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FERTILISER PRICES: WHAT TO DO?

Fertiliser prices have increased significantly in the last 6 months and it must be tempting for many farmers to withhold fertiliser inputs, at least in the short-term. I suggest - think again! There are several good reasons.

Remember the past?

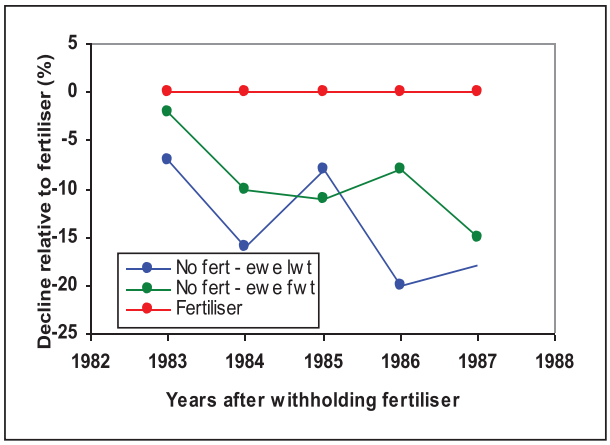
In the mid 1980's subsidies on fertilisers were removed. Many farms responded the best they could by withholding fertiliser inputs. In 1990, the then called Meat and Wool Economic Service, conducted a survey to assess what happened post-subsidies. They found that the profitability on those farms where fertiliser inputs were continued was about 3 times higher than the unfertilised farms (Table 1). These farmers were in a stronger position to capture the benefits of the slowly improving markets.

Table 1. Meat and Wool survey results in 1990.

Meat & Wool Survey 1990		
	Fertiliser History	
Measurement	nil	>100 kg/ha
Gross Revenue ($/ha)	253	441
Expenditure ($/ha)	207	291
Profit ($/ha)	*46*	*151*

Remember the science?

At this time several on-farm experiments were commenced looking at the effects of withholding fertiliser P inputs, especially on sheep and beef hill country. One experiment was conducted at the Te Kuiti research farm (initial Olsen P 14). The key results are given in Figure 1 which show the decline (%) in Olsen P, pasture and animal production over time, relative to maintaining fertiliser inputs (200 kg/ha super/ha, red line)



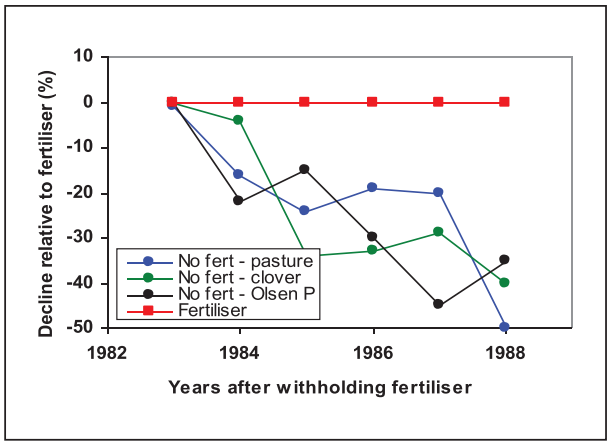


Figure 1 Effect of withholding fertiliser on animal and pasture production on a sedimentary soil in the King Country.

A similar trial was conducted at Ballantrae on a sedimentary soil in the Manawatu. The results are shown in Table 2, as the decline (%) over 7 years in Olsen P, pasture and animal relative to maintaining an Olsen P of 12.

Table 2. Effects of withholding fertiliser P inputs at Ballantrae.

Ballantrae				
	Fertiliser History			
History	Olsen P	Pasture	Ewe lwt	lamb lwt
Hi fert (Olsen P 12)	-37	-30	-7	-27

In a nutshell these results indicate that if fertiliser P inputs are withheld then it is likely that soil fertility (Olsen P), pasture and animal production will decline by about 5% annually. It is important to note that the initial soil Olsen P levels in these two experiments were initially modest by today's standards, in the range 12-14. Expressed in today's terms, the results suggest that if the Olsen P level is in the range 20-25 it may decline 1 to 2 Olsen P units per year as a consequence of withholding fertiliser P. This will have negligible effect on pasture production in the short term (1 year).

We have been here before?

