



GET YOUR FERTILIZER ACT TOGETHER

This issue of the Fertiliser Review focuses on 3 relatively new products: **Sustain** (from Summit Quinphos Ltd, a wholly owned subsidiary of Ballance AgriNutrients Ltd), **LessN** (Donaghys Industries Ltd) and **EcoN** (Ravensdown Fertiliser Co-operative Ltd).

These recent arrivals have one feature in common. They have been launched onto the New Zealand market with bold claims which subsequent research has shown are either exaggerated or just plain wrong. There was a time when this sort of activity occurred on the fringes of the fertiliser industry but now it seems that the big boys are in on the act. I say, it is time the industry got its fertiliser act together. Is it time to re-examine the need for some ‘consumer protection’ for farmers?

Farmers have been protected, at least to some extent, from unscrupulous fertiliser merchants since the first Fertiliser Act was enshrined in law in 1908. It was updated in 1927, amended in 1948, updated again in 1960 and amended further in 1982. All of this came to an end in 1997 with the passing of the Agricultural Compounds and Veterinary Medicines Act which repealed all the previous fertiliser legislation. Importantly it removed from the statute books any definition of the word ‘fertiliser’.

Farmers now have no protection. Anyone can sell a product and call it a fertiliser even if it has no value as a source of nutrients. The consumer jungle rule applies – let the buyer beware.

Parliament’s Hansard records the various reasons advanced over the years as to why farmers need protection. These include: the importance of agriculture to New Zealand’s economy, the importance of fertilisers in maintaining soil productivity, the complexity, from the farmer’s perspective, inherent in choosing the right fertiliser (fertiliser chemistry, soil fertility and plant nutrition) and the ever presence of unscrupulous merchants prepared to take advantage of farmers’ vulnerability in this respect. These arguments reduce to the very human desire on the part of various governments to give farmers confidence to

know that their fertiliser dollars are well spent in the interest of both them and the nation.

These well meaning motives and intentions were overwhelmed by the ‘new right’ philosophies which were part of the reforms introduced into New Zealand agriculture from 1985 onwards: less government and more market, the market knows best so let the market regulate itself, farmers are not stupid they do not need protection, choice is good. The endpoint of this type of thinking resulted in the repealing of all previous fertiliser legislation in 1997 and the establishment of the voluntary Fertmark scheme currently operated by the Federated Farmers (Fertiliser Quality Council, FQC).

The question begs: is New Zealand better or worse for these changes? Is there any rational argument to revisit this issue?

Certainly, post the reforms, it is now fully appreciated and accepted that agriculture is important to New Zealand’s economy – the sun has indeed set on the ‘new right’ argument that agriculture is a ‘sunset industry’. And fertilisers are still a major cost to agriculture and the farmer – in excess of \$1 billion annually and about \$30-\$40,000 per farmer per year.

For the farmer, there is now greater complexity in choosing which fertiliser to use – there is greater choice of products, the science is more advanced and complicated and in addition, environmental issues need to be considered. There is evidence that farmers are more confused than ever. It is estimated that dairy farmers alone are spending \$70-\$80 million more on fertiliser than required for the current levels of production. This confusion is exacerbated because the farmer’s traditional source of independent advice (e.g. MAF Farm Advisors) has been reformed into extinction and the fertiliser field officers have moved from their previous technical role to a sales role as the fertiliser cooperatives now compete for market share.

Furthermore, we now know that self regulation does not work, as demonstrated with the meltdown in the financial market, the leaky home disaster and Fertmark. If Fertmark did work the spate of recent court cases including Probitas and Southern Minerals would not have occurred if appropriate protection was in place.

Fertilisers are different from most consumer products. Once the product is applied there is no way for a farmer to know if the product is not working. Many other confounding factors can mask a farmer's best assessment: the weather, changes in stock policy or grazing management, the current soil fertility and its rate of change over time, to use a few examples. It is for these reasons that a scientific approach is required to account for all these variables when assessing fertilisers. Furthermore, if in the farmer's assessment a product has not worked as advertised the product cannot be taken back!

