Pasture development on peaty sands.

E. N. Fitzpatrick

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Areas of land known as teatree, bottlebrush, or kangaroo grass flats are found throughout the higher rainfall districts. To grow clover successfully on the dark grey or black peaty sands found on these flats, lime should be applied before the seed is sown. Ground limestone topdressed at one ton per acre and well disced into the top four to six inches, will give excellent results.

Clover seed should be inoculated with bacterial culture and the initial fertiliser should be superphosphate with added zinc and copper. Potassium will not be needed in the first year but should be applied annually from the second year onwards.

Approximately a quarter of a million acres of flats of this type are scattered through coastal districts from Albany to the west coast, and up the coastal plain at least as far north as Muchea. Limited areas also occur in the Pemberton, Rocky Gully and Kybelup districts, where paper-bark and stunted jarrah grow on them as well as teatree, bottlebrush and kangaroo grass.

The soils on these flats are dark grey to black peaty sands, acid in reaction (pH 4.5 to 5.0). Below one foot the soil is white or light grey or coffee-stained.
sand for another one to three feet. These areas are waterlogged in winter, or in some cases, through most of the year. A typical soil of this group discussed in the soil survey of the Denmark Estate by Hosking and Burvill, 1938 was named the Plantagenet peaty sand.

EARLIER ATTEMPTS AT DEVELOPMENT WERE DISAPPOINTING

Farmers, attracted by the ease with which they can be cleared, have made many attempts to develop these soils for pasture, usually with disheartening results. When seeded down to clovers, the seeds germinate evenly but the young plants do not become nodulated, and, as a result, suffer from acute nitrogen deficiency. Many plants die within a few months of germination. The surviving plants become stunted, have small reddened leaves, which are infolded along the midrib, and have a restricted root development, with little development of the lateral and finer roots.

Satisfactory establishment and subsequent growth has been obtained in the past only where timber has been stacked in heaps or windrows, and burnt; or where the area has been top-dressed heavily with farmyard manure.

Some experimental work has been done on these plots in the past. Baron Hay (1933) reported that Yorkshire Fog was a promising species, but that legumes planted on the area turned pink and died. He did however mention that limestone benefited the surviving species. Later, Teakle, Morgan and Turton (1941) showed that maize developed acute copper deficiency when grown on the Plantagenet peaty sand at Torbay.

The work reported below was commenced on Mr. P. Burton's property, Walpole in 1949. It was expanded in 1953 on areas made available by War Service Land Settlement on the Pingerup Plains (known in the district as the Y plain) between Walpole and Shannon River, and on a plain south of Northcliffe; and on a small area made available by Mr. F. E. Bellanger at Nornalup.

EXPERIMENTAL RESULTS

Lime is Essential for Clover Establishment

On all the experimental area, subterranean clover has grown very well on the limestone-treated plots. There has been virtually no growth on the plots where limestone has not been used, regardless of other fertiliser treatments. The clover yield obtained from first year pastures is shown in Table I. To ensure that the experimental areas received adequate phosphate, copper and zinc, all plots received a uniform dressing of 4 cwt./acre of superphosphate containing copper and zinc. The experimental areas were seeded with a mixture of the Yarloop and Mt. Barker midseason strains of subterranean clover, each sown at 6 lb./acre. The later maturing Tallarook strain may, however, be more suitable, as the soils stay damp late in the year. This strain could be used with the Yarloop strain instead of the Mt. Barker strain on some areas. Palestine strawberry clover may grow satisfactorily on summer moist areas, but does not appear to be a satisfactory species for the drier areas.

Table I.

<table>
<thead>
<tr>
<th>Area</th>
<th>No Lime</th>
<th>Limed*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pingerup Plain</td>
<td>0.5</td>
<td>25.8</td>
</tr>
<tr>
<td>Northcliffe Plain</td>
<td>1.4</td>
<td>17.0</td>
</tr>
<tr>
<td>P. Burton's—Walpole</td>
<td>0.5</td>
<td>15.1</td>
</tr>
<tr>
<td>F. E. Bellanger's—Nornalup</td>
<td>1.4</td>
<td>17.0</td>
</tr>
</tbody>
</table>

* Lime was applied as ground limestone (98 per cent. calcium carbonate) 1 ton/acre at Northcliffe and Pingerup and as limesand (40 per cent. calcium carbonate) 2½ ton/acre at Nornalup and Walpole.

All the evidence indicates that, while it is not necessary to use more than 1 ton/acre of limestone or its equivalent, it is not advisable to use less. The limestone should be applied before seeding and disced into the surface 4 to 6 in. of soil.

When broadcasting limestone it must be spread evenly. A shoveful here and there is not good enough; an even cover is essential. If necessary, run over the area three or four times with the broadcaster to get the necessary even distribution.

