Title:
A Long-Term Study to Further Enhance Variable Rate Fertility Management

Investigator(s):
Kent Shannon, Todd Lorenz, Joni Ross Harper, and Peter Scharf

Objectives, including relevance of project to Missouri fertilizer/lime use:
Variable rate fertilizer application has become a major component of the fertilizer industry. The technology for its development has progressed in tandem with GPS, the two combining to provide for accurate "on-the-go" variation in fertilizer application.

Regardless of the methodology used for variable rate fertility management, the rate of fertilizer applied is still highly dependent on the results of the analysis of soil samples and the fertilizer recommendations used.

As regional extension faculty two questions have been asked as relates to variable rate fertility management:

1) Could University of Missouri fertilizer recommendations be modified to better account for spatial variability using variable rate fertility management?
2) How can yield data be utilized in variable rate fertility management of phosphorus (P) and potassium (K) as relates to nutrient removal rates?

This project will address those questions through on-farm research and education.

The objectives of this project are:

1) To evaluate proposed changes in University of Missouri fertilizer recommendations in variable rate fertility management of P and K as relates to soil test critical values.

2) To gain a better understanding of how yield map data can be used to fine tune removal rates of P and K in a variable rate fertility system.

3) Provide producers and service providers the production and economic information necessary to make more informed variable rate fertility management decisions.

The main goal of the project is to better understand how the answers to the above questions can further improve the efficiency of variable rate fertility management of P and K while maintaining or improving crop yields. With the volatility of P and K prices, being able to further improve fertilizer use efficiency is important in today's production system. The result of the project also has the potential to further increase the adoption of variable rate technologies which not only effects profitability but in the end it also protects the environment.

Procedures:
Four crop fields of approximately 100 acres in size with high visibility will be selected for the research project. These fields will be selected so that corn will be in two of the field

in the proposed four year study. The fields will be grid soil sampled on a 1 acre grid capturing as much variability as possible. This will allow for better placement of the treatments within the field.

Four treatments will be used to evaluate the effectiveness and economics of furthering enhancing variable rate fertility management. These treatments will include:

1) A control which receives no fertilizer.
2) Whole field management of P and K fertilizer based on current University of Missouri fertilizer recommendations.
3) Variable rate fertility management of P and K based on a 2.5 acre grid using current University of Missouri fertilizer recommendations.
4) Variable rate fertility management of P and K based on a 2.5 acre grid using proposed University of Missouri fertilizer recommendations using soil test critical values of 30 lbs/acre for P and 200 lbs/acre for K.

The four treatments will be laid out to minimize any differences in soil type and terrain within the field. Each treatment will be replicated at least four times depending on the field layout. Plots will be at least 50'x300'. Plots will be embedded in a variable rate application map and applied with standard variable rate fertilizer application equipment. Plots will be harvested with a yield mapping equipped combine collecting data using a one second time interval.

Yield data will be processed utilizing GIS software to analyze treatment differences Estimations of P and K removal rates from grain yield will also be calculated by treatment to gain a better understanding of how yield map data can be used to fine tune removal rates of P and K in a variable rate fertility system.

As part of the data collection, actual plots will be soil sampled separately to better account for soil test changes as relates to variable rate fertility management and crop nutrient removal rates.

<u>Current status/importance of research area:</u>
Few long term studies across the Midwest have related to the issue of variable rate fertility management of P and K. None of been conducted in Missouri on a long-term basis. Conducting a four year study matches University of Missouri recommendations of soil sample every three to five years as stated in MU Guide G9217, Soil Sampling Hayfields and Row Crops.

There has been some work related to adjusting the soil test critical value. The soil test critical value is the target soil test level for optimum crop growth. When soil test levels are below the critical value crop yield and/or quality may be restricted by nutrient availability in the soil. University of Missouri soil test recommendations for phosphorus (P) assign a critical value of 40 to 45 lbs soil test P, depending on crop selection. Recommended potassium (K) critical value is based on crop selection and soil cation exchange capacity (CEC). For example, the critical value for corn is: 225 + (5 X CEC).

The proposed soil test critical value for variable rate fertility management will be 30 for P and 200 for K.

