Towards Environmentally Conscious Precision Agriculture

By varying seeding densities for corn on fields with non-uniform productivity and using small format remotely-sensed imagery to monitor growth, investigators were able to demonstrate that this practice can optimize yields, reduce farming expenditures and inputs, and minimize agriculture's impacts on the surrounding landscape.

Who cares and why?

Precision agriculture (PA) allows farmers to make marked improvements in efficiency, profitability, and sustainability. Yield monitoring (a major component of PA) allows for unprecedented insight into how yield varies across a field, while Remote Sensing (RS) allows farmers a real-time snapshot of infield crop performance. In fact, normalizing several seasons of yield data in conjunction with RS imagery helps farmers identify areas that can be individually managed depending on their yield potential (management zones). So far, most management zone (MZ) research has been limited to in-season chemical applications, although benefits are possible in other aspects of PA. In fact, its use in variable rate seeding (VRS) exhibits great potential since traditional uniform rate seeding leads to reduced efficiency and adverse environmental effects. This is pertinent since agricultural inputs are now fetching higher than normal prices. It is also especially important in sensitive areas such as the Chesapeake and Coastal Bays watershed where excess fertilizers can lead to harmful algal blooms and reduced ecosystem vigor. Therefore, it is imperative to evaluate solutions to such problems in an effort to maintain a vibrant and responsible agriculture sector.

Some PA tools: (Counterclockwise from top left) Combine, yield monitor, RS platform, and kite.

What has the project done so far?

During the trial period, the researchers tested the hypothesis that the use of MZs in conjunction with VRS and RS can increase farming efficiency. To accomplish this, several MZ's on a 50-acre research field were identified from 3 years of yield data. Once the data were georeferenced, each zone was seeded with corn at three seeding densities recommended by the University of Maryland Extension Office. During the growing season, several parameters were measured, including the leaf area index (LAI), plant height, and relative greenness. These were then analyzed by ANOVA to identify the differences existing between the various trial combinations. Small-format RS images were also captured to provide in season crop vigor data. Finally, seed, fertilizer costs, harvest price, and a host of other parameters were used to compute a series of cost-benefit analyses. These subsequently determined the optimum management strategy for each MZ and have been instituted on the UMES farm ever since. With the research phase concluded, the findings were disseminated in several venues. Some of these include the agriculture field days held at the University of Maryland Eastern Shore (UMES) and several professional meetings and conferences. In fact, this project was awarded first place in Graduate Research for Sustainability at the 2011 Association of Research Directors (ARD) Meeting in Atlanta, GA. Furthermore, this research has also laid the foundation for additional graduate and undergraduate research, which has increased the research capabilities on the UMES campus and collaborations among faculty, scientists, and other researchers at USDA Beltsville, NASA Wallops, and Delaware and Morgan State Universities.

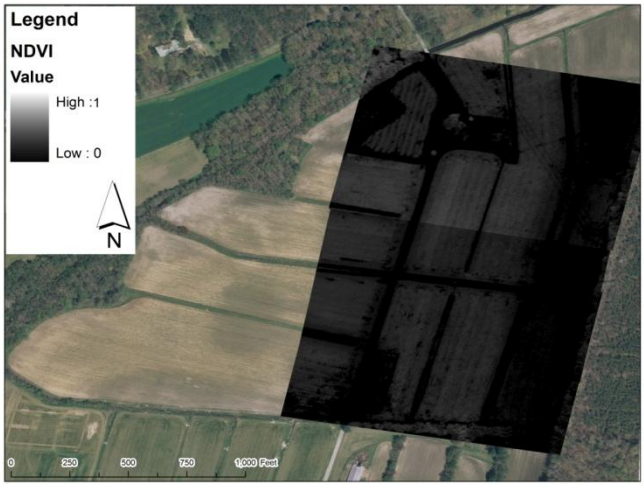
Impact Statements

Studied the relationship between seeding density and yield potential and their effect on final crop yield, resulting in new management strategies for fields with variable productivity.

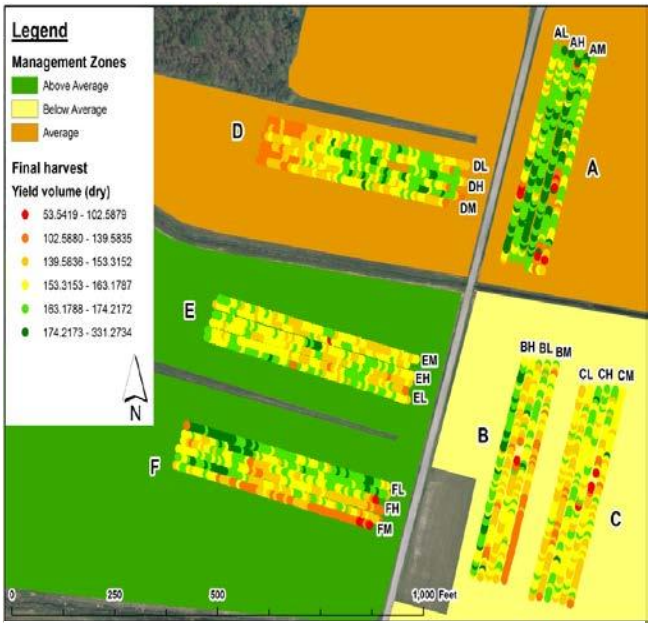
Compared the performance of small-format RS imagery to that of traditional sources and proved that small-format was indeed beneficial for day-to-day in season observations. Improved the profit margins and reduced environmental impact of farm activities on the UMES Research Farm through strategies that can be implemented at other settings.

Demonstrated the value of small-format RS platforms for quick in season measure of crop vigor. Developed a set of standard procedures for researchers or farm operators to utilize such platforms in day-to-day agricultural activities.
Presented at extension and outreach programs to other small farmers and stakeholders. Research and findings were also published in a peer-reviewed journal and presented at several professional meetings and conferences and was selected as a top project in the area of sustainability systems at the ARD 2011 Conference in Atlanta. Research also led to a master's thesis in natural resources management.

Developed a list of best practices for seeding and farm input management that has was since instituted on the UMES Research Farm. Changed attitudes toward yield optimization and nutrient management that have the potential of reducing agriculture's footprint on sensitive ecosystems.



Crop performance data as obtained from RS platform. Lighter areas indicate better crop performance.



Final crop yields within management zones at the UMES Research Farm complex.

What research is needed?

While these strategies can improve some aspects of farming, more research is needed to see how precision water management and nitrogen use efficiency can further improve farming practices, especially since this is becoming an increasingly limited resource.

Want to know more?

Madhumi Mitra, Ph.D.
mmitra@umes.edu

Abhijit Nagchaudhuri, Ph.D.
anagchaudhuri@umes.edu

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