PDA NEWS

January 2025

Introduction

According to Defra figures the national balance for phosphate in England has been declining over the last few decades and is now only about 5% of the 230 kt surplus from 1990. Whilst a net balance between nutrient inputs and outputs may be seen as ideal, this now marginal surplus is an average for the country and does not give the true picture at an individual level. Farm level balances are a better indication for each business and whilst some, particularly those with livestock, are likely to find themselves still in a positive balance, this would suggest there are plenty of other businesses which are now in a deficit position.

Whilst the published trend is for phosphate (all inputs and outputs), it is likely to be similar for potash.

Any negative balance will deplete soil reserves and if not corrected will result in potential yield and financial penalties down the line.

This latest newsletter looks at the familiar, yet often overlooked subject of crop offtakes, specifically focussing on some demonstration work carried out by the PDA on grass silage and the subsequent impact on soil nutrient levels.

Implications of crop offtakes

Despite UK soils usually containing large total quantities of phosphorus and potash, most of this will be unavailable in the short to medium term. Just because the diagram illustrating soil 'pools' (figure 1) shows an arrow depicting movement from the slowly available pool to the readily available pool does not mean that the 'cupboard will restock itself' each year. Indeed complete restocking is extremely rare, although certain clay soils can release useful quantities of potassium from pools not measured by soil analysis.

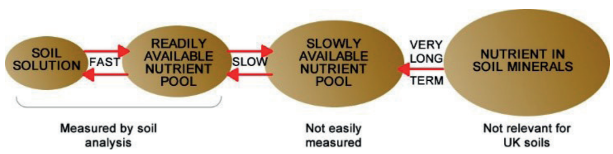

Figure 1. Nutrient reserves in soil

Long term trends in nutrient use

Whether an overreliance on soil buffering is behind the recent evidence showing a continued decline in P&K fertiliser use, or as is probably more likely, it is purely down to economics, either way it is a concerning trend.

Data from the British Survey of Fertiliser Practice show significant reductions in major nutrient use in Great Britain over the past forty years. The overall rate of fertiliser phosphate has decreased by around 67% and that of fertiliser potash by around 55%. Rates of phosphate and potash application have remained greater in Scotland than in England and Wales:

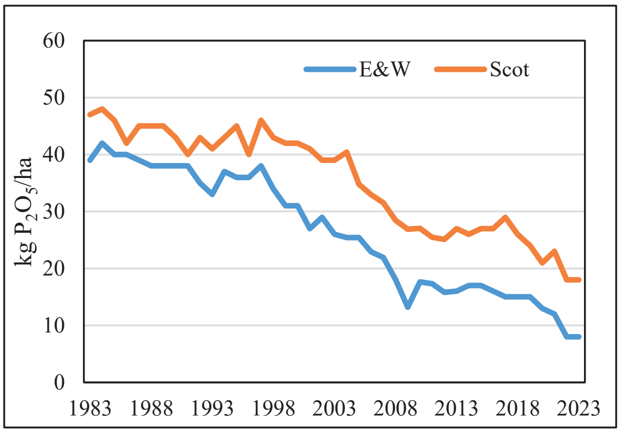

Figure 2a.
Total fertiliser P_2O_5 use on crops and grass
(Source: BSFP)

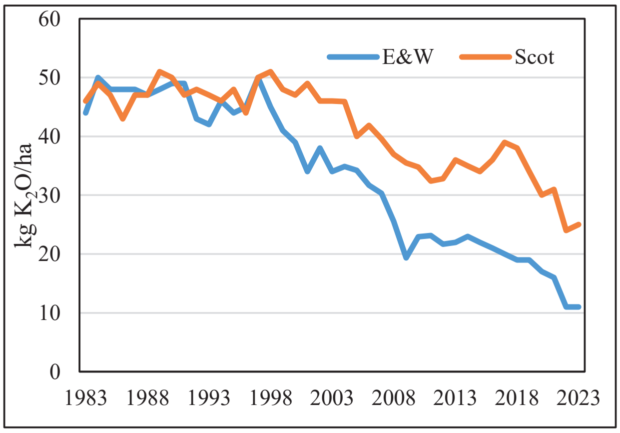

Figure 2b.
Total fertiliser K_2O use on crops and grass
(Source: BSFP)

Although this data does not include organic manure use, this would clearly not make up the difference between what is removed and what is required as a large proportion of soils are continuing to fall into suboptimal levels of phosphate and potash. The latest data provided by NRM shows that around a quarter of all arable soils are below the target level for P, K and Mg, whilst the situation is even worse for grassland soils at 36-42%.

