Dr. Harold E. Reetz, Jr.

Reviving High-yield Production Systems

Space-age technology is providing some important tools to help meet the challenges of the next century.

Summary: *Site-specific, high-yield management via a Global Positioning System is our future. It involves keeping good records, detailed yield data, "hands-on" knowledge of site-specific systems, sampling, scouting, and connection with the Internet. Most of all, it means higher yields and higher profits for those who commit.*

There are sufficient reasons for reviving high-yield production systems. Increased world demand for food necessitates it. Growers are increasingly aware of the need. Untapped research information is more accessible than ever before. Both dealers and farmers are better trained. Finally, there is the new technology of site-specific management.

Indeed, profitable and environ-mentally sound nutrient management planning may be enhanced by managing within-field variability. Site-specific nutrient management planning involves the recording of 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 according to maps 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. The objectives of site-specific management are to: 1) identify and quantify variability, 2) understand the impact of variability, and 3) manage variability to increase profits.

New computer software allows 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 benefits of site-specific management for high-yield systems are: 1) more information about site, 2) in-field tracking of responses, 3) geo-referenced data sets, 4) ability to target treatments and vary rates of all inputs, and 5) ability to vary management system within field.

The Tools

Computerized records form an information source 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 data, thereby linking management information and records to specific points within a field.

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).

Applications

Soil sampling. By 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 applications.

Trouble shooting. Pesticide application can also be guided with GPS methods to fit rates to soil types and to specific pest trouble spots in the field. Portable electronic scouting tools also allow instant on-site analysis of soil and crop nutrient status to aid in identifying management problems in a field.

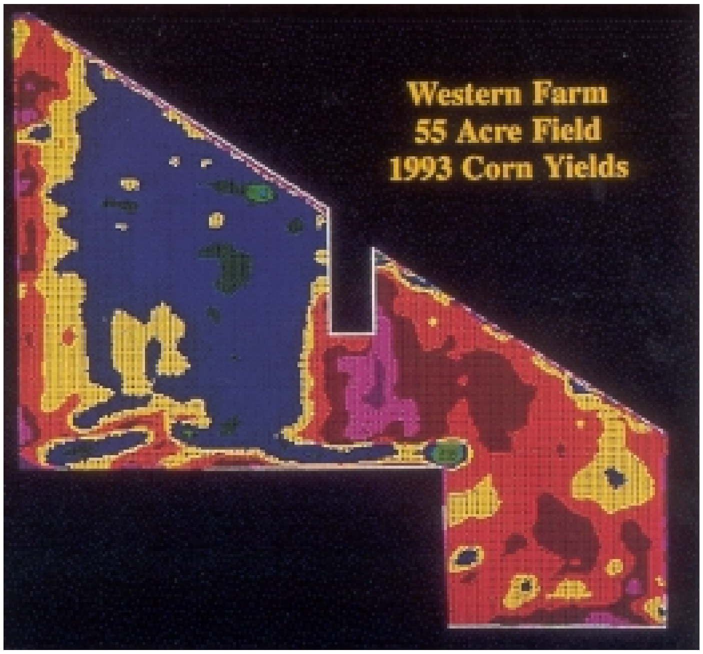

Figure 1. Typical yield map.

Reducing downtime. Electronic communication systems permit ready access to suppliers, advisers, and other information sources to provide support services and reduce downtime 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 may soon be common tools in the field.

Mobile yield monitors, installed in combines, allow collection of site-specific yield data during harvesting. Yields can be displayed and/or stored for later analysis. including the creation of yield maps. Yield maps, such as shown in Figure 1, provide proof, offering: 1) site-specific response data, 2) ground truth for plans and models, and 3) a basis for adjustments in management. 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 type, soil fertility, weed populations, drainage, and other factors.

How a map is generated through SGIS is shown in Figure 2.

