

## Indiana NCERA-180 Report—2006

### Site-Specific Management Center (SSMC)

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#### **Principal Investigators:**

Jay Akridge, Agricultural Economics	Kevin Gibson, Botany & Plant Pathology
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Jeff Boyer, Manager, Davis-Purdue Agricultural Center	Javed Iqbal, Agronomy
Sylvie Brouder, Agronomy	Chris Johannsen, Agronomy
Shawn Conley, Agronomy	Jess Lowenberg-DeBoer, Agricultural Economics
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Bernard Engel, Ag. & Biological Engineering	Phillip Owens, Agronomy
Bruce Erickson, Agricultural Economics	Gary Steinhardt, Agronomy
Daniel Ess, Ag. & Biological Engineering	Mack Strickland, Ag. & Biological Engineering
Jerry Fankhauser, Director, Purdue Ag. Centers	Larry Theller, Ag. & Biological Engineering
Jane Frankenberger, Ag. & Biological Engineering	Tony Vyn, Agronomy
Raymond Florax, Agricultural Economics	Stephen Weller, Horticulture & Landscape Architecture

**Abstract:** In 2006 the work of the SSMC focused on disseminating results of site-specific management research at Purdue to the agricultural community, via the website ([www.purdue.edu/ssmc](http://www.purdue.edu/ssmc)), the monthly site-specific management seminar on campus, articles in the trade press and conference presentations.

#### **Publications** (all available at [www.purdue.edu/ssmc](http://www.purdue.edu/ssmc)):

Erickson, B., and J. Lowenberg-DeBoer. Will Higher Fertilizer Prices Drive Adoption of Precision Fertilizer Management? *SSMC Newsletter*, January, 2006.

Lowenberg-DeBoer, J. Effect of Higher Energy and Fertilizer Prices on Precision Ag Adoption. *SSMC Newsletter*, February, 2006.

Owens, P.R., J. Iqbal and D.M. Miles. Using Geostatistics to Determine Spatial Variability of Nutrients Within a Poultry House. *SSMC Newsletter*, March, 2006.

Fulton, J.P., M.W. Veal and S.A. Shearer. Performance Assessment of Variable Rate Fertilizer Technology. *SSMC Newsletter*, April, 2006.

Erickson, B. The Use of Information Technology in Danish Agriculture. *SSMC Newsletter*, May 2006.

Lowenberg-DeBoer, J. and T. Griffin. Potential for Precision Agriculture Adoption In Brazil. *SSMC Newsletter*, June 2006.

Erickson, B. On-Farm Testing, Robotics, and Guidance Featured at the 2006 Top Farmer Crop Workshop. *SSMC Newsletter*, July, 2006.

Terry Griffin, T., C. Dobbins, and J. Lowenberg-DeBoer. Whole Farm Profitability Impact from Implementing and Harvesting On-farm Trials: A Linear Programming Model. *SSMC Newsletter*, August, 2006.

Erickson, B. Precision Agriculture in Colombian Sugar Cane. *SSMC Newsletter*, September, 2006.

Erickson, B. A Comprehensive New Resource: Handbook of Precision Agriculture. *SSMC Newsletter*, October, 2006.

Struthers, R., and B. Erickson. The Modifiable Areal Unit Problem in Precision Agriculture. *SSMC Newsletter*, November, 2006.

Armstrong, S., and P. Owens. Spatial Variability of Nutrients in Soils Following Long-Term Poultry Litter Applications. *SSMC Newsletter*, December, 2006.

### **Precision Agricultural Services Survey**

**Principal Investigator:** Jay Akridge

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**Abstract:** The annual survey of crop input retailers showed that 81 percent of respondents used precision technologies in some way in their dealership, up from 75 percent in 2005. Precision activity is highest among outlets of cooperatives and national/regional chains. Dealers are expanding adoption of precision technologies for internal uses. The growth in the number of dealerships offering precision services has slowed, but grower adoption has continued to expand at a modest pace. Another survey is planned for early 2007.

#### **Publications:**

Whipker, Linda, and Jay Akridge, "2006 Precision Agricultural Services: Dealership Survey Results." Staff Paper No. 06-10, Center for Food and Agricultural Business, Department of Agricultural Economics, Purdue University, West Lafayette, IN, USA, August 2006.