Limestone Drilled at Lower Rates is not as Effective as Broadcast Heavier Rates

There may be some soils of this type where a small amount, say 2 cwt./acre of ground limestone, drilled with the seed, will be sufficient to ensure good clover growth for a number of years. However,
on the experimental areas, establishment was good where the limestone was drilled, but growth in subsequent years was not satisfactory. The best clover grew on the plots where the limestone was first broadcast at 1 ton per acre and then disc'd into the top four inches. Even with as much as 8 cwt./acre of limestone drilled, the clover did not grow as well, in the second year, as that on the plots which were top dressed with 1 or 2 tons per acre of ground limestone. Data demonstrating this point is shown in Table II.

**What Form of Lime is the Best?**

Ground limestone, lime sand, and slaked or hydrated lime are equally effective, provided they are applied at equivalent rates. This means that, since the soil needs 1 ton of 100 per cent. ground limestone, if a sample contains only 80 per cent. limestone it should be used at \( \frac{5}{4} \) ton/acre. When lime sands are used the sample may only contain 40 per cent. limestone, in which case 2\( \frac{1}{2} \) tons/acre would be needed.

On the other hand, three quarters of a ton of slaked or hydrated lime is equivalent to one ton of ground limestone. The guiding principle in selecting a lime source should be the cost in relation to the amount needed per acre.

**When Can the Lime be Applied?**

The limestone should be top-dressed on the area before seeding and disc'd into the top four to six inches. However, if the area has already been seeded and has germinated, the clover will recover—even after it has become very red and unthrifty—if it is top dressed with a ton per acre of limestone. In this case allow the rain to wash it in; do not attempt to disc it in. Provided there are living plants present on the area they appear to recover once lime

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**Table II.**

<table>
<thead>
<tr>
<th>Treatments*</th>
<th>1954</th>
<th>1955</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. No Limestone</td>
<td>1·5</td>
<td>1·5</td>
</tr>
<tr>
<td>2. Limestone Drilled, 4 cwt./acre</td>
<td>16·6</td>
<td>6·9</td>
</tr>
<tr>
<td>3. Limestone Drilled, 8 cwt./acre</td>
<td>22·1</td>
<td>13·7</td>
</tr>
<tr>
<td>4. Limestone Broadcast, 1 ton/acre</td>
<td>28·2</td>
<td>27·3</td>
</tr>
<tr>
<td>5. Limestone Broadcast, 2 ton/acre</td>
<td>24·8</td>
<td>28·6</td>
</tr>
</tbody>
</table>

* N.B.—All plots received 4 cwt./acre of copper, zinc super in 1954 and 2 cwt./acre of plain super in 1955.
has been applied, but as might be expected they do not grow as well as those which received lime before seeding. The degree of this recovery is shown in Table III. Experiment 1 was sown in 1954 and experiment 2 in 1955.

Table III.

<table>
<thead>
<tr>
<th>Treatments*</th>
<th>Exp. 1 1954</th>
<th>Exp. 2 1955</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. No Limestone</td>
<td>0.6</td>
<td>2.3</td>
</tr>
<tr>
<td>2. Limestone 1 ton/acre at seeding</td>
<td>21.8</td>
<td>23.4</td>
</tr>
<tr>
<td>3. Limestone 1 ton/acre 1 month after seeding</td>
<td>15.5</td>
<td>9.7</td>
</tr>
<tr>
<td>4. Limestone 1 ton/acre 2 months after seeding</td>
<td>6.0</td>
<td>6.0</td>
</tr>
<tr>
<td>5. Limestone 1 ton/acre 3 months after seeding</td>
<td>1.5</td>
<td></td>
</tr>
</tbody>
</table>

* All treatments received 4 cwt./acre of copperised superphosphate.

How Long does the Lime Last?

As yet there is no reliable information on this point. Early indications are, however, that a 1 ton/acre dressing of ground limestone will last at least three years. Further information will be becoming available on this point in the near future.

Plant the Seed with Super Containing both Copper and Zinc

Like all virgin land, these soils need superphosphate. If possible use up to 3 cwt./acre in the first year. Good establishment will, however, be obtained with the usual one bag (187 lb.) per acre. The data in the table below are from a trial in which various plots received 2, 3, 4, 6 and 8 cwt. per acre of superphosphate in 1954 and a uniform dressing of 2 cwt./acre of superphosphate in 1955.

Table IV.

