

SUPER, RPR AND LIQUIDS – OBSERVATIONS ON 40 YEARS OF SCIENCE AND SEMANTICS, ZEALOTRY AND BIGOTRY, REGULATION *vs* DEREGULATION, CONS OR COMMERCE, FACT OR MYTH, INTERPRETATION OR MISINTERPRETATION

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Abstract

Over the past 40 years, the author has been able to observe fertiliser and soil fertility research, and the fertiliser industry, from a number of very different perspectives. These included 10 years in laboratory and field research, 2 years in a research coordination and government liaison role, 3 years as Chief Scientist for Soil Fertility at the MAF's largest research centre (including a year as Scientific Advisor to the Queen's Counsel who successfully defended MAF during the year-long Maxicrop defamation case), a year as Technical Manager for Duraphos, a start-up RPR and PAPER importer, a year as an international consultant, 17 years as founding Managing Director of Quinphos and then Summit-Quinphos, and 6 years as a private fertiliser company consultant and developer of new products and technologies.

Of the many issues and stories over this time, the key ones include investigating and explaining the superphosphate quality scandal, observing the demise of the Fertilisers Act and the beginning of industry self-regulation, exposing the Maxicrop rip-off and seeing through the resulting court case to the end, initiating, designing and coordinating the 'National Series' of RPR vs superphosphate trials, and commercially introducing, promoting and defending RPR and its place in New Zealand agriculture. These and other issues are viewed from a more human aspect than is the norm in scientific research.

Given how little new production-based research is likely to be funded in the near to medium term economic outlook of today, a plea is made to free-thinking new scientists to revisit old research from a modern and broader perspective.

Introduction

The author has the late Professor Keith Syers to thank for his belated entry into fertiliser and soil fertility research in 1974. The author had intended, after completing a Ph.D in biogeochemical exploration under the late Robert Brooks, to take up a post-doctorate fellowship in lake geochemistry in Canada. Before leaving for a sabbatical in the UK in 1973, Professor Brooks asked his friend Keith, who had recently taken up the position of Professor of Soil Science at Massey, to 'look after' the author. Well, he did more than that. He inspired the author to try to use his analytical chemistry training and perspective to help develop agricultural production in New Zealand. This led to being offered a position with MAF to set up a laboratory at the Winchmore Irrigation Research Station in mid-Canterbury, and that settled it.

With very different background and perspective to the agronomy focus of most of his MAF peers, the author tried to immerse himself in the MAF's soil fertility philosophy. Tried but mostly failed. The author came to the conclusion that some major issues were not even being identified, let alone understood, because they were essentially chemical in nature, not 'agronomic', and partly because of an attitude that it 'wasn't our job' to get involved in anything that could be seen as questioning the dominance and behaviour of New Zealand's 75-year-old single superphosphate industry.

In any scientific field of endeavour, a variety of human foibles come along for the ride. The fertiliser industry is no different. These can be looked at under the following headings.

- Science and semantics – what exactly is superphosphate, an RPR, a liquid?
- Zealotry and Bigotry – the evil twins
- Regulation vs Deregulation – where is the compromise?
- Cons or Commerce – where is the line?
- Fact or Myth? Repetition blurs the difference
- Interpretation or Misinterpretation – we see what we want to see

A. Science and Semantics

The Quality Saga - What exactly is single superphosphate (aka SSP or 'super')?

Single superphosphate is without doubt the most important fertiliser in New Zealand's history. There was no other known product at the time that could have brought about the same transformation of New Zealand's agricultural production since the 1930s. It provided the P, S and Ca so vital for the establishment of grass/clover pastures. It ideally contains about 9% total P, almost all of which should be (and used to be) water-soluble monocalcium phosphate, 11-12% sulphate-S, and 20-22 % Ca.

During the 1960s, a combination of cost and incentive circumstances, supported by an industry-wide belief that 'super is super' led to increasing use of cheap, high Al and Fe, Christmas 'B' grade rock for manufacture (Quin 1982). Citric solubility dropped from 8.3% (North Island) and 7.8% (South Island) to 7.3% and 6.2% respectively (Table 1 & Figure 1).

Table 1. South and North Island Regional Analyses (from Brown 1981)

South Island Regional Analyses									
	Total P			Citric P			No. of Samples		
	1965-70	'71-77	'78-81	1965-70	'71-77	'78-81	1965-70	'71-77	'78-81
Nelson	-	8.9	8.0	-	6.4	5.2	-	2	1
Canterbury	9.7	9.0	9.1	8.3	6.5	5.9	22	12	6
Otago	9.2	8.8	7.4	7.4	6.2	5.3	32	38	16
Southland	9.3	8.8	-	8.3	6.8	-	4	6	-

North Island Regional Analyses

	Total P			Citric P			No. of Samples		
	1965-70	'71-77	'78-81	1965-70	'71-77	'78-81	1965-70	'71-77	'78-81
Northland	9.9	9.4	9.2	8.4	7.7	7.2	5	4	4
Auckland	9.9	9.5	8.8	8.4	7.3	7.0	15	40	9
Waikato	9.6	9.5	9.4	8.1	7.7	7.5	18	36	12
Bay of Plenty	9.7	10.2	10.1	8.6	8.3	8.2	11	13	1
Hawke's Bay	9.9	9.9	9.3	8.8	8.5	7.6	11	6	4
Taranaki	9.4	9.2	-	8.0	7.2	-	9	11	-
Manawatu	9.7	8.5	-	8.2	5.6	-	8	3	-