Take comfort from the fact that we have been here before and survived. During the global financial crisis of 2008/09 superphosphate prices went over $500 per tonne (Figure 2). The question arises – how long will the current spike last? If is it a short-term problem, as it was in 2008/09, then it is sensible to adopt a business-as-usual approach. If it is to be a longer-term event then higher fertiliser costs should not be a problem in the long-term providing the ratio of fertiliser costs versus revenue remains constant, which appears to be the case over time (Figure 2).

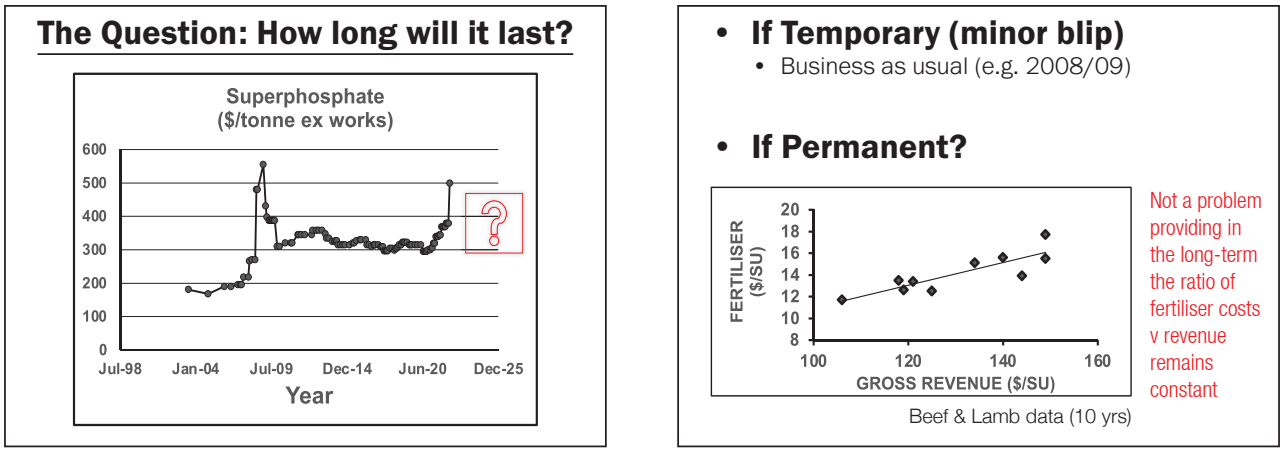


Figure 2 Historical fertiliser prices for superphosphate.

In the meantime, some practical compromises are possible.

Withhold P

Phosphorus (P) is not only the most expensive nutrient, it also largely stays put in the soil, relative to the more mobile nutrients potassium (K) and sulphur (S). Thus, if the P nutrient tank is full (see later) P inputs can be withheld in the short-term (1-2 years) without losing too much production and the funds directed to maintain the soil pH, and soil K and S levels.

This becomes really important when there are other factors limiting pasture production such as K and/or S deficiencies and/or low pH. The plant can only grow as fast as the most limiting nutrient so redirecting the P fertiliser dollar into correcting nutrient deficiencies can be a big winner financially. We have cases on our books where this strategy has been adopted with the result that production has increase by 20-30% without increasing the fertiliser budget.

Farming at the Economic Optimal Nutrient Levels

Another way to rationalise the fertiliser program is to divide the farm into blocks of different economic value/profitability (e.g. flats, rolling and steep). The days of putting the same fertiliser across the whole farm should be a long-gone. The fertiliser program should be adjusted for each block based on its potential carrying capacity as expressed by the gross margin (Figure 3)

When fertiliser P is applied to a soil with a low Olsen P, large increases in production can be expected, such that the value of the increase in pasture production is much greater than the cost of applying fertiliser. In other words, it is economic to apply fertiliser (Figure 3). Alternatively, when the Olsen P is high, the value of the increase in pasture production is less than the fertiliser cost – it is not economic (Figure 3). The economic optimal Olsen P occurs when the cost of applying fertiliser is equal to the benefit derived from the additional pasture.

The position of the economic optimal Olsen P, on the pasture production curve, depends on the economic efficiency of the block – i.e. the dollars generated per kg DM produced. A good estimate of this is gross margin which is the gross income minus the variable cost (animal health, shearing, supplements – all those costs associated with a change in stock numbers).

Different blocks have different potential carrying capacity, different gross margins and hence economic Olsen P. The fertiliser policy should reflect this. Thus, it may be economic to run the flats at an Olsen P of 25-30, the easy country at say15-20 and the steep land at 10-12.

