

## **Phosphorus and potassium in organic systems: Getting the best from your soils**

### **Introduction**

One of the guiding principles of organic farming is that fertility should be built up through biological cycles. In practice this usually means using legumes as part of crop rotation, supplemented by applications of animal manures, green manures and composts. It is relatively easy to building up sufficient nitrogen (N) through these methods. However, it is much more difficult with respect to phosphorus (P) and potassium (K) and many farmers have to use permitted fertilisers to stay productive. This is not ideal from point of view of the organic principles and, more pragmatically, reserves are becoming depleted. Estimates of global P reserves vary between 30 and 90 years at current levels of usage, but the price hikes as supply becomes increasingly restricted are likely to make their use in agriculture uneconomic before this time.

This factsheet aims to:

- Identity sources P and K in the soil
- Discuss how more of the nutrient reserves could be made available to crops
- Optimise the use of P and K bearing fertilisers.

### **P and K in the soil**

There are large amounts of both nutrients present in most soils (500-2500kg/ha of P and 1000-75,000kg/ha of K), which occur:

- as soil minerals (e.g. adsorbed on to clay minerals);
- in organic matter (soil organic matter, animal and green manures etc);
- in inputs such as permitted P and K bearing fertilisers;
- in solution.

The vast majority of reserves are insoluble. Only the labile (readily dissolved) nutrients and those in solution are considered to be available to the crop and together they account for only a tiny fraction of the whole. Figures 1 and 2 summarise the cycles of P and K in soils.

