agKnowledge
TNM™ "Total Nutrient Management"
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SUSTAIN VERSUS UREA

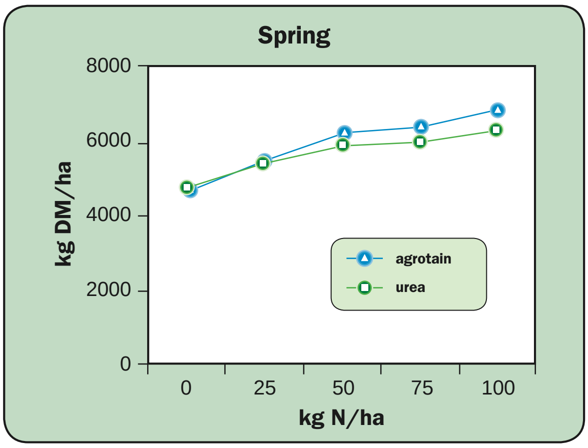
It is a good question: is SustaiN (urea treated with the urease inhibitor called agrotain) more efficient and therefore more cost effective than urea in our New Zealand pastoral conditions? No, was the answer based on theoretical considerations (see Fertiliser Review No 15, October 2005). We now have field trial data which confirms this earlier view.

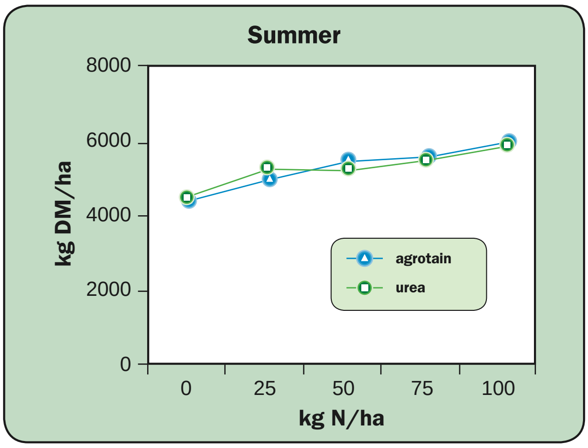
In 2008, Ballance AgriNutrients Ltd, published (see Fertiliser and Lime Research Centre, Conference, February 2008) the results of 10 field trials comparing SustaiN and Urea. In some of these trials the 2 products were compared over a range of fertiliser N rates, and in others, fertiliser N was applied in different seasons (autumn, winter and spring). The trials were properly replicated, designed and managed and were carried out by independent professional staff.

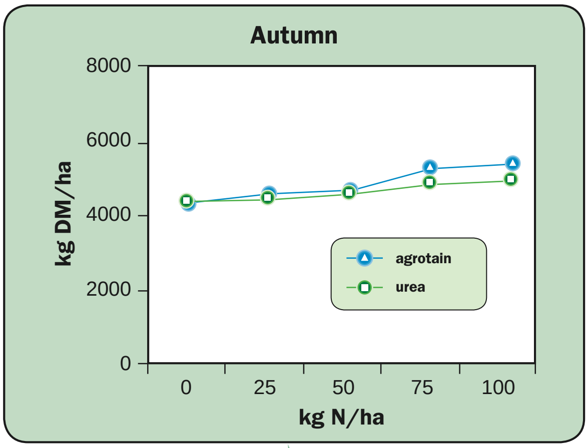
The authors of the report concluded that the, "pasture N-response advantages to SustaiN Green over urea proved to be small and non-significant". Decoding these words we get, the differences between SustaiN and urea, when applied at rates between 30-60 kg N/ha/application were less than the background 'noise', which occurs in all field trial work.

More recently (Proceedings of Grasslands Association Conference 2008) data from 3 trials conducted by Crop and Food were presented. SustaiN and urea were compared at 5 rates of N (0, 20, 40, 60 and 100 kg N/ha), applied in the spring, summer or autumn. The results (see figures) speak for themselves. At the normal rates that pastoral farmers apply fertiliser N (20-50 kg N/ha/application), SustaiN is no better than ordinary urea.

