THE POTENTIAL FOR NEW FERTILIZER TECHNOLOGIES TO CONTRIBUTE TO PROFITABILITY

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Introduction

Landholders in higher rainfall areas who need to topdress their improved pastures with superphosphate to maintain productivity have seen a rapid increase in the cost of superphosphate during the last 12 years (Fig. 1). This cost increased at more than twice the rate of the CPI over this period. It is an interesting observation that the cost of super. on farm was actually constant for 20 years; it therefore declined in cost in real terms between the early 50's and 70's. This was an abnormal price trend and obviously could not last. When Morocco decided to increase its phosphate rock price almost 3 fold in three months in 1974, the era of cheap super. had come to an end. Fertilizer expenditure now represents the major cost in the maintenance of improved pasture productivity.

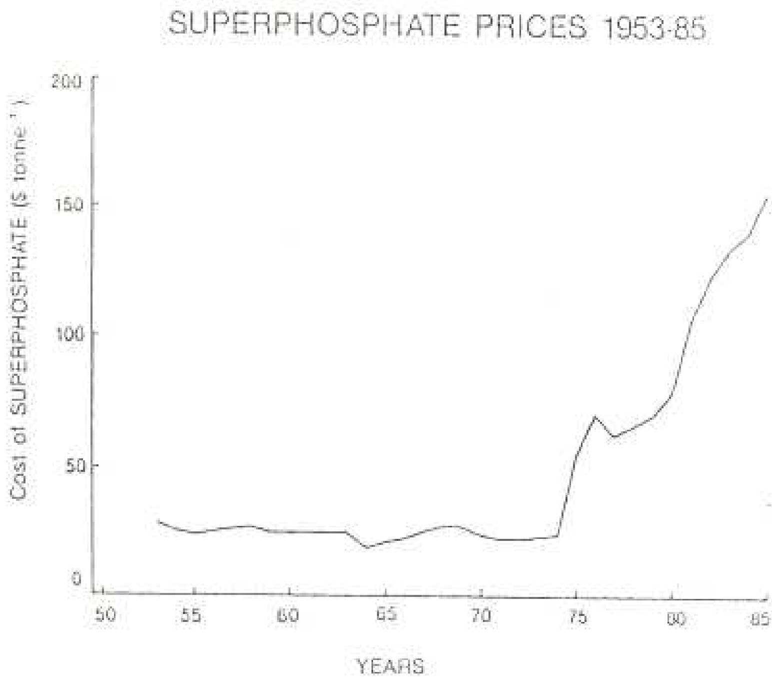

Figure 1. Changes in the price of superphosphate from 1953 to 1985. The price includes a $10.50 works to farm cost in 1974-75, indexed backward and forward by the BAE contracts index.

This paper addresses itself to the question as to whether it is possible to apply phosphate (P) to pastures in alternative fertilizer forms to super. at lower costs than those incurred in applying super. A number of alternative forms are possible depending on the raw material used. The basic chemistry is to change an insoluble, tricalcium phosphate into a plant available monocalcium phosphate by mixing the rock phosphate with an acid. The use of sulphuric acid will add S, while the more expensive phosphoric acid will add additional soluble P. Rock phosphates vary between the reactive North Carolina rock and the less reactive Christmas Island and Nauru rocks, with the latter being less useful agronomically in their original form. The different combinations of acid type, amount of acid, rock type, and whether or not elemental S is added to the product.

In order to determine whether cost savings are possible, I have attempted to cost the various options to arrive at an ex-works cost per unit of P. The costings have erred on the side of conservatism. The second cost component is that of freight and spreading charges per unit of P. These have been calculated for a property located 45kms from the Walcha railway depot, which is 340km from Newcastle. All fertilizers used on this place will be spread by air. Implicit in this comparison is the assumption that the products are equivalent in agronomic effectiveness. Further research is required to validate this assumption. It would appear that any difference would be of a minor nature.

The problem with superphosphate

Superphosphate is the product that results from the mixing of about 10 parts of rock phosphate with 6 parts of sulfuric acid, resulting in plant available P and gypsum being formed. The gypsum, resulting from the suplus calcium combining with the S from the sulfuric acid, makes up about 60% of the weight of super. On the one hand, it is a source of plant available S but on the other, it reduces the concentration of P in the fertilizer. The lower the P concentration, the more fetilizer one has to buy, the greater the freight bill from the works and the greater the spreading costs on the farm, to apply a given amount of P per unit area.

The first option to super. one might consider is ESPARP, a test product that has been developed at the University of New England. Its development was based on the premise that we need the same S:P ratio as occurs in super.