For all these reasons I suggest it is time to revisit the need for appropriate fertiliser legislation to protect farmers for the betterment of the nation. Such legislation should provide a clear definition of what a fertiliser is (i.e. a source of available nutrients and there are 18 we must consider), it should require compulsory registration, and it should put the onus of proof of efficacy of a product on the proprietor and not the farmer.

LESS N

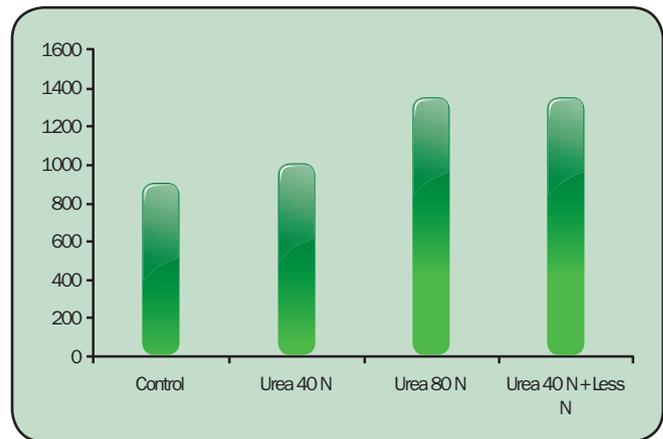
Donaghys Industries Ltd have been promoting a product called LessN. According to their literature it is a "natural microbial based nitrogen utilisation enhancer formulated and trialled specifically for use in combination with dissolved urea fertiliser". LessN is said to contain "high levels of beneficial compounds to stimulate plant growth. Oligopeptides and alcohol peptides are compounds included to improve the uptake of nitrogen and other nutrients". It is claimed to "improve the efficiency of nitrogen use by stimulating plant growth as a nitrogen enhancer, by encouraging clover growth for improved nitrogen fixation and increasing plant nutrient uptake".

I recently reviewed all the available field trial data on this product. There are essentially 2 sets of data, all available at www.donaghys.co.nz. One set of 34 trials (26 in the South Island and the balance in the North Island) were conducted by their own staff (in-house trials). These were replicated trials with 4 main treatments: control, urea at 18.4 kg N/ha + LessN (urea40+LessN) and urea applied at 36.8 kg N/ha (urea80). There were also 7 other trials, with essentially the same design, but these trials were conducted by independent science organisations. Both sets of trials were short term: treatment effects were measured on average 24 days following treatment application.

Results: In-House Trials

From the 34 trials there were 54 comparisons of control with urea80 and urea40+Less N. The average effects (after omitting 5 anomalously high results for the urea40+LessN treatment) the various treatments on pasture production are shown in Figure 1.

Figure 1: The average effects of control, urea40, urea80 and urea40+LessN on pasture production over all field trials after removal of 5 anomalous results.



As expected the pasture production increased with increasing rate of urea application. On average pasture the production from the treatment urea40+LessN was greater than that from urea40. Of the 54 comparisons all were positive and all but 10 were statistically significant. Pasture production from the treatment urea80 was greater than that from urea40+LessN on 27 occasions (50%) and less than urea40+LessN on 27 occasions (50%). These effects were not significant on 52 occasions (96%).

These results taken at face value, support Donaghy's claim that LessN enhances the effect of urea. But there is a but! The measured treatment differences are small, relative to the 'background noise' in pasture trials. The "least significant differences" (LSDs) in these experiments are typically in the order of 200-300 kg DM/ha and the average difference between urea40 and urea40+Less N was 320 kg DM/ha. In other words these trials are operating close to the limits of detection.

When this occurs scientists become very wary about how to interpret the data – is it a real treatment effect or is it just experimental noise?