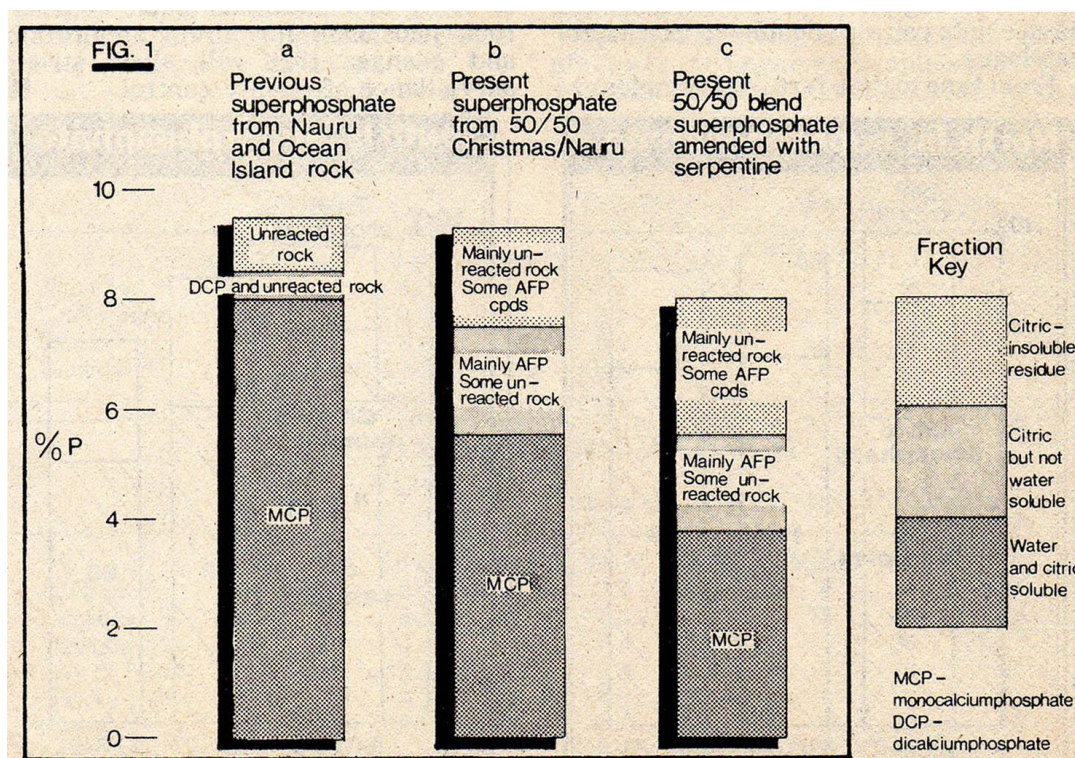


Fig 1. Probable composition of previous and present superphosphates (from Quin 1981)

A lack of (a) regulatory quality control, (b) chemical understanding of the chemicals formed, and (c) regular agronomic comparison against a standard, meant that more than 15 years went by without any alarms going off.

Despite the drop in effectiveness of 30-50%, the on-farm effect would have been only an annual drop of 0-1.5% in production relative to what it should have been, far too low for a farmer to pick up himself amongst climate-induced year-to-year +/- 25% variances in production.

It took publication, initially in the NZ Farmer (Brown 1981, Quin 1981), of the changes in P content of SSP, and production and soil test data from the long-term rates of superphosphate trial at Winchmore in mid-Canterbury to demonstrate that something was seriously wrong. Relative production levels and soil P tests were no longer being maintained (Figures 2 and 3). From these parameters, and from a comparison of pasture production with SSP and pure monocalcium phosphate (Quin 1982), it was deduced that the performance of the forms of SSP been sold widely at the time had dropped by 50%, and even more where 10-15% serpentine was being added to improve flowability.

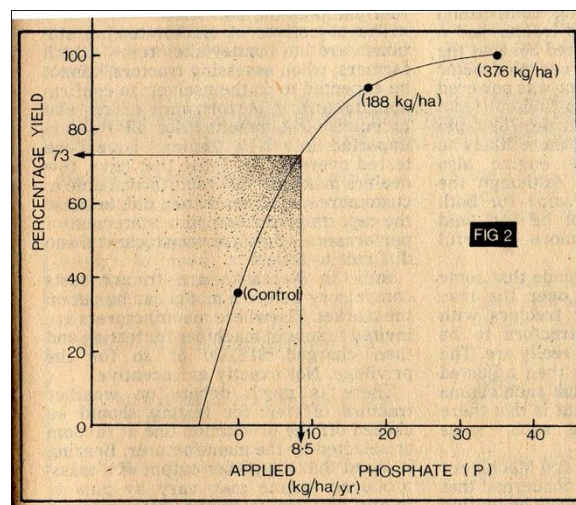


Fig 2. Response curve for percentage of maximum yield versus applied P on the Winchmore trial prior to the use of Christmas rock in superphosphate. Current production from the 188kg/ha superphosphate treatment (1705kg P/ha) has declined from over 90% to 73% (arrowed). This level of production should be maintained with only 8.5 P/ha from good quality superphosphate.

