

Fertility targets suited to pasture and landscape

KEY POINTS

- Within a farm, different phosphorus (P) fertility targets should be chosen based on pasture species and landscape.
- There are at least seven separate mechanisms with which grazing enterprises can respond to P application, which work together by increasing the quantity and quality of feed.
- Where there are sufficient high-quality native grasses, fertility can be increased to moderate levels without the expense of resowing.
- Sown perennial grasses require at least moderate fertility levels to ensure persistence.
- Soil testing is relatively insensitive at separating between low and moderate P fertility levels.
- Rotational grazing, particularly in summer and autumn, is critical to ensure the long term survival of both native and sown perennial grasses.

Most phosphorus (P) guidelines focus on fertilising to the agronomic optimum, but relatively few sheep producers fertilise to this level. This Fact Sheet focuses on fertiliser strategies and expected responses between no application and this optimum.

Potential P fertility strategies range from no application to a fully fertilised pasture, with distinct steps in between (Table 1). Each strategy may be appropriate to different parts of the farm (Figure 1).



Figure 1. The different production areas can be seen in this farming landscape based on land class.

Very low fertility: Input costs are low, but low feed quality and quantity limits stocking rates and animal growth rates.

Low fertility: Small amounts of P are applied, which is sufficient to stimulate clovers but insufficient to retain sown grasses.

Moderate fertility: Additional P further stimulates the clovers, and there is sufficient fertility to retain sown grasses such as phalaris.

Moderately high fertility: Further P supports higher stocking rates, but a sown perennial grass is required to avoid high-fertility annuals.

High fertility: This is the agronomic optimum, and P application is only required for maintenance.

What changes occur as P fertility is increased? This brochure outlines what these changes are and the turning points, based on the Long-term Phosphate Experiment at Hamilton and similar studies on native pastures.

Table 1. Soil test values, P maintenance rates, based on the Long-term Phosphate Experiment at Hamilton.

	Fertility level				
	Very low	Low	Moderate	Moderately high	High
Olsen P (mg/kg)	<5	5-7	7-8	8-14	>14
Colwell P* (mg/kg)	<12	12-14	14-19	19-33	>33
DGT P+ (µg/L)	<3	3-4	4-6	6-13	>13
Carrying capacity (DSE/ha)	<8	9	12	14-22	>22
Maintenance P application rate (kg P/ha/year)	0	5	8	10-18	>18
kg P/DSE/yr	0	0.5	0.6	0.7	0.8
Which species persist?					
Low fertility native grasses	Y				
Moderate fertility native grasses	Y	Y	Y		
Sown grasses (phalaris, ryegrass)			Y	Y	Y

* Guide for soils in the Moderate category of P Buffering Index (PBI =190).

+ Diffuse Gradient Thin-films, a test developed by the grain industry for improved predictability on alkaline soils.

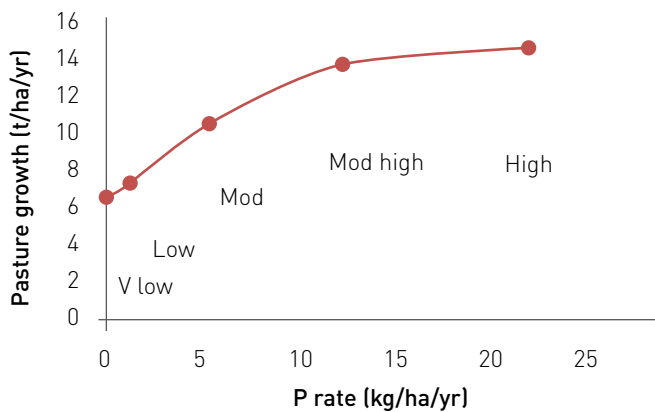


Figure 2. Pasture growth (1980-87) in response to P on a perennial ryegrass-based pasture, showing the fertility categories used in this publication.

1. THE PASTURE GROWS MORE

Annual pasture production can be nearly doubled by adding sufficient P, but the greatest response occurs between nil and about 10 kg P/ha/yr, after which there are diminishing returns from extra P (Figure 2).