These results like the earlier ones from Ballance are no surprise – indeed they are entirely predictable from theory. Agrotain inhibits the breakdown of urea to ammonia (see Fertiliser Review 15, October 2005) and for this reason may, (under certain circumstances), reduce the loss of ammonia to the atmosphere (volatilization), thereby increasing N use efficiency. However, it has been known for 20 years that very little ammonia volatilization occurs when urea is used as recommended on pastures. That is to say, at rates of 20-50 kg N/ha per application in the spring, autumn and winter. The only possible role I can see for SustaiN is in horticulture and in some field crop situations, where large inputs of fertiliser N are required in the summer months.







TO THE FERTILISER CO-OPS: Who do you serve?

The article on SustaiN in this issue of the Fertiliser Review highlights a very serious, and I believe, emerging problem within the fertiliser industry. This is the scenario being played out: a new product is introduced into the market with a blaze of publicity. The claimed benefits of the new product are trumpeted far and wide. No doubt there is a rush of sales. And then science kicks in; research dollars are scraped together and trials undertaken. In time it emerges from the science that the claims are not substantiated. Is this not putting the cart before the horse? Surely a product should thoroughly tested **before** it is released into the market?

There are many examples – here are a few in approximate chronological order of appearance:

Maxicrop: so strong that 'a pint could feed an acre'. We all know the rest of the story. Research finally caught up with the precious black fluid – it was no better than the water it contained.

All Liquid Fertilisers: As above but see the review paper at www.agknowledge.co.nz

RPRs: Introduced in the mid 1980s – they were cheaper than super and, it was claimed, just as effective. Thousands of research dollars and many years later the truth emerged: They may have been cheaper then, but they are not now. More importantly, they are not agronomically equivalent to super, as many farmers has found to their peril.

Probitas: If it is too good to be true it probably is! You know the rest. Convicted of misleading advertising by the Commerce Commission and fined heaps.

SustaiN: Introduced several years ago and claimed to improve the efficiency of fertiliser N use – one again to fiddle accompaniment, '...increase production and reduce environmental pollution'! As discussed elsewhere in this issue – fiddle de dee.

EcoN: Another new product introduced to supposedly increase production, and, at the same time, reduce the farm's environmental footprint. There may be some evidence for the later claim (although much more research is required), but the current field evidence does not support the former.

I see a trend. All of these products have been introduced into the market without sufficient relevant and comprehensive research by independent organizations. Is this responsible behavior? Is this the deregulated, self-regulated industry in action? Such behavior may be understandable by those who operate at the fringe of the fertiliser industry, who typically have a pathological disrespect for science and, in any case, would not know a piece of science from a piece of 4 by 2! But this behavior from our co-operatives? The same co-operatives who claim to be science-based organizations? What do their shareholders – the farmers who own them – think? Is it fair to them? I think not.

I was challenged recently by one such shareholder who claimed that my 'Do-Good-ing' (as in writing the Fertiliser Review and making other public statements), was eroding his competitive advantage. He told me that he went to University so that he could learn the difference between fact and fiction, and as a consequence, out-compete his neighbors', thereby making more money, and ultimately, buying his neighbor's farm and thus generating more wealth for himself. Fair enough.

My view as a scientific observer of the industry is different: If I was CEO of "New Zealand Pastoral Farming Inc." I would want all my farm owners to have the best information available so that they could make the best decisions possible to ensure that they maximized their profitability. I call this acting in the common good.

It is in this sense that I challenge the Fertiliser Industry to examine itself – are they in business for themselves or for the common good – their shareholders, the farmers?

POOS AND WEES: How much and where does it go?

Our clover-based pastoral system is unique in terms of its extent and its efficiency. It has 3 components: the soil, the clover-based pasture, and the animal. The animal has a dual role – no only do they make products but they also recycle the nutrients – from the soil, to the pasture, through the animal, and back to soil. The importance of the role of the animal was demonstrated in Fertiliser Review 21 Spring 2008. Let us take this a bit further and in doing so I acknowledge my old colleague, Mr Jeff Morton (now of Ballance AgriNutrients Ltd) for these data. I also add a word of caution. There are so many variables in this science that it is hard to be precise – treat the numbers therefore as 'of interest only'.

The biggies in the nutrient cycling game are N and K, in terms of the amounts being recycled.

About 80% of the N ingested by an animal is excreted, either in urine (about 60%) and dung (about 40%). Depending on the size of the animal, the application rate of N in urine patches ranges from 200kg N/ha, for say sheep, up to 1000kg N/ha from a large cattle beast. Similar figures apply to the N in dung.

