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Soil improvement with bauxite residues

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The sandy soils of the Peel-Harvey catchment hold water and nutrients very poorly. The Gavin ridges dry out quickly during rainless periods and this severely limits pasture growth. These ridges and the lower lying Joel and Coolup sands also lose a large proportion of the phosphorus, sulphur and potash fertilisers applied to them. Normally the sands lack clay materials to bind and hold the nutrients so rainfall leaches them out.

The Peel-Harvey Study Group, CSIRO, Alcoa and Murdoch University have studied the use of a residue from bauxite mining to help overcome these problems. The treated residue has a texture similar to loam and helps to hold more water and nutrients. When the residue is incorporated into these sandy soils, little phosphorus is leached out and productive pastures can be grown on otherwise poor country.

Experimental work

Untreated bauxite residue is very alkaline. However, it can be neutralised by using calcium sulphate, a gypsum by-product from the fertiliser industry. It could also be neutralised by using copperas (ferrous sulphate) from the titanium industry.

At Alcoa’s refinery, gypsum can be introduced into the residue production circuit to produce a filtered, dried and shredded residue that can be spread on to land and mixed into the topsoil.

In experimental plots, from 200 to 2000 t/ha of gypsum-treated residue were incorporated into Gavin and Joel sands using a rotary hoe. Elevating scrapers can also be used.

Medics and subterranean clover pastures were grown on the treated plots. Nutrient requirements of plants growing on the modified soils were investigated.

Special micro-plots were set up on treated areas to collect the leached solution from rainfall. Up to 270 kg/ha of phosphorus—15 times the normal application rate—was spread on these micro-plots as a test of the residue’s ability to prevent phosphorus leaching.
with BAUXITE RESIDUE

Productivity and phosphorus retention

First-year pasture production increased significantly on Gavin sand treated with the residue. Increased productivity should be maintained in subsequent years on treated soils, but is likely to decrease on the untreated soils because of low water retention, potash deficiency and legume rhizobia nodulation problems. The addition of the residue also improved yields on Joel sand in the first year (Figure 1).

Potassium (potash) dressings are needed in the first year of pasture establishment. The treated soil should retain the added potash against leaching, so potassium requirements should be low unless hay crops are grown. Phosphorus requirements are not especially high, partly because the added gypsum contains some phosphorus. About 40 kg/ha of phosphorus is adequate for optimum growth on first year pastures. Requirements in the second and subsequent years are being ascertained.

Field experiments showed the added residue effectively prevented phosphorus losses to the drainage water. Even the very high 270 kg/ha of phosphorus treatment had no detectable effect on losses (Figure 2).

Figure 1. Effect of residue addition on pasture productivity on Gavin and Joel sands in the first year. ▲ indicates the usual productivity of clover on Gavin sand.

Figure 2. Effect of residue addition on phosphate lost from Gavin sand. 270 kg/ha of phosphorus was applied.

Large scale treatment

Two strategies are possible for broad-scale farming. One is to cover a lot of country quickly with a low level of residue to reduce phosphorus loss and pollution of the estuary. Calculations by Dr J. W. Bowden of the Department of Agriculture showed that less than 20 tonnes of residue per hectare could be enough. This strategy would however, forgo the other benefits of applying residue, especially the better water retention.

The other strategy would be to use about 1000 to 2000 t/ha of residue. This level would virtually replace the topsoil with a new 'soil' with much better qualities than the original sand. It would be possible to combine these strategies, or use other intermediate rates.

About 90 per cent—or 28,000 ha—of the sandy soils of the Harvey River catchment are cleared. If the residue were spread at 200 t/ha, the cleared area could be covered in seven years. Commercial production of suitable residue would be possible from 1987.

The programme has potential benefits to three groups of people. Alcoa would benefit because it would not have to store the residue. However, the cost of transporting residue to the catchment and of spreading it on land is higher than the cost of storing it. Farmers would benefit through increased productivity of their land, although long-term data are still required on this aspect. The increased productivity alone would not be enough to justify the extra cost. The community would benefit from a cleaner estuary.

These costs and benefits have to be examined and compared with those for other potential solutions to the Peel-Harvey algal pollution problem.

The future

If bauxite residue can be used to bind the existing 'super bank' in the soil then continuing losses of phosphorus from soils may be prevented. This would reduce the run-down time in which algal pollution would continue to be a problem and may reduce the need for more dramatic solutions. It also offers the prospect of actually increasing farm productivity and usefully employing industrial by-products.

One of the challenges is to work out equitable cost-sharing arrangements and to find the best ways to arrange distribution of the treated residue.