Whipker, Linda and Jay Akridge. "A New Future," *CropLife*. June 2006, pp 10-15.

### **Site Specific Agricultural Research at Regional Agriculture Centers**

**Principal Investigators:** Jeff Boyer, Stephen Hawkins, P.C. Walker, and R.L. Nielsen.

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**Abstract:** The increasing availability of precision agriculture technologies is facilitating an increase in field-scale agronomic research by researchers and farmers alike. Such large-scale research, however, challenges research station personnel to develop efficient systems that best balance researchers' needs for statistical design and experimental precision with the research farm's logistical needs associated with operating commercial-scale field equipment for field research purposes. Additionally, long-term field-scale research usually requires the development of a GIS database to document the spatial nature of field equipment operations, imposed research treatments, and geo-referenced data collected from the research

plots. Finally, researchers want to avoid anomalies in the field while ensuring that plots really will fit in a field before traveling or wasting hours redrawing plot plans in the field. One solution in managing larger plots is to utilize DGPS-enabled software, hardware, and equipment to locate reference points over time, collect data, and communicate results with researchers and the public. Work will continue in 2007 with several researchers using GPS technology for large scale research plots at the Davis-Purdue Agricultural Center.

## **Site-Specific Fertilizer Recommendations and Sampling Guidelines**

**Principal Investigator:** Sylvie Brouder

Department of Agronomy, Purdue University, West Lafayette, IN 47906, phone: (765) 496-1489; fax: (765) 496-2926; email: [sbrouder@purdue.edu](mailto:sbrouder@purdue.edu)

**Abstract:** Research involves site-specific data integration, evaluation, and development related to fertilizer recommendations and use efficiency in Indiana cropping systems. Research activities have emphasized protocols for delineating management zones and evaluation of soil fertility interactions related to grain quality.

### **Publications:**

Adamchuk, V.I., M.T. Morgan, and S.M. Brouder. 2006. Analysis of variability in automated soil pH measurements. *Trans. ASAE*. 22(3): 335-344.

Scharf, P.C., S.M. Brouder, and R.G. Hoefl. 2006. Chlorophyll meter readings can predict nitrogen need and yield response of corn in the North-Central USA. *Agron. J.* 98:655-665.

## **Theory and Practice of Spatial Econometrics**

**Principal Investigators:** Raymond Florax

Department of Agricultural Economics, Purdue University, West Lafayette, IN 47906, phone: (765) 494-4300; fax: (765) 496-9176; email: [rflorax@purdue.edu](mailto:rflorax@purdue.edu)

**Abstract:** Research deals with spatial data analysis, spatial econometrics, spatial and environmental modeling, and meta-analysis. Named External Fellow of the Mansholt Graduate School for Social Sciences at Wageningen Agricultural University, Wageningen, The Netherlands (<http://www.sls.wau.nl/mi/mgs/index.htm>).

### **Publications:**

Griffin, T.W., J.M. Lowenberg-DeBoer and R.J.G.M. Florax, "Improving Farm Management Decision Making: Experience from Spatial Analysis of Yield Monitor Data from Field-Scale On-Farm Trials," presented at the 8th International Precision Agriculture Conference, Minneapolis, MN, July 23-26, 2006.

Lambert, Dayton M., R.J.G.M. Florax, and Kevin McNamara.. Multiplicative Heteroskedastic-Spatial Process Models: Monte Carlo Experiments and an Empirical Example, proceedings of the 53rd Annual North American Meetings of the Regional Science Association, November 16-18, 2006, Toronto, Canada.

Nistor, Adela, Jason Brown, Raymond Florax, and Jess Lowenberg-DeBoer. Spatial Modeling of Yield Monitor Data: Implications for Crop Yields with Drainage Water Management, proceedings of the 53rd Annual North American Meetings of the Regional Science Association, November 16-18, 2006, Toronto, Canada.