Option 1: ESPARP

ESPARP is similar to super. except that only half the sulfuric acid is added to the rock phosphate, and that some elemental S (6% w/w) is added. ESPARP therefore contains rapidly available P and S fractions (as in super.) but also contains slow releasing P from rock phosphate and S from elemental S. It was originally postulated that the slow release fractions would increase the residual effectiveness so that cost-savings might result from a reduction in the frequency of applications. Despite the fact that the rock phosphate is an unreactive type, its dissolution would be significantly improved by the sulfuric acid that is produced by the bacterial oxidation of elemental S in the granule.

ESPARP has performed quite well in field trials in the Armidale district, in comparison with super. (Sale and Blair, 1985). In good seasons, on established topdressed pasture, the two fertilizers appear to be equivalent in effectiveness. ESPARP has been shown to be superior when sulphate leaching occurs (light, unimproved country in wet years) but inferior in dry seasons. There is no evidence of a superior residual P effect in ESPARP. Thus any cost savings with this fertilizer will come from cheaper costs of manufacture or from savings in freight, or spreading charges, or both.

It would appear from a preliminary examination of manufacturing costs that ESPARP would cost more to manufacture per tonne then super., at the Newcastle Cockle Creek Works. The additional cost of elemental S, plus the extra rock would appear to exceed the savings made by using less sulfuric acid. However, because there is less gypsum in ESPARP the final P concentration is about 12% higher than that in super., so the cost per kg P ex-works is similar to that in super (Table 1). Because of the higher grade of ESPARP, some modest cost-savings should be possible by lower freight and spreading charges, particularly if the spreading surcharge on low application rates can be avoided.

ESPARP is currently being evaluated with superphosphate at sites across NSW. Should it prove to be as effective as super., then the magnitude of associated cost savings and perceived advantages such as superior residual S effects, would determine whether it will be manufactured commercially.

Table 1 Estimated costs (per unit of P) of an annual application of 11.2 kg P/ha in different fertilizer forms on a Walcha property (45 km from railway).

Fertilizer	Application rate (kg/ha)		Costs of (per kg p)			% saving over single
	P	S	Ex-works	On-Costs	Total	
Single super	11.2	14.1	1.47	0.78	2.25	- #
ESPARP	11.2	14.1	1.46	0.75	2.21	1.8 (4.4)
LL super (NZ)	11.2	9.1	1.39	0.78	2.17	3.5 (6.1)
Hyphos S (NZ)	11.2	5.6	2.00	0.49	2.49	-10.6(-8.0)
Double super	11.2	2.9	1.60	0.49	2.09	7.1 (11.1)
Tri-fos	11.2	1.6	1.51	0.45	1.96	12.8(15.5)
Hyphos (NZ)	11.2	0.6	1.52	0.49	2.01	10.7(13.3)

Figures in brackets represent the % saving over the cost of single super. where high rates of application are applied less freqently to minimise the spreading surcharge. This strategy also assumes that the products are poorly granulated to improve aerial spreading characteristics.

Do we need all the S in super?

Given that one of the major problems with super. is its low P concentration due to the presence of gypsum (60% w/w), the question must be asked as to whether all the gypsum is necessary. Pasture fertilizer recommendations in the past have been to use super "because the extra S will ensure no S deficiency occurs". With the cost of aerial spreading superphosphate at over $200 a tonne in many parts of NSW, this attitude towards the usefulness of the S component in super needs to be closely examined.

During the last 30 years of the pasture improvement era, agronomists in the Northern Tablelands have considered that there was a continuing need for S inputs to maintain the productivity of improved pastures. Early survey work during the 1950's by Spencer and Barrow (1963) found that 90% of New England soils in the virgin state showed responses to added S together with responses to P. These findings, I believe gave rise to this attitude of the continuing need for S inputs. In 1972, the P and S response in topsoil from sites used by Spencer and Barrow, of which all had received a minimum of 1230 kg super. per ha were examined in the glasshouse (Blair, unpublished data). whereas 90% of soils were still responding to P, only 40% were responding to S over time. Recent field trials conducted in the southern New England have looked at the P and S responses on country that has received a minimum of 1845 kg super. per ha, only 33% of sites showed any response to added S (Crocker and Holford, unpub. data). Thus there appears to be a trend of declining of S responsivesness with the continuing use of single super.

Responses to applied S by livestock are probably more elusive than pasture yield responses. Unless they do occur, then the rationale for adding S with P comes into question. In a series of grazing trials at 4 sites in the New England that were considered likely to respond to S, responses in animal production to applied S only occurred in one of the two replicates, at two of the four sites, in one growing season over a five year period. (Shedly, 1982; McCaskill, 1984). Only 2 season x replicate combinations out of a possible total of 37 showed livestock responses to S.

