Feasibility of Developing an On-farm Research Program in Minnesota

Final Report and Recommendations

September 12, 2014

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Section 1: Introduction and Summary

Current trends in technology, policy, and sociology are driving interest in on-farm research programs. The widespread availability of variable rate equipment, yield monitors, and other GPS-enabled technologies make on-farm trials more feasible than they were even a few years ago. Economic realities and political activities are increasing pressure on farmers to produce more efficiently and to show they are protecting the environment. Widespread interest in farmers’ activities is demonstrated by the State Nutrient Reduction Strategies being developed across the Mississippi River Basin, the Nitrogen Fertilizer Management Plan in Minnesota, and growing interest among consumers about the source of their food.

1.2. Project Background and Approach
The Agricultural Fertilizer Research and Education Council (AFREC)
http://www.mda.state.mn.us/chemicals/fertilizers/afrec.aspx funded the "Feasibility of Developing an On-farm Research Program in Minnesota" project to examine whether and how an on-farm program should be established in the state. This document is the final project report, describing what was learned about on-farm research from stakeholders across the state and from interviews with leaders of similar programs across the country, and recommending an approach for Minnesota.

Project Advisory Team
An advisory team was established comprised of representatives of the agriculture sector, with attendance by University of Minnesota Extension researchers acting as advisors to the team. The team met in September 2013 to discuss goals of an on-farm research program, and met in December 2013 to discuss a potential program structure.

The Advisory Team members represented:
- Minnesota Soybean
- Minnesota Corn Growers
- Minnesota Wheat Growers
- Irrigators Association of Minnesota
- Independent Crop Consultants
- Ag Industry
- Univ of Minn Extension

Program Interviews
Leaders of on-farm research programs around the country were interviewed to learn about their experiences. Interview topics feel into eight categories:
- Project origin, goals, and outcomes
- Funding and budgets
- Human resources - requirements and roles
- Research topics
- Producer involvement
- Communication methods and data privacy
- Program management details
- Advice for Minnesota

The programs tended towards one of two approaches: (1) peer learning groups focused on individual producers learning to better utilize agricultural technology, or (2) research programs focused on improving research results by dispersing research activities across the state (Table 1). In reality, every program was a mix of the two approaches (Figure 1). For example, the Nebraska On-Farm Research Network was established by University Extension to help growers conduct more effective on-farm trials. It emphasized the use of standardized protocols for a limited number of research topics. More recently, the program has been increasingly supporting individuals in designing and implementing their own trials.
Table 1: Two general directions of existing on-farm programs

Each on-farm program tended to follow one of two models for organizing field trials: peer group learning or dispersed research.

<table>
<thead>
<tr>
<th></th>
<th>Peer Learning Groups</th>
<th>Dispersed Research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary goal</td>
<td>Farmers build skills for conducting trials that provide adaptive management information for that operation.</td>
<td>Improve the quality of agronomic information by aggregating data from diverse farm-scale trials.</td>
</tr>
</tbody>
</table>
| Additional benefits | • Farmers learn to critically analyze research information  
• Networking, peer learning | • Agronomic guidelines gain higher credibility and broader support  
• A vehicle for stronger outreach and engagement between the University and agriculture community |
| Leadership | Farmer-led independent organization(s), or producer organizations | University Extension, or producer organizations |
| Presentation of data | Results and procedures discussed at meetings and publications dedicated to on-farm trials. On-farm information is a separate body of information. | Results discussed at meetings and publications dedicated to particular topics. On-farm research is an integral part of the body of information behind University and other guidelines. |

Figure 1: Program leaders from the following projects were interviewed

Most programs are a mix of the peer learning and research models.

**Peer learning group**
- KS Kansas Ag Research & Technology Assn (KARTA)
- MN Southern Minnesota Peer Group
- MN NW MN On-Farm Research Group
- IN On-Farm Network
- IA On-Farm Network (ISA)
- IL Council on Best Management Practices
- NE Nebraska On Farm Research Network
- NY On-farm Research Partnership
- IN Purdue Collaborative On Farm Research
- PA On-Farm Research Program
- VT Extension research program

**Dispersed research**
- Led by producer organizations
- Led by Extension
Feedback from Minnesota Stakeholders
After studying other programs and discussing approaches with the advisory team, we conducted listening sessions and an online survey of stakeholders. For both the listening sessions and the survey, we presented a proposed structure and potential activities and outcomes of an on-farm program, and then asked for feedback. A fact sheet describing the preliminary proposal was used at this stage. (See “Appendix B: Fact Sheet”.)

The online survey asked respondents what reasons for an on-farm research program are important, which research topics they are interested in, and how likely they are to participate. See the full survey in “Appendix C: Online Survey”.

The online survey was promoted via the Small Grains meeting, Extension winter meetings and Crop E-News, Best of the Best conference, Minnesota Corn Growers Association weekly membership mailing, Minnesota Soybean County meetings, to MN Crop Production Retailer members, and in an article in “The Farmer”.

Listening session discussions were held during meetings of the Wheat and Soybean On-Farm Research Summit, the Extension Crops Team, the MCGA Production Stewardship Team, and the Minnesota Ag Innovators.

1.2. What is On-Farm Research?
Many types of learning activities occur on farms; this document is focused on one segment of that learning. The following definitions of on-farm research are based on discussions around Minnesota, and are consistent with how on-farm programs are viewed in other states.

“On-farm” means:
• Using normal farm equipment and operations. Thus, test areas are more diverse than in small plot research, likely covering multiple soils and landscape positions in a field.
• Strong farmer involvement. Thus, we are excluding research activities managed primarily by researchers even if conducted on working farms.
• Typically relying on precision agriculture technologies to apply treatments and collect data.

“Research” means:
• Statistically sound designs and analysis, with data quality control.
• Generating information that can be generalized and applied beyond the situations where the research trials were conducted.