Two projects previously funded by the Fertilizer and Agricultural Lime Fund have indicated that soils in Missouri differ in the amount of P and K that is needed to raise soil test levels on a per unit soil test increase basis. Differences in buildup rates among Missouri soils raise the distinct possibility that soils also differ in critical value. The same mineralogical and chemical properties that cause one soil to need double the P to raise soil test a specific number of units may also affect the soil test level needed to provide optimum growth potential. This indicates a need for the proposed change in variable rate fertility management.

One other issue that arise with utilizing soil tests for fertilizer recommendations under variable rate fertility management the uncertainty that the crops growing in that particular spot where the test is taken yields the same as the crops in other locations in the field. If a field averages 150 bu/acre of corn, then maintenance fertilizer recommendations call for replacement of the P and K removed by the crop across the whole field. In reality, fields have a wide range in yield (for example, from 90 to 210 bu/acre). Using yield maps to correctly identify where the high and low yielding (plus everything in-between) areas are located would allow a more exact replacement of nutrients removed by a previous crop. Relying solely on soil tests for fertilizer recommendations tends to over-fertilize low-yielding areas and under-fertilize high yielding areas. Combining yield mapping and soil testing would reduce the amount of over-fertilizing of low yielding areas and under-fertilizing of high yielding areas. This may prove to be economically as well as environmentally friendly. This is another research area where little work has been done on a field scale such is proposed to be accomplish with this project.

<u>Timetable for proposed research:</u>
2010
Winter/Early Spring: Site selection, initial 1 acre grid soil sampling, apply fertilizer treatments
Summer: Demonstrations and field day
Fall: Yield map data analysis of the treatments

2011 and 2012
Summer: Demonstrations and field day
Fall: Yield map data analysis of the treatments

2013
Summer: Demonstrations and field day
Fall: Yield map data analysis of the treatments, final site specific soil sampling
Fall/Winter: Finalize data analysis and publish outcome

Strategy for application/transfer of knowledge:
Our greatest tool will be field and demonstration days, workshops and on-farm outreach seminars. Educational information will also be distributed through publications of our regional newsletter “Ag Connection”, press releases to local newspapers and radio outlets.

The evaluation plan for this project will include presentation pre and post test for producers participating in our workshops related to their knowledge of the specific topic areas. A follow-up survey will be mailed to the participants to evaluate long-term behavioral changes to their management practices for economic impact analysis.

We appreciate your consideration of this grant.

Proposed budget by years and by category: salaries/operating/equipment/other

Item	Description	2010	2011/12	2013
Soil Tests				
800 pre and post @ $10.00		4,000	0	4,000
Plot Specific Soil Tests	40 pre and post @ $10	200	0	200
Soil Sampling Equipment				
Computer Hardware/Software/Sampling Equipment		4125	0	0
Supplies	bags, markers, sign	125	0	125
Field Days	4 @ $500	500	1000	500
Publication	printing, postage	300	600	400
Travel	4,000 miles @ $.52	780	520	780
Sub total	by year	$10,030	$2,120	$6,005
Support Salary	25% of the above total	$2,508	$530	$ 1,501
Grant Total	by year total	$12,538	$2,650	$7,506

Four year total $22,694

D. Kent Shannon

Work Address	Home Address
1012 N. Highway UU	12901 East Hwy FF
Columbia, MO 65203	Centralia, MO 65240
573-445-9792	573-682-9990

SUMMARY OF QUALIFICATIONS

- Have a practical knowledge of agricultural production.
- Have developed educational programs with the goal of improving agricultural profitability.
- Have a good ability to work with others.
- Take pride in a job well done.
- Willing to learn, so as to broaden my knowledge as an agricultural engineer.

RELEVANT EXPERIENCE

Helped Missouri citizens turn knowledge into know-how as a Regional Extension Agricultural Engineering Specialist.

- Developed educational programs for agricultural producers in the following areas: farm safety, water quality issues, no-till crop production, proper pesticide application, and the design of cattle handling facilities.
- On-farm consultations in the following areas of animal waste management, livestock buildings, livestock watering systems, and moisture problems in homes as well as other related areas of agricultural engineering.
- Developed educational programs for youth in the areas of farm safety and water quality.
- Served as county 4-H computer project leader educating youth on the use of the INTERNET.

