



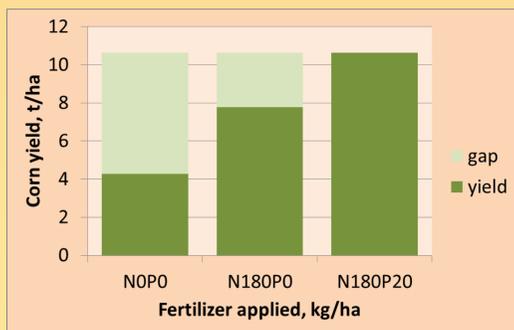
ABSTRACT

Over the past century, the use of phosphorus fertilizer has contributed substantially to productivity increases on agricultural cropland. This contribution has not been uniform globally or within regions, but has ranged from rapid accumulations of surpluses in excess of crop need to depletions limiting crop yield. The industry's 4R Nutrient Stewardship concept, while focusing on application of the right source at the right rate at the right time and in the right place, includes a full systems approach to sustainability improvement, assessing management choices through key performance indicators related to impacts on productivity, soil fertility, nutrient use efficiency, and water quality.

LEGACY – BENEFITS AND CHALLENGES

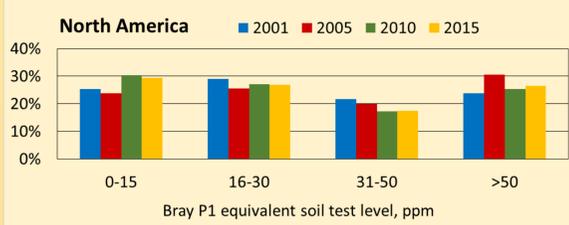
- Yield contribution
- Soil fertility improvement and surplus
- Nutrient use efficiency
- Water quality impacts

Long-term, more than one quarter of crop yield is attributed to P



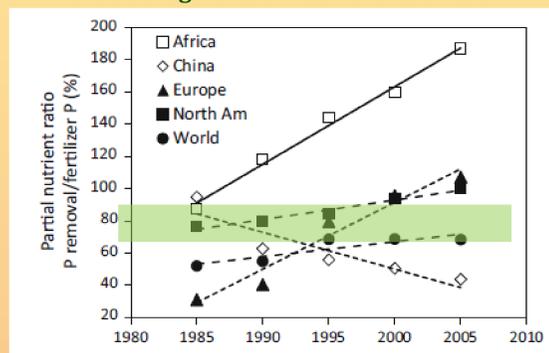
Long-term contribution of P to yield of irrigated corn in Kansas – 40-year average, 1961-2000 (Stewart et al., 2005, Agron. J. 97:1–6)

Soil test P remains below, at and above optimum



<http://soiltest.ipni.net/>

Global cropland PUE of ~70% is the average of too much and too little



Fixen et al., 2015, cited in Nziguheba, Zingore, et al., 2016. *Nutr Cycl Agroecosyst* (2016) 104:321–340