“Demonstrations”:
• Support outreach and education, or generate information for individual operations.
• Usually do not provide new, generalizable information (e.g. N-rate trials)
• Usually do not involve statistical analysis (e.g. variety trials)

“Trials”:
• Are an individual field study for either research or demonstration purposes.

On-farm research is credible to both farmers and researchers, and generally addresses topics with immediate applicability to farming operations.

“On-farm research” is . . .
Trials conducted on commercial farms using full-size equipment, with significant involvement of the farm operator, and using statistically sound designs and analysis.

On-farm research is credible to both farmers and researchers, and generally addresses topics with immediate applicability to farming operations.
1.3. Summary of Recommendations

The value of on-farm research trials is in the quality of learning. The resulting information is a rich complement to plot research and anecdotal observation because the studies are done in varied and realistic settings. Producers have a better understanding of the results because of their first-hand participation in the process and the direct applicability of the topics.

On-farm studies are currently conducted across Minnesota by farmers, by researchers (e.g., staff at Research and Outreach Centers and Extension), and by agricultural industry. These activities are generally uncoordinated with one another, and vary in the type of information produced.

Leaders in the agriculture and research sectors could choose to continue in this ad hoc approach or could choose to establish a coordinated on-farm program. The value of a coordinated program would come from collaboration and sharing among producers, agricultural organizations, agriculture industry, and the research and Extension community. A useful on-farm program requires commitment from these key partners from the beginning.

If partners choose to establish a program in Minnesota, we recommend a structure with two hubs of leadership – one hub oriented towards research and the other oriented towards producers. This structure gives key stakeholders control over the aspects most important to them, while establishing a means for collaboration and building the body of agronomic information.

For the research community, the integrity of the data and its interpretation is paramount. For the commercial agriculture community, the flexibility to address the needs of individual operations and to protect their personal information and resources are paramount.

The research hub of the program would develop standardized protocols and manage data analysis and interpretation. A producer hub would give producers flexibility in their level of involvement in the larger program and in the topics they choose to study. For example, producers may participate as simply as reading guidelines for conducting their own on-farm trials; or they may choose to join a small group to discuss trial results and the use of specific agricultural technologies; or they may participate in a statewide coordinated study.

The two hubs together would choose priority research topics and establish data management policies that protect privacy and prevent inappropriate spinning of results. They would bring diverse interests together to learn from each other.

Section 3 of this document provides further detail about the roles of various partners.

Section 2 describes several potential pitfalls of on-farm programs. These include competition for research funding, data privacy concerns, data quality, choices about how to interpret and disseminate results, and integration with other sources of agronomic information.

An on-farm research program requires adequate financial investment. On-farm research produces unique results, but it is not a cheaper way to generate research results. The sample budgets presented in Section 3 suggest a starting budget on the order of $300,000.
Section 2: Features of On-Farm Programs

2.1. Goals and Impacts

The benefit of an on-farm research program is efficient and effective learning about agronomic practices. The goals or outcomes below were broadly supported by participants in the listening sessions and survey, and are consistent with outcomes observed from programs in other states. The desired impacts serve to motivate participation in an on-farm program.

Primary goals

- Greater capacity among producers to make data-driven decisions about products and practices to enhance profitability and productivity, and to reduce negative external impacts. “Greater capacity” means building producers’ and researchers’ skills for using agricultural technology and data more effectively, and sharing timely results of meaningful trials. According to survey respondents, better decision-making for profitability was the most popular reason for an on-farm program. In a 2002 survey, participants in Nebraska’s on-farm trials reported an average of $7,800 improved profitability from participating in the project.\(^1\)

- Improved agronomic guidelines from the University based on richer data from farms around the state.

- Farmer networks to promote peer learning about agricultural technology and data. Leaders of existing on-farm programs around the country cited farmer networks as one of the most valuable outcomes of their programs.

- Networks among multiple stakeholders to enhance collaboration and sharing of information among researchers, producers, and other members of the agriculture sector.

Desired impacts

- Greater profitability for individual farm operations and a stronger agriculture sector.

- More efficient management of water and nutrients, based on better information, to improve agricultural productivity while protecting the environment.

- Stronger collaboration between the University and the agriculture sector.

- Better understanding of agriculture within non-farm communities, based on documenting and communicating agricultural activities and impacts. Non-farmers are taking increasing interest in the source of their food and water, but they have limited knowledge of agronomic processes. An on-farm program would provide opportunities to share information with a broad audience.

- An alternative to commercially sponsored on-farm trials.

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\(^1\) University of Nebraska-Lincoln web page. “Nebraska Soybean and Feed Grain Profitability Project Shows Financial Impact”. Accessed 1Jul2104: [http://cropwatch.unl.edu/farmresearch/NSFGPPImpact](http://cropwatch.unl.edu/farmresearch/NSFGPPImpact)
2.2. Specific Objectives
Specific goals can be defined to address three aspects of the program: research topics, communication, and participation. The following lists reflect priorities gleaned from listening sessions and the online survey.

Research Objectives
Research objectives address what topics will be studied.

Design research to:

- Focus resources on high quality data meeting broad information needs. Individual learning goals and less rigorous data can also be supported, but with fewer collective resources.
- Consider ancillary information – i.e. information beyond the treatment variables and yield. Be able to describe the context of the results (soils, cropping system, weather), and other impacts (economics, environmental).
- Take advantage of multiple and diverse sites to generate data unavailable in other ways.
- Consider a long term focus, rather than jumping from one topic to another or not allowing for adequate trial years.
- Support the development of decision heuristics or decision support tools. E.g., recommendations expressed as probabilities of success for a given set of conditions.
- Address policy concerns.

Select topics that are:

- Suited to on-farm work. Not all questions are best addressed in on-farm settings.
- Immediately relevant and applicable to agricultural production issues.
- Designed to integrate production and environmental concerns.
- Linked to information from small plots and other data sources.

Topics preferred by survey respondents.