- Served as Associate Director of the Missouri Precision Agriculture Center.
  - Have developed educational programs on using GPS receivers, yield monitors, GIS software relating to precision agriculture, as well as, overall basic concepts of precision farming for regional meetings and field days.
  - Have worked with regional extension specialists in developing educational programs tailored to the various needs of producers in different parts of Missouri.
  - Have worked with local cooperators on demonstration/research projects to better understand precision agriculture techniques such as variable rate seeding and variable rate nitrogen management.
  - Have hands-on experience with various precision agriculture technologies such as GPS receivers and yield monitors.

- Worked along with my dad and brother on the family farm.
  - Operation consisted of backgrounding about 100 feeder cattle a year, 600 acres of row crops, and 150 acres of hay.
  - Rented 40 acres for row crop production and feed 25 feeder steers for my project while a member of the FFA.

EMPLOYMENT HISTORY

2008 to present	University of Missouri Extension Natural Resource Engineering Specialist, University of Missouri System-Boone County, Columbia, Missouri
1998 to 2008	Associate Director of the Missouri Precision Agriculture Center, University of Missouri-Columbia, Columbia, Missouri
1992 to 1998	University Outreach and Extension Agricultural Engineering Specialist, University of Missouri System-Adair County, Kirksville, Missouri
1991 to 1992	Graduate Student University of Missouri-Columbia, Missouri
Summer of 1990-1991	Extension Associate University of Missouri-Portageville, Missouri
Summers of 1987,88 and 89	Brush Crew Laborer Macon Electric Cooperative-Macon, Missouri
1982-90	Helped work on family farm Larry Shannon Farms-Anabel, MO

EDUCATION

M.S., Agricultural Engineering, University of Missouri, May 1993
B.S., Agricultural Engineering, University of Missouri, December 1990

PROFESSIONAL AND COMMUNITY INVOLVEMENT

American Society of Agricultural Engineers, served as President, Vice President, Secretary, and Parliamentarian of the Student Branch-University of Missouri. Honored at Mid-Central Conference in the Student Paper Contest 1990. Honored as Young Member of the Year of the Missouri Section of the American Society of Agricultural Engineers 1997. Honored as with the Achievement Award from the Missouri Agriculture Extension Professionals 2001.

Member of Ten Mile Baptist Church, Anabel, MO, served as Sunday School Superintendent for 5 years.

Selected Publications

Shannon, K., J. Brumett, C. Ellis, G. Hoette. 2001. Can A $300 GPS Receiver Be Used for Yield Mapping? ASAE Paper No. 011154, St. Joseph, MI:ASAE.

Shannon, K., C. Ellis, G. Hoette. 2002. Performance of "Low-Cost" GPS receivers for Yield Mapping. ASAE Paper No. 021151, St. Joseph, MI:ASAE.

Shannon, K., G. Davis, K. Sudduth, W. Wiebold. 2002. Precision Agriculture Masters Program – Educating Missouri Crop Producers About The Benefits Of Precision Agriculture Through On-Farm Research. ASAE Paper No. 021016, St. Joseph, MI: ASAE.

Shannon, D.K., H.L. Palm, N.R. Kitchen, K.A. Sudduth. 2004. Implementation and Validation of Sensor-Based Site-Specific Crop Management Through On-Farm Research. *In* Proc 7th Intl. Conf. on Precision Agriculture. ASA/SSSA/CSSA, Madison, WI.

Shannon, K., C. Ellis, M. Herring, G. Hoette. 2004. Evaluation of Recreational GPS Receivers for Use in Precision Farming. In Proc AM 04 ION 60th Annual Meeting, ION, Fairfax, VA.

Brumett, J., C. Ellis, G. Hoette, D. Smith, K. Shannon. 2000. Application of Variable Rate Technology to a Tractor Drawn Fertilizer Cart. *In* Proc 5th Intl. Conf. on Precision Agriculture. ASA/SSSA/CSSA, Madison, WI.

Abstracts and Professional Presentations

Shannon, K., C. Ellis, M. Herring, G. Hoette. 2003. Comparison of Various Recreational GPS Receivers For Use in Precision Farming. ASAE Paper No. 031009, St. Joseph, MI: ASAE.

Shannon, K., C. Ellis, M. Herring, G. Hoette. 2004. Comparison of Various Recreational GPS Receivers For Use in Precision Farming. ASAE Paper No. 041083, St. Joseph, MI: ASAE.

