UK COOPERATIVE EXTENSION SERVICE
University of Kentucky – College of Agriculture

Site Specific Issues

A Precision Agriculture Newsletter

Spring Planting 2003

Edited by: Dennis Hancock, *Extension Associate for Precision Agriculture*

VR Applications

Dennis Hancock and Lloyd Murdock

In theory, varying input rates across a field makes good sense because areas that need more (less) get more (less). It seems like it would work great for the major inputs/expenses such as lime, N - P - K, seed, pesticides, etc. However, for each of these to be accepted by the producer, it has to provide an increase in profit. Research success has been marginal for P and K with some studies showing the potential exists within given fields, while many others have shown no impact. The research on lime has been more favorable.

Crop yield within a given area of a field is the result of a system of independent and interdependent factors. Research has been conducted to determine what part of the system is limiting yield in a given spot by controlling a limited number of these factors at a time - too many variables makes it impossible to interpret results, too few variables and the results are meaningless.

One of the keys is having a clear, rational reason for varied management in a field. A multitude of methods exist to develop this "blueprint," and there is much debate as to which is best. Some have used areas that stand out on a yield map. For example, Dr. Murdock tried varying N rate on low, medium, and high yielding areas within a Trigg County field that had been identified on a yield map (Figure 1). To be profitable, the yield increase for additional N must be different between the management areas. In this example, the yield response to an additional N was at a similar rate in the three different yield zones, for 2000-02.

Perhaps the leading candidate for defining management areas are those based on identified differences in topsoil depth. In other studies by Dr. Murdock, topsoil depth has been shown to explain 70-90% of the yield variability in a field. On average, each additional inch of topsoil, up to 8 in., increased corn yields by 10.1 bu/acre. Topsoil depth can be thought of as an indicator of the reservoir available for the plant. It stores nutrients and (most importantly) water and makes them available to the plant.

The topography in the field, particularly if intensively cropped in the past, usually will have different topsoil depths within a given field. Thus, using landscape position as a proxy for topsoil depth might be reasonable. Preliminary results from a study in Hardin County have indicated that varying seeding along with N rate may have potential (Table 1). In small plots, N and seeding rates were increased on foot slope positions, held at conventional rates on ridge tops, and decreased on the hill sides. This resulted in an average increase of 8.1 bu/a on the hill sides and 27.0 bu/a on the foot slopes.

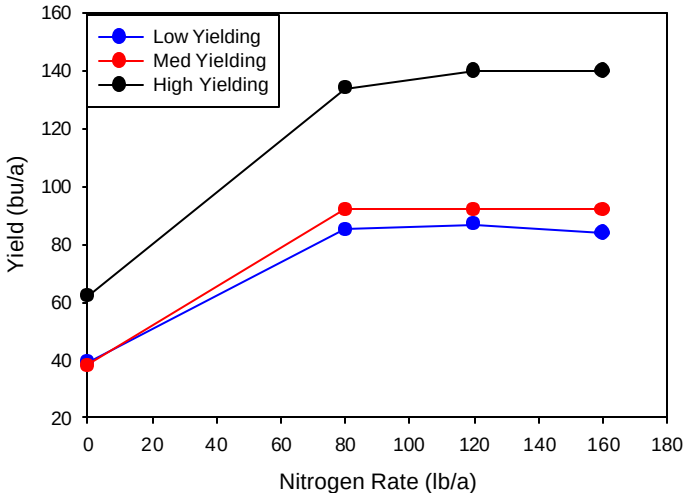

Figure 1: Yield response to increased N rate on high, medium, and low yielding areas within a field during 2001.

Table 1. Effects of varying seeding and nitrogen (N) rate based on landscape positions in a corn field.

Landscape Position	*Seeding Rate (K/a)*	*N (lb/a)*	*Yield (bu/a)*
Hill side	27	160	120.6
Ridge top	27	160	145.9
Foot slope	27	160	155.5
Hill side	24	140	**128.7**
Ridge top	27	160	146.4
Foot slope	30	180	**182.5**

Also in this Issue...

If we accept that this potential exists, there are still other considerations:

- Is there enough variability within a field?
- Will it result in a NET return?
- Is the equipment accurate? (see John Fulton's article on pg. 3)

Not all fields exhibit enough variability to justify site-specific management.