- Figure 2 shows how survey respondents ranked the suggested topics. The list would likely differ regionally. For example, irrigation would generate far more interest in the Central Sands than it does statewide.
- Nitrogen management was of the greatest interest as a research topic because of its significant input cost, high profile among policy-makers and public, and its impact on protein content in wheat.
- Regarding fungicides and other pest management products: participants in stakeholder discussions were interested in non-biased testing of various products, but had several concerns: the endless supply of new products could divert attention from other topics; products could be legitimized simply by including them in a sanctioned trial; positive and negative results may not be reported correctly; and trial results may have limited value because products change quickly.
- Additional topics written in to the online survey included: effectively using precision agriculture technology, including drones; soil health, soil organic matter, soil water holding capacity; and water quality.
**Communication Objectives**
Communication objectives address how data will be turned into information through analysis, interpretation, and availability.

- Provide technology and data management training (how to conduct trials, interpret data, manage data, and use information for adaptive management).
- Deliver analyses to individual participants quickly so they can use it to inform decisions for next season.
- Host regional and statewide meetings.
- Support local group meetings.
- Develop decision support tools.
- Promote data-driven decisions.
- Refine University recommendations.
- Improve the image of agriculture.

**Participation Objectives**
Participation objectives address who will participate and how, and what networks and relationships will be strengthened.

- Diverse stakeholders will be engaged and interacting, taking advantage of their various motivations and strengths. Producers and researchers will both feel ownership of the program.
- Relationships will strengthen between the University and agriculture industry and producers. The University engages farmers; learns with them; shares with them. Producers share experience with the University; help build and use better guidance.
- Non-farmers learn more about agriculture.
- Increasing pride in the University and agriculture.

**Figure 2: Survey ranking of research topics**

Which topics are you interested in for on-farm research?

<table>
<thead>
<tr>
<th>Topic</th>
<th>Not interested</th>
<th>A little interested</th>
<th>Somewhat interested</th>
<th>Very interested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilizer timing and rates</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable rate applications</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nutrient loss</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Economic analyses</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tillage methods</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fungicides and other pest mgt. products</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water management</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Cover crops</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manure timing and application methods</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Number of respondents
2.3. Key Program Features
Several features are key to achieving the objectives described above.

1. **Collaboration.**
   Strong connections and information sharing within and between the agricultural community and the University.

2. **Localization.**
   Producers are key to keeping the program relevant and for conducting useful trials. Local partners can help coordinate peer learning groups and support producers in conducting research protocols. Local partners may include:
   - Farmers
   - Consultants
   - SWCD staff
   - FFA and other citizen or student groups
   - County Extension Specialists
   - Regional researchers

3. **Centralization and standardization.**
   Equally important as local leadership is the need for centralized data management and standardized protocols.
   Central leadership can:
   - Provide data management services to make it easy for local organizations to participate.
   - Create efficiencies by centralizing the overhead needed to establish and maintain data and analysis systems.
   - Maximize information produced by ensuring data quality, consistent protocols, and data aggregation.

4. **Effective science.**
   Statistically sound protocols and good quality control processes are required to generate meaningful data. Provide adequate support for the producers and the local partners who work directly with the producers.

5. **Accessibility of information.**
   Use multiple formats (meetings, newsletters, blogs, media, reports, etc.) to reach a variety of audiences with a variety of types of information. Establish good communication networks and fast turn-around on data interpretation to make information available quickly.

6. **Strong farmer engagement and ownership.**
   Involve diverse types of growers in setting up and analyzing trials, and in reporting to peers. This increases the base of support and improves learning.

7. **Support for both rigorous research and exploration.**
   Define a few priority research areas and also support individuals in pursuing their own questions.

8. **Integration of profit and the environment.**
   Economics, yield, nutrient loss, water management, logistics, and so on are all components of agronomic decision-making. Collect ancillary data about operations, soils, etc. to understand the context and impact of results.
2.4. Potential Pitfalls

The flipside of key features are the program characteristics that would cause failure or ineffectiveness.

The following list of potential pitfalls is based on concerns expressed during discussions with Minnesota stakeholders and in warnings expressed by leaders of on-farm programs in other states.

1. Inadequate commitment of resources.

On-farm research is neither cheap nor quick.

Remedies:
- Before starting, ensure sufficient base support from researchers, as represented by Extension, and from growers, as represented by one or more commodity organizations or check-off boards.
- Dedicate new staff to the program for strong central leadership. Don’t rely on adding responsibilities to existing staff.
- Hire the right skills.
- Work towards consistent base funding. Don’t rely entirely on grants.

2. Too much centralized control, or control by a narrow base of stakeholders.

The program depends on commitment from the growers who generate the data and use the information. Local ownership is as critical as centralized support. This should not be perceived as simply a university research project.

Diverse partnerships generate robust ideas but also bring conflicting missions to the table. As with any productive collaboration, each stakeholder group must focus on their mission and niche while understanding and contributing towards others’ goals.

Remedies:
- Central coordinators provide two different types of support: for standardized, rigorous research and for less rigorous studies of individual design.
- Explicitly describe the strengths, authority, and responsibilities of the leaders, staff and participants. For example, the central research component has authority for research protocols and data management and analysis. Local groups manage implementation of protocols, learning activities, and application of information. Individuals own their data.
- Support local groups driven by their own objectives, even when they are not the same as research hub objectives.
- Identify various subgroups of stakeholders (e.g. types of agricultural operations, ages of producers, types of Extension Educators). Address their different motivators, communication modes, and training needs.
- Create a structure that communicates a single cohesive program with multiple points of control. I.e., the research component and producer component can have different leadership but are clearly a single program.

3. Mistrust about data handling.

Extensive data is the power of on-farm research, and potentially the Achilles heel.

Participation will be low if people do not trust how their data is being managed and who could potentially access it.

Remedy:
- From the beginning, with multiple stakeholders, develop and clearly communicate data management policies that clarify who has ownership and access.

4. Poor-quality trials.

Many things can go wrong when trying to conduct valid trials in the midst of farming operations. If not managed well, they can cost a
lot of time and money without producing meaningful information.

Participation requires a significant commitment of growers’ time and attention, and a potential yield hit.

