is not the case.

Table 2: Effect of Form of Application of DAP Fertiliser on Pasture Yield (Korte et al 1996)

Treatment	Amounts of Nutrients Applied (kg/ha)[1]			Pasture Yield[2] (Control = 100)
	N	P	S	
Control	0	0	0	100
FPA (DAP slurry)[3]	3.3	3.3	5.3	103
DAP solid	3.6	3.6	0.4	103

Notes: 1) mean inputs for 3 trials on dryland yellow grey earths
2) mean over 3 trials. The relative yields for the normal fertiliser treatments were 120-130
3) as recommended by the proprietor

And there is other evidence. Many years ago Joe Karlovsky (Ruakura) compared fertilisers applied either in a solid form or as a liquid. There was no difference in their agronomic effectiveness as shown in Table 3. This evidence destroys Mainland Minerals claim that fertilisers are more efficient and effective if they are applied accurately and evenly, as would be the case with liquid and suspension fertilisers, including FPA.

Table 3: Effects of Nutrients Applications Applied as either Liquid Fertiliser or Solid Fertiliser (Karlovsky et al 1978)

Source of P	Amounts of NPK Applied (kg/ha/yr)	Relative Pasture Production (control = 100)	
		Applied as Liquid	Applied as Solid
Control	0, 0, 0	100	100
Mono-calcium phosphate	0, 15, 0	113	117
Di-ammonium phosphate	14,15, 0	120	114
Di-potassium phosphate	0, 15, 37	118	119
Phosphoric acid + urea	20, 15, 0	105[1]	114
Glycerophosphoric acid	0, 8, 0	108	108
	Average	**113**	**114**

Notes: 1) some scorching occurred following application

The point is this. Solid fertilisers are as effective agronomically as suspension and liquid fertilisers when compared at the same rate of nutrient application. But, and here is the rub, solid fertilisers are cheaper per unit of nutrient applied than either liquid or suspension fertilisers. The reason? It costs money to refine fertilisers so that they are water soluble or to grind them so that they can be kept in suspension.

My Advice? Be cautious. Ask the salesman for an analysis of the product to be applied and calculate the rates of application

per hectare for each nutrient. Work out the cost of buying these nutrients from a traditional fertiliser outlet.

FLUID FERTILISER LTD

So far we have examined the effectiveness of liquid fertilisers generally (The Fertiliser Review No 3) and it was concluded that applying nutrients in a liquid form is not more efficient that applying solid fertiliser and that liquid fertiliser are a more expensive method for adding nutrients to the soil. In the last bulletin (The Fertiliser Review No 4) we began a series on specific products, looking at the product Nitrosol. It was concluded that the claims made for this product are no supported by the facts.

In this bulletin we focus on the products produced by Fluid Fertilisers Ltd. This company promotes a wide range of liquid fertilisers -its prominent brand is called Reaction. The company produces a widely distributed Newsletter called "Fertworks". It also has run a high profile advertisement on television.

The company literature states that Reaction products contain the major nutrients (N,P,K,S,Mg), trace elements (Mn, Zn, Fe, Mo, Co, Cu, B, Se), plant growth stimulants (cytokinnins, giberrellins auxins, betaines), added to an organic base of seaweed extract.

The company claims that Reaction increases pasture growth and quality and animal health. To support this they quote results from a series of "eight independent trials", conducted by Dr Max Turner of Massey University, stating that on average Reaction increased pasture production by about 20%.

Cost Effective?

The product called Reaction 6.9.5 is, according to the company literature the "premium blend ideal for properties that need a good lift." It costs $900 for 200-litre drum ($4.5/litre) and is recommended to be applied at 10 litres/ha. From the stated nutrient content and the application rate, we can calculate the amount of nutrient applied if the product is used as recommended. The value of the nutrients can also be calculated based on their cost if they were purchased in a solid form:

Nutrient ($/ha)	Concentration (%)	Amount of nutrient (kg/ha @ 10 l/ha)	Value of nutrient
N	6.0	0.6	0.48
P	9.0	0.9	1.12
K	5.0	0.5	0.35

Two points are obvious. First, the amounts of major nutrients applied if this product is used as recommended are trivially small in relation to the amounts needed to maintain production. It is certainly not the product for "properties that need a good lift!"

Also at the recommended rate of 10 litres/ha, the cost of the product (ignoring the application costs) is $45/ha. For this, the product supplies about $2.00 worth of the key major nutrients! It is a very expensive means of buying nutrients.

The Claims

The main claim made for Reaction is that it increases pasture production by 20%, as mentioned above. What does the science say?