2. CARRYING CAPACITY INCREASES

In order to utilise the additional feed and maintain pasture composition, stocking rates must be increased (Figure 3). The increase in carrying capacity is greater than the increase in pasture growth, because of higher pasture quality.

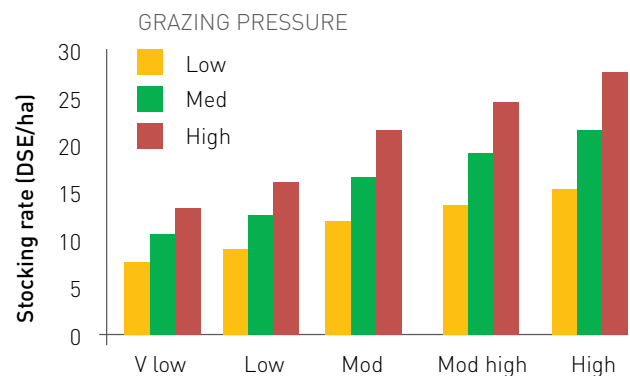


Figure 3. Stocking rates that could be imposed long-term (1988-97) at Hamilton at low, medium, and high grazing pressures at a range of fertility levels.

3. PASTURE COMPOSITION CHANGES

As fertility increases, native perennial grasses are replaced by annual clovers, annual grasses, and perennial grasses (if sown), such as phalaris (Figure 4).

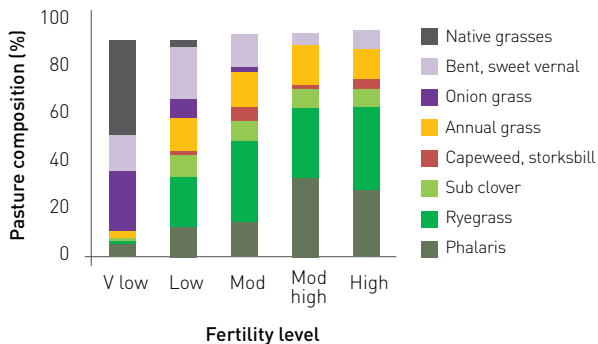


Figure 4. Botanical composition of the Long-term Phosphate Experiment at Hamilton (Nov 2013).

Native perennial grasses will persist up to a threshold fertility, after which they will tend to be replaced by annual grasses that are more competitive at high fertility levels. This threshold depends on species and their relative competitiveness. See the brochure "Fertilising Native Pastures" for a guide to the native species more tolerant of higher fertility. Sown perennial grasses persist down to a threshold fertility level, below which species of low palatability tend to be more competitive.

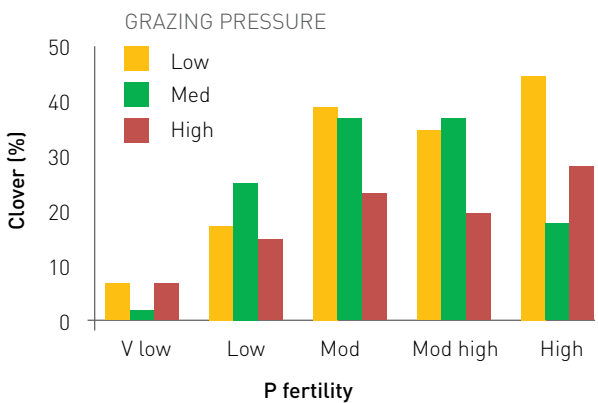


Figure 5. Clover content in response to P fertility and low, medium and high grazing pressures (Oct 1997).

There can be a "gap" between the fertility tolerance of native perennial grasses and sown grasses.

Annual grasses such as silver grass and barley grass dominate this gap.

Legume contents also increase up to the moderate P fertility level (Figure 5), which improves feed quality.

4. HIGHER LAMB GROWTH RATES

As feed quality increases, lamb growth rates increase, particularly at higher grazing pressures (Figure 6).

