GRID SAMPLING: THE WORTH OF INFORMATION

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BACKGROUND

Soil sample collection and chemical analysis is a time honored, scientific procedure for providing information used in determining limestone and nutrient needs in crop production fields. In fact, without that information one cannot make appropriate limestone and nutrient input decisions. At best they would be educated guesses, and most likely would be incorrect. Inherently then, in the soil testing process is a worth of the information derived. This worth is dependent upon the test results and the interpreted need for input application (specifically, the worth of soil testing would be based on the difference in the interpreted input need and the application that would have occurred without the test results). If soil testing is reliable, and the guessed at input need is very wrong, then the worth of the sampling - interpretation process is great.

SOIL TESTING FOR MAPPING WITHIN-FIELD VARIABILITY

A similar consideration is being debated today. It is not whether fields should be soil tested, but whether fields should be sampled to determine field average or median central tendency (and interpreted for uniform input application) or sampled to map field variability (and interpreted for variable input application). With the availability of computer controlled application equipment that can variable apply crop inputs, the potential to easily manage identified within-field variability is a reality. Of prime importance then is the worth of information gained from mapped variability. There is a dilemma. Before sampling to map field variability, how can one determine if enhanced economic return from variable application will at least repay the testing, interpretation, and mapping costs?

Economy of scale is an important factor in the sampling debate. Clearly improvement in delineation of variability occurs as sample intensity increases (grid sizes quite smaller than that recommended for measure of central tendency). Concurrently, improved economic return from mapping variability and variable applying crop inputs is compromised because of escalation in soil testing costs. The break even point is difficult to resolve and many factors weigh in the economic analysis (this analysis continues today and will no doubt continue for some time). It is important that the farmer, who ultimately pays for all steps in the soil testing process, be assured that the economy of scale question is considered.

If fields have never been intensely sampled, then it is a real unknown as to any potential benefit from intense grid sampling. If no treatable variation is found, then is the cost of grid

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sampling a waste of money? Not completely. Information is gained and knowledge about the field is enhanced; such as no treatable variation exists, a good value is determined for the central tendency, and confidence that sound information was used for both determining uniform input rate and resolution of the question concerning the need for variable application. What is the worth of that set of grid sample test results? Is it the same if the field was identified as highly variable and in great need of variable application? No. The potential return is certainly different, and likely less. Current economic analyses of grid sampling, however, do not always consider the worth of information in the aforementioned case. Even for uniform application, more than one sample per field is required to accurately determine the field central tendency.

Great importance historically is placed on the crop input application process. In fact, few individuals seem to question when application costs are greater than soil testing costs. With the importance of management decisions, perhaps this should be reversed. Which has greater worth, the application process or the information generation process?

Perhaps the greatest unknown in this discussion is the environmental issue. Current societal concerns demand knowledge about soil test levels in fields, and appropriate treatment of those fields. Can intense grid sampling and variable input improve environmental problems? What worth is placed on environmental improvement? There is a cost to the farmer that must be offset. It is not always known what potential payback can be achieved or if governmental program moneys will be available to defray intense soil testing and management costs. One can debate if an environmental problem is real, or if intense sampling and possible variable input application can improve environmental quality, but the reality is that today farmers must face and deal with the issue, and deal with the costs associated with the issue. No matter what, a perceived if not economical value may be gained by addressing the environmental issue.

PROVIDING ECONOMICAL GRID SOIL SAMPLING

How can suppliers of grid soil sampling offer an economical sampling package to farmers? Several possibilities include:

- Follow research derived guidelines for sampling intensity. One example is the recommendations from the University of Illinois. Researchers there have studied sampling protocols for many years and have recommended grid sampling for over 60 years. Recommendations change over time, and with the advent of computer controlled application equipment, grid size recommendations have intensified to accommodate capabilities of computer processing and application equipment.
- Be flexible and consider modifying grid sampling protocols when improved sampling techniques are identified, especially those with the potential to reduce the total number of samples required per field or ability to target intense sampling in fields or areas of fields identified as potential candidates for variable application (in essence using existing information to guide future intense sampling).
- Be flexible, and reduce future sampling intensity when fields are identified as non-candidates for variable applications.

