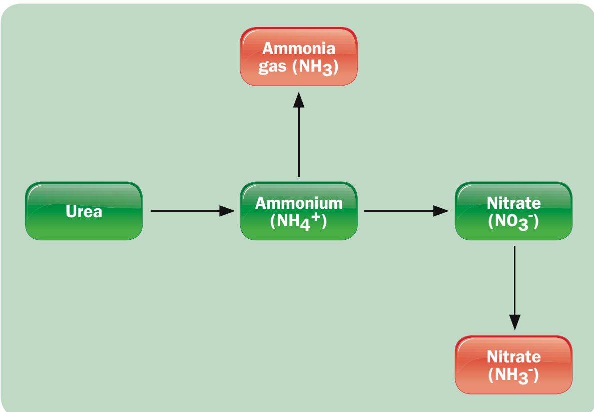
agKnowledge
TNM™ "Total Nutrient Management"
October 2005
THE Fertiliser Review
ISSUE 15

# Urea versus SustaiN

SustaiN is a proprietary product marketed by Summit-Quinphos Ltd. It is made by treating urea with agrotain, a chemical which slows down the conversion of urea to ammonium and hence to nitrate (see below). In theory this should reduce losses of urea N by volatilization (as ammonia gas) and also via leaching as nitrate.




The Dairy Exporter (May 2005) ran a story under the headline "UREA RESPONSE HALF THAT ACHIEVABLE". The story contained the following statements from Summit Quinphos Ltd representatives.

"Urea is the most widely used fertiliser on New Zealand farms but farmers may only be getting half its benefit ....."

"Poor efficiency [of urea] of less than 50 percent is widely regarded as the fault of the pasture in New Zealand rather than the fertiliser."

"Current inefficiency of urea ..... stemmed from volatilization and caused record losses of up to 53 percent with calculated average volatilization losses ranging from 12-34 percent."

"Other forms of N can be much more efficient."

The message that most farmers would take from this is that urea is inefficient. The article then goes on to suggest that Summit Quinphos product SustaiN is more cost effective and environmentally safer.

So what is the evidence: Is urea only 50% efficient? Are the volatilization and leaching losses of N from urea really that high?

Measurements of direct losses

Measurements of the volatilization losses from urea have been made and they are typically small (between 0-5% of the N applied). However, there are some special situations when the losses can be higher. These include: applying high rates of N in a given application (> 100 kg N/ha) or when urea is applied under hot, dry summer early autumn conditions. Losses in these circumstances can be as high as 30-40%.

Direct losses of urea N via leaching have also been made using an isotope 'labeled' urea. These losses urea N are also small - about 1% of the N applied at 200 kg N/ha/yr and about 10% at 400 kg N/ha/yr.

## Field trials

In the 1960s and 1970s hundreds of rates of N fertiliser trials were conducted in New Zealand looking at their effects on autumn, winter and spring pasture production. Many of these trials included comparisons of the different forms of N fertilisers. Some of these, like urea, are more susceptible to volatilization; others were nitrate fertiliser, more prone to leaching losses.

The conclusion from all this research was that there was "little difference in the effectiveness among the forms of mineral nitrogen fertiliser commonly used in New Zealand.". Expressed differently, they gave comparable DM responses per kg N applied despite their different chemical forms. The N efficiencies (kg DM/kg N applied) ranged from as low as 1 up to 24. These differences were attributed to agronomic factors (eg pasture species, pasture age, grass/clover balance, defoliation frequency, rate of growth), climatic factors (eg moisture and temperature) and soil factors (eg the rate of soil N mineralization and immobilization). It could be misleading therefore to suggest that differences in the effectiveness of N fertilisers are solely related to their chemical form.

Thus, the field trial data is consistent with the direct field measurements and it is reasonable to conclude that the losses of N from urea are of little practical importance when urea is used as recommended – 25-50 kg/ha per application in the late autumn, winter and early spring.

## Company Trials

Summit Quinphos have already published results from two field trials comparing urea with SustaiN. The first of these trials was in Northland on a kikuyu pasture, conducted in the summer. Arotain treated urea was no better than ordinary urea when compared at 25 and 50 kg N/ha.

