AUSTRALIA

Research Shows Benefits of Liming to Correct Deep Soil Acidity

By Mark K. Conyers

Soil acidification is a problem of increasing importance in Australian agriculture. This is particularly so in the zone receiving 500 mm to 850 mm rainfall in central New South Wales (NSW) to the central Victorian areas. In the more severe cases, soil pH levels low enough to adversely affect plant growth have extended deeper than 50 cm into the soil profile.

Soil acidification and its control are significant problems in Australia. Research data emphasize benefits of liming.

The application of lime to cropping soils in this key farming area has been shown to be profitable for the farming community. However, the use of lime in the permanent pasture areas of the region has not been widely adopted because it is much more difficult to demonstrate its value in the grazing industries, even though small plot experiments have shown significant responses to the application of lime.

While the correction of soil acidity is important in the cropping areas, it is equally important in the permanent pasture areas, if the land's productivity is to be maintained and the soil base is to be protected. However, in these situations treatment is difficult to justify on an economic basis, and is also technically difficult to do, particularly when deeper soil is affected.

New South Wales Study

A long-term experiment was established to address the problems of acidification deep in the soil and specific

TABLE 1. Annual rainfall at Brooklyn, Wagga Wagga, NSW.

Month	1992	1993	1994	Long-term average
		Annual rainfall, mm		
January	na	16	23	49
February	20	9	135 [1]	43
March	1	45	50	49
April	96	5	15	50
May	36	30	12	62
June	53	30	45	51
July	50	97	15	62
August	142	38	14	62
September	7	116	8	57
October	82	89	38	70
November	56	71	—	49
December	87	54	—	47
Total	**630**	**600**	**370**	**650**

[1]Rainfall in February 1994 occurred as a heavy summer storm with heavy runoff and little benefit to the farming program.

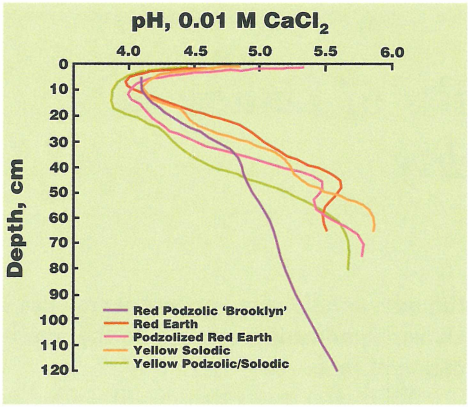


FIGURE 1. Profiles of the pH trial site and other strongly acid soils in the Wagga Wagga area.

aspects of soil acidification. Objectives of the study were:

- to test whether perennial pasture is less acidifying than an annual pasture;
- to demonstrate the economics of using lime for the long-term benefit of the pasture, grazing animals and the crops grown in rotation; and
- to demonstrate the time required to ameliorate acid subsurface soils through surface applications of lime.

The trial was established in 1991, on "Brooklyn", a property 40 km southeast of Wagga Wagga, owned and operated by the Hurstmead Pastoral Company.

The first objective was to characterize the site and enable a long-term experiment to be established, so that the real extent and causes of any changes that will take place in subsequent years will be known with certainty.

Results After Two Years

Two years into the programme, the chemical characteristics of the plots have been thoroughly defined, changes in the soil characteristics as a result of treatments since the start of the trial have been recorded and there are now 2.5 years of animal and pasture data as well as two years of crop data available.

While results to date are very interesting and give good pointers to future effects, seasonal conditions have been generally very dry, particularly in 1994. In view of the very large part that rainfall plays in Australian agriculture, it is useful to know the pattern of rainfall in the trial area. Rainfall recorded during that time is shown in **Table 1**, together with the long term average annual rainfall.

Figure 1 shows pH profiles of the site and other strongly acid soils in the Wagga Wagga region.

Soil pH levels ranged from about 4.1 ($CaCl_2$), in the surface 10 cm, to about 6.2 at 100 to 120 cm deep.

