DEVELOPMENT OF FIELD InSITE™ AS AN EFFECTIVE NUTRIENT MANAGEMENT TOOL

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Why Precision Nutrient Management?

Nitrogen, phosphorus, and potassium are essential nutrients for crop production. Crop nutrient management is critical to the success of any farming operation. Land stewardship is a concern for most producers as long as yields and profitability are not affected significantly. While farmers are eager to improve the efficiency with which they apply nutrients, maintaining expected crop revenue per acre is equally important. Higher fertilizer costs have increased the desire to find better ways to apply fertilizer that improves profitability without lowering yield potential. Growers have also significantly increased their yield levels in corn and wheat in the last 10 years. As yields increase, the amount of nutrients required has also increased to supply the crop with needed plant nutrition. When growers apply more than the recommended rates of nutrients, they do so for a variety of reasons, including not taking appropriate nitrogen or phosphorus credits, desire for additional insurance for crop yield, or not taking into account the variability of nutrient needs within a field. Regardless of the reason for over-application, doing so means wasted dollars spent on fertilizer and increased likelihood that the fertilizer may end up in ground water and streams. Thus, recommended management practices to increase nutrient use efficiency must maintain current yields and economics. An effective system to record field activities and practices provides documentation necessary for compliance in government programs and for land owners.

The concept of precision nutrient management and variable rate nutrient application is simple in theory. When constant rates of fertilizer are applied to field crops (such as 150lbs. N/acre used across an entire corn field), those areas with low yield potential lose a disproportionately high amount of nutrients to the environment, while areas with high yield potential are under-fertilized. Variable rate technology is designed to identify areas within a field with high to low yield potential and to target nutrient amounts to match the yield potential in specific areas of a field. The areas with high yield potential would receive a higher rate of nutrient application than the recommended flat rate levels in order to maximize crop yield in these areas. Areas within a field where yield potential is low would receive nutrient rates below the recommended flat rates. This targeting of nutrient rates within a field provides a win for the farmer and a win for the environment. The farmer should be able to increase fertilizer use efficiency while maintaining or enhancing crop yields. By reducing the amount of fertilizer applied to field areas with low yield potential, less fertilizer is wasted and ultimately lost to the environment. Those areas of a field with low yield potential are 'hot spots' where the loss of nutrients to the environment is greatest. Variable rate techniques provide the most cost effective practice to reduce nutrient losses to the environment while providing a positive return in profits for the farmer. An understanding of the degree and distribution of field variability is necessary to determine a strategy for managing it.

Recent Technology Developments:

The adoption of early precision agriculture tools, which focused on hardware such as yield monitors and grid sample strategies, has been slower than desired for a variety of reasons. Yield monitors provide validation of resulting farming practices, but have not been useful in implementing best management practices. Yield monitors help show the grower the degree and variability of yield within a field. Development of precision nutrient placement using yield monitor data and Global Position Satellite (GPS) mapping, while useful and beneficial, is very time consuming and not cost effective. Grid soil sampling provides an accurate picture of residual nutrients in the soil, but growers have been reluctant to adopt the practice on all of their acres due to high cost per acre and the long-term commitment. Also, providers often fail to demonstrate the benefits of grid sampling, which results in termination of the service. While variable rate lime applications are common following grid sampling, few acres receive variable rate fertilizer applications.

Fortunately, newer, more effective and efficient tools for variable rate application of nutrients are either in development or commercially available. New variable-rate systems for nutrient application illustrate the wide range of approaches being applied to the evolving science of precision farming. One such technology is a satellite-based software system designed to utilize available soil information and university approved fertilizer recommendations to develop a variable-rate prescription for each field.

The Mosaic Company is a leader in precision agriculture systems with its pioneering Field InSite™ service. Field InSite™ is a web-based program that helps you understand your entire farming operation and "transform data into actions" thru the use of mapping and record keeping tools. Gather, store, and analyze information to make intelligent decisions. Field InSite incorporates the basics of field mapping and record keeping with advanced methods of defining field variability and precision product application. Soil sampling and field scouting efficiency and effectiveness can be enhanced using Field InSite.

Field InSite analyzes field variability with new technologies developed in collaboration with NASA, USDA, GEOSYS and Cargill, Inc. Over 15 years of research and development has made FieldInSite an essential worldwide precision agricultural tool. It can be used as a planning and communication tool between growers, dealers, crop consultants, bankers, and farm managers. A unique feature of the Field InSite program is the ability to evaluate the economics of the variable rate application prior to grower incurring costs. Prescriptions can be made for any product, including customized blends, applied any time throughout the year.

Components of Field InSite™

1. Intelligent Enterprise – helps in gathering and storing field information
2. InSite YPM (Yield potential maps) – helps quantify amount of field yield variability
3. SaMZ (Satellite Derived Management Zone) – defines multi-year field variability
4. InSite VRN (Variable Rate Nutrient System) – help decide the kind and amount of nutrient/fertilizer to be applied

Intelligent Enterprise™
Intelligent Enterprise is designed to help increase your business's productivity, maintain return on investments, reduce fuel costs, and save time by improving the decision making process. In every situation, it can assist in farm management and help analyze past performance.

