Fact sheet

Phosphorus – the facts

Most New Zealand soils are naturally deficient in phosphorus (P). On farmland, high production of animal and horticultural products exacerbates deficiencies if the phosphorus removed is not replaced. Therefore, the use of phosphorus-based fertilisers is vital for the success of New Zealand agriculture.

Phosphorus and plants

Phosphorus is essential for storing energy and for specific metabolic functions during the early stages of plant and root growth. Therefore, plants need a steady supply of phosphorus during germination and root growth, tillering, seed and fruit setting, and ripening. Starter fertiliser is frequently applied when crops are sown to ensure a sufficient amount of phosphorus is available to the seedling. Different plants have differing requirements for phosphorus. Legumes, such as clover, require higher amounts than grasses.

Signs of deficiency

Plants with phosphorus deficiency will have:

- Poor seedling and root development
- Stunted top growth
- Spindly stalks
- Delayed maturity
- Low fruit production

Clovers will have poor nodule formation.

Signs of deficiency are usually seen on older leaves first. If severe, the stem and leaves will show reddish-purple discolouring. Other factors, such as cold stress, can have similar effects, so a diagnosis should never be attempted based on visual appearance alone.

Phosphorus deficiency in animals

Animals generally don't show obvious signs of phosphorus deficiency. However, when under physiological stress, e.g. after calving, animals that are deficient in phosphorus may show signs of:

- Reduced fertility
- Reduced weight gain (important for meat production)
- Reduced milk production (in dairy cows)
- Reduced mobility (dairy cows can go down with similar symptoms to milk fever)

Phosphorus loss

It is estimated that 80-90% of phosphorus applied to land is eventually used by plants. This means that the combined long-term losses of phosphorus are 10-20%. Phosphorus is added to the system through fertiliser, excreta and by the decay of plant material. It is lost primarily by run-off and less-so by leaching.

Phosphorus run-off

The major mechanism by which phosphorus is lost is by entering waterways, either dissolved in run-off water or bound to soil particles, e.g. by erosion (particulate-associated P - PAP). Increasing phosphorus levels in soil by applying phosphorus fertiliser increases the amount and concentration of both dissolved phosphorus and PAP.

Phosphorus leaching

In most soils, phosphorus reacts with certain minerals that prevent it from being lost by leaching. Phosphorus can irreversibly bind to some minerals, e.g. aluminium, iron and calcium. (This is different to phosphorus fixation, which is reversible.)

In soil types that lack these minerals in the upper layers, phosphorus can move down the soil profile and leach into groundwater. Sands and podzols have the greatest tendency to leach phosphorus.

Soil tests

In New Zealand, soil phosphorus levels are usually measured with the Olsen P test. Other tests, e.g. the Truog, Bray and Resin P, have not been calibrated for New Zealand soils to the same extent as the Olsen P. Therefore, the Olsen P shows the best relationship between test results and plant growth in New Zealand soils.

One exception is when testing land that has been fertilised with reactive phosphate rock (RPR). The Olsen P test can not detect RPR residues, even though these will provide phosphorus for plants. One way to account for this is to multiply the Olsen P test result by 1.5 to 1.7; i.e. if the Olsen P result is 20, then for a soil fertilised with RPR, this is equivalent to an Olsen P between 30 and 34.

Alternatively, the Resin P test can be used. However, this has not been calibrated over a wide range of soils, so can be difficult to interpret in many situations.

The depth that soil samples are taken from varies depending on the crop: recommendations are 75 mm for pasture and 150 mm for crops such as brassicas, wheat and maize.

	Inputs of P to increase Olsen P by one unit (kg/ha)	
Soil group	**Average**	**Range**
Ash	11	7-8
Pumice	7	4-15
Sedimentary	5	4-7
Peat	-	6-9

Table 1: Amount of phosphorus needed to raise the Olsen P by one unit in different soil groups

Herbage tests

Herbage tests are mainly used to check animal intake of phosphorus, rather than to diagnose soil deficiency. They can also be used to test crops with a suspected phosphorus deficiency.

For most field and horticultural crops, samples should be specific tissues of a specific age: it is important to sample the correct part of the plant. Pasture samples may be mixed herbage, clover only or grass only. Legumes are more sensitive to nutrient stress than grasses, therefore, a clover-only sample should be used when looking for a plant deficiency in pasture. When testing the nutritive value of the plant to animals, the sample should be from the plant material that the animal consumes, i.e. a mixed herbage sample if testing pasture.

