

## **M.L. 2015 Project Abstract**

For the Period Ending June 30, 2017

**PROJECT TITLE:** Southeast Minnesota Cover Crop and Soil Health Initiatives

**PROJECT MANAGER:** Matt Drewitz, BWSR Reporting and Outcomes Coordinator

**AFFILIATION:** Minnesota Board of Water and Soil Resources

**MAILING ADDRESS:** 12 Civic Center Plaza, Suite 3000B

**CITY/STATE/ZIP:** 56001

**PHONE:** 507-344-2821

**E-MAIL:** [matt.drewitz@state.mn.us](mailto:matt.drewitz@state.mn.us)

**WEBSITE:** <http://www.bwsr.state.mn.us/soils/index.html>

**FUNDING SOURCE:** Environment and Natural Resources Trust Fund

**LEGAL CITATION:** M.L. 2015, Chp. 76, Sec. 2, Subd. 04e

**APPROPRIATION AMOUNT:** \$253,000.00

**AMOUNT SPENT:** \$214,299.58

**AMOUNT REMAINING:** \$38,700.42

### **Overall Project Outcome and Results**

This project was very important in keeping the momentum going for cover crop and soil health awareness in Southeastern Minnesota. In 2014 when BWSR applied for the LCCMR grant, very limited outreach and awareness of implementing cover crops was occurring in Southeast Minnesota as well as Statewide. Over the last 4 years, the work of this project has helped keep cover crops and soil health on the forefront of innovative conservation in Minnesota. This project was successful in establishing cover crop demonstration sites, providing education and outreach through workshops and field days, and completing an economic analysis report of cover crops. The following includes the major accomplishments of this project:

**Field Days:** This project lead or assisted in sponsoring 9 different field days through the course of this project, which was the target goal for the project. A total of 575 people attended these field days.

**Workshops:** A total of 832 people attended 11 workshops that were sponsored by this project, which exceeded our initial goal of 6 workshops.

**Cover Crop Demonstration Sites:** This project worked with 13 landowners to implement 2098 acres of cover crops over 2 years. These sites represented farmers from across the focus area using different farming methods and cover crop seed mixes.

**Soil Health Sampling and Method/Protocol Development:** This project was important in working with our partners at USDA-NRCS and local SWCD staff to develop a sampling protocol for collecting soil samples for soil health analysis. Soil tests were collected at each of the landowner demonstration sites.

**Cover Crop Economic Analysis:** A report on the economics of cover crops based on data from the landowner demonstration sites was developed.

**Partnership Development:** This project was instrumental in bringing University of Minnesota, Federal, State, and local partners together to coordinate and ensure project success.

### **Project Results Use and Dissemination**

This project provided dissemination of information regarding soil health, cover crops, and alternative crops through the many workshops and field days that were outlined above. This project utilized the U of M Soil Health website, as well as many other local sources, to provide information about upcoming

workshops and field days. See web link: <https://extension.umn.edu/soil-and-water/soil-management-and-health> .

Specific new information that was developed and disseminated through this project include:

- Cover Crop Economics Report by Dr. Bill Lazarus, U of M Applied Economics:
- Updates to U of M Cover Crop Economics Spreadsheet tools,
- Soil health testing results were supplied to each of the 13 cooperators,
- Project updates on BWSR's website, such as this BWSR Snap Shot article: <http://www.bwsr.state.mn.us/news/webnews/december2016/1.pdf>

Through this project over the last 3 years, BWSR has learned a lot about the positive impacts of soil health, the pros, cons, and risks of implementing cover crops into a farming operation, and what types of information farmers and local conservation practitioners are looking for. This project was instrumental in providing a basis for BWSR adopting cover crops as practice for our grant programs, helping provide insight into the development of the new BWSR/University of Minnesota joint venture with the Office for Soil Health, and was a precursor to a recently awarded Conservation Innovation Grant from the USDA-NRCS focusing on soil health metrics. BWSR is confident that the momentum created by this project will help move the State of Minnesota forward in developing new strategies for soil health that will lead to greater adoption of cover crops and other soil health practices.



# Environment and Natural Resources Trust Fund (ENRTF) M.L. 2015 Work Plan Final Report

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<b>Date of Status Report:</b>	August 17, 2018 (revised Feb 25, 2019)
<b>Date of Next Status Update Report:</b>	Final Report
<b>Date of Work Plan Approval:</b>	June 11, 2015
<b>Project Completion Date:</b>	June 30, 2018

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**PROJECT TITLE: Southeast Minnesota Cover Crop and Soil Health Initiatives**

**Project Manager:** Matt Drewitz, BWSR Reporting and Outcomes Coordinator

**Organization:** Minnesota Board of Water and Soil Resources

**Mailing Address:** 12 Civic Center Plaza, Suite 3000B

**City/State/Zip Code:** Mankato, MN 56001

**Telephone Number:** (507) 344-2821

**Email Address:** [matt.drewitz@state.mn.us](mailto:matt.drewitz@state.mn.us)

**Web Address:** [www.bwsr.state.mn.us](http://www.bwsr.state.mn.us)

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**Location (Counties):** Goodhue, Rice, Dodge, Steele, Wabasha, Winona, Fillmore, Mower, Houston, Freeborn, Olmsted

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<b>Total ENRTF Project Budget:</b>	<b>ENRTF Appropriation:</b>	<b>\$253,000.00</b>
	<b>Amount Spent:</b>	<b>\$214,309.65</b>
	<b>Balance:</b>	<b>\$38,690.35</b>

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**Legal Citation:** M.L. 2015, Chp. 76, Sec. 2, Subd. 04e

**Appropriation Language:**

\$253,000 the first year is from the trust fund to the Board of Water and Soil Resources to promote cover crops as a means of protecting soil and water quality in southeastern Minnesota through training and education for local practitioners, economic analysis of implementation, and on-farm demonstration sites. This effort must be coordinated with the University of Minnesota Forever Green Initiative. This appropriation is available until June 30, 2018, by which time the project must be completed and final products delivered.

## I. PROJECT TITLE: Southeast Minnesota Cover Crop and Soil Health Initiatives

### II. PROJECT STATEMENT:

**Overall Project Goal:** This project aims to accelerate the adoption of cover crops in agricultural cropping systems in Southeastern Minnesota to reduce pollution runoff and sedimentation, improve water quality, and improve soil health. The three primary objectives of this project are outlined below:

1. **Providing technical training, education, and outreach:** BWSR, the University of Minnesota Forever Green Initiative, the University of Minnesota Extension, Natural Resource Conservation Service (NRCS), and the Southeast Minnesota Technical Service Area 7 Joint Powers Board staff will lead 6 workshops and 9 field days on cover crop management techniques and other soil health best management practices. In addition, this project will take approximately 400 soil tests at targeted demonstration sites to gauge and measure soil health. To demonstrate the effectiveness of cover crops in reducing soil erosion and runoff, a small rainfall simulator will be utilized for the on-farm demonstrations. This project component is important because training and education efforts have been limited in Minnesota and this effort will accelerate those efforts in Southeastern Minnesota, which is a region of the state where cover crops are greatly needed and can have significant positive environmental impacts.
2. **Conducting and disseminating a cover crop economic study for Southeastern Minnesota:** The lack of comprehensive economic data on cover crops is a road block to implementation. A cost benefit analysis will be conducted by Dr. William Lazarus with the University of Minnesota, Department of Applied Economics, to help farmers make informed choices about cover crop adoption and management. This work is one of the priority first steps that are needed to increase the adoption of cover crops in Southeastern Minnesota.
3. **Cover Crop Demonstration Sites:** This project will establish approximately 700 acres of cover crop demonstration projects on the ground to demonstrate the effectiveness of reducing soil erosion and runoff, improving water quality, improving the health of the soil, and providing secondary benefits of increased wildlife habitat. Demonstrating that cover crops can be successfully integrated into row crop agriculture is a crucial step towards increased adoption. This is especially critical in this project's target area in Southeastern Minnesota, which has a diverse landscape that is prone to soil erosion and pollution runoff from agricultural fields. This project will demonstrate cover crop methods in a variety of different landscapes and agricultural systems to maximize the education opportunities for this project. In addition, this project will enhance and leverage Federal United States Department of Agriculture-Environmental Quality Incentive Program funds to farmers to help increase the adoption of cover crops in the region.

**Cover Crop Definition:** Cover crops are plants seeded into agricultural fields, either within or outside of the regular growing season, with the primary purpose of improving or maintaining ecosystem quality.

**Project Importance:** Southeastern Minnesota is a unique and sensitive landscape that is prone to soil erosion from production agricultural practices. With over 1.3 million acres of highly erodible and vulnerable soils out of 2.7 million total cropland acres in the target area of this project, Southeast Minnesota is a prime geographic area for accelerating cover crop adoption to realize positive environmental outcomes. Environmental and on-farm benefits of cover crops include: reduced soil erosion and nutrient runoff, improved nutrient cycling and reduced fertilizer costs, reduced sedimentation and improved water quality, and increased soil organic matter and water holding capacity. The region's vulnerability was exemplified in 2013, and again in 2014, with intense storm events and flooding which resulted in catastrophic soil loss. Cover crops and other soil health activities minimize the damage from intense rainfall events by protecting the soil surface, increasing infiltration rates and total water holding capacity, and creating a more resilient system. Cover crops are also an important practice to

reduce nutrient loss as identified in MPCA's MN Nitrogen in Surface Water Report and will assist the state in achieving a 20% nitrogen reduction goal.

