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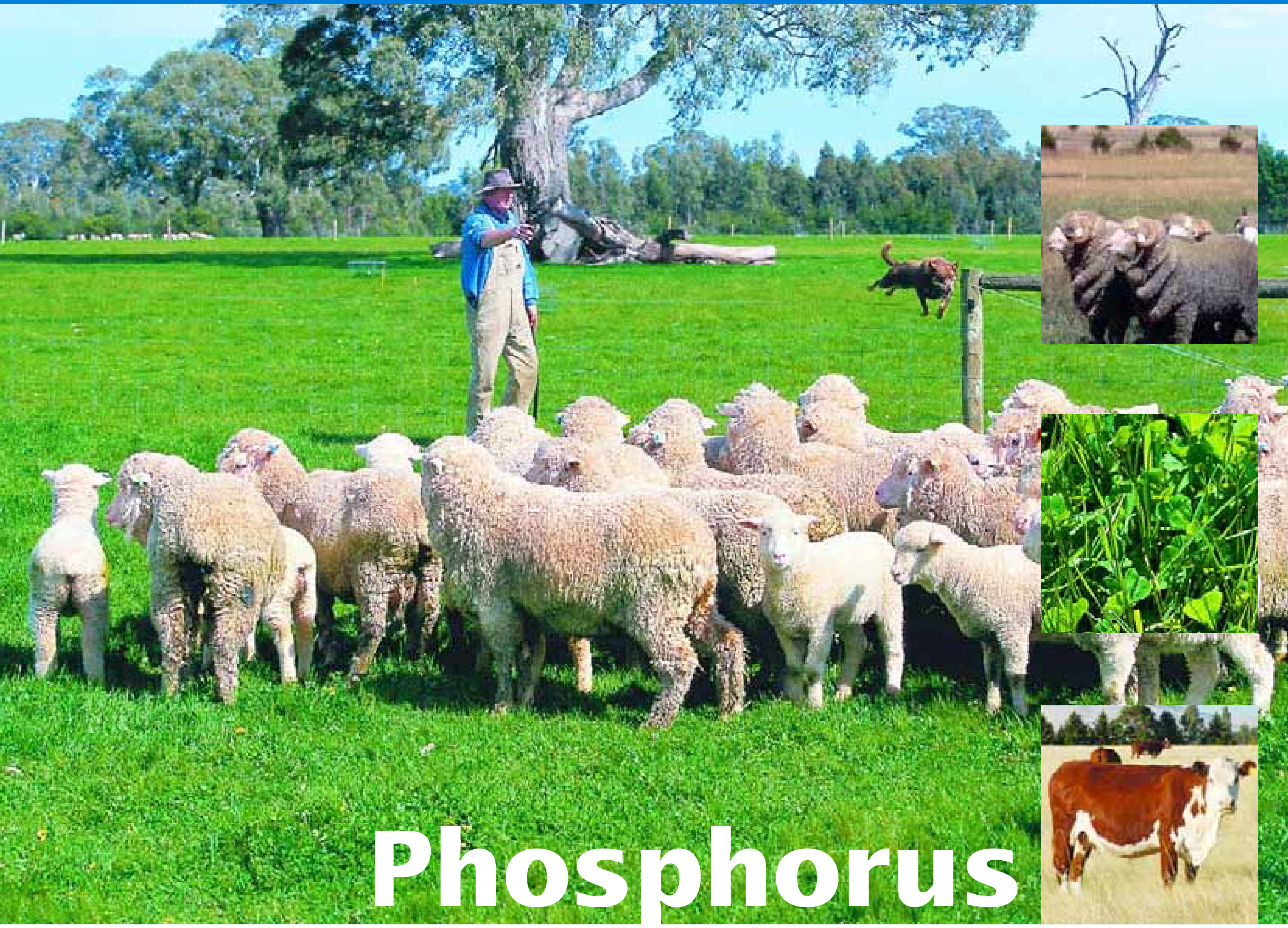
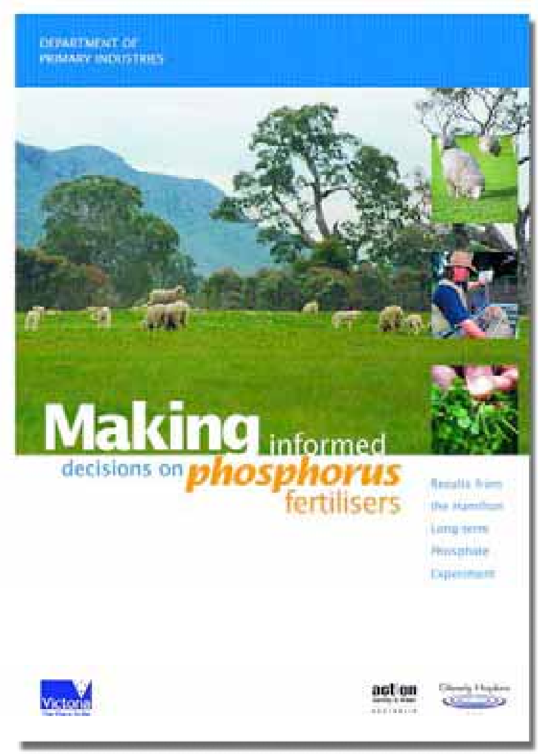


