Site-Specific Nutrient Management Systems for the 1990s

By H. F. Reetz, Jr.

Space-age technology is providing some important tools for farmers, with the help of their various suppliers and advisers, to meet the challenges of the 1990s and beyond. With new technology now available, farmers should be developing record systems and management plans for each of their fields that include site-specific referencing of variability within the field.

PROFITABLE AND ENVIRONMENTALLY SOUND nutrient management planning may be enhanced by managing within-field variability. Site-specific nutrient management planning involves recording yield, soil test and soil properties with a precise description of the location within the field where the data were collected (geo-reference). Nutrient applications are varied based on maps that are created from geo-referenced records of soil test values, soil yield potential, previous yield histories and nutrient applications that can be coded into the computerized record keeping system.

New computer software allows the geo-referenced records to be analyzed and displayed as management maps. Computers use the maps to automatically change fertilizer rates and blends during application.

The Tools

- **Computerized records** form a data base of information about cropping history, nutrient applications, and soil tests for individual fields. Each record is identified within a field by specific coordinates.
- **Computer software called geographic information systems (GIS)** provides a means of graphically presenting, analyzing and interpreting the data, linking management information and records to specific points within a field.
- **The Global Positioning System (GPS)** of earth-orbiting satellites, established by the U.S. government, allows field operations and measurements to be precisely located within an area during the operation (real time).

The Applications

- **Using GPS technology** to pinpoint soil sample sites on a grid basis, soil test maps (through GIS) can be generated that then serve as the basis for GPS-guided variable rate nutrient application.
- **Pesticide application** can also be guided with GPS capability to fit rates to soil types and to specific pest trouble spots in the field.
- **Portable electronic scouting** tools allow instant on-site analysis of soil and crop nutrient status to aid in identifying management problems in the field.
- **Electronic communication systems** permit ready access to suppliers, advisers, and other information sources to provide support services and reduce down-time during critical seasons. Cellular phones, fax machines, satellite and phone-modem communications are becoming common farm "tools". Hand-held, pen-based and voice-activated computers will soon be common tools in the field.
- **On-the-go yield monitors** allow the collection of site-specific yield data during harvesting. The yields can be displayed and/or stored for later analysis, including the creation of yield maps. Furthermore, GIS applications can be used to create map overlays, which will permit the study of relationships between yield and other mapped attributes such as soil

Dr. Reetz is Midwest Director of PPI, located in Monticello, IL.

type, soil fertility, weed populations, drainage and other factors.

This description of tools for the high-tech farm of the future is built around technology and services that are available today. The technology costs are falling rapidly and are economically viable in many farming operations. New developments and refinements could further reduce costs and increase technology applications. But the technology will be useful only to those who make a commitment to begin the detailed monitoring and record keeping system necessary to build a farm data base.

How to Start

Begin a computerized record keeping system. Select a software package that will allow you to organize and link your field data with precise locations within the field. Select a position referencing system such as latitude - longitude or state plane coordinate system to spatially link all records. Soil test information, nutrient application, and yield records referenced to specific locations within a field are important components of the field records. Additional information from photographs and other maps can be digitized into the record keeping system as the availability of time and technology permits.

Investigate GIS computer software packages that can analyze and display your geo-referenced field data as maps. You may choose to work with a consultant or adviser in analyzing your computerized records to develop site-specific interpretations for individual fields. Farm level GIS applications are rapidly evolving with several companies developing farm level applications for sophisticated GIS packages currently used in research and education.

Collecting Soil Samples

Sample collection is the most critical part of soil testing for developing variable rate fertilizer application maps. Research is underway on how to optimize sampling for various combinations of soil properties, cropping systems, and fertilization/manuring histories. For example, it is likely that sampling requirements in the unglaciated Great Plains where neither manuring nor fertilizing has been done extensively will be less intensive than in the heart of the Corn Belt.

Research in Wisconsin and Illinois has resulted in the following sampling suggestions.

Soil Sample on a Systematic Grid Pattern

- Overlay the field with a grid.
- For the initial sampling, each grid cell should be no larger than 1 acre unless the field has a history of high soil test values and fertilizer applications in excess of normal crop removal. In the latter case a 2 acre cell may be acceptable. Be prepared to sample portions of the field on a finer grid if responsive sites are identified with the first sampling pass.
- Future sampling of the field may be done using a larger grid size or by nutrient management areas, depending on the outcome of the initial sampling.
- Locate the sample point by counting rows and measuring distances, or preferably navigate to the point using GPS.
- Taking samples in straight rows across the field may be biased by previous management such as fertilizer application patterns. A systematic but unaligned pattern may be a better choice, especially if GPS-referencing is available.
- Collect at least 5 to 8 soil cores for each grid cell, taking the cores from within a radius of 10 feet of the sample point.