<table>
<thead>
<tr>
<th>Rate of Superphosphate Experiment.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Dry Yield (cwt./acre).</td>
</tr>
<tr>
<td>Total above ground Parts.</td>
</tr>
<tr>
<td>1954</td>
</tr>
<tr>
<td>1954 Yield</td>
</tr>
<tr>
<td>1955 Yield</td>
</tr>
</tbody>
</table>

It will be noticed that the big difference in yield (25 per cent.) between 2 and 3 cwt. was obtained in the second year. It is doubtful whether the further increase between 3 and 8 cwt. (15 per cent.) is an economic one.

Copper and zinc must be used on these soils. Use one bag per acre of superphosphate containing copper and zinc when the seed is sown. No more copper and zinc should be necessary for some years. Any extra super which is supplied at planting (if 3 cwt./acre are used in the first year) can be supplied as plain superphosphate. In this case it would be necessary to apply the copper, zinc super in one operation and the plain super in a separate operation.
These Soils Also Need Potash

The natural reserves of potassium in these soils are very low. Even without grazing or hay-cutting, potassium deficiency developed on the experimental sites in the first two years. Under grazing management there would be some transfer of potassium away from the area, and some concentration in droppings, so that the deficiency would occur more severely, at an earlier stage. If a hay cut is taken, an acute deficiency could be expected immediately.

To prevent potassium deficiency under normal grazing management use the standard super-potash maintenance mixture (155 lb. super to 31 lb. muriate of potash per bag) at a bag per acre each year. If a hay cut is taken, apply at least 1 cwt. per acre of muriate of potash in the autumn following the hay cut.

The table below shows the improvement in subterranean clover growth following the use of potash fertiliser on the Pingerup Plains, where there had been no grazing or hay-cutting; and at Denmark Research Station on one area which had been sown down to pasture for many years, and doubtless cut for hay during that period.

Table V.
CLOVER RESPONSES TO POTASH.
Air Dry Weight (cwt./acre).

<table>
<thead>
<tr>
<th>Area</th>
<th>0</th>
<th>2 cwt./acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pingerup Plain</td>
<td>13.3</td>
<td>28.4</td>
</tr>
<tr>
<td>Denmark Research Station</td>
<td>7.9</td>
<td>29.0</td>
</tr>
</tbody>
</table>

What about Other Fertilisers?

Boron, molybdenum, magnesium or manganese have not given any growth increases when applied to pasture growing on these soils. Chemical data obtained from analyses of leaf samples indicate that these fertilisers are unlikely to have any effect in the future.

A Good Seedbed is Essential

Seedbed preparation is difficult on these soils but, it is a very important factor in their successful development. If possible the scrub on the area should be burned before it is ploughed. It should then be ploughed and cross-ploughed to 6 to 8 in. with a heavy disc plough—although the hydraulically-mounted twin-disc ploughs will do the job as well. All experimental areas were left fallow through one winter. Although there is no evidence that this fallow period is essential it is very desirable. After a ploughed area has lain for nine months or so it is easier to prepare a satisfactory seedbed. During seedbed preparation, every effort should be made to remove stumps and other obstacles from the area.

Drainage should also be considered. The fallow period will give the farmer an opportunity to watch the direction of water flow and make some provision for drainage. Waterlogged soils do not give as much production as well-drained soils, and are hard to manage, so that the thought and effort given to drainage will be quickly repaid.

SUMMARY

Lime is essential for establishment of legumes on the acid peaty sands found on what are commonly known as bottlebush, teatree or kangaroo grass flats. These soils are found in the semi-coastal regions of W.A. extending from Albany to Muchea. Isolated pockets are also found in the Rocky Gully, Kybelup and Pemberton districts. They have general similarities to the Plantagenet peaty sand (Hosking and Burvill, 1938).

The lime should be applied at a rate equivalent to 1 ton per acre of ground limestone. It should be broadcast on and disced into the surface 4 to 6 in.

On the experimental sites, lime drilled at low rates (2-8 cwt./acre) did not give a satisfactory pasture, although early establishment was excellent.

The seed should be sown with superphosphate containing both copper and zinc. Potassium deficiency can be expected to occur shortly after development. No other fertilisers have given growth increases when used on subterranean clover pasture. Seedbed preparation is discussed.

ACKNOWLEDGMENTS

The authors wish to acknowledge the valuable assistance given by officers of the War Service Land Settlement Branch of the Lands Department in providing the areas and facilities in the Pingerup and Northcliffe districts.
Also to Mr. P. Burton of Walpole and Mr. F. E. Bellanger of Normanup, who have made areas available on their properties for experimental work.

Also to Dr. T. C. Dunne for valuable advice while the work was in progress and to other members of the Plant Research Division of the Department of Agriculture who assisted with the field work, particularly Messrs. N. J. Halse, N. W. O’Garr and J. A. Parish.

REFERENCES
Hosking and Burvill (1938)—C.S.I.R. Bulletin No. 115.

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