Phosphorus for *sheep and beef* pastures

Victoria
The Place To Be



A summary of the results from the Hamilton Long-term Phosphate Experiment is reported in the publication: *Making informed decisions on phosphorus fertilisers* and is available from:

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Phosphorus for sheep and beef pastures

Farm profitability is linked closely with the correct use of fertiliser.

The key to successful pasture production is the combination of well-fertilised and high-quality pastures, stocked at an appropriate grazing pressure, with livestock of high genetic merit.

To make the phosphorus fertiliser decision for Victoria sheep and cattle producers easier, we have combined the results from the Long-term Phosphate Experiment at Hamilton with a fertiliser decision method developed in New Zealand.

This package assists producers to:

- decide how much phosphorus to apply to particular paddocks
- decide what type of phosphorus fertiliser to use
- plan a soil phosphorus monitoring program
- decide which paddocks have the greatest need for fertiliser

Contents

The key message of this package is that the old rule of thumb of one kilogram of phosphorus per dry sheep equivalent can be greatly refined to improve profitability, and minimise environmental impacts.

Research indicates that the amount of phosphorus per dry sheep equivalent (kg P/DSE) needed to maintain productivity varies from 0.42 to 1.46 kg P/DSE, depending on rainfall, soil type, pasture species and grazing management.

Adequate amounts of all other soil nutrients need to be present to get the full benefit from phosphorus fertiliser.

Abbreviations

cm	centimetre
DSE	dry sheep equivalent
ha	hectare
kg	kilogram
mg	milligram
mm	millimetre
K	potassium
P	phosphorus
S	sulphur
t	tonne
%	percentage
yr	year

NOTE

The recommendations in this package are designed to supply an adequate amount of phosphorus fertiliser for the level of production supported by a particular paddock. It assumes other major nutrients are in adequate supply - this is to get the full benefit of the applied phosphorus.

Phosphorus in grazing systems

Phosphorus is essential for all living things. It is required for respiration, photosynthesis, energy expenditure, cell division and growth, and the uptake and movement of nutrients. In animals, phosphorus is a major constituent of bones, teeth and the central nervous system.

The phosphorus in a grazed paddock moves continuously between the soil, plants and animals (Figure 1).

Some phosphorus may be lost from the grazing system through soil reactions and the movement and management of livestock. If insufficient fertiliser phosphorus is applied to balance these losses, the soil phosphorus status of the paddock will fall. Eventually productivity will also fall.

Soil losses

Phosphorus in dung and plant litter is unavailable to plants until the organic matter is mineralised (broken down) by micro-organisms in the soil.

Phosphorus in the soil will react with iron and aluminium to form insoluble compounds. This phosphorus is known as fixed or sorbed phosphorus. It cannot be used directly by plants but over time may become available through weathering of the soil particles.

Other losses of phosphorus occur by leaching (especially in acid sandy soils), run-off following heavy rain immediately after fertiliser application, and soil erosion.

The amount of phosphorus lost due to soil factors varies with soil type and increases with rainfall.

To maintain an adequate soil phosphorus status, the phosphorus lost from each paddock through soil and animal processes must be replaced

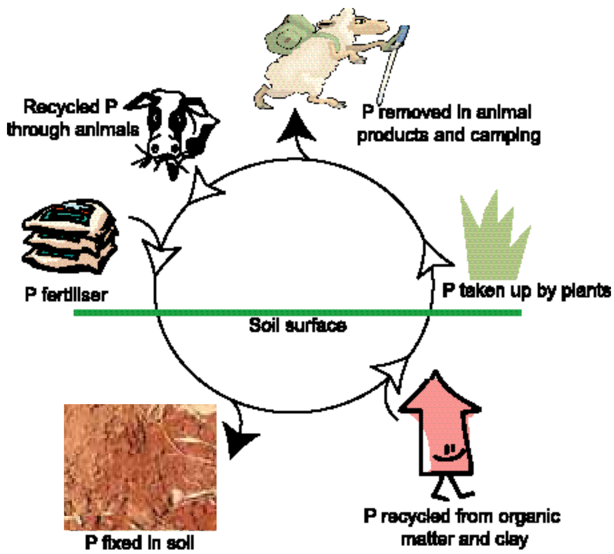
Animal losses

A high proportion of the phosphorus consumed by livestock returns to the soil in dung and urine, but much of it is transferred to stock camps within the paddock, leading to a net loss of phosphorus from the main part of the paddock. Stock camps are more pronounced on hilly terrain and set stocked areas, and less pronounced on flat areas or where paddocks are rotationally grazed.