The argument for the economics regarding phosphate and potash applications can be more difficult than for nitrogen, as no direct yield response is likely if soils are at the target index level. However, that doesn't mean to say there is no economic link. Optimal yields are only likely to be achievable where soils contain sufficient phosphorus and potassium in a readily available form so that they are able to release enough of these nutrients into the soil solution on a daily basis to satisfy crop uptake requirements. Nitrogen is also likely to be used less efficiently where potash levels are suboptimal, reducing the returns from this valuable input and increasing the potential for negative environmental effects.

PDA Grass Potash Demonstration Trials

To demonstrate the impact of removals on soil levels, alongside yield and herbage content, the PDA carried out a multi-year demonstration trial on grass silage in the early 1990's at the National Agricultural Centre, Stoneleigh. The same treatments were used on the same plots for each of the 4 years. Three cuts were taken each year and crops were weighed and analysed. Soil was sampled in the autumn before the first harvest year and in each autumn of the comparison.

The soil was a light sandy loam with an available soil K level of 93 mg/l (index 1) at the start of the work. This K status is typical of over one third of soils in the UK.

Treatments

Three potash treatments were applied to the same plots each year:

K0	K1	K2
0 kgK_2O/ha	160 kgK_2O/ha	320 kgK_2O/ha

Visual differences

No visual differences were apparent in the first year at any of the cuts. In the second year (yields were 30% higher for the K1 and K2 plots) some slight differences were visible because the crops were in adjacent plots. However, in a field situation and without the comparative treatments alongside, it is unlikely that the lower yielding K0 treatment would have aroused concern. For the last 2 years the nil potash plot was clearly evident with patchy irregular growth with yellowing of leaf tips and early death of older leaves particularly in the dry conditions of those years.

Soil analysis

Large quantities of potash are removed in silage and after 3 cuts in the first year, levels of available soil K were reduced on all plots with the greatest reduction where no potash fertiliser was applied. Whilst visually there were no problems at this stage the potential problem of lower yield had already been created. The K0 plot receiving no potash remained at seriously deficient levels. Although yields were highest on the K2 plot, the 320 kg/ha of potash applied each year appeared to be sufficient to maintain, or even slightly improve, soil fertility over the 4 years. The 160 kg K_2O/ha applied to the K1 plot did not fully maintain the initial level of soil K even though yield and K offtake was lower than that for K2.

Potassium in herbage

The potash limitation to yield was reflected in the %K content of the herbage. At the start of the study the K content of the first cut grass was around 3.5% for all plots. By second cut in the first season the poorer K supply in the K0 plot resulted in a marked drop in leaf K content which continued for all subsequent cuts in following years. The fluctuation of K content in the other two plots is typical of herbage samples but it is possible to conclude that in this study satisfactory yields were associated with a herbage K content of between 2.0-3.5%. These levels were not indicative of any luxury uptake.

N:K ratio in herbage

Other studies have indicated that N:K ratio is a more reliable measure for advisory purposes than %K content. In these comparisons, the herbage from the K2 plot which gave the highest yields had a ratio consistently around 1:1 (Figure 3).

The very poor yields of the K0 plot were associated with an N:K ratio of 1.5:1 and greater. With this nutrient imbalance, the utilisation of nitrogen was much reduced (the same level of fertiliser N was applied to all plots) and the risk of loss of nitrogen to the environment was therefore increased.

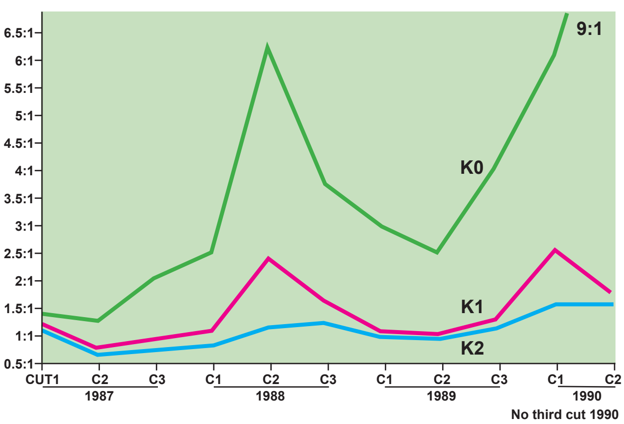

Figure 3. N:K ratio in grass

N:K partnership

Grass requires a balance of nitrogen and potash to obtain full response to applied nitrogen.