**Leveraging BWSR Clean Water Fund Goals:** Current funding for cover crops with Clean Water Funds provides on-the-ground technical assistance to farmers planting cover crops (Clean Water Fund Accelerated Implementation Grants via the Board of Water and Soil Resources) and applied cover crop research (Minnesota Department of Agriculture). Of note, neither of these efforts funded with the Clean Water Fund address cover crop education and outreach, which is the focus of this project. Specifically, the Board of Water and Soil Resources Clean Water Fund grant to the Southeast Minnesota Technical Service Area 7 Joint Powers Board provides for a Soil Health Technician, Dean Thomas, who will be instrumental in selecting and assisting farmers in establishing demonstration sites (Activity 3) for this project. Dean has many years of experience working with landowners in Southeastern Minnesota and his work, along with our other project partners, will be critical to the success of this project.

**Measurability:** Board of Water and Soil Resources will work with our partners to track and quantify the following through the course of the project through the following methods:

- **Environmental Outcomes:** Board of Water and Soil Resources staff will work with Southeast Minnesota Technical Service Area 7 to determine the soil and phosphorus reduction outcomes for each specific demonstration site.
- **Soil Health Measurements:** An integrated approach is used to test chemical and biological components of the soil. The soil testing methodology used in this project measures soil biology and its role in nutrient cycling. By utilizing a holistic testing approach, we will quantify the wide-ranging benefits soil health benefits of cover crops. Measured parameters include soil phosphorus, nitrogen, potassium, soil organic phosphorus and organic nitrogen, microbial activity, water extractable carbon, and the carbon to nitrogen ratio.
- **Economic Study and Barriers:** The National Wildlife Federation's *Roadmap to Increased Cover Crop Adoption* publication identifies the lack of economic analysis on cover crops as a barrier to implementation. Farmers make agronomic decisions based partly on cost/benefit analysis. Without cover crop-specific cost/benefit data, producers cannot make an informed decision on integrating cover crops into their crop rotation. Dr. Lazarus and a graduate student will collect detailed information from participating farmers and input the data into an economic model. Data collected includes agronomic practices, labor and equipment costs, fuel and chemical costs, forage and cash crop yields, etc.
- **Social Measures:** The Board of Water and Soil Resources will utilize our Training Coordinator staff person, in conjunction with the University of Minnesota Extension, to thoroughly evaluate the 6 workshops and 9 field days for their effectiveness. The feedback from the participants, especially the farmers in the region, will be important in improving how we as a State approach cover crops and soil health issues. Additionally, the Board of Water and Soil Resources is tentatively planning to contribute additional match to this project (match funds beyond our initial proposal) to quantify specific social indicators related to individual, regional, and organizational, and programmatic levels.

### III. OVERALL PROJECT STATUS UPDATES:

#### Project Status as of December 1, 2015:

BWSR staff Megan Lennon and Matt Drewitz worked to secure professional technical contracts with the three project partners receiving funds for this project: 1) U of M Extension, 2) U of M Applied Economics Department, and 3) Southeast Minnesota Technical Service Area 7. All professional contracts are now in place for these three partners. BWSR did experience some delays with contacting through Minnesota Management and Budget and

also BWSR was short on accounting staff this summer due to turnover in BWSRs Central Office. See email from Matt Drewitz to LCCMR staff in August 2015 that explains this issues in more detail.

A project partner meeting was held in Rochester on September 18<sup>th</sup>. This meeting included all the project partners and was a good meeting to kick off the project and also to do some future planning. From this meeting, we began planning for the first set of workshops that Jill Sackett, U of M Extension, will be leading. Tentative dates have been set for March 2016 for two workshops. Additionally, we worked on developing a guidance document for Dean Thomas, TSA 7 staff, to use when promoting the program. Lastly, Dr. Bill Lazarus discussed options for a graduate student to work on the project and he has a good lead on a student that would fit well. This student would assist him for his part of the project in 2016.

**Project Status as of June 1, 2016:**

BWSR Staff Matt Drewitz organized a number of conference calls with core project team members Jill Sackett-Eberhart (U of M Extension), Dean Thomas (Soil Health Technician), and Dr. William Lazarus (U of M Applied Economics) to work on strategies to recruit farmers for the cover crop demonstration sites and also to plan for two workshops on March 8, 2016. More detail is in the Activity 1 update on the workshops, but they were very successful in getting the word out about the project, finding farmer cooperators, and also engaging private industry manufacturers and seed dealers that support cover crops on the landscape. The feedback from the workshop participants was very important to glean topics that could headline future field days and workshops.

On May 24, 2016, a project partner Technical Team meeting was held in Rochester, MN to discuss a number of topics related to this project. Primary topics for the meeting were to review the outcomes of the March 8<sup>th</sup> workshops, plan for summer/fall 2016 field days, develop a list of topics for winter 2016 and 2017 winter workshops, discuss the usage of the rainfall simulator for the project, and review the landowner participants that will be establishing cover crops for this project.

**Amendment Approved by LCCMR 6-2-2016:** On Friday, May 20, 2016, Matt Drewitz was made aware by email that BWSR accounting staff had charged \$764 to the LCCMR account for additional rainfall simulator expenses. The rainfall simulator budget for LCCMR was \$10,000 and that entire amount had already been spent. BWSR additionally had spent \$3,475 of match funds for the simulator as well. It was Matt's understanding earlier from BWSR accounting staff that BWSR funds would be used for additional expenses for the rainfall simulator. BWSR accounting staff explained to Matt that they had zeroed out the BWSR fund account they had been using and they would need to charge the LCCMR account for the additional expenses. Upon learning this, Matt contacted LCCMR Michael McDonough on Monday, May 23, 2016 to explain the accounting error that had occurred and the need to change the line item budget for the rainfall simulator.

Therefore, BWSR requested and was approved by LCCMR that the rainfall simulator budget be changed from \$10,000 to \$10,764 and the soil sampling budget be changed from \$20,000 to \$19,236. BWSR believes there will not be an impact to the project outcomes and success with these budgetary changes.

**Project Status as of December 12, 2016:**

Much progress has been made towards the goals of this project in the last six months.

- Two field days were held in August and September 2016 that focused on the efforts of this project and demonstrated the use of cover crops and perennial cover in increasing soil health, improving water quality, and enhancing livestock grazing potential in the region;
- The rain fall simulator worked well and was operational at the August field day and other special events in southeastern Minnesota;
- U of M Applied Economics staff have begun to interview farmers for the economics component of the project;
- A total of 16 cover crop demonstration sites were established from this project covering 1,049 acres;

- Soil samples were taken at each site and submitted for analysis. Soil sampling data will be reviewed this winter and summarized for the project cooperators.

The project partner technical team for this project met on October 11, 2016 to discuss the results of the field days and begin planning for workshops and field days for 2017. Next year will be a very busy year for this project, and BWSR will be working with the U of M and other project partners to plan out all the activities that need to be accomplished in 2017.

Earlier in 2016, Megan Lennon, BWSR State Soil Scientist, took a new joint position with BWSR and the USDA-NRCS as a Technical Training Coordinator. It has been determined that because of her work load with her new position, she will not be available to work on this project directly. Megan will be available for helping in an advisory role only. Megan's responsibility was primarily to assist with the soil sampling component. Matt Drewitz is coordinating this component, and BWSR has recruited BWSR Board Conservationist staff in our Rochester office to help collect samples in the field.

In July, Jill Sackett-Eberhart took a new position with BWSR as a Board Conservationist and left her position with the U of M Extension Service. Jill was able to coordinate the two field days for this project before taking her new job. With Jill's role with BWSR, she will not work directly on this project, but will be available as an advisor as needed. Jake Overgaard, U of M Extension from Winona County, has taken Jill's place and is the designated lead for the U of M Extension responsibilities for the project. Jake has a lot of experience with cover crops and forage systems and was part of the planning process for the March 2016 workshops.

Also, in May 2016, Matt Drewitz took a new position as the BWSR Reporting and Outcomes Coordinator (previously BWSR Clean Water Specialist). Matt will continue to be the primary contact for this project and will be responsible for overall project coordination, so there is no change in Matt's role.

**Project Status as of June 21, 2017 (revised from June 1, 2017):**

The project has been progressing well and all partners in this project have been active in completing their components of the project. Here are highlights from the last six months:

- **Two winter workshops:** Two workshops were held in St. Charles and Owatonna respectively with approximately 50 people attending each meeting for a total of 100 people.
- **One spring field day:** 60 people attended a field day event near Pine Island, MN in Dodge County with farmer cooperator Tom Pyfferoen.
- **Soil testing data disseminated:** Soils test data was distributed to all of the farmer cooperators, and TSA 7 and/or USDA-NRCS staff reviewed the results with the farmers.
- **Initial economic analysis drafted:** University of Minnesota staff developed their first draft of the economic analysis based on data provided by the farmer cooperators.

Along with this report is an updated photo library from the workshops and field day events. See Attachment B.