Some phosphorus is exported from the grazing system when animals, meat, milk or wool leave the farm.

If insufficient phosphorus is applied, the phosphorus status of the paddock will fall and eventually productivity will also fall

Figure 1. A simplified phosphorus (P) cycle showing the continuous movement of phosphorus in the animal grazing system and potential loss pathways. After Cornforth and Sinclair (1982).



Research leads to better decision making

The long-term experiment at Hamilton, Victoria, shows there is a close relationship between inputs of phosphorus and profitability.

The maximum profit from wool sheep (sale of wool and lambs) at Hamilton occurs when 1.3 kilogram of phosphorus per ewe (about 0.9 kg P/DSE) is applied each year. This figure is relatively insensitive to changes in the cost of fertiliser and the price of wool, and enables reasonably confident recommendations on how much phosphorus fertiliser to use for pastures on the basalt soils in south-western Victoria.

Widespread recommendations across farms and districts of a single kg P/DSE rate are incorrect because the amount of fertiliser required will depend on soil type, the animal enterprise and the potential productivity of individual paddocks.

The Hamilton results have been integrated with a method developed in New Zealand which is based on replacing the phosphorus lost in the grazing system with fertiliser phosphorus (Figure 1). The combined approach provides Victorian graziers with a new and better way to make decisions about phosphorus fertiliser.

Previously, soil tests alone were used to determine a phosphorus application rate. This package gives recommendations based on applying a given amount of phosphorus per DSE. This ensures that paddocks with the highest stocking rates receive the most fertiliser.

Results from the Hamilton Long-term Phosphate Experiment show there is a close relationship between inputs of phosphorus and profitability

Figure 2. An aerial view of the 18 plots of the Long-term Phosphate Experiment at Hamilton, Victoria.

This package presents a method that enables fertiliser rates to be tailored to individual paddocks. It ensures that more fertiliser is used in paddocks with high removal rates, and less is used in paddocks with poor carrying capacity.

How much phosphorus is needed?

This package tailors phosphorus fertiliser recommendations to individual paddocks because soil type, carrying capacity and topography will vary between paddocks.

To make decisions on how much phosphorus fertiliser to apply to an individual paddock, to support the desired production and maintain adequate soil phosphorus status, you will need to know:

- average rainfall
- soil type
- grazing system used
- steepness of the paddock
- pasture species present
- stocking rate expressed as DSE / ha
- phosphorus content of the fertiliser

In determining a phosphorus application rate, this package takes into account the phosphorus lost from grazing systems. In New Zealand, losses of phosphorus due to soil and animal processes are classified as low, medium or high. This approach has been adapted for Victorian soil conditions.

Table 1 gives soil phosphorus loss factors for different Victorian soil types as well as the corresponding 'P sorption index' for each soil - the two factors being a much better indicator of phosphorus loss than soil type alone. Table 1 also gives ratings for animal loss factors based on grazing management and topography.

In incorporating the New Zealand recommendations into this package, an estimate of carrying capacity has been calculated based on average annual rainfall and pasture type using the equation developed by French (1987). French predicted 1.3 DSE / ha could be carried for each 25 mm of rainfall over 250 mm.

Using the appropriate soil and animal loss factors from Table 1, together with average annual rainfall, Table 2 gives the predicted phosphorus requirement per DSE for a paddock. The phosphorus requirement is then multiplied by the stocking rate (DSE / ha) to calculate phosphorus requirement per hectare.

The same predictions for phosphorus requirement can be obtained from the 'Phosphorus Ready Reckoner' attached to this brochure.

An example calculation

Your paddock has podzol soil, in a 600 mm rainfall zone, growing improved pasture. The paddock supports set stocking on flat to rolling country

➜ *the soil loss factor will be* ***medium*** *(Table 1)*
➜ *the animal loss factor will be* ***low*** *(Table 1)*

Having selected the soil and animal loss factors for your paddock, and taking into account improved pasture, slope and 600 mm rainfall, the appropriate phosphorus rate per DSE is determined from Table 2.