Remedies:

- Create a work flow that addresses the logistical realities of implementing on-farm trials.
- Provide for local oversight – someone to provide regular support and reminders about protocol.
- Staff should include expertise in on-farm trial statistics to oversee trial design, interpretation and data quality control.

5. **Destructive competition.**

Other efforts around the country have been constrained by antagonism between universities and commodity groups, competition between neighboring farmers, preference for one agronomic authority exclusively over others (e.g. university recommendations, crop consultants, sales reps, or personal observation), or adversarial relationships between types of farming.

The relationship between industry and the University must protect the integrity of research while utilizing industry’s capacity to implement trials and to commercialize and promote practices.

The agriculture sector is understandably defensive about attacks on their practices. An on-farm program could provide an opportunity to document actual practices, costs, and impacts, and communicate them in a way that multiple audiences trust. This requires information sharing, and program policies that engender trust in how information will be handled.

Remedies:

- Create benefits – e.g. early access to information – for people who participate by sharing information, protecting privacy, and sharing program control.
- Producer peer groups should be encouraged to draw members from a large enough geographic area to avoid near neighbors.
- Establish clear data management policies to protect the integrity of the research and prevent special interests from misrepresenting data.
- Ensure that oversight of program processes and policies is shared by multiple stakeholders.
- To reduce competition between information sources, explain appropriate use of data interpretations and recommendations and how they relate to other information sources.
- Leverage (rather than isolate) the strengths of each sector: University, agricultural industry, and producers.

6. **Slow communication.**

The value of an on-farm program depends largely on a quick turn-around of information. Producers will be more motivated to participate if they gain an information advantage over non-participants.

The high level of producer engagement will provide an effective avenue for sharing messages.

Remedies:

- Develop a work flow aimed at analyzing field data and getting results back to participants in early winter
- Share interpretations widely and frequently.
Section 3: Proposed Program for Minnesota

3.1. Program Structure
If an on-farm program is pursued, the structure described below would address the key features and potential pitfalls presented above.

The strength of an on-farm program would come from the interplay of conflicting forces:

- centralized standardization alongside decentralized attention to local needs, and
- diverse stakeholders bringing diverse ideas and motivations to the table.

The challenge is to create a structure that draws out the strengths of these forces. One way to do this is to create two entities, or “Hubs”, to drive the centralized and the decentralized components. The entities would be developed separately, but meet frequently to react and adapt to the other’s development process. Thus, both entities should be created in parallel on a similar timeline.

The names chosen for the entities should make clear that they are part of a single program. “On-Farm Learning Network” is a possible name for the program with the centralized and decentralized entities named the “Research Hub” and the “Producer Hub”, respectively.

Together, the two hubs would establish a program oversight structure to ensure input from all stakeholders.

Minnesota On-Farm Learning Network – Research Hub²
Creation of the Research Hub would be led by UMN Extension. The Hub could be an independent entity with its own, self-sustaining budget.

The primary role of the Research Hub is standardization and coordination of research. Activities would be:

- Serve as the point-of-contact for researchers and educators.
- Define annual research topics in collaboration between peer groups and University researchers.
- Develop and maintain standardized research protocols.
- Manage data resulting from on-farm research trials.
- Analyze and interpret data.
- Communicate results and interpretations in multiple formats (newsletters, blogs, fact sheets, decision support tools). Work with peer groups to develop and distribute.
- Coordinate training and educational resources for Extension personnel and producers about using agricultural technology, managing and using data, and setting up and analyzing on-farm trials.
- Interact with other on-farm programs around the country to share materials and potentially coordinate research.
- Provide support and training to researchers and educators to promote the use of on-farm components in their work.
- Work closely with the Producer Hub and with individual peer group research coordinators to
  - Provide training on research protocols and program procedures
  - Gather feedback on producers’ research interests and experiences.
- Ensure adequate “boots on the ground” to manage trials – both from Research Hub staff and from well-trained peer group coordinators.

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² Alternative terms for “hub” could be: group, division, team, unit, sector, section, part, branch, module, component, center, core, or nucleus.
Minnesota On-Farm Learning Network – Producer Hub

Creation of the Producer Hub would be led by a producer- or commodity-organization.

The primary role of the Producer Hub is to support peer groups across the state that can address regional priorities. The Producer Hub will promote decentralized learning through the following activities:

- Serve as the point-of-contact for producers and consultants.
- Provide logistical support to establish and maintain peer groups, such as scheduling and facilitating meetings.
- Work with the Research Hub to provide training and resources.
- Solicit participation in coordinated research projects.
- Help peer group research coordinators provide support for implementing on-farm trials.
- Work with the Research Hub to communicate program results to producers, e.g., scheduling local results meetings in early winter to present and discuss results with each peer group.
- Host an annual late-winter statewide meeting to share results.
- Solicit and develop on-farm research ideas from producers.
- Meet regularly with the Research Hub to exchange feedback.

Peer groups:

- Address local/regional priorities for learning about agronomic practices and technologies.
- Each have between 10 and 20 producer members from several neighboring counties.
- Facilitate farmer-to-farmer learning, individual on-farm trials, and effective use of precision technology.
- Have a research coordinator to oversee implementation of Research Hub projects. The research coordinator might be an agricultural consultant, local government staff member, local Extension Educator, or a producer. They are the personal contact with producers to ensure protocols are followed, collect feedback, and discuss results.

**Staffing Skills**

The success of the program relies on the following expertise within the staff of the Research Hub and Producer Hub:

- **Agronomic technology** – fluency in using and understanding variable rate equipment, sensors, GPS-enabled equipment, etc.
- Research design and statistical analysis – in the context of on-farm research.
- **Data management** – GPS-labeled information generates large files and challenging security issues
- **Communication** – two-way communication skills are needed: i.e., sharing outcomes, and supporting genuine participation.