The N in urine is quickly broken down, first to ammonia gas (just take a whiff from a baby's nappy) and then to nitrate. It is estimated that the recovery (i.e. the retention of the N in the soil / plant / animal system) of urine N is between 7-65% – it is variable because it depends on the animal type, when it is deposited, the frequency and intensity of subsequent rainfall events and, of course the soil properties. Some is lost as ammonia gas but most is lost via leaching. This arises because nitrate N can be leached, and because the soil-plant system cannot absorb large dollops of nitrate N. The leaching loses are greatest when the soil is already saturated with water (i.e. late autumn and winter). This is the major leak of N in the pastoral system and is the source of N getting into waterways. It is for this reason that the search is on for deeper rooted pasture species which will intercept this N lower in the soil profile and before it gets into waterways.

Dung N is different – it is mostly present in an organic form (mainly as proteins). This N is not readily available and hence not prone to leaching. It must first be broken down by the soil bugs into eventually ammonia and nitrate. The recovery of dung N is about 20-25%.

For K, most of the ingested K is excreted as urine (70-90%), with the balance in the dung. The rates of application are similar to N (remember the concentrations of N and K in pasture are of a similar magnitude). Most of the urine K (30-40%) is retained in the soil with only small amounts being leached (about 5%), reflecting the fact the soil can hold K better than nitrate N. For dung K, the recovery is even higher (14-50%).

The concentrations of P and S in pastures are about an order of magnitude less than for N and K and hence the amounts of these nutrients being recycled are much less. A further difference is that most of the P and S excreted by animals are in a slow release dung form, for which the recovery is relatively high (25-40%).

And here are some more interesting numbers. The duration of the effect of dung has been estimated to be up to 2 years. In other words, the effects of the application of dung N, P and K can still be seen in some situations 2 years later, although this will depend on the presence and severity of the prevailing soil N, P and K deficiencies. The nutrients in urine are readily soluble and hence its effects on subsequent pasture growth are more fleeting, estimated to be 3 months for the urine N effect and up to 24 months for urine K.

Jeff Morton has used this type of information to calculate what proportion of a given farm or paddock is covered by dung or urine in any 12 months period. Once again treat these numbers carefully because there a many assumptions involved.

	Cattle stocking rate		
	1.25/ha	2.5/ha	3.7/ha
Urine	25-30%	40-60%	60-90%
Dung	20	33	45

	Sheep stocking rate		
	10 su/ha	15 su/ha	20 su/ha
Urine	60-100%	80-100%	85-100%
Dung	7	10	14

Obviously as the stocking rate increases the annual coverage increases – there are more bums per unit area, expressing it crudely. This is one of the reasons for the revolution in dairying which occurred in the 1950's, when rotational grazing became the norm. The concept that we should be thinking about to increase the rate and efficiency of nutrient cycling is: very high stocking rates for short periods of time – a child's guinea pig cage is an example that springs to mind.

PROGIBB® SG

agKnowledge Ltd was asked by NuFarm to review the research they had conducted to develop their product ProGibb® SG. This was completed in early 2009.

ProGibb is a proprietary formulation of gibberellic acid (GA) which is one of several plant growth regulators (The others are cytokinnin and auxin). These chemicals are made by plants and control key functions during plant growth. GA affects cell elongation for example. These plant chemicals, and their synthetic counterparts, have been used for very specialized purposes in plant propagation and horticulture for many years.

In the 1960s work was done in New Zealand and Australia looking at the effects of GA on pasture growth and production. The conclusion from this early work was that, yes, GA applied to pastures does stimulate pasture growth but this initial effect was offset by subsequent reductions in growth – the net effect was zero.

That is where the matter rested until the recent research by NuFarm here and in Australia. They have explored and then optimized the conditions where ProGibb can be used for maximum benefit, in terms of pasture production.

They had, by the time of the review, completed 38 trials over the period 2005 to 2008 and covering a range of climatic zones within New Zealand. The trials were, based on scientific standards, well designed, conducted, analyzed and reported. Indeed I was impressed with the quality of the research. This is often not the case with in-house research on proprietary products.