➜ ***0.83 kg P/ DSE*** *is recommended*

The next step is to express stocking rate in terms of DSE/ ha. Use the average stocking rate for the paddock from the previous year calculated from paddock records. Or use commercially available computer-based farm management programs such as 'Farm Tracker' or 'Paddock Action Manager'. Alternatively, we have developed a computer spreadsheet that does this job. Contact DPI at Hamilton for a copy – see page 2 for contact details. If individual paddock information is not available, use an average stocking rate for the farm.

The DSE values for different classes of livestock are shown in Table 3.

In our example, the paddock is stocked with 50 kg wethers, running at 10 head/ha. A 50 kg wether has a DSE value of 1.0, so the stocking rate of the paddock is 10 x 1.0

➜ ***10 DSE/ ha***

The amount of fertiliser to apply per hectare can be determined using the following equation:

$$\frac{100 \times \text{kg P/ DSE} \times \text{DSE/ ha}}{\%P}$$

If single super (9% phosphorus) is used, the fertiliser application rate will be:

$$\rightarrow \frac{100 \times 0.83 \times 10}{9} = 92 \text{ kg single super/ha}$$

Table 1. A description and rating of phosphorus loss factors in sheep and beef cattle grazing systems, based on soil characteristics, grazing management and landscape. Soil types listed here are described in Table 4.

Soil phosphorus loss factors		
Soil type	***P sorption index***	***Loss factor***
Recent alluvial soils, loams and sandy loams	Less than 100	Low
Podzols, clay loams, redzinas	100 to 300	Medium
Krasnozem and other clays, organic soils	Greater than 300	High
Acid sands (leaching leads to high loss factor)	Less than 100	High

Animal phosphorus loss factors		
Grazing Management	***Landscape***	***Loss factor***
Intensive rotational grazing (e.g. cell grazing or block grazing)	Flat and rolling (mostly less than 10° slope)	Very Low
	Easy hills (mostly less than 25° slope)	Low
	Steep hills (one third of paddock greater than 35°)	Medium
Set stocked or intermittent grazing	Flat and rolling	Low
	Easy hills	Medium
	Steep hills	High

Table 2. Recommended phosphorus rate (kg P / DSE) for maximum profit, according to loss factors, pasture type and rainfall.

Soil loss factor	**Animal loss factor**	**Poor pasture** *Annual rainfall (mm)*			**Improved pasture** *Annual rainfall (mm)*		
		400	*600*	*800*	*400*	*600*	*800*
Low	Very low	0.42	0.45	0.48	0.43	0.48	0.53
	Low	0.54	0.58	0.62	0.55	0.62	0.68
	Medium	0.65	0.70	0.75	0.67	0.75	0.83
	High	0.77	0.83	0.89	0.80	0.89	0.98
Medium	Very low	0.61	0.65	0.70	0.63	0.70	0.77
	Low	0.72	0.78	0.84	0.75	0.83	0.92
	Medium	0.84	0.91	0.97	0.87	0.97	1.07
	High	0.96	1.03	1.11	0.99	1.11	1.22
High	Very low	0.80	0.86	0.92	0.82	0.92	1.01
	Low	0.91	0.98	1.05	0.94	1.05	1.16
	Medium	1.01	1.11	1.19	1.06	1.19	1.31
	High	1.15	1.24	1.32	1.18	1.32	1.46

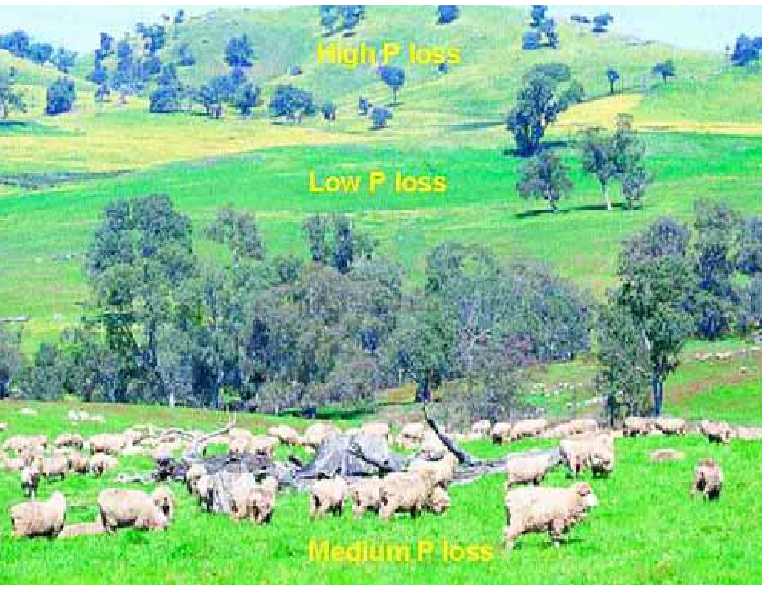
Table 3. Dry sheep equivalent (DSE) values for different classes of livestock, at different live weights.