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3 Alternative terms for “producer” could be: peer learning, learning, outreach, sharing, production, application, or development.
Partners and Their Roles

Producers
- Producers are key participants in providing land, time, and ideas.
- Producers participate in a variety of ways – using results and guidance, participating in peer group discussions, sharing experience with researchers, conducting individual studies, and participating in coordinated research trials.
- Drivers: improving profitability

Producer Organizations
- Disseminating results
- Gathering ideas and needs assessments
- Funding and logistical support
- Drivers: advocating for producer’s interests in profitability and better public understanding

Researchers
- Framing research questions, based on producer ideas
- Ensuring research information integrity
- Analyzing and interpreting results in the context of data from other sources
- Drivers: better research that attracts funding and supports publications

Extension and other educators
- Disseminating and gathering information
- Communicating between farm and city
- Drivers: better outreach, solving clients’ problems

Agricultural consultants
- Overseeing on-farm activities
- Disseminating results
- Assessing needs
- Drivers: providing client services, building a knowledge base

Agricultural industry
- Resources, technology
- Disseminate results
- Drivers: profitability and market share

Local government agencies
- Overseeing on-farm activities
- Disseminating results
- Drivers: providing value to voting citizens

Communication
Develop several ways to communicate, including:
- Annual meetings,
- Small group meetings,
- Other agricultural events,
- Fact sheets, blogs
- Research publications,
- Newsletters.

The variety of communication methods is meant to promote different levels of participation from a variety of audiences. Account for quick turn-around of information as well as more permanent publications.
3.2. Collaborations across the Agricultural Information Sector

Many sources of agronomic information and tools for data interpretation already exist. A newly-created on-farm program will have to define its niche and relationship to these other programs and tools.

Information for optimizing agricultural production is generated from labs, small plots, large plots, comparison trials, demonstrations, on-farm research, on-farm exploratory trials, and anecdotal observations. Information is generated at all scales from multi-state studies to unique trials on a single farm. Information is gathered by researchers, commercial interests, associations, and individuals. The trick is to pick the right information source for the question being asked, and to integrate information from multiple sources.

The recommendations in this document described a program that directly implements research projects. Alternatively, a new program could be established with the purpose of coordinating, standardizing, interpreting, and communicating results from the wide range of existing on-farm efforts across the country. In either case, program developers must consider their relationship to the following players in the agronomic information sector.

Other on-farm research:

- **Research and Outreach Centers (ROCs)** and University Extension have a long history of conducting trials on farms. In some cases, researchers may find it useful to conduct their projects through a coordinated on-farm program. However, many projects will likely remain independent efforts. Competition, or perceived competition, for funding could be a concern.
- **Multi-state collaboration.** A multi-state collaboration is forming for the purpose of coordinating on-farm trials of high impact topics across several states and sharing lessons and standards. Representatives of Universities, commodity organizations, and non-governmental organizations from 12 states met for an initial planning meeting in April 2014 in Chicago, hosted by the Iowa Soybean Association and the United Soybean Board. The next meeting is proposed for August 2014, hosted by the Michigan Soybean Promotion Committee.
- **ISA On-Farm Network®.** The On-Farm Network® in Iowa has a wealth of experience in standardizing and aggregating on-farm trials. Minnesota could choose to purchase some of their services for aerial imagery, guided stalk sampling, and data handling for some trials. Some Minnesota organizations may cooperate independently with the On-Farm Network®.
- **Other states.** Programs in Nebraska, Kansas, New York, and other states have years of experience in on-farm research.

Related programs:

- **NRCS financial and technical assistance programs** including the Environmental Quality Incentives Program (EQIP) and the Conservation Stewardship Program (CSP), could be designed to provide payment for producers to participate in on-farm studies.
- **Discovery Farms Minnesota** conducts whole field water quality monitoring, provides water quality information to producers, and supports peer-to-peer learning. On-farm research trial data would complement Discovery Farms data.
- **Business management peer groups** are a model of how local peer groups could be organized (e.g., The Executive Program for Agricultural Producers (TEPAP), and the Center for Farm Financial Management and
the Southwest Minnesota Farm Business Management Association)

Agricultural input supply companies leading their own on-farm trials:
- Pioneer
- Winfield
- West Central Chemical

Commercial data analysis and management services:
- Premier Crop Systems [http://www.premiercrop.com] – A company like this could provide data analysis services to an on-farm program
- FieldtoMarket [http://www.fieldtomarket.org/] uses GPS data and other info about the operation to assess soil, water, nutrient practices.

Training and education institutions that might collaborate on conducting trials:
- Ridgewater College at Willmar has a two-year degree program in agronomy technology, and another in GPS/GIS technology in agriculture.
- Minnesota Association of Agricultural Educators [http://www.mnaged.org]

3.3. Budget and Funding Sources

Diversity of funding sources contributes to the financial resilience of an organization, while predictable base funding is important to ensure stable and reliable core staff.

Based on the experience of other programs, each on-farm trial costs between $1,000 and $5,000. That includes salary for core staff – half-to-one FTE is required to manage 30-50 trials. Remaining dollars (ranging as high as $4,000/trial) is for lab analysis, travel, equipment, hourly labor for sampling, and so on. As one example, recently the Iowa On-farm Network® charged just under $500 per field for guided stalk sampling and aerial imagery, and $1500 per strip trial. Table 2 shows a sample budget for the first year of the proposed on-farm program.