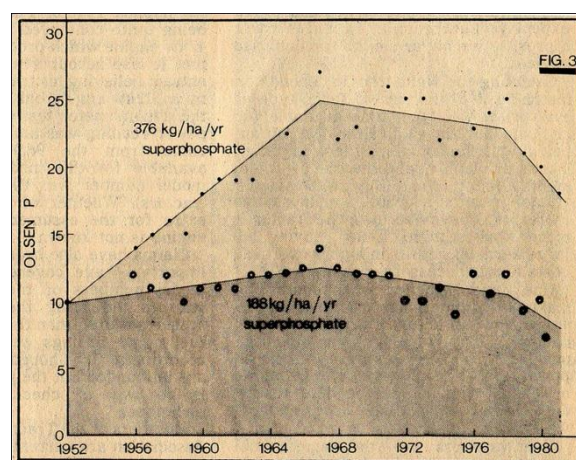


Fig 3. Changes in Olsen P soil test with time on the Winchmore trial. Use of Christmas rock was introduced in the late 1960s, and reached a maximum about 1976!

Despite a lack of involvement in the issue from senior MAF scientists, the manufacturers accepted what was happening. Quality improved substantially from 1981 to 1985 (Figure 4).

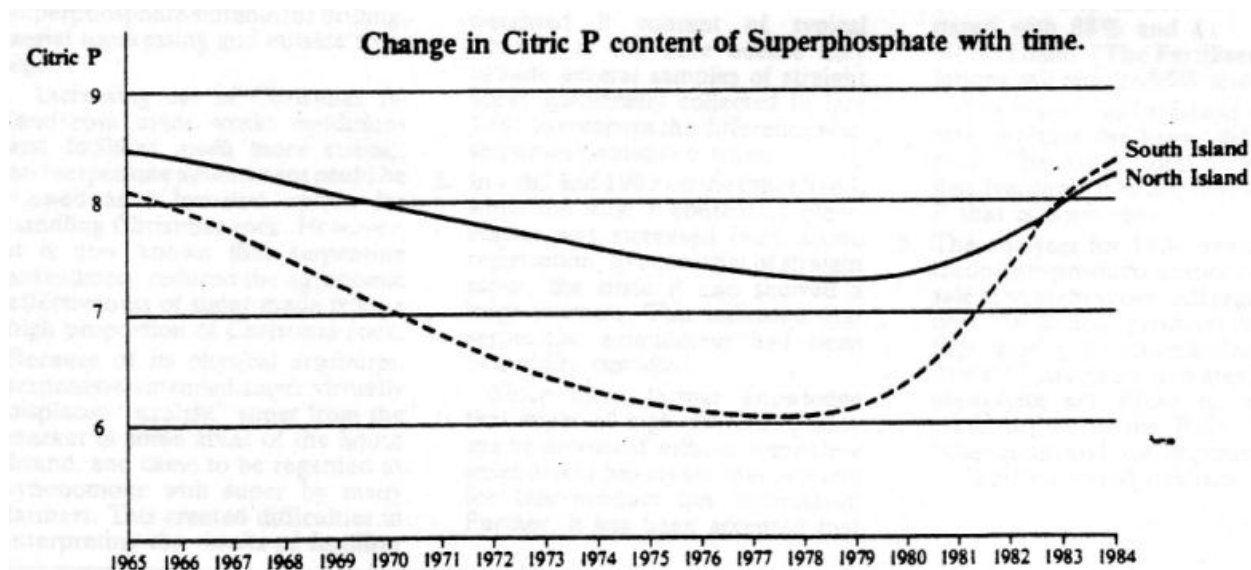


Fig 4. Change in Citric P content of Superphosphate with time (from Quin and Brown 1984)

The most tragic facet of this saga was the financial cost of more than 15 years of poor quality SSP to New Zealand agriculture and individual farmers personally – a cost conservatively estimated at \$200 million annually expressed in 2012 dollars and fertiliser prices.

One of the unfortunate side-effects of this lengthy and variable decline in quality was a diminishment in value of fertiliser comparison work by earlier researchers such as John Grigg and Nelson Cullen. To avoid this problem in the 'National Series' of RPR vs superphosphate trials that the author designed with Chris Dyson, and had oversight of from 1981-6, the standard product used for the response curve at each site was TSP (with elemental S) from the USA. Ironically, if commercial super from 1981 had been used, RPR would have looked exceedingly good!

What is a liquid fertiliser?

Essentially, a liquid fertiliser is one that utilises water to assist in handling and spreading. Some also utilise the water to solubilise some or all ingredients.

Government subsidies on super led at least in part to the Maxicrop court case. Alternative products could not compete with SSP on a nutrient basis, leading to the marketing of magic brews for which preposterous claims were made.

The negative publicity this understandably attracted had the unfortunate side-effect of essentially destroying scientific interest in liquid fertilisers in NZ. This attitude was reinforced by published trial work which demonstrated that DAP/S applied in slurry form was no more effective per unit nutrient than conventional granular product.

This lack in interest in the possible benefits of liquid fertilisers only started to change early this century, with field-trial results (Quin *et al* 2006) and later, scientifically-published research (Dewar *et al* 2011) demonstrating that fluidised urea containing a urease inhibitor was 2.3 times as effective as granular urea per kg N in increasing production (Table 2c), as well as reducing nitrate and nitrous oxide losses (Table 2b and 2a).

Table 2a. Total N₂O-N loss, the proportion of applied N lost as N₂O-N and % changes during 63 days of the experiment from plots treated with urea, with or without the urease inhibitor (NBPT), applied in granular or FPA form (from Dewar *et al* 2011).