The second trial was in the Waikato and was carried out by Summit Quinphos Ltd, also in the late spring-early summer. Urea and SustaiN were compared at a single application rate of 150 kg N/ha. No statistical analysis of the data was reported and the recorded rate of pasture production was of the order of 10,000 kg DM/ha over 82 days! So the data is difficult to interpret. In any case the reported losses of N from urea were about 7%.

I understand the company has other trials in progress. That is good. But until these trials are published in the peer reviewed scientific literature, or the data is made available for scrutiny by scientists without a vested interest, I cannot recommend SustaiN. That is a fair and reasonable standard which should be applied to all fertiliser products.

**My Advice?** At present urea costs about $490 per tonne ex works ($1.06/kg N) and SustaiN is selling at about $600 per tonne ($1.30/kg N). Is the margin (+ 23%) worth it, if the increase in efficiency is only about 5%? Based on the current evidence available to me, my answer is no.

## LIME: IS FINER BETTER?

The lime-slurry products phlolime (Rural Research Ltd) and limephlo (Mainland Minerals Ltd) have been on the market for some time (see Fertiliser Review No.11) These slurries contain micro fine lime (< 100 microns). More recently, several companies have started selling micro-fine lime as granules or pellets and in suspensions. How do these products compare and what claims are made for them?

The active ingredient in lime (I'm using the word lime in a generic sense covering all forms of lime applied to soil to change the soil pH) is the carbonate (CO32-) not the calcium (Ca). This comes as a big surprise to many. Our New Zealand soils have plenty of Ca, a consequence of their youthfulness – we have only recently emerged from the sea! Absolute Ca deficiency (as distinct from induced problems like milk fever) in plants and animals is not known in New Zealand. In any case, New Zealand farmers have always been big users of superphosphate (20% Ca) and lime (40% Ca).

Lime is beneficial because it adds carbonate to soil – it is the carbonate which neutralizes the acids produced in the soil through biochemical reactions (see Fertiliser Review No's 6 and 14).

$$\underset{\text{[lime]}}{CaCO_3} + \underset{\text{[acid]}}{2H^+} \longrightarrow \underset{\text{[calcium]}}{Ca^{2+}} + \underset{\text{[carbon dioxide]}}{CO_2} + \underset{\text{[water]}}{H_2O}$$

This chemistry says: the more carbonate added the more acid is 'mopped up' and hence the bigger the change in soil pH – the measure of H+. As a rule of thumb, 1000 kg/ha of a good limestone (ie greater than 80% carbonate) will increase the soil pH by 0.1 pH units.

If carbonate is the active ingredient then we should compare and cost different lime products, based on the carbonate equivalent. The Table below shows the carbonate equivalents of different liming materials and the cost per unit lime equivalent.

| Product | Lime equivalent (%) | Cost ($/tonne)[1] |
|---|---|---|
| Ag Lime (ground limestone)[2] | 80 - 90 | 15 - 20 |
| Kiln dust | 60 - 110 | 36 - 66 |
| Granulated & suspension lime[3] | 80 - 90 | 100 - 200 |
| Slurry lime[3] | 80 - 90 | > 650 |

**Notes:** 1) these costs are 'ex works' and are indicative only
2) typically 95% < 2.00mm and 50% < 0.5 mm
3) typically made from ground micro fine (< 0.01 mm)

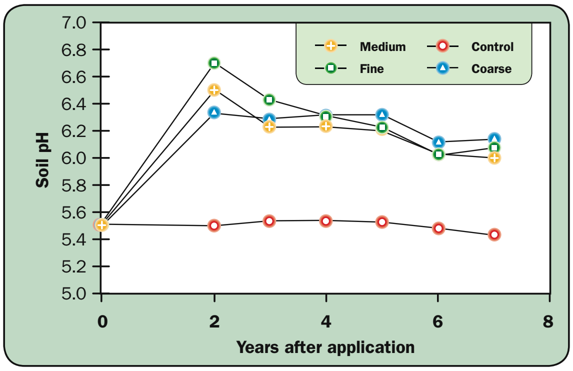
It is clear from this comparison is that aglime is the cheapest form.

One question arises: are the higher costs of slurry, suspension or granulated lime justified? Is there an agronomic benefit from fine lime?