Careful optimisation of nitrogen is a waste of time and money if potash supplies are not adequate. As shown in Figure 4, both the level of yield and shape of response curve are radically altered by potash limitation. Application of potash alongside optimal nitrogen increased annual yield from 9 to 13 t/ha.

If potash supply is limiting, the uptake and utilisation of nitrogen will be restricted. If soluble forms of nitrogen remain in the soil and are not taken up there is increased risk of leaching giving environmental concern when through-drainage occurs. Ready availability of both nutrients helps the uptake of the large requirements of nitrogen and potassium necessary for full yield. During rapid vegetative growth, the large uptake of nitrogen as negatively charged nitrate ions (NO_3^-) is normally balanced by a similar uptake of positively charged potash ions (K^+) which maintains the electrical neutrality of the plant.

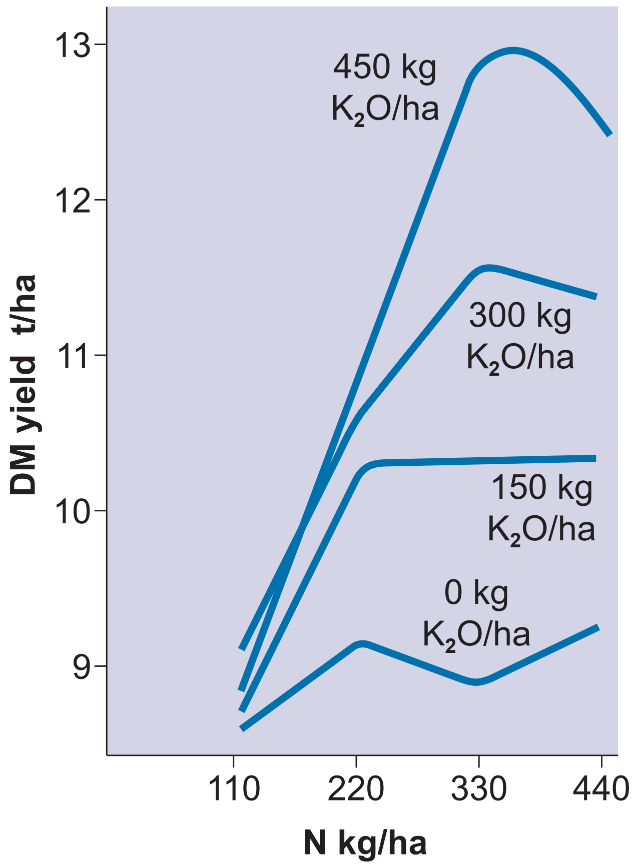

Figure 4. Grass nitrogen response at differing Potash application rates

Potash removal

The large quantities of potash removed with silage were well illustrated by these crops. Over the four seasons, the K2 plot produced around 250 t/ha of grass which removed a total of over **1250 kg/ha** of potash.

Conclusions

Large quantities of potash are removed where silage is taken. Over 320 kg K_2O/ha per year was needed in this comparison to maintain soil K reserves.

At soil K index 1 responses to fertiliser potash are well worthwhile. If soil fertility is allowed to fall, responses increase and in the fourth year of this work, yields of grass were doubled by potash application.

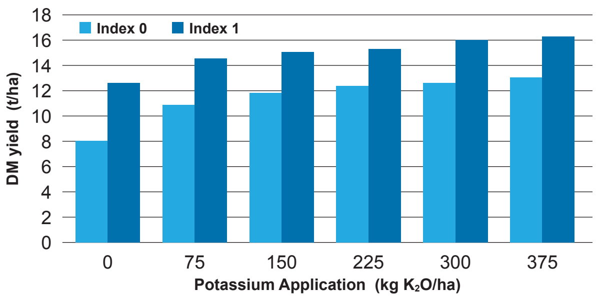

Figure 5. Silage yield response to potassium

Potash reserves in the soil are more effective at supplying the plant than fresh fertiliser applications. Impoverished soils often do not produce the same yields as fertile soils even if higher fertiliser rates are applied (Figure 5).

An adequate reserve of phosphate and potash to feed the crop should be maintained in the soil by using fertilisers and manures to replace what is removed by cutting or grazing. For soils with low reserves, extra fertiliser should be used to restore fertility to target levels. For soils with high reserves, fertiliser usage should be reduced or omitted.

Where potash supply is limiting, nitrogen response will be impaired with increased risk of N loss to the environment.

A ratio of 1:1 for N:K in herbage was associated with the highest yields. The quantities of nitrogen and potash removed in silage are therefore similar and need to be replaced in similar proportions depending upon soil K contribution.

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