Fertophobia and beyond: an outsider's perspective on current fertiliser policies and practices on legume based pastures in NSW

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Abstract

Evidence from previously fertilised legume based pastures in New Zealand shows that pasture and animal production decreases at about 5% per annum when fertiliser inputs are withheld. Furthermore farm surveys in New Zealand show that those farmers who maintain fertiliser inputs during times of poor financial returns are more profitable and financially sustainable.

Fertiliser inputs in NSW have decreased significantly over several decades and this has been reflected in a steady decline in animal production (wool/head, total DSE) over the same period. The current soil fertility of most NSW soils is very poor. It is suggested therefore that current fertiliser and nutrient management practices are exploitive rather than conservative.

In addition to decreasing the productive capacity of the soils, the current fertiliser practices are likely to result in environmental degradation of the soil resource through a decrease in ground cover, an increase in nutrient runoff and soil erosion and an overall decline in soil quality.

The technology is currently available to sow, fertilise and manage legume based pastures, and if adopted would overcome these problems and improve the income, profitability and welfare of the legume based pastoral sector.

In their virgin state, most of the pastoral soils in both New Zealand and Australia are deficient in key nutrients, particularly phosphorus (P) sulphur (S) and the trace elements molybdenum (Mo), copper (Cu) and zinc (Zn). Furthermore, many of the biochemical process which take place in healthy pastoral soils produce acid. Both fertiliser and lime inputs are therefore essential to sustain and maintain their production. [Note that throughout this paper the terms "pastoral soils", and "pastoral farming" and the word "pasture" refer to legume based pastures. In the context of NSW this means improved pastures in areas with average annual rainfall > 400mm].

The most important component of temperate pastures is the legume. Not only is it a good source of animal feed, but more importantly, it fixes nitrogen (N) from the atmosphere. This N is consumed by the animal and returned to the soil in dung and urine, or as plant litter (fig 1). Given time, fertiliser and lime inputs, and the influence of the grazing animal, the soil N status gradually increases until pasture production reaches a maximum (fig 2). This general relationship between soil fertility and pasture production – the soil fertility production function – should be understood by all grassland farmers.

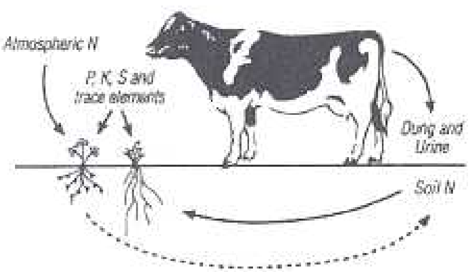

Figure 1. The key components of the nitrogen cycle in legume based pastures (Roberts et al 1993).

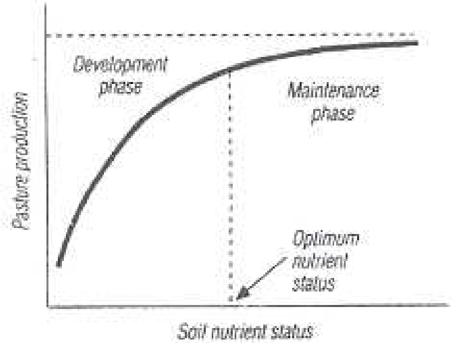

Figure 2. The pasture production - soil fertility production function (Roberts et al 1993).

Forage legumes, including white and subterranean clover, have higher nutrient requirements than grasses. Thus, the primary reason for applying fertiliser, lime and trace elements to pastoral soils is to maximise their production, and with it, inputs of N into the soil/pasture/animal system. Conversely, a decline in legume growth and subsequently N inputs, is the first consequence of withholding nutrient inputs, driving the system back down the production function (fig 2).

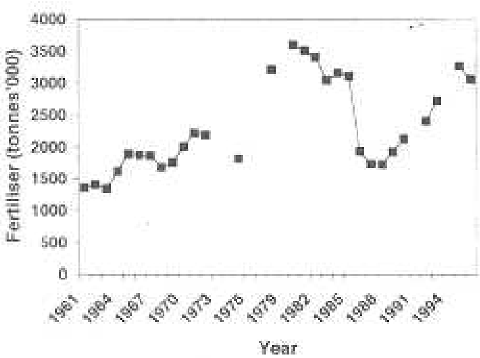

Figure 3. Sales of superphosphate in New Zealand (source: Statistics New Zealand, Agricultural Statistics 1996).

Frequently these simple principles of the legume based pastoral system are forgotten or overlooked. This occurred in New Zealand during the 1980s when fertiliser inputs declined by 50% due to poor commodity prices and the removal of all farming subsidies (fig 3). It has taken over a decade for fertiliser inputs to return to their pre-crash levels.