The earliest field trial in New Zealand on the effects of lime on pasture production was conducted in the 1940s. In this experiment three grades of lime were compared at the same rate:

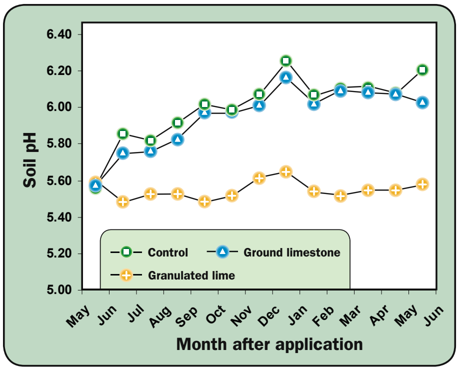
- coarse (97% of the particles less than 2.0mm and greater than 0.5mm),
- medium (50% of the particles less than 2.0mm and greater than 0.5mm and 50% less than 0.5mm) and
- fine (100% less than 0.5 mm).

The changes in soil pH levels over time, following application are shown below.

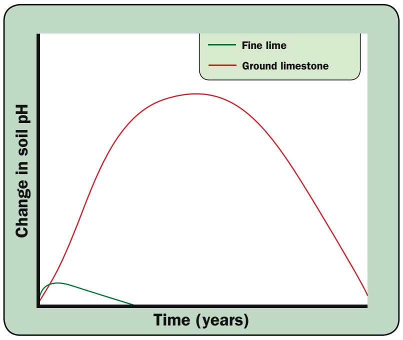



The finer lime "pushed" the pH up more quickly but its effect did not last as long. The coarse material was slower acting but its effect lasted longer. In other words the average soil pH over the trial duration was similar for the 3 treatments (6.1). In other words, when it comes to neutralizing acidity the degree of fineness does not matter but the amount of carbonate does.

To illustrate this point further the graph below shows the changes in soil pH over time following the application of 5 tonnes/ha of either aglime or a granulated lime. There was no practical difference between the products in terms of their effect on soil pH.




Some of the companies who supply these fine lime products claim that, because their product is finer, less material is therefore required. This is expressed as, for example, 100 kg/ha of our product is as good as 1000 kg/ha of aglime? Such claims defy the laws of chemistry. The diagram below illustrates the point.




It takes about 12-18 months for aglime to fully dissolve in the soil and have its maximum effect on pH. Thereafter the soil pH declines again, due to the production of acids in the soil. If the red line above represents what happens when a 1 tonne/ha of lime is applied then the green line represents the change in soil pH if, say, 100 kg/ha of fine lime is applied. Because it is finer it will react with the soil more quickly but its maximum effect will only be one tenth.

The point is this: finer equals faster, not bigger. Furthermore the faster the initial affect the shorter the residual effect. There is no free lunch in the world of chemistry!

It costs money to grind lime to a fine powder (as in slurries and suspensions) and then granulate it (as in granulated lime). Is the additional cost of value?

In my opinion the only situations where a faster acting lime is beneficial is when cropping – sometimes the soil pH must be increased quickly before sowing. For most pastoral situations I cannot see any great advantage.

**My Advice:** Finer means faster not bigger. Ignore salesman who would tell you other wise and buy liming products on the basis of their carbonate content.

## WHEN IS A FERTILISER NOT A FERTILISER?

The Fertiliser Industry is deregulated. The Fertiliser Act has been repealed and there is now no legal definition of the word 'fertiliser'. It is possible at present to sell anything and call it a fertiliser. Here is a case in point.

A Tauranga based company, Agrissentials New Zealand Ltd, markets a product called Rok Solid. It is described as, "A rock mineral based dry fertiliser blend, formulated to restore both essential minerals to tired soils and the microbial activity necessary to process them." In a report to a farmer the product is called Basalt Rock!

Many general claims are made for the product.

"'Farmers using Agrissential's fertilisers have said good-bye to bloat, facial eczema mastitis, staggers, and deaths from nitrate poisoning."

"You'll grow better quality grass and stock grazing it may never again need to see a vet! Your cows will produce better milk and be easier to handle."

"Agrissential's fertilisers make plants grow better and the flavors, appearance and shelf life of produce is improved out of sight."

