Objective & Relevance:
This proposal addresses the Stakeholder Topic of Interest “Mechanical Research” and the sub-topics:

- Spreading / application technologies
- Evaluation of quality differences in fertilizer materials and the impact of the differences on crop production due to spreading variability.

Our objective is to evaluate spread pattern of dry nitrogen fertilizer (urea, ammonium nitrate, other urea-based products like SuperU and ESN) applied to corn, wheat, and fescue fields in Missouri. Cotton could also be included at the request of the Fertilizer & Ag Lime Council.

Dry nitrogen fertilizer makes up 40 to 50% of the total nitrogen fertilizer used in Missouri. Although this proportion is lower than in the past, due mainly to regulations on ammonium nitrate, dry nitrogen will remain important for several reasons:
1. It is more suited, by far, for application to grass than liquid or gas.
2. It is the fastest application option—especially important when the time window is small, as with in-season N applications to corn.
3. It has lower transport cost than liquid (higher analysis).

Most dry fertilizer in Missouri is applied using spinner spreaders. These spreaders are very efficient in spreading fertilizer. However, broken granules will not travel as far as intact granules when applied with a spinner spreader. When poor quality fertilizer with lots of broken granules is applied using a spinner spreader, the small particles all fall near the path of the spreader. This results in a high N rate near the path of the spreader and a low N rate midway between passes. We have seen lots of streaks in aerial photographs of Missouri corn fields that are 40 to 80 feet in width and appear to correspond to poor fertilizer distribution patterns from nitrogen applied with spinner spreaders (see photo). The severity of this problem is not well known, but needs to be so that we know how hard to work to fix it.
Procedures:
1. Standard fertilizer trap pans will be set up in a number of production fields receiving dry N each year.
   a. We will coordinate with producers and retailers who would like to cooperate in this project.
   b. Corn, wheat, and grass fields will be used. Cotton could be added for extra cost.
   c. Different applicators and different N fertilizer sources will be represented.
   d. We will weigh the fertilizer caught in each pan and determine distribution.
   e. Each pan will be located with both a global positioning system (GPS) and a flag.
   f. The location of the applicator’s path will be recorded with GPS in the applicator.
2. At the time of the fertilizer application, a fertilizer sampling tube will be used to take samples from the applicator’s bin and particle size distribution will be measured.
3. We will analyze how particle size distribution affects spread pattern.
4. We will also analyze how fertilizer type and applicator type affects spread pattern.
5. Near harvest time, corn yield will be determined in selected fields at points corresponding to trap pan locations.
   a. Either hand harvest or yield map depending on spread pattern observed.
   b. Target fields with non-uniform N applications or where N loss may have occurred.
6. May also collect harvest observations or yield measurements in wheat and grass—more difficult, so fewer will be done.
7. The relationship between spread pattern and yield variability will be analyzed.

Current status and importance of dry nitrogen fertilizer quality:
Changes in the dry N supply
Price spikes in North American natural gas production from 2000-2010 resulted in many U.S. N fertilizer factories being idled. To meet demand for N fertilizer, imports increased. Urea imports in 2011 were 4 times higher than during the 1995-2000 period. One result was that the physical quality of urea available to U.S. farmers went down. The urea had to go through many more augers between manufacture and application, resulting in more breakdown of prills/granules.

Ammonium nitrate import levels did not change, but Agrium’s move away from manufacturing ammonium nitrate in North America in 2006 meant that imports made up a higher proportion of the supply. Quality issues similar to those for urea became more frequent.

How big is the problem?
The size of the problem is based more on how much yield is lost, or other production problems occur (lodging of wheat, for example), than on how often spread is uneven. We are not aware that anyone has done any research to put numbers on the cost of uneven applications of dry N. We will attempt to make a start at answering this problem by collecting spatial yield data in fields where we find uneven N distribution. We will also measure how often the spread is uneven—it’s an easier question to answer.
Potential solutions
Premium urea products like SuperU and ESN are one potential solution. These products are marketed based on their ability to reduce volatile ammonia loss and wet-weather N loss. They may be able to bring additional value due to better spread patterns. My experience with both is that they are large, hard, and uniform.

Another potential solution is air boom spreaders. Dust can’t be thrown, but it can be blown. But how evenly can they spread dusty material? Numbers are needed. But many retailers are moving away from air boom spreaders due to maintenance issues. Unless the spread advantage is pronounced, and the yield loss is substantial, this solution may not be viable.

Natural gas prices have dropped and new urea production is under construction in the U.S. More good-quality urea will be available. Will this better physical quality will bring enough value to make it worth deliberately sourcing from these facilities? Paying a premium for higher quality product? Checking product quality on delivery with a hand-held screening device?

We will attempt to get information that will help to assess all three of these solutions.

Poor distribution of nitrogen fertilizer may be costing Missouri crop producers a substantial amount of money. We need to understand the extent of the problem and how uniform or non-uniform current dry nitrogen applications are. Then we will know how much effort or expense is justified to improve distribution patterns of dry N fertilizers.