Potential funding sources include:
- Check-off dollars
- Commodity organizations
- Input supply companies
- State budget line items
- Grants for individual projects (state and federal funds)
- Farm Bill payments to individuals (e.g. EQIP for stalk sampling)
- In-kind staff provided by Extension and other partners.
- Dues, meeting fees (small component)
Table 2: Sample Initial Annual Budgets

<table>
<thead>
<tr>
<th>Research Hub</th>
<th>Producer Hub</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manager, Research Lead (0.5 FTE)</td>
<td>Coordinator (0.5 FTE)</td>
</tr>
<tr>
<td>$60,000</td>
<td>$50,000</td>
</tr>
<tr>
<td>Technician (0.5 FTE)</td>
<td>Ag. tech. specialist? (0.5 FTE)</td>
</tr>
<tr>
<td>$35,000</td>
<td>$45,000</td>
</tr>
<tr>
<td>Office space, Fac&amp;Admin</td>
<td>Office space, F&amp;A</td>
</tr>
<tr>
<td>$17,000</td>
<td>$10,000</td>
</tr>
<tr>
<td>Communications support</td>
<td>Communications support</td>
</tr>
<tr>
<td>$10,000</td>
<td>$20,000</td>
</tr>
<tr>
<td>Tech support (Data management system set up and</td>
<td>Travel</td>
</tr>
<tr>
<td>management)</td>
<td>$4,000</td>
</tr>
<tr>
<td>$10,000</td>
<td>Annual conf. and mtg. expenses</td>
</tr>
<tr>
<td>Travel</td>
<td>$2,000</td>
</tr>
<tr>
<td>$4,000</td>
<td>Travel</td>
</tr>
<tr>
<td>Annual conf. and mtg. expenses</td>
<td>$4,000</td>
</tr>
<tr>
<td>$2,000</td>
<td>Annual conf. and mtg. expenses</td>
</tr>
<tr>
<td>$15,000</td>
<td>$3,000</td>
</tr>
<tr>
<td>Trial expenses (testing, sampling; 30 trials @</td>
<td></td>
</tr>
<tr>
<td>$500)</td>
<td>$15,000</td>
</tr>
<tr>
<td>Local research coordinators (30 trials @ $1000)</td>
<td></td>
</tr>
<tr>
<td>$30,000</td>
<td></td>
</tr>
</tbody>
</table>

**TOTAL** $183,000  **TOTAL** $132,000
3.4. Potential First Steps

Program Establishment
1. Identify key partners to develop the two hubs – presumably UMN Extension and a producer-based group.
2. Partners meet to discuss their strengths, assumptions, values, and goals.
3. Partners work separately to create a work plan for each hub, answering questions such as where it fits within the larger work plan of the organization, what resources are needed, and how it could be staffed.
4. Partners meet to present plans to each other, discuss modifications needed to integrate the hubs, and agree on a funding strategy. This would be a good point to develop criteria for measuring progress and for determining if/when the partnership should be dissolved (see Table 3 and Table 4 for examples).
5. Secure initial funding, hire staff, and implement work plans for each hub. Put in place surveys or other means to measure progress criteria.
6. Formalize frequent communication between the hubs to ensure integration and to track progress.

First Year Outputs
- Hire initial staff.
- Establish 3 to 5 peer learning groups with 10-20 members each.
- Train a local research coordinator for each peer group.
- Select and design 2 to 3 on-farm trials, and offer to peer group members.
- Establish procedures:
  - Protocols for trials,
  - Steps for local research coordinators overseeing trials,
  - Data quality control and assurance procedures,
  - Data handling policies,
  - Communication plan.
- Establish 30 formal trials, aiming for 60% success rate. (Eventually, aim for 80%)
- Establish online communication and provide general guidance about conducting on-farm trials.
- Peer groups meet twice in the year, including once in December to discuss trial results and plans for next year.
- In January, local coordinators, staff and other stakeholders meet to assess results and plan next year.
- Outcomes:
  - meaningful trial data analyzed,
  - initial networks established,
  - general guidance provided about on-farm trials.

Advice from other states:
Focus on establishing good process – building networks, sharing ideas, and building capacity – rather than on specific outcomes such as a number of trials.
Table 3: Examples of measures of success tied to desired outcomes

A fourth column labeled “benchmarks” can be added to specify how much and when each measure will be reached.

<table>
<thead>
<tr>
<th>Actions</th>
<th>Desired Outcome</th>
<th>Measures of success</th>
</tr>
</thead>
<tbody>
<tr>
<td>Select and design on-farm research trials aimed at improving specific guidelines. Examinate alternative decision support tools (e.g. expressed as probabilities, and accounting for additional production factors such as weather, rotation, tillage, etc.) Provide statistical and research design support and training to Extension staff at all levels.</td>
<td>Better agronomic guidelines</td>
<td>Number of new and revised University guidelines based on on-farm data. More use of University resources and guidance. More producers reporting that recommendations are appropriate for their situation.</td>
</tr>
<tr>
<td>Provide online and in-person training resources to peer groups.</td>
<td>A subset of interested producers become more skilled using precision agriculture technology, managing and utilizing data, and adaptive management.</td>
<td>Individual producers report more confidence in using data and technology, and can link improved profitability to better use of data.</td>
</tr>
<tr>
<td>Regular reporting of examples of how on-farm research results can improve decision-making.</td>
<td>Producers generally become more interested in data-driven decision-making.</td>
<td></td>
</tr>
<tr>
<td>Provide training in statistics and research design targeted at producers’ needs</td>
<td>Producers generally expand skills in critically analyzing research and product claims.</td>
<td>Increasing sophistication of questions asked at research update events.</td>
</tr>
<tr>
<td>Provide logistical support to establish peer groups.</td>
<td>More networking and peer learning among producers.</td>
<td>The number of active peer groups. The number of people attending local and statewide peer meetings. Number of media stories about peer groups.</td>
</tr>
<tr>
<td>Structure the on-farm program to encourage effective engagement from producers and Extension. Ensure that Extension personnel workplans and evaluations support farmer engagement activities. (Also see first outcome regarding better agronomic guidelines)</td>
<td>Enhanced partnership between the University and agricultural sector</td>
<td>More agriculture-University co-learning activities. More ideas and suggestions offered and jointly developed at Extension training events. Pride expressed in the University and in agriculture.</td>
</tr>
</tbody>
</table>
Table 4: Examples of Signs of Failure

Use these signals to trigger program changes:

Missing a broad base of support.

1. Lack of longer term base funding commitments from both Extension and commodity organizations.
2. Lack of diversity in funding sources (grants, federal and state agencies, participants, check-off dollars, commercial).
3. Destructive competition or lack of cooperation.
4. Negative or minimal press coverage.