Rationalizing the fertiliser policy for the farm in this manner can optimize the fertiliser spend and, in some cases, reduce overall fertiliser costs.

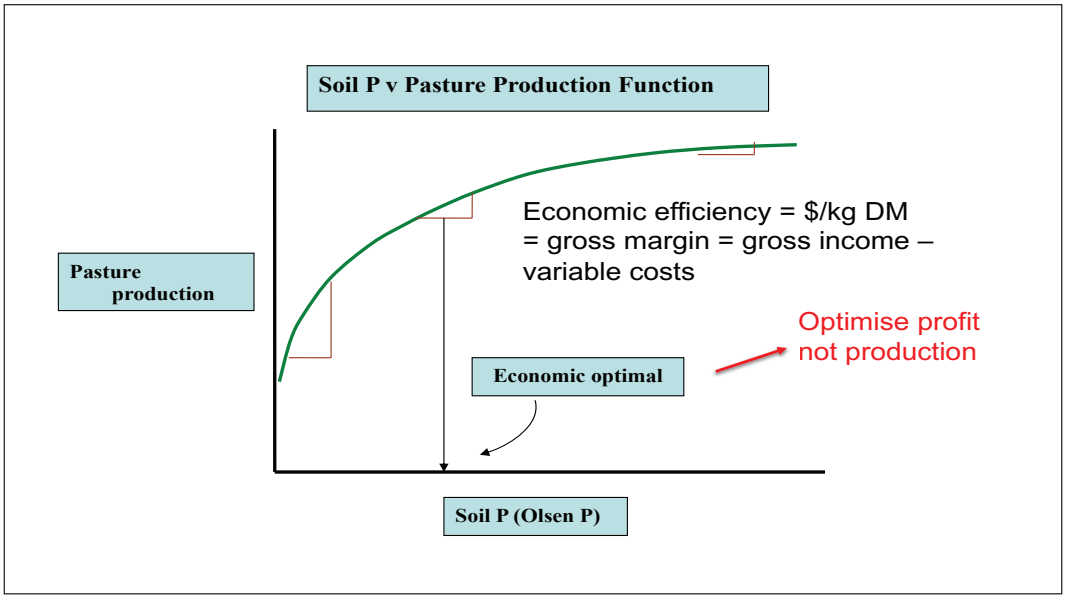


Figure 3 The economics of fertiliser P use.

REGENERATIVE AGRICULTURE: THE EVIDENCE IS ACCUMULATING

Recall that in Fertiliser Review 46 we reported on a survey comparing the meat quality from 9 Conventional farms with meat from 9 farms operated as Regenerative Agriculture (RA) farms. Meat quality was assessed by measuring pH, moisture, elemental analysis, fat-soluble vitamins, intramuscular fatty acid profile and colour. The conclusion was that there was "very little difference" in meat quality.

Since then, further evidence has emerged as to the veracity of RA. As reported in "New Ground" (Volume 2, December 2022 or go to https://ourlandandwater.nz/wp-content/uploads/2022/12/Regenerative-agriculture-%CE%93Co-opening-up-the-wallet.pdf) a survey was undertaken comparing the economics of 8 conventional farms with 8 RA farms, paired for region, climate and land class. Financial data was collected from these 16 farms covering the years 2017/18 and 2020/21. In short, while there was no difference in farm expenses, gross farm revenue was higher (+39%) on the Conventional farms ($1,473/ha) versus the RA farms ($1,060/ha). There was no difference in the total GHG emission per hectare.

These results are consistent with those from a similar study conducted in NSW, Australia, (Regenerative Agriculture – quantifying the cost Australian Farm Institute Occasional Paper No 20.01, 2020) where it was found that the return on assets (over a 10-year period) was about 4% from the Conventional farms compared to about 2% from the RA farms. This difference essentially arising from the lower profitability per hectare on the RA farms.

And practical experience seems to be reflecting this survey data. Align Farms are running a comparison (Regenerative versus Conventional) on their Clareview Farm at Ashburton. Data is now available from the first year of the "trial" (Dairy Exporter January 2023). Operating profit was down by 24% on the RA farmlet relative to the Conventional farmlet.