Treatments	N ₂ O-N losses (kg ha ⁻¹)	N lost as N ₂ O (% of the applied N)	% difference in N ₂ O loss relative to urea (G)
Control (no N)	0.16 ^a		
Urea (G)	0.42 ^b	0.26 ^a	
Urea + NBPT (G)	0.39 ^c	0.20 ^b	-7
Urea (FPA)	0.40 ^{bc}	0.24 ^a	-5
Urea + NBPT (FPA)	0.37 ^d	0.21 ^b	-12

Within columns, means with the same letters are not significantly different at the $P < 0.05$ level where $n = 4$.

Table 2b. Individual and total NO₃⁻-N loss (kg/N ha⁻¹) during leaching events and % difference in NO₃⁻-N relative to granular urea from plots treated with urea, with or without the urease inhibitor (NBPT), applied in granular or FPA form (from Dewar *et al* 2011).

Treatments	Nitrate-N lost at each time period (kg ha ⁻¹)			Total NO ₃ ⁻ -N losses (kg ha ⁻¹)	N lost as NO ₃ ⁻ -N (% of the applied N)	% difference in NO ₃ ⁻ -N loss relative to urea (G)
	D-35	D-49	D-60			
Control (no N)	0.76 ^a	0.56 ^a	0.36 ^a	1.68 ^a		
Urea (G)	1.67 ^b	1.36 ^b	0.80 ^b	3.83 ^b	2.15 ^a	
Urea + NBPT (G)	1.14 ^c	0.80 ^c	0.52 ^c	2.46 ^c	0.78 ^b	-36
Urea (FPA)	1.07 ^c	0.96 ^c	0.57 ^c	2.60 ^c	0.92 ^b	-31
Urea + NBPT (FPA)	0.75 ^a	0.50 ^a	0.48 ^c	1.73 ^a	0.05 ^c	-55

Within columns, means with the same letters are not significantly different at the $P < 0.05$ level where $n = 5$.

Table 2c. Total herbage dry-matter (DM) (kg/N ha⁻¹), % difference relative to urea-G, total N uptake (kg/N ha⁻¹), % difference relative to urea-G, response efficiency (kg DM kg⁻¹ of applied N) and the recovery above ground (%) from plots treated with urea, with or without the urease inhibitor (NBPT), applied in granular or FPA form (from Dewar *et al* 2011).

Treatments	Herbage dry-matter (kg ha ⁻¹)				% difference relative to urea-G	Response efficiency (kg DM kg ⁻¹ of applied N)	Total N uptake (kg N ha ⁻¹)	% difference relative to urea-G	Total N recovery (%)
	D-21	D-42	D-63	Cumulative					
Control (no N)	865 ^a	705 ^a	843 ^a	2412 ^a			81 ^a		
Urea (G)	1403 ^b	958 ^b	1079 ^b	3439 ^b		10 ^a	107 ^b		26
Urea + NBPT (G)	1625 ^c	1203 ^c	1175 ^c	4003 ^c	16	16 ^b	129 ^c	20	48
Urea (FPA)	1648 ^c	1540 ^d	1171 ^c	4359 ^d	27	19 ^c	136 ^c	27	56
Urea + NBPT (FPA)	1724 ^d	1642 ^c	1366 ^d	4731 ^e	38	23 ^d	148 ^d	38	67

Within columns, means with the same letters are not significantly different at the $P < 0.05$ level where $n = 7$.

2.3 times higher

What is an RPR?

The greater issue of what benefits – environmental and residual performance in particular – that RPR could potentially bring to NZ pastoral agriculture has been to a large degree hidden in a smokescreen of argument over (a) how many years do they really take to equal the performance of (good quality) superphosphate, and (b) how do you define an RPR anyway?

In the National Series, answering (a) was the main objective. Answering (b) was done simplistically, using 30% of the total P soluble in the citric acid test in the product ‘as sold’ (ie, without grinding) as the industry-agreed cut-off. Question (a) will be returned to later. In hindsight, a far superior definition for (b) would have used a maximum crystal a-axis measurement of 3.34 Å as proposed by the IFDC (Van Kauwenbergh 1998), combined with an agreed particle size distribution as sold. The a-axis measurement (Chien and Van Kauwenbergh 1992) has the major advantage of being an absolute measurement, and one that has only one known outlier, *viz* Sechura RPR from Peru, in which partial replacement of carbonate by hydroxide in the crystal lattice gives it an atypically large a-axis, but an agronomic performance equaling the likes of North Carolina, Tunisian and Algerian RPRs, and New Zealand’s Chatham Rise phosphorite nodules (essentially RPR in the making). The particular Egyptian RPR (there are several different deposits) imported to New Zealand by Quinphos had a highly-reactive classification a-axis of 3.341 Å (Van Kauwenbergh 1998), but was prone to excessive coarse content in some shipments, requiring screening and crushing in New Zealand. On an equivalent particle size basis, its citric solubility matched North Carolina (Brown 1994). Unfortunately, vested interests confused what were two separate issues.

B. Zealotry vs Bigotry – The evil twins

Superimposed on the semantic and scientific issues were, and still are to some degree, heavy layers of zealotry and bigotry. The former was identified by the attitude “Forget your science, I believe what I choose to believe”. Bigotry masqueraded under a slightly more subtle attitude, which could be described as “‘The Science’ means that information arising from research conducted according to arbitrary rules, thought processes and boundaries that we are comfortable with”. These attitudes can be seen as twins – mirror images even – of each other. Both attitudes have been very damaging to the advancement of scientific knowledge in NZ agriculture.

