Staff Report No. 2006-02 March 2006

# Variable Rate Application—Does It Pay?

**Kenneth W. Paxton and D. Keith Morris**[1]

Historically, farmers employing a high degree of mechanization have applied production inputs to fields at a uniform rate across the field. More recently, developments in precision agriculture technologies make it possible to apply production inputs in variable rates across the field. These variable rate applications are possible within current mechanized production agriculture technology. The idea behind using variable rate technology is that most fields are not homogenous with respect to yield limiting variables. Therefore, some efficiency can be gained and profits increased by managing resources within the field to optimize output.

## How Does It Work?

In order to implement variable rate technology on a farm, there are a number of issues that must be addressed. These include agronomic, economic, technology, and other issues. To get started there must be some basis for varying the rate of inputs across the field. This is most commonly based on some type of field map that identifies different areas or management zones. Currently, evolving technology is improving the possibility of basing variable rate applications on sensor-based, "on-the-go" data. This technology, however, is not currently available in a wide range of applications. There are some sensor-based technologies that are used to generate field maps delineating management zones.

A field map may be developed in a variety of ways. One of the most commonly used techniques is grid based soil sampling. By sampling the field in a systematic manner and spatially identifying the sampling sites, a map can be created identifying soil characteristics and/or fertility levels across the field. Another commonly used technique is yield monitors with a global positioning system. The spatially referenced yield data can be used to develop a map of the field showing high and low yielding areas. Another technique gaining in popularity is a sensor based machine that measures the electrical conductivity (EC) of the soil. This information can be used to develop maps related to physical characteristics of the soil.

Field maps may also be developed using a variety of remote sensing techniques to assess plant vigor. Remote sensing is defined as the observation of an object without being in direct contact with it. Remote sensing methods that can be used to assess crop growth include- satellite imagery (less common), aerial imagery (more common) or ground-based imagery used to assess individual plant needs. Field maps using these methods can identify areas in the field that have very vigorous plants and areas with less vigorous plants. This type of information is generally used to vary fertility or plant growth regulator treatments across the field.

[1] Professor, Department of Agricultural Economics and Agribusiness, Assistant Professor, Department of Biological and Agricultural Engineering, LSU Agricultural Center.

Regardless of how the map is developed, the idea is to identify areas within a field that have similar levels of yield limiting variables. Once identified, these areas can be treated differently using variable rate application technology. The varying levels of inputs for areas within the field are defined in a "prescription" for the field. This prescription defines the kinds and amounts of inputs applied to each of the identified areas or management zones within the field. In theory, production inputs are applied in each area in such a manner as to maximize profits for that area. In doing so, profit for the whole field is also maximized.

There are a variety of variables that must be manipulated in the production process. Maps or other forms of information must be developed to address site specific management of each variable. For example a grid soil sample may provide excellent information about soil fertility upon which to base a prescription for applying fertilizer. This information may not be adequate for developing prescriptions for managing other variables such as plant growth regulators, insects, weeds, or others. Additional information must be gathered to effectively manage each variable of interest.

Obviously, if there were no or small variations in the yield limiting variables across (or within) the field, site specific and whole field prescriptions would yield the same results. In this case, output from the field would be the same under either management regime. The only difference would be the cost associated with obtaining and analyzing the information necessary to implement the variable rate technology.

Profitability

Should site specific management and variable rate applications be used? One key to answering this question is identifying the amount of variability in a yield limiting variable within a field. As noted earlier, if there is little variability, site specific management will yield the same results as whole field management. Since whole field management is less costly to implement, it would be most profitable. The key question then is how much variability is required to justify implementing variable rate application?

The answer to the question is it depends. Different yield limiting variables have different influences on yield. Further, costs associated with modifying these variables are also different. To determine if a field exhibits enough variability to justify implementing variable rate technology, it is first necessary to assess the variability within a field. Variability may be assessed as discussed earlier via mapping or sensing technologies. This assessment provides a basis for dividing the field into areas with similar levels of yield limiting variables. A prescription is then developed for applying inputs to each management zone in such a way as to mitigate the yield limiting variable of interest or apply inputs in such a way that the level of input use is economically justified in each management zone.

Profitability is determined by the potential to modify input use among management zones in such a way that yield is increased and/or the level of input use is reduced. The magnitude of these changes must be sufficient to cover the costs of implementing

variable rate application technology. Therefore, not only is the change in yield and/or level of input use important, but the price of the crop also enters the equation.

## Variable Rate Application Technology Costs

Implementing variable rate technology requires the acquisition of the necessary information and converting this information into a prescription for application. Because of costs and the steep learning curve associated with many of these technologies, many producers elect to acquire the information through services of a custom operator. Table 1 summarizes some of the services available in Louisiana and approximate charges.

Table 1. Estimated Costs per acre for Selected Precision Agriculture Services

| Precision Agriculture Item | Approximate Cost per Acre[1] |
|---|---|
| Site specific soil sampling (grid or zone) | $5-8 |
| Aerial photographs | 6 |
| Electrical conductivity (EC) | 5-7 |
| Developing application prescription | 1 |
| Custom variable rate application of lime | 6 |
| Custom variable rate application of fertilizer | 6-8 |
| Yield monitor—cotton picker[2] | 3-4 |
| Yield monitor—combine[2] | 3-4 |
| | |

[1]Costs are based on custom charges for the service except for yield monitors.
[2]Ownership and operating costs based on 1500 acres annual use.

## Potential Returns

Variable rate application technology profitability depends on the individual field and management issue being addressed. Therefore, it is virtually impossible to develop rules of thumb to guide the adoption process. This explains why many early adopters rely on service vendors to collect and process much of the site specific management information. Once processed, this information (in the form of a prescription) is given to a custom applicator who applies the inputs in the prescribed manner. Generally, the custom applicator will provide producers with an as-applied field map showing the areas covered and the quantities applied. This serves as confirmation that the correct material was applied in the correct amount to the correct field.