The average pasture response to ProGibb was 36% with a range of 12% to 62%. But it is important to realise the qualifying conditions which apply. The product must be applied as recommended within 0-5 days post grazing and harvested (or grazed) within 50 days post-application. The available evidence shows that if these conditions are not followed depressions in pasture growth may occur. Further research is being conducted looking at the longer term effects of the product and the effect of repeat applications.

Importantly, it must be stressed that ProGibb is not a fertiliser – our legume-based pastures need regular maintenance inputs of P, K, S, Mg, Mo and lime to optimize production and these inputs must continue. ProGibb could however be used as a substitute for fertiliser N to make good feed shortfalls.

My Advice:

1. ProGibb SG, providing it used as recommended can be considered as another tool, like fertiliser N, to fill feed shortfalls.

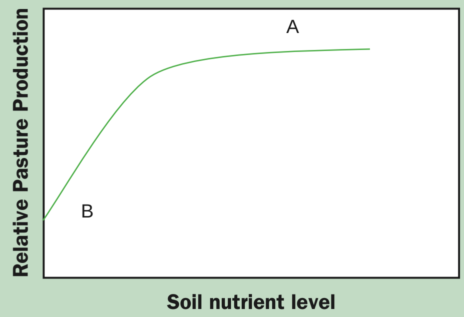
NUTRIENT BUDGETS: Interpret with Caution

A farmer, with whom I had recent contact, informed me that he did not require any fertiliser this year because the nutrient budget for his farm indicated that his soils were in balance – that is to say the inputs of nutrients were equal to the outputs. At least that is what his fertiliser man advised. I asked him what the soil nutrient levels on the farm were and it was very clear to me that they were suboptimal and therefore fertiliser inputs were most definitely required to optimize pasture production.

This exchange highlighted to me a lack of understanding about nutrient budgets.

Think of the relationship between soil fertility and pasture production (see below). If you are at point A you are at the top of the response curve – production is optimized. In terms of fertiliser inputs, all that is required is to apply enough nutrients to make good all the losses (as in product going off the farm, removal of nutrient to unproductive areas, leaching and runoff losses etc.). In other words, you will need a maintenance application of fertiliser. If you did a nutrient budget the inputs of nutrient should be exactly equal to the losses.

However, consider a farm at Point B. The soil fertility is low and so is pasture production. If this farmer applied maintenance fertiliser (i.e. nutrient inputs are equal to outputs) there would, by definition, be no change in the soil fertility. The farm would say stuck at low soil fertility and hence production, even though a nutrient budget would indicate the farm was in balance.



To improve this low fertility farm, capital inputs of fertiliser (over and above maintenance) are required to increase the soil fertility. In other words nutrient inputs would need to be in excess of outputs and this will show up in the nutrient budget.

The point should be obvious. A nutrient budget tells you where the nutrients are coming from and where they are likely to end up. It says nothing about where you are on the soil fertility production function. And this is the most important thing to know when it comes to designing a fertiliser and nutrient management plan.

ELEMENTAL SULPHUR: Our Recent Experience

Over the last few years we have prepared fertiliser and nutrient management plans for a significant number of farms on which the Olsen P levels were very high (>50 and well above the economic optimal range). In these situations, no fertiliser P was recommended so that the Olsen P levels could be mined down to the optimal range. However, ongoing inputs of both fertiliser S and K were required. For this purpose we recommended a mix of muriate of potash and Durasul (Ballance's elemental S). To our great surprise in all of these cases, the soils subsequently became S deficient. We are sure of this because of the low soil organic S levels and suboptimal concentrations of S in the clover-only samples. Visually the pastures lacked vigor and the clover leaves showed the classic symptoms of S deficiency (yellow leaves). This experience led us to think that perhaps the elemental S which we had recommended was not 'breaking down' fast enough to provide sufficient *plant available* sulphate S.

To explain: the S in elemental S is not plant available and must be oxidized (broken down) by soil microbes, (called *thiobacillus*), to *plant available* sulphate S. The speed at which this breakdown occurs depends on a) the particle size of the elemental S and the prevailing climatic conditions, in particular the soil temperature and moisture. The table below shows the effect of particle size and climate on the rate of oxidation. This is from research completed in the 1980's and 1990's.

Effect of particle size on the proportion of elemental S oxidised in the year of application in two climate zones.