One example of just how close they are arose out of the Maxicrop court case, the author had been appointed by MAF’s Ruakura Soil and Plant Director Nelson Cullen as Technical Advisor to the Crown’s QC Don Matheson. One of the author’s Group Leaders at the time (D.C. Edmeades) was brought in some time later to help the MAF witnesses prepare their evidence. The case literally took a year out of our lives.

Professor Paula Jamieson (then of Otago, now Canterbury) was the only scientific witness for Maxicrop. While in no way disputing the very low levels of nutrient applied in a normal application of Maxicrop, Paula did point out that it contained, as claimed, growth hormones such as gibberellic acid which, in the right situation and even at very low concentrations, could enhance plant growth. The benefit of these was given the solid thumbs down by MAF witnesses (justifiably given the zero growth responses in pasture trials).

But, and here is the irony, today we not only have ProGibb being widely used by dairy farmers to profitably increase production, but Dr Edmeades recently did a paid review of their trial data, and (correctly, in the author’s assessment) concluded that the growth

enhancement claims made by Nufarm were correct, even though the application rates used in the Nufarm trials (typically only 20 gms gibberellic acid/ha) were less than 10% of the rates considered necessary for a viable response by MAF back in the 1980s. Gibberellic acid is now suspected as being the undeclared key ingredient in many low-nutrient products, added to help ensure a pasture response!

C. Regulation vs Deregulation – where is the compromise?

After the superphosphate quality saga, the author was convinced that more regulation was the way to go. The existing 1960 Fertilisers Act and its Regulations were too lacking in detail to be effective. He became involved in writing the regulations that would have come under the proposed new 1985 Fertilisers Act. However this Act was stillborn, a casualty of the Government's deregulation binge of the late 1980s.

In hindsight, the author pleased this happened. Whilst it undoubtedly made life easier for a few 'muck and mystery' merchants, technical regulations invariably become outdated by increasing knowledge in the very industry they were designed to serve the user in, and often end up stifling initiative and competition. After a difficult gestation, Fertmark has succeeded in managing most fertiliser issues quite well.

But an equal danger, in a small industry like New Zealand's, is letting industry self-regulation end up serving the interests and attitudes of a small number of individuals. Free and open debate on the issues is necessary for balance.

D. Cons or Commerce – Where is the Line?

Here are few favourites from the decades-

- From the 1970s – “Super is super, no matter what phosphate rock we use to make it”. Enough said.
- From the 1980s – “3 pints (of Maxicrop) will feed an acre”. The line that launched a thousand scientists!
- From the 1990s – “I'm independent and to be trusted, because I don't sell fertiliser”. An absurd attitude that science and selling fertiliser as opposed to your time are somehow are automatically mutually exclusive.
- From the 2000s – “You only need to apply eco-N once a year”. More on this later.

E. Fact or Myth – repetition blurs the difference

- In the 1970s, the attitude – in the MAF at least - was “Agriculture does not pollute the environment. “ The author's bringing attention to the extent of N losses from urine patches, and fertiliser P runoff, were not well received in some quarters.
- In the 1980s, the MAF's attitude was that “No liquid fertiliser works, period”. It took 20 years for this Maxicrop-induced attitude to change.
- In the 1990s, the MAF attitude was “P is not permanently fixed, it's just 'stored'”. So the name of the P retention Test was misleadingly changed to the Anion Storage Capacity test. To most of us, a store means somewhere you put something until you want to use it. On the highly P-fixing allophanic soils, newly-applied P continues to be fixed year after year, with little sign of abatement.
- In the 2000s, the MAF view was “Granular urea is efficient: so there's no point trying to improve fertiliser N efficiency”. Wrong again, as discussed earlier.

F. Interpretation or Misinterpretation – Seeing what we want to be seen

RPR vs SSP comparisons – playing with numbers

The author developed and co-published an RPR predictive model towards the end of the trial series (Quin *et al* 1987), before resigning from MAF to join Fletcher Challenge's shortlived new RPR/PAPR importing venture Duraphos as Technical Manager. Quinphos was formed in 1989.

If you look at the full data from all 19 sites, the full data released to Quinphos by order of the Ombudsman to Quinphos in 1990 showed that, averaged over all rates of application, RPR produced 3.1% less growth in Year 1 than TSP (compared to 5% for the no P controls), 1.4% less in Year 2, 1.1% more year 3, 0.7% less in year 4, 1.0% more in year 5 and 2.7% more in year 6 (Table 3). In subsequent research, RPR also showed much better residual performance in the years following cessation of P application.

Table3. Summary of full data released to Quinphos in 1991 by Order of the Ombudsman.