Inadequate central management.

5. Trial success rate below 70%.
6. Infrequent communication about program activities.
7. Clear policies are not in place within one year to guide data management, work flow for managing trials, process for interpreting and distributing data, and corporate relationships.
8. No sustainable business model in place.

Inadequate local engagement.

9. By the end of year two, fewer than 5 peer groups and fewer than 30 trials.
10. Narrow pool of participants. Look for diversity in size and types of operations, age of participants, and geography.

Not achieving goals.

11. Can’t point to specific management recommendations supported by on-farm data.
12. Participant evaluations don’t report financial benefits of participation.
13. Participant evaluations don’t show improved use of data and technology.
14. Low attendance at small group meetings and statewide meetings.
### Appendix A: Resources

#### Coordinated On-farm Research Programs

<table>
<thead>
<tr>
<th>State</th>
<th>Program</th>
<th>URL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indiana</td>
<td>Indiana On-Farm Network</td>
<td><a href="http://www.in.gov/isda/ofn/">http://www.in.gov/isda/ofn/</a></td>
</tr>
<tr>
<td>Indiana</td>
<td>Purdue Collaborative On-Farm Research</td>
<td><a href="http://www.agry.purdue.edu/ext/ofr/">http://www.agry.purdue.edu/ext/ofr/</a></td>
</tr>
<tr>
<td>Iowa</td>
<td>Practical Farmers of Iowa Cooperators Program</td>
<td><a href="http://www.practicalfarmers.org/programs/Cooperators.html">http://www.practicalfarmers.org/programs/Cooperators.html</a></td>
</tr>
<tr>
<td>Kansas</td>
<td>Kansas Ag Research &amp; Technology Association (KARTA)</td>
<td><a href="http://www.kartaonline.org/">http://www.kartaonline.org/</a></td>
</tr>
<tr>
<td>Minnesota</td>
<td>Minnesota On-Farm Research and Discovery Team</td>
<td><a href="http://www.smallgrains.org">www.smallgrains.org</a></td>
</tr>
<tr>
<td>Nebraska</td>
<td>Nebraska On-Farm Research Network</td>
<td><a href="http://cropwatch.unl.edu/web/farmresearch">http://cropwatch.unl.edu/web/farmresearch</a></td>
</tr>
<tr>
<td>Nebraska</td>
<td>Nebraska Agricultural Water Mgt. Network</td>
<td><a href="http://water.unl.edu/web/cropswater/nawmdn">http://water.unl.edu/web/cropswater/nawmdn</a></td>
</tr>
<tr>
<td>New York</td>
<td>ADAPT Network</td>
<td><a href="http://adaptnetwork.org">http://adaptnetwork.org</a></td>
</tr>
<tr>
<td>New York</td>
<td>New York On-Farm Research Partnership</td>
<td><a href="http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/index.htm">http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/index.htm</a></td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>Penn State On-Farm Research Program</td>
<td><a href="http://extension.psu.edu/on-farm">http://extension.psu.edu/on-farm</a></td>
</tr>
</tbody>
</table>

Minnesota support for farmer-led trials:
- NCR-SARE Grant Programs, [http://northcentralsare.org/Grants](http://northcentralsare.org/Grants)
- MDA Greenbook Program, [http://www.mda.state.mn.us/protecting/sustainable/greenbook.aspx](http://www.mda.state.mn.us/protecting/sustainable/greenbook.aspx)

#### Tools and Materials for on-Farm Trials

**Nebraska On-Farm Research**
- [http://cropwatch.unl.edu/farmresearch](http://cropwatch.unl.edu/farmresearch)
- Many resources for guiding producers interested in trials

**MapWindow GIS**
- Plot layout software from Purdue
- [http://www.purdue.edu/agsoftware/mapwindow/](http://www.purdue.edu/agsoftware/mapwindow/)
- Do they also do data analysis?

**Multi-State On-Farm Partnership**
- Seth Naeve is the representative from Minnesota

**AgStats02**
- [http://pnwsteep.wsu.edu/agstatsweb/](http://pnwsteep.wsu.edu/agstatsweb/)
- From Oregon State University, Washington University, and Idaho State University. Created for the Solutions to Environmental and Economic Problems (STEEP) program.
- Online software for running ANOVA and LSD calculations on on-farm trial data.
- Good material explaining basic statistics for on-farm testing
Data Management Services for Farmers
Farm Intelligence
- For use by farmers to analyze spatial data
- an affiliate of an older company called Superior Edge
- CTO Steve Kickert
- Inputs:
  - Aerial crop data
  - Agricultural operation data
- WingScan software
- Benchmark with peers
- “replace pretty pictures with action alerts”
- Approached MN Ag Innovators in 2012 to test UAVs for image analysis
- Other articles:

RainWave
- [http://www.rainwave.org/](http://www.rainwave.org/)
- precipitation monitoring
- division of Trimble

Growers Edge
- [http://growers-edge.com](http://growers-edge.com)
- free, cloud-based source of customized market and weather data
Appendix B: Fact Sheet
This 2-page fact sheet was presented in January 2014 as a preliminary proposal -- a starting point for discussions.

On-Farm Research in Minnesota
We need your opinion

The University of Minnesota is working with the Agricultural Fertilizer Research and Education Council (AFREC) to determine the need and opportunities for on-farm research in Minnesota. Your input is requested to determine if an on-farm research program should go ahead, and if so, what it should look like. Read through this preliminary plan and then tell us what you think.

Why do on-farm research?
- Find out if practices or products make sense for an individual producer.
- Hone skills for interpreting research results and product claims.
- Learn to conduct trials that provide meaningful information for an individual operation.
- Network with other producers asking similar questions.
- Improve statewide understanding and recommendations by analyzing data from a variety of soil and climate scenarios around the state to supplement data from University research centers.

