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WHAT FAIRFAX MEDIA CHOSE NOT TO PUBLISH

Editors Note

Most of you will be aware that I write a fortnightly column for Fairfax Media's "NZ Farmer". Reproduced below is a column I wrote some months ago, which Fairfax's lawyers decided not to publish because of concerns about potential legal action arising from possible defamation. Fairfax, I am told, are risk averse in such matters. Fair enough – that is their policy. I take a different approach – if we are to have an efficient agricultural sector then it is important that it is well informed, especially in terms of fertiliser products.

There are two important tests for defamation: Is/are the statement(s) true on the balance of probabilities or, is/are the statement(s) fair comment on a matter of public importance and offered without malice?

Given the importance of fertiliser to the primary sector, and given the prominent advertising for the fertiliser product SustaiN, I am sure the second criterion is met, making it clear that my motivation is to inform farmers.

Establishing the truth can be more difficult. In this case I will apply the test: Is it reasonable for a person in my position (an independent scientist who has conscientiously examined all the relevant information available to him) to reach the conclusion and opinions offered.

The original column has been modified slightly to improve clarity and because there have been changes since it was first written in October 2015. So here it is with some editorial changes. Please note that the style of writing for these columns is different from 'normal' science writing. These columns are for lay people – they are about science but with a human touch.

"When is a co-operative not co-operative? And, to avoid possible complications, I am not thinking of Fonterra. My attention at this moment is the Fertiliser Industry. I think of them as sports teams – the Blue team (Ballance Agri-Nutrients Ltd) and the Green Team (Ravensdown Cooperative Ltd).

According to the Companies Office, "A co-operative is a term used to describe a business organization that is owned and democratically controlled by its members," and perhaps more revealing, "A cooperative is run for the mutual benefit of its members who may purchase goods or use the services at a favourable rate rather than being established for the purpose of earning profits for investors."

I was driven to seek a definition of a cooperative company because of recent advertising by the Blue Team with respect to their product SustaiN. You have seen the ads I am sure. The one in front of me as I write is from the Dairy News (October 13, 2015). A full-page ad showing a farmer holding a placard claiming: MY SUSTAIN GAIN, $1013, NET BENEFIT. The ad tells us that this is the benefit from using SustaiN instead of urea – SustaiN is urea treated with the urease inhibitor agrotain. The reader is directed to a website (**www.sustaingain.co.nz**) for more information. Oddly when I accessed the website the "SustaiN Gain" for the same farmer was $1,541.

[These slight discrepancies are of little concern to me – it is the overall message that the reader may take from these ads that is important. It appears that the Blue Team uses different input data when calculating the SustaiN Gain benefit in different situations].

Here is one example of how the SustaiN Gain is calculated. It is assumed that 60 kg of product, either urea or SustaiN, is applied. Further it is assumed that 15% of the urea N is volatilised (lost to the air) and only 7.5% is lost from SustaiN (i.e. a 50% reduction in volatilisation). Thus the inputs of 'effective' N are 25.5kg N/ha for SustaiN and 23.4 for urea. Applying a conversion factor of 10 kg DM/kg effective N applied means the extra pasture production from SustaiN is 255 kg DM/ha compared to 234 kg DM/ha from urea. This implies a marginal 9% response in DM from SustaiN, relative to urea. It is also assumed that pasture utilisation is 80% and that 12.5 kg DM produces 1 kg MS. Based on a MS payout of $3.80/kg MS the benefit of using SustaiN relative to urea in five applications per year, over 105 ha works out at $1013 per year.

I recently reviewed all of the field trial data that I could find nationally and internationally comparing urea and SustaiN on pastures and crops yields **(see agknowledge.co.nz/publications Fertiliser Review 34)**. There are 105 comparisons in the data-set that I assembled and the average response of SustaiN, relative to urea, was 2% with a confidence interval of about +/- 1%. The range in responses was from -11% to +23%. In other words the results straddle zero. The probability of getting a positive response is about 62%, slightly better than calling heads.

[Please note that if 100 field trials were conducted comparing a control (no treatment) with a completely inert material the results would range from about -20% to + 20% with the average at about zero. This range in results is due to the background noise that occurs in all field trial work].

