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## EVALUATING IMPACTS OF 4R NUTRIENT STEWARDSHIP

**Impacts of nutrient stewardship reach far and extend broadly.** Nutrients are essential for plant and animal agriculture and comprise a large portion of its outputs. But the starting point for assuring beneficial impacts is the adaptive management built into 4R Nutrient Stewardship.

**To manage adaptively means to evaluate impacts in your decision cycle.** The metrics you evaluate need to reflect impacts important to your local farming system. Three key outcome metrics are farmland productivity, soil health, and nutrient use efficiency. The three directly relate to nutrient stewardship practices, complement each other well, and connect to the farther-reaching impacts of crop nutrition. Applying the right source of nutrients at the right rate, time and place boosts a cropping system's productivity while maintaining soil health and optimizing nutrient use efficiency.

**Fertilizer inputs make cropping systems more productive.** They increase yields, and can also increase the nutrient density of crops. Of course, many other crop management factors also influence yield and quality. The same can be said for the health of soils. Soil health depends on maintaining nutrient reserves, as well as practicing soil conservation. Nutrient use efficiency, in the same manner, is influenced by applying the right source of nutrients at the right rate, time and place...but can be influenced just as much by any management factor affecting yield, and by the health of the soil.

**Considering the three key metrics together helps the manager seek sustainable synergies.** Overemphasis on nutrient use efficiency can lead to nutrient-depleted soils and foregone productivity. Overemphasis on productivity can lead to poor nutrient use efficiency. But when source, rate, time and place decisions are evaluated by all three metrics, the combinations that produce the most sustainable results are favored for adoption.

**What are the farther-reaching impacts of crop nutrition?** These include water quality, air quality, and carbon footprint. Negative impacts in these three areas arise from nutrient losses, and thus tend to diminish with increases in nutrient use efficiency. But sometimes, choices of source, timing and placement can have larger direct impacts on these end points than on nutrient use efficiency alone. A good example is placing phosphorus (P) in the soil within conservation tillage systems: it reduces loss of dissolved P by a lot more than its impact on crop nutrient uptake.

**Going yet further, impacts extend to food and nutrition security, biodiversity, and economic value.** Crop nutrition can be managed for positive social benefits in these three areas. Producing more food, and more nutritious food, contributes toward ensuring all are properly nourished. Producing higher yields enables society to spare land for nature. Producing with better practices and with better documentation enhances economic value, providing employment and economic benefit well beyond the farm gate. These extended benefits depend on many more management factors beyond the 4Rs, but the 4Rs make a real and essential contribution.

**Crop producers, crop advisers, and agricultural input retailers already engage in adaptive management.** We all play a role in communicating to society the broad and far-reaching benefits of continuously seeking the right source, rate, time and place of nutrient application. By better documenting the decision cycle, our current and past practices, and their relation to impacts, the industry has the opportunity to build public trust.

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