This paper is about the lessons learned by the New Zealand pastoral industry during this period and attempts to relate these to the current situation in the NSW pastoral sector.

Lessons from New Zealand

Consequences of withholding fertiliser inputs

Beginning in the early 1980's several field experiments were commenced to measure the long-term consequences of reducing or withholding fertiliser inputs. The results are summarised in Table 1. Typically, pasture production, and with it animal production, declined by about 4-5 % per annum on these previously well-fertilised (about 250 kg/ha/yr superphosphate) sedimentary soils.

The accumulating effects of this are shown for one of these trials (Table 2). Over 5 years the amount of plant available soil P (Olsen P) had decreased from 15 to 7, and with this decline in soil fertility, pasture and animal production declined by about

20%. The legume (white clover) content decreased by 28% and the proportion of weeds in the pasture increased by 58%.

Table 1. A summary of the effects of withholding fertiliser inputs on pasture and animal production in three field trials in the North Island New Zealand.

Trial and Reference	Duration (yrs)	Rainfall (mm)	Olsen P[1]	Decrease in Production (%)[2]	
				Pasture	Animal
Summerlee (Morton et al (1997)	10	840	10-12	13-25	Not measured
Ballantrae Lambert et al (1990)	7	1200	9-11	20-30	5-32[3]
Te Kuiti (O'Connor et al (1990)	6	1550	12-14	20-30	15-18[3]

Notes 1) Olsen P at the commencement of the trial
2) Due to witholding fertiliser for the duration of the experiment.
3) ewe and lamb liveweights and wool weights

Table 2: Effects of witholding fertiliser inputs for 5 years on animal and pasture production on a sedimentary soil in New Zealand (from O'Connor et al 1990).

Measurement	Effect of no fertiliser (%)
Ewe liveweight	-20
Ewe fleece weight	-15
Lamb liveweight	-18
Lamb fleece weight	-19
Pasture production	-20
White clover content	-28
Weed content	+58
Soil P	-45

Note 1) difference (%) between fertiliser (250 kg superphosphate) and nil fertiliser treatments after 5 years.

Although these effects were predictable from the basic principles of legume-based pastures, the speed with which they occurred was surprising. The productivity of legume-based pastures, even those with a good fertiliser history, is very sensitive to withholding fertiliser inputs.

Given the sharp decline in fertiliser sales, it was not long before the impacts of this became apparent on commercial farms. A sample of 174 Hill Country sheep and beef farms in the North Island was surveyed in the season 1988/99. They were categorised into three groups, depending on their fertiliser use in the previous three seasons (Table 3).

Table 3. Effect of fertiliser history on the performance of North Island sheep and beef farms over the period 1985-86 to 1987-89 (adapted from NZ Meat Producer 1991)

Measurement (1988/89)	Fertiliser History for period 1985/86 to 1987/88		
	none	< 100 kg/ha/yr	> 100 kg/ha/yr
Fertiliser ($/ha) inputs	8.40	23.66	50.01
Change in stock units (since 1985/86)	- 4%	-1.0%	+2%
Lambing percentage	94	99	110
Lamb weight	11.9	12.1	14.1
Wool sold (kg/SU)	4.5	5.4	5.8
Gross revenue ($/ha)	253	334	441
Profit ($/Ha)	46	81	140
Equity (% assets)	69	80	88
Interest payments ($/ha)	61	48	30

Those farmers who had maintained fertiliser expenditure, despite the economic conditions during the previous three years, produced more, and more importantly, were in a sounder financial position in 1998/99. These farmers had already learned the lesson that fertiliser expenditure should not be regarded as discretionary.

This has been the major lesson learned by the New Zealand pastoral industry during the 1980s. Expenditure on fertilisers is not optional. It is essential to sustain the long-term productivity. It is as vital as maintaining capital stock, or essential plant and equipment. Fertiliser expenditure should be regarded as, and treated as, capital expenditure. Those farmers who did not continue to apply fertiliser soon realised this truth when they had to apply capital fertiliser inputs to replenish soil nutrient levels.

Alternative fertilisers

Given that fertilisers are a major item of expenditure on most New Zealand farms, it is understandable that when real prices for fertiliser increase, or returns from farm sales decline, farmers look for alternative cheaper products. It is no surprise therefore that many new fertiliser products entered the New Zealand market during the 1980's. Most of these were not tested, or at least not adequately tested, in scientifically designed and conducted trials, under New Zealand conditions.