Thus, there is a hint in the data that SustaiN is better than urea but is hard to 'see' given the background noise. This conclusion is consistent with the view that when urea is used as recommended (typically 50 kg urea/ha per application in winter, spring and autumn) on temperate clover-based pastures, the losses of N via volatilisation are typically small (< 5%).

The Blue machine obfuscates this fact by claiming that SustaiN reduces volatilisation by 50%. This is true - but 50% of a small amount is a small amount!!! They also claim that the difference between the products is not 2%, as calculated above on an absolute basis, but 5% when calculated on a marginal basis. In the example referred to earlier a marginal response of 9% was applied. In my opinion calculating the difference between these products on a marginal basis, as distinct from an absolute basis, appears to me as a mathematical contrivance that makes the difference between the products look bigger **(see Fertiliser Review No 24)**.

It is likely that the Blue team will also respond by saying that volatilisation of N from urea is variable and depends on a number of factors and in particular rainfall post-application of the urea. This may, I accept, explain some of the variability in the data. Where sufficient rain has fallen post application, volatilisation will be minimized resulting in small differences between SustaiN and urea. The larger differences, and they go up to +23% in this data set, may be trials in which there was no rain post application and the weather was warm and humid. This explanation for the range in the positive results (the 62% of the 105 trials) is tempting. But if these results are accepted as 'real' – as distinct from expressions of background noise – then what about the 38% of results that showed 'negative' responses, suggesting that SustaiN depresses DM yield relative to urea. Are they 'real' or are they background noise? Statistics is unforgiving.

I can see the Green team blushing ever so slightly because I'm sure they would not like to be reminded of their promotion of their sister product, EcoN. Remember – EcoN? It was claimed to increase pasture production by up to 20%. My review (NZ Grasslands Conference 2011) of the field trials with this product (n = 28) indicated very similar results to those discussed above – an average response of 2% with a range -17% to +17%. Once again a hint of an effect but hardly discernible above the 'experimental noise.' Being charitable, the ad was half correct – up to about 20%!

[Since writing this column Ravensdown has introduced its own branded agrotain-treated urea called N-Protect. It has similar specs as SustaiN.There have been recent changes in pricing - currently the margin for SustaiN relative to urea is about $50/tonne].

The interpretation of scientific trials is fraught with difficulty when the results are within the margin of experimental error, which in agronomic field research is typically +/-20%. It is my view that both companies are playing commercial games in this space at the expense of their owners.

I have of course raised these issues from time to time with both teams. The answer is always the same. "Doug, Dougie, Douglas, Dr Edmeades" – depending on the depth of their wound – "Our owners, the farmer, expect us to be efficient and make a profit." It is a foolproof argument until the next question – "That is fine. I understand. But at the expense of your owners!!!!!

My opinion

This is not the product for a cost aware pastoral farmer using urea as recommended at rates of about 50 kg urea/ha when the pasture is growing (spring, autumn and winter). Recall – urea is a growth multiplier best used when the pasture is actively growing.

The product, in my opinion, is best suited in cropping situations where high rates of N (up to 100 of N/ha (217 kg urea/ha) are required 'up-front' and when conditions are warm and humid.

NEW PRODUCT: THERMOPHOS

A "new" phosphorus fertiliser has been recently introduced into the New Zealand market. It is "new" only to this generation of farmers, farm consultants and scientists because, in fact, a considerable amount of research was done on the product in the 1950's, 60's and 70's. The reason for this early research is interesting: there were fears after WW II that the world would run out of sulphur. Sulphur in the form of sulphuric acid is used to make superphosphate. So the hunt was on to find alternative sources of plant available phosphorus (P).

Thermophos is made by fusing (heating together at a very high temperature) typically low-grade phosphate rocks with either serpentine or dunite, both of which contain magnesium (Mg) silicates. The resultant fine powder or sand contains about 8% total P. This P is not water soluble like the P in superphosphate (9% total P), but is 90% soluble in citric acid, a mild acid, which means that it is plant available. This has been demonstrated in several pasture field trials, which showed that Thermophos is as good as super as a source of plant available P, when compared on an equivalent rate of available P.