Timetable:
February 2016 Make contacts with producers and retailers to arrange fields where tests will be conducted
March-April 2016 Measure dry nitrogen fertilizer distribution patterns during normal nitrogen application operations of cooperating producers/retailers. Sample fertilizer from the applicator’s box in each test field.
June 2016 Pre-harvest observations at wheat fields; possible hand-harvest.
Summer 2016 Analyze fertilizer distribution patterns. Provide and discuss report with each cooperating producer and/or retailer.
September 2016 Harvest corn at fertilizer trap pan locations.
Dec 20016 Progress report.
March-Nov 2017 Repeat March-Dec 2016
Dec 2017 Final report.
Jan-Feb 2018 Develop educational programs, present results.

Strategy for application/transfer of knowledge:
1. Written and oral (presentation) educational materials will be developed to promote understanding and application of results.
2. Written materials will include newsletter and farm press articles and press releases.
3. Presentations will be used in Extension meetings, sent to regional Extension Agronomists for their use, and shared with anyone who requests them.
**Budget:**

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
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<tbody>
<tr>
<td>Research Specialist time</td>
<td>$19,500</td>
</tr>
<tr>
<td>Benefits @ 33%</td>
<td>6,500</td>
</tr>
<tr>
<td>Student worker(s) to make catch pans</td>
<td>2,000</td>
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<tr>
<td>Materials for fertilizer catch pans</td>
<td>2,000</td>
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<tr>
<td>Sieves and fertilizer probe</td>
<td>600</td>
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<tr>
<td>Field supplies and mileage</td>
<td>2,000</td>
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<tr>
<td><strong>Total year 1</strong></td>
<td><strong>$32,600</strong></td>
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| Research Specialist time                  | $19,500|
| Benefits @ 33%                            | 6,500  |
| Field supplies and mileage                | 2,000  |
| **Total year 2**                          | **$28,000** |

**2-year total budget**  
**$60,600**
Peter Clifton Scharf  
Professor and Nutrient Management Specialist  
Plant Sciences Division  
210 Waters Hall  
University of Missouri  
Columbia, MO 65211  

2015 serving as Past Chair, Soil Fertility and Plant Nutrition Division, Soil Science Society of America

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
- long-term protection of the soil resource
- minimizing environmental impacts of agricultural nutrients
- economic comparisons of production alternatives

Education

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<tr>
<th>Degree</th>
<th>Date</th>
<th>Institution</th>
<th>Major</th>
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<tbody>
<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>
</tr>
<tr>
<td>B.S.</td>
<td>August 1982</td>
<td>University of Wisconsin</td>
<td>Biochemistry, Genetics</td>
</tr>
</tbody>
</table>

Selected Recent Research Publications


Selected Recent Extension Publications

Scharf, Peter. 2015. Managing Nitrogen in Crop Production. American Society of Agronomy, Madison, WI.


Hein, Treena. 2015. Improving late nitrogen application. Top Crop Manager, April 2015. Using information from Peter Scharf.


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EDUCATION AND PROFESSIONAL EXPERIENCE

Education
Brigham Young University  BS  1984  Agronomy  
University of Missouri  MS  1986  Agronomy  
Colorado State University  PhD  1990  Agronomy/Soil Science

Professional Employment
2003-present  Adjunct Professor (2014), Associate Professor, University of Missouri  
1996-present  Soil Scientist, USDA-ARS, Cropping Systems and Water Quality Research Unit, Columbia, MO  
1990-1996  Research Assistant Professor, Soil and Atmospheric Sciences Dept, University of Missouri

Professional Summary
Dr. Kitchen Recognized for his research in integrated agricultural systems as related to precision agriculture systems, soil and water quality in agroecosystems, and nutrient management for improved fertilizer use efficiency. His research is documented in more than 270 technical publications (including 85 peer-reviewed journal articles, 8 book chapters, and 38 invited papers). He developed soil management and agronomic solutions to the issues associated with within-field soil-landscape variability and nutrient management for improved soil and water quality. He has attracted grant throughout his career supporting leading-edge research, recognized as important by stakeholders and government agencies. In all, has been the PI or Co-PI for grants totaling over $10 million. Examples of research contribution include: 1) Initiating some of the earliest work relating spatially-measured soil and landscape data obtained by automated sensors to soil physical and chemical characteristics and crop productivity; 2) Producing new concepts, methodology, and tools for delineating within-field management zones; 3) Establishing relationships of cropping practices on ground and surface water quality for poorly-drained U.S. Midwest soils; 4) Developing new strategies and procedures for variable-rate N application in crop production; 5) Pioneering a plan and implementing at field-scale a precision agriculture system that encompasses carefully-prioritized grain crop production and environmental goals; and 6) Developing bioenergy management practices for degraded soil landscapes. He has advised graduate degree programs for 12 M.S. (Spautz, Fridgen, Williams, Myers, Roberts, Landers, Allphin, Easterby, Randall, Weeresakara, Bean, Gossel), and 6 Ph.D. (Hughes, Jung, Jiang, Myers, Boardman, Ransom, ) students, and advised or co-advised three post doctorates. His stature is foremost evidenced by his election to serve in 2011
as President of the American Society of Agronomy (ASA). ASA serves ~7,000 scientific and ~13,000 practicing agronomists.

**PROFESSIONAL HONORS AND AWARDS**

- American Society of Agronomy President, 2011
- Fellow, Soil Science Society of America, 2008
- Fellow, American Society of Agronomy, 2007
- Robert E. Wagner Potash and Phosphate Institute Award (Jr. Scientist), 2003

**SELECTED JOURNAL PUBLICATIONS DURING THE LAST FOUR YEARS**