The project Technical Team met on May 23, 2017 to plan work for 2017 and share progress on this project.

There are a number of planned activities for this project for the rest of calendar year 2017. Including,

- **Field days:** We have six field days to complete as part of the project and hope to get most, if not all, completed in 2017.
- **Soil Sampling:** For the fall sampling, we will be working with USDA-NRCS to revise the protocol.
- **Cover Crop Demonstration Sites:** All 13 landowners are under contract to implement cover crops this fall.

**Revision on June 21, 2017:** Added two tables to the report. Table 1 on page 11 lists all of the completed workshop and field days completed to date. Table 2 on page 17-18 describes the 2016 cover crop seeding information for the demonstration sites.

**Project Status as of December 27, 2017:**

The project has continued to make progress and meeting the goals and objectives of the LCCMR grant. Here are highlights from the last six months:

- **6 Field Days Completed:** the project supported 6 field days across southeastern Minnesota with approximately 385 people in total attendance,
- **Demonstration Sites Planted:** Cover crop sites were planted and certified by Soil Health technician Dean Thomas,
- **Soil Sampling Completed:** Soil sampling was completed and results were collected at each farmer cooperator site,
- **Economic Analysis:** Spreadsheet tool update and survey sent to farmer cooperators to collect additional information.

Along with this report is an updated photo library from the workshops and field day events. See Attachment B.

The project Technical Team met on September 15, 2017 to plan work for 2017 and share progress on this project.

**The planned activities for 2018 include:**

- 2 winter workshops with farmers,
- 1 winter workshop with certified crop advisors,
- Supporting 3-4 workshops/seminars sponsored by the Land Stewardship Project featuring speaker Ray Archuleta.
- Dissemination of soil testing data with farmers,
- U of M Applied Economics staff will meet with farmers on cover crop economic data, and
- Potential for additional field days in the spring depending on weather and cover crop conditions.

**Project Status as of June 30, 2018:**

During the spring of 2018, a number of activities were completed for the project, which include the following:

- **3 winter workshops completed:** Two workshops were completed that focused on educating citizens in the project area about cover crop economics, soil health testing methods and results, soil health metrics, and providing farmer perspectives through a panel discussion. Additionally, a workshop was also completed that was targeted to Certified Crop Advisors, or CCAs. There were 100 people trained through these 3 workshops.
- **Support of Ray Archuleta Workshops:** This project assisted the Land Stewardship Project (LSP) and partner SWCDs to bring Ray Archuleta, to talk about the benefits of improving soil health. Mr. Archuleta is a former USDA-NRCS soil scientist and nationally known speaker on the topic. Over 3 days for a total of 4 workshops, Mr. Archuleta educated and informed 560 people about the benefits of soil health.
- **Soil Data Provided to Landowners:** Soil test results were disseminated to the landowner participants for the project. Last year, BWSR provided each landowner with a binder of information.
- **Economic Report Completed:** Dr. Lazarus and his graduate student completed the economic analysis of the participating farms in this project. The final report can be found on the BWSR website here: [http://www.bwsr.state.mn.us/soils/LCCMR\\_Cover\\_Crop\\_Final\\_Report\\_U\\_of\\_M\\_Applied\\_Economics.pdf](http://www.bwsr.state.mn.us/soils/LCCMR_Cover_Crop_Final_Report_U_of_M_Applied_Economics.pdf)

### **Overall Project Outcomes and Results:**

This project was very important in keeping the momentum going for cover crop and soil health awareness in Southeastern Minnesota. In 2014 when BWSR applied for the LCCMR grant, very limited outreach and awareness of implementing cover crops was occurring in Southeast Minnesota as well as Statewide. Over the last 4 years, the work of this project has helped keep cover crops and soil health on the forefront of innovative conservation in Minnesota. This project was successful in establishing cover crop demonstration sites, providing education and outreach through workshops and field days, and completing an economic analysis report of cover crops.

### **The following includes the major accomplishments of this project:**

- **Field Days:** This project lead or assisted in sponsoring 9 different field days through the course of this project, which was the target goal for the project. A total of 575 people attended these field days.
- **Workshops:** A total of 832 people attended 11 workshops that were sponsored by this project, which exceeded our initial goal of 6 workshops.
- **Cover Crop Demonstration Sites:** This project worked with 13 landowners to implement 2098 acres of cover crops over 2 years. These sites represented farmers from across the focus area using different farming methods and cover crop seed mixes.
- **Soil Health Sampling and Method/Protocol Development:** This project was important in working with our partners at USDA-NRCS and local SWCD staff to develop a sampling protocol for collecting soil samples for soil health analysis. Soil tests were collected at each of the landowner demonstration sites.
- **Cover Crop Economic Analysis:** A report on the economics of cover crops based on data from the landowner demonstration sites was developed.
- **Partnership Development:** This project was instrumental in bringing University of Minnesota, Federal, State, and local partners together to coordinate and ensure project success.

### **Addendum: Future next steps and how this LCCMR project will impact new and future initiatives**

- **Minnesota Office for Soil Health (MOSH):** In 2017, the BWSR worked cooperatively with the University of Minnesota to form the Minnesota Office for Soil Health, or MOSH. Information about the MOSH can be found here at the University of Minnesota Water Resources Center Website: <https://www.wrc.umn.edu/mosh>. The mission statement of the MOSH is: *Building local expertise to promote soil health and soil and water conservation. Research and outreach will expand the tools and skills of Minnesota's local conservation delivery community, and promote understanding of the economic impacts of soil and water management practices.* Recently, Dr. Anna Cates was hired to the new State Soil Health Specialist position and she will be housed at the University of Minnesota Soil, Water, and Climate Department. Through the LCCMR project it was evident that this type of effort was needed to ensure that soil health and cover crop practices will continue to increase on the agricultural landscape of Minnesota. The MOSH will be very important in bring forward the concepts discussed and analyzed in this LCCMR project.
- **USDA-NRCS Conservation Innovation Grant (CIG):** One of the components of the LCCMR project was to conduct a limited soil health analysis using new soil health sampling methods and tests on the demonstration sites managed by the farmer cooperators in this project. This LCCMR project, along with efforts at USDA-NRCS and the University of Minnesota, shed light to the fact that a comprehensive study and database development for soil health metrics was needed. BWSR supported a recent USDA-NRCS CIG program application from the University of Minnesota to do this work and the proposal was accepted for funding in July 2018 for \$885,000 by USDA-NRCS (see description: [https://www.wrc.umn.edu/sites/wrc.umn.edu/files/minnesota\\_office\\_for\\_soil\\_health\\_receives\\_usda\\_f](https://www.wrc.umn.edu/sites/wrc.umn.edu/files/minnesota_office_for_soil_health_receives_usda_f)

[unding.pdf](#) ) . We are hoping to recruit farmer cooperators involved with this LCCMR project to be a part of this future work with the new CIG project.

- **U of M Extension Publications on Cover Crop and Grazing:** Both Jake Overgaard with U of M Extension and Dr. Bill Lazarus U of M Applied Economics have been working with other Extension staff to develop a more comprehensive publication on cover crops and grazing adoption for farmers. Insights and information from this LCCMR project have and will be helpful as this publication is completed later in 2018.
- **Forever Green Initiative:** Through this project, Dr. Don Wyse and Dr. Scotty Wells were consulted about the objectives of this project and provide valuable insight in how to make the project success. Dr. Scotty Wells presented his findings from the Forever Green Initiative and Cover Crop work at workshops in 2017 and 2018 through the LCCMR project. Also, through a separate appropriation to BWSR from the Legislature (non-LCCMR funds), BWSR worked with a diverse group of stakeholders to develop the “Working Lands Watershed Restoration Feasibility Study and Program Plan” that was completed February 1, 2018. The report can be found here: [http://forevergreen-umn.info/Working\\_Lands\\_Watershed\\_Restoration.pdf](http://forevergreen-umn.info/Working_Lands_Watershed_Restoration.pdf). This Legislative Report, along with work completed through the LCCMR Project, will help provide a roadmap for BWSR and our conservations partners on future adoption of cover crop and soil health practices.
- **Presentation on Cover Crop Economics and Future Adjustments:** Dr. Bill Lazarus presented a poster to the Soil and Water Conservation Society (SWCS) National meeting in July 2018 on cover crop economic analysis from this project and also impacts of cover crops to help reduce hypoxia in the Gulf of Mexico. This poster was in conjunction with work Dave Wall, MPCA Hypoxia Coordinator, who is working on the Nitrogen and Phosphorus BMP tools that take into account cover crop economics. Dr. Lazarus plans to continue pursuing to improve the economic work and analysis related to cover crop adoption in Minnesota. Also, Dr. Lazarus plans to continue to develop the cover crop economic spreadsheet tools that he has developed and were modified based on information and input from this LCCMR project. A copy of the latest spreadsheet is included with the final report.

#### IV. PROJECT ACTIVITIES AND OUTCOMES:

##### **ACTIVITY 1: Training, Education, & Outreach on Cover Crop Methods & Techniques**

**Description:** This activity provides training to local practitioners on new cover crop methods and innovative techniques to enhance soil health within agricultural systems in southeastern Minnesota through six (6) practitioner workshops and nine (9) field days at targeted demonstration sites. In addition, site specific soil sampling to measure soil health will be conducted at field demonstration sites. Lastly, a portable rain fall simulator will be used to demonstrate the effectiveness of cover crops in reducing soil erosion and runoff.