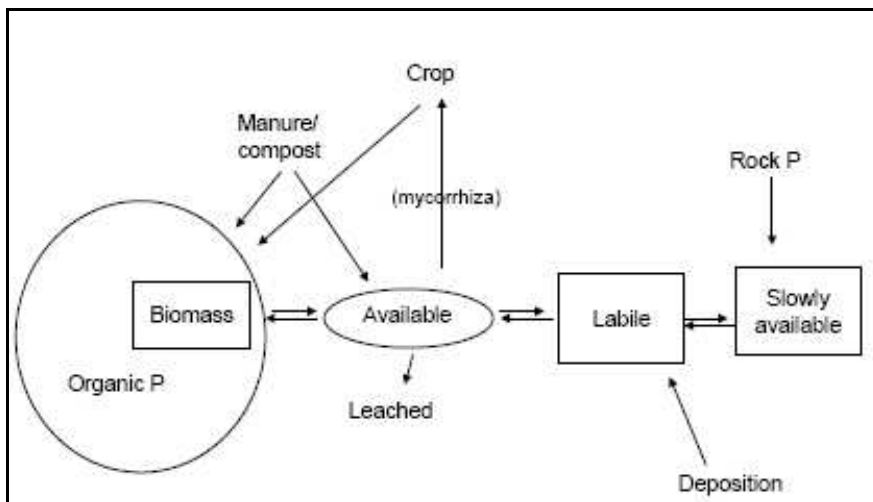


Figure 1: Phosphorus cycle in the soil

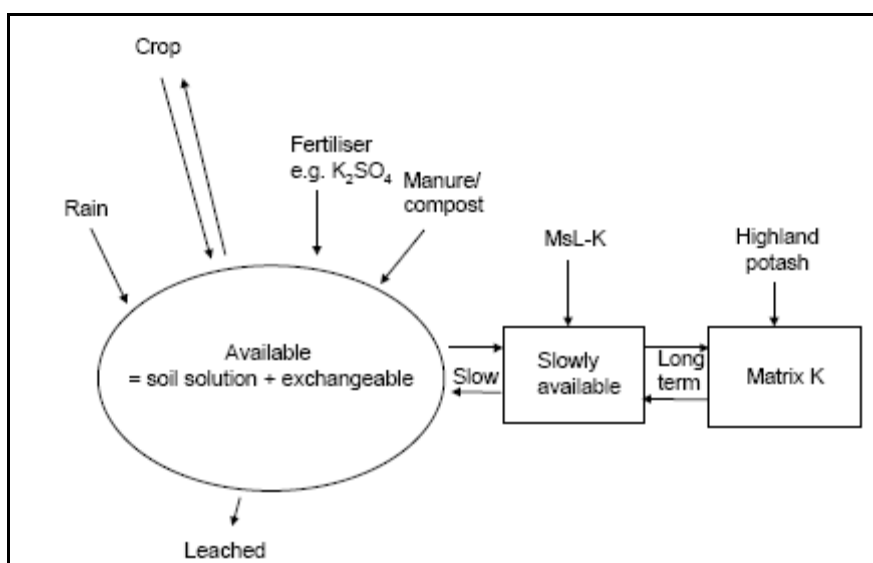


Figure 2: Potassium cycle in the soil<sup>1</sup>

Source: Stockdale, E (2001) *Optimisation of P and K management in organic farming systems.* (DEFRA)

### Increasing availability

In order to make more of the P and K in the soil you need to manage your soils and your farming system in ways that encourage the soil to release more P and K into the soluble and labile fractions. These are some of the things you can do:

#### **Promote biological activity**

Good biological activity is the cornerstone of a fertile soil and we rely on soil microbes, in particular, to make the nutrients locked up in organic matter available to the plant. Plants also form mycorrhizal associations which help them to scavenge P. It is these associations that enable a leek, for example, which has very few roots to access enough P to thrive. Most of the points below are effective because they enable soil life to thrive.

#### **Pay close attention to soil structure**

A well structured, open soil is vital to sustaining good soil life. It allows the air (and therefore the oxygen) to get into the soil and to circulate freely. It also helps with drainage, thereby ensuring optimal moisture levels.

<sup>1</sup> K tends to be in solution and depletion by root uptake encourages a higher rate of rock weathering and organic matter breakdown.

## Get the pH right

pH has a big influence on the availability of nutrients as indicated in Figure 3. K availability is optimal between pH 6 and 8. P release, particularly from rock phosphate, is better at lower pH (about 5.5), hence the need to split liming and P applications. Since different nutrients have different optimums, and because different crops have different requirements, it is difficult say exactly what the 'correct' pH is for a specific soil or situation, but between 6 and 7 is widely regarded as the 'happy medium'.

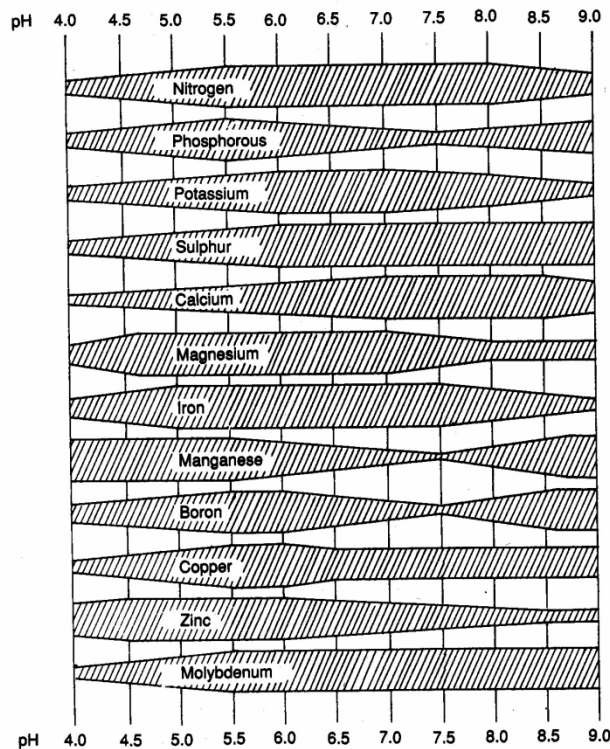


Figure 3: Influence of pH on the availability of key nutrients

Source: Potash Development Association

## Make good use of animal manures and composts

These are very important, not only because they are sources of supplementary sources of P and K, but also because they are an important food source for soil life. A technical guide *Managing Manure on Organic Farms* is available from OCW, and provides guidance on best practice. K is particularly prone to losses from manures, so take particular care when storing and handling them.