The most important of these where Reactive Phosphate Rocks (RPRs) and their derivatives; Partially Acidulated Phosphate Rocks (PAPRs) and mixes of superphosphate and RPRs, such as Longlife.

In the mid to late 1980's these products were cheaper per unit of total P than soluble fertilisers such as superphosphate. Furthermore, they were marketed on the basis that they were as agronomically effective as superphosphate. From a zero base in 1980 these products made up about 30% of sales in the late 1980s.

Many thousands of research dollars were expended to examine the agronomic effectiveness of these products and the key point to emerge from this research in 1990 (Edmeades et al 1990) was that they are not agronomically equivalent to soluble fertilisers. They are slow release fertilisers and the research showed that it could take

4-6 years before they were as effective as soluble P fertilisers. It was also discovered that not all RPRs are equal. The best dissolve in New Zealand conditions at about 30% per year (range 10% to 70%) (Sinclair et al 1998).

These research results did not become publicly available until the early 1990s, by which time many farmers had already found from their own experience, and at their own cost, that these new products did not live up to their early promise.

The farmers response to this experience and to the emerging research results was to go back to products which had been thoroughly tested, such as soluble fertilisers. Today RPRs and their derivatives make up < 5 –10% of the fertiliser market.

The other range of products to enter the New Zealand were liquid fertilisers – products derived from seaweed, fish waste or blood and bone – and recommended to be applied at between 10-20 litres/ha. These products were promoted initially to do the same thing as solid fertilisers but at a fraction of the cost. Many farmers, no doubt motivated by their economic plight, were tempted into using them. Once again the science showed that they were worthless and had no practical benefits on pasture and animal production or health (Feyter et al 1989).

Thus the second lesson from the 1980s was to use fertiliser products that are scientifically tested and proven by reputable, independent scientists.

Technical confusion

Beginning in the late 1970's, soil scientists in both New Zealand and Australia began developing computer-based models to calculate fertiliser requirements. These various systems were known by different names (Decide in Western Australia (Bennet and Bowden 1976), Fairmaid in NSW (Helyar and Godden 1977), Superate in Victoria (Maling et al 1984) and CFAS in New Zealand (Cornforth and Sinclair1984).

These were based on static, as distinct from dynamic, nutrient models and calculated the nutrient inputs required *to maintain the* current production, irrespective of where the current production was on the soil fertility production function (see fig 2). But most practitioners interpreted the term, *maintenance fertiliser input,* to mean the amount of fertiliser to maintain the *optimal* production.

The consequence of this in New Zealand, was that many farmers were applying 'maintenance fertiliser inputs' in the belief that this was sufficient to increase soil nutrient levels and achieve maximum production. They understandably lost faith in soil science and scientists, and advisors, when they discovered they were not reaching their production targets. Many simply doubled the 'maintenance fertiliser input' recommended, thereby discovering through their own experience the benefits of capital fertiliser inputs when soil fertility is below optimum.

This experience highlighted the urgent need for scientists to develop further the biological basis for making fertiliser recommendations based on sound, unambiguous and readily understood principles.

Remedies

The situation confronting the soil scientists in the New Zealand Ministry of Agriculture and Fisheries (MAF, now AgResearch [NZ Pastoral Research Institute Ltd]) at the end of the 1980s were:

- The general confusion, and lack of confidence in the market place regarding the need for fertilisers and which types to use,
- A lack of understanding of the basic principles of legume-based pastures and the important role of fertilisers
- A lack of confidence in the maintenance fertiliser models.

To address these issues a long-term science program was implemented. It's key components were:

- Recording and reviewing all past fertiliser trial research
- Developing the pasture production response functions for P, S, K and lime.
- Developing dynamic nutrient models for each of these nutrients, so that the economics of moving up or down the response functions could be calculated.
- Packaging all this information in forms that could be readily understood by farmers and their advisors.

Beginning in 1993 a series of farmer friendly booklets for both Dairy farmers and Sheep and Beef farmers were produced (Roberts and Edmeades 1993, Roberts et al 1994, Roberts et al 1995, Morton et al 1996). These went free to all New Zealand farmers. The booklets emphasised the basic biology of legume pasture and the role of fertiliser, and presented all the soil test-pasture production functions, and how much fertiliser was required to move up the response curve.

Literally hundreds of farmer's meetings were held and items appeared regularly on the Farming with Pictures videos. These were also free.

In addition a new computer software package – the AgResearch PKSLime Fertiliser program, incorporating these dynamic nutrient models, was made available to advisors free of charge in 1983. And finally the biological basis of all this research was formally published in 1995 (Currie and Loganathan 1995).