Currently Thermophos costs about $430 per tonne ($5.3/kg P) compared with super at $320/tonne ($3.6/kg P). This comparison does not consider the value of the other agronomically useful ingredients in each product (viz. sulphur (S) in superphosphate and the lime and Mg in Thermophos).

It is the other ingredients that differentiate Thermophos from superphosphate. Unlike super, Thermophos contains no S. Thus, if you were contemplating using this product, sulphur would need to be added. This could be achieved by blending it with elemental S (SulphurGain Pure from Ballance or Sulphur90 granules from Ravensdown) assuming that their respective granule sizes are compatible.

Thermophos also contains about 8% magnesium – there is no Mg in super. Assuming that this Mg is present as the oxide and not as Mg silicate, this Mg should be plant available. Mg currently costs about $1.7/kg. Factoring this into the calculation reduces the cost of the P from $5.3/kg P to $3.56/kg P. So that apples are compared with apples, the S in super would then need to be accounted for and this brings the cost of P in super down to $3.20. Thus the comparative costs are $3.20 v $ 3.56.

But there is a further matter to consider. Because of the manufacturing process, Thermophos contains oxides of both Mg and calcium (Ca). These are liming materials and from the analyses I have seen Thermophos has a liming equivalent of 80-90%, meaning it is similar to ground limestone in terms of the concentration the active ingredient – the liming component.

Assuming that Thermophos was applied at 560 kg/ha on a dairy farm to give a maintenance input of P (say 45 kg P/ha), then at this rate of application about 0.5 tonnes lime equivalent/ha would also be applied. This represents an annual maintenance input of lime on a high producing dairy farm. Thus, the liming component in the product is of some significance. Taking this lime content into account brings the cost of the P component in Thermophos down to $3.48/kg P compared to super at $3.20.

Does the product have a place in NZ? Yes, possibly on soils that contain above optimal levels of sulphur – this could apply to some volcanic soils which have accumulated S from past super applications – or soils which require annual inputs of Mg and some lime – the pumice soils are the obvious target soils in this category.

SPECULATION ABOUT SILICON

As noted above Thermophos is made using Mg silicates. Analyses of the product indicate that it contains about 18% total silicon (Si) and about 3% of this is said to be 'soluble'. The question arises: is this – the soluble Si in Thermophos - likely to have a beneficial affect on plant growth?

First some background. Silicon is the second most abundant element in the earths crust. Typically topsoils contain 33% total Si (world average range 25-35%) present as silica (SiO_2 in many forms) or silicate minerals (in many forms). In the process of weathering silicate minerals (but not silica which is chemically inert) is released Si into solution and hence Si is present in soil solutions in most soils as monosilicic acid ($Si(OH)_4$ or H_4SiO_4). I recall some research I did in the 1980's looking at the composition of soil solutions; the concentrations of Si across a range of soils were 0.10 to 0.68 mM.

Plants take up Si from soil solution as the neutral entity H_4SiO_4 and typical concentrations in pasture grasses are about 0.5-2.0% and <0.1% for the clovers. Silicon taken up by the plant can be deposited in the outer walls of the epidermal cells on the surfaces of leaves and in the reproductive organs of the plant and there are suggestions in the literature that this forms a physical barrier against water loss, fungal infections and insect damage, and provides rigidity for the plant.

However as soils weather the sparingly soluble silicate minerals are converted (weathered) to inert silica (SiO_2) and it is known that some weathered tropical soils have low levels of 'available' Si. Now the plot thickens.

It is known that on such soils, some important agricultural plants (wetland rice and some C4 plants such as sugar cane and maize) benefit from the addition of silicate containing materials. Benefit in this instance does not mean an increase in yield – it means the plants stand more upright, are more drought resistant and more resilient to stress caused by insects and fungi.

Thus, although Si is not regarded as one of the essential plant nutrients there is some evidence that it may, in some situations, have beneficial effects on some plants.

*[**Definition:** an element is regarded as an essential nutrient only if in its absence the plant cannot complete its natural life cycle from germination, reproduction and then senescence]*

Some time ago I reviewed the literature on this topic and wondered. Because Si in the form of silicates is so ubiquitous in New Zealand's generally unweathered soils, it is most unlikely that the addition of sources of soluble Si will have any affect on agriculturally important plants – C4 or otherwise - grown in New Zealand.