MAF "NATIONAL SERIES OF RPR TRIALS"

AVERAGE DIFFERENCE IN PRODUCTION BETWEEN RPR AND SUPERPHOSPHATES
YEAR BY YEAR

(Averaged over all rates of P)

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6
Trial 1	- 2%	+ 1%	0%	- 6%	0%	+ 2%
Trial 2	- 6%	- 9%	0%	- 3%	+ 6%	+ 12%
Trial 3	+ 1%	+ 2%	0%	+ 5%	+ 4%	+ 3%
Trial 4	- 7%	- 1%	+ 2%	+ 3%	+ 6%	+ 9%
Trial 5	0%	+ 1%	0%	0%	+ 3%	+ 5%
Trial 6	0%	- 2%	- 1%	- 3%	0%	+ 2%
Trial 7	- 7%	- 7%	- 1%	- 2%	- 5%	- 1%
Trial 8	- 8%	- 3%	0%	-	-	-
Trial 9	- 6%	- 2%	0%	- 2%	- 2%	-
Trial 10	- 3%	+ 1%	+ 3%	-	-	-
Trial 11	- 8%	- 4%	0%	-	-	-
Trial 12	+ 9%	+ 4%	+ 10%	-	-	-
Average	- 3.1%	- 1.4%	+ 1.1%	- 0.7%	+ 1.0%	+ 2.7%

NOTE:

a) The average difference between RPR and superphosphate of 3.1% on year 1 is exaggerated by the difference at very high (above maintenance) rates of P. At typical rates of P applied, the average difference is less than 2% in year 1.

b) The advantage to RPR in years 5 and 6 may be slightly exaggerated in Trials 2, 3, 4 and 5 by the possibility of a molybdenum deficiency being counteracted by the significant level of molybdenum in one of the RPR's.

However, on the way to scientific publication of the full trial data by staff from what was by now AgResearch, several sites were dropped, for a variety of reasons. A couple had extreme variability problems. About 5 more were excluded for 'not running the full 6 years intended'. This was interesting, because these trials were stopped early simply because RPR had been as good as TSP since day 1, and so the local scientists understandably concluded 'case proven'.

Most concerning, 7 sites were excluded because of concerns they *might* have been Mo deficient, and the Mo content of Sechura RPR, used for the RPR response curve, *could* have given it an advantage. Herbage analysis indicated differences in Mo content, but Mo *responses* to the Sechura RPR Mo content were never actually positively identified. RPR performed very well in these deleted sites.

Intriguingly, in all the references to this ‘Mo problem’, no consideration was given to the fact that most of the trials had single rates of a range of other products, including two other low-Mo RPRs (North Carolina and Chatham Rise), all applied at 0.75 Calculated Maintenance (CM) P for the individual sites. These calculations were amazingly accurate thanks to CFAS, Overseer’s predecessor. Consequently, and because all sites were deliberately chosen to be slightly sub-maintenance to start with, the 0.75 CM points with TSP and RPR always fell on the quite sloped part of the response curve.

The Mo issue was first raised in the paper by Sinclair *et al* (1990). They found, on all 12 trials the ran for the full 6 years, Sechura had reached equivalence with TSP, at least up to full maintenance application , by year 3, and was statistically superior by year 6 (Figure.5).

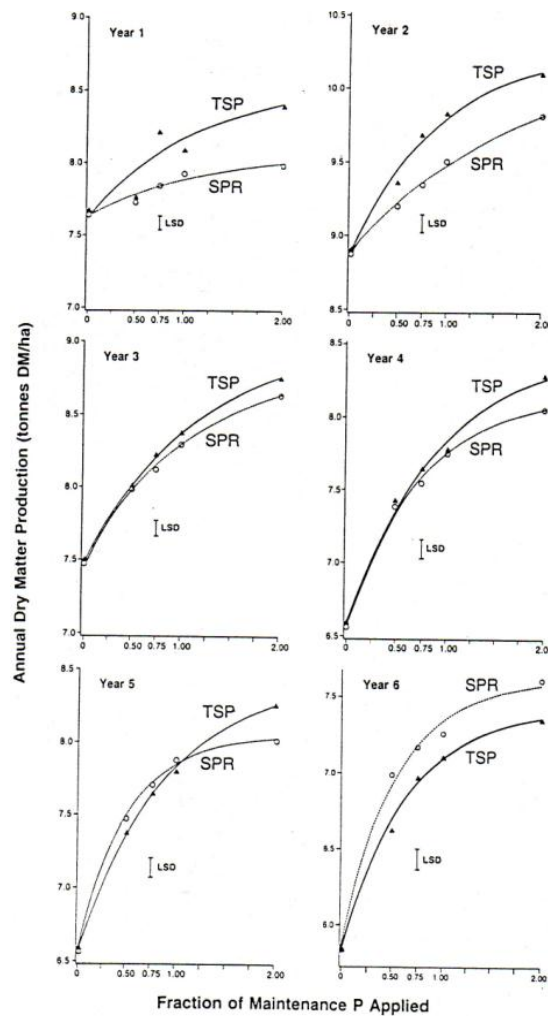


Fig 5. Mean annual response curves for all operating trials in year 1 to year 6 (from Sinclair *et al* 1990)

Regarding Mo, they stated ‘...low and *possibly* deficient Mo levels had developed in control and TSP plots at some sites *towards the end of the trials*’. The Mo issue could and should have been resolved then and there by reference to the fact North Carolina and Chatham Rise RPR, both low in Mo, performed identically to Sechura in all trials.

The ‘Mo problem’ in the series was elevated in seriousness at the following Grasslands conference by Edmeades *et al* (1991), who excluded a full seven sites (sites 2-5 and 17-19), at all of which RPR performed well) on the grounds of “*an apparent Mo deficiency*”. The fact that on these sites, Mo deficiency could not possibly have adversely affected TSP performance before year 4, according to the authors’ own modeling, and by which time Sechura had already reached equivalence, is ignored.

