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Improved fertilizing practices on the Peel-Harvey catchment

By Peter Arkell, Senior Adviser, Metropolitan District Office, South Perth

Broad-acre farmers in the Peel-Harvey catchment have met a challenge and achieved a great deal since the fertilizer extension programme started in 1983.

Peel-Harvey farmers have:

• participated willingly in the Department of Agriculture's soil testing programme;
• tested and helped develop some important fertilizer innovations, for example, Phosul K computer program for making fertilizer recommendations, coastal super, improved methods of applying gypsum and late spreading of fertilizers on sandy soils;
• helped organize and participated in field days, seminars, farm walks and group meetings; and
• provided sites for numerous trials and demonstrations.

As a consequence these farmers gained a better understanding of their soils and of fertilizer use. In addition, phosphorus application rates between 1982/83 and 1986/87 were 30 per cent lower than average application rates between 1978/79 and 1981/82.

The main objective of the extension programme has been to ensure that every year three-quarters of farmers make economically and technically sound fertilizer decisions, thus causing a minimum amount of phosphorus to enter the waterways of the Peel-Harvey estuarine system.
The soil testing/fertilizer advisory programme

The soil testing/fertilizer advisory service formed the foundation of the fertilizer extension programme. The service started in 1983 with 100 farms south of Pinjarra. It peaked in 1984 when the Department of Agriculture sampled 480 farms and 3,800 samples were analysed by the Chemistry Centre of W.A. (Table 1). Since 1985 farmers have collected their own samples and in recent years CSBP analysed them. Departmental advisers visited every farm to discuss the results of the analyses and the Phosul K fertilizer recommendation with the farmer.

By collecting their own soil samples individual farmers acquired a personal stake in the programme. Costs of sampling were also substantially reduced. Farmers soon developed good soil sampling skills, an important feature of any soil testing programme.

Table 1 shows that a high proportion of farmers participated in the soil testing programme. Advisers recommend that farmers sample their farms every three years or one-third of the farm every year, so the participation rate recorded in Table 1 was satisfactory. Overall, 70 per cent of farmers have soil tested at least once since 1985, the last year Department of Agriculture staff collected soil samples. Several respondents to the 1985 farmer survey, however, preferred to sample soil regularly for a few years, make whatever changes to their fertilizer programme were needed, and then sample soil less frequently to monitor soil fertility. This, too, seems a good approach.

As well as their high level of involvement in soil testing, Peel-Harvey farmers were introduced to and helped develop some important innovations. One of these was Phosul K, a computer program for making fertilizer recommendations.

Phosul K

The Phosul K computer program is designed to help advisers give fertilizer advice to farmers in the high rainfall area (above 700 mm average annual rainfall) of south-west Western Australia. Phosul K deals with three important plant nutrients, phosphorus, potassium and sulphur contained in superphosphate, coastal super, gypsum and muriate of potash.

The Phosul K program uses information on soil analysis, soil type, fertilizer costs and profitability of the enterprise to work out four alternative fertilizer programmes for each paddock.

Table 1. Soil testing record

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of farms sampled by Department</th>
<th>No. of farmers collecting own samples</th>
<th>Total no. of farmers participating</th>
<th>Participation rate (%)</th>
<th>No. of samples collected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1983</td>
<td>100</td>
<td>Nil</td>
<td>100</td>
<td>95-100</td>
<td>3,800</td>
</tr>
<tr>
<td>1984</td>
<td>480</td>
<td>85</td>
<td>480</td>
<td>95-100</td>
<td>3,800</td>
</tr>
<tr>
<td>1985</td>
<td>213</td>
<td>85</td>
<td>218</td>
<td>85</td>
<td>3,000</td>
</tr>
<tr>
<td>1986</td>
<td>Nil</td>
<td>120</td>
<td>120</td>
<td>62</td>
<td>1,682</td>
</tr>
<tr>
<td>1987</td>
<td>Nil</td>
<td>218</td>
<td>218</td>
<td>45</td>
<td>1,910</td>
</tr>
<tr>
<td>1988</td>
<td>Nil</td>
<td>120</td>
<td>120</td>
<td>25</td>
<td>1,200</td>
</tr>
<tr>
<td>1989</td>
<td>Nil</td>
<td>136</td>
<td>136</td>
<td>28</td>
<td>1,342</td>
</tr>
</tbody>
</table>

The computer printout contains all the information and shows which fertilizer programme is the most profitable one to use. Advisers discuss the fertilizer recommendations with each farmer and together they work out a profitable and practical programme for the whole farm.

Farmers have contributed to the development of Phosul K by suggesting improvements to the computer's output and by helping advisers make the enterprise budgets in the program more realistic.