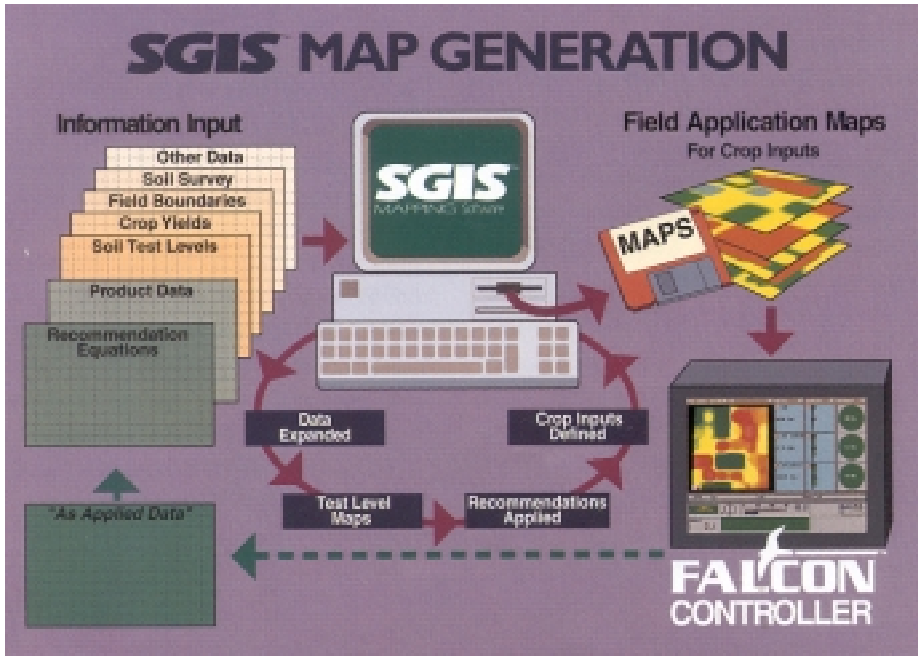

Figure 2. Generating map via SGIS.

How to start

Record keeping. Begin with a computerized record keeping sy stein. Select a software package that will allow you to organize and link your field data with precise locations within a field. Select a position referencing system such as a 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 field records. Additional information from photographs and other maps can be digitized into record keeping systems as availability of time and technology permits.

Software. Investigate GIS computer software packages that can analyze and display your geo-referenced field data as maps.

Consultants or advisers can help in analyzing your computerized records to develop site-specific interpretations for individual fields.

Matching right. Farm-level GlS applications are rapidly evolving with several companies devel-oping farm-oriented 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 under way on how to optimize sampling for various combin-ations 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.

Grid pattern. Research in Wisconsin and Illinois has resulted in the following suggestions:

- overlay field with a grid
- for initial sampling, make each grid cell no larger than one acre unless field has a history of high soil test values and fertilizer applications in excess of normal crop removal (in the latter case, a two-acre cell may be acceptable)
- sample portions of the field on a finer grid if responsive sites are identified with the first sampling pass
- perform future sampling of fields by using a larger grid size or by nutrient management areas, depending on the outcome of the initial sampling
- locate sample point by counting rows and measuring distances, or, prefer-ably, navigate to the point using GPS
- give preference to a systematic but unaligned pattern (especially if GPS referencing is available) over taking samples in straight rows across fields that may be biased by previous management such as fertilizer application patterns
- 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.

Uniform depth. Soil tests are usually calibrated on the basis of an acre furrow slice—approximately two million pounds of soil. Check with your 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 6-2/3-inch standard. For no-till fields, consider collecting a set of samples at the standard depth and another set to represent the top two inches. This will help identify stratification of nutrients, and is especially important for pH determination.

Commitment

Every farmer should develop a strategic plan that works toward detailed, site-specific nutrient management.

Commit to keeping accurate, detailed records of inputs and yields, including variability within fields.

Collect soil test, nutrient application, and crop yield data on a grid basis, identifying each sample with its exact location and using GPS location referencing if possible.

Develop a nutrient management plan that accounts for variability within fields, using spot spreading or variable rate application where appropriate.

Use mobile yield measurement of yield variations across fields as a check on responses to site-specific management.

Add information annually and begin more detailed analysis of records to refine the site-specific nutrient manage-ment plan. Even though the detail level

of different data sets varies, each field point can be associated with each data set if all 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.