Sheep	**30 kg**	**40 kg**	**50 kg**	**60 kg**
Dry ewes or wethers (maintaining weight)	-	0.9	1.0	1.2
Last month of pregnancy (singles / twins)	-	1.2 / ***1.4***	1.4 / ***1.6***	1.6 / ***1.9***
Lactation (singles / twins)	-	2.6 / ***3.7***	2.7 / ***3.9***	2.9 / ***4.4***
Weaners (growth rate 100 g/day)	1.1	1.3	-	-
Average (year) ewe	-	1.5	1.6	1.8

Beef cattle	**400 kg**	**500 kg**	**600 kg**
Dry cows or store steers (maintaining weight)	6	7	8
Dry cows or store steers (growth rate 0.5 kg/day)	8	11	12
Dry cows or store steers (growth rate 1.0 kg/day)	11	13	15
Last 3 months of pregnancy	8	9	11
Cows with 0-3 month calves	13	14	17
Cows with 3-9 month calves	19	21	24
Average (year) cow and calf	15	16	19

Table 4. Description of soil types listed in Table 1.

Alluvial soils	Derived from river activity, they are usually well drained and more fertile than soils derived from underlying rock.
Loam	Both friable and cohesive; when worked moist, can be worked into a ball, but cannot be rolled out into a ribbon. Sand grains cannot be felt.
Clay loam	Like a loam, but can be rolled into a ribbon that soon breaks up. Sand grains cannot be felt.
Clay	Tough, plastic soil that can be rolled into a long ribbon when just dry enough not to be sticky.
Podzol	Acidic sandy to clay loam topsoil with a change in texture (more clay) down the profile.
Krasnozem	Dark red-brown clay with very friable and stable crumb structure. The subsoil is red clay, friable and very porous.
Organic soils	Reclaimed swamps with mixed inorganic (clay) and organic compounds.
Acid sands	Acid sands are not cohesive and are coarse to the touch, often high in organic matter, with no change in texture with depth.
Redzina	Black to grey friable clay over limestone, neutral to alkaline, with aunifrom profile.



Fodder conservation

Large quantities of nutrients are removed when hay or silage is made. Pasture hay contains about 0.25% phosphorus and 2% potassium, so a 2.5 t / ha hay crop removes about 6 kg P / ha and 50 kg K / ha.

If the fodder is not fed back onto the paddocks from which it was made, the nutrient status of the paddock will decline.

A fertiliser program on hay and silage paddocks should aim to replace the phosphorus and potassium in the hay or silage, *in addition* to phosphorus removed through livestock (kg P / ha) and *in addition* to any phosphorus required to bring the soil phosphorus up to maintenance levels.

Regular soil tests should be taken in summer to monitor fertility of hay and silage paddocks.

A program for monitoring soil fertility should be in place in all situations to ensure that a fertiliser application program maintains soil nutrient reserves

Increasing stocking rates

Improving pasture quality and grazing management may enable an increase in stocking rate. This will necessarily require more phosphorus fertiliser in order to replace the extra phosphorus removed through the increased production. However, the investment in extra phosphorus should be profitable.

Reworking the calculations outlined in this package, using the increased stocking rate target, will enable you to determine the new phosphorus rate.

Maintenance and capital applications of phosphorus

The amount of phosphorus required to replace the phosphorus used on the farm and maintain soil reserves at existing levels is the most profitable rate to apply for the current stocking rate. This is called a maintenance application.

Application of additional phosphorus is profitable if the additional pasture grown is used by increasing the stocking rate. Applications of phosphorus made in excess of maintenance are called capital applications.

Capital applications of phosphorus:

- may be required where fertiliser has not been applied for several years and there are still responsive pasture species present
- are most likely to be effective on newly sown pastures with low reserves of phosphorus and where the additional feed grown can be used
- are not profitable unless the stocking rate is increased to use the additional feed grown.

Applying more than maintenance rates of phosphorus to a soil already with high reserves of phosphorus is always uneconomic. At high levels of fertility, the response to each additional amount of phosphorus applied is progressively less, so that a plateau in yield is reached.

The amount of phosphorus required to maintain Olsen P varies with soil type. At Hamilton, about 10 kg / ha of P in excess of maintenance is required to increase the Olsen P by 1 unit (Table 5). For Dundas Tableland soils, only 6 kg / ha of P in excess of maintenance is needed to do this. But on some soils as much as 13 kg of P in excess of maintenance may be required to achieve this increase.

Maintenance phosphorus

The amount of fertiliser needed to maintain soil reserves of plant nutrients in adequate supply

Capital phosphorus

The amount of phosphorus required in excess of maintenance to build up soil reserves of phosphorus or production capacity

Table 5. Predicted Olsen P (mg / kg) after different amounts of fertiliser were applied at Hamilton or the Dundas Tablelands.