Shannon, D.K., H.L. Palm, N.R. Kitchen, K.A. Sudduth. 2005. On-Farm Research – A Tool for Implementing and Validating Spatial Technologies for Site-Specific Crop Management. ASAE Paper No. 051069, St. Joseph, MI: ASAE.

Shannon, K., K. A. Sudduth. 2005. Performance of Lower Cost GPS Receivers for GPS-Aided Guidance. ASAE Paper No. 051090, St. Joseph, MI: ASAE.

Shannon, K., C. Ellis, G. Hoette. 2006. Performance of a Decimeter Accuracy GPS Receiver for the Development of Topographic Maps. ASAE Paper No. 061046, St. Joseph, MI: ASAE.

Shannon, D.K., H.L. Palm, P. C. Scharf, N.R. Kitchen, K.A. Sudduth. 2006. ALTERNATIVES TO USING A REFERENCE STRIP FOR REFLECTANCE-BASED NITROGEN APPLICATION IN CORN. *In* Proc 8th Intl. Conf. on Precision Agriculture. ASA/SSSA/CSSA, Madison, WI.

Extension Publication Guidesheets

Precision Agriculture: Yield Monitors (WQ 451)
Casady, W.W., D.L. Pfost, C. Ellis, and D.K. Shannon
http://extension.missouri.edu/explore/envqual/wq0451.htm

Precision Agriculture: Global Positioning System
(GPS) (WQ 452)
Pfost, D.L., W.W. Casady, and D.K. Shannon
http://extension.missouri.edu/explore/envqual/wq0452.htm

TODD E. LORENZ

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207 Barnes St.
Pilot Grove, MO 65276
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LICENSE OR CERTIFICATES
Missouri Department of Agriculture, Plant industries division,
Missouri Certified Public Operators, Category 1A License: P3450 1992-2003
Missouri Commercial Drivers License
Missouri Department of Health: Registered Installer
American Society of Agronomy: Certified Crop Advisor 26268 1992-2003

EDUCATION

M.S. December, 1996. University of Missouri, Columbia, MO 65211. Major: Agronomy. Thesis Title: Wheat Management for Red Clover Establishment. Advisors: Drs. Ken Kephart and J. R. Brown.

B.S. May, 1986. Central Missouri State University, Warrensburg, MO 64093. Major: Agriculture Business. Awarded the CMSU Agriculture Sophomore of the Year. Major Professor: Dr. Harold Van Cleaves.

WORK EXPERIENCE:

July 2000-Present University of Missouri Extension, Boonville, MO 65233
Regional Horticulture/Agronomy Specialist-Providing equal program leadership in the fields of horticulture and agronomy in the Central Missouri 14 county region. Responsibilities include needs assessment, facilitation of educational programs, teaching, problem solving, assessing horticulture and agronomy related subject matter for clientele and developing university, community, agency, business and extension council linkages. Provide educational leadership in the development of programs and dissemination of research-based information related to agronomy and horticulture for producers, agribusiness, homeowners and the general public. As the Regional Horticulture Specialist, I am responsible for program development and leadership of the Central Missouri Master Gardener Program. I am responsible for coordination of core training modules, advanced education, meetings, field days, and conferences. I have modified the original Master Gardener program for

correctional facilities to provide an opportunity for inmates to participate and volunteer hours back to the community, now titled Master Gardeners In Corrections (MaGIC). Our intent is to provide them the necessary education, skills and abilities to seek and keep job in the field of horticulture upon release. I am responsible for identifying and developing positive relationships with agricultural leaders and assist in informing agribusiness and producers of program activities and current updates. In partnership with the University, I also serve on the Cooper County Soil and Water District board. I make all programs available to all audiences and promote the total mission of University of Missouri Extension using mass media, direct teaching methods, short courses, producer meetings, Internet capabilities, and individual consultations.