**Workshops and Field Days:** The University of Minnesota Extension, Southeast Minnesota Technical Service Area 7, and NRCS staff, and the Board of Water and Soil Resources will be the primary leaders of these educational events. Jill Sackett, University of Minnesota Extension Cover Crop Expert, will be lead staff person in organizing, promoting, and facilitating the workshops and field days. Dean Thomas, Soil Health Technician with the Southeast Minnesota Technical Service Area 7 will also be assisting Jill Sackett as well. The 6 workshops will take place during the winter time and will be focused on providing technical information to practitioners in Southeastern Minnesota. The 9 field days taking place at the demonstration sites will facilitate the discussion of cover crop benefits, establishment success, species selection, establishment and termination logistics, on-farm benefits to producers and benefits to soil health and water quality. It is anticipated that approximately 40 people will attend each workshop and that 30 people will attend individual field days for a total of approximately 510 individuals being trained through this project. The skills and knowledge shared at these workshops and field days has potential to impact SE Minnesota’s nearly 2.7 million acres of land devoted to row

crop production. Also, field days will inform farmers on the benefits of cover crops, opportunities and challenges associated with them, and the benefits of enhancing soil health over time.

**Educational Materials:** The University of Minnesota Extension, with cooperation with the project partners, will develop and disseminate educational materials for this project. Those materials will be made available in electronic format on the web, as well as in printed form at the educational events described above.

**Soil Test:** BWSR will work with the project partners to undertake Soils tests at the landowner demonstration sites and potentially at other long term sites that have been established already in the region. The tests look at both the nutrient content (ex. nitrogen, phosphorus, potassium, and micronutrients) as well as the living microbial components. This comprehensive test provides the best single metric for measuring soil health. Megan Lennon, State Soil Scientist with BWSR, will coordinate this element of the project. It is anticipated that 400 soil tests at \$50 per test will be analyzed for this project in testing the 700 acres of cover crops being demonstrated through this project.

**Portable Rainfall Simulator:** To assist with the field day demonstrations, this project will utilize a portable rainfall simulator to show the benefits of cover crops in reducing soil erosion, sheet water runoff, and increased water infiltration capacity. Most rain fall simulators are large, bulky, and very expensive. This rainfall simulator is relative small, more economical, and can be set up quickly and easily in variety of terrains. This simulator will be used at the 9 field days and potentially at other soil health and cover crops events in southeast Minnesota. Dean Thomas, Soil Health Technician with the SE MN Technical Joint Power Board, will work with USDA Natural Resource Conservation Service and Minnesota Department of Agriculture staff in utilizing this rainfall simulator in the field.

**Summary Budget Information for Activity 1:**

**ENRTF Budget: \$110,000.00**  
**Amount Spent: \$76,099.14**  
**Balance: \$33,900.86**

<b>Outcome</b>	<b>Completion Date</b>
1. Develop website and post educational materials	Spring 2016
2. Provide training to local SWCDs, USDA-NRCS, crop consultants and local agronomist staff in 2015 and 2016	Summer 2016
3. Develop educational materials focusing in on the unique Southeast Minnesota landscape	Summer 2017
4. Conduct soil tests and analysis to measure soil health benefits	Fall 2017
5. Conduct 9 field days and 6 winter workshops in 2015-2017 for farmers focusing on cover crops/soil health	Fall 2017

**Activity Status as of December 1, 2015:**

Jill Sackett, U of M Extension, has been working on logistics for the first set of workshops that are slated for March 2016. These workshops will be at least ½ day in nature and the plan it so have one of the workshops in the evening to accommodate schedules for farmers. The overall plan is to have more extensive workshops in winter of 2016-2017 and 2017-2018 (full day workshops) once demonstration sites have been established and the preliminary economic analysis has been developed.

The rainfall simulator has been purchased and will be delivered very shortly. The price for the rainfall simulator increased since the application was made to the LCCMR for the project. To purchase the equipment, the \$10,764 budgeted in the work plan was used, along with \$3,475 from BWSR own funds (project match), for a total costs of \$14,239. The rain fall simulator will be used for field days during the growing season for 2016, 2017, and 2018.

**Activity Status as of June 1, 2016:**

Primary work during the six month period of December 2015 thru May 2016 was on event management and project communication by Jill Sackett-Eberhart, U of M Extension. Below is her summary of work she had been involved with:

**Event Management:** Much of the project time in December, January, and February was spent on workshop development. During that time there were communications with the team, event planning steps (dates, times, locations, speakers, topics, advertising, local contacts, etc.), and then the workshops on March 8. The two workshops were held on either end of the project area, Steele County and Winona County, to better reach the targeted audience of farmers and Ag and natural resource professionals. There were a total of 72 attendees with 64% of attendees identifying themselves as farmers and 21% identifying themselves as Ag professionals. Of the returned evaluations, 75% stated they were 'much' or 'very much' satisfied with the workshop. The majority of the returned evaluations also showed learning on different areas of emphasis the workshops focused on (project knowledge, cover crop agronomics, cover crop economics, and efforts in southeast Minnesota).

**Project Communication:** Another large part of the education and outreach time was spent on project communication. There are a number of local soil and water conservation districts, Natural Resources Conservation Service, watershed organizations, University of Minnesota Extension, non-profits, and state agency personnel working in the 11 county area the project is focused on. Open communication on what the project is and the events that have been held is important. Jill discussed the project at various opportunities around the state (internal University of Minnesota Extension meetings, state soil health meetings, etc.) and even discussed it with staff members from Congressman Walz's office. Jill has been invited to be a leading member of an internal U of M Extension team developing a Soil Health Team that will be planning soil health and cover crop related events, educational materials, and targeting areas of research that are the most needed. Jill's leadership will be helpful for this project because not only will educational articles and materials developed for the project area get better disseminated in southeast Minnesota, they will also have the opportunity to be disseminated statewide. An example is the article Jill wrote on spring management of cover crops, <http://blog-crop-news.extension.umn.edu/2016/04/spring-management-of-cover-crops.html>. Just for clarification, the original article did include information about the Minnesota Environmental and Natural Resource Trust Fund and LCCMR. Jill is currently working on taking the article and developing it into a fact sheet to be used at future project events and be posted on the University of Minnesota Extension website.

**Future Plans:** During summer/fall 2016, the U of M Extension staff is planning 2-3 field days in the 11 county project area focused on cover crops and soil health and highlighting the farmer-cooperators and the new rainfall simulator. The project team will also begin discussion and decision making regarding the 2017 winter workshops.

**Rainfall Simulator:** The rainfall simulator was delivered in the spring of 2016 and is housed at the Fillmore SWCD office in Preston, MN, which is the same location that Dean Thomas, Southeast Minnesota Technical Service Area 7 Soil Health Technician, is office out of. BWSR staff Matt Drewitz inspected the simulator to ensure that all of the equipment that was ordered was delivered. BWSR used our own funding (not LCCMR funds) to purchase a trailer that will transport the equipment, along with signage for the trailer and additional tools that were needed. This simulator will be used at the summer/fall field days and other educational events that can showcase the LCCMR project.

**Soil Sampling:** Matt Drewitz with BWSR is working with Kristin Brennan, USDA-NRCS Soil Health lead staff, and with Minnesota Department of Agriculture (MDA) staff on developing a plan for soil sampling for the fall of 2016. BWSR will be securing a soil lab to analyze the samples.

## Activity Status as of December 12, 2016:

**Field Days:** A total of two field days were implemented for 2016 and they are summarized below. Pictures from field days are in Attachment B: Project Photo Library.

- **August 11, 2016:** We partnered with a number of agencies (MDA, USDA-NRCS, and U of M) and Midwest Forage Association for a field day at the Ron Pagel Farm near Eyota, Minnesota. Mr. Pagel did not receive funding for cover crops from this grant, but he has cover crop plots that he is working on with other agencies and also has field plots (intermediate wheat grass) in conjunction with the Forever Green Initiative with the U of M. Through this field day, we were able to convey the importance of cover crops and perennial crops in promoting soil health and environmental conservation. The rainfall simulator was demonstrated at this field day to show the impacts of different types of land cover. Lastly, cover crop equipment and implements were demonstrated. This event drew a larger crowd than we anticipated with well over 100 people in attendance. We hope to partner with these groups again in 2017 if possible. Because we partnered with other groups, our costs towards this large field day were relatively low compared to if we funded it alone with just LCCMR funds. The *AgriNews* was in attendance and wrote short article about the field day.
- **September 27, 2016:** This field day was at the Anthony Rossman farm near Oronoco, Minnesota, and the focus was on the environmental benefits of cover crops as well as how cover crops can be used in cattle grazing operations. The speakers for the field day were Eric Mousel with the University of Minnesota, Dan Nath, USDA-NRCS Soil Scientist, and Dean Thomas, Southeast Minnesota TSA 7. Also, Mr. Rossman, who is one of the LCCMR project participants, also spoke. This demo site planted a six species mix after a canning crop of peas. There were approximately 30 people at this field day, many of which were local farmers with grazing operations in the southeastern Minnesota. Dean and Jake Overgaard with the U of M Extension Service received many positive comments from farmers about this field day, so it is hoped that this format can be a model for field days in 2017 and 2018.