Who would be involved?
An effective on-farm program would have a broad group of partners participating in trials and providing leadership. Potential partners are:
- Individual producers – their interest and needs would sustain the program
- Ag consultants – provide local coordination and support
- Local ag dealers – provide local support and cooperation to implement trials
- Regional/national ag industry – potential source of funding and products for research
- Producer organizations – communication channel, potential funding source, protect data privacy
- Researchers and University Extension – technical advising on choosing research topics, designing protocols, interpreting results, and integrating results with other research
- Program staff – specialists in research, communication, ag technology, field work and data management to coordinate all the partners.

Which of these are important to you?

What is an on-farm program?
Many farmers already conduct their own (in)formal research, and some researchers already work on-farm with growers. A dedicated on-farm program would help coordinate and expand these activities. A new program would feature:
- Collaboration. Stronger connections between the University and the ag community.
- Effective science. Help growers design and conduct sound research.
- Standardization. Create standardized protocols to make it easier to set up trials and compare data.
- Automation. Control costs and improve data quality by centralizing data collection and processing.
- More information. Combine results from many sites with different weather and operations, generating more information faster than from a single site.
- Availability of information. Generate information and share results quickly.

Would you participate?
If so, how?
How would it work?

The current proposal is to create two independent but closely aligned organizations. Both would support on-farm trials using precision ag technology to apply treatments and collect yield data. One organization would focus on individual farmers improving their management by running trials for their operation and learning from peers. The other would focus on coordinating trials and aggregating data across the state.

The Peer Group Track
- Leadership is mainly at the local level, with occasional state-level gatherings.
- Small groups of farmers select topics and conduct trials to improve the profitability of their individual operations.
- Members meet with other producers to provide feedback on using precision ag technology, conducting meaningful trials, and interpreting the results.
- If desired, the groups may consult with Extension or other specialists for advice on designing and interpreting trials.

The Coordinated Research Track
- Leadership is coordinated by a newly created entity closely tied to University Extension and/or ag commodity organizations.
- Agricultural representatives and researchers collaborate to choose a few research topics.
- Researchers design standard protocols.
- Ag consultants or other local coordinators work with producers to help them implement the protocols using their own equipment.
- Researchers and program staff ensure data quality, analyze data, and interpret results, while protecting the privacy of individual operations.

What would be studied?

Topics will be selected that address important agronomic questions, are well suited to on-farm trials, and are of interest to individual producers. A few topics will be selected to study on many farms using the same procedure so data can be aggregated. In addition, individuals may choose to address a topic that is important to their operation. Here are some topics that have been studied on farms in other states:

- Fertilizer timing and rates
- Variable rate applications
- Fungicides and other pest management products
- Tillage methods
- Cover crops
- Manure timing and application methods
- Any of the above in irrigated fields
- Economic analyses

What do you think?

Let us know your thoughts on this proposal by completing the survey at:

z.umn.edu/onfarmsurvey  (survey closes March 31st)

Or send your comments to Ann Lewandowski, alewand@umn.edu, 612-624-6765.

1/14/2014
Appendix C: Online Survey

On-Farm Research in Minnesota
Opinion Survey

The University of Minnesota is working with the Agricultural Fertilizer Research and Education Council (AFREC) to determine the need and opportunities for on-farm research in Minnesota. Your input is requested to determine if an on-farm research program should go ahead, and if so, what it should look like.

Before answering these questions, please read through the one-page preliminary plan: “On-Farm Research in Minnesota”, available at http://z.umn.edu/onfarm

1. What is your profession? (check all that apply)
   - Farmer
   - Ag consultant or adviser
   - Ag industry representative
   - Producer organization staff or board member
   - University Extension employee
   - Other researcher or educator
   - Local, state, or federal agency employee
   - Other (please specify): __________________________

2. How important are these reasons for participating in an on-farm research program?

<table>
<thead>
<tr>
<th>Reason</th>
<th>Not important</th>
<th>A little important</th>
<th>Somewhat important</th>
<th>Very important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Find out if a particular practice or product is profitable on my farm, or on my clients’ farms.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Get better at understanding research results and product claims.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learn how to use precision ag equipment to conduct good field trials on my own.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meet with other producers who are also using precision ag equipment to run field trials.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improve regional recommendations by analyzing local data from farms around the state.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other important reasons:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Which topics are you interested in for on-farm research?

<table>
<thead>
<tr>
<th>Topic</th>
<th>Not interested</th>
<th>A little interested</th>
<th>Somewhat interested</th>
<th>Very interested</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilizer timing and rates</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variable rate applications</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fungicides &amp; other pest management products</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tillage methods</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Cover crops</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manure timing and application methods</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic analyses</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nutrient loss</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water management</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other (please specify):</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4. How likely are you to participate in the following on-farm research activities?

<table>
<thead>
<tr>
<th>Activity</th>
<th>Very unlikely</th>
<th>Somewhat unlikely</th>
<th>Somewhat likely</th>
<th>Very likely</th>
<th>Not applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conduct my own trials on my farm.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Conduct trials on my farm following standardized protocols for a topic I am interested in.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Meet with other farmers to talk about our on-farm trials.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Attend (or present) training on how to use precision ag equipment to conduct field trials.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Coordinate my clients to help them conduct on-farm trials.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>(If you are a researcher): work with the on-farm program to conduct my research on commercial farms.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Other ways I’d like to participate:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. I have access to the following GPS-enabled equipment:

- [ ] Variable rate fertilizer applicator
- [ ] Variable rate sprayers
- [ ] Variable rate planters
- [ ] Vehicle guidance systems
- [ ] Yield monitor
- [ ] Other (please specify): ________________________________________________________________________________________

6. What is a problem with this plan that you are concerned about?

7. What part of this plan are you most excited about?

8. Other thoughts or suggestions?

Thank you for taking time to answer these questions.

If you have further questions or comments, contact Ann Lewandowski, 612-624-6765, alewand@umn.edu.
University of Minnesota, 173 McNeal Hall, 1985 Buford Avenue, St. Paul MN 55108

Project web page: http://z.umn.edu/onfarm.