Current Olsen P (mg/kg)	P applied in fertiliser (kg/ha) 0	5	10	20	40	80
Predicted Olsen P at Hamilton 12 months later						
3	3	3	4	5	7	11
5	5	5	6	7	9	13
10	9	9	10	11	13	17
15	13	13	14	15	17	21
20	17	17	18	19	21	25
25	21	21	22	23	25	29
Predicted Olsen P Dundas Tablelands 12 months later						
1	1	2	3	4	7	14
3	3	3	4	6	9	15
5	4	5	6	7	11	17
10	8	9	10	11	15	21
15	12	13	14	15	19	25
20	16	17	18	19	23	29
25	20	21	22	23	27	33

Soil testing, sampling and monitoring

Why should we test the soil?

To monitor trends in soil phosphorus
A soil test will help determine if the soil phosphorus level is rising, falling or remaining relatively constant from one year to the next. Having monitor paddocks that are sampled carefully each year to detect changes in soil nutrient levels is the best way to ensure soil nutrient reserves are being maintained.

Soil tests determine phosphorus levels in the soil using the Olsen extraction method. The result is commonly referred to as an Olsen P, and reported as milligrams of phosphorus per kilogram of soil (mg/kg).

If test results indicate that soil levels of phosphorus are declining, i.e. the Olsen P is declining, the rate of phosphorus application needs to be increased to sustain production.

If test results indicate soil levels of phosphorus are increasing, i.e. the Olsen P is increasing, the phosphorus rate is more than required for maintenance of soil phosphorus reserves. In this case the profitability of fertiliser application must be considered. Stocking rate can be increased to better utilise the pasture growth resulting from the high phosphorus reserves; or cost effectiveness of the enterprise can be improved by reducing the amount of fertiliser applied.

If soil test results for a paddock vary by more than 20% over time, further investigation of monitoring and application rates is required. Firstly, ensure sampling methods are uniform and conducted at a similar time each year (see page 11 for details).

Secondly, if the phosphorus application rate is being determined using the method described in this package, it may be necessary to revise the soil loss factor (Table 1). For example, the soil type in a particular paddock may be more variable than first thought, and the soil loss factor has been based on the wrong soil type. Reconsidering the soil loss factor, will lead to a revised and more appropriate phosphorus application rate (see the example to the right).

For example
If the monitor paddock has a medium soil phosphorus loss factor, the animal phosphorus loss factor is low, rainfall is 600 mm/year, and has poor pasture, the recommended P/DSE from Table 2 will be 0.78 kg P/DSE.

If the stocking rate of a monitor paddock is 10 DSE/ha, the recommended P/ha rate will be 10 x 0.78 = 7.8 kg P/ha or ***87 kg/ha of single superphosphate.***

Now suppose that the Olsen P increased by 3 mg/kg when 87 kg of fertiliser was applied. This means that the soil loss factor was overestimated. Using a ***low*** *soil loss factor instead of a* ***medium*** *soil factor, will give a recommended P/DSE of 0.58 kg P/DSE.*

The revised phosphorus application rate will be 10 x 0.58 = 5.8 kg P/ha or ***64 kg/ha of single superphosphate.***

The recommended rate of phosphorus is a guide - verify by testing the soil of monitor paddocks

To identify other nutrients required

To get the most from phosphorus applications we must ensure that pasture plants have access to adequate amounts of all essential plant nutrients. In addition to phosphorus, the nutrients most likely to be deficient in Victoria are sulphur, potassium, nitrogen and molybdenum.

As well as phosphorus, soil tests will assess the status of all major nutrients, including potassium and sulphur. Where the soil test indicates low reserves or a declining level of nutrient it will be necessary to include that nutrient in a fertiliser mix.

Adequate nutrient levels are critical when re-sowing pasture, especially if nutrient deficiency has contributed to pasture failure previously. A soil test at this time is a valuable tool to make decisions to ensure future success of re-sowing programs.

To assess the need for lime

Soil tests report pH and aluminium levels of the soil, both of which are reliable predictors of the need for lime. It is normal for the soil to become more acidic with time. Nitrogen fertiliser use and hay or silage production increase the rate of soil acidification.

Pasture plants are adapted to slightly acidic soils, preferring a pH(water) range of 5.5 to 6.0. The further the pH is below 5.5 the more urgent is the need for lime and it may be more important to apply lime than fertiliser. The level of aluminium in the soil must be considered. Soils naturally low in aluminium can tolerate a relatively low pH before plant growth is restricted.

