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Better Crops, Better Environment...through Science

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PHOSPHORUS LEGACY AND 4R NUTRIENT STEWARDSHIP

Phosphorus feeds the world. Take away the nutrient phosphorus from agricultural crop production, and how much of world food production would be lost? The answer depends on the length of time considered, and we have data from only a few long-term research trials. A 40-year study in Kansas found that without phosphorus inputs, yields were lower by 27% for corn and by 10% for grain sorghum. At Rothamsted in England, wheat without phosphorus for 25 years yielded 44% less. In many tropical soils, crop yields are even more strongly dependent on it. Phosphorus contributes a lot to global food security. 4R Nutrient Stewardship manages its legacy to reduce harm from the little that's lost.

Definitions of phosphorus legacy vary. But they usually include any human influence on phosphorus stored or its pathways of transfer. The practice of agriculture typically builds up a store of phosphorus in soil through application of fertilizers and manures. But it can also deplete those stores when crop removal is not replenished. Legacy can include accumulations in stream banks and sediments, built up from human-induced soil erosion. Some authors include the modification of stream flows and installation of tile drains that expedite the transfer of phosphorus from field to stream.

Phosphorus legacy in cropland is reflected in the soil test. Soil test summaries have been conducted over time by the International Plant Nutrition Institute and its predecessors. They reveal that across North America, the fraction of soils testing below critical for phosphorus decreased from about 60% in the 1960s to a low of 40% in 2005, but has increased to 44% over the past ten years. In key states of the Corn Belt, the depletion trend continues from the mid-1980s.

The 56% of soils currently above critical represent two levels of legacy. Many of these soils are at optimum levels, levels at which losses to the environment do not much exceed those coming from lower P soils. But a considerable proportion is also built up well beyond the range of crop need. The legacy in the latter is a chronic risk to water quality, and sustainable nutrient stewardship calls for drawing it down. While it is difficult to define the precise soil test level that separates “too much” from “optimum” legacy, the tools of precision agriculture should equip growers to maintain soil test levels just a little above critical. Variable rate technology—applying the “right rate” of phosphorus in the “right place” to match soil and crop need—enables the management of legacy to desirable levels.

Most soils retain most of any phosphorus applied. The little that leaks, however, can harm the environment. Acute risks of losses accompanying application of fertilizers or manures can be controlled through “right time” and “right place.” Timing applications to avoid periods when risks of runoff are high, and placing them into instead of on top of the soil can make large differences on the amount of phosphorus delivered to the edge of the field. Conservation practices that control soil erosion are also important in controlling losses of particulate forms of the legacy.

Phosphorus use efficiency is important, but requires careful interpretation. Many organizations promoting conservation and ecological integrity focus on efficiency, for good reasons. Excess nutrients harm the environment and waste resources, so efficient use is desirable. But it’s important to focus on the right kind of efficiency. At optimum soil test levels, short term recovery of phosphorus is low, but its ratio of output to input can often be close to 1, with replenishment equaling removal. At lower soil test levels, optimum yields depend on adding more than crops remove. And at higher soil test levels, the output-input ratio can and should be greater than 1. The interpretation of use efficiency of phosphorus, therefore, depends on its soil test.

The phosphorus legacy reflected in an optimum soil test is beneficial. A soil test in the optimum range indicates ability to deliver an optimum concentration of soluble phosphorus to crop roots. Managing phosphorus using 4R Nutrient Stewardship conserves resources, limits losses, and optimizes crop yields.

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