Sample at a Uniform Depth

Soil tests are usually calibrated on the basis of an acre furrow slice, approximately 2 million pounds of soil. Check with the analytical lab for its recommendation on sampling depth, because some labs use their own calibration data set that is based on a sampling depth different from the 6⅔-inch standard.

For no-till fields, consider collecting a set of samples at the standard depth and another set to represent the top 2 inches.

HIGH-TECH TOOLS FOR SITE-SPECIF

Photo Credit: Dealer PROGRESS Magazine

Variable rate fertilizer application can improve efficiency.

Grid sampling guided by GPS gives more accurate soil test data.

PAST YEARS' YIELDS

SOIL TEST (K)

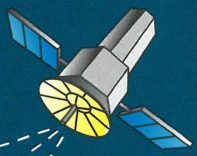
SOIL TEST (P)

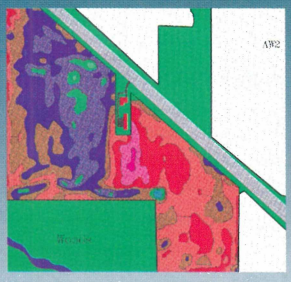
SOIL MAP

IC CROP NUTRIENT MANAGEMENT

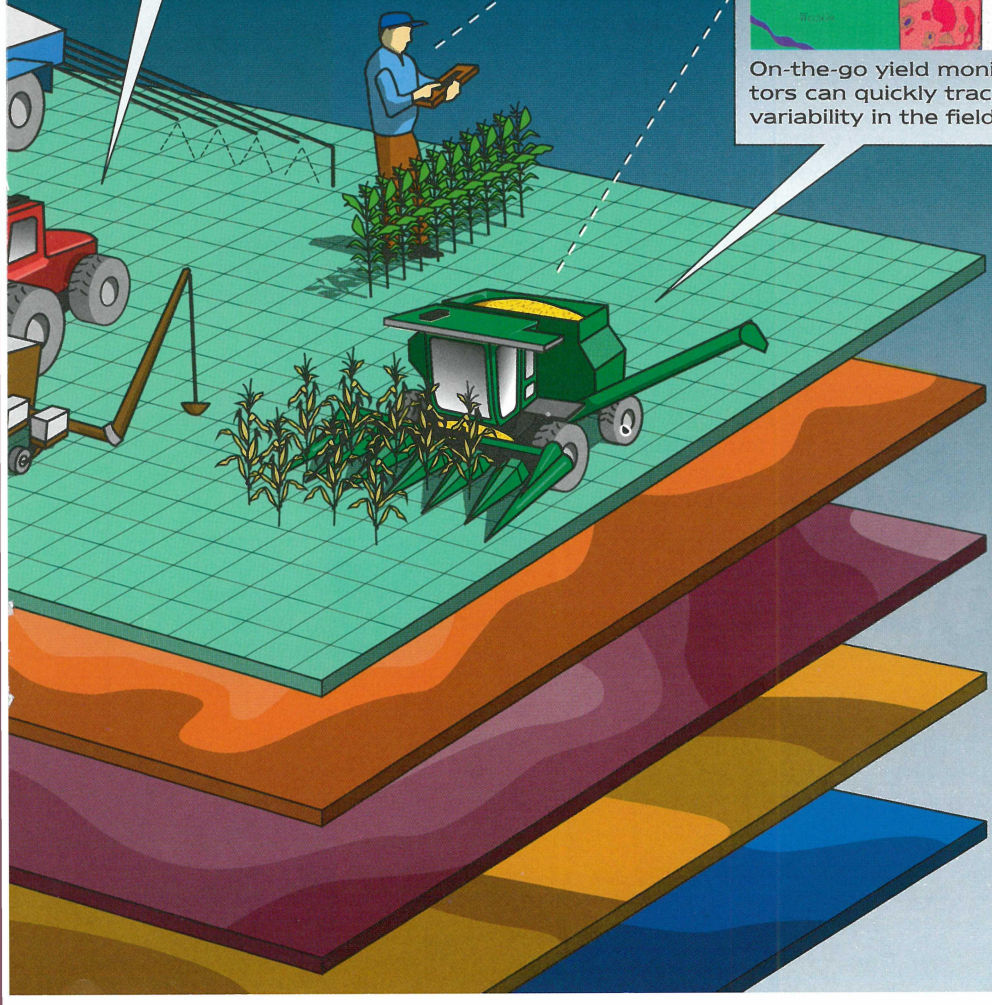
Variable rate seeding, variety changes and starter can adjust for soil properties and productivity.