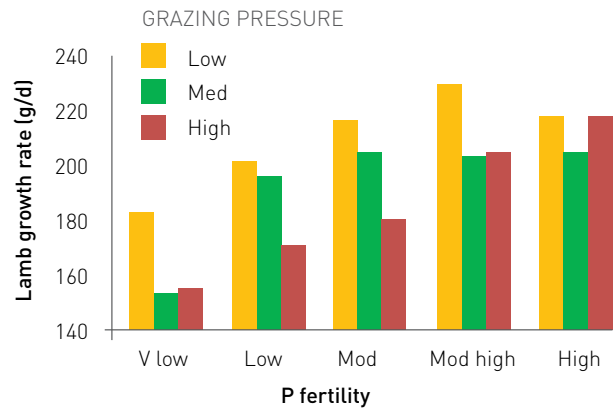


Figure 6. Lamb growth rates (1989-97) from birth to weaning.

5. MORE LAMBS

Higher quality pastures lead to weight gain in ewes, and improved reproductive performance at their next joining (Figure 7).

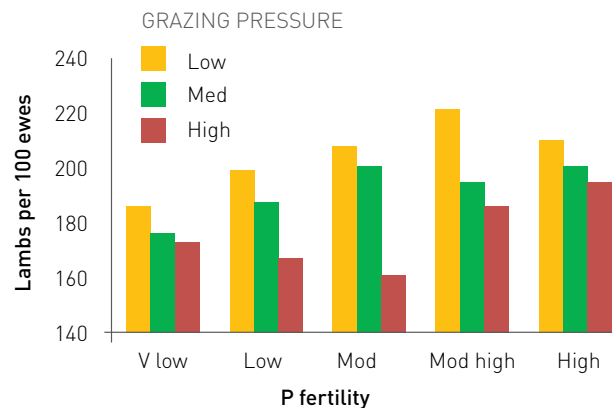


Figure 7. Reproductive rate in Merino ewes (lamb in utero per 100 ewes) estimated from changes in ewe weight in the 9 months prior to joining (1989-97).

6. LESS SUPPLEMENTARY FEED

At medium and high stocking pressures, less supplementary feed is required in late summer and early autumn (Figure 8), because the dry carryover feed is of higher quality.

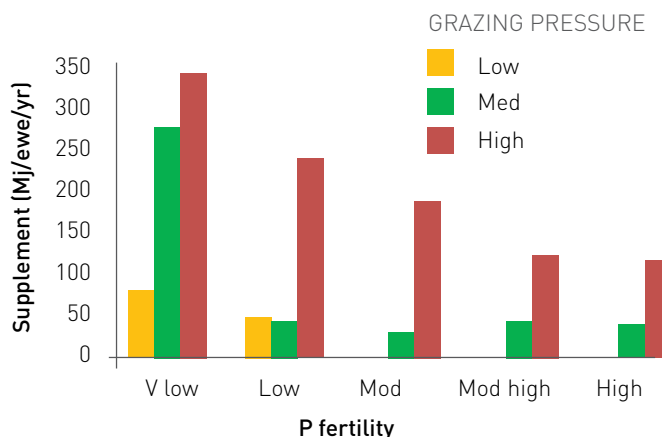


Figure 8. Supplementary feed required to maintain the weight of Merino ewes during summer and autumn.

7. LESS AFFECTED BY DROUGHT

Pasture production is less affected by drought at higher levels of P fertility (Figure 9), because plants can make better use of available water.

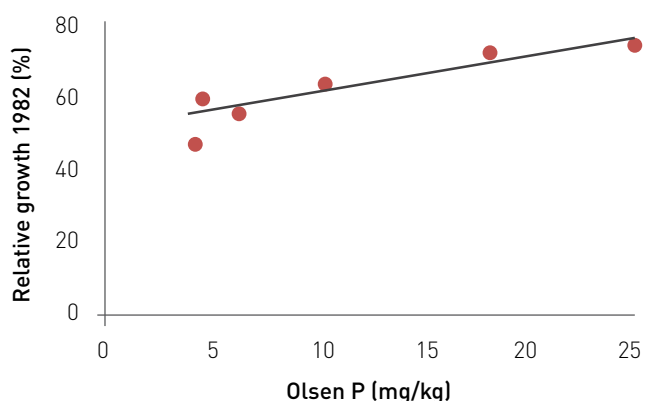


Figure 9. Winter-spring pasture growth in a drought year (1982) relative to non-drought years (1980-81 and 1985-87).