However we have soils in NZ that are highly weathered (e.g. the Northern podzols – the so-called "gum land" soils of Northland and some soils on the West Coast). We also have large areas of peat soils that are of course developed from plant material and not the rocks that contain Si.

We grow maize, paspalum and kikuyu - all C4 plants - on these soils and they are exposed to droughts and damage due to insect and fungi. Would adding silicate minerals to these soil-crop combinations be beneficial?

Research on this topic in NZ is meagre and piecemeal. The old Fertiliser Manufacturers Research Association (FMRA) reported results from pot trials suggesting beneficial yield effects on sorghum and paspalum on a highly weathered Northland soil, but no effect on ryegrass. AgResearch reported no effect of a silicate containing fertiliser on maize yields in the field trial on a peat soil but they noted that the silicate material they used may not have contained soluble Si.

Further research is required to take a systematic look at a) sources of soluble Si in NZ and b) possible effects of such materials on C4 crops looking at not only possible yield effects, but importantly, pest and drought resistance. Just a thought.

WHEN IS AN RPR NOT AN RPR?

In the mid 1980's fertiliser subsidies were removed and the rush was on to find cheaper sources of fertiliser nutrients, particularly for the most expensive nutrient phosphorus (P). Reactive phosphate rocks (RPR's) were one option. They contained between 10-12% P in a sparingly soluble form. Initially they were thought to be as effective agronomically as the water soluble P fertiliser like super, DAP and Triple super and, importantly they were, at that time, cheaper – about 30% cheaper per kg P as I recall. RPR's became a significant part of the fertiliser market in a short time. As the National Science Leader (Soils and Fertiliser) in AgResearch, a very large part of our research expenditure was directed to research on these alternative fertiliser products.

As the research came in, it became clear that RPR's were not agronomically equal, kilogram P per kilogram P, to soluble fertiliser, and that all RPR's were not equal. The best (Sechura) dissolved at about 30% per year and the worst (Egyptian) at about 12% per year.

Thus, Sehura RPR became the 'gold standard' for RPR and a chemical standard was set for RPR's: they had to contain at least 10% total P of which 30% was soluble in a mild acid (citric acid).

Today the RPR market is much diminished; a combination of the science, farmer experience and importantly the price – it is now more expensive than super as a source of P.

Nevertheless RPR's are still sold in New Zealand. Both of the co-ops have it listed on their product lists and there are a number of smaller importing and retailing companies offering RPR.

Now the tricky bit: Sechura RPR as noted above was the standard (> 10% total P and > 30% citric soluble P). Compare this with what Ballance is currently offering. They call their product "CloverKing Sechura." It contains 7.5% total P of which > 50% is citric soluble.

In their Newsletter (Grow Spring 2015) they say: "Ironically CloverKing Sechura currently (July 2015) cannot be called a 'reactive phosphate rock' (RPR). This is only because it contains 7.5% phosphorus and the current definition of a RPR stipulates a minimum of 10%."

This seems to be an honest assessment but then they add. "However it can be used wherever you might chose to use RPR." It appears that Ballance accept that their product is not an RPR but can be used as if it is an RPR. Curious? I can also understand the annoyance of the small importers. One of them imports the genuine article, Sechura RPR (10% total P and > 30% citric soluble) and must compete in the market against a product, which does not meet the specs of the real McCoy but is still called Sechura.

In their defence I am informed by Ballance that there are now three companies mining from different places in the legally defined Sechura deposit in the Peruvian desert. So all three can rightly claim that their product comes from the Sechura deposit. The problem as I see it is that all three cannot claim that their product from their part of the deposit meets the specs we have developed in NZ for an RPR.

Solution?

All parties should drop the word Sechura, because it is now quite meaningless in terms of defining or implying the quality of materials being mined in the Sechura deposit. The focus should now be on the standard and not the product, which initially set the standard.