The days of carrying a pocket notebook with history of your fields are gone. Field information and records are too complex and valuable to risk having them lost or damaged. The Intelligent Enterprise program allows a grower to record field information to a geo-referenced field border. The information is always there for quick reference and to generate reports for the past, present, and future.

Intelligent Enterprise allows you to record field inputs, operations, notes about soil and crop conditions, and scouting reports, all of which provide a key piece to your Intelligent Enterprise strategy.

SaMZ™
SaMZ technology uses a series of images acquired over past 15 years and compiles them into soil-based management zones to better predict the future.

The concept behind comparing multiple years of imagery shows that a field, under variable weather patterns, presents different soil-water-vegetation responses. SaMZ compiles all these responses over the years and summarizes the different types of responses or crop behavior into management zones.

Zoning products, derived from historical data, are consistent and easy to use for technical decisions and to add a geographic dimension in the decision making process for:

- Soil sampling (soil or plants) that is targeted to specific zones
- Variable rate solutions (planting density, fertilizer applications, etc.)
- Soil corrections and field management (tiling, irrigation, new field boundaries)

InSiteYPM™
Yield potential maps are generated from satellite imagery to identify crop productivity levels. These virtual yield maps can be generated without the need of a yield monitor. Vegetation and organic matter distribution maps paint a clearer picture of what is happening above and below the soil surface. Management zones can be identified for multiple product applications or exported to any GIS program for soil sampling or data analysis.

Management practices change depending on the productivity potential within the field.

1. Low yielding areas: reduce expenses by reducing nutrient use in very poor soils where fertilizer is not the limiting factor for yield.
2. Good yielding areas: improve profitability by lowering nutrient investment in good, but overfed field areas.
3. Better yielding areas: maintain performance by consistently delivering exactly the right amount of nutrients that were perfect in previous years.
4. Best yielding areas: get superior yields with increased nutrient investments in the very best parts of the field.

InSiteYPM maps are the basis for proper nutrient applications using InSiteVRN.

InSiteVRN™

InSite VRN™ is the application portion of the program that uses a "check book" approach toward making nutrient recommendations that can address variability in soils and management across states, fields, and within fields. It uses two historical satellite images with 30-meter resolution resampled to achieve a 5-meter resolution.

The first image is a bare soil image that measures soil brightness. Our research showed a very good correlation between soil brightness and soil organic matter (Figure 1). The grower/soil test results provide the average organic matter level for the field. Organic matter level is distributed across the field based on soil brightness. Appropriate university defined mineralization calculations are used to allocate credits for nitrogen and phosphorus.

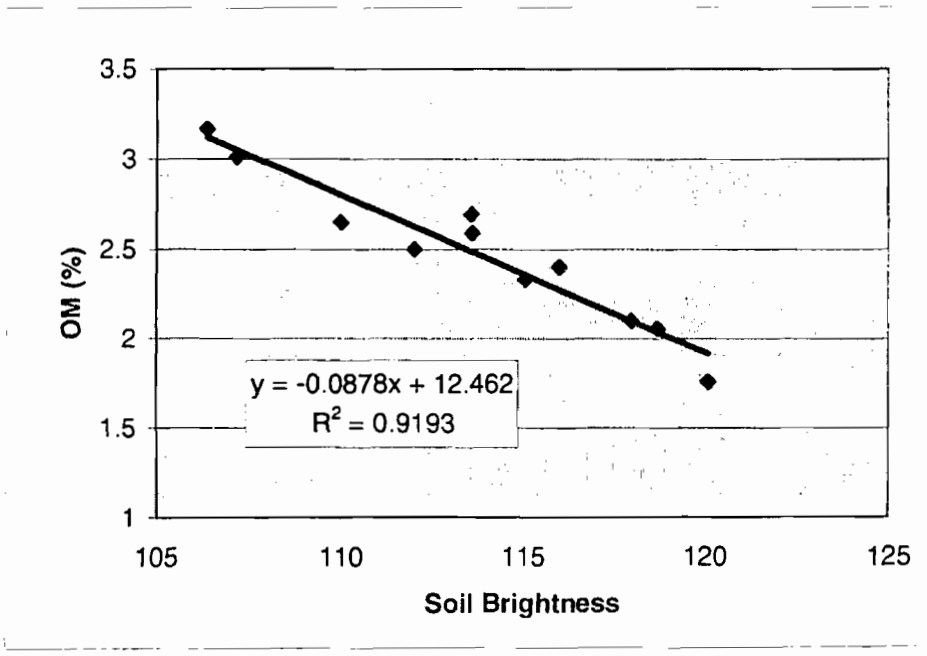

Figure 1: Organic matter in relation to soil brightness values. Holdrege, NE.

The second image is a multi-band image measures biomass (LAI) for the corn, wheat, barley or rice crop. The high correlation between biomass and grain yield for these crops allows the program to distribute yield across the field (Figure 2). The grower supplies the 5-year crop average or his yield goal to complete the debit side of the checkbook.