Be objective

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

Write plans in detail with appropriate supporting records. Include credits for previous crops, manure, sludge, or industrial by-product applications. Consider all nutrient resources and select the best combination for each field. Good nutrition may be expensive, but inadequate nutrition can be even more costly through lost yields and profits!

Master producer

A sterling example of what proper nutrition and farm management can do for crop yields and profits is the late Herman Warsaw of Saybrook, Illinois. In 1985, corn yields for the entire Warsaw farm averaged about 200 bu/A. Warsaw stated at the time that the higher yields per acre helped to reduce the cost of each bushel produced. Included in the averaging was a test plot where yields averaged 370 bu/A—a world record (Figure 3). A profile of Warsaw's 1985 soil test showed: P at 161 lbs/A, K at 800 lbs/A, Mg at 8.71 lbs/A, Ca at 4.850 lbs/A, CEC 23, 5 at 35 ppm, pH 6.0, organic matter 5.3%, and zinc, iron, boron and copper all "good."

The secret to Warsaw's success? His plan was designed for a specific soil, climate, and management system. In other words, his plan was site specific, even though he didn't have access to the computer and satellite technology we have available today. He did the right things for the right reasons in the right place at the right time. It is a concept that fits anywhere in the world!

Moving toward 2000

As we move toward the new century, we have a developing technology that offers limitless opportunities. The grower can reach new yield plateaus. Agronomists can provide continuing education, information for growth of knowledge, interdisciplinary research, and personal professional development. It's a great time to be an agronomist!

Should you wait? Well, remember. Most profit from new technology or practices comes to the early adopters!

Are there hurdles? Oh yes. Lack of research on interactions (correlation among layers of GIS) is one. Shortages of trained agronomists (continuing education, etc.) is another. There's also a need for long-term commitments.

But overall, the picture is optimistic. As the technology advances, it is important we remember that site-specific management is not designed to remove variability in field nutrient levels. Rather it is designed to capitalize on inherent variability and build soil tests in more productive areas of fields and reduce fertilizer application in less productive areas. Ultimately, that should lead to the most agronomically sound, economically efficient, profitable, and environmentally responsible nutrient management plan for each field.

Dr. Reetz is Midwest director for the Potash & Phosphate Institute.

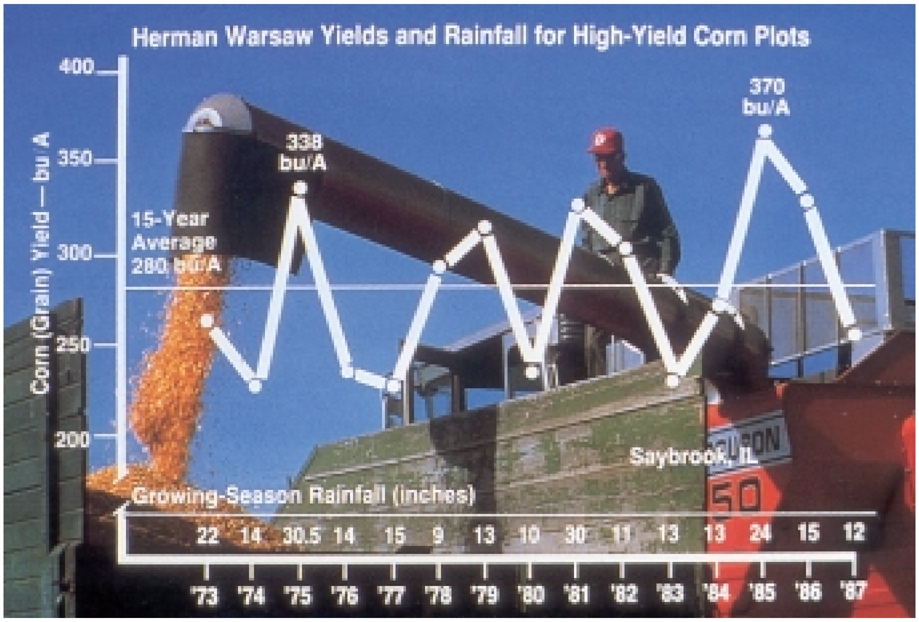

Figure 3. World record yields of Herman Warsaw.