The development of the Phosul K program and the widespread adoption of soil testing have been the major contributors to changes in fertilizer practice on the Swan Coastal Plain.

Phosphorus application rates drop

Catchment farmers now use less phosphorus than they did in 1979/82, the period before the extension programme began (Table 2).

Phosphorus use dropped from an average 1,723 tonnes per year in the period 1978/79 to 1981/82 to 1,221 tonnes per year during 1982/83 to 1986/87. A further drop to 949 tonnes in 1987/88 appears partly due to heavy rain in May preventing farmers from completing their fertilizing programmes. By comparison farmers in the Busselton-Augusta-Margaret River area used 8 per cent less phosphorus (2,276 tonnes compared with 2,101 tonnes) between 1982/83 and 1986/87 than between 1978/79 and 1981/82. In the Albany region phosphorus use dropped 10 per cent in the same period.

This reduction in phosphorus application rates is a major achievement by Peel-Harvey farmers. Although it was a logical change because soil phosphorus levels in 70 per cent of the paddocks surveyed were high, it was not an easy one as many farmers believe that 'good farmers use super.'

Superphosphate contains two important plant nutrients, phosphorus and sulphur. Virgin Western Australian soils are low in phosphorus and initially need high rates of super-
phosphate to provide enough phosphorus. As soil phosphorus levels increase with each application of superphosphate, the soil’s requirement for phosphorus declines, even on the leaching grey sands.

However, the sandy soils in high rainfall areas do not develop a substantial bank of sulphur and need an application of sulphur every year. The traditional application of 150 to 200 kg/ha of superphosphate near the break of the season provides pastures with enough sulphur. Unfortunately, it also means applying 13.8 to 18.0 kg/ha of phosphorus, far more than is needed.

**Alternative sources of sulphur**

Farmers needed alternative methods of supplying sulphur to reduce phosphorus application rates on sandy soils. The alternatives suggested by the Phosul K program were:

- Coastal super at 80 to 100 kg/ha (7 to 9 kg/ha of phosphorus) applied near the break of the season;
- Superphosphate at 80 to 100 kg/ha (7 to 9 kg/ha of phosphorus), applied in early August;
- Gypsum at 100 kg/ha applied in early August (no phosphorus).

Dairy farmers in the Coolup area introduced another alternative - the application of sulphate of ammonia in August.

**Effects of soil type**

A survey of 100 farmers in 1986 showed that phosphorus application rates dropped on all soil types (Table 3), the biggest drop being on the loams and clays. Sulphur does not leach readily from these soils, so they do not need a sulphur fertilizer every year. Superphosphate recommendations for these soils depend entirely on the soils’ need for phosphorus.

**Application time**

The 1986 survey showed that farmers now apply phosphorus to sandy soils later in the year (Figure 1). In 1982, 70 per cent of the phosphorus was applied to sandy soils in autumn, but in 1986 only 51 per cent was applied in autumn.

Time of application barely changed on the loams and clays. In 1982, 87 per cent of the phosphorus applied to loams and clays was applied in autumn, in 1986 it was 79 per cent.

May remains the most popular month to fertilize sandy soils; about 35 per cent of the phosphorus being applied then.

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**Table 2. Phosphorus use by Peel-Harvey farmers**

<table>
<thead>
<tr>
<th>Year</th>
<th>Tonnes</th>
<th>Phosphorus use kg per cleared ha</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Before the extension programme</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1978/79</td>
<td>1,708</td>
<td>11.3</td>
</tr>
<tr>
<td>1979/80</td>
<td>1,783</td>
<td>11.8</td>
</tr>
<tr>
<td>1980/81</td>
<td>1,740</td>
<td>11.5</td>
</tr>
<tr>
<td>1981/82</td>
<td>1,662</td>
<td>11.0</td>
</tr>
<tr>
<td><strong>Av 1978/79 - 1981/82</strong></td>
<td>1,723</td>
<td>11.4</td>
</tr>
<tr>
<td><strong>During the extension programme</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1982/83</td>
<td>1,329</td>
<td>8.8</td>
</tr>
<tr>
<td>1983/84</td>
<td>1,239</td>
<td>8.2</td>
</tr>
<tr>
<td>1984/85</td>
<td>1,085</td>
<td>7.2</td>
</tr>
<tr>
<td>1985/86</td>
<td>1,224</td>
<td>8.1</td>
</tr>
<tr>
<td>1986/87</td>
<td>1,230</td>
<td>8.1</td>
</tr>
<tr>
<td>1987/88</td>
<td>949</td>
<td>7.4</td>
</tr>
<tr>
<td><strong>Av 1982/83 - 1986/87</strong></td>
<td>1,221</td>
<td>8.1</td>
</tr>
<tr>
<td><strong>Av 1982/83 - 1987/88</strong></td>
<td>1,176</td>
<td>7.8</td>
</tr>
</tbody>
</table>

Source: Environmental Protection Authority and CSBP
Area: 151,000 ha cleared
April is the most popular time to fertilize loams and clays, about half the phosphorus being applied then.