The question of "how variable is too variable?" still remains. Certainly, the answer to that is field/farm-specific. In some situations, input levels may potentially increase beyond the increase in returns. Thus, site-specific management may actually decrease the net returns in those fields. Ultimately, as a producer in Hardin County recently said, it's just as important to "know when not to use it."

Varying input rates of major inputs/expenses across a field is a good theory, and some studies have had encouraging results. In practice, it has to provide a measurable increase in profit within each field that it is used. The nature of the system involved in crop production means that profitable variable rate applications will likely involve optimizing the whole system. The success of site-specific management is thus dependent on the site. ?

Multifaceted Research Highlighted at Conference

Laura Skillman,
Extension Associate for Agr. Communications

Research efforts in precision agriculture at the University of Kentucky College of Agriculture focus on this vast new technology with an eye toward enhancing income and environmental quality.

Nancy Cox, associate dean for research, said a grant from the USDA, secured by U.S. Sen. Mitch McConnell, has helped support the research since 1999. Cox said the research is geared toward Kentucky farms by a multidisciplinary team of UK specialists who work well together.

> ***"This is a team effort."***
> - Scott Shearer, an Extension agricultural engineer and steering committee chair.

"They are committed to being relevant," Cox said. "They want to answer the questions that are most relevant to the farmers."

A nine-member steering committee consisting of faculty from the departments of agronomy, agricultural economics and biosystems and agricultural engineering guides the research efforts.

"This is not the type of research that can be undertaken by one academic discipline or by any one group whether that be service providers, manufacturers or farmers," said Scott Shearer, an Extension agricultural engineer and steering committee chair. "This is a team effort."

There are 24 UK faculty and eight professional staff members participating in various research and Extension projects. In addition, there is an industry advisory board of farmers and private industry representatives that review project proposals. The U.S. Natural Resources Conservation Service also is involved.

"There is a broad range of people who have something to say with regard to how this project proceeds," he said.

The team's effort focuses on research and outreach programs that are pertinent to Kentucky farmers, based on the scale of Kentucky farms and the nature and variety of what is produced in Kentucky, he said.

In Kentucky there is probably more variability in soils and climate across the state than any other state in the nation, Shearer noted.

"It's this variability that Kentucky farmers need to exploit," he said. "It's doing the right thing at the right place at the right time."

In addition to meeting the needs of producers, precision agriculture can serve society at large by its site-specific technologies and its impact on environmental quality. Evaluating these technologies and their relationship with environmental quality is another of UK's research objectives.

To date, nearly 40 precision agriculture projects are ongoing. Research is being conducted in eight Kentucky counties from central to western Kentucky. Projects range from equipment accuracy testing to variable rate seeding to site-specific nutrient management to profit mapping. There also are cooperative projects being conducted with two regional universities.

Some of the research was highlighted during the first precision agriculture conference sponsored by UK during the recent National Farm Machinery Show in Louisville. Plans are to have an annual conference to update farmers, industry and the public on the latest research findings.

In addition to the research, there is a strong outreach component that uses the UK Cooperative Extension Service to get information generated from the research quickly into the hands of producers. For more information on precision agriculture research projects as well as educational materials access the Precision Agriculture website at www.bae.uky.edu/precag. ?

Research HIGHLIGHTS

VR Fertilizer and Lime Application

*John Fulton**

Some producers have started to utilize variable-rate technology (VRT) to help adjust inputs to local needs. One of the ways VRT is being employed is through the use of existing spinner spreader technology. Spinner spreaders have long been used to apply granular materials; however, it is typical for application variation to be up to 20% or even higher with this equipment. This variation is largely overlooked due to the cost and simplicity of spinner spreaders. But a couple questions remain regarding VRT and spinner spreaders: is the process profitable, and is the equipment accurate enough to accomplish the objectives.

Our research thus far has focused on the accuracy of the equipment. When moving from fixed to variable-rate (VR), users need to be aware of some of the potential errors that may occur. Most VR control systems require some time to make adjustments, thus rate changes are not performed instantaneously (Figure 1). However, software manufacturers supporting VR control provide a "look-ahead-time" to help compensate for response times of VR control systems.