Finally, four years later, a multi-authored paper (Morton *et al* 1995), which did not include Edmeades as an author, compared annual and triannual applications of Sechura RPR and TSP *on all 19 sites of the National Series*. These author’s only mention of Mo, perhaps a nod to the missing author, stated “As the Northland and Southland sites did not receive a basal Mo application, the significant Mo content of Sechura could have benefited SPR treatments relative to TSP at these sites (Sinclair *et al* 1990). Consequently, comparisons between fertilisers in terms of DM production should not be made from these sites”. Despite this caution, every graph and table in the paper co-presents DM data from both, obviously inviting the reader to make the comparison.

The other major issue in the author’s view is the fact that virtually all sites also contained a PAPR made by partially phosphoric-acidulating North Carolina RPR. This product equaled the performance of TSP from Year I on every site. The importance of this finding has been overlooked by most researchers, leaving it to Rajan and Marwaha (1993) to refer to the data in a brief review. To quote “The diagram shows the results obtained with North Carolina (phosphoric) PAPR applied annually to seven sites over a period of 6 years....the results indicated that there was no difference in dry matter production between PAPR and TSP ...North Carolina RPR was lagging behind for the first 3 years... MacKay and Wewala (1990) also found that a commercial 30% phosphoric PAPR was as effective as SSP for permanent pastures”.

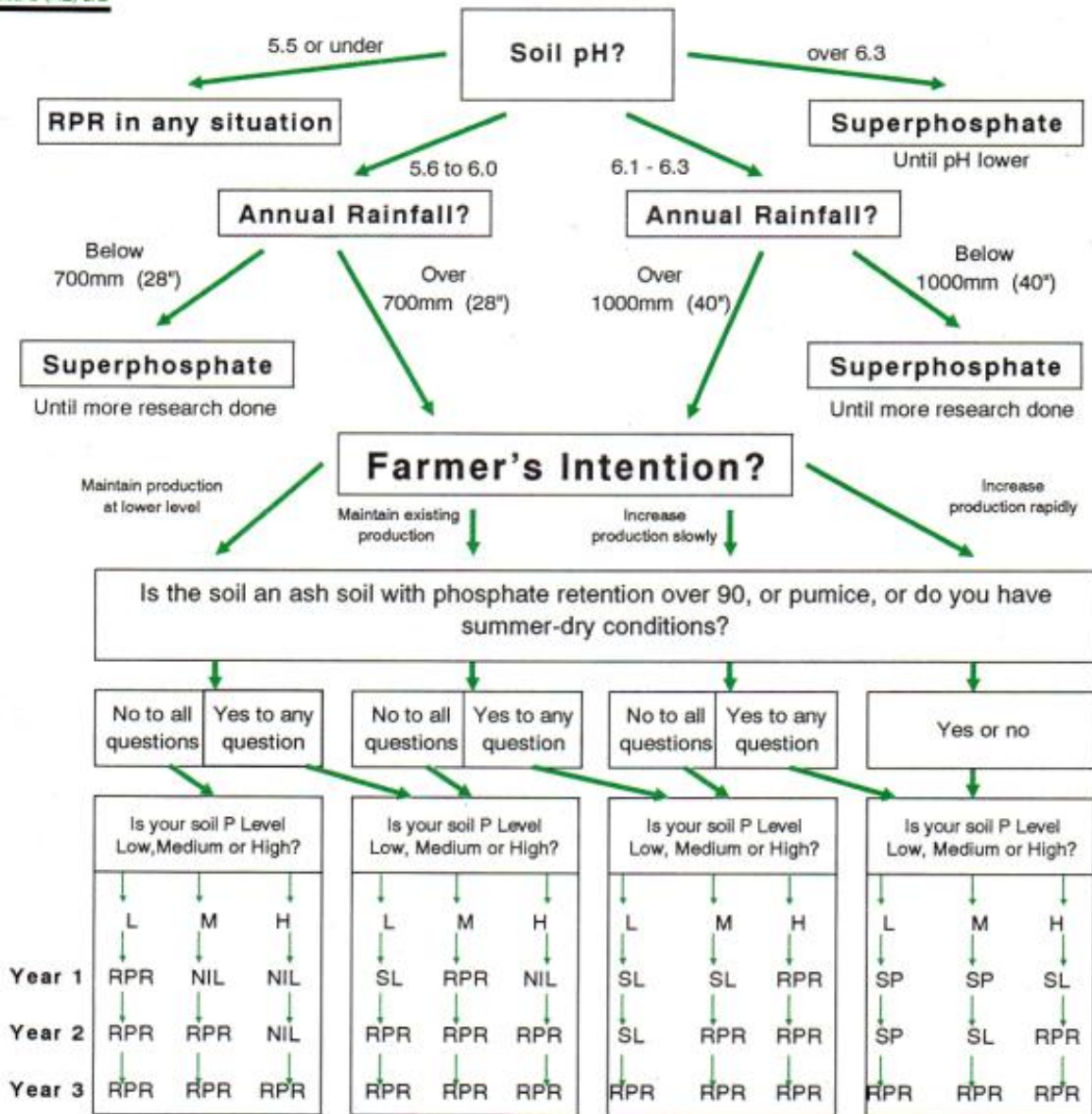
The failure by AgResearch to publicise the benefits of RPR/soluble blends is particularly damning when the “National Series” is reduced on very questionable grounds to about 5 sites, most of which are quite P retentive, a factor that is known to very significantly increase the time it takes for RPR to get ‘up and running’ and match the yield of water-soluble P. It was the average of these sites that has been written into Overseer, and developed into Ravensdown’s econometric model, which the author understands typically indicates that it takes about 15 years for RPR to be as cost-effective as SSP, a time-lag which the average farmer understandably considers to be too long to consider using RPR..