Many farmers and contractors have put bigger tyres on their fertilizer spreaders so they can traverse winter-wet sandy soils. Cost savings of $7.00 per hectare provided a good motivation for this change.

Coastal super

CSBP and the Department of Agriculture developed coastal super because a slow release fertilizer was needed for the leaching grey sandy soils of the high rainfall areas of the west and south coasts of the State, an area estimated to cover 400,000 ha. The new fertilizer needed to be suited to an autumn application, the time when most farmers fertilized their land.

Coastal super first appeared on the market in 1983 when 765 tonnes of coastal super and coastal super:potash 3:2 were sold in the Peel Harvey catchment. A form of reverted super, it was made by adding calcium oxide to the ‘brew’ during the superphosphate manufacturing process. This partially reversed the conversion of insoluble rock phosphate to highly soluble superphosphate. This (1983) version of coastal super was not made after 1983 and became known as ‘old’ coastal super.

Farmers found ‘old’ coastal super difficult to spread, and laboratory tests showed that the phosphorus in it leached more readily than expected. It contained no more sulphur than ordinary superphosphate, so low rates of application (100 kg/ha) were only feasible in late winter.

‘New’ coastal super, first marketed in 1984, contained phosphorus and sulphur in a slowly available form and was much more satisfactory to use. It was composed of one-third superphosphate, one-third rock phosphate and one-third elemental sulphur, with only 27 per cent of the phosphorus in a water soluble form. Because of its high sulphur content, farmers could spread it at 80 to 100 kg/ha, half the rate of ordinary superphosphate when applied at the traditional time near the break of the season.

Coastal super proved ideal for acid sandy soils with a good phosphorus level that were too wet to fertilize in late winter. Farmers using new coastal super in this situation have been impressed by the amount of spring pasture growth it produces.

Many farmers willingly used new coastal super in 1984 and 1985. They bought 1,933 tonnes of coastal super and coastal super:potash 3:2 in 1984 and 2,402 tonnes in 1985. Sales of both fertilizers dropped to 519 tonnes in 1986/87 when farmers discovered that they could fertilize their sandy soils in late winter at a reduced cost by using ordinary superphosphate, gypsum or sulphate of ammonia and still fertilize them well.

Farmers also found that new coastal super’s hard granules abraded fertilizer spreaders and that the elemental sulphur it contained irritated operators’ eyes - a particular problem for contractors. In addition the cost of coastal super rose faster than the cost of ordinary superphosphate.

Gypsum for sandy soils

Gypsum, costing $7.00/tonne at CSBP’s Kwinana works and $9.50/tonne at Endeavour Resources gypsum pit near Wyalkatchem, is by far the cheapest source of sulphur for Peel-Harvey farmers. Cartage and spreading charges bring the cost of lake bed gypsum to $50.00/tonne spread, but per hectare it is still the cheapest source of sulphur.

Gypsum cannot be spread with conventional fertilizer spreaders and fertilizing in early August presents difficulties on many farms.

Table 3. Effect of soil type on phosphorus application rates

<table>
<thead>
<tr>
<th>Soil type</th>
<th>Year</th>
<th>Change</th>
<th>% Drop</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1982</td>
<td>1986</td>
<td></td>
</tr>
<tr>
<td>Sandy soils</td>
<td>10.6</td>
<td>8.0</td>
<td>-2.6</td>
</tr>
<tr>
<td>Loams and clays</td>
<td>11.1</td>
<td>5.9</td>
<td>-5.2</td>
</tr>
<tr>
<td>All soils</td>
<td>10.8</td>
<td>7.3</td>
<td>-3.5</td>
</tr>
</tbody>
</table>

Figure 1. The 1986 survey showed that farmers now apply phosphorus later in the year.
because of waterlogging. Some Peel-Harvey farmers and contractors have found solutions to this problem. They have found that:

- Lake bed gypsum spreads better than CSBP gypsum.
- CSBP gypsum can be spread with a Marshall Multispreader provided the soil is not too wet, but practical application rates often reach 200 kg/ha.
- Mixing gypsum with muriate of potash makes gypsum easier to spread.
- Gypsum and muriate of potash can be mixed on the farm using a front-end loader. The mixture does not 'set', it stays spreadable. A 2:1 gypsum:potash mix is practical. It can be spread at a rate of 150 to 200 kg/ha.