Crop scouting with new technology improves field records.





On-the-go yield monitors can quickly track variability in the field.



This will help identify stratification of nutrients, and is especially important for pH determination.

Site-Specific Nutrient Management Action Plan

A goal of every farmer should be to develop a strategic plan that works toward detailed, site-specific nutrient management:

- Make a commitment to keep accurate, detailed records of production inputs and yields for each field, including variability within the field.
- Begin collecting soil test, nutrient application and crop yield data on a grid basis. Identify each sample with its exact location in the field. Use GPS location-referencing if possible.
- Analyze records and develop a nutrient management plan that takes into account the variability within a field. Use spot spreading or variable rate application where appropriate.
- Measure yields for each field. Using on-the-go yield measurement to develop a yield map of each field is even better. Individual field yield records are a good starting point, but yield variation across the field must be measured to get an accurate check on response to site-specific management.
- Continue to add information each year and begin more detailed analysis of the records to refine the site-specific nutrient management plan. Even though the level of detail of different data sets will vary, each point in the field can be associated with each data set if all of the

Implementing Site-Specific Management

Present Plan	Future Enhancements
Accurate, detailed records of all inputs and yields for each field, with spatial referencing for any variable rate applications.	Computerized data base of multiple-year records for each field.
Detailed soil sampling . . . preferably on an organized pattern, spatially referenced so samples can be related from one year to another.	GPS-referencing of each sample location, to be correlated with soil survey, fertilizer application and yield maps.
Spot-treat or double spread parts of the field to account for variability in soil test and yield potentials. Reference variable locations on application records.	GPS-guided, variable rate nutrient application related to soil test and yield records and other data mapped with GIS techniques.
Individual field yield records based on actual scale weights or weigh-wagon strip tests. Note areas of the field with obviously high or low yields.	GPS-referenced, on-the-go yield measurement to provide a detailed yield map of each field. Yield monitoring may be the most important starting point in building a site-specific management system.
Adjust the nutrient management plan according to the records and samples collected.	Build on the detailed crop record data base and utilize geostatistical analysis and various management decision aids to refine site-specific nutrient management plans for each field.

records are properly geo-referenced. As technology improves, some data sets can be replaced with more accurate or more detailed data sets for the same parameters.

Nutrient Management Plan

Every field should have a nutrient management plan that integrates the information from all sources of data available for the farm. The plan should integrate the specific experience, preferences and goals of the farmer. Yield goals should be realistic and profitable, but also progressive. Assessment of potential environmental impact and compliance with applicable regulations should be a part of the plan.

Plans should be written out in detail, with appropriate supporting records and other information.

Nutrient management plans should include proper credits for previous crops, manure, sludge or industrial by-product applications. Consider all of the nutrient resources available and select the best combination for each field. Good nutrition may be expensive, but **inadequate** nutrition may be even more costly in terms of **lost yield potential . . . and lost profits!**

Start Now–Build for the Future

A site-specific nutrient management system begins with a commitment to develop a good record keeping system that will document the past and help plan the future management practices and crop responses. Other components, including yield monitoring, grid soil sampling, and variable rate fertilizer application, can then be added as best fits the management and economics of the operation.

To begin the process requires no major capital investment of specialized equipment. Computers and satellite-based positioning systems may be important tools in the long run, but they are of little value until the basic management strategy is established. Much can be done to implement site-specific management, even before new technology is added. The important step is to make a commitment and get started with accurate, detailed records and careful attention to management details.

Impact on Recommendations

Where nutrient management has been based on field average soil tests and fertilizer applications have followed the soil test results, moving to site-specific application based on detailed sampling will often result in increased fertilizer rate recommendations, or at least redistribution of rates within the field. This is because high-testing areas of the field overshadow low-testing areas when computing the field average soil test.

Site-specific nutrient management is not designed to remove variability in the nutrient levels in the field, but rather to capitalize on the inherent variability and build soil tests in more productive areas of the field and reduce fertilizer application in the less productive areas. Ultimately, that should lead to the most agronomically sound, economically efficient, profitable and environmentally responsible nutrient management plan for each field. ■

New Brochure– Site-Specific Nutrient Management Systems for the 1990s

A COLORFUL eight-panel brochure which presents the high-tech information featured in the article "Site-Specific Nutrient Management Systems for the 1990s" will be available soon from PPI.

If you would like further information regarding this brochure, pricing and availability, please contact the PPI Circulation Department, 655 Engineering Drive, Suite 110, Norcross, GA 30092-2821; phone (404) 447-0335, fax (404) 448-0439. ■