Finding the Value in Precision Soil Sampling

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Growers who were early innovators with GPS related technologies, have now collected 5+ years of data and are asking, "Where's the value". To answer the question for soil sampling systems it is important to take a step back and look at how we arrived to this point. Soil sampling and testing is not a new technology. With the introduction of commercial fertilizers there was a need to differentiate between potentially responsive and non-responsive sites, primarily for phosphorus and potassium. The result was a concentrated effort on the part of our land-grant institutions to run field studies designed to correlate crop response from fertilizer applications against soil test values derived from various extracting solutions and laboratory procedures. Refinement of these initial correlation studies have continued to this date to not only define responsiveness of sites, but also to calibrate soil test values against the application rate of nutrients necessary to achieve optimum economic yield. This effort has been partially successful. Soil testing does a very good job of indicating the probability of response and tracking soil fertility status over time. Soil testing also provides good information on long-term yield response when averaged over a number of years. However efforts to develop a soil test and sampling procedure that will provide a prediction of the optimum fertilizer rate for a specific field and year has been only partially successful.

Effectiveness of Soil Testing as a Guideline to Fertilizer Rate and Crop Response

Optimum fertilizer rate to apply for a specific field and/or year.	**Fair**
Relative yield response for a specific location and/or year.	**Fair**
Average long-term optimum fertilizer rate to apply over a number of years.	**Fair-Good**
Relative long-term yield response averaged over a number of years.	**Good**
Probability of a yield response.	**Very Good**
Soil fertility status over time.	**Very Good**

For phosphorus and potassium, soil testing is best used in combination with a historical perspective. Noting soil test values in relationship to other sample results taken over time for the same field adds credibility to the data. If the trends make sense based on nutrient applications and cropping, the grower can be reasonably confidant that the test result represents the average nutrient status of the field.

It was recognized by some of the early researchers that one of the limitations to predicting response to crop nutrients, based on soil tests, was the variability in nutrient status within a field.

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This is especially true on farms where there is a long history of livestock production and manure application. The University of Wisconsin should be recognized for suggesting a sampling system to deal with this variability. The use of 5-acre composites and the "W" sampling system provides some feel for the variability of a field and reduces the probability of obtaining a misleading result due to soil cores pulled from a nutrient hotspot in a random soil sampling system.

How well has the industry done with the traditional soil sampling systems? Some have done an exceptional job, however there is significant opportunity for improvement. In reviewing soil test records for growers taken from the files of dealerships throughout the region it is common to find one or more of the following problems.

1. Lack of a field identification system that allows for comparison of results through time.
2. Lack of uniformity in sampling system.
3. No convenient method for discerning nutrient applications and/or crop yields.
4. Inconsistent sampling time, depth, number of samples, etc.

Enter the 90's and geo-referenced soil sampling systems. **This technology holds tremendous potential for improving the value of soil testing.** However, in its short history several mistakes have been made which may slow or seriously hamper its widespread application. First, geo-referenced soil sampling is often automatically linked to variable rate applications of crop nutrients. The value of these two technologies should be considered separately. As the equipment with the ability to change fertilizer application rates "on the go" were developed there was a need to have application maps to drive the process. In many cases accurate collection of such information was secondary to covering the maximum number of acres possible with the equipment. Second, to keep sampling and analysis costs low, much of the original grid sampling was done on a 4.4 acre basis. The problem was not the size of the grid, since it provided valuable information on the variability that exits within fields. Problems arose by inferring more accuracy than what really existed. By interpolating grid points on a 4.4 acre basis and developing a color map, the idea was generated that fertility levels graded in a predictable, gradual manner and that we could reasonably map nutrient variation from sampling points 440 feet apart. Subsequent research demonstrated that to map variability with reasonable accuracy, grid points need to be closer. Producers who resampled fields at a smaller grid size, 330 or even 210 feet, frequently found that the original data gathered did not resemble information obtained with more intensive sampling.

The result was that many growers and university research and extension personnel were left questioning the value of the technology. Is the problem the value of the data or uncertainty over the economics of variable rate application of fertilizer?

The ability to geo-reference offers numerous options with distinct advantages over traditional systems for collecting and storing soil test data.

1. Geo-referencing provides a permanent record of field boundaries, reducing errors in field identification.
2. Versatility. Geo-referencing is of value to all sampling systems. This allows for the utilization of equipment across all of the sampled acres at a dealership.
3. Geo-referencing provides a history of sample location. The result is improved repeatability of results, which improves the ability to monitor the impact of changes in nutrient management over time.
4. Soil sampling has traditionally been a service that has generated little or no added revenue at a dealership. Adding value to the data, through the use of geo-referencing, allows the opportunity to reposition this service with growers.

The result is a range of soil sampling options, each adding additional decision-making value. The values in the chart below are relative numbers based on my own personal biases. While the values and rankings are open for discussion, the primary concept that soil testing increases in value with history and increased sampling intensity should not be in dispute.