- Soil test only for those characteristics needed to determine input needs and rates. With some recommendation systems, these might include only pH and available P and K. Also, utilize tests with the greatest reliability.
- Frequently soil test only for those characteristics that change rapidly or change because of farmer management.
- Infrequently measure those characteristics that do not change rapidly, are not used in the recommendation process, or are not needed on a site-specific basis. This might include organic matter, CEC, Ca, and Mg.
- Provide maps that can be generated from soil test databases in future years, thus eliminating the costly map building process.
- Provide maps that are compatible with other systems, such as yield monitoring and variable applicators.
- Realize that soil testing to assess within-field variability will not be perfect. Instead strive for as much improvement as economically possible (and realize that management foot by foot and applying only what is needed exactly where it is needed is probably not a reality and not economically feasible).
- Offer the ability (through modeling) to evaluate the need for variable application on an individual field basis and be willing to alter future sampling protocols to enhance delineation of important test areas in fields.
- Spread sampling and mapping costs over multiple input needs.

PROBLEMS THAT DETRACT FROM GRID SAMPLING

What problems detract form the worth of grid sampling? Several possibilities include:

- Sampling scale and inability to map all variation features within fields.
- Inherent laboratory analysis errors. These occur in all laboratories and cannot be eliminated, although every effort is usually taken to keep them as small as possible.
- Soil tests with less than ideal calibration to expected crop response.
- Repeatability between samplings. Although point sampling (cores taken within a small radius of grid intersection points) reduces variability in cores composited into a sample, sample collection usually is the largest source of variation. This occurs as a result of time of year, depth, fertilizer bands, uneven manure application, previous crop, residue distribution, and vertical nutrient stratification. Problems with analysis stability over time vary with different analyses. Some, like pH, are more stable than others, like available potassium. Grid point sampling, utilizing positioning systems, greatly improves repeatability, although only within the constraints listed above.
- The real world. Soil sampling does not take place in a test tube. Soils are dynamic systems and the soil sample only represents one time frame.

BENEFITS FROM GRID SAMPLING

Many benefits are derived from grid soil sampling. Several possibilities include:

- Ability to map major soil fertility features within fields. This is needed more today because of the increase in spatial variability as a result of farmer activities.

- Ability to produce site-specific application maps, for either manual or automated applications.
- Increased confidence of central tendency values and lowered sample averaging across low and high test areas.
- Although not an immediate benefit to farmers, generates a geographic soil test database that can be analyzed to help make many decisions; such as future nutrient application needs, nutrient problem areas, potential environmental problems, potential for variable application, and enhanced knowledge about soil properties, such as buffering capacities (when tied to nutrient application databases).
- Ability to re-sample the same locations in fields (especially with the availability of positioning systems such as GPS). This enables long term monitoring of management practice effects on soil test levels.
- Tie harvest nutrient removals (with the capabilities of grain yield mapping) to immobile nutrient replacement and soil test changes over time.

DATABASE INFORMATION

Data of direct importance to farmers is, of course, that from their own fields. For input suppliers, farmer advisers, researchers, and farmers, interest would also include geographic compilation across many fields. Data manipulation could provide information such as soil test summaries, variability within fields, nutrient removal, potential for variable application, soil buffering capacities, nutrient application summaries, and nutrient mass balances. At this point in time, the cost-benefit to farmers is unclear. Individual farmers would bear the initial data collection cost, but not necessarily the database analysis costs. Farmers could, through enhanced knowledge, benefit through improved management decisions and enhanced understanding of nutrient behavior in soils.

THE FUTURE

What does the future hold? Higher levels of farm management will continue to be a necessity. This will be driven by economics as well as societal pressures. Farmers will address this by increasing the efficient use of inputs as well as implementing practices that help protect the environment. Grid soil sampling, or some variation of that approach, certainly will be part of the practices for managing limestone and crops nutrients.

What is needed for the future? One, continued development of efficient, cost effective, and reliable soil testing methodologies. The issue of small scale variation must be resolved. Could this be on-the-go sensing? This would be ideal, but is still futuristic. Two, as grid sample test results are evaluated for variable input application, predictive economic simulation would help decisions for individual fields and for geographic regions. Research and development should continue in both of these areas.

PROCEEDINGS OF THE TWENTY-FOURTH

NORTH CENTRAL EXTENSION-INDUSTRY

SOIL FERTILITY CONFERENCE

October 26-27, 1994

Holiday Inn St. Louis Airport

Bridgeton, Missouri

Volume 10

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