The company literature appears to use scare tactics to promote its products:

"NPK heavy fertilisers like super, urea and DAP are so concentrated that they are toxic to soil micro-organisms…"

"……fifty years of applying artificial accelerating growth additives (he refuses to call them fertilisers) like super, DAP and urea has stripped the soil and left many farms critically deficient in whatever trace elements were originally present."

"Sure, super makes the stuff in your paddocks grow green and long but it's not really grass, its water."

"Salt-based fertiliser is junk food for grass. Just as eating salted chips and peanuts makes you thirsty, so it is with salt-based fertilisers!"

## So what is this product?

The major component of Rok Solid is silica (43%). However silica is very inert. If this was not the case our beaches would dissolve! It is most unlikely the adding silica to pastoral soils would have any affect whatsoever because they typically contain about 30-40% silica.

The concentrations of the major nutrients required for plant growth in Rok Solid are given below:

| Nutrient (%) | | | | | |
|---|---|---|---|---|---|
| N | P | K | S | Ca | Mg |
| 0.15 | 0.8 | 1.4 | 0.14 | 4.4 | 5.7 |

Using the conventional rating system for fertilisers, and rounding to the nearest whole number, the N, P, K, S, Mg rating of Rok Solid is 0, 1, 1, 0, 6. Based on the old Fertiliser Act (1960), this product would not meet the definition of a fertiliser which required that the sum of the NPK ratings was greater than 3.

Applied at 1000 kg/ha, the product would supply the following nutrients (in kg/ha): N 1.5, P 8, K 14 and Mg 57. The value of these nutrients, based on current costs, is about $60. Based on one quotation from a company rep, the product sells at about $300 per tonne! Even allowing for the cost of grinding the rock, this seems a very high margin! And these calculations assume that the nutrients present in Rok Solid are plant available! This is unlikely if the product is indeed basalt rock.

In his defense, Mr John Morris, the company Director stated, "…. our system of soil fertility bears no relationship to the NPK "Balance Sheet" theory, which you advocate, and therefore cannot be measured, or compared to such a theory." The only system I advocate is the sensible practical application of soil and plant science to ensure that soil, plant and animal, health, and production, is achieved and maintained, at the least cost for the farmer. To suggest that his company has its own system, distinct from this, which cannot be measured, is to advocate a dogma. New Zealand farming deserves better than this.

In my opinion this example highlights the need for an appropriate legal definition of the word fertiliser (s) and regulations regarding their use. New Zealand's economy depends on an efficient farming sector and fertilisers are a major cost – this will always be so. Leaving farmers vulnerable to exploitation in this very technical area is not sensible business for NZ Inc. Fertilisers are different from most consumer products – you cannot take them back if they do not work!

**My Advice?** Not a product for the financially efficient, sustainable farmer.

## FERTILISER: ALWAYS A GOOD INVESTMENT

Experienced farmers know that fertiliser is a good investment. But can this be quantified. The answer is yes – we do these calculations routinely. Here is an example.

A client recently purchased a block of bare land of 400 odd hectares. The farm was cut out of heavy bush many years ago but never properly farmed. It was then purchased by a new owner with the intention of putting the whole block into pine trees and accordingly the fences, yards, sheds and house were removed. It remained idle for a few years and the forestry idea was canned. The property was then purchased by my client.

The block is easy to steep hill country and the current pastures are typical of 'raw' pumice soils – dominated with browntop with a thick turf mat. Clover, although small and sparse, is present.

The new owner is currently fencing the block and installing a water system. His goal is to gradually make improvements such that in 5 years it is a stand-alone profitable unit. He asked me to develop as fertiliser plan accordingly.

## Current soil fertility

Two recent soils tests confirmed what was obvious to the eye – the current soil fertility is very poor (see Table). The soil is grossly deficient in phosphorus (P) and to a lesser extent sulphur (S). The priority is to correct these deficiencies but in time some potassium (K) and lime may be required.

| | pH | Olsen P | K | Sulphate S | Organic S | Mg | Na |
|---|---|---|---|---|---|---|---|
| Average | 5.6 | 10 | 9 | 6 | 10 | 18 | 5 |
| Optimal range | 5.8 - 6.0[1] | 25 - 30[2] | 7 - 10[1] | 10 - 12[1] | 10 - 12[1] | 8 - 10[1] | 3 - 4[1] |

**Notes:** 1) range required for maximum pasture production
2) range required for maximum profitability.

## Optimum soil test levels

Phosphorus (P) is the most expensive nutrient by a large margin. So the approach I take is to bring all the other nutrients up to there the optimal range so they are not limiting production and then calculate the optimal Olsen P – that is the level required to maximize profits long term (10 years).