A third field day was planned for November 2016 to look at the effects of cover crops on a field with liquid manure application, but bad weather and late harvest for this particular site didn't allow for it. The plan is to conduct a field day in the spring or fall of 2017 at this specific site to talk to this issue.

In 2017 we plan to have a number of field days for this project. Now that cover crops were established last fall, we can have field days this spring or after planting. Also, looking at summer and fall field days. Matt Drewitz will work with U of M Extension and our project partners over the winter to develop a plan for implementing field days in 2017.

**Special Events:** Dean Thomas with Southeast Minnesota Technical Service Area 7 was able to demonstrate the benefits of cover crops and soil health at a few additional special events during the summer. These special events helped promote the project and fine tune how the simulator runs (set up, cover crop types, etc.). Dean demonstrated the simulator at the Mower County Fair, Minnesota Land Trust Event with Representative Tim Walz (August 23, 2016), Area 7 SWCD employee meeting (all SWCD staff in southeastern Minnesota), and soil lab class for the Riverland Technical College. Here is a video from the Mower County Fair demo:

<http://kimt.com/2016/08/10/residents-take-part-in-a-rain-simulator-demonstration/>. Jake Overgaard is working with Dean Thomas to make a video of the rainfall simulator, how it works, and show the benefits of cover crops. The Riverland Technical College event was used as the backdrop for the video. Also, Jill Sackett-Eberhart met with a number of farmers in Faribault at a Rice County Ag Day event in June of 2016 and talked about the purpose of the LCCMR project and the benefits of cover crops and soil health.

**Workshops:** U of M Extension is beginning to plan for 2017 workshops. U of M, BWSR, and Dean Thomas will be meeting in December to develop the agenda for these workshops and begin working on the logistics for speakers and meeting locations. Last year's workshops were half-day in nature, and we are considering both half-day and full-day options for 2017.

**Rainfall Simulator Usage:** The rainfall simulator was utilized at the field days and special events mentioned above. The rainfall simulator was well received by the audiences in attendance at these events, and Dean Thomas received a lot of positive feedback. Because of its popularity, there have been a lot of inquiries about use of the simulator at events in 2017. The primary purpose of the simulator is to support the LCCMR project and demonstrate the value of cover crops, soil health, and water quality protection. BWSR is developing a usage policy that will be clear on what types of events are appropriate for use of the rainfall simulator, who can run the simulator, and who the main contacts are. This policy is in DRAFT form and is currently in review by BWSR staff.

**Soil Sampling:** Matt Drewitz has taken the lead in coordinating this aspect of the project. BWSR contracted with Ward Labs Inc. out of Kearney, Nebraska to analyze soil samples from each of the cover crop demonstration plots. Soil sampling included the Haney Test and the Phospholipid Fatty Acid (PLFA) test. Both these tests were recommended by USDA-NRCS to utilize to use as metrics for soil health. Matt worked with Kristen Brennan, Assistant USDA-NRCS Minnesota Soil Scientist, to develop a sampling protocol for this project. Upon finalizing the protocol, BWSR Board Conservationists Adam Beilke and Dave Copeland collected soil samples in the fall of 2016 after cover crop establishment and crops had been harvested. Soil samples were shipped to Ward Labs for analysis. Over the winter, BWSR staff, along Dean Thomas and Kristin Brennan, will review the data from the soil tests and summarize the results. Also, the sampling protocol will be revisited and revised as needed. One goal out of this project is to help USDA-NRCS and BWSR provide better guidance to landowners and local government staff on the protocols to use and follow for this type of soil sampling. Of note, BWSR intends to collect samples as well for fall of 2017. As of this report, we have received two invoices from Ward Labs Inc. for soil sampling work done and will be receiving an additional invoice later in December for the last run of soil samples from the fall of 2016.

**BWSR Highlights for December 2016:** BWSR Board Conservationist Adam Beilke is developing a BWSR Highlight story that will be posted to the BWSR website December of 2016 and will also be disseminated through social media and to the BWSR Board. This will be a short article that talks about the project and its goals and objectives. The final write up is still in DRAFT form at the time of this report, but a copy will be provided in the next semiannual report.

#### **Activity Status as of June 21, 2017:**

**Two Workshops Completed:** The U of M Extension, led by Jake Overgaard, helped organize two winter workshops that focused on cover crops. These workshops were held on February 28 and March 2 in St. Charles and Owatonna, Minnesota, respectively. We had very good attendance at these workshops and filled each room with approximately 50 people at each session. The agenda for these sessions included:

- Dr. Scotty Wells with the U of M Forever Green Initiative. He spoke about what works and doesn't work well for cover crops, the research he is working on, and the genetic research that he and others at the U of M are doing for perennial crops.
- Liz Stahl with U of M Extension spoke about the perils with herbicide residuals and how residuals impact different cover crops species from establishing.
- Randy Pepin with the U of M Extension spoke about a project he is working on with cover crops and manure application.
- T.J. Kartes with Saddlebutte Ag Inc. talked about success and failures he has seen with cover crops as a seed dealer and a farmer who uses cover crops. T.J. only spoke at the Owatonna workshop.

**One field Day Completed:** Jake Overgaard with the U of M Extension and Dean Thomas with TSA 7 worked together to set up an evening field day at the Tom Pyfferoen farm near Pine Island, Minnesota, in rural Dodge County. Tom is one of the farmer cooperators for the project and is a strong cover crop advocate. There were at least 60 people that attended this field day. Pictures can be found in the Attachment B photo library. The field day focused on the following:

- Tom talked about his experiences with cover crops and what he is currently doing on various fields in his farming operation. Tom also showed the planter he uses to plant the cover crops in the fall. A number of other farmer cooperators were present at the field day and shared their experiences.
- J.T. Kartes with Saddlebutte Ag Inc. talked about recent issues with cover crop establishment and provided tips to the audience on what he has found to work and how he has learned from past failures.
- Dean Thomas, TSA 7, and Dan Nath, USDA-NRCS, talked about cover crops in more depth. Specifically, they used the rainfall simulator to show the differences in erosion from different soil cover samples on Tom’s farm and an adjoining farm.
- Dan Nath took farmers into the cover crop field and showed the effects of Tom’s farming practices and cover crop establishment on soil health. A soil pit was dug in the field for field day participants to see what was actually happening within the soil.

**Planning for Field Days in 2017:** The project Technical Team helped put together a plan for field days in 2017. At this point, six field days are required to meet the projects goals. The project team came up with more than six viable field day ideas. Jake Overgaard with U of M Extension will be working in June 2017 to set up these field days for calendar year 2017. We are hopeful that most of the remaining field days will occur this calendar year, but may have to have one or two field days in the spring if weather doesn’t cooperate this summer and fall.

**Soil Sampling Component:** The final soil sampling data was compiled in December for the fall soil sampling work. BWSR, TSA 7, and local USDA-NRCS staff reviewed the data with Assistance State Soil Scientist Kristin Brennan with USDA-NRCS. The results from the sampling where packaged up and sent to all 13 landowner cooperators. Dean Thomas and Dan Nath met with the landowners and reviewed the soil sampling results. A revised soil sampling protocol will be developed before sampling occurs this fall.

**Rainfall Simulator Use Policy:** Matt Drewitz, BWSR, worked with the MN Attorney General’s Office and the project local partners in developing a usage policy for the rainfall simulator. This policy helped clarified who can use the simulator and under what conditions. This policy will be kept by Dean Thomas, TSA 7 staff.

<b>Field day or Workshop</b>	<b>Date of Event</b>	<b>Event Description</b>	<b>Location of Event</b>	<b>Number of Attendees</b>
Workshop	March 8, 2016 (morning)	2016 winter workshop with speakers Dean Thomas with TSA 7, Jill Sackett Eberhard with U of M, Dr. Bill Lazarus, U of M, and Matt Drewitz, BWSR.	St. Charles Community Center, St. Charles, MN	42
Workshop	March 8, 2016 (afternoon)	2016 winter workshop with speakers Dean Thomas with TSA 7, Jill Sackett Eberhard with U of M, Dr. Bill Lazarus, U of M, and Matt Drewitz, BWSR.	4-H Building, Steele County Fair Grounds, Owatonna, MN	30
Field Day	August 11, 2016	Partnered with the Midwest Grazing association to show the benefits of cover crops through the use of the rainfall simulator.	Rural Olmsted County	100

