# Live long and phosphor

A TEAGASC study examined the factors influencing phosphorus use efficiency on Irish agricultural catchment farms, how to get the most from it, and keep it from our water bodies.

Phosphorus (P), nitrogen (N) and potassium (K) are essential nutrients for plant growth and have been used by the agricultural sector to increase crop yields for many decades. P is a finite resource, and hence its efficient usage is important for sustainable food production and food security. However, excessive P applied to land can transfer to watercourses and lead to adverse water quality outcomes. Therefore, finding a balance between applying the correct amount of P to ensure optimum crop yield, encouraging efficient use of this finite reserve, and protecting the natural capital of waterbodies is a major challenge for land managers, researchers and policy makers.

The optimum use of P at farm level is determined by a range of factors including biophysical, farm management and socioeconomic characteristics (**Figure 1**). The focus of this study was to investigate the land management and socioeconomic factors that influence the movement towards optimum soil P on Agricultural Catchment Programme (ACP) farms. ACP farms in six catchment locations had their fields sampled and analysed according to agronomic standards for available P, soil test P (STP), between 2009 and 2011, and the same fields were sampled again three to four years later.

Optimum soil P fertility levels are based on a soil P index system. Soils are at an optimum P status if the soil test results fall into STP Index 3 (**Table 1**). For soils in STP Index 3 there is enough P available for crop and animal requirements, and the farmer will only need to replace the nutrients being removed in products (meat/milk/grain) to maintain ideal soil P levels. STP Index 1 and 2 soils indicate a very low and low P supply in the soil, and require additional P to increase the fertility levels of the soil and replace the P being removed in products. Index 4 soils have a high P supply and present an opportunity to save money on fertiliser inputs by utilising legacy P soil reserves.

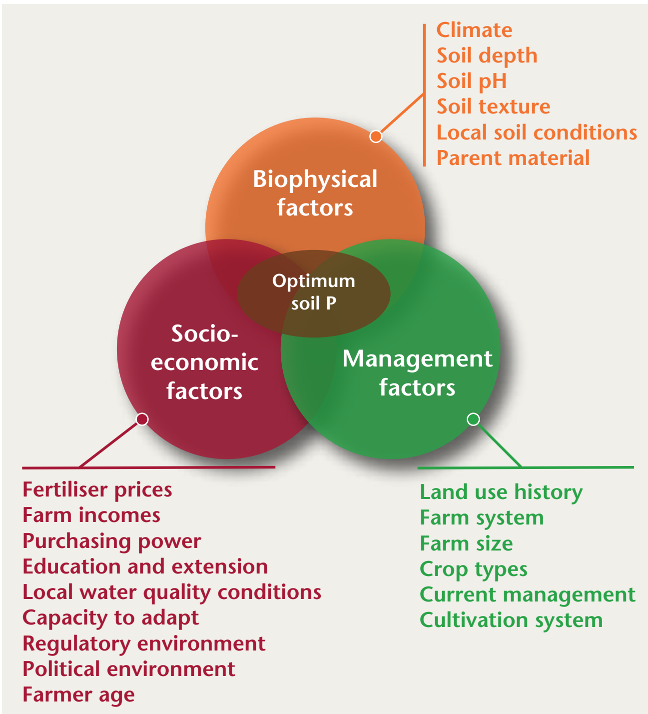


*FIGURE 1: Factors influencing the achievement of optimum soil P.*

**Table 1: P index system.**

| Soil P Index | Soil P ranges (mg/L Morgan's extractable P) | | |
|---|---|---|---|
| | Grassland | Other crops | Index description |
| 1 | 1.1-3.0 | 1.1-3.0 | Very low |
| 2 | 3.2-5.0 | 3.2-6.0 | Low |
| 3 | 5.1-8.0 | –10.0 | Optimum |
| 4 | > 8.0 | > 10.0 | High |