Considering only scientifically designed trials (ie excluding observational trials which are not replicated) there have been 59 trials comparing the effects of liquid fertilisers like Reaction on pasture production. The average "response" was 1.2% with an error of plus or minus 1.8%. In other words at a practical level we can say these products have no effect on pasture production. This is of course consistent with the conclusion reached above that Reaction, and products like it, simply do not contain sufficient amounts of nutrients or any other substances that promote plant growth.

How is it then that Dr Turner of Massey University can announce that the product increased plant growth by 20%? The fact is the trials he ran were not scientific trials – they were observational trials – the treatments were not replicated. Because of this the results cannot be given any weight. They are interesting perhaps but they do not prove the product works.

But lets assume for a minute that they were bone fide trials. The result – a 20% increase in production - would have to be considered together with those from the other 59 trials world wide on pastures. Adding in this result to the overall world picture would not change the conclusion –these products do not work as claimed.

One final thought – the company claims that the trials conducted by Dr Turner were "independent trials." Dr Turner is employed by the Liquid Fertiliser Manufacturers Association as their Technical Consultant! In fairness to farmers this conflict should have been made clear.

My advice? Not the product for the farmer who wants a "big bang for his fertiliser buck."

SODIUM FERTILISER: AN UPDATE

The Sodium (Na) requirements for pastures were reviewed in The Fertiliser Review No 2. The main points were:

- Na is not essential for pasture growth
- For optimal animal production pasture Na concentrations of > 0.1% are required for lactating cows, > 0.06% for lactating sheep and cattle maintenance and > 0.04% for ewe maintenance.
- Concentrations of Na in pasture can vary over the season and will be lower in pastures containing a high proportion of browntop, paspalum and kikuyu.
- Na deficiency in animals is currently rare but will increase particularly in regions remote from the coast and on soils with a low CEC. The pumice soils and some volcanic soils in the North Island are the mos vulnerable.

After searching for many years for a Na deficient farm (ie a dairy farm where the pasture Na levels were consistently below 0.1%), my old mentor, Mr Mike O'Connor (Ruakura), has finally hit the jackpot, not surprisingly on a farm on a pumice soil in the Waikite Valley (Rotorua). The soil Na level was 4 and the pasture Na concentrations were consistently below 0.05%.

On this farm he recorded a 12% response in milk production to Na supplementation (14g Na [35g common salt]/cow/day over a six month period from November through February. He reported that, given the size of the response and the cost of the supplementation, this was a very economical proposition.

The question he is now addressing is - how best to overcome Na deficiency. First he is emphasising the need to take pasture samples and analyse them for Na. If the results are consistently below 0.1% Na he suggests either drenching, dusting or fertilising. For maintenence, water trough treatment for licks and blocks are satisfactory.

Adding to this I am finding in my practice an increasing number of Na soil tests of 4 and less, often 2 and 3, and am advising these farmers to monitor pasture Na levels very closely. This should be done routinely as part of the normal soil testing program.

PRICE WATCH: MAGNESIUM FERTILISER

Magnesium deficiency is becoming more widespread and within the next decade Mg will become a common component in most fertiliser mixes. The magnesium (Mg) requirements of New Zealand pastures and the agronomic effectiveness of the various Mg fertilisers was discussed in The Fertiliser Review No 3.

Product	Brand Name (if given)	Company	Indicaive Price ($/tonne)[1]	Cost of Mg ($/kg total Mg)[2]
Serpentine super (5.0 - 5.5% Mg)[3]	na[6] na	BOP Ravensdown	162.50 150.00	0.89 0.57
Magnesium oxide (52 - 54% Mg)[4]	E-Mag[7] na	BOP Ravensdown	385.00 346.00	0.71 0.66
Magnesium Superhosphates (4.2 - 5.4% Mg)[4]	Magphos Magnesium super	BOP Ravensdown	194.00 180.25	0.81 0.81
Nitrogen magnesium Superphosphates (4.3 - 4.7% Mg)[4]	Pasturemag Super Mag N	BOP Ravensdown	194.00 183.25	0.89 0.53
Dolomite[5] (11.5% Mg)	na	Ravensdown	94.00	0.66

Notes:
1) all prices are ex-works and exclude GST. Actual prices will depend on variations in agent's margins
2) calculated after deducting where necessary the value of the other nutrients or lime (S @ $0.40/kg, P @ $1.25/kg, N @ $0.82/kg and $18 per tonne lime equivalent)
3) about 70% of the Mg is immediately available (months) and the balance slowly available (12 - 24 months)
4) immediately available (0 - 6 months)
5) slowly available (0 - 24 months)
6) na = not applicable
7) a grade of magnesium oxide which has particle size compatible for mixing with other fertlisers.

Comments:

1. Serpentine supers and mixtures thereof are ideal where P, S and K are also required and the intention is to maintain the current Mg soil status.
2. The magnesium oxides (calcined magnesites) and dolomite are the preferred product if a large and rapid increase in soil Mg is required.

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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