Removing hay and not feeding it back will also gradually acidify the soil. About 75 kg/ha of lime is required to compensate for the effect of removing a 2.5 t/ha hay crop.

If the lime is to be applied to a paddock being re-sown, incorporation of the lime into the surface soil before seeding will provide the most effective use of lime.

Soil tests and trace elements

Soil testing cannot reliably assess the need for trace elements. Trace elements are more reliably tested from samples of pasture plants.

The most commonly deficient trace element in Victorian soils is molybdenum. Molybdenum is required by the nitrogen-fixing bacteria in nodules on the roots of legumes. Poor legume growth may be an indicator of a lack of molybdenum if the soil test shows adequate levels of other plant nutrients.

In areas that have marginal levels of copper, the addition of molybdenum can induce a copper deficiency in animals grazing these pastures. This is most likely on sandy soils. In this case the inclusion of copper in the fertiliser mixture will ensure the benefits of molybdenum are realised without detriment to livestock.

Soil sampling and monitoring

The most important information obtained from a soil test is about the changes in a paddock's fertility over time. These changes are hard to detect if soil samples are taken in a random pattern over the whole paddock from one test to the next. Nutrient levels vary from place to place across a paddock therefore soil samples collected for monitoring nutrient status should be taken at regular intervals along a fixed transect such as a line between marked fence posts each sampling time. Careful positioning of sampling transects is very important to obtain the best information and value from the soil monitoring program.

Monitor samples should be collected at the same time of the year when soil conditions are similar and to minimise variation in the proportion of nutrients held in herbage above the ground. The best time to sample is in late spring-early summer when the soil is slightly moist.

Avoid collecting soil samples from dung and urine patches, or from areas of fertility concentration such as around walking tracks, water troughs and stock camps. One or two soil cores from these areas can greatly affect the values obtained.

Most plant nutrients are concentrated near the soil surface, so it is vital to sample a constant depth of soil, generally a 0-10 cm interval. At least 30 soil cores should be collected.

It is best to send soil samples to a laboratory belonging to the Australian Soil and Plant Analysis Council. These laboratories regularly check their testing methods by comparing test results from shared samples.

Phosphorus fertilisers

Phosphate rock is the main source of phosphorus used in the manufacture of fertilisers in Australia and overseas. This material is insoluble in water, and therefore its phosphorus is unavailable to plants.

Superphosphates are the most common fertilisers used to supply phosphorus to sheep and beef pastures. Superphosphates are produced by reacting phosphate rock with acids, changing the phosphorus in the rock to a form that is water soluble and available to plants.

Some types of phosphate rock, called reactive phosphate rock (RPR), given adequate rainfall and acid soils, will release the phosphorus in a form that plants can use. More information on for the use of RPR on Australian pastures is available on the Internet at: **http://www.latrobe.edu.au/rpr**

The type of phosphorus fertiliser to use depends on the phosphorus and sulphur status of the soil, and to some extent soil type.

Phosphorus status

The most efficient phosphorus fertiliser to increase soil phosphorus levels (as indicated by the Olsen P test) is triple superphosphate.

Reactive phosphate rock releases its phosphorus slowly over several seasons and in most situations is not suitable for increasing soil phosphorus levels (i.e. as capital applications) or where stocking rates are above average.

Reactive phosphate rock used with gypsum as a source of sulphur may be suitable maintenance fertilisers, provided annual rainfall exceeds 700 mm, the growing season is longer than 9 months and the soil pH (water) is less than 5.6.

Reactive phosphate rock may be superior to the soluble phosphorus fertilisers for acid sandy soils, as the slower release of phosphorus leads to less phosphorus being leached – provided there is enough growing season rainfall to make the phosphorus available before winter.

Sulphur status

Where a soil test indicates a high level of available sulphur, the use of low sulphur fertilisers such as triple superphosphate is warranted, especially if these are the cheapest source of phosphorus.

A soil test from dry soil over summer will indicate the amount of sulphur required. Typical application rates of single superphosphate and sulphur-enriched high analysis fertilisers also apply 10–15 kg S/ha which is generally adequate to maintain sulphur status.

Type of sulphur

Sulphur can be applied as either sulphate sulphur (soluble) or as elemental sulphur (slow release). Sulphur in the sulphate form is readily available to plants but is prone to leaching, particularly in high rainfall zones where the topsoil is sandy. Where leaching occurs, a mixture of elemental and sulphate forms will result in a more even supply through growing season. Single superphosphate contains soluble sulphur (as does gypsum), whilst sulphur-enriched high-analysis fertilisers contain elemental sulphur. Paddocks with a very low sulphur soil test (less than 5–7 mg/kg) should have sulphate sulphur applied. Elemental sulphur is acceptable where soil sulphur levels are above 10 mg/kg. Between 5 and 10 mg/kg, a mix of sulphate and elemental sulphur would be appropriate.