## **Soil Spatial Variability/Remote Sensing/Crop Simulation Modeling/ Hydrological Modeling in GIS**

**Principal Investigators:** Phillip Owens, Javed Iqbal

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**Abstract:** Research involves spatial variability analysis (variogram, autocorrelation, Moran's I, kriging/co-kriging etc.) of soil physical and chemical properties, remote sensing of crop biophysical condition (water and nutrient stress) and mapping of soil properties on a field-scale, crop simulation modeling (GOSSYM and DSSAT), hydrological modeling in GIS at landscape level in agriculture, and soil moisture sensors calibration (Diviner 2000 and Troxler 200AP) and soil moisture monitoring.

### **Published Abstracts:**

Iqbal, J., P.R. Owens, B.D. Lee and H.E. Winzeler. 2006. Apparent conductivity of a Fragiudalf-Glossaqualf Catena in Loess over Illinoian till, Southeastern Indiana. America Society of Agronomy International Meetings. November 12-16, 2006, Indianapolis, IN.

Owens, P.R. D.G. Schultz and G. Van Scoyoc. 2006. Utilizing SSURGO and GPS on tablet PC's to elucidate geomorphology-soil relationships in the glaciated portions of Indiana. America Society of Agronomy International Meetings. November 12-16, 2006, Indianapolis, IN.

Owens, P.R. F.V. Hearnly, J. Iqbal and B.D. Lee. 2006. Using SSURGO and historic data to delineate the drained Kankakee Marsh in Northern Indiana. America Society of Agronomy International Meetings. November 12-16, 2006, Indianapolis, IN.

Winzeler, H.E., P.R. Owens, B.D. Lee, J. Iqbal and K. Hart. 2006. Soil spatial variability on the Wabash end moraine, Indiana. America Society of Agronomy International Meetings. November 12-16, 2006, Indianapolis, IN.

Owens, P.R. and J. Iqbal. Remote Sensing of Soil Surface Texture, Carbon and Water Contents using Bare Soil Imagery. 2005. American Geophysical Union Meetings, San Francisco, CA.

Iqbal, J., P.R. Owens, and S.M. Brouder. 2005. Evaluation of AEGIS/WIN a crop model interface to simulate Maize crop yield under different soil input scenarios. America Society of Agronomy International Meetings. November 6-10, 2005, Salt Lake City, UT.

Iqbal, J. and P.R. Owens. 2005. Field-Scale Mapping of Soil Properties Using Hyperspectral/Multispectral Aerial Imagery. America Society of Agronomy International Meetings. November 6-10, 2005, Salt Lake City, UT.

Owens, P.R., J. Iqbal and D.E. Rowe. 2005. Spatial variability of nutrients in soils following long-term poultry litter applications. America Society of Agronomy International Meetings. November 6-10, 2005, Salt Lake City, UT.

### **Journal Publications:**

Iqbal, J., P. Owens, and I Ali. 2006. Application of Remote Sensing Data to Assess Weed Infestation in Cotton. *Agricultural Journal* 1(4): 186-191.

Iqbal, J., J.A. Thomasson, J.N. Jenkins, P.R. Owens and F.D. Whisler. 2005. Spatial Variability Analysis of Soil Physical Properties of Alluvial Soils. *Soil Science Society of America Journal*. 69: 1338-1350

## **Remote Sensing Applications in Agriculture**

**Principal Investigator:** Chris J. Johannsen

Department of Agronomy, Purdue University, West Lafayette, IN 47906, phone: (765) 494-6248; fax: (765) 496-2926; email: [johan@purdue.edu](mailto:johan@purdue.edu)

**Abstract:** Focus on remote sensing applications including soil landscape dynamics relating to soil variability and soil management zones, yield-influencing factors, automated correction of sensor errors, vegetation damage by insects, flooding impacts on corn and soybeans, and weed anomaly monitoring. Research related to apparent electrical conductivity (ECa), crop residue detection, and spatial/temporal variability pattern analysis of soil properties on different landscape scales is planned for 2007.

### **Publications:**

Mercuri P. A., B.A. Engel and C. J. Johannsen. 2006. Evaluation and Accuracy Assessment of High-Resolution IFSAR DEMs in Low-Relief Areas. *International Journal of Remote Sensing*. Vol. 27 (13): 2767-2786, July.