DICALCIC PHOSPHATE: WEASLE WORDS

[A weasel word (also, anonymous authority) is an informal term for words and phrases aimed at creating an impression that a specific and/ or meaningful statement has been made, when only a vague or ambiguous claim has been communicated, enabling the specific meaning to be denied if the statement is challenged].

A survey

A recent paper published in the FLRC Workshop Proceedings (2015) has drawn my attention. Not because it shines a light, solves a problem, or comes up with a new theory. Quite the opposite – it is an appalling piece of science which deserves analysis. What can we learn from it in terms of the conduct of science?

The paper reports the "soil and pasture, productivity and financial outcomes" from 11 farms throughout the North Island over a 5 year period from 2009 to 2013, who had been using dicalcic phosphate (DCP). They were further subdivided into long-term users (> 15 yrs, n = 3), medium term users (6-15 years, n = 4) and new users (< 5 years, n= 4). Where possible and relevant the outcomes from these 11 farms were compared with the average data for Farm Classes 3 (North Island Hard Hill Country) and 4 (North Island Hill Country), from the surveys conducted by Beef & Lamb NZ.

The average stocking rate on the 11 survey farms was about 9.4 su/ha, compared with 9.3 su/ha on Class 4 and 8.0 su/ha on Class 3. Net production (net meat output, kg /ha) on the survey farms ranged between about 100-200 kg/ha and lambing percentages 110 to 120%. In other words these 11 farms were average.

The annual P inputs over a five-year period (2009-11) were on average 9 kg P/ha for the 11 survey farms and 20 kg P/ha for the Class 3 and 4 farms. The Olsen P levels at the start of the survey period were 35 (new users), 25 (medium users) and 15 (long-term users). Importantly they declined over the 5 years of the survey, to about 20, on both the new and medium user farms, but remained constant on the long-term users farms.

Essential background

DCP is essentially a 50:50 mix of lime and superphosphate and thus the P and S content in DCP are typically 50% of that in super. The product is applied at similar rates as super and hence DCP users typically apply about half the amounts of P and S.

The chemical form of the P in DCP is di-calcium phosphate - hence the name - which is less soluble than the mono-calcium phosphate and it is claimed that this form of P is more efficient – it does not get ‘locked up’ in the soil and does not get removed in surface runoff.

Many field trials have shown that DCP has the same agronomic value as soluble P when applied at the same rate of P application **(see Fertiliser Review 12 and for the full science review go to dougedmeades.com)**. The best example of this is a trial that ran for 14 years – in the Hawkes Bay – the region where the dicalcic company, ‘Hatuma’ is domiciled. There was no difference in pasture production between dicalcic P and soluble P (Figure 1). It has also been shown that in the long term (> 3 months) the amount of P in surface runoff from DCP treated plots is no different from soluble P treated plots.

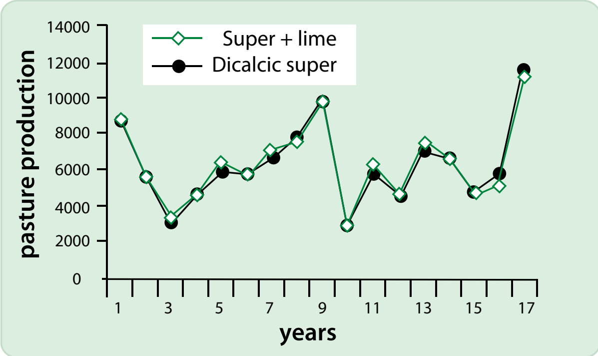

Figure 1 Effect of dicalcic superphosphate (DCP) and the same amounts of superphosphate and lime applied separately on annual pasture production over 17 years.

Survey Results

At a general level the results of the survey show that the production and financial performance, over 5 years, of these 11 farms representing DCP users, lies between the average of Classes 3 and 4 farms. There appears to be nothing exceptional about DCP fertilised farms relative to farms where, it is assumed, only soluble P is applied. But how can that be, given that the average annual P inputs were about 50% lower on the DCP farms (viz. 9 kg P/ha/yr on the 11 survey farms and 20 kg P/ha/yr on the Class 3 and 4 farms)? Does this not suggest greater P efficiency?