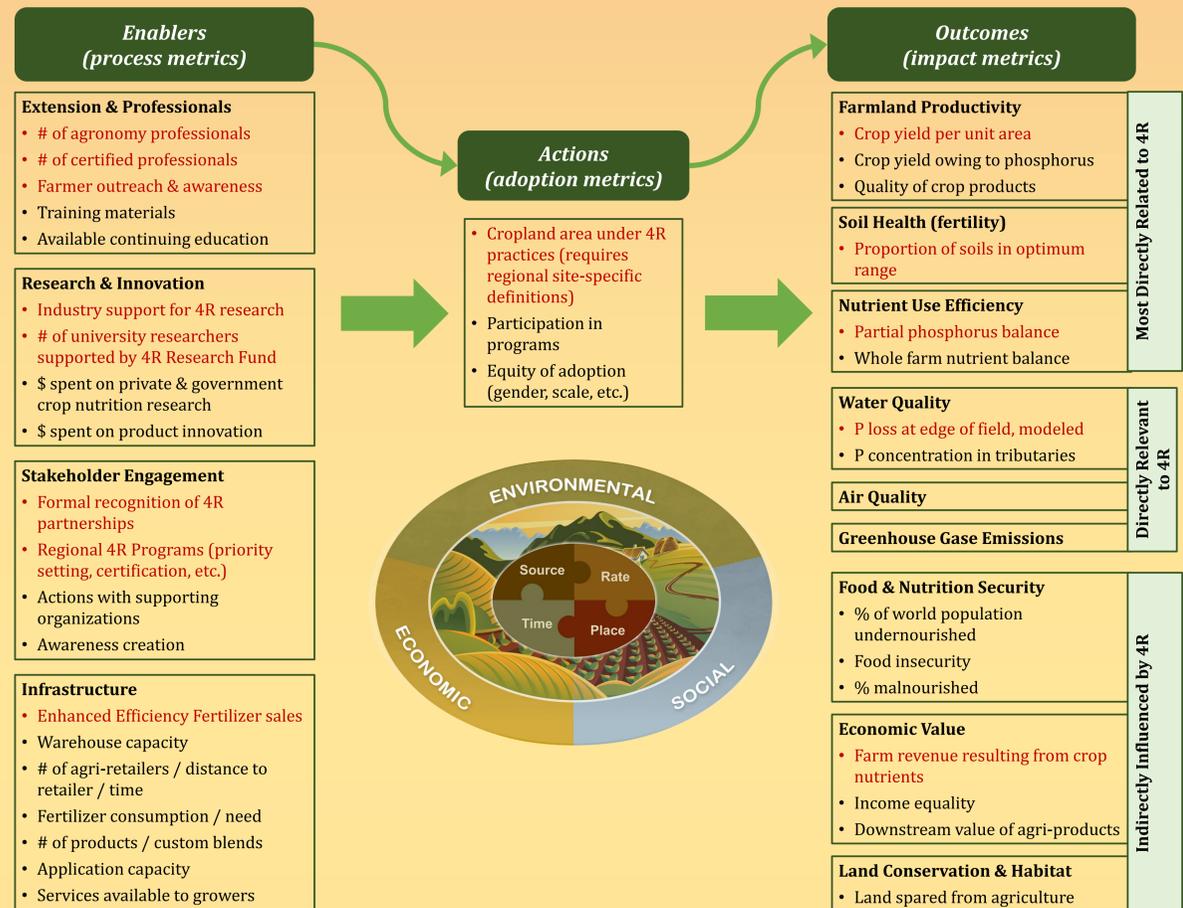
- The legacy of phosphorus use has contributed considerably to increases in crop productivity.
- Large opportunities exist to optimize soil fertility levels and use efficiency.
- Agronomic and conservation practices need to address both particulate and dissolved forms of P loss that impact water quality.
- Source, rate, time and place of phosphorus application can have large impacts on losses of dissolved P.

4R STEWARDSHIP - OPPORTUNITIES

- Doing 4R – right source, right rate, right time, right place
- Communicating 4R performance metrics
- Engaging stakeholder sustainability programs



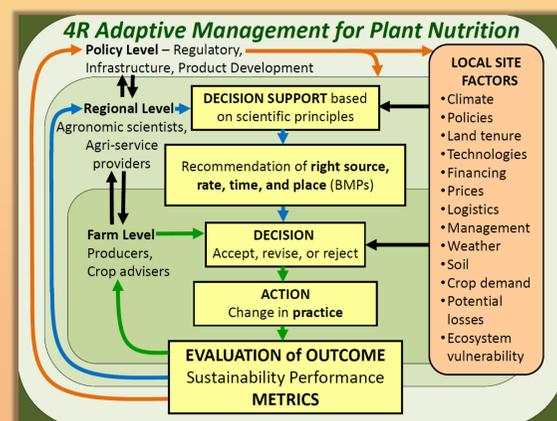
4R Phosphorus Stewardship Metrics for Sustainable Crop Nutrition



4R STEWARDSHIP - STRATEGIES

- Right practices – regional definitions of 4R
- Scalable metrics in balanced complements
- Water quality metrics requiring credible models
- Stakeholder engagement through sustainability organizations like

Field to Market®



The use of scalable metrics gives producers and crop advisers the best opportunity to make local decisions adapting site-specific factors to achieve sustainability improvement aligned with stakeholder goals.

Acknowledgement:

The development of the concept and framework of 4R Nutrient Stewardship and its principles and metrics has been based on extensive input over many years from committees and members of the International Plant Nutrition Institute, the International Fertilizer Association, the Fertilizer Institute, and Fertilizer Canada.