Johannsen, C.J. 2006. "Land Remote Sensing Applications for Human Welfare Support: Food Security". Contributions of Remote Sensing for Decisions about Human Welfare Workshop, National Research Council, Washington, DC. Appendix A 4 pp.

## **Economics of Knowledge Intensive Agriculture for Crop Farms**

**Principal Investigator:** Jess Lowenberg-DeBoer

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**Abstract:** Research in 2006 provided insights into 1) the economic feasibility of spatial and temporal management of crop inputs and practices 2) development of statistical methods for using sensor data and 3) the potential for knowledge intensive solutions to crop production problems that maintain or increase profits while at the same time improve the environment. Previous research on the economics of site-specific crop management indicated that higher input and crop prices encourage adoption of precision agricultural practices. A reanalysis of data from Indiana site-specific fertilizer studies in 1990s suggests that while the higher fertilizer and corn prices in 2006 increase the profitability of site-specific management, these prices do not change the overall results of those earlier studies. Variable rate application (VRA) of lime is even more profitable than it was in the 1990s. Studies show that VRA of phosphate and potash is sometimes profitable, depending on soil test levels, information costs, VRA fees and crop response. The profitability of VRA of nitrogen varies widely from year to year because of the temporal variability of nitrogen response. Evidence from on-farm-trials near Windom, Minnesota, showed that phosphate response is quite stable in parts of the field, but nitrogen response varied widely from year to year.

Research on knowledge intensive crop management practices showed that controlled drainage could provide enough yield advantage to cover the cost of labor and of installing water management structures. Spatial econometric analysis of yield monitor data from central Indiana fields in 2005 showed a corn yield advantage of controlled drainage of 5 to 20 bu./acre at the average field elevation. The yield advantage was slightly higher in the lower portions of the topography and negligible in the upper portions of the topography. With the 2005 level of yield advantage, the annual benefit of controlled drainage ranged from \$11.45 to \$14.19 per acre without government subsidies.

### **Publications and Presentations:**

Brown, Jason, "Methodology for Determining the Economic Feasibility of Controlled Drainage in the Eastern Corn Belt," MS Thesis, Department of Ag Economics, Purdue University, West Lafayette, IN, USA, 2006.

Erickson, B., and J. Lowenberg DeBoer. Will Higher Fertilizer Prices Drive Adoption of Precision Fertilizer Management? Purdue Agricultural Economics Report, April, 2006.

<http://www.agecon.purdue.edu/extension/pubs/paer/2006/april/paer0406.pdf>

Erickson, Bruce. "Economics of Precision Agriculture: Implications for Sugar Cane Production," presented at the Colombian Association of Sugar Cane Technologists National Conference, Cali, Colombia, September 2006.

Griffin, Terry, "Decision-making from On-Farm Experiments: Spatial Analysis of Precision Agriculture Data," PhD Dissertation, Department of Ag Economics, Purdue University, 2006.

Griffin, Terry, and J. Lowenberg-DeBoer, "Worldwide Adoption and Profitability of Precision Agriculture: Implications for Brazil," *Revista de Politica Agricola*, 14:4 (2005), [http://www.embrapa.br/a\\_embrapa/unidades\\_centrais/sge/publicacoes/tecnico/revistaAgricola/index\\_htm](http://www.embrapa.br/a_embrapa/unidades_centrais/sge/publicacoes/tecnico/revistaAgricola/index_htm), p. 20-38.

Griffin, Terry, J. Lowenberg-DeBoer and R.J.G.M. Florax, "Improving Farm Management Decision Making: Experiences from Spatial Analysis of Yield Monitor Data from Field Scale On-Farm Trials," Paper presented at the 8th International Precision Agriculture Conference, Minneapolis, MN, July, 2006.

Lambert, Dayton, J. Lowenberg-DeBoer and Gary Malzer, "Economic Analysis of Spatial-Temporal Patterns in Corn and Soybean Response to Nitrogen and Phosphorous," *Agronomy Journal*, 98 (2006), pp. 43-54.

Lowenberg-DeBoer, J., Terry Griffin, R.J.G.M. Florax, "Use of Cross Regression to Model Local Spatial Autocorrelation in Precision Agriculture," Paper presented at the 8th International Precision Agriculture Conference, Minneapolis, MN, July, 2006.