Fertiliser sales are now back to early 1998 levels (fig 3) and it is possible to think that this comprehensive review and back-to-basics program has contributed in some way to a new confidence that farmers can have in the fertiliser advice they receive.

The NSW situation

Fertiliser use and soil fertility

The sales of superphosphate in Northern NSW, and for the Northern Region of NSW, for the years 1984 to 1996 are shown in fig 4. Fertiliser use appears to have declined by about 50% since 1989. But this trend is only part of the story. Total sales of superphosphate in NSW have been declining statewide since 1964 (fig 5).

Assuming that these trends reflect the total consumption of all fertilisers containing P and S, the increasing trend in the incidence of both soil P and S deficiency over the same period of time is not surprising (fig 6). Currently about 65% of all soil tests indicate P deficiency and 85% indicate S deficiency (Table 4).

Given the relationship between soil fertility, pasture production and animal production it is also not surprising that total stock numbers in NSW, and the production of wool per head, (Figs 7 & 8), is also declining.

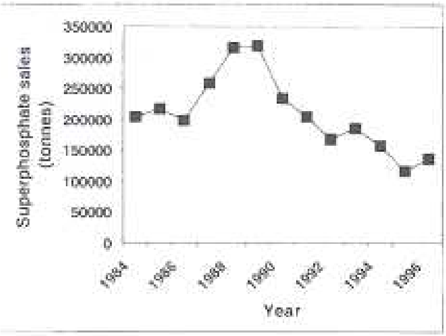

Figure 4. Sales of superphosphate in Northern NSW and the Northern Region of NSW.

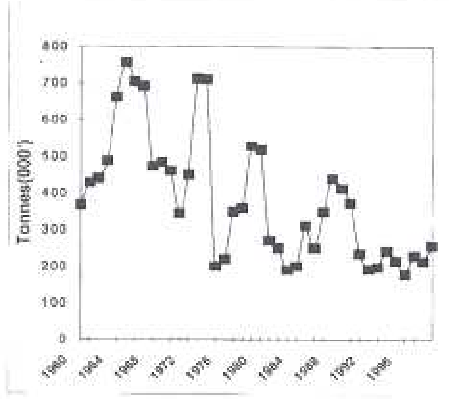

Figure 5. Sales of superphosphate in NSW.

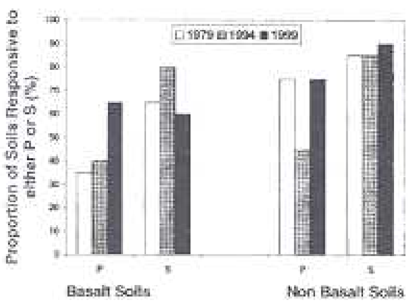

Figure 6. The incidence of phosphate (P) and sulphur (S) deficiencies on basalt and non-basalt soils on the Northern tablelands, NSW.

Table 4. Summary of soil tests results from the Upper Hunter, Northern Tablelands, Northern Slopes and Central West districts of NSW (R Watson pers comm).

District	Proportion of Soil Tests below Optimum	
	P	S
Upper Hunter	58	82
Northern Tablelands	55	84
Northern Slopes	55	82
Central West	90	80
Coastal	95	70

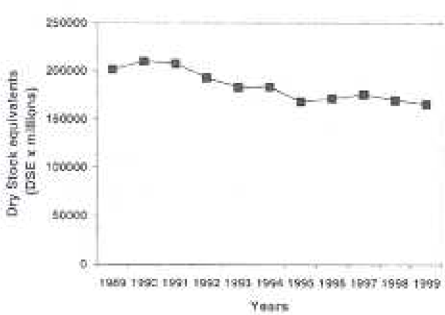

Figure 7. Total stock numbers (DSE) in NSW (source: Australian Commodity Statistics 1999) (assumptions: 1 cow + calf = 14 DSE and 1 ewe + lamb = 2 DSE).

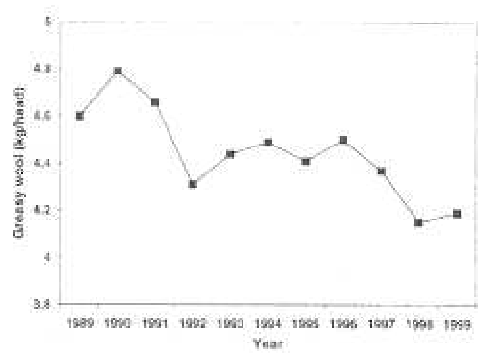

Figure 8. Wool production (kg greasy wool per head) in NSW (source: Australian Commodity Statistics 1999)

These data are consistent with farmer's experience indicating that they can no longer keep legumes in their pastures, or the frequency of weeds and bare ground is increasing.