THE CAUSE OF CHANGE

Farmers on the Peel-Harvey catchment have changed their fertilizing practices because it makes sound technical and economic sense and because it also protects the environment.

Examples 1 and 2 illustrate the effect of the soil test results and the fertilizer recommendations based on the Phosul K program.

Example 1 is of a beef farm on a grey sandy surfaced soil. A phosphorus level of 25 ppm (adequate for a high level of pasture production), a low potassium level of 55 ppm (aim for 100 to 120 ppm) and a reactive iron of 450 ppm indicate that the soil is a low phosphorus absorbing soil and will respond to applied sulphur.

How much muriate of potash is needed? What is the cheapest and most profitable way of fertilizing this paddock? The total cost and extra profit columns in the Example 1 table provide the answer.

In Example 1, the cheapest and most profitable time to fertilize is in late July/early August with gypsum and muriate of potash or alternatively with super and muriate of potash.

Most farmers use super and muriate of potash because gypsum is difficult to spread and because they like to maintain the soil's phosphorus levels. An application of super-potash 3:2 at 150 kg/ha fits the bill for this paddock.

The third cheapest and most profitable time to fertilize is near the break of the season with coastal super at 100 kg/ha and muriate of potash at 60 kg/ha. This method approximates closely to coastal super-potash 3:2 at 150 kg/ha.

The most expensive, least profitable and most environmentally damaging programme is the traditional application of superphosphate near the break of the season, especially when applied before the break of the season.

Example 2 is of a beef farm on a loamy soil. It has high reactive iron indicating that it is a high phosphorus absorbing soil and does not respond to sulphur fertilizers. As in Example 1, the phosphorus level of 30 ppm is adequate for a high level of pasture production and the potassium level is low, at 55 ppm.

The soil does not need extra phosphorus and does not respond to sulphur fertilizer so it does not need superphosphate, coastal super or gypsum. The recommendation for this paddock is muriate of potash at 60 kg/ha costing $15.00/ha delivered and spread.

The recommendation for a dairy farm or for meadow hay paddocks with the same soil analyses would be about 25 to 35 per cent higher than the beef farm in these examples because dairying and meadow hay are more profitable than beef at current prices.

The Marshall Multispreader is the best machine for spreading gypsum. It has a wide rubber belt feeding system. Some operators can spread lake bed gypsum at a rate of 100 kg/ha with this machine; others prefer a minimum rate of 150 kg/ha.

Three-point linkage spreaders struggle to spread gypsum and gypsum:potash mixtures.

Large rubber tyres (such as aeroplane tyres) on the spreader have proved invaluable when fertilizing sandy soils in August.

Future fertilizer programmes

The fertilizer extension programme succeeded because farmers willingly participated in the Department of Agriculture's soil testing and fertilizer advisory service. In addition, farmers could choose between several fertilizer pro-
grammes that were practical, technically sound, within their budgets and which, at the same time, reduced phosphorus application rates without reducing pasture production.

Although the introduction of coastal super received the most publicity, most Peel-Harvey farmers reduced their phosphorus application rates on sandy soils by fertilizing with superphosphate or super: potash 3:2 in winter. In 1989, this programme cost $9.00/ha less than using coastal super. It is effective on pastures and is just as appropriate for the environment. A few farmers applied gypsum or sulphate of ammonia in August and so used no phosphorus at all.

However, coastal super or fertilizers like it have an important place on the acidic sandy-surfaced soils of the Peel-Harvey catchment and on sandy soils throughout the west and south coasts of the South-West. On many farms, particularly along the south coast, it is impractical to fertilize these soils in August, and a coastal super type of fertilizer is essential to prevent excessive use and loss of phosphorus. The Leschenault, Vasse-Wonnerup and other south coast estuaries are already experiencing some eutrophication problems caused by phosphorus leaching.

As a result of reduced sales and production problems CSBP has stopped making coastal super and is looking for an alternative product with these specifications:

- phosphorus and sulphur in a slowly available form;
- phosphorus and sulphur in a ratio of one part to three; and
- a spreadable product, suited to present farm machinery, and competitively priced.

Partially acidulated rock phosphate (PARP) promises to be a suitable source of phosphorus. The acidification process granulates the finely powdered rock phosphate, and by restricting the acid reaction time the product (PARP) has much less water soluble phosphorus than superphosphate. Three potential sulphur sources exist: crushed rock gypsum, pelleted phosphogypsum and sulphur residue, a waste product stored at CSBP's Kwinana plant. The new fertilizer would be a mixture of PARP and one of the sulphur sources. Department of Agriculture research indicates that such a fertilizer would be most effective on the acid sandy soils of the west and south coasts of Western Australia.