To do several assumptions were made:

1. The potential stocking rate was set at 12.0 su/ha. This should be readily achievable within 5 years on this class of land given reasonable management inputs.
2. A gross margin of $50/su was assumed, based on typical figures from Meat and Wool New Zealand economic survey data.
3. The cost of P on the ground was calculated to be $2.10/ kg P. This allows for the price of supper at $186/tonne and for $60/tonne transport and spreading.

With these assumptions the economic optimal Olsen P range for this farm was calculated to be 25-30.

## Fertiliser requirement

Pumice soils require about 7 kg/ha of soluble P to increase the Olsen P by one unit. In this case we needed to increase the Olsen P by 17 units, from the current level of 10 to the optimal range (25-30). This will require about 140 kg P/ha equivalent to an application of SuperTen (a Ballance product because the client chose this supplier) of about 1.4 tonnes/ha.

The estimated cost of this capital input on the whole farm is about $140,000. This is a large investment - is it profitable and what is the likely return on investment?

## Economic analysis

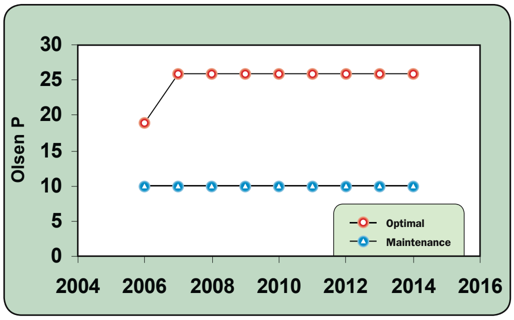
To answer these questions two scenarios were compared:

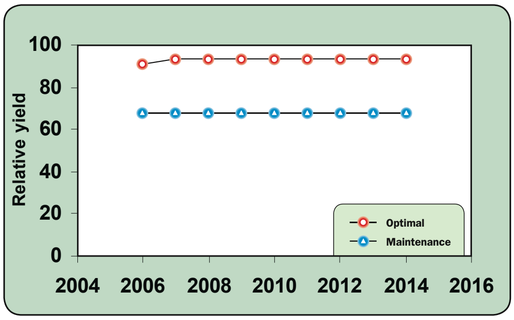
Maintenance: apply sufficient fertiliser to maintain the current soil nutrient levels and hence current production.

## Optimal:

Applying sufficient P (and S) to bring the soil nutrient levels up to the level which with optimize the profitability of the farm.

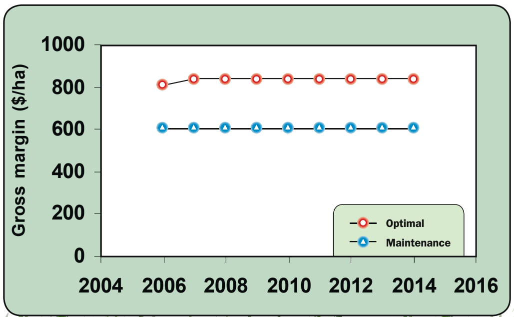
The first two graphs below show the likely changes in Olsen P and relative pasture production for each scenario:

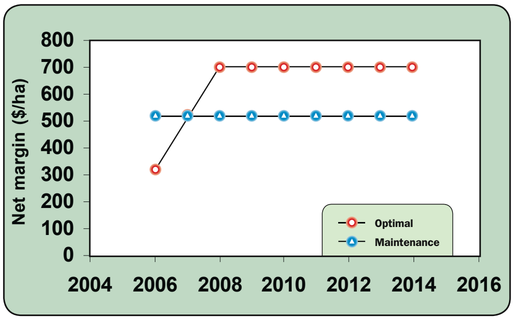



These results indicate that the optimal Olsen P level is about 27 (say in the range 25-30 allowing for normal variability) and that by achieving this, the relative production will increase by about 30%.