Field Day	September 27, 2017	Field day at Anthony Rossman Farm to demonstrate the use of fall cover crops for grazing purposes.	7000 70th Street, Oronoco, MN, Olmsted County	30
Workshop	February 28, 2017	2017 winter workshop with Speakers Dr. Scotty Wells, Liz Stahl, and Randy Pepin with the U of M talked.	St. Charles Community Center, St. Charles, MN	50
Workshop	March 2, 2017	2017 winter workshop with Dr. Scotty Wells, Liz Stahl, and Randy Pepin with the U of M. Also, TJ Kartes, a cover crop seed supplier also talked.	4-H Building, Steele County Fair Grounds, Owatonna, MN	50
Field Day	April 12, 2017	This was a field day at the Tom Pyfferoen farm in rural Dodge County to demonstrate the use of cover crops on his farm in reducing erosion and helping improve soil health.	53249 275th Ave, Pine Island, MN, Dodge County	60
Field Day	June 23, 2017	This field day was at the Brian Hazel farm (one of our demo sites) to demonstrate and discuss the impacts of cover crops on new row crop establishment and how cover crops can help reduce soil erosion on steep slopes.	27919 Hwy 250, Lanesboro, MN	25
Field Day	June 27, 2017	This field event was for the public to learn about the objectives of the LCCMR project and learn more about soil health. Dean Thomas gave a demo of the rainfall simulator and performed a slake test. This demo was a part of the Fillmore SWCD 75 <sup>th</sup> Anniversary Celebration.	Fillmore County Fair Grounds, Preston, MN	50
Field Day	August 8, 2017	U of M Extension staff talked about using cover crops for feed (Eric Mosel) and nitrogen impacts of cover crops and conventional systems (Jake Overgaard) at the Southeast Minnesota Forage Council and Midwest Forage Association summer field day.	Farm outside of Spring Valley, MN	45
Field Day	August 9, 2017	Assisted the Freeborn County Soil Health Team with their summer cover crop field day that featured Frank Gibbs, retired soil scientists with USDA NRCS. Dean Thomas assisted in the field day by using the rainfall simulator to	7068 East Hwy 30, Blooming Prairie, MN	70

		demonstration the effectiveness of cover crops.		
Field Day	August 10, 2017	Sustainable Farming Association cover crop council held field days across Minnesota. Dean Thomas participated in the field day in Faribault to discuss the merits of the LCCMR project and also demonstrate the rainfall simulator to show the benefits of cover crops.	Rice County Fairgrounds, Faribault, MN	45
Field Day	September 19, 2017	We were one of the primary sponsors for the Plowville field day events. Many years ago on this site farm site in Dodge County, there used to be a major plowing contest that was held. This field day was to show how far technology and environmental stewardship has come since the mid-20 <sup>th</sup> century. This field day had speakers talk about cover crops, field plots with different cover crop mixes, and equipment demonstrations. Also, two of our farmer cooperators brought their planting equipment for a lives demos (Tom Pyfferoen and Bonde Farms)	21609 County Hwy 34, Dodge Center, MN	150
Workshop	February 28, 2018	2018 Winter Workshop that focused on a small group of Certified Crop Advisors (CCA). Speakers included Dr. Bill Lazarus, U of M, on the cover crop economic report; Liz Stahl, U of M, on testing for soil health; and Ann Journey, USDA-NRCS, on soil health metrics;	Heintz Center, 1926 Collegeview Road East, Rochester, MN	20
Workshop	March 2, 2018	2018 winter workshop for farmers in SE MN. Speakers included Dr. Bill Lazarus, U of M, on the cover crop economic report; Liz Stahl, U of M, on testing for soil health; Ann Journey, USDA-NRCS, on soil health metrics; and the workshop concluded with a farmer panel.	St. Charles Community Center, St. Charles, MN	30
Workshop	March 6, 2018	2018 winter workshop for farmers in SE MN. Speakers included Dr. Bill Lazarus, U of M, on the cover crop economic report; Liz Stahl, U of M, on testing for soil health;	4-H Building, Steele County Fair Grounds, Owatonna, MN	50

		Ann Journey, USDA-NRCS, on soil health metrics; and the workshop concluded with a farmer panel.		
Workshop	March 27, 2018	Ray Archuleta, former USDA-NRCS Soil Scientist, is a Nationally known speaker and technical resource on soil health. He spoke at 4 events in SE MN to talk about the benefits of soil health. LCCMR funds helped co-sponsor this workshop, which was organized by local SWCD staff and the Land Stewardship Project.	Lewiston Community Center, 75 Rice Street, Lewiston, MN 55952	160
Workshop	March 28, 2018 (AM)		American Legion, 112 5 <sup>th</sup> Street NE, Faribault, MN 55021	160
Workshop	March 28, 2018 (PM)		Riverland Technical College, 1900 8 <sup>th</sup> Ave. NW, Austin, MN 55912	130
Workshop	March 29, 2018		Kasson Event Center, 401 8 <sup>th</sup> St. SE, Kasson, MN 55944	110

**Activity Status as of December 27, 2017:**

**Six Field Days Completed:**

This project assisted with 6 field days over the summer/fall of 2017. See Table 1 above with updated list of field days that were held since the last LCCMR report. We have been able to partner with a number of other entities regarding field days, which has helped reduce the costs for this component of the project. Three of the field days were in Fillmore County, while the others were in Dodge, Freeborn, and Rice County respectively.

The largest attended field day of the summer was the Plowville field day event near Dodge Center, MN. This event occurred near a historic site where a large plowing contest was held 65 years ago that brought in thousands of farmers and two Presidential candidates back in 1952. Some of the farmers that were at the 1952 event were present for the 2017 event. The purpose of this field days was to show the progress that has been made in 65 years regarding soil conservation methods, improvements to soil health with the use of cover crops, and new technologies that are available to farm most sustainably. There were talks from farmers and University staff on the benefits of cover crops, field demonstration plots were farmers could see various cover crop mixes up close, and field demonstrations with the latest equipment for applying cover crops.

The use of the rainfall simulator was again an important part of a number of field days this summer. This relatively inexpensive technology has enabled Dean Thomas to locally educate farmers and interested citizens in the benefits of cover crops. Dean is able to take soil samples from various fields with or without cover crops and show the differences in runoff and erosion potential. The rainfall simulator has been a great tool because of the visual nature of the demonstrations as well as how well it lends to conversation with the audiences that have observed it in action.

**Planning for Winter Workshops and Additional Field days:**

The project technical team met on September 15, 2017 to plan for the winter workshops for 2018 and discuss ideas for additional field days. For winter workshops, the plan is to hold 2 workshops for farmers like we have in the past two years plus do one additional workshop just for certified crop advisors. Also, we'll be partnering on 3 to 4 additional farmer workshops that are being sponsored by the Land Stewardship project later in the spring. Those workshops will be led by Ray Archuleta, who is a retired USDA-NRCS soil scientists who conducts soil health seminars across the nation. In the work plan for this project, we stated that 9 workshops would be conducted and if all goes as planned that number will be exceeded.

Jake Overgaard, U of M extension staff involved with the project, is looking to possibly add an additional field day in the spring before planting and also a potential project wrap up field day in June 2018.

### **Soil Sampling Project:**

A second round of soil sampling was conducted in the fall of 2017. Field conditions were much more difficult in the fall of 2017 vs. the fall of 2016 because of colder weather and delayed harvest. Prior to sampling, Matt worked with Kristen Brennan, Assistant USDA-NRCS Minnesota Soil Scientist, to update the soil sampling protocol for this project from lessons learned in 2016. BWSR Board Conservationists Adam Beilke and Dave Copeland collected soil samples in the fall of 2017 after cover crop establishment and crops had been harvested. Minnesota Department of Agriculture (MDA) staff in the Rochester office provided shipping containers to BWSR. Also, USDA staff in Rochester provided a GPS unit to collect the location data of all the sampling. Soil samples were shipped to Ward Labs for analysis. Over the winter, BWSR staff, along Dean Thomas and Dan Nath, USDA-NRCS, will review the data from the soil tests and summarize the results.

### **Final Report Summary for ACTIVITY 1: Training, Education, & Outreach on Cover Crop Methods & Techniques**

Below is a summary of work that has been completed between December 28, 2017 and June 30, 2018:

- **3 winter workshops completed:** Two workshops were completed that focused on educating citizens in the project area about cover crop economics, soil health testing methods and results, soil health metrics, and providing farmer perspectives through a panel discussion. Additionally, a workshop was also completed that was targeted to Certified Crop Advisors, or CCAs. There were 100 people trained through these 3 workshops.
- **Support of Ray Archuleta Workshops:** This project assisted the Land Stewardship Project (LSP) and partner SWCDs to bring Ray Archuleta, to talk about the benefits of improving soil health. Mr. Archuleta is a former USDA-NRCS soil scientist and nationally known speaker on the topic. Over 3 days for a total of 4 workshops, Mr. Archuleta educated and informed 560 people about the benefits of soil health.
- **Soil Data Provided to Landowners:** Soil test results were disseminated to the landowner participants for the project. Last year, BWSR provided each landowner with a binder of information to collect and store the data. Each producer will have two years of soil health testing data from this project.
- **Rainfall Simulator:** The rainfall simulator was put into action again for 2018. Dean Thomas worked with Dan Nath, USDA-NRCS, to feature the simulator at events throughout the summer and fall of 2018. The plan for future is for the rainfall simulator to continue to be used in SE MN by Dean Thomas and Dan Nath. BWSR has a contractual agreement with the Fillmore SWCD to maintain and house the rainfall simulator beyond the duration of the LCCMR project.