Phosphorus fertilisers

Fertilisers are the only significant source of additional phosphorus for New Zealand farms.

Efficient use of phosphorus fertiliser is important because:

- Phosphorus is the most costly of all the fertiliser nutrients, so its use has the greatest impact on farm economics
- Phosphorus losses from the farm system can affect the environment
- Phosphorus fertilisers provide either rapidly soluble or slowly soluble phosphate. It is important to use the right product for the right job.

Soluble phosphate:

- Best used in situations where a rapid supply of phosphorus is required, e.g. for establishing crops, to correct a deficiency, or to raise soil fertility
- Shouldn't be used if there is a high risk of run-off to the environment
- e.g. Superten, di-ammonium phosphate (DAP), Cropzeal Boron Boost, Sulphurgain, Triple Superphosphate

Slow-release phosphate:

- Best used to maintain soil fertility or when there is a high risk of run-off to the environment
- e.g. SurePhos, Serpentine Super, dicalcic phosphate or reactive phosphate rock (RPR)

Direct animal supplementation

Animals may need to be supplemented when they are being fed crops that are naturally low in phosphorus, e.g. fodder beet. This can be achieved by dusting the crop with feed-grade dicalcium phosphate or by using molasses blocks that are fortified with phosphate.

Animal health

If animals ingest phosphate fertiliser they can develop health issues, such as fluorosis. This is not caused by the phosphate, but by the fluoride in the fertiliser. To avoid this, grazing should not occur for 3 weeks after application or until 25 mm of rain has fallen (to wash the fertiliser particles onto the soil).

Environmental issues

As most soils can store phosphorus, there is low risk of losses affecting the environment. Phosphorus fertiliser should not be applied to waterways, water-logged soil or when heavy rain is expected. Apply after winter to minimise losses from run-off. It is only necessary to use split dressings if application rates are higher than 100 kg P/ha.

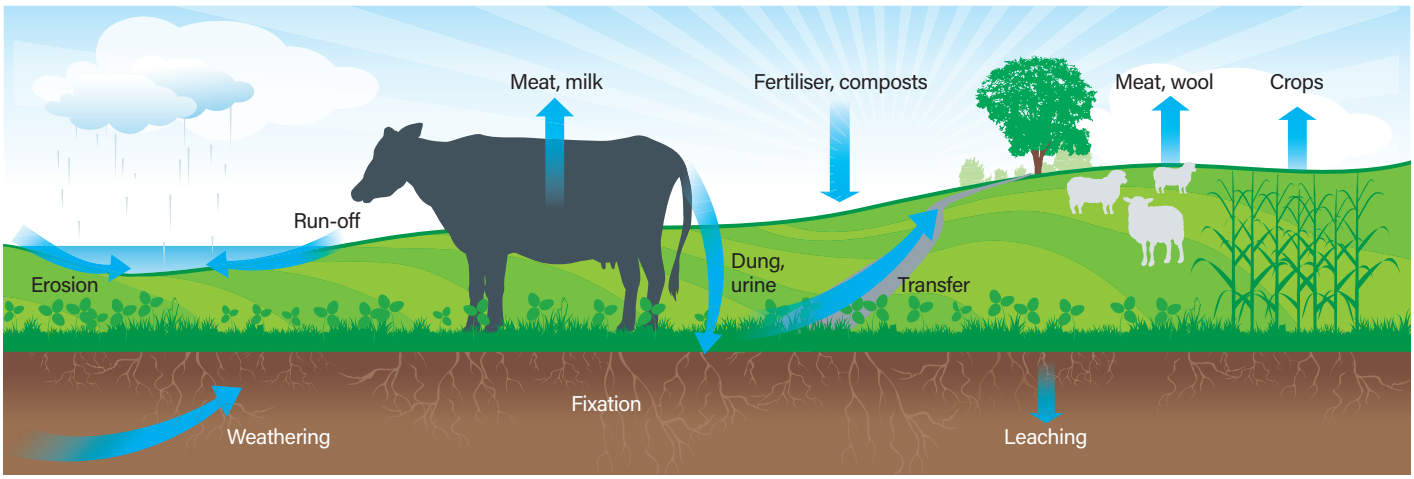

Figure 1: The major features of the phosphorus cycle on a pastoral farm