The Olsen P levels on the new and medium user groups, ranged from 20 up to 35 with most (8 of 10) being 25 and above. For this class of country and given the recorded levels of production, these are high - above the economic optimal range. The sensible fertiliser policy in these circumstances would be to withhold or at least reduce P inputs. This is what they did by adopting a low P and S, DCP fertiliser policy. This is reflected in the Olsen P levels, which declined over time as the soil P levels were mined.

This in no way proves that using DCP is more efficient than soluble P. It simply means that new and medium term users of DCP were farming on the fat of the soil P reserves.

The Olsen P levels on the long-term user group was about 15 initially and remained constant of the 5 year survey period. Once again no surprise. The economic optimal range for farms running about 8-9 su/ha is 15-20 and a P input of about 10 units P/ha/ yr is probably enough to maintain the Olsen P levels at this stocking rate and level of production. Once again there is nothing magical about the use of DCP. All these results are consistent with the known science.

The survey results also show that duration of use of DCP does not differentiate DCP farms. In other words the effects of using DCP, if any, do not increase over time. How many farmers have been sold the story, by the snake oil salesman that they have to stick to the plan to reap the rewards!

At a specific level the report concludes:

1. "Stocking rate and lambing % did not differ between user groups"
2. "Average soil quality values did not change significantly over time."
3. "Overall there was no change in the number of earthworms……"
4. "Most of the pasture macronutrients and palatability values did not change noticeably on the farms with no clear differences between user groups."
5. "This [meat output in kg/ha/yr] varied notably between years with no clear difference between groups."

Weasel Words

But this is what we find in the summary to the paper.

"The Farming for the Future project described here has provided ***some insights*** into the outcomes associated with lower nutrient input use on sheep/beef farms. It is acknowledged that the project has used a case study approach, with a ***limited number of farms***. Nevertheless, the findings ***indicate*** that key production and financial outcomes ***could be*** maintained by a lower nutrient inputs system. ***Additional*** research looking at the outcomes on farms applying less nutrients ***could be valuable*** given that phosphate rock is finite…"

The weasel words identified in ***italics*** above, suggest or imply that the real answers that the authors were seeking, or thought they would find, are just around the 'corner' if only more work could be done! The blunt fact is that no serious conclusions can or should be drawn from this survey.

Science Process

"Nil" results can and do happen in science and the normal scientific process in such cases is to review the work: Was the "nil" result a consequence of a poorly designed experiment (survey) or was the question being asked (the hypothesis) wrong? The authors themselves acknowledge that the number of farms in the survey was small (n = 11). This alone is fatal. But lets look at the hypothesis.

The introduction states: "…… the project described here set out to gain a better understanding of the outcomes of lower nutrient input use on sheep/beef farms in NZ applying pH neutral dicalcic phosphate fertilisers (DCP)."

Has a "better understanding of the outcomes of lower nutrient input use on sheep/beef farms" been gained? At best the results from this survey provides

DICALCIC PHOSPHATE: WEASLE WORDS continued…

no evidence that would contradict the hypothesis that DCP is no better or worse that soluble P fertiliser like superphosphate.

The normal scientific practice before embarking on a new scientific experiment is to review the scientific literature. In this case such a review would consider whether there is any evidence to suggest that DCP is better than soluble P fertiliser and does this benefit increase over time? If the authors had followed this normal process they would have found all the earlier research and in all likelihood decided that the question they posed had already been answered. No further research required and especially not a poorly designed survey.

Why the Survey?

To answer this question I think we need look no further than the acknowledgments in the paper, which state, "This research was funded by Hatuma Dicalcic Phosphate Lime Ltd." This company makes and markets DCP.

I would be most surprised if they did not know about the research that has been undertaken investigating their product showing it was not better agronomically than soluble P, albeit more expensive. Perhaps they went fishing - lets undertake a survey and come back with the numbers we need to support our myth.

The science tragedy is that they found people to undertake a survey who were either unaware of the scientific process or who were prepared to set it aside for the sake of a few research dollars. This regretfully is becoming more common today – it is called Post Normal Science which embraces the notion that the purpose of science is no longer about seeking the truth – the role of science now in this post modern world is to support the narrative. How else can the weasel words be explained?

Dr. Doug Edmeades