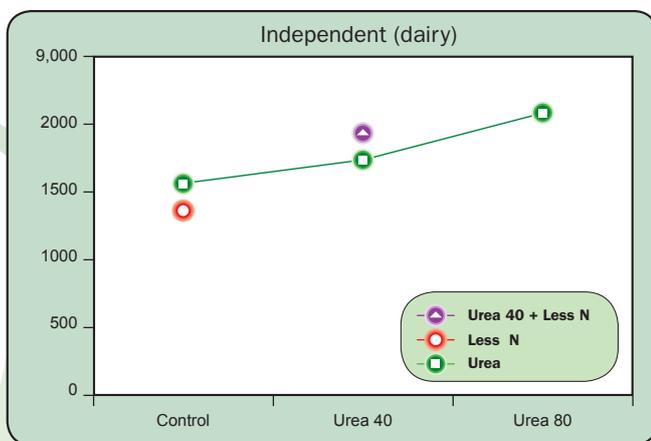
[A measure of the "background noise" is the coefficient of variation (CV). Typically in pasture trials these are in the range 5-10%, from which together with other information, the Least Significant Difference (LSD) can be calculated. When comparing 2 treatments, the difference has to be greater than the LSD to be 'statistically significant' – i.e. not just due to the "experimental noise"].

When this occurs (i.e. the treatment differences are within the margin of error) scientists seek other evidence to support, or otherwise, the results. For example, the effects of urea40 and urea80 on pasture production in Figure 1 are also within the limits of detection but we can readily accept them as "real effects" because there is so much independent data to say that urea increases pasture production. Is there any corroborating evidence in the case of LessN?

Results: Independent Trials

To give them credit Donaghys Industries Ltd contracted several independent science organisations to run trials on LessN and the results are posted on their website together with the in-house trial results.

These trials (7) suffer from some of the same problems as the Donaghys in-house trials – some trials were not N responsive, others were not responsive at some times and for some rates of urea applied. However, there were 5 occasions when there was a significant response to urea, and in all these instances, urea40+LessN was not statistically significantly different from urea40 alone. On 3 occasions LessN alone was no better than control and on 1 occasion LessN was better than control. An example of these results is given below.



Thus, the independent trials do not support the in-house trials. There are several possible reasons for this conflicting evidence: a) the in-house trials have not been properly conducted b) the design of the trials was inappropriate given the likely size of the effect of LessN or c) the active ingredient in the LessN used in the in-house trials was more active than that in the product used in the independent trials.

This raises a few final points. No data was presented from either the in-house trials or the independent trials to support the claims that LessN improved clover growth, increased N fixation or plant nutrient uptake. Indeed N applied as fertiliser normally has a negative effect on these parameters. Similarly no evidence was presented as to what 'beneficial compounds,' are present in LessN and their concentrations. In other words we do not know what the active ingredient is in LessN.

For all these reasons, I concluded that until further research was conducted and peer reviewed the hypothesis that LessN increases pasture production by enhancing the utilisation of urea cannot be justified.



SUSTAIN: IN MORE TROUBLE?

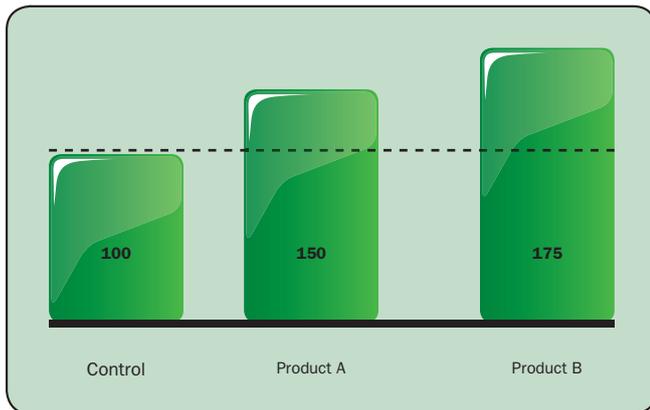
Summit-Quinphos's urea-alternative, SustaiN, is in more trouble. In Fertiliser Review No 15 (October 2005), I argued from theoretical grounds that it was unlikely that SustaiN (urea treated with agrotain) was better than urea. This was followed in Fertiliser Review 22 (Autumn 2009) with a summary of field trial results showing that SustaiN was no better than urea. More recently (Fertiliser Review 23, Spring 2009) I expressed my anger and disgust at the ongoing advertising of SustaiN, and specifically the claim that it is 50% better than urea.