## Use green manures and balanced crop rotations

Green manures and the type and length of rotations can make a significant contribution to increasing nutrient availability. This is particularly important for P. The physical properties of the soil and the soil chemistry are the primary influences on the release and fixation of K, but biological factors still play an important role.

Far from being passive straws, roots interact with the soil in a very complex ways. For example, they release enzymes that break down organic matter directly, releasing nutrients including P and K. At the same time they excrete other plant chemicals which reduce the pH in the root zone, and solubilize inorganic P.

Green manures also contribute indirectly. Their large root systems support large populations of microbes, which in turn increase the release of P and K from organic matter. Crops with particularly deep rooting systems, such as chicory, can mine P and K from the deeper in the soil profile. The nutrients are then returned to the top soil. In stockless systems this could be by cutting and mulching. In mixed or livestock systems, they can also be grazed and the manure returned to the soil.

## Efficient use of soil inputs

Mineral fertilisers should be used as supplements to, rather than replacements for the approaches described above. These fertilisers are slow release and based on natural forms (Table 1). In most cases you will be required to justify their use to your control (certification) body, so always check with them before you use any

fertility input. Because of the slow release nature of these products, you should aim to apply them at least one year prior to growing the target crop.

	Source	Notes/comments
P	Natural rock phosphate	Cadmium content must be less than 90mg/kg P <sub>2</sub> O <sub>5</sub>
	Calcined aluminium phosphate rock	Only where the soil pH is greater than 7.5.

K	Wood ash, only when added to composts and manure	Relatively low immediate solubility in water and low chlorine content
	Plant extracts, such as	E.g. Kali Vinasse (by-product from sugar beet molasses industry)
	Natural rock potash	
	Potassium salts	E.g. sylvinite and kainite
	Sulphate of potash	Restricted and only used to treat severe deficiencies.

### Monitoring

Keeping a close eye on your soils and nutrients is an important aspect of managing P and K.

*Soil analysis* gives a 'snapshot' of available nutrients on which to base input and cropping decisions in the short and medium term. Standard soil tests assess pH (lime), phosphate (P), potash (K) and magnesium (Mg). However soil analysis only gives you part of the picture. Soil biology, structure and moisture levels, which are not picked up by analysis, are just as important. You should get in the habit of regularly going out and digging holes to monitor the physical and biological aspects of soil health.

*Farm-gate nutrient budgets* are useful for designing systems with minimal inputs. The 'budget' is simply the balance of inputs and outputs of any nutrient (usually N, P or K) from the whole farm. It gives an indication as to whether nutrients are likely to become deficient, or if excessive amounts have been applied. It does not, however, give information about the distribution of nutrients *within* the farm and is not a substitute for soil analysis. You can 'benchmark' your nutrient budget annually against itself, or against other farms of similar type, as a guide to how efficiently nutrients are used.

### Further information

Title	Description	Author
GDC Factsheets	Series of factsheets including: soil analysis; green manures and clover; recognising and solving soil physical problems	Grassland Development Centre, IBERS
Effect of compost on nutrients, soil health and crop production	Advisory leaflet	Institute of Organic Training and Advice
Managing manure on organic farms	Technical guide	ADAS & Organic Centre Wales
Soil fertility building crops in organic farming	Advisory leaflet	DEFRA

Copies available from OCW, or downloadable from:

[www.organiccentrewales.org.uk/producer-support-soils.php](http://www.organiccentrewales.org.uk/producer-support-soils.php) or [www.grassdevcentre.co.uk](http://www.grassdevcentre.co.uk)