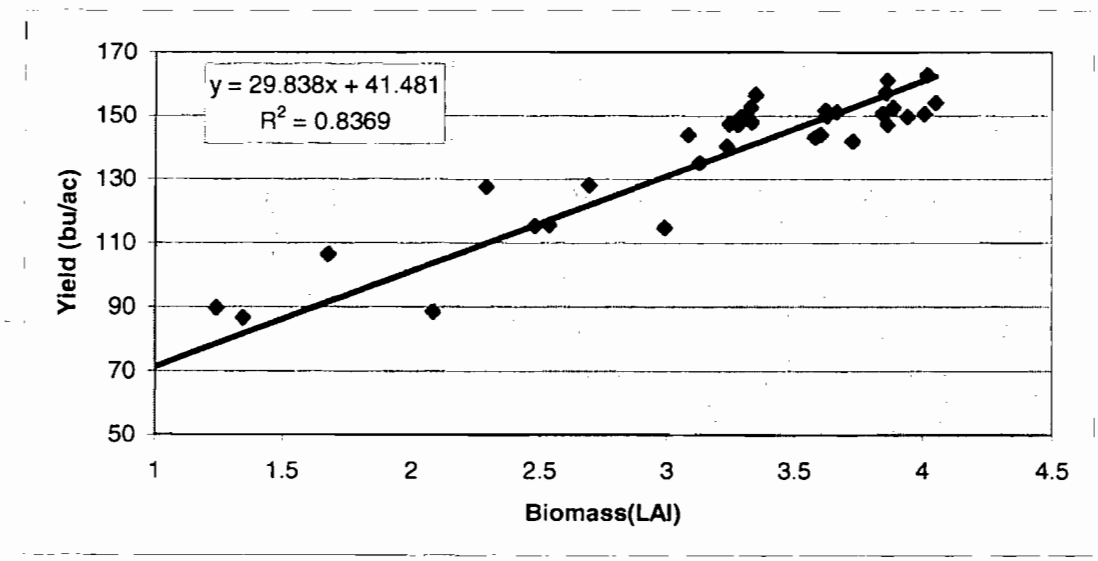

Figure 2: Yield in relation to biomass values. Blue Earth, MN.

The algorithm calculates the amount of fertilizer needed to achieve the desired yield goals and subtracts the appropriate credits. The program is designed to follow university recommendations for the area. The agronomy behind the recommendation is not changed, only the delivery of the recommendation.

The nitrogen recommendation model is customized to individual dealerships, growers, and fields. Product to be used is selected with grower price per ton. Default levels are established for each region but can be changed on an individual basis. These default levels include: pounds of N per unit of yield goal, pounds of N released per percent of organic matter, average soil nitrate level, and previous crop nitrogen credit. Planned starter, side dress and phosphate fertilizer nitrogen applications are specified. A minimum nitrogen application rate can be defined if grower is not comfortable going below a minimum or if application equipment does not have a bi-pass to allow for low application levels.

Phosphorus and potassium applications are derived using recommended university crop removal formulas and incorporating additional information that is available. Results from composite or zone sampling can be used or grid sample results can be incorporated into the program. Phosphorus and potassium credits are taken from manure and/or starter applications.

Benefits of Variable Rate Application

A two-year grower study was conducted in northwest Iowa to measure the effects of using variable rate application of nitrogen versus the standard flat rate in corn. Forty-three fields totaling 4,276 acres in five counties were evaluated. Total nitrogen applied was 212,167 less than the standard fertilizer application. This represents an average reduction of 49.6 lbs N/acre or 24.8%. Yield levels were increased an average of 3.1 bu/acre for the two-year study. Average fertilizer savings was $9.57/acre and the average revenue gain from increased grain yields was $7.45/acre. The overall increased revenue was $17.02/acre using VRN.

Comparisons between VRN yield potential maps and combine yield monitor maps were made to determine the frequency in which the VRN prescription applied the correct rate for the ultimate yield generated in the field. The correct rate was defined as plus or minus one half standard deviation. VRN applied the "correct" amount of fertilizer based on final yield 68-82% of the time. Standard flat rate applications were "correct" 15-33% of the time.

The InSite VRN application system is an effective method to variably apply fertilizer where it is needed. It involves dialogue with the grower so they are comfortable with the recommendation. Most growers recognize over-application of fertilizer, but they don't want to take the risk of the large, across-the-field cuts in rates. VRN allows the rates to be reduced gradually over time to demonstrate to the grower he is not losing profitability. Fields must have adequate variability to be cost effective. Our experience in the first five years of commercialization is that VRN is cost effective on 80-85% of the fields evaluated. Growers do not have to invest any money to determine if it is the right practice to follow.

These new technologies provide growers with the ability to not only reduce the total amount of nutrients applied to a field by using it much more efficiently, but also apply it precisely where it is needed. This saves the grower money and reduces nutrient loss to the environment. These technologies can be used independently or sequentially for the most effective prescription available to date.

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