While all this was going on, and, I am pleased to say unbeknown to me, another drama was unfolding. Ravensdown complained to the Federated Farmers, Fertiliser Quality Council (FQC, also referred to as FertMark) about the SustaiN advertising. In turn the FQC sought independent advice from a Dr Watson, an Irish scientist who has done a lot of research on urease and nitrification inhibitors (the 'magic' ingredient in SustaiN is agrotain a urease inhibitor). Dr Watson reported back, agreeing that the advertising was misleading. The FQC decided to make public Dr Watson's report and so Summit-Quinphos took out an injunction to prevent this occurring. Just before Xmas 2009 the court ruled against Summit-Quinphos and hence the public can now read the full report (see the FQC website). I say well done FQC. That is what they should be doing – protecting their members (farmers) from misleading advertising.

You would have thought this would be the end to the matter. No way. The CEO of Summit-Quinphos, Mr Willie Tomson, responding to the now public Watson report, said in effect: the process was wrong, there were misunderstandings, Dr Watson got the wrong end of the stick, sure we will change our advertising, but the science is sound and we will stand by our product SustaiN. What!!! At least Lord Nelson has a legitimate blind eye!

At the heart of all this are numbers and science and, surprise-surprise, some lovely tricks. Let the buyer beware!

Consider a hypothetical trial comparing products A and B to a control (i.e. no treatment). Let's assume that the control yields 100 units of production and that Product A yields 150 and Product B 175 (see Figure over page).



Product A produces 50 more units of production than the control and thus the increase in production relative to the control (i.e. the solid line) is $50/100 = 50\%$. Similarly, product B produces $75/100 = 75\%$ more than the control. Would we then conclude that product B was $75-50 = 25\%$ better than product A. We will call this **Method 1**.

How about comparing the increases in production over and above the control (i.e. the dotted line)? For Product A we would say we get 50 units of increase and product B, 75 units of increase. The percentage difference between the products is now $75-50/50 = 50\%$ (**Method 2**).

Magic, and it all depends on the base-line for the calculation (the solid line or the dotted line). One refers to the absolute increase in production, relative to the control and the other is the marginal increase in production, over and above the control. Which do you prefer?

I think most farmers and consultants, if they were told that product B was 50% better than product A, relative to the control, would immediately think along these lines: I'm growing 50 kg DM/ha per day at present so if I use product A I will get a 50% increase, that is 25 kg DM/ha per day for my outlay of the cost of product A. If I use product B, I will get 37.5 kg DM/ha per day at a cost of product B. If Product A and B were the same price the comparison is obvious.

But if you were told only that Product A was 50% better than product B what are you likely to conclude? Therein lies the problem! A statement such as Product B is 50% better than Product A is meaningless without knowing the yield of the control and the method of calculation and that is why it is misleading the present data in that manner.

But you can see the temptation of the retailer. If you want to inflate the value of your product, use **Method 2**, the marginal comparison. If you want to minimize the value of a competitor's product, use **Method 1**, the absolute comparison.

And now for the interesting twist to the story: Dr Jamie Blennerhassett is currently Summit-Quinphos's Technical Manager and he would have learned all these tricks when he was hired straight from University by Dr Bert Quin, the founding Managing Director of Summit-Quinphos. This company came into the market in the late 1980s promoting RPR as an alternative to super. Which method do you think he used to compare these 2 products – you got it, Method 1 - it made RPR look better than it was relative to soluble P!



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The December issue of Primary Industry Management (Vol 13, No 4, December 2009) contained an article entitled, "The Effectiveness of Nitrification Inhibitor Technology to Improve the Sustainability of Agriculture," by Keith Cameron, Hong Di and Jim Moir, from Lincoln University.