Particle size (microns)	Proportion (%) oxidised in 1 year	
	Warm temperate[1]	Cold temperate[1]
1000-2000	15	10
500-1000	30	20
250-500	50	30
150-250	75	55
75-150	95	80
38-75	100	100

Note 1) see below

Obviously, the finer the elemental S and the warmer the climate the faster the breakdown. Note that for particles >1.00mm the rate of breakdown is slow – about 10-15% per year and of course it is even less for particles >2mm. (2000 microns).

From this data we can calculate what the particle size must be if *all* of the applied elemental S is to become plant available in the year of application.

The effect of climatic zone on the oxidation of elemental S.

Region	Particle size for 100% to be oxidised in the year of application (microns)
Warm temperate: Northland, Waikato, BOP, King Country, Taranaki, Northern, East Coast	<250
Cool temperate: Taupo, Hawkes Bay, Wairarapa, Wanganui, Malborough, Canterbury	<150
Cool temperate high rainfall: West Coast	<250
Cold temperate: Otago, Southland	<75

This suggests that the *ideal* elemental S product for most New Zealand conditions should have a particle size of <250 microns with a finer product (<150 microns) required for the colder regions.

So, the question arises: what is the particle size of the common pure elemental S products and products which contain pure elemental S (i.e. the sulphur supers). First, let us look at the composition of the various elemental S products:

Product	Total S (%)	Proportion of total S as elemental S	Proportion of total S as sulphate S
Ballance Durasul[1]	95%	100%	0
Ravensdown Industrial elemental S	~95%	100%	0
Summit-Quinphos elemental S	93%	100	0
Tiger 90[2]	90%	100%	0
Screened elemental S[3]	~95%	100%	0
Sulphur super 30[4]	~29-30%	70-72%	27-30%
Sulphur super 50[4]	~46-47%	86-87%	13-14%

Notes
1) Durasul is a Ballance product made by extracting S from the Marsden Point oil refinery
2) A granulated product made from mixing elemental S and bentonite
3) These products are not now available because they pose a fire and explosive hazard
4) The comparable Ballance products are Sulphur Gain 30S and Sulphur Gain 50S

The S in the first 3 products listed is present solely as elemental S. The S supers contain predominantly elemental S but also contain some sulphate S. The table below shows the typical particle size distribution of the elemental S in these products, listed in order of increasing fineness:

Product	Percentage of elemental S in product in each particle size range (in microns)					
	2000-1000	1000-500	500-250	250-150	150-75	<75
Ravensdown Industrial Sulphur	10.5	2.5	4.5	-	-	-
Balance Durasul	1	46	42	8	3	0
Tiger 90	0	87	4	3	6	0
Screened elemental sulphur	16	34.5	32.5	10.5	6	0
Sulphur super 50	11	23	24.6	16	14.6	11
Sulphur super 30	0	8.3	26.6	19.6	38.6	7
Summit-Quinphos elemental S	5	20	25	15	40	0

Ravensdown Industrial S is very coarse and only about 18% of the elemental S is <2000 micron (2mm). The Ballance Durasul product is all less than 2mm but is has very few 'fines' (i.e. <250 microns). Tiger 90 and Screened Elemental S do have some fine material (<250 microns). The sulphur supers are finer again but the elemental S becomes coarser as the proportion of elemental S added to the super increases. The Summit-Quinphos product is similar to sulphur super 30.

From this information the proportion of elemental S becoming plant available in the year of application can be determined and the enlightening thing about this data is that the particle size of the elemental S in all these products is too coarse, *on the assumption that we want the elemental S to become completely plant available in the year of application.*

Product	Proportion of Elemental S 'breaking' down within 12 months	
	Cool Regions	Warm Regions
Sulphur super 30	57	65
Summit-Quinphos elemental S	50	66
Sulphur super 50	44	57
Ballance Durasul	29	44
Screened elemental S	29	43
Ravensdown Industrial elemental S	3	5

What does this all mean in terms of fertiliser advice?