The focus in the above analyses is on profitability and, as one Regenerative farmer expressed it, "……the focus on getting the most financially out of the land is not necessarily a key reason why RA farmers farm the way they do. The desire to improve the health of the soil, add biodiversity to pastures and reduce nutrient loss to the waterways is important. Get that right and the financial side follows on from there." For example, in the Clearview trial the total greenhouse gas emissions were 26% less from the Regenerative farmlet.

I imagine there are some farmers who will be prepared to accept lower profits if this reduces their environmental footprint. But a word of caution. Recently a Southland couple, who originally embraced RA, only to find after several years that their farm went "belly up". They have reverted back to Conventional farming.

It is relevant in this context to remind ourselves of the meaning of the word "sustainability" and the best definition I have come across is from two Canadian scientists *(Smyth A. J. and Dumanski J. 1994. Progress towards and international framework for evaluating sustainable land management. Transactions of the 15th World Congress on Soil Science. July 1994, Vol. 6a)*.

They defined "sustainability" in terms of five goals, arguing that any farm management practice is sustainable if the following five criteria (goals) are achieved *simultaneously:*

- **Production** – does the practice achieve the desired production goal?
- **Risk** – does the practice reduce the risk of not achieving the production goal?
- **Economic** – is the practice economic?
- **Environment** – is the practice sustainable with respect to soil, water, air and other relevant resources?
- **Social** – is the practice socially acceptable?

The important word is **simultaneously**. Regenerative Agriculture may be socially acceptable to some people because it meets some environmental goals. But if it does not achieve the production and economic goals it is sustainable?

MAKING N MORE EFFICIENT

Tow and Fert

A cap has been introduced on the use of synthetic fertiliser N on pastoral soils in New Zealand. Now, no more that 190 kg N/ha/year can be applied. Not surprisingly there has been a surge in products and services in the market claiming to reduce the need for fertiliser N. I will use **Tow and Fert** as an example.

As best as I can understand it, **Tow and Fert** is the brand name for a series of specialised spray equipment, produced by Metalform, a Dannevirke engineering company. This equipment enables farmer to apply a range of products in a soluble or slurry form. As expressed in their latest **Tow and Fert** publication (November 2020):

"Liquid N is just one way that fertiliser efficiency is finding its way to the market these days. Others include the application of traditional P, K and S products as Fine Particle products, the use of seaweeds, humates, molasses and fish fertiliser, as supplements or replacements for chemical fertiliser ……" It seems clear from this that they believe that liquid N and fine particle application of nutrients is the 'way to go'.

Tow and Fert make many claims about the benefits of applying fertiliser in a liquid or slurry form. These include the 'normal' candidates: improved soil and animal health, reduced fertiliser costs, improved pasture production and N use efficiency, and reduced environmental footprint. Farmer testimonials are frequently used in their advertising.

Allied to this, **Tow and Fert** features in many of the stories in the popular press told about the virtues of Regenerative Agriculture. Several farmers who have adopted Regenerative Agriculture talk about replacing their normal granular fertiliser program with **Tow and Fert** soluble or slurry programs, claiming that this saved them money.

Ironically nowhere in the Tow and Fert literature do they discuss the amounts of nutrients that can be applied using this equipment or the cost of doing so.

To assess the claims being made by **Tow and Fert** we need to remind ourselves of the relevant scientific evidence.

Soluble or Granular?

It is frequently claimed that applying nutrients in a soluble form is more efficient because the nutrients are absorbed by the plant via foliar absorption rather than via the soil. The implication is that when some nutrients 'hit the soil' they get tied up in all sorts of chemical reactions making them unavailable for plant uptake. This old, but persistent, myth is still perpetuated today.

Several decades ago it was believed that the nutrient phosphorous (P) got "locked up" in the soil and that the way around the problem was to apply P as a solution. A foliar liquid fertiliser "Liquiphos" was introduced to the market. Karlovsky et al. (1978) reported a number of trials comparing this product with solid fertilisers applied either at the same rate, or at the same cost, of nutrients, on pasture production. The essential results are given in Table 3.

Table 3. The effect of the foliar liquid fertiliser Liquiphos on relative pasture production compared with the solid fertiliser applied an equal nutrient input basis and an equal cost of nutrient applied (Karlovsky et al. 1978).

Treatment	Relative Yield[1] (Control = 100)
Control	100
Liquiphos (at rate recommended by proprietor)	106
Solid fertiliser (equal nutrient basis)	106
Solid fertiliser (equal cost basis)	118

Notes: 1) means of 4 trials, all on nutrient deficient sites.

