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EFFECTIVE NUTRIENT USE EFFICIENCY IMPROVEMENT

The world's population growth is projected to continue increasing demand for food, fiber, and fuel. Fertilizer nutrients have helped spare millions of acres of land while sustaining crop production increases to meet the demand. Efficiency improvement is key, therefore, for cropping systems as a whole, and for nutrient use within them. Effective nutrient use improves both, minimizing risks of losses that potentially harm air and water quality.

Efficiencies are calculated as ratios of inputs to outputs in a system. A recent scientific review identified 18 different forms of nutrient use efficiency. Four of them are very commonly used, but are often misinterpreted.

- 1) **Partial factor productivity** (crop yield per unit of nutrient applied) answers the question: "How productive is this cropping system in comparison to its nutrient input?"
- 2) **Agronomic efficiency** (yield increase per unit of nutrient applied) answers a more direct question: "How much productivity improvement was gained by the use of this nutrient?"
- 3) **Partial nutrient budget** (nutrient in harvested crop per unit of nutrient applied) answers the question: "How much nutrient is taken out of the system in relation to the amount put in?"
- 4) **Recovery efficiency** (increase in above-ground crop uptake per unit of nutrient applied) answers the question: "How much of the nutrient applied did the plant take up?"

In the short term, all four of these ratios increase as rates of fertilizer application are decreased, even to levels well below the economic optimum. This might cause one to falsely conclude that the lowest fertilizer rate results in the most efficient cropping system. This is untrue.

Cropping systems depend on multiple inputs, including land, labor, seed, plant protection, capital, and more. At the rate where the net return to the use of a plant nutrient peaks, it is making its best contribution to increasing the efficiency of all other inputs involved. This most economic rate is also often associated with minimal nutrient loss.

Best management practices ensure effective use of fertilizers in improving the efficiency of all inputs used in cropping systems. The goal of their use is to apply the most appropriate sources at the right rate, time, and place. Opportunities abound for improving nutrient use efficiency effectively:

- Genetics and management practices assuring maximum economic yields.
- Enhanced-efficiency fertilizer products using controlled-release technologies.
- Precision agriculture technologies to sense crop needs and improve application.
- Increased use of on-farm measures evaluating nutrient use efficiency.
- Decision support tools applying science at the farm level.

Yield improvement has increased partial factor productivity for N use on U.S. corn by 50% in the past 30 years. A partial nutrient balance reveals, however, that removal is less than 80% of the amount applied. For non-legume crops in general the figure is 64%. Room for further improvement exists.

Nutrient use efficiency improvements must always be evaluated in terms of their effectiveness in supporting cropping systems with both increasing yields and diminishing nutrient losses.

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Abbreviations in this article: N = nitrogen.

Note: *Plant Nutrition TODAY* articles are available online at the IPNI website: www.ipni.net/pnt