Likelihood of acidification

Phosphorus fertiliser will not directly cause acidification but its increased use will promote acidifying factors such as nitrogen fixation and subsequent nitrate leaching, and product removal. The use of elemental sulphur increases soil acidification slightly, so, an application of 1 kg/ha of elemental sulphur requires 3 kg/ha of lime to neutralize the resulting acidification. For soils prone to acidification, particularly those with a light-textured topsoil and organic carbon less than 2.5%, the pH of the soil must be monitored. The pH balance is restored with applications of lime. See the "Further reading" list for information about the management of soil acidity.

Priorities for phosphorus fertiliser use

The phosphorus application program over the whole property will be a staged process taking into consideration logistics and economics.

The values in Table 2 will help decide the optimum amount of phosphorus to apply to different paddocks, or major soil types within the farm, thereby maximising the investment for each kilogram of phosphorus applied.

It is possible to further set priorities for phosphorus applications based on paddock use, pasture composition and soil tests.

The information below is based on practical experience of factors that drive responses to phosphorus fertiliser.

Proposed use

Paddocks with the greatest need for phosphorus are those that run pregnant, lactating or fattening stock, or where hay or silage is to be made. Phosphorus fertiliser improves pasture quality, as well as pasture production, and stock will respond profitably to high quality herbage.

Anticipated stocking rate

The need for phosphorus fertiliser increases as the stocking rate increases and more pasture production is required.

If available pasture contains more than 10% old pasture (on a dry matter basis) in August, the pasture is under-used or over-fertilised. Alternatively, poor quality pasture may be preventing stock eating all that is available.

Spreading the same amount of fertiliser per hectare over the whole farm is unlikely to give the best return for the money invested

Pasture type

Paddocks can be classified into different categories depending on their potential response to phosphorus fertiliser. For a given soil test value, it is likely that the paddocks with the best pasture composition will give the highest response to phosphorus fertiliser.

Four different pasture types are listed in order of priority for phosphorus fertiliser applications:

1. **Re-sown pasture:** applying fertiliser on re-sown pasture protects the investment already made. It is essential to apply adequate nutrients following pasture renovation.

2. **Good pasture:** pasture that consists mainly of sown perennial grasses and annual or perennial legume.

3. **Moderate pasture:** sown perennial grass and clover is present, but there is also onion grass, bent grass or silver grass. Capeweed and barley grass may also be present.

4. **Poor pasture:** run-down pasture where sown species are inconspicuous, and the sward is dominated by onion grass, silver grass and cat's-ear. Clover, if present, is stunted with small dark-green leaves indicating nutrient deficiency.

Phosphorus status of paddock

The lower the soil phosphorus status, the greater is the likely response to phosphorus fertiliser, provided other nutrients are non-limiting and the pasture is not run down.

If the soil phosphorus level is not known, consider the amount of phosphorus applied in the last four years or the soil test results from similar paddocks. It is best, however, to soil test the paddock.

Other soil-related factors

Excessive salinity, high aluminium, excessive acidity, waterlogging or a lack of water-holding capacity will limit the extent to which pastures will respond to phosphorus.

Responsible fertiliser use

A well-fertilised and well-managed improved pasture is responsible land management. The benefits from dense, perennial grass based pastures on fertile soils are:

- improved ground cover
- reduced water run-off
- higher water use compared with low fertility sites

Most soils readily 'fix' applied phosphorus, where it remains in the top few centimetres of soil. Research into phosphorus run-off at the Hamilton Long-term Phosphate Experiment has shown losses of applied phosphorus to be, at most, 0.3% - even at high application rates (more than 20 kg P/ha every year for 20 years). However, even small amounts of phosphorus can contribute to environmental problems in waterways, impact on flora and fauna habitat and ultimately affect the marine environment.

Best practice fertiliser application can minimise nutrient loss and reduce any impact on the environment.

Research into the effects of phosphorus is continuing at several sites around Victoria, with the aim of lifting productivity and minimising environmental impacts.

Current best practices for phosphorus fertiliser application are:

- Avoid applying fertiliser when ground cover is less than 70%, or land is over-grazed, or affected by drought or flood.
- Prevent fertiliser entering waterways and water storages during application.
- Do not apply fertiliser if heavy rain is forecast within four days.
- Avoid applying fertiliser to waterlogged soils or soils likely to flood soon after application.
- Locate fertiliser storage areas away from potential run-off areas.

Best practice in applying phosphorus fertiliser can minimise nutrient loss and reduce any impact on the environment

Phosphorus fertiliser is best applied in autumn to paddocks with at least 70% ground cover

Further reading

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