Research Needs for Site-Specific Nutrient Management to Benefit Agriculture

By P.E. Fixen

The nature of many of the questions related to site-specific nutrient management suggests that at least some studies must be conducted on a field scale and be systems oriented, nutrient management being just one component. The multitude of potentially interacting factors influencing response that vary across a field limits the reliability of controlled studies where all factors except one or two are fixed. Such traditional studies are still necessary, but their results need to be tested on a field scale in an integrated cropping system. A network of linked experiments, with potentially diverse designs, conducted at a regional level is one approach being utilized. The geographic boundaries of such studies are defined based primarily on agronomic interpolation potential rather than political lines on a map.

The potential benefits cited most frequently for site-specific nutrient management include increased profitability through higher yields and/or crop quality or through lower costs of nutrient management, improved quality of the soil, water, and air resources upon which agriculture and society depend; and increased accountability for agriculture. In some cases these benefits are already occurring.

Built on partnerships. The cost of technologies required to conduct the research, the rate of change of the technologies, the immediate need for results, and the need for scientific guidance in the direction of technology change demand that research be done via partnerships of significant stakeholders. The alternative is useless technology or useless science. Potential partners in design, conduct, outcome implementation, and funding include universities, government agencies, technology suppliers, input and service suppliers, commodity groups, and the "watchers." The watchers may also be referred to as the skeptical clients of agriculture...consumer groups, environmental groups, food safety activist groups, etc. It may not always be easy to involve these groups, but if industry and universities are going to partner, as they must, the stakeholders most skeptical of that partnership must be included.

Long term and short term. Patience appears to be in very short supply today, yet many of the needed changes at specific locations within landscapes will take many years to make. For example, removing mineral nutrients as limiting factors from the infertile eroded hills of much of the western Corn Belt and Great Plains will not be very effective unless water infiltration into those hill-top positions is improved. That can be done with improved residue management and production, but it takes time. Many other examples could be offered, but the main point is that long-term studies are needed.

Dr. Mark Alley of Virginia Tech is one of 22 scientists cooperating in a Mid-Atlantic regional interdisciplinary cropping systems project.

An example. The Foundation for Agronomic Research (FAR) and PPI recently initiated a Mid-Atlantic regional interdisciplinary cropping systems project, involving a research team of 22 scientists. A total of 10 experiments in Virginia, North Carolina, Maryland, and Pennsylvania, all with a common objective, are being conducted. Nine compliment the main study located in Virginia, which compares various cropping systems at a field scale.

A complimentary experiment located in North Carolina focuses on variable rate nitrogen (N) management and will generate results that will be applied and tested in the main study. Cash and in-kind contributions from commodity groups, private industry, and agencies support the project.

Priority Research Themes

The following is a set of suggested priority research themes that were developed in part from input received from other symposium presenters and PPI staff.

Maximum yield research. For every yield monitor that's purchased, there is one more individual eager to learn about yield limiting factors...nutrient or otherwise. An Illinois farmer by the name of Herman Warsaw taught us in 1985 how much yield potential we don't normally realize when he produced a corn yield of 370 bu/A. That was the potential of the technology and genetics of 1985. What is the potential of one-acre areas of the fields of 1998? We need smartly designed research to answer that question.

Soil sampling efficiency. One approach or size does not fit all. How is the optimum sampling approach for a given field determined, for variable rate application as well as for uniform rate, considering what we now know about nutrient variability? A host of issues surround this theme.

Improvement or verification of soil test calibration and interpretation. Because management systems are dynamic and today's soil tests are empirical, ongoing soil test calibration is a must. Numerous examples can be given of situations where recent calibration research resulted in major changes in nutrient recommendations.

Development of multi-variate soil test interpretation. We have known for a long time that more than one factor determines the nutrient supply available to a growing crop. The model developed is one of the simplest nutrient uptake models ever developed, and it has 11 parameters. It should not surprise us if current soil test interpretation systems fail to accurately predict response across fields. A recent study of winter wheat

There is a need for research at a field scale, where nutrient management is just one of the components being evaluated.

Research with soil sensors will be important in nutrient management.

response to phosphorus (P) across eastern Colorado landscapes may well be a reflection of reality in many fields. In that study, 62 percent of the sampling locations testing less than 14 (ppm) Olsen P respond to P while 50 percent of the sites testing greater than 14 ppm did. We now have the technology to utilize multi-variate approaches to determining nutrient needs.

Continued development of geographic information system (GIS)-based nutrient management decision aids. Site-specific nutrient management is a potentially wonderful customer for many of the relationships that are currently hidden away in scientific journals. Research focus on integrating what we already know about how nutrients, soils, plants and weather interact and delivering it through a user-friendly interface is sorely needed and would be very well received. Temporal variability in crop nutrient demand needs to be considered in such programs.

Development of models to predict soil fertility status over time. Without a doubt, soil sampling will be more intensively done in the future than it is now and there will be increased pressure to sample less frequently. A need exists for more accurate approaches to predicting soil fertility status between sampling times based on nutrient additions, crop removal, and other site-specific factors that may change among fields and across individual fields.

Plant and soil nutrient sensing (remote and otherwise). Can satellites tell us which parts of a field contain corn plants that are deficient in a specific nutrient or contain specific weed species and can the information be delivered in an acceptable, timely and cost effective manner? What can soil sensors deliver to the nutrient management table? These are researchable questions.

Waste disposal. Like it or not, agriculture is being asked and will continue to be asked to dispose of municipal and industrial wastes. Many of these contain essential plant nutrients, but may also contain potentially toxic materials. Animal manures continue to be a challenge for sound nutrient management in many regions. Research to determine the short and long term consequences of these practices and the appropriate role of site-specific nutrient management is needed.

Conclusion

Research topics are challenging and abundant, exciting technologies exist that are poised to utilize the fruits of science, and a user group is ready to pounce on every piece of practical knowledge that can be offered. One can speculate that there has never been a better time to be an agronomic scientist with interest in plant nutrients. BC

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