All of these trends are predictable from basic science principles and result from a common cause – lack of fertiliser. Furthermore, it is predictable that both pasture and animal production will continue to decline if the current trend in fertiliser use in NSW continues.

These data indicate a significant, emerging problem confronting pastoral farmers in NSW. It is similar in many respects to the problem faced, particularly by the New Zealand Sheep and Beef producers, in the period 1985 to 1990. The question arises therefore, is the solution used in New Zealand applicable to NSW?

Does the New Zealand solution apply to NSW?

The question reduces to the proposition; what predictable benefits, in terms of pasture and animal production and hence profit, would accrue to the average NSW pastoral farmer if he applied more fertiliser?

The results from a series of trials conducted across NSW are summarised in Fig 9. The largest pasture production responses to the application of superphosphate (116 kg/ha/yr) were of the order of 200% to 600%. The smallest response was zero, predictably on a highly fertile soil. The median response was about 70-80%.

By New Zealand standards, these are very large responses, indicating the extreme deficiency of P and S in many NSW soils. Assuming that these sites are representative of NSW soils generally, then these results indicate that the majority of farmers could increase pasture production by between 50 – 100% with the application of a modest input of superphosphate.

It is known from research in New Zealand and Australia (Morton et al 1995, Cayley and Hannah 1995, Gourley 1999) that with appropriate management, such as simply increasing stock numbers, these relative increases in pasture production can be captured in similar increases in animal production.

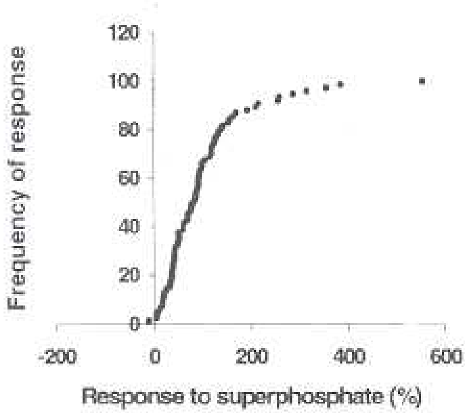

Figure 9. Cumulative distribution function of the size (%) of pasture production responses to superphosphate in 76 trials in the Northern Slopes, Northern Plains, Central West Slopes, Central West Plains and Upper Hunter (from Freebairn et al 1994).

But many NSW farmers could do better. Figure 10 summarises data from 6 trials in the same series, and shows the relationship between pasture production and the amount of superphosphate applied. An application of 250 kg/ha/yr doubled production pasture. It is predictable that many NSW farms could double their gross revenue simply by applying fertiliser.

Indeed there is evidence in NSW showing that this is, in fact, what some farmers are already achieving commercially (Table 5). These results are from farm benchmarking analysis conducted in 1997-98 and 1998-99 of some 200 pastoral farms, throughout the temperate pasture zone of southern Australia, largely in NSW and Victoria by leading farm management consultancy

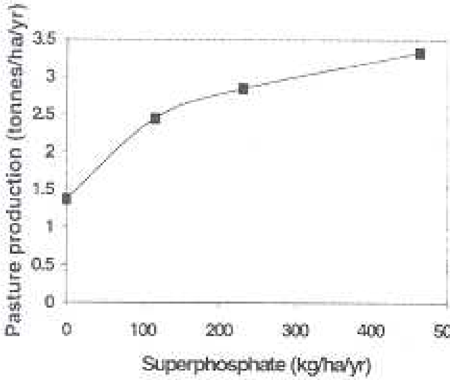

Figure 10. Effect of rate of superphosphate on pasture production (from Freebairn et al 1994).

group Holmes Sackett and Associates (H.S.A.) based at Wagga NSW. Their data shows the bottom 20% of farms in this group spent $24/ha on fertiliser and had a net loss of $42/ha. This probably represents the more typical farm situation. It should be noted that the bottom 20% in this data is equivalent to the average data generated by ABARE grazing farm data over the same period. The H.S.A. average farmer is closer to the top 20% on ABARE's national basis. The average producer in H.S.A. group spent $23/ha on fertiliser for a modest profit of $29/ha and the top 20% spent $33/ha on fertiliser and also generated three times the farm profit.

There are some lessons to be learnt from what the top 20% are doing and achieving:

- The top 20% of producers spend on average twice the gross dollars on fertiliser compared to the average and three times as much as the bottom 20%.
- The top 20% are applying on average 1.5 times the $/ha on fertiliser and 1.5 times the total amount of P/ha as the average or bottom 20%.
- The top 20% utilise their rainfall and fertilised pastures better, by running 20-30% higher stocking rates than the rest.
- The top 20% of farmers are producing good profits year in and year out while the bottom 20% or more typical farm situation is struggling to make a profit.
- Fertiliser and pasture utilisation are key drivers of profits on all grazing operations.