PUTTING IT TOGETHER

The combination of more pasture growth and better quality leads to higher gross margins, but higher stocking rates are required to capture the benefits of fertiliser investment (Figure 10). The most rapid increase in gross margin is from nil to 10 kg P/ha/yr, after which there are diminishing returns from extra P.

The optimum gross margin depends on stocking rate, and at Hamilton occurs at about 1 kg P per ewe, or 0.7

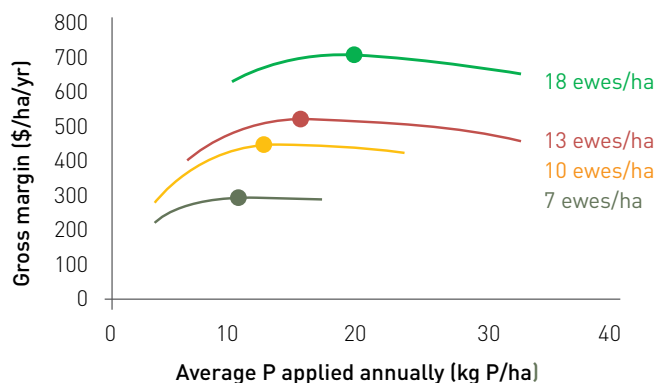


Figure 10. Gross margins for a steady-state wool production system based on the Hamilton Long-term Phosphate Experiment and 2014/15 prices.

kg P/DSE (Figure 10). This value ranges between 0.4 and 1.5 kg P/DSE depending on rainfall, pasture type, soil type, steepness and grazing management. The approach has been used in several decision support packages, such as “Five Easy Steps”. The optimum is broad, and provided the pasture is receiving 10 kg P/ha/yr there is a wide range of values a producer can choose with only small changes in gross margin. At P application rates below the optimum, more supplementary feed is required in the autumn, while above the optimum there is surplus feed.

Although extremely useful, this gross margin has limitations. Firstly, it is “steady state”, and does not include the investment costs of changing from one fertility level to the next. Secondly, it does not include sowing costs, because it is based on a pasture that has already been sown to clover, perennial ryegrass and phalaris. But what if there is already a good naturalised pasture?

COSTS ARE IN TWO STAGES

Where a grazing-tolerant native grass is present, investing in higher fertility is initially relatively low-cost because the main costs are additional P and livestock (Table 2). Once the fertility and grazing pressure exceeds what the native perennial grass will tolerate, the costs of developing to the next fertility stage increase because a full pasture sowing is required to introduce a sown perennial grass, otherwise the pasture is likely to become dominated by annual weeds. The additional costs of sowing may not be justified on land that is steep, or where sown perennial grasses are unlikely to persist.

Costs not identified here include fencing and stock water, and provision of other feed while the paddock is being sown. In some cases, other amendments or fertilisers may be needed, such as lime, trace elements, or potash. These limitations would be revealed by soil testing.

Table 2. Major investment costs in increasing fertility from one fertility stage to another (based on 2014/15 costs and returns, and values in Table 1 and Figure 10), and assuming a native perennial tolerant of the Moderate fertility level.

	Change from one fertility category to the next			
	Very low to low	Low to moderate	Moderate to moderate high	Moderately high to high
Capital P (kg P/ha)	10	15	30	45
Maintenance P kg/ha for 1 year	5	8	14	18
\$/ha (super @ \$344/t spread)	\$59	\$90	\$172	\$246
Additional livestock DSE/ha	2	3	6	6
\$/ha (\$81/ewe, 1.4 DSE/ewe)	\$162	\$243	\$486	\$486
Sowing \$/ha (herbicide, seed, equipment)			\$200	
Total capital costs \$/ha	\$221	\$333	\$858	\$732
Gross margin of higher fertility system (\$/ha/yr)	\$265	\$364	\$540	\$683

If current areas of sown pasture are already close to the top of the response curve (Figure 11), the next best pasture investment on a property may be fertilising a suitable native pasture where sowing is not required. For paddocks dominated by onion grass, chemical control will in many cases be required first, and the following year there should be sufficient native and naturalised species to respond to P.