When applied on an equal nutrient input basis there was no difference between the liquid or solid fertiliser, but the solid fertiliser applied on an equivalent cost basis gave higher pasture production, indicating that Liquiphos is a very expensive way to buy nutrients.

Karlovsky took this a step further and compared the effect of liquid and solid applications of some P fertilisers and P containing minerals, when applied at the same rate of N and P, on pasture growth, on a P deficient soil. Once again, the form (solid or soluble) had no effect on pasture production (Table 4).

Table 4. Effects of nutrient applications applied as either liquid or solid fertiliser (as reported in Karlovsky et al. 1978).

Source of P	Relative Pasture Production (Control = 100)	
	Applied as Liquid	Applied as Solid
Control	100	100
Mono-calcium phosphate	113	117
Di-ammonium phosphate	120	114
Di-potassium phosphate	118	119
Phosphoric acid + urea	105[1]	114
Glycerophosphoric acid	108	108
Average of all treatments	**113**	**114**

Notes: 1) some scorching occurred following the liquid application.

This early research showed in a fairly robust manner that the form in which fertiliser is applied has little effect on pasture production. This being the case, farmers were advised to buy the cheapest form of fertiliser which invariably meant using solid fertilisers.

Granular or FPA?

The next fad to curse the industry was the idea that fertiliser, even those fertilisers which were not water soluble, could be ground into a fine slurry and sprayed onto pastures. The claim was made that this enabled fertiliser nutrients to be applied more evenly, than granulated fertilisers, thus improving nutrient use efficiency. Initially this was done using DAP. This hypothesis was been duly tested initially by Korte in 1996, who found that DAP was not more effective when applied in a slurry form. This trial has been criticised because the amounts of nutrients applied were very small but it must be remembered that this was the rate that the 'slurry boys' were recommending commercially.

Table 5. Effect of form of application of DAP fertiliser on pasture yield (Korte et al. 1996).

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

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

More recently the idea has been applied to urea, based on the argument that the utilisation of urea N was very poor. Muir et al. (2005) compared granular urea and FPA urea at 2 rates in a field trial in the Hawkes Bay. Again, the form of the application had no effect on pasture production on the N responsive pastoral soil (Figure 4).

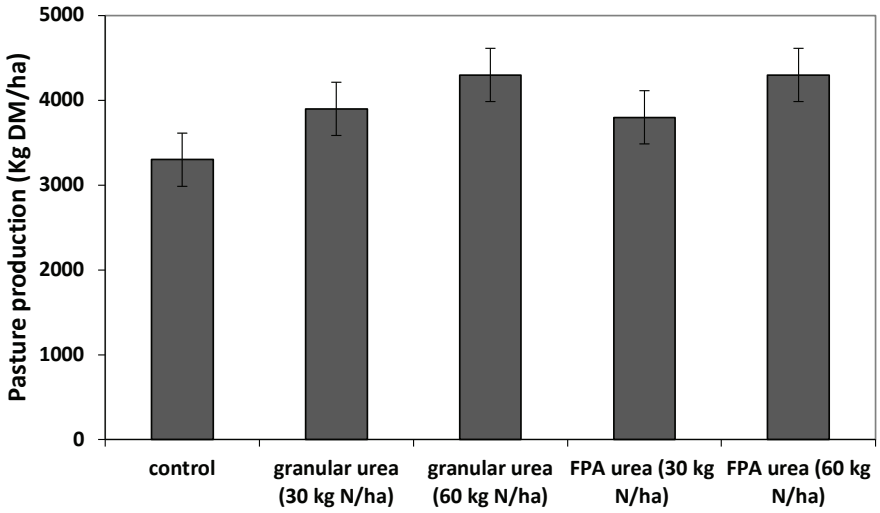


Figure 4 Effect of granular and FPA urea on pasture production applied at two rates of N (Muir et al. 2005)

A similar experiment (Figure 5) was reported by Wyn in 2007, whose results confirmed those of Muir et al. (2005). In this case the effect of FPA was tested on both urea and Sustain, a derivative of urea containing a stabiliser.