Aluminum (Al) saturation of the exchangeable cations ranged from about 30 to 40 percent at the soil surface to less than 5 percent at depths greater than 30 cm. There were, however, some large and significant "bulges" at some sampling sites, at various points down the profile.

Soil manganese (Mn) levels were about 0.1 to 0.12 meq/100g in the surface 30 cm and declined to levels below 0.01 meq/100g at greater depths.

Soil potassium (K) levels ranged from about 0.24 meq/100g (9.3 percent K saturation), at the surface to 0.126 meq/100g (3 percent saturation) at 30 cm, and then a small increase in K levels at lower depths in the profile.

There was a systematic variation in the soil K levels across the site. Reasons

TABLE 2. Effects of rotation and treatments on crop grain yields in 1993.

		Grain yield, kg/ha	
		No lime	Plus lime
Rotation		pH 4.0	pH 5.0
Perennial pasture/crop —	Oats	1,552	1,641
	Peas	368	1,431
	Wheat	1,872	4,187
Annual pasture/crop —	Wheat	2,592	4,008

for this variation are thought to be due to nutrient transfer during the previous history of the trial site. The variability was taken out by an application of 200 kg/ha of potassium chloride to the whole site, and this is being monitored by annual soil and plant analyses to check on the need for further applications of K.

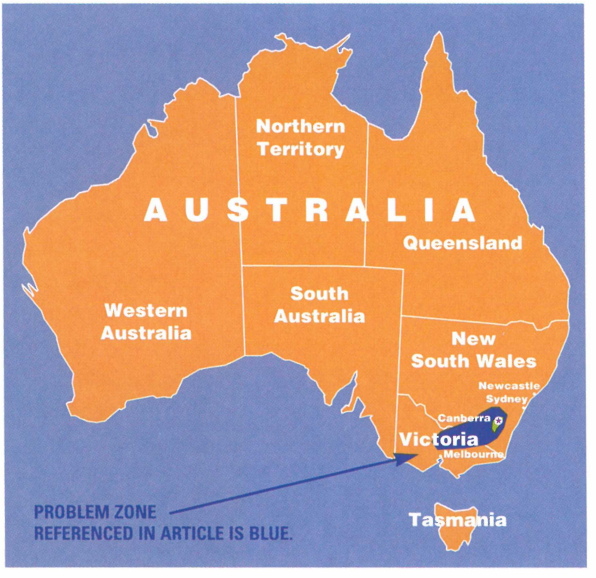
There were significant larger responses to K by wheat in the limed plots than in the unlimed plots, indicating that acidity inhibited response to K. Lime had little effect on the response to K by the pastures. **Table 2** shows the response of the crops to lime.

Pasture and animal responses to the application of lime of around 33 percent have been demonstrated, with the value of increased wool production being sufficient to pay for the initial capital cost of the lime in a 2 to 3 year period. These responses are also about seven times the cost of annual applications of lime required to prevent acidification.

The application of lime has led to an increase in the pH of surface soil. However, a much longer time is necessary to determine how long it will take for the increase in soil pH to become significant at depth.

INCREASNG soil acidity is a significant production problem in wheat-pasture production systems in New South Wales. Liming is a key to maintenance of production and profitability in both crop and animal production.

Animal production has been quite markedly affected by the type of pasture being grazed. Animal liveweight gains were fastest on the limed perennial pasture treatments. In the cropping rotations, animal production was also affected by the clover regeneration under wheat stubble. There were some unexpected results, however. For example, clover regeneration was more vigorous under the sparse stubble from the no lime treatments in early 1994 which led to faster liveweight gains in these treatments than in the limed treatments where heavy stubble led to less clover regeneration.



INCREASING soil acidification is a concern in the area of central New South Wales to central Victoria in Australia. The zone receives 500 to 850 mm annual rainfall.

Dr. Conyers is a Senior Chemist with NSW Agriculture, Agricultural Research Institute, Private Mail Bag, Wagga Wagga, NSW, 2650, Australia.