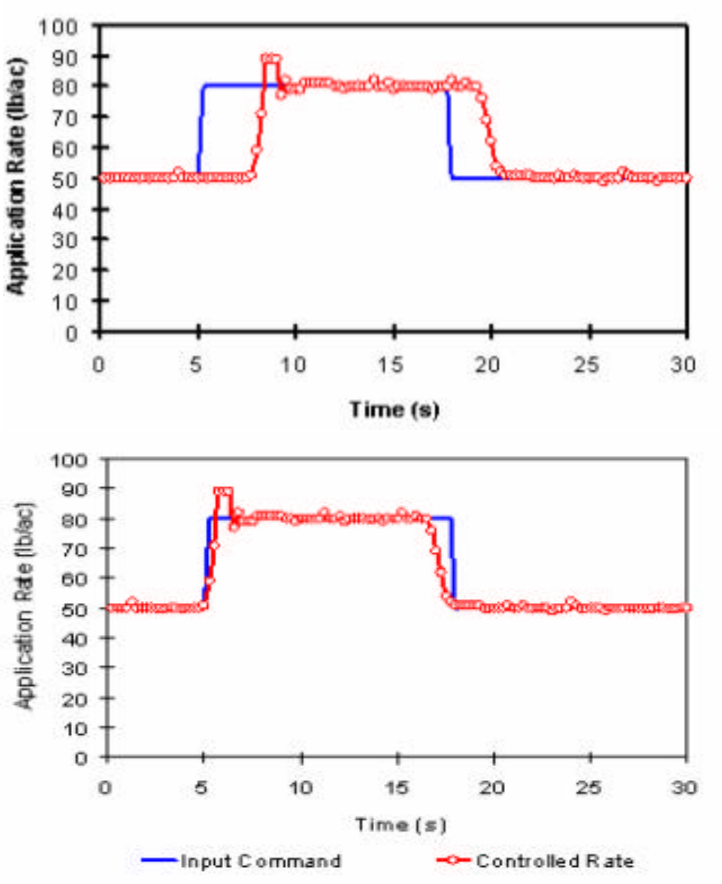

Figure 1. Hydraulic system response without a look-ahead-time (top) and with a 3 second look-ahead-time (bottom).

Another issue observed with VR spinner spreaders is distribution pattern shifts. Undesirable distribution patterns are sometimes created at different application rates (Figure 2). These different patterns indicate that spreader settings need to be simultaneously adjusted during rate changes to maintain a desirable distribution pattern. These are just a couple of the potential problems what have been observed and quantified so far with this research. These machine performance limitations will have a direct impact on the minimum zone size that can be managed.

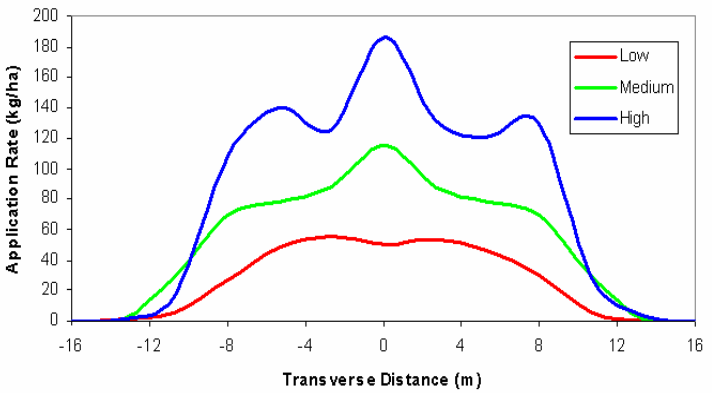

Figure 2. Distribution patterns shifts with changes in application rate.

Another aspect of this research is the development of a model to generate 'As-Applied' maps. The model merges characterized distribution patterns with a field application record. Most VRT software allows users to capture application information while controlling VRT during field operations. Typically, the field application record represents the amount of material applied in the field, but does not describe how the material was actually distributed across a field. For example, the spreader may tend to apply more material to one side. Such information would not show up in the field application record map. Therefore, by understanding distribution patterns from a spreader and merging this with the field record information, an 'As-Applied' map can be generated to represent actual distribution of material across a field. In return, this map can be used to assess VRT and answer some of the questions regarding the use of this technology.