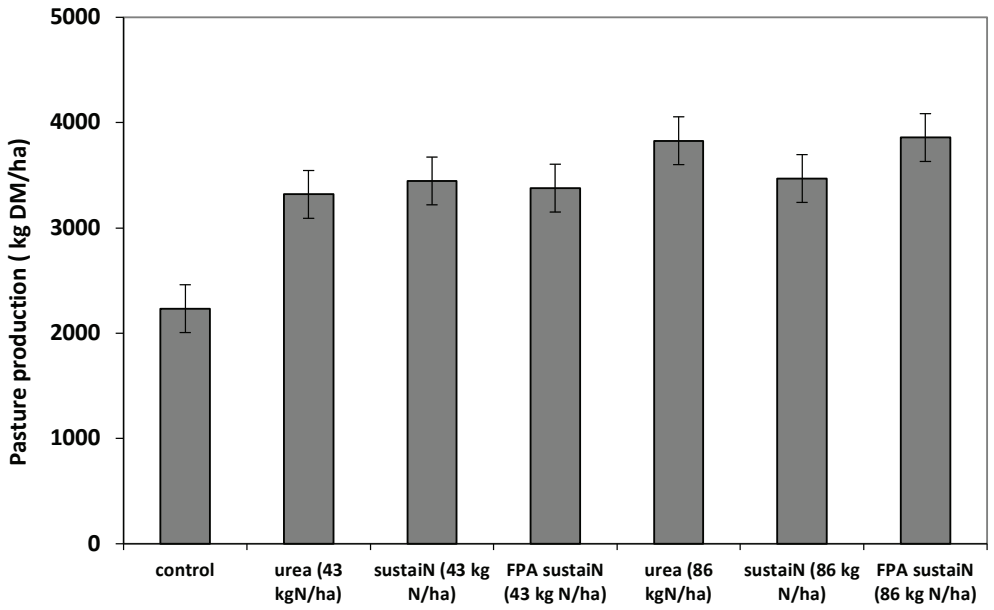


Figure 5 The effect of urea and SustaiN applied at 2 rates of application, as either granular applications or fine particle application (FPA) in Northland over a two-month period (Sept-Oct) (Wyn 2007)

Morton et al. (2018) more recently reviewed the New Zealand research on FPA and concluded that, "Not one of the nine trials comparing fully dissolved liquid and granular forms of N and P showed an advantage to the liquid form."

Tow and Fert Advertising

In their recent newsletter (The Tow and Fert Times, November 2022) they ask the question "Where is the Science?" They claim that "….. there is a lot of science out there that testifies to the effectiveness of foliar applied fertiliser." They report a study involving 3 trials which they describe as "……. a terrific example of how effective foliar fertiliser applied fertiliser (in this case N) can be." Note in particular the wording – they are talking about the effectiveness of foliar applied fertiliser. They then discussed the results from the 3 trials.

In fact, the report from which the results are taken is called "Summary of: Using Humic compounds to improve the Efficiency of Fertiliser Nitrogen." In other words, the purpose to these three trials was to examine the effects of adding Humic acid to urea, whether in a solid or liquid form. They do not deal with the key issues which lie at the heart of the Tow and Fert's claims viz:

1. Does the form a fertiliser N (solid or liquid) matter? and
2. Does FPA improve nutrient use efficiency of urea?

There are other problems with these trials.

First, it is not clear from reading the original report whether the treatments in each of the three trials are replicated. In what are referred to as trial 1 and 2 no statistical data is offered suggesting the treatments were unreplicated. Without such information it is nigh on impossible possible to interpret the results in any meaningful manner – are the treatments real or due to the underlying variability which occurs in all such field trials?

Second, some of the results are implausible. It is claimed based on the trial 2 results that soluble urea plus humic acid produced 3 times as much dry matter compared to applying granular urea alone. The relevant numbers were: Solid urea (about 100 kg DM/kg N applied) versus liquid urea plus humic acid (about 350 kg DM/kg N applied). These figures are frankly implausible given that urea typically produces about 5-20 kg DM/kg N applied.

What is the message?

I'm sure the message that most farmers would take from **Tow and Fert's** recent advertising is that **Tow and Fert** is a new, modern way for applying nutrients, which is cost effective, increases nutrient use efficiency and reduces the environmental footprint. Unfortunately, the results from these 3 trials, when properly scrutinised, do not stack up against the science.

To the best of our knowledge the form (liquid or slurry) in which fertiliser is applied has no benefits relative to applying granulated fertiliser.