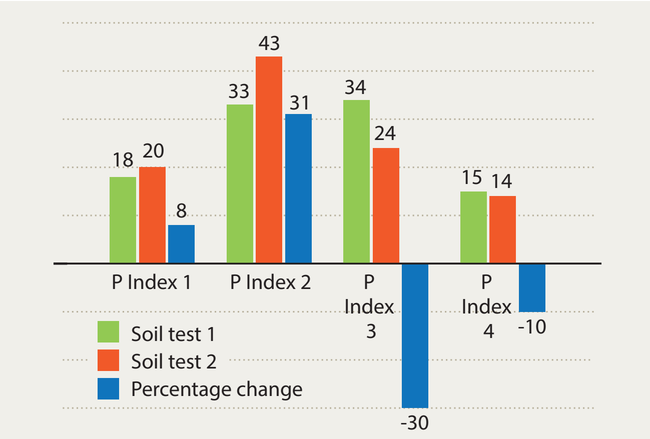


*FIGURE 2: The percentage of farms at P index levels in soil test 1 and soil test 2, and the percentage change between the two soil tests (N = 132).*

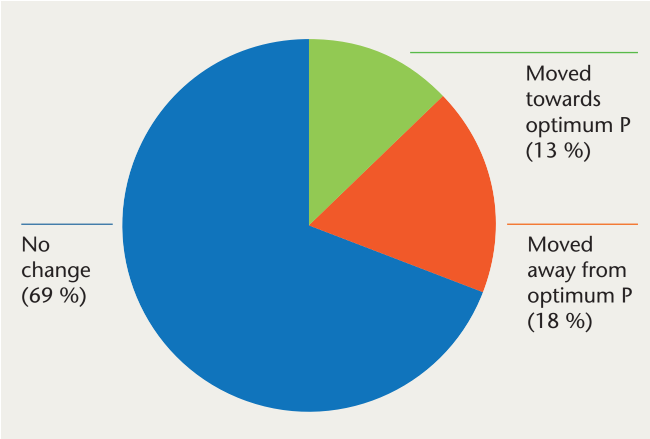


*FIGURE 3: The direction of the changes in soil P status.*

## Results

**Figure 2** represents the average farm soil P levels across the soil P index categories and the percentage changes between the first and second soil tests. The greatest percentage changes occurred between STP Index 2 and STP Index 3, with a drop of 31 % in optimum STP Index 3 levels and an increase of 30 % in STP Index 2. There was also a 10 % drop in the number of farms with STP Index 4 and a slight increase of 8 % in STP Index 1 farms. From an environmental risk perspective, this outcome tends to suggest a reduced risk of transfer to the aquatic environment; however, the decline in soil fertility levels may have agronomic productivity consequences.

**Figure 3** represents the direction of change in STP index levels. On 69 % of farms there was no change in soil P levels between the two soil test periods. Movement towards the optimum P level is defined as a movement in average farm soil P fertility levels towards Index 3. To increase soil P levels from Index 1 or Index 2 to Index 3 can be expensive, as it requires additional fertilisers (chemical or organic). Decreasing soil P levels from Index 4 is a cost saving, because the farmer can utilise legacy P reserves in the soil and reduce the amount of chemical fertiliser applied. Therefore, the costs associated with a positive movement in soil fertility P levels are different for these two groups of farmers. Overall, 13 % of farms moved towards optimum P Index 3 between the two soil test periods, while 18 % moved away from optimum P levels. The results of a regression analysis suggest that the factors in **Table 2** have a significant influence on the movement towards optimum P status: a plus sign indicates that these farms/farmers are more likely to move towards optimum P status; and, a negative sign indicates that these farms/farmers are less likely to move towards optimum P status.

**Table 2: Factors with a significant influence on P use efficiencies.**

| Variable | Direction of the influence |
|---|---|
| Specialist tillage farms | + |
| Farms at P Index 4 | + |
| Farmers who have a nutrient management plan | + |
| Farmers who have more advisory contact | + |
| Bigger farms | + |
| Farmers who work more hours off farm | - |
| Farms with higher stocking rates | - |

## Conclusions

Reaching and maintaining optimum P soil fertility levels is a complex and difficult task for farmers and depends on biophysical, farm management and socioeconomic factors. A significant finding of this study is that farms that were previously P Index 4, which is above the optimum level, were more likely to move towards optimum P Index 3 than farms at low index P levels. A reduction in high soil P levels is a positive outcome in terms of risk of nutrient transfer to watercourses and improved sustainability of production.

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