The introduction to the paper sets out the need for research on nitrification inhibitors and goes on to say, "There is a lot at stake and we need to provide the public with confidence that future agricultural practices will reduce environmental effects. Therefore it is timely to review the effectiveness of eco-N [my emphasis] nitrification inhibitor technology" Thus, this review is not as wide as the title suggests – it is in fact about eco-N, a proprietary formulation of one of the several generic nitrification inhibitors DCD. The patent for eco-n is jointly owned by Ravensdown and Lincoln University and the product is marketed and sold by Ravensdown.

The review summarizes in tabular form, all the peer reviewed scientific research on the effects of eco-N on nitrate leaching and nitrous oxide emission conducted by Lincoln University, and includes a table summarizing some of the field research, both published and unpublished, on the effects of eco-N on pasture production.

The key conclusions from this review are that the use of the nitrification inhibitor (one assumes that "the" refers eco-N) on grazed pasture soils can -

- Reduce nitrate leaching from urine patch areas by an average of 64 percent.
- Reduce nitrous oxide emission, a potent greenhouse gas, from urine patch areas by 68 percent.
- Increase on-farm pasture production by up to 20 percent in the **South Island** [my emphasis].

The review goes to some lengths to point out that pasture production responses to eco-N are variable and states, "... the most common reason for variability in on farm performance of the inhibitor is that the inhibitor has been used incorrectly."

Are These Conclusions Appropriate?

Before answering that question it is important to note the context in which these conclusions have been offered. The Primary Industry Management journal is the official publication of the New Zealand Institute of Primary Industry Management whose members are typically farm advisers; people who work at the applied end of agricultural research and who are normally seeking robust scientific information that they can apply on-farm. So how applicable are the conclusions above to New Zealand farmers?

Nitrate Leaching and Nitrous Oxide Emission

The data presented summarize the effects of eco-n on nitrate leaching and nitrous oxide emissions. They are taken from peer reviewed, published science papers. It is undoubtedly good quality research - that is not in contention. But readers must understand the specific conditions – the experimental protocol - under which these results were obtained. These effects of eco-n were made on pastoral soils treated with urine applied at 1000 kg N/ha **AND** 200 kg N/ha as urea.

These are extremely high N inputs and are not typical of any dairy farm. (The authors say a typical urine patch "may" contain the equivalent of 1000 kg N/ha. That is true but typically the range is 500-1000 kg N/ha). The authors themselves acknowledge, although not in this paper, that eco-n is being test in the worst case scenario! Understandably the reported effects of eco-n on nitrate leaching and nitrous oxide emissions are very large – on average 64% and 68% respectively.

Importantly, these results cannot, and should not, be extrapolated to the 'normal' farm situation where, in any given paddock, there is a mosaic of urine patches of varying age which possible occupy < 10% of the total area.

This is not a criticism of the research per se – these experiments were designed, quite properly and appropriately, to test the valid question; does eco-n affect nitrate leaching and nitrous oxide emission from a urine patch (1000 kg N/ha) to which 200 kg of urea N is also applied.

Much further research is required at a national level, before farmer advisers will have sufficient information to say with any confidence: on this farm and under these soil conditions and climate, the estimated effects of eco-n will be a reduction of nitrate leaching of X % and nitrous oxide emissions of Y%.

Pasture Production

In 2007 I completed a review of all the field research, both published and unpublished, in New Zealand, on the effects of eco-n on pasture production. This review was funded by Ravensdown Fertiliser Co-operative Ltd.

At that time there were 17 reported studies on the effects of DCD (see Footnote) and all but one were on pastures. The exception was a study in Canterbury where the test crop was wheat. The studies were evenly distributed with 9 in the South Island and 8 in the North Island.

The focus of my review was the question: What is the effect of ecoN on pasture production when it is applied to a 'normal' pasture i.e. one which contains a mosaic of excreta patches (dung and urine) and non-excreta areas. This is after all what the farm adviser needs to know. For this reason I set aside 4 studies in which the effects of DCD were measured on pasture plots wholly treated with urine (3 trials) or wholly untreated with urine (1 trial).