Quinphos developed its simple but effective ‘Quinplan Decision Tree’ to ease farmers into RPR gradually, to avoid any temporary lag-phase or drop in production by using blends of soluble P and RPR where appropriate (Figure. 6). In fact, more than 90% of RPR sold by the company was blended with TSP or DAP.



"QUINPLAN" DECISION TREE FOR SWITCHING PASTURE FARMS FROM SUPERPHOSPHATE TO QUINPHOS RPR

- With absolutely no loss in production and with guaranteed savings -



NOTES:

- | | <u>Sedimentary and Peat Soils</u> | <u>Pumice & Ash Soils</u> |
|--|---|-------------------------------|
| 1) Soil P Status (Olsen P) | - L (Low) <9
- M (Medium) 9 - 19
- H (High) >19 | <15
15 - 30
>30 |
| 2) This table determines the form of phosphate to be applied in Years 1, 2 and 3. The rate of P to be applied, and which other nutrients such as sulphur, potash and trace elements should be applied, and in what quantity, must be assessed from stocking rate, rainfall, soil tests and plant analysis. In general, to slowly increase production will require 50-100% increase in P over maintenance for 2 years; a rapid increase will require 2 to 3 times maintenance for 1 to 2 years. | | |

Fig 6. "Quinplan Decision Tree".

There is I believe a real need for a free-thinking young graduate, looking for a PhD project with the difference, to go back to the archives and take a fresh look at the results, from the starting points of –

- (1) We have to reduce P run-off losses from agriculture. Every published comparison has demonstrated that using RPR results in significantly less P run-off than using water-soluble P, and
- (2) What management practices could be used to avoid any RPR ‘lag-phase’, that is, any short-term difference in production, such as either true PAPRs or RPR/soluble P blends, RPR/elemental S granules or fluids, initial capital RPR application (cash-flow permitting), etc.

Regardless of actual agronomic performance, RPR has served a very important purpose in demonstrating that the *type of fertiliser itself* plays a very important role in P run-off (hart *et al* 2004, McDowell 2012). Finding ways to reduce it offers the win-win of reduced environmental pollution and improved cost-effectiveness, with no additional cost or labour input for the farmer.

New products such as anionic copolymers and even sodium metasilicate offer enormous potential to improve the efficiency of high analysis P fertilisers such as DAP, by reducing P fixation, as discussed by Peter Bishop (Bishop *et al* 2012).

eco-N and urine N loss

The avalanche of peer-reviewed scientifically published papers in the last decade, the majority by Cameron and Di, have demonstrated that eco-N (fluidised DCD) applied with lots of water to artificial urine at very high N rates, could very significantly reduce nitrate leaching and nitrous oxide emissions from the urine patch.

However, serious errors were made in the extrapolation of this research to the real-farm situation. The key issues overlooked were-

- (1) On a real-life dairy farm, a given paddock is being grazed every 2-4 weeks. Any urine patch deposited on a paddock being grazed on a particular day has a ‘treatable’ life – that is, the period before too much of the N has already been converted to nitrate anyway – of about a week or two, or say 2-3 weeks in Canterbury and Southland, and
- (2) DCD has an active life of about 2 weeks (NI) or 3 weeks (SI). So it has to go on no more than 7-10 days before a grazing (and even then providing no irrigation or heavy rain occurs), within a week or so.

Putting (1) and (2) together, any one application of eco-N can only hope to be effective on the urine patches deposited in *one grazing of a particular paddock*. But in a year, the average dairy farm paddock gets grazed about a dozen times. One or two applications per year will struggle to be effective. This fact is finally becoming understood (Balvert *et al* 2012, Kim *et al* 2012).

Certainly, we can choose say two application times that might be the most efficient, and give us an annual reduction of 25-30% in N losses, if we know when the levels of urine-N that are sitting in the topsoil as ammonium-N are at their highest. Realistically, this would require expensive monitoring of soil urea and ammonium-N levels, or the development of improved farm-specific predictive models.

The author suggests that maybe the time has come to seriously consider putting simple ‘Taurine’ inhibitor-dispensing devices on the cow’s tail (Bishop and Quin 2010) is actually the cheap, effective, on-time every-time way to apply inhibitor.

Conclusions and Recommendations

In today’s economy, there is little or no chance of extensive, nation-wide production research to be carried out. But the answers to many of the questions we are asking today can I believe be found hidden within the masses of trials conducted in previous decades. One often has to look past the sometimes outdated questions and attitudes that shaped the focus and writing of the results for scientific publication, and go back to the raw data.

A classic example is RPR. We now know it offers considerable benefits in terms of reduced P runoff (Hart *et al* 2004, McDowell 2012) and stronger residual performance, but many farmers have been scared off being prepared to ‘risk’ trying out by greatly exaggerated short-term agronomic limitations. There is a real need to revisit the data with an open mind, including all data on partially-acidulated products and RPR/soluble P mixes.

Finally, there are many, many farmers out there who have been using RPR as their major P input for up to 25 years. It obviously works for them, otherwise they would not still be in business! There is a great deal that could be learned from interviewing these farmers and studying their environment, farm management and production.

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