The results from this subset of high producing NSW farmers show that the scientific principles, relating soil fertility to the pasture production, can readily be applied in NSW. This message is not new. These current research and commercial results simply confirm the science and technology of legume-based pastures developed in the 1950s and 60s (see Sears, 1953 for an early NZ example).

What is less certain are the reasons why this well proven, 40-50 year old technology, can be so easily set aside and "forgotten' by farmers and advisors, from generation to generation.

Barriers to applying this technology

The major reason why farmers in New Zealand lost sight of the importance of fertiliser during the 1980's was the lack of sound scientifically-based technical information on the biology of legume-based pastures, in a form they could readily understand and digest.

Without this foundation farmers are unlikely to take the "apparent risk" and apply fertiliser. Also, the absence of this information makes them vulnerable to the immense volume of misleading information they receive by way of advertising and advertorial comment. Confounding this in recent years has been the fact that fertilisers have become an environmental issue.

Lack of relevant technical information

The crisis of the 1980's in New Zealand occurred about two generations after the pioneering soil fertility research of the 1950s and '60s. Many of these 'new' farmers had not seen, first-hand, the large benefits of applying fertilisers to nutrient deficient pastoral soils. Many had forgotten about the vital role of the legume. It was necessary in the 1990's to re-educate this new generation with the simple message represented in figs 1 & 2.

Most farmers found the relationships between the various soil tests and pasture production (fig 11), very informative and instructive, because it enabled them to assess, using soil testing, where their farm was in relation to its biological potential.

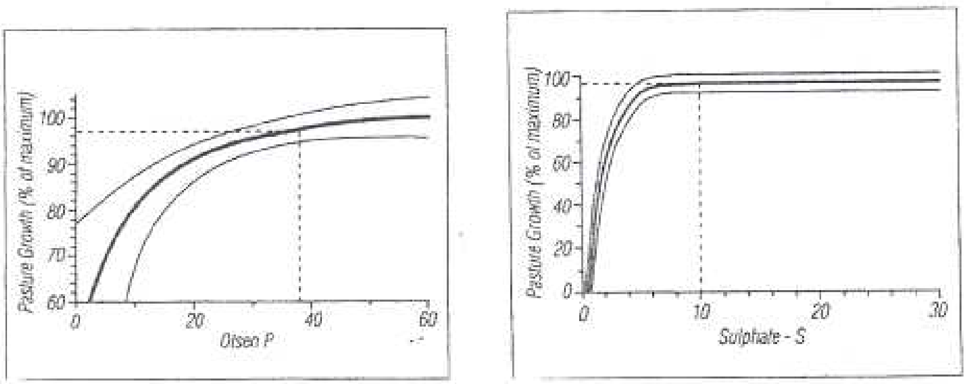

Figure 11. Examples of the relationships between relative pasture production and available P and S on soils in New Zealand. (a) Olsen P (b) available sulphate S. (Roberts et al 1993)

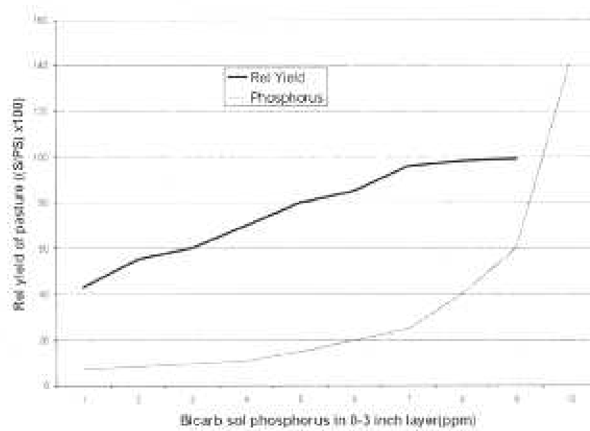

Figure 12.

Such relationships are not unique to New Zealand. Fig 12 shows the relationship between relative pasture production and available P (Colwell), or sulphate S, for sets of field trials in NSW. They indicate that for maximum production, soil P and S levels would need to be above 50 and 10 respectively (Spencer et al 1969). There are other examples of these relationships in the Australian scientific literature (Spencer and Glendinning 1980, Helyar and Spencer 1977) suggesting that it should be possible to develop these relationships for all the agriculturally important soils in NSW.