SOIL TESTS

Soil tests are a guide to soil fertility, but should be complemented by other sources of information at low and moderate fertility levels. The Olsen soil P test shows a steep response in pasture growth between 5 and 9 mg/kg (Figure 11). Given sampling and laboratory error, it may be difficult to distinguish fertility levels from soil test values alone, so previous fertiliser rates and pasture composition should also be considered as indicators of fertility, as outlined in Table 1. Colwell P values don't show such a steep response between low and moderate fertility, but require a test for Phosphate Buffering index (PBI) to enable interpretation.

ROTATIONAL GRAZING TO MAINTAIN PERENNIAL GRASSES

Continuous stocking frequently leads to a decline in the perennial grasses in both naturalised and sown pastures, and eventually leads to invasion by annual grasses and

weeds. Rotational grazing, particularly in summer and autumn when the plants are under stress, allows these grasses to recover and maintain their density for the long term.

Annual grasses provide quality feed over a shorter period than the native and introduced perennial grasses. A good base of perennials ensures long-term sustainability of the pasture, provides summer ground cover, responds to summer rainfall, and takes up nitrogen to minimise nitrate leaching and soil acidification.

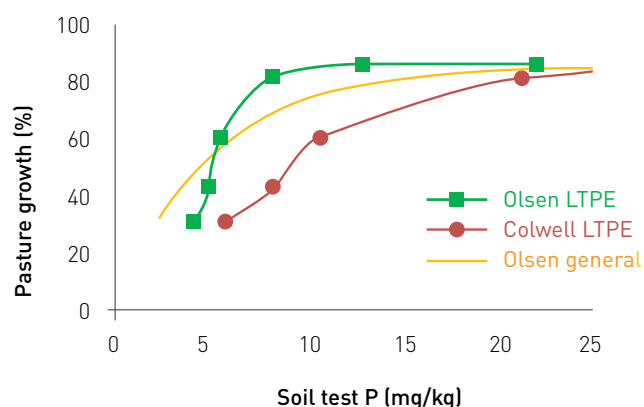


Figure 11. Pasture growth relative to non-limiting P for the Long-term Phosphate Experiment using the Olsen test and a Colwell equivalent, and a general relationship with Olsen P developed from 303 experiments.

LOCKING IN PRODUCTIVITY BENEFITS OF LEGUMES

Annual legumes, such as sub clover, are initially the first pasture component to respond to extra P fertiliser. This is because they are more effective than most other pasture plants at extracting soil P, and fix their own nitrogen. While the higher legume content boosts animal growth rates, the benefits could be short-lived because as nitrogen levels build up, annual grasses and plants of low palatability such as capeweed and onion grass become more competitive (Figure 12).

To maintain animal productivity the pasture needs either a palatable native grass, or a sown grass such as phalaris. The sown grasses require regular application of P (Figure 13) to remain persistent.



Figure 12. Phalaris grows poorly in this low fertility pasture (5.6 mg P/kg Olsen, 9 mg P/kg Colwell) that was resown 4 years earlier, whereas sub clover persists at a high density but is gradually being replaced by less palatable species such as capeweed and onion grass

The State of Victoria Department of Economic Development, Jobs, Transport and Resources 2016



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Figure 13. Regular fertiliser application is required to maintain sown grasses such as phalaris.

FOR MORE INFORMATION

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USEFUL RESOURCES

[Managing P in native pastures](#)

[Understanding soil tests](#)

[5 easy steps](#)

[EverGraze](#)

[Native Pasture Management](#)

Acknowledgements: Malcolm McCaskill, Victorian DEDJTR; Meredith Mitchell, Victorian DEDJTR; Roger Armstrong, Victorian DEDJTR.

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