Figure 3 provides an overlay of a generated 'As-Applied' map and the prescription map for potash application by a spinner spreader. The legends for both maps are the same, so seeing particular points indicates deviation from the desired rate. As can be seen, the 'As-Applied' map does not closely represent the prescription map. Some of the variation happens at zone borders where rate changes occur. Some of the variation could be operator induced by not maintaining parallel passes.

The key conclusion is that what an operator tells the spreader to do and what it actually does may be very

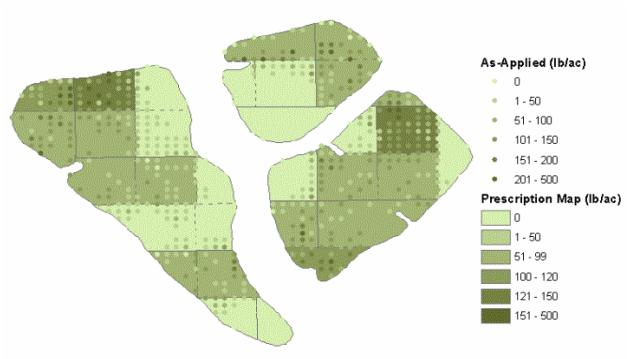

Figure 3. An 'As-Applied' map overlaying a prescription map.

different. Accepting the prescription map as actual application is misleading thereby leading to potential errors when evaluating VRT. This could be one of the reasons why research has concluded that the VR application of P and K is not profitable. The actual application is not close to the desired.

The VRT research and the development of an 'As-Applied' model are helping to address some of the concerns and questions regarding VRT. Being able to generate 'As-Applied' maps is a step to helping identify VRT errors and correcting them to improve application accuracy. These maps can be used to assist in calibration, determine optimal pass-to-pass distance, and set the proper look-ahead time. They also can be used to assess the profitability of VR application of P, K and lime. There may also be the potential to extract fertilizer response curves when used in conjunction with yield and fertility maps.

Future research involves enhancing the 'As-Applied' model and looking into VRT profitability by understanding the errors of VRT equipment. A few commercially available spinner spreaders are going to be tested along with air-boom delivery systems to see if they provide more uniform distribution over a range of application rates. In return, the objective of all is this research is to provide a feedback mechanism to help address VRT application and aid research on this technology by portraying the actual application of granular products. ?

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* John Fulton is a Research Engineer in the Biosystems and Agricultural Engineering Department. John has been actively researching VRT equipment and technology, as well as many other areas of Precision Agriculture.

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Check out some of the new additions to our website: www.bae.uky.edu/precag/

- **2003 Precision Agriculture Research Report**
  – Summarizes the UK PA research projects that are currently on-going or have just completed.
- **2003 Precision Agriculture Publication Report**
  – Lists the publication, presentation, and scholarly efforts of the UK PA research and Extension team.
- **Adoption of PA in Kentucky**
  – A research study that looked at who is using PA technologies and why.
- **Crop Management Journal**
  – This new online journal, published in conjunction with the Agronomy Society of America, is written with a practical flair and is now linked to our website.

Hands-on Training Opportunities:

UK Agronomy Field Day

When: Thurs., June 12: 2:00 – 8:30 p.m.
Where: Spindletop Research Farm, off Iron Works Pike, Lexington

Includes tours and presentations about agronomic topics and research at UK. Precision Ag equipment will be demonstrated, as well as bale wrapping, no-till tobacco, and water run-off management, starting at 2 p.m. Tours start at 4:30 p.m. An evening meal prepared by the KY beef and pork producers will be available. For more information, contact your County Extension Agent.

Got Questions? ..... We've Got Answers!

Quotables: *Technically Funny*

"Everything that can be invented has been invented." – **Charles H. Duell,** U.S. Commissioner of Patents, 1899

"If it keeps up, man will atrophy all his limbs but the push-button finger." **– Frank Lloyd Wright**

"Don't anthropomorphize computers -- they hate it." **– Anonymous**