

Variable Rate P Application Increases Rice and Soybean Yields

More precise application of P helps maximize yield and stabilize production

Summary: Low rice and soybean yields were associated with low soil P and compaction in cut areas. Variable rate P application increased whole field yield and reduced yield variability. Higher crop yields and potentially greater uptake of applied P should also result in reduced environmental P risks.

Approximately 1.1 million acres of soybeans and 250,000 acres of rice were produced in the Mississippi Delta region in 2003. Because of the alluvial nature of Delta soils, the variability in soil properties can be extensive. In addition to this natural variability, the practice of precision land leveling of fields for irrigation purposes

can significantly contribute to soil and crop variability. Soil and crop variability that results from the land-leveling process is now being more accurately quantified by using precision farming (PF) tools such as differential-corrected global positioning systems (DGPS), yield monitors, and geographical information systems (GIS).

The implementation of PF tools is not just beneficial to researchers. If used correctly, PF tools have the ability to help producers operate more efficiently, which often increases cash flow. The use of PF tools has increased since the technologies became commercially available in the mid-1990s. One important PF tool used by many rice and soybean producers in the

Mississippi delta is the DGPS yield monitor that allows producers to collect enormous amounts of data each year.

Many producers, however, have begun to experience difficulties in data management and synthesis after having collected multiple years of yield data. As a result, implementation of site-specific practices designed to help their crop management programs has been seriously impaired, causing many producers to question the feasibility of this technology.

The objectives of the research as outlined in this article were to use PF tools to: 1) define zones within a rice/soybean field where yields were consistently high, average, or low, 2) determine the factors that cause yield

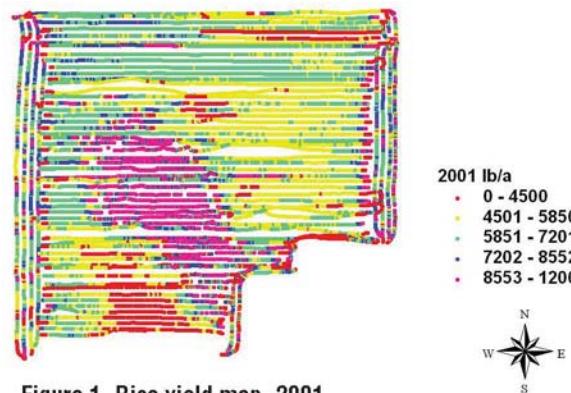


Figure 1. Rice yield map, 2001.

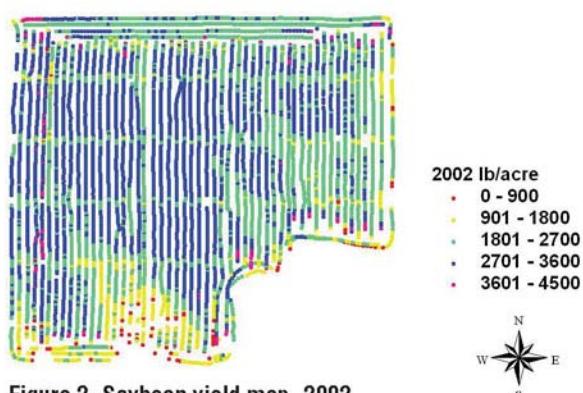


Figure 2. Soybean yield map, 2002.

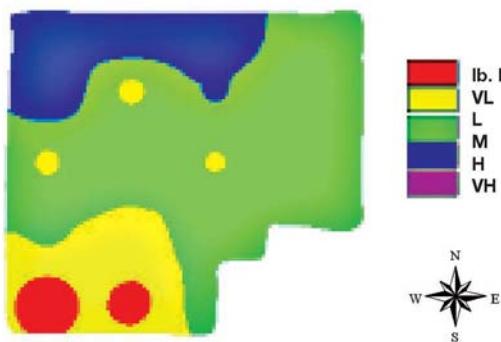


Figure 3. Extractable P levels, spring 2003.