In terms of maintenance S requirements for pastures there are 2 groups of soils: the High S loss soils (peats, pumice, podzols and soils under high rainfall (i.e. >2,000mm), which require about 50kg plant available S/ha/yr and the low loss soils (all the rest) which require about 30 kg plant available S/ha/yr. Assuming we are dealing with a **warm** climatic zone then the amount of each S fertiliser required to meet the annual S requirement is as follows:

Product	Approximate amounts of fertiliser (kg/ha/yr) to provide 30 or 50 kg/ha of plant available sulphur in the year of application	
	30 kg/ha/yr	50 kg/ha/yr
Summit-Quinphos elemental S	50	83
Ballance Durasul	71	119
Screened elemental S	74	120
Ravensdown Industrial elemental S	690	1130
Sulphur super 30	~140	~232
Sulphur super 50	~107	~178

This seems to be the explanation for our experience with Durasul. We had assumed that most of the elemental S would become plant available in the year of application and had hence recommended applications of 30 or 50kg Durasul/ha annually (depending on the soil group), when in fact, after taking into account the plant availability of the S, we should have been recommending 70 to 100kg Durasul/ha.

It seems to me that the fertiliser industry should spend some R & D dollars on this issue. The industry needs a granulated elemental S product with a particle size < 150 to 250 microns, which can be safely blended with other fertilisers. But I get that de ja vu feeling: back in my agResearch days we were well down the track to develop just such a product. But it was deemed to be too close to industry and hence government funding was stopped! Let's try again shall we?

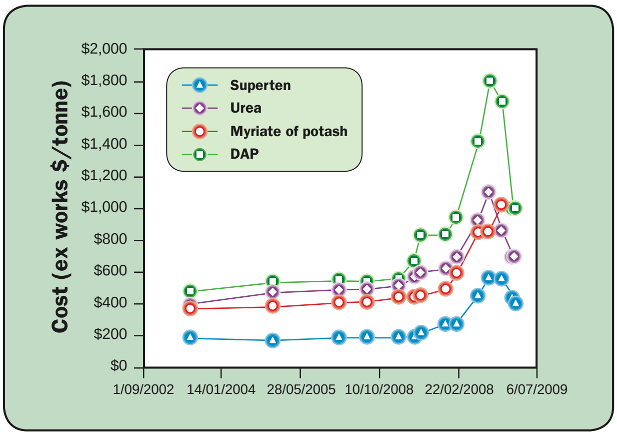
My Advice:

1. Adjust fertiliser S requirement to take into account the availability of the S in the elemental S.
2. The Ravensdown Industrial S is too coarse for most agricultural uses on New Zealand pastures.

PRICE WATCH

The figure below shows the changes in prices (ex works) of the key generic fertilisers sold in New Zealand. After being reasonably steady since 2002, prices for super, urea, muriate of potash and DAP began to increase in 2007 and reached a peak in September 2008. Since then prices for all of these products, except muriate of potash, have declined. These changes over time are a reflection of international prices (Rabobank Global Focus: Farm Inputs, Summer 2008).

According to other data published by Rabobank (Rabobank Agribusiness Review, March 2009) international prices for urea and DAP, but not muriate, have now returned to their mid 2007 values and hence it can be projected that the New Zealand farmer can expect further decreases in fertiliser costs going into 2009. Muriate of potash is the one exception.



The active ingredients in fertilisers are the nutrients and hence it is instructive to compare the costs of each nutrient.

Nutrient	Cost ($/kg nutrient ex works Ballance)		
	December 07	September 08	April 09
P	1.89	4.96	3.31
N	1.10	2.39	1.50
K	0.80	1.71	2.00
S	0.35	1.13	0.95

Phosphorus (P) is still the most expensive nutrient and is currently costing about $3.31/kg. This is still well above the December 2007 price. Assuming the trends from Rabobank it is possible that this could come back to about $2.20/kg P. The cost of N is still half way between the December 2007 and June 2008 figures and once again this may ease further in time. The nutrients K and S are anomalous – the cost of both these nutrients has increased since December 2007 and do not appear to be easing.

My Advice:

1. Given that P is still the most expensive nutrient it is the nutrient to focus on if you want to prune the fertiliser budget. If Olsen P levels are above the economic optimal then withhold P inputs, keeping track of soil P levels over time.

2) If all the soil nutrient levels are above optimal then withhold all fertiliser inputs this autumn and wait for fertiliser prices to bottom out.

Optimise farm profitability

Make your fertiliser dollar go further

Decrease your farm's environmental footprint