Similarly, the AgResearch PLS, Lime Fertiliser Program enabled farm advisors and farmers to explore the economic implications of applying or withholding fertiliser at the individual farm level. Such a tool it is suggested would also greatly assist advisors in NSW and give them confidence in their advice to farmers.

The review process undertaken in New Zealand also required that old myths concerning fertiliser research, which had caused confusion, both in scientific and farming circles for years, were confronted and resolved. Two of these are relevant to the technical problems currently confronting the pastoral industry in NSW.

For example, the accumulated field trial evidence showed that mowing trials were a valid method for measuring the relative responses of pastures to fertilisers, even though the absolute increases in pasture production were different. This cleared the way for using relative pasture production -- the percentage response - as the basis for the soil fertility production functions (fig 11).

Similarly, there were arguments about which soil tests were best, particularly for P. This matter has been resolved within scientific circles at least, with the realisation that the search for the perfect soil tests is futile. As expressed by Sinclair et al (1997) " even a 'perfect test', measured with utmost precision, maybe unable to account for more than a small fraction of the variability in the response to P". The reason for this is that many other factors, not related to the amount of available P in the soil affect the ability of the plant to access the available soil P.

The key to resolving these potentially divisive issues has been to accept that soil science does not yet, and never will, have all the answers. But rather than leaving the farmer in a state of confusion, it was decided that the responsible path forward was to give the farmers the benefit of our 'best approximation' to the truth. This necessarily pragmatic approach did not please all scientists, but most New Zealand farmers benefited greatly.

Economics

In a survey of almost 300 producers throughout the Upper Hunter on attitudes to fertiliser use, by Ross Watson in 1988 and a replicated study throughout the New England of almost 400 producers in association with M Duncan and P Vickery in 1989 (Freebairn 1994) showed that the majority of producers nominated "lack of surplus finance" as the primary reason for not supering. This becomes a compounding problem because the ability to purchase fertiliser from cash flow, decreases in proportion with the loss in production from the previous year, when no fertiliser was applied.

The solution to this downward spiral is to come to terms with the fact that fertiliser expenditure is not discretionary in a biological sense. Indeed the data in Table 5 shows that cash flow is stronger when fertiliser is applied!

Table 5. Financial performance of 200 pastoral farms in NSW and Victoria for the period 1997/98 and 1998/99 (from Holmes, Sackett and Associates, Watson, 2000).

	Group	
	Average	Top 20%
Effective area (ha)	1483	1625
Fertiliser ($/ha)	23	33
Fertiliser expenditure (total $)	28556	57316
Fertiliser expenditure (% total expenditure)	11	13
Stocking rate (DSE/ha)	11.2	13.8
Improved pasture (%)	83	91
Profit (total $/farm)	48241	184965
Profit ($/ha)	29	113
Profit ($//ha/mm rainfall)	3.97	16.92

Today most New Zealand farmers, farm advisors, accountants and farm bankers, regard fertiliser expenditure as capital expenditure, and there are cases where loans to purchase property are advanced on the condition that the fertiliser expenditure is maintained. Indeed, one of the reasons for conducting and publishing the survey cited earlier (Table 3) was to convince farm financiers of this need (R Davidson pers com).

It is appropriate therefore to suggest that NSW pastoral farmers put together the relevant biological and economic information, such as in Table 5, to help the financial sector understand the vital importance of fertiliser, in the long term financial viability of the pastoral industry.

Risk management

Unreliable seasonal condition was cited by NSW producers as a secondary reason for not applying fertiliser (Freebairn et al 1994). This is understandable because the intuitive response to risk, such as the risk of drought, is to withhold expenditure.

This is an appropriate short-term tactic, provided withdrawing that expenditure does not affect the short-term productive capacity of the farm. This applies to fertiliser only when sufficient fertiliser has been applied in the past, such that the soil nutrient levels are already at, or above, the optimal for that enterprise.

When soil nutrient levels are below optimum however, as is the currently the case for most pastoral NSW, withholding fertiliser inputs has an immediate effect on current production. For this reason the perception that fertiliser expenditure is discretionary needs to change.

Similarly, the attitude that the risk of drought is a good reason not to apply fertilisers should be challenged. Rainfall and nutrients are two of the vital resources required for pastoral farming, but only nutrient inputs can be controlled. It makes sense to maximise the benefit of the uncontrollable resource by optimising the controllable resource.