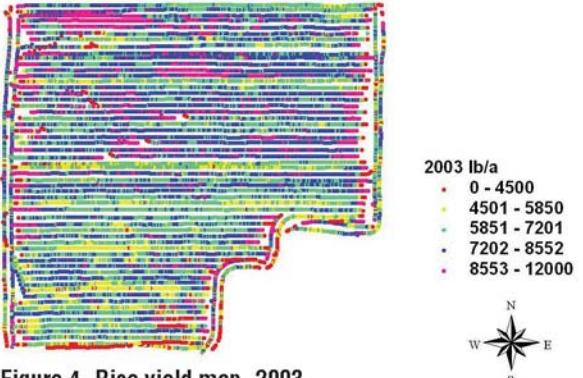


Figure 4. Rice yield map, 2003.

variability and address these factors, and 3) determine the economic feasibility of implementing these technologies in a production environment.

Yields

Rice/soybean. Average rice yield in 2001 (Table 1) was highly variable within the yield map (Figure 1). Though the yield variability or coefficient of variation (C.V.) was much less in the subsequent soybean crop (Table 1), the apparent yield zones (Figure 2) appear to be consistent with what was seen in the previous rice crop. The yield zone consistency was confirmed by performing a Multi-Year Yield Analysis in which those management zones were defined: high yield, average yield, and low yield. Soil test P results indicated that a P application was warranted over the majority of the field, but the southern portion of the field had a greater probability of obtaining a yield response (Figure 3). Analyses of the yield data collected from the 2003 rice crop indicated a substantial decrease in variability compared to the 2001 crop (Table 1). Figure 4 indicates a definite increase in rice yield in the P-limiting areas of the field as a likely result of variable rate (VTR) P application. Weather differences or other factors may also have been involved.

Our studies also showed that P fertility may not have been the only source of yield variability. One hypothesis from our data is that compaction after precision land leveling may have been limiting yields the first two years.

Further research has additionally shown a strong correlation between

Year	Crop	Average, lbs/A	C.V.%
2001	Rice	6,932	38.9
2002	Soybeans	2,662	23.6
2003	Rice	7,159	2.22

Table 1. Crop Yield average and coefficient of variation (C.V.) over time.

total soil volume that was cut and the difference in yield compared to the fill area. Thus, a second hypothesis that may further define the decrease in field variability from 2001 to 2003 is that organic matter additions (e.g., crop stubble) from the previous cropping year aided in the restoration of the disturbed microbiological ecology that was caused by the land-forming process.

Economics

A question that is asked often by producers when discussing the implementation of PF is: "Will this technology pay for itself?"

A cost analysis was conducted for the field from which these data are reported. When comparing the whole field average rice yield in 2001 to that of 2003, the net increase in grain of 227 lbs/A would amount to a net return of \$21.44/A.

The cost of applying these PF technologies would be approximately \$16.57/A. The Mississippi State University Extension Service (MSU-ES) recommends that when fields have been recently land leveled, that soil samples be randomly collected and composited based on whether the area has been 'cut' or 'filled.' If this method had been used, based on the soil samples that were collected from areas of 'cut' and 'fill', it is highly probable that a blanket application of 30 lbs/A of P_2O_5 would

have been recommended. This would have cost \$12.96/A, or \$453.60 for the 35-acre field. That is less than the cost of the VRT-P treatment. However, studies by MSU scientists indicate that if P had been uniformly applied at the recommended rate, maximum rice yields would not have been obtained in the area of the field where soil test P was in the very low to low range. That theoretically would have resulted in a lower whole-field yield average.

Conclusions

Use of PF tools (i.e., DGPS yield monitors, GIS, grid soil sampling, and VTR), coupled with topography maps (i.e., "cut" and "fill" maps): 1) successfully defined management zones, 2) determined yield limiting factors, and 3) addressed one of the key limiting factors: inadequate P fertility. These tools decreased whole-field yield variability and increased total rice production.

Although there was an added expense of applying P with VRT, this method was more agronomically appropriate. More precise application of P to areas of need helped to maximize yield and resulted in more consistent production of rice within management zones.

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