Nov. 1991- Soil Science Dept., University of Missouri, Columbia, MO 65211.
July 2000 Senior Research Specialist-Conducted soil fertility and forage fertility research for the Missouri Agriculture Experiment Station. While primarily responsible for the management of historical Sanborn Field and the F.L. Duley-M.F. Miller Soil Erosion Plots, I was also responsible for forage research on native warm season grasses on farmer cooperative sites and both the Wurdack and Bradford Agronomy Research Centers. My duties included: establishment of research in cooperation with private land owners and farmers, site selection, experimental design and layout, independent field research, hiring and supervision of field staff and students, land preparation, equipment maintenance for both modern farm and research plot equipment, pest control, harvesting, soil and plant sample data management from collection to analysis and from electronic input to statistical analyses, annual report and grant proposal writing, maintaining web site, conducting tours for people with varied background in agriculture, participation in field days and outreach activities. My responsibilities included work with the National Onsite Demonstration Project at Rock Bridge State Park. Coordination of soils and engineering research activities including monitoring of treatment fields where innovative onsite wastewater treatment and modern dispersal technologies were used. I was involved with the Field day activities in coordination with the Show-Me Clean Streams and the Bonne Femme Watershed Partnership that allowed demonstration of the Missouri Wastewater Small Flows Research and Training Center. Additionally, active with the development of a Soil and Water Conservation Clinic and Tour cosponsored by Mo-Ag industries Council and the University of Missouri to provide Certified Crop Advisors continuing education units in soil and water management.

PROFESSIONAL MEMBERSHIP AND COMMUNITY ACTIVITIES

National Association of County Agriculture Agents
North Central Region Vice Chair
Missouri Association of Agricultural Extension Professionals
President
University of Missouri Extension Association
Fertilizer Agriculture Lime Advisory Council
University of Missouri Extension Agri-Business Counselor
Central Missouri Agriculture Category Chair
Central Missouri Regional Technology Committee
University of Missouri Farms and Centers Advisory Council
Pilot Grove C-4 School Board
Cooper County Soil and Water District; Moniteau and Cooper
Cooper County Local Emergency Planning Committee
Boonville Area Chamber of Commerce
Knight of Columbus, Cleer Creek Council 2261

AWARDS AND PROFESSIONAL ACCOMPLISHMENTS

CMSU Agriculture Sophomore of the year, 1984
University Outreach and Extension Gold Medal Award, 2001-2002
University of Missouri Extension Association, UMEA Rookie of the year, 2002
Community Development Academy, 2002
University of Missouri Programming Excellence Award 2003
Public Issues Leadership Development Conference, 2004
National Association of County Agricultural Agents, North Central Region Communication Award: Computer Generated Program, 2004; Regional Finalist, Slide Set, 2005
Missouri Extension Leadership Development, 2004-05
Missouri Agricultural Extension Professional State Achievement Award 2004
National Association of County Ag Agents National Achievement Award, 2005
National Association of County Agricultural Agents National Recognition and Awards Vice Chair, 2002-2006; Chair 2007-2008
Missouri Extension Leadership Development, 2004-2005
National Extension Leadership Development, 2006-2007
Chamber of Commerce Service to Agriculture, 2007

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Versailles, MO 65084
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Education **M.S.**, Crop, Soil & Environmental Science, December 2004 (University of Arkansas, Fayetteville, AR)

- Thesis title: Soybean Response to Boron Fertilizer Applications.

B.S.A., Crop Management, May 2002 (University of Arkansas, Fayetteville, AR)

Experience Regional Agronomy Specialist: (March 2007-present)
University of Missouri Extension, Versailles, MO. I am the Regional Agronomy Specialist for Morgan, Moniteau, Benton, and Pettis Counties.

Class Instructor: (August 2005-May 2006)
Western Illinois University, Macomb, IL. Taught a Jr./Sr. level undergraduate course that focused on developing the student's skills in public speaking and scientific writing.

Graduate Research and Teaching Assistant: (May 2002-Dec. 2004)
University of Arkansas, Fayetteville, AR. Conducted field research experiments for major advisor, as well as conducting M.S. research. Preformed several soil testing procedures in the Soil Testing Laboratory. Taught Introduction of Soil Science Laboratory class.

Gypsy Moth Trapper: (May-August 2000 and 2001)
USDA-APHIS, headquartered in Chicago, IL. Worked two summers for the USDA-APHIS department in the trapping, tracking, and eradication of the destructive gypsy moth. The job entailed a basic knowledge of the gypsy moth, mapping reading, and the ability to write clear and concise reports.

Laboratory Technician: (Aug. 1998 to May 2001)
University of Arkansas, Fayetteville. Worked in the Soil Characterization Laboratory for three years. Was in charge of performing various soil procedures such as: carbon analysis, particle size, extractable acidity, soil moisture and sand content. A knowledge of field work, such as running a soil probe, taking soil water table measurements, and writing soil descriptions, was acquired in this job.