The results in fig 13 show large year to year differences in pasture production due to rainfall. They also show that fertiliser increased pasture production in all years, irrespective of the rainfall. Viewed differently, the fertilised pasture produced 2 to 5

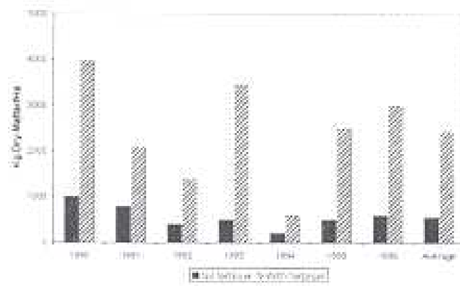

Figure 13. Total autumn to spring pasture yields – Scone (NSW Agriculture Scone).

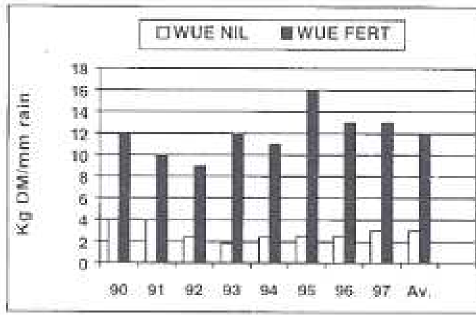

Figure 14. Water use efficiency of fertilised pasture at Scone (1990-1997) (Watson, Freebairn and McDonald, 2000)

times more pasture for the same amount of rainfall. In this trial the fertilised pasture produced 15 tonnes extra pasture DM over 7 years, for an annual expenditure on fertiliser of $150-200/ha.

This data demonstrates that fertiliser inputs (the controllable resource) can be regarded as a tool to minimise the risks imposed by drought (the uncontrollable resource).

Social and environmental issues;

The political buzzword in New Zealand and Australian agriculture is "sustainability" and for a time New Zealand went through a period when this was interpreted by most to mean, "low input agriculture".

Today there is a more enlightened and robust interpretation applying to sustainability. For example, the definition of sustainability, which has been accepted by many international agencies, is called FESLM (Framework for the Evaluation of Sustainable Land Management) (Smyth and Dumanski (1994). A management practice is deemed sustainable by this definition if it meets all of five criteria:

1. Production – does it maintain and enhance production?
2. Risk – does it reduce the risks of maintain and enhance production?
3. Resources – does it have an adverse effect on soil, water or air quality?
4. Economic – is it economic?
5. Social – is it socially acceptable?

Applying this definition there can be no doubt that fertiliser use is a sustainable land management practice. Fertilisers certainly are required to increase and maintain production. They reduce the risks imposed by droughts, they are economic, and most urban people when exposed to hunger, will surely agree that they are socially acceptable.

The crucial, and most confused issue with respect to fertiliser use today, is their impacts on the environment. There is an abundance of evidence to show that fertilisers, both chemical and organic, have beneficial effects on the biological, chemical and physical properties of soils, and enhance soil quality (Edmeades 1999). This is especially so for soils under legume-based pastures. It is equally true that not applying fertilisers decreases the soil ground cover and hence increases the runoff of nutrients and erosion

(Freebairn et al 1994).

The environmental problems in pastoral agriculture, attributed to fertilisers, such as nitrate leaching and runoff of P into waterways, are the result of having fertile soils. They cannot be managed, or minimised, by changing fertiliser policies such as moving to slow release or organic fertilisers.

There are two solutions to minimising these effects (Morton et al, 1995). One involves allowing soils to become depleted of nutrients - hardly likely to be socially acceptable in the long term, or finding appropriate management options. For example, a high pasture cover when fertiliser is applied significantly reduces surface runoff.

There is currently much comment in the popular farming press today regarding the apparent negative effects of fertiliser on the environment. Much of it is ill considered and scientifically unsound. This misinformation, like the current lack of fertiliser input, represents a threat to the long-term sustainability of pastoral agriculture.

Conclusion

The current situation in the pastoral sector of NSW with respect to fertiliser use is very similar to that which faced the New Zealand pastoral industry at the end of the agricultural reforms in 1990.

The current fertiliser policies and practices in pastoral agriculture in NSW are not sustainable. If continued they will result in further depletion of the soil nutrient reserves, further decline in soil quality and productivity, and an increase in the collateral environmental problems of soil runoff and erosion and weed infestation.

Applying a robust and officially accepted definition of sustainability, that includes; production, risk, resources, economic and social factor, fertiliser use is a sustainable land management practice and is essential to ensure the long-term sustainability of legume-based pastures.

The biology of legume-based pasture is well known and understood and the technology to manage high producing legume-based pastures using new cultivars, fertiliser inputs and soil testing is available and is economic.

There is however an urgent need in NSW, as there was in New Zealand, to "rediscover" this technology and to ensure that farmers and their advisors are equipped with all the basic information they require to make economically sound and environmentally safe decisions.

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