### **Overall Project Summary**

Over the course of this project, 9 field days and 11 workshops were held that educated approximately 1,400 people on the value of cover crops, methods to make cover crops more successful, what the economic impacts of cover crops are, the do's and don'ts of trying cover crops for the first time, and how cover crops and other conservation practices improve soil health. This project worked with 13 farmers to install over 1,000 acres of cover crops in both 2016 and 2017. The farmer's involved with this project helped provide data for the economic analysis report and assisted with field days and workshops. Soil samples were collected at each of the farmer participant's cover crop fields. BWSR staff collected and prepared the samples, Ward Labs Inc. in Nebraska analyzed the samples for soil health metrics (Haney test, phospholipid fatty acid test, organic matter, etc), BWSR staff summarized the analyzed data, and Dean Thomas and Dan Nath helped disseminate and interpret the results to the land owner participants.

The field day component included a few small field days and a couple of larger field days with upwards of 100 to 150 people. The rainfall simulator, which was purchased through this project, was used at most of the field days and provided site specific insights into the local soil health conditions. The U of M staff, Jill Sackett-Eberhart (now with BWSR) and Jake Overgaard, provided the coordination and set up for all of these field days. A few highlights of the field days were looking at how grazing systems interact with cover crops, how the soil changes under cover crop and conservation tillage systems, the opportunities and challenges of planting row crops into cover crops in the spring, how different seed mixes produce different results, and seeing how different types of farm implements are used to seed cover crops. Through this project, we were able to coordinate with a number of organizations throughout the region, which helped reduce costs and brought more exposure to the field days.

The workshops included seven (7) winter workshops that were targeted towards farmers and crop consultants in Southeastern Minnesota. These workshops were held over 3 years and provided information on a number of soil health and cover crop related topics. A total of 272 people attended these 7 workshops. Also, in the spring of 2018, this project helped support Ray “the soil guy” Archuleta to speak at four (4) workshops for the public in Southeastern Minnesota to learn more about the benefits of soil health. Ray is a very engaging speaker and his workshops and message were a very positive capstone to the outreach component to this project. His workshops drew attendance of 560 people.

The project helped BWSR and the University of Minnesota understand more about the methods for sampling for soil health in fields with cover crops. The science of measuring soil health by laboratory methods is still in its infancy and many of the tests available are very expensive and have been used a limited amount in Minnesota. BWSR will be working with the University of Minnesota through the Minnesota Office for Soil Health to further investigate the assessment methods, protocols, and science behind soil health sampling to determine the best next steps to help farmers assess soil health changes over time.

## **ACTIVITY 2: Cover Crop Economic Study for Southeastern Minnesota**

**Description:** Dr. William Lazarus with the Department of Applied Economics at the University of Minnesota, and one graduate student will be working to develop a cost/benefit study will quantify the direct, indirect and opportunity costs associated with cover crop adoption.

### **Identified Need for this Economic Analysis:**

The need for this activity was identified as a top priority in 2012 within the document *Roadmap to Increased Cover Crop Adoption*, which was published by the National Wildlife Federation. This document was a product of a consortium of experts in the Upper Midwest that identified critical policy, research, social, and technological needs to increase cover crop adoption. This project component is important in realizing this unmet need and will provide a valuable resource in analyzing the economics of cover crops for this region of Minnesota. Dr. Lazarus will identify and quantify specific costs and benefits and related information that may drive farmer’s economic decisions to establish cover crops.

Some of the information that would be useful in a cost/benefit budget may be things that the producers themselves would know and have readily available during interviews. Other things may need to be estimated indirectly based on what is known generally about the specific farm situation. One example of the latter might be the impact of the cover crop on soil erosion, which could be estimated via the RUSLE2 software and the soil mapping unit, slope, and crop rotation on the specific field.

The following is a list of items that could be included in questionnaires for the producers, and/or estimated indirectly:

- Farming system (row crops, grazing, livestock operations, canning crops),
- Previous main crop where the cover crop was/will be seeded, and timing of main crop harvest,
- Cover crop species seeded (one species or mixture),

- Cover crop establishment method, seeding rates, equipment and labor required, and timing of cover crop seeding,
- Costs per unit for seed, equipment, labor, and any other inputs involved,
- Success of the cover crop establishment (how to define success, and in particular, how much growth is associated with how much nitrogen sequestration, erosion mitigation, and other benefits),
  - Completely successful
  - Partially successful
  - Total failure
- Equipment, labor, chemicals, and any other inputs required for cover crop termination, and timing of cover crop termination,
- Forage harvested from the cover crop, yield/acre,
  - Utilization of the harvested cover crop
  - Value of the forage harvested, \$/ton
  - Harvesting cost, \$/acre
- Main crop planted following the cover crop, and impact on yield of the following main crop,
- Impact on soil erosion – possibly estimate via RUSLE2 for specific situations,
- Impact on soil organic carbon (Dr. John Baker, University of Minnesota, says this has been documented under a kura clover living mulch in pecan orchards, but seems doubtful about winter annual cover crops in Minnesota.)

**Identifying Barriers to Adoption of Cover Crops:** Barriers to adopting cover crops are directly related to economic constraints and uncertainties. Dr. Lazarus will be interviewing farmers in the region to quantify those barriers to adoption cover crops and determine what solutions from an economic standpoint are needed to increase adoption rates. Comprehensive economic data on cover crops is a well-known information gap and a barrier to cover crop adoption and this project’s goal is to help quantify and disseminate this information to practitioners in this region. Conducting a comprehensive economic analysis and disseminating the economic outcomes helps market cover crop practices and accelerates adoption by farmers. An assigned graduate student and Dr. Lazarus in the Department of Applied Economics at the University of Minnesota will collect data on farms participating in the implementation and demonstration project component of this project.

**Tool for Farmers and Practitioners:** The educational materials and tools developed from this project will be disseminated through efforts in Activity 1, as well as through other modes of outreach through the University of Minnesota Extension Service.

**Summary Budget Information for Activity 2:**

**ENRTF Budget: \$43,000.00**  
**Amount Spent: \$38,210.51**  
**Balance: \$4,789.49**

<b>Outcome</b>	<b>Completion Date</b>
1. Data gathering – field season one	Summer 2016
2. Data gathering – field season two	Summer 2017
3. DRAFT economic report developed	Fall 2017
4. Economic report finalized and dissemination	Spring 2018

**Activity Status as of December 1, 2015:**

Dr. William Lazarus attended the September 18<sup>th</sup> kick off meeting, has made contact with Dean Thomas with Area 7, and is pursuing a graduate student to assist him with the U of M Applied Economics Department portion

of the project. Significant work on this component of this project will not start until early spring of 2016 in preparation for gathering data in the summer of 2016.

**Activity Status as of June 1, 2016:**

Dr. William Lazarus worked on the following during this reporting period:

- Reviewed the literature on cover crop economics, especially regarding impacts on erosion and crop yields,
- Developed a draft questionnaire and summary spreadsheet for use with the planned farm visits,
- Met with Dr. David Mulla and Solomon Folle regarding the possibility of using the EPIC model to estimate impacts of soil erosion on future crop yields,
- Discussed project needs with Marc Ribaud at USDA-ERS to obtain background information on the erosion reduction values listed in his report as being derived using EPIC {Hansen, 2008 #2523}
- Developed a simplified spreadsheet model for estimating the impacts of soil erosion on future crop yields, and implications for the value of reducing soil erosion,
- Reviewed the NRCS cover crop economics spreadsheet decision tool for efficacy of use for this project, and
- Presented on the plans for the economic study at the March 8, 2016 workshops at St. Charles and Owatonna.

Dr. Lazarus has secured a graduate student to work on this project and that student will be assisting him with farmer interviews starting late summer 2016. This student attended the March 8, 2016 workshop to begin learning about the project and meeting potential landowner participants in the economic study.

**Activity Status as of December 12, 2016:**

Dr. William Lazarus and his graduate student worked on the following during this reporting period.

- Attended Field Day events sponsored by the LCCMR project and met with project participants at those field days;
- Initiated meetings with a few of the landowner participants this summer before harvest to talk about the economics related to cover crop establishment. Landowner's included Pat Clemens, Travis Wilford, and Brian Hazel;
- Began to review the efficacy of using the Prioritized Targeted Measurable Application (PTMApp) software program (GIS tool bar) for assessing cover crop environmental impacts;
- Dr. Lazarus has been running RUSLE2 calculations for before/after with cover crops on each cooperators farm to determine the benefits to soil loss reduction. He also reviewed the Agren Tools from Land O Lakes Inc. to see if they were viable products to use for this project.

Dr. Lazarus and his graduate student will be working with Dean Thomas, Southeast Minnesota Technical Service Area (TSA) 7 Joint Powers Board staff, and landowner participants over the winter months to discuss in more detail the economic inputs for cover crops, the strategies that landowners are implementing, and challenges that exist with cover crop implementation and establishment.

**Activity Status as of June 21, 2017:**

Dr. William Lazarus and his graduate student worked on the following:

- Talked with 11 of the 13 farmer cooperators about their farm economic data and, specifically, the costs associated with planting the cover crops for this project. He met with some of the landowners in person and with some over the phone, depending on the farmer cooperator's schedule. Dr. Lazarus will be talking with the final two cooperators about their economic data this summer.

