European Commission

Science for Environment Policy

Target the crop not the soil - to reduce fertiliser use

'Feed the crop not the soil' is the message of a new review into sustainable phosphorus use. Currently, phosphorus fertiliser is applied to the soil, and plants then take it up through the roots. However, more precise nutrient management is needed on farms, the researchers say, so that the phosphorus is targeted at the crop just as it needs it.

Modern agriculture is dependent on phosphorus, which is mined and extracted to produce fertilisers, animal dietary supplements and food additives. Plant growth and yield levels depend on the availability of phosphorus but this is not always used efficiently and can result in excessive soil enrichment and losses into the environment, leading to eutrophication. Additionally, the gradual depletion of mineral phosphorus reserves threatens future food security. Furthermore, there are some recent reports that consumption of too much phosphorus in food could damage human health.

Currently, farmers 'feed the soil to feed the crop' – fertilisers are applied to the soil and plants then take up phosphorus through the roots. However, a large proportion of phosphorus is immobilised in the soil by chemical and biological processes, making it difficult for plants to access. Moreover, crop roots occupy a relatively small volume of soil and can only take up a small amount of the total fertiliser applied.

The researchers also highlight the fact that standard tests to measure soil phosphorus do not take into account 'legacy' phosphorus that has accumulated in soils from past fertiliser and manure application. These tests estimate the immediately available phosphorus (i.e. that can flow freely from the soil and is easily taken up by plants) but this is only a very small proportion of the total phosphorus reserve potentially available.

A more sustainable way to manage phosphorus, say the authors of this study, is to target the crop, not the soil. They propose a number of changes to use phosphorus more efficiently, so that high yields can still be achieved but with less impact on the environment.

1) *Reducing crop demand for phosphorus*. Plants can store surplus phosphorus in their tissues. Breeding crops that store less phosphorus could be one solution, as long as this does not seriously compromise crop yield or quality.
2) *Use 'legacy' phosphorus reserves in soil*. Previous research suggests that legacy stores of phosphorus will be released when soil phosphorus levels fall below the level typically recommended for optimal crop growth. Plants can also increase their root growth or exude acids to release the stored phosphorus. In addition, crops could be bred and microbial populations manipulated to exploit legacy phosphorus in the soil.
3) *Use recycled and recovered phosphorus*. In addition to recycling livestock manures, phosphorus can be recovered from municipal wastewaters and biowastes, including composts and sludge incineration ash. Where their use will not contaminate the food chain, they can be recycled and used as fertilisers.
4) *Increase efficiency of applied phosphorus fertiliser*. Fertilisers can be modified to reduce their immobilisation in the soil. Targeted application of fertilisers, for example to the roots, as a seed dressing, or as foliage feed, should provide improved efficiency.

Combining these strategies will reduce reliance on mined phosphorus and the water contamination that has accompanied population growth, agricultural expansion and urbanisation in recent decades.

4 September 2014
Issue 384

Source: Withers, P.J.A., Sylvester-Bradley, R., Jones, D.L. *et al.* (2014). Feed the Crop Not the Soil: Rethinking Phosphorus Management in the Food Chain. *Environmental Science and Technology* 48, 6523-6530. DOI:10.1021/es501670j

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