[Footnote: DCD is the abbreviation for one of the generic nitrification inhibitors. DCD has been formulated into 2 proprietary brands for use in New Zealand: eco-N (Ravensdown Fertiliser Co-operative Ltd) and DCn (Ballance Agri Nutrients Ltd). Recent trial work has shown that there is no difference in the efficacy between these formulations and or between the generic and branded products. Thus, in the context of this report DCD and eco-N are synonymous].

Within the remaining studies (13) there were 6 in-house Ravensdown trials, in which the treatments were either not replicated and/or the trials were undertaken by unskilled staff. I also set these trials aside on the grounds that they did not meet the standard required for a peer-reviewed scientific review and, furthermore, would not have survived scrutiny in a court of law.

This left 7 studies; one in South Island (Southland) and the balance in the North Island (Northland, Waikato, Central Plateau, Manawatu). Within these studies there were 28 trial-years of data. The average pasture response to DCD was 2% (SE 1%) and the range of measured pasture responses straddled zero (-17% to +17%) – the range simply reflects the underlying variability in pasture production measurements. Typically the coefficient of variation (CV) in this type of work is between 5-10%.

The average pasture response to DCD (eco-N) of 2% is also intriguing. DCN is a nitrogen-based chemical and contains 66% N. When applied as recommended it adds about 10 kg N/ha/yr. This is sufficient to give a pasture N response of about 1%-2% assuming a 10:1 response to N and 5-10 tonnes of DM/ha/yr.

The evidence above is consistent with a conclusion that a) the most probable size of pasture responses to eco-n, or DCn, or DCD, when applied as recommended in May and again in August, is about 2% with a range of -3% to +3% (the approximate 95% confidence interval) and b) it is likely that this small benefit, if it is measurable or not, arises from the N content of the DCD.

My conclusion applied to both the North and the South Island. In contrast, Cameron and co-workers concluded that econ can “increase on-farm pasture production by up to 20 percent in the **South Island**” [my emphasis]. The implication is that it does not work on North Island pasture. Is this consistent with the evidence?

Cameron and co-workers state that the reason why econ increases pasture production is because it reduces N losses (N leaching and emissions of nitrous oxide), making more N available for plant growth. Of the two N loss pathways, nitrate leaching is by far the largest. If this logic is correct it follows that econ will have a large effect on pasture production on soils prone to nitrate leaching (ie on coarse soils and under higher the rainfall). These conditions apply to most of the trial sites (6) I reviewed. They were in the North Island on volcanic ash and pumice soils and we know from other research that significant leaching of N occurs on these soils. That being the case, why were the pasture responses to DCD so small?

In other words, this evidence is not consistent with the conclusion that econ works (increases pasture production), but only in the South Island. Furthermore the available data suggests that the most likely size of pasture responses is in the range of -3% to +3% and not up to 20% as claimed.

Cameron and coworkers refer to anecdotal evidence from farmers that econ does not appear to work sometimes. They go to some length to suggest that the likely reason for these variable results is that the product has not been used as recommended. I remember the Bell Booth boys using the same argument to justify the absence of positive results with their liquid fertiliser Maxicrop! The data above allows an alternative explanation; it is possible that the farmers are getting ‘variable’ results with econ on pasture production because it only has a very small effect, irrespective of whether the label instructions as followed or not.

Where does all this leave the farm advisor and the farmer? The current evidence is that DCDs (econ and DCn) have little effect on pasture production but may reduce nitrate leaching and the emission of nitrous oxide. In other words, the principle is established, but further research is required before these effects can be quantified with any degree of accuracy in specific farm situations. Fortunately there is a national series

of trials underway, funded in part by the government with input from industry, to advance our state of knowledge about these chemicals. Pending further trial work, I would advise farmers and their adviser to put the cheque book away in the meantime. There are already plenty of other proven management practices to reduce N losses from pastures.