Part of the problem in the determination of S status of improved pasture is that there is no effective soil test for S. There is a great need for further research in this area. Until we can accurately determine the likelihood of a response to S with added P, the ability to obtain any cost savings from low S fertilizers will be limited. The fertilizer options that follow involve the use of P fertilizers with lower S:P ratios than super. Their use might be considered if one was confident that there was adequate S in the soil for maximum pasture growth.

Options 2 and 3: double super. and tri-fos

If we were confident of having pasture that did not respond to S, then cost savings are immediately available by the use of high analysis P fertilizers such as double super or tri-fos. In their present form, savings would amount to 7% and 12.8% respectively of the cost of applying 11.2kg P/ha as single super. (Table 1). Additional savings could be achieved if a landholder was prepared to double the application rate and do half the intended area each year. This would avoid the surcharge on spreading the low rates of product per ha. If the fertilizer was to be spread by aircraft, then additional problems would be encountered due to the eveness of granule size with these high analysis products.

They would fall from an aircraft in a narrow swath, necessitating more flying time and higher costs to spread the material. It should be possible to adjust the granulation process at Newcastle to produce a less granular product that would have a wide range of particle size and a wider spread patter from an aircraft.
With higher application rates, every second year, and with less granulation their estimated savings could increase to 11.1% and 15.5% for double super. and tri-fos respectively.

Option 4: Long-life super (NZ)

Major changes have taken place in New Zealand in recent years in the range of fertilizers that are available for pastures. They are concerned that single super. may not be the most efficient form in which to apply P (and S) to their country, particularly in the North Island. Because of the higher S status in these soils, they consider that the optimum S:P ratio should be 0.6, which is half that of super. One product that they are selling with a lower S:P ratio is called "long life super". This is similar to ESPARP except that instead of adding unreactive rock to a mixture of super. and elemental S, only reactive North Carolina rock is added to the super. (in a 30:70 ratio), thereby reducing the S:P ratio. This formulation has been costed for Australian conditions and has been estimated to result in savings of between 3% to 6% over that of single super. (Table 1).

Option 5: Hyphos (NZ)

This new product is now being manufactured and marketed by East Coast Fertilizers Ltd, at Napier on the East Coast of North Island of New Zealand. It contains virtually no S; its high P concentration of (16%P) is achieved by adding to North Carolina Rock, about 30% of the phosphoric acid that would be required to convert all the rock P to water soluble P. It is therefore a reactive rock that has been underacidulated with phosphoric acid. The use of some phosphoric acid provides for a portion of readily available P yet the bulk of the P would still come from the rock, which is the cheaper source of P. Its future in Australia would depend on clear cost savings over products like tri-fos. However the costing comparison indicated no advantage over tri-fos (Table 1). The reason for this is that tri-fos is itself an under-acidulated product, and has a higher P concentration because high P rocks such as Nauru and Christmas Island rocks (17% and 15.3% P respectively) are used in its manufacture, whereas North Carolina rock has a low P concentration (13% P)>

Option 6: Hyphos -S (NZ)

The final option is to look at the cost effectiveness of another East Coast high analysis P product called Hyphos S. This is similar to Hyphos except that elemental S has been added so that it has an S:P ratio of 0.6.

It would be used by landholders who were concerned with the S status in their country, and were not prepared to risk topdressing without S. The question that is posed for us is whether we can obtain cost savings by using phosphoric instead of sulfuric acid (thereby having a high P concentration) and then adding elemental S to ensure that adequate S is also applied. Given the prices of raw materials and the cost structures in Newcastle fertilizer works, the answer would quite clearly be no (Table 1).

Conclusions

The scope for cost-savings in the application of P fertilizers to pastures depend on their requirements for S. If we need a high S:P ratio as in super., then only modest savings might be possible by using products like ESPARP. With ESPARP, the savings result from a slightly higher P concentration resulting in lower freight and spreading charges per unit of P.

If the S:P ratio in pasture fertilizer could be reduced then products such as NZ Long-life super. would offer greater savings. There would appear to be no scope for products like the NZ Hypos S in our industry. If S is required in a pasture fertilizer, then we need to look at low analysis formulations based on suphuric acid.

The only hope for significant savings in the cost of applying P (i.e. greater than 12% savings over the cost of super.) lies in adding P with minimal S. This would involve the use of some modified forms of tri-fos. However, caution is urged when considering this option, because of the risk of S deficiency. There are indications that pastures with a long history of super. application are becoming less responsive to S, but we are not able to do so, landholders are advised to refrain from the use of tri-fos applications. One of the most pressing research objectives for our industry is surely the development of an effective test for determining the S status on pastures. Such a test would provide the key to unlock the door to potential cost-savings when applying P to pastures.

References

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