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.

Current status/importance of research area:
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.

Timetable for proposed research:
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

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<th>Item</th>
<th>Description</th>
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<th>2011/12</th>
<th>2013</th>
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</tbody>
</table>
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


Abstracts and Professional Presentations


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)
http://extension.missouri.edu/explore/envqual/wq0452.htm
TODD E. LORENZ

WORK ADDRESS
University of Missouri Extension
608 East Spring Street
Boonville, MO 65233
(660) 882-5661

HOME ADDRESS
207 Barnes St.
Pilot Grove, MO 65276
(660) 834-6969

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

EDUCATION

Major: Agronomy. Thesis Title: Wheat Management for Red Clover

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- University of Missouri Extension, Boonville, MO 65233
Present 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
Chamber of Commerce Service to Agriculture, 2007
Joni Ross Harper  
100 E. Newton St. 4th Floor  
Versailles, MO 65084  
(578) 378-5358  
rossjo@missouri.edu

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


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. Performed 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
Publications


Presentations


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

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<tr>
<th>Degree</th>
<th>Date</th>
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<tr>
<td>Ph.D.</td>
<td>May 1993</td>
<td>Virginia Polytechnic Inst. and State University</td>
<td>Crop &amp; Soil Environmental Sciences</td>
</tr>
<tr>
<td>M.S.</td>
<td>July 1988</td>
<td>Virginia Polytechnic Inst. and State University</td>
<td>Agronomy</td>
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<tr>
<td>B.S.</td>
<td>August 1982</td>
<td>University of Wisconsin</td>
<td>Biochemistry, Genetics</td>
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Recent Research Publications


Recent Extension Publications


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