Memberships Missouri Association of Agricultural Extension Professionals
University of Missouri Extension Association

Soil Science Society of America
American Society of Agronomy
Crop Science Society of America
University of Arkansas Crop, Soil, and Environmental Science Club
Alpha Zeta: University of Arkansas Fraternity/Sorority of Alpha Zeta

Publications

Ross, J.R., N.A. Slaton, K.R. Brye, R.E. Delong. 2006. Boron Fertilization Influences on Soybean Yield and Leaf and Seed Boron Concentrations. Agron. J. 98:198-205.

Ross, J.R., N.A. Slaton, R.E. Delong, K.R. Brye, B.R. Golden, R. Thompson, R. Wimberly, R. Klerk, M. Hamilton, M. Mozaffari, and L. Espinoza. 2003. Soybean Grain Yield Response to Foliar Boron Application Rate and Time. *In*: N.A. Slaton (ed.) Wayne E. Sabbe Soil Fertility Studies 2003. University of Arkansas Agricultural Experiment Station Research Series 515: 61-65. Fayetteville, Ark.

N.A. Slaton, K.R. Brye, T.C. Daniel, R.E. Delong, R.J. Norman, B.R. Golden, and J.R. Ross. 2003. The Phosphorus and Potassium Fertilizer Value of Two Poultry Litter Sources Used for Flood-Irrigated Rice. *In*: R.J. Norman, J.-F. Meullenet and K.A.K. Moldenhauer (eds.) B.R. Wells Rice Research Studies 2003. University of Arkansas Agricultural Experiment Station Research Series 517: 286-293. Fayetteville, Ark.

N.A. Slaton, B.R. Golden, K.R. Brye, R.J. Norman, T.C. Daniel, R.E. Delong, and J.R. Ross. 2003. The Nitrogen Fertilizer Value of Preplant-Incorporated Poultry Litter for Flood-Irrigated Rice. *In*: R.J. Norman, J.-F. Meullenet and K.A.K. Moldenhauer (eds.) B.R. Wells Rice Research Studies 2003. University of Arkansas Agricultural Experiment Station Research Series 517: 294-302. Fayetteville, Ark.

N.A. Slaton, T.W. Walker, P.K. Bollich, D. Dunn, and J.R. Ross. 2003. Rice Response to Boron Application Rate and Time in Arkansas, Louisiana, Mississippi, and Missouri. *In*: R.J. Norman, J.-F. Meullenet and K.A.K. Moldenhauer (eds.) B.R. Wells Rice Research Studies 2003. University of Arkansas Agricultural Experiment Station Research Series 517: 303-311. Fayetteville, Ark.

Ross, J.R., N.A. Slaton, M. Mozaffari, and L. Espinoza. 2002. Soybean Response to Soil and Foliar Boron Applications. *In*: N.A. Slaton (ed.) Wayne E. Sabbe Soil Fertility Studies 2002. University of Arkansas Agricultural Experiment Station Research Series 502: 75-77. Fayetteville, Ark.

N.A. Slaton, P.K. Bollich, D. Dunn, J.R. Ross, M. Mozaffari, and L. Espinoza. 2002. Rice Response to Boron Application Rate and Time in Arkansas, Louisiana, and Missouri. *In*: R.J. Norman and J.-F. Meullenet (eds.) B.R. Wells

Rice Research Studies 2002. University of Arkansas Agricultural Experiment Station Research Series 504: 315-320. Fayetteville, Ark.

Presentations Ross, J.R., N.A. Slaton, R.E. DeLong, M. Mozaffari, and L. Espinoza. 2002. Rice and soybean response to boron fertilizer in Arkansas. Oral paper given at the Ark. Crop Protections Association Conf. on 5 Dec. 2002, Fayetteville, AR.

Ross, J.R., N.A. Slaton, M. Mozaffari, and L. Espinoza. 2003. Rice and soybean response to boron fertilization in Arkansas. Poster paper given at the Southern Branch ASA Annual Meeting on 2-4 Feb. 2003, Mobile, AL.