Lowenberg-DeBoer, J., and B. Erickson. "Economics of Innovative Technologies in Precision Agriculture Nutrient Management," presented at the American Society of Agronomy International Meetings, November, 2006.

### **Trade Articles:**

Erickson, B. "Equipped to Succeed." *CropLife*, March 2006, pp 19-20.

Erickson, B. "Fertilizer and Precision," pp. 12-13 in 2006 Technology Tune-Up, supplement to February 2006 editions of *CropLife*, *American Vegetable Grower*, *CottonGrower*, and *Western Fruit Grower*.

### **Using Soil Electrical Conductivity to Delineate Soil Management Zones**

**Principal Investigator:** Gary Steinhardt

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**Abstract:** The use of soil electrical conductivity (EC) as a means of delineating soil management zones is being investigated. Bare soil areas have been established at the Purdue Agronomy Center for Research and Education in an area with a good Order II soil map, and EC and soil moisture information is being collected weekly (weather permitting). At the Davis-Purdue Agricultural Center in East-Central Indiana,

work is in progress to investigate how site-specific long-term yield monitor data correlates with Order I soil survey information. 120 acres of an Order 1 survey have been completed at the Davis Farm.

**Publications:**

Struthers, R. R. Spatial Temporal Variability Pattern Analysis of Soil Properties on Different Landscape Scales. Ph.D. Dissertation, Department of Agronomy, Purdue University, 2006.

**Automatic Guidance and Site-Specific Applications for Tillage Systems, Fertility Placement and Crop Response**

**Principal Investigator:** Tony Vyn

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**Publications:**

Omonode, R.A., and T. Vyn. 2006. Spatial dependence and relationships of electrical conductivity to soil organic matter, phosphorus, and potassium. *Soil Science* 171(3):223-238.

**Using Remote Sensing to Detect and Manage Weeds in Mint**

**Principal Investigators:** Stephen C. Weller and Mary Gumz

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**Abstract:** Peppermint and spearmint are grown as high value essential oil crops in the Midwestern U.S. (IN, MI, and WI) and the Pacific Northwest (OR, WA, MT, and ID). Remote sensing-based site-specific weed management offers great potential to decrease weed control costs by simplifying weed detection and producing site specific herbicide application maps. In order to automate the process of turning a remotely sensed image into an herbicide application map, some type of spectral identifier is needed that can be used to differentiate weed-free pixels from weedy pixels. Our past research has developed spectral vegetation indices (SVIs) for differentiating mint and key weed species. Our objective in these studies was to apply SVIs calculated from handheld spectroradiometer reflectance data to reflectance data calculated from airborne hyperspectral images to determine which method had the highest accuracy for differentiating between mint and weeds in the image. Airborne imagery is the fastest and most economical method to obtain reflectance data for production fields, but absolute reflectance can vary between images. SVI calculations were made from experimental field plots of peppermint, spearmint, giant foxtail, white cockle, tall waterhemp, Powell amaranth, common lambsquarter, and velvetleaf. SVIs based on simple ratios of reflectance values in the near infrared and green portions of the spectra accurately differentiated between peppermint and weed species, while simple ratios of near infrared and red reflectance values accurately differentiated between spearmint and weed species. The ratio of mint to weed SVI values was approximately 2 to 1 in both instances even though the absolute values of SVIs varied between spectroradiometer and image calculations. The 2X difference in SVI values can be used to identify weedy areas of a mint field in a hyperspectral image and allow accurate targeting of postemergence herbicide applications which would reduce costs and increase efficiency of weed management for growers.

**Presentations:**

Gumz, M.S. and S.C. Weller. 2006. Identifying weeds and mint based on spectral reflectance characteristics. WSSA Abstracts. 46:52.

Gumz, M.S. and S.C. Weller. 2006. Differentiation of mint and weeds using spectral vegetation indices. Proceedings of the 8th International Conference on Precision Agriculture. 8:57.

Gumz, M.S. and S.C. Weller. 2006. Using hyperspectral vegetation indices for weed detection in mint. Proceedings of the North Central Weed Science Society. 61:69.