THE COMMERCIALIZATION OF SCIENCE

I have for a numbers of years now been expressing concern about the dangers of commercializing science (see Edmeades, D.C. 2004. Is the Commercial Model Appropriate for Science? NZ Science Review 61: Vol 3-4 and Edmeades, D. C. 2009. Science Under Threat: Why and what can be done. Australian Agricultural Science 1/09. Copies available on request to the author at doug.edmeades@agknowledge.co.nz).

Science, must be, and must be seen and known to be, open, objective and impartial. Introducing the profit motive into science has the potential to undermine these pillars on which quality science depends. The obvious historical example is the way science was initially used, and then distorted, in support of the tobacco industry. Of course there are times when science and industry should work together but the process of science should never be captured and controlled for commercial gain.

Our CRIs are now required to make a profit. This drives science towards including non-disclosure and non-publishing clauses in their research management to protect IP, patents and trade secrets; the exact opposite of what is required for science! Furthermore it introduces a conflict of interest between private and public good. AgResearch for example develops pasture species (public good) and derives royalties (private good) from selling the rights to use this material to seed companies. Thus, when an AgResearch plant scientist speaks publicly is he acting as an objective, impartial scientist (public good) or is he a salesman for AgResearch (private good).

The article by Professor Cameron and coworkers “Nitrification inhibitor technology” touches on these issues. The patent for econ is owned by Ravensdown and Lincoln University. One assumes that both parties receive royalties from this arrangement. That being the case, how does the public assess this review by Lincoln University: Is it an honest and open assessment of all the relevant data or is it an infomercial for econ? The fact that the article is not about inhibitors generally but about a specific inhibitor called econ, and the fact that it does not include much other trial work on econ which is in the public arena suggests the later. It is, it appears, an article written for the private good not the public good.

It is likely that the commercialization of science is here to stay and so what should be done to inform the public and protect the public interest? I think the only solution is that scientists, when writing and commenting about products and services, are made to declare all their private interests (see example below) so that the public can make its own assessment as to what weight, if any, should be placed in any opinion and conclusions which are offered.

D. C. Edmeades
Managing Director
agKnowledge Ltd.

Disclaimer: I do not have any pecuniary interests in the fertiliser industry or their products. I draw my livelihood exclusively from offering scientific advice.



POST SCRIPT

I am aware that all three companies (Summit-Quinphos Ltd, Ravensdown Fertiliser Co-operative and Donaghys Industries Ltd) have ongoing research on their respective products; Sustain, EcoN and LessN. That is encouraging and laudable.

Given that further research on these products is pending any conclusions offered to date in respect to their efficacy must be regarded as interim – they are conclusions based on the currently available evidence and in the best scientific tradition must be amended subject to further evidence. If that is so then why offer interim conclusions? Why not wait until all the evidence is in? That would be the responsible action to take, would it not? After all, it is possible that any interim conclusions may in fact be found to be incorrect in the light of new evidence?

The answer to these questions is of course, yes, qualified with, “under normal circumstances.” And the ‘normal’ sequence would be: a new product is conceived and developed, research is then undertaken to test the product as a concept and to refine it’s design or formulation, and then further research would be undertaken to test it’s efficacy in the field. This last stage is important and complex because “in the field” means, for agricultural products applied to plants and soils, “in all those conditions where farmers will use it,” taking into account the likely variables of soil and the climate. Once the research is completed then the claims for the product, how it works, its costs and its benefits, can then be determined and the product offered for sale to farmers.

These ‘normal circumstances’ do not seem to apply in this case. All three products have been put onto the market without it appears adequate research and it is only ‘after the event’ that the appropriate research is done. Is that fair?

I have been, and no doubt will be again, heavily criticized by the affected companies who will claim that, because they have ongoing research, no interim conclusions about these products should be offered. They will complain that I am not offering them the necessary ‘duty of care’ that the law requires.

The problem is of course they have chosen to put these products on the market prior to undertaking adequate research. In effect saying to the farmer “you trial it” Where is their ‘duty of care’ to their clients, you the farmer? I think under these circumstances it is appropriate to offer interim conclusions so that farmers can be in a better situation to decide whether or not to use these products.

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