Ross, J.R., N.A. Slaton, R.E. DeLong, M. Mozaffari, and L. Espinoza. 2003. Soybean response to boron fertilization in Arkansas. Oral paper given at the Ark. Crop Protections Association Conf. on 1 Dec. 2003, Fayetteville, AR.

Ross, J.R., N.A. Slaton, M. Mozaffari, and L. Espinoza. 2004. Rice response to boron fertilization in Arkansas. Oral paper given at the Rice Technical Working Group Conf. on Feb. 2004, New Orleans, LA.

Ross, J.R., N.A. Slaton, R.E. DeLong, M. Mozaffari, and L. Espinoza. 2004. Soybean response to boron fertilization in Arkansas. Oral paper given at the Southern Branch ASA Annual Meeting on 28 Jun. 2004, Biloxi, MS.

Peter Clifton Scharf

Nutrient Management Specialist and Associate Professor
Plant Sciences Division
210 Waters Hall
University of Missouri
Columbia, MO 65211

Research and Extension education interests

- developing, evaluating, and promoting tools to predict crop N needs, including variable-rate N management
- evaluating N management alternatives including source and timing
- minimizing environmental impacts of agricultural nutrients
- coordinated management of soil, fertilizer, and manure nutrients
- tailoring fertilizer and lime recommendations to account for soil properties
- economic comparisons of production alternatives

Education

Degree	*Date*	*Institution*	*Major*
Ph.D.	May 1993	Virginia Polytechnic Inst. and State University	Crop & Soil Environmental Sciences
M.S.	July 1988	Virginia Polytechnic Inst. and State University	Agronomy
B.S.	August 1982	University of Wisconsin	Biochemistry, Genetics

Recent Research Publications

Nelson, K. A., Scharf, P. C., Bundy, L. G., and Tracy, P. 2008. Agricultural management of enhanced-efficiency fertilizers in the north-central United States. Online. Crop Management doi:10.1094/CM-2008-0730-03-RV.

Hong, N., P.C. Scharf, J.G. Davis, N.R. Kitchen, and K.A. Sudduth. 2007. Economically optimal nitrogen rate reduces residual soil nitrate. J. Environ. Qual. 36:354-362.

Scharf, P.C., N.R. Kitchen, K.A. Sudduth, and J.G. Davis. 2006. Spatially variable corn yield is a weak predictor of optimal nitrogen rate. Soil Sci. Soc. Am. J. 70:2154-2160.

Scharf, P.C., S.M. Brouder, and R.G. Hoeft. 2006. Chlorophyll meter readings can predict nitrogen need and yield response of corn in the north-central U.S. Agron. J. 98:655-665.

Scharf, Peter C., Newell R. Kitchen, Kenneth A. Sudduth, J. Glenn Davis, Victoria C. Hubbard, and John A. Lory. 2005. Field-scale variability in optimal N fertilizer rate for corn. Agron. J. 97:452-461.

Recent Extension Publications

Scharf, Peter and John Lory. 2006. Best Management Practices for nitrogen fertilizer in Missouri. 12 p. MU Extension publication IPM1027.

Lory, John and Peter Scharf. 2008. Rescue nitrogen applications on corn can still be profitable. Integrated Pest & Crop Management 18:80.

Scharf, Peter. 2008. Soil samples show nitrogen loss. Integrated Pest & Crop Management 18:74.

Scharf, Peter. 2008. Drainage installation field day to be held in July. Integrated Pest & Crop Management 18:75.

Scharf, Peter. 2008. Nitrogen loss scoresheet. Integrated Pest & Crop Management 18:68.

Lory, John and Peter Scharf. 2008. Is my nitrogen still there? Integrated Pest & Crop Management 18:27,35.

Scharf, Peter and David Dunn. 2008. Nitrogen loss in wheat. Integrated Pest & Crop Management 18:22,25.

Scharf, Peter. 2008. Nitrogen prices through the roof again. Integrated Pest & Crop Management 18:25.

Scharf, Peter and David Dunn. 2008. Potential for N loss with heavy rains on wheat. Mid-America Farmer Grower, March 25, 2008, p. 13.

Rich, Doug. 2008. Challenging times put a premium on research. High Plains Journal, March 12, 2008. Using information from Peter Scharf.

Oltman, Brian. 2008. Wheat N timing. Ag Professional, Jan. 2008. Using information from Peter Scharf.