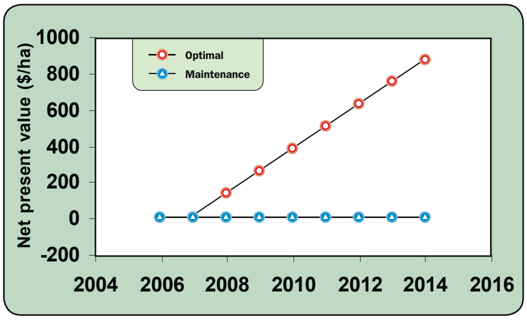
Assuming that the extra pasture is utilized (ie extra su units will need to be purchased) the predicted changes in the gross margin (GM in $/ha) and net margin (NM in $/ha) are as follows: (Note the Net margin is the GM minus the cost of the fertiliser and the cost of additional animals – it therefore is the profit from the fertiliser investment).



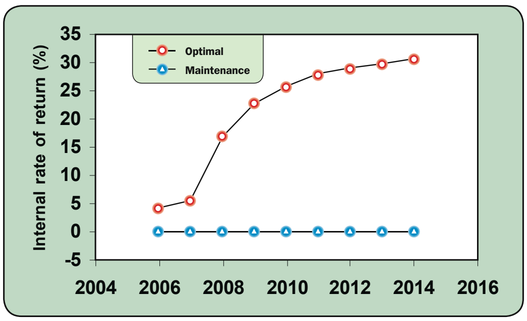



The changes in the GM over time simply reflect the relative yields, as expected. Initially the net margin is lower for the optimal scenario, because the cost of the fertiliser is incurred before the benefit is achieved.

Summing up all the annual net margins over time, and accounting for the inflation rate (5% in this calculation), the Net Present Value (NPV in $/ha) can be calculated relative to the maintenance scenario (below).




This indicates that, relative to maintenance (ie staying where you are currently), the farm will be more profitable by about $900/ha in year 10. This represents a return on the fertiliser investment (of $140,000) of about 30% (below).




What these calculations make explicit is that fertiliser is a good investment. Where else can you get 30% on your dough?

## Fertiliser Advice

One of the more important assumptions in the above calculations is that the additional pasture growth is utilized. This assumes that all the necessary infrastructure on the farm is in place, including fencing and water and that additional animals are purchased as the feed supply increases. Note also that we are dealing with a biological system and it takes time to get the soil-pasture-animal N-cycle underway and with it the improvement in the pasture species.

My client wanted to make these improvements slowly over a 5 year period. According a capital fertiliser program over 3 years was recommended, as follows:

| Year | Fertiliser | Tonnes required[1] | Cost ($)[2] |
|---|---|---|---|
| 1 | 800 kg/ha superTen3 | 323 | 79,830 |
| 2 | 800 kg/ha superTen | 323 | 79,830 |
| 3 | 800 kg/ha superTen | 323 | 79,830 |
| 4 onwards | Maintenance (300 kg/ha) | 121 | 29,936 |

**Notes:** 1) assuming 404 ha
2) assuming $187/tonne plus $60/tonne transport and spreading
3) this will provide 78 kg P/ha and 88 kg S/ha

If you are wondering why the total cost of spreading the capital program over three years (ie 3 x 79,830 = 239,490) is greater than the cost of doing it all in one year (ie $140,000), then just remember we have to include the maintenance component.

Because these are pumice soils both selenium (Se) and cobalt (Co) were recommended to be included in are applied with the fertiliser at standard rates.

It was also recommended that soil tests taken on an annual basis to monitor progress and adjust ongoing fertiliser inputs accordingly. For instance, it may be that the optimal P range will be achieved earlier that predicted, or, that some potash (K) will be required at some stage.

## The Moral of the Story?

An old-timer up North heard me give a talk to a group of farmers one day. I was preaching forth on the benefits of fertiliser and lime. He took me aside afterwards to offer me advice. “Son” he said, “I think you’ve got is about right. When I was a youngster my dad used to say, if you’ve got a debt put some fertiliser on and pay it off!” He was right in his Northland sort of way.