- Developed preliminary economic analysis report based on 2016 cover crop data from the project cooperators. Dr. Lazarus and his graduate student presented the preliminary findings at the project Technical Team meeting May 23, 2017.
- Attended the field day on April 12, 2017 and met with farm cooperators regarding this project. Dr. Lazarus was available to answer any economic questions farmers may have had.

This fall more data will be collected from the farmers to further develop the economic analysis component.

**Activity Status as of December 27, 2017:**

Dr. William Lazarus and his graduate student Andrew Keller worked on the following:

- They worked on further refinement of the of an economic analysis spreadsheet tool for cover crops. This spreadsheet tool is currently under review.
- Graduate student Andrew Keller developed a detailed survey that was sent out to the landowners participating in the project in November 2017 after the fall harvest. Dr. Lazarus and Mr. Keller will be meeting with these producers in 2018 to go over the results of the survey data and economic analysis work that they have been working on and get feedback.
- Dr. Lazarus and Mr. Keller attended summer project field days to meet with landowners and gather data.
- For 2018, they will be meeting with the farmer cooperators for this project to get more information and feedback on cover crop economics. Dr. Lazarus will also be presenting his findings at the winter workshops as well.

**Final Report Summary for ACTIVITY 2: Cover Crop Economic Study for Southeastern Minnesota**

Below is a summary of work that has been completed between December 28, 2017 and June 30, 2018:

- **Final Economic Report:** Dr. Lazarus and his graduate student completed the economic analysis of cover crops utilizing data from the farmer cooperators involved in Activity 3 of this project. This information was presented at the three winter workshops this spring and revisions were made from comments from workshop participants. This report can be found on the BWSR website at: [http://www.bwsr.state.mn.us/soils/LCCMR\\_Cover\\_Crop\\_Final\\_Report\\_U\\_of\\_M\\_Applied\\_Economics.pdf](http://www.bwsr.state.mn.us/soils/LCCMR_Cover_Crop_Final_Report_U_of_M_Applied_Economics.pdf)
  - . The major findings of this report are:
    - Planting and termination costs significant expenditures for producers,
    - The yield benefits were not consistent with each producer and a larger sample size will be needed for future projects of this nature,
    - Establishing cover crops successfully in the fall is more attainable with crop rotations including a short season crop (peas, etc), and
    - Cover crops provided erosion control and soil organic matter benefits, but these parameters are difficult to accurately equate economic benefits to.
- **Updated Spreadsheet Calculators:** Dr. Lazarus made additional adjustments to the economic calculator tools that he has developed based on the outcomes of this project. These tools will be attached to this report. Dr. Lazarus consulted with BWSR and other U of M economic staff on developing a web application based on cover crop economic spreadsheet tool, but because of the complex nature of the spreadsheet model it would be difficult and costly to develop a simple, web tool at this point in time.
- **Story Map Completed:** Dr. Lazarus developed a story map for this project and utilized photos of cover crops he took in spring 2018 as part of the project.

## Overall Project Summary

Dr. Bill Lazarus and his graduate student Andy Keller at the U of M Applied Economics Department collected data over the entirety of the project and were responsible for the developing cover crop economic reports and spreadsheet calculator updates. There is limited data about cover crop economics nationwide and very few good examples of work within the literature. At the beginning of the project, Dr. Lazarus consulted the available literature, spoke with other University staff, and consulted project partners to review the input parameters for this work. Dr. Lazarus had done some economic analysis for cover crops with his work with Dr. David Mulla at the U of M and Dave Wall, Minnesota Pollution Control Agency (MPCA) hydrologist, as it related to the Minnesota Nutrient Reduction Strategy (MNRS). Dr. Lazarus was able to build upon that previous work for this project.

Andrew Keller worked with Dr. Lazarus to develop a survey to collect information from the farmer participants in the project. The data from this survey was the basis for the economic report developed from this project. Dr. Lazarus also worked with Dean Thomas to get additional background information on producers cover crop seeding plans, planting methods, as well as their means for termination of the cover crop. Data was collected and analyzed by the U of M and a DRAFT report was developed. This DRAFT report was sent out for review and was previewed at the 2018 winter workshops. The final report was completed May 2018 and is posted on the BWSR website here:

[http://www.bwsr.state.mn.us/soils/LCCMR\\_Cover\\_Crop\\_Final\\_Report\\_U\\_of\\_M\\_Applied\\_Economics.pdf](http://www.bwsr.state.mn.us/soils/LCCMR_Cover_Crop_Final_Report_U_of_M_Applied_Economics.pdf).

The work from this project will be foundational for additional economic analysis work to be completed in the future in Minnesota and the Upper Midwest. This report will help inform the [Minnesota Office for Soil Health](#) to what areas of data deficiencies exist and what new strategies can be undertaken to fill the knowledge gap on cover crop economics in Minnesota.

### ACTIVITY 3: Cover Crop Implementation Projects

**Description:** Southeast Minnesota Technical Service Area (TSA) 7 Joint Powers Board staff, in cooperation with local SWCD and NRCS staff, will identify innovative farmers interested in working cover crops into their existing crop rotation. The goal is to work with approximately 10 different sites throughout the target area for establishing demonstration sites. Demonstration sites will be established in fall of 2015, fall of 2016 and fall of 2017 for a total of approximately 700 acres.

**Demonstration Sites:** Site selection will target erosion-prone soils (sloped fields and/or rotations leaving little vegetative cover). Depending on the farmer's resource concern and needs, pilot plots will range in size and utilize tailored species mixes that include legumes, grasses, brassicas, and other appropriate plant species. Cover crop plants are typically in place on the landscape for short time windows before, during, or after the growing season and native seed mixes used with other types of conservation practices would not be appropriate for cover crop establishment. Farmer cooperators will be given financial incentive payments to implement these practices. Focus will be put on sites with a high risk of soil erosion, high potential for ground water impacts, and fields that are highly visible to the public. Use of existing inventories and geographic information system (GIS) data will be used to prioritize practices and target specific landowners and landscapes that will provide environmental benefits and to meet the full objective of this project.

**Project Match - Soil Health Technician:** Dean Thomas, staff with Southeast Minnesota Technical Service Area (TSA) 7 Joint Powers Board, will provide technical support for this project for Activity 3 directly and also will provide technical services for Activity 1 as well. Dean's position is funded for four (4) years with Clean Water Funds from a Board of Water and Soil Resources Accelerated Implementation competitive grant (\$250,000). Without Deans' position in place, this project as a whole would be very difficult to implement. No LCCMR funds will be used to fund Dean's position or any administrative costs associated with Activity 3.

**Landowner Contracts:** Payments to landowners will be based on current United States Department of Agriculture-Natural Resources Conservation Service rates for cover crop practices. Southeast Minnesota Technical Service Area (TSA) 7 Joint Powers Board will be responsible for these contracts and will follow

established Board of Water and Soil Resources protocols for land owner contracts, operation and maintenance, record keeping, and grant administration.

This project will leverage existing regional Farmer Councils to facilitate development of cover crop mentors. Mentors are producers with experience in successfully using cover crops. Mentors are a peer-to-peer resource and provide guidance on local resource concerns, seeding rates and dates, planting strategies, successful termination and pest control.

**Summary Budget Information for Activity 3:**

**ENRTF Budget: \$100,000.00**  
**Amount Spent: \$100,000.00**  
**Balance: \$0.00**

<b><i>Outcome</i></b>	<b><i>Completion Date</i></b>
1. Establish cover crop mentors in strategic watersheds	Fall 2015
2. Targeted projects identified and implementation begins	Fall 2015
3. Cover crop projects (years 1, 2, and 3) implementation completed at approximately 10 sites for a total of 700 acres.	Fall 2017

**Activity Status as of December 1, 2015:**

Dean Thomas, Southeast Minnesota Technical Service Area 7, has been working with landowners to put in demonstration sites for cover crops for 2016. Because of contract delays, Dean was not able to get any cover crops in for the fall of 2015. In talking with Dean, the project will look to add additional landowners for 2016 and 2017 to ensure that the project covers the number of acres specified in the work plan. Dean, in cooperation with the project partners, has developed a promotional document that he will be providing to landowners that he works with so the farmers know their responsibilities as a cooperator with the LCCMR project.

Match funds from Dean’s position will be updated at the June 1, 2016 report, as BWSR requires Clean Water Fund Grants recipients to report annually February 1<sup>st</sup> and that information will be added to the match contribution to the project.

**Activity Status as of June 1, 2016:**

Dean Thomas, Southeast Minnesota Technical Service Area 7, has spent significant amount of staff time during the winter and spring lining up landowners to participate in the project. At the time of this report, Dean has encumbered 90% of the project funds for installation of cover crops with landowner participants. Farmers will be paid once the cover crops are established. The first installment landowner payments will be made in the fall of 2016. BWSR will reimburse funds back to the Technical Service Area 7 and the partner landowners once Dean Thomas has certified that the cover crops were established in accordance with the local landowner contracts.

In addition to projects funded with LCCMR funds, three cover crop participants utilizing USDA-NRCS EQIP funds are willing to use their sites for field days, as well as participate in the economic analysis.

Matt Drewitz with BWSR assisted Dean Thomas in developing a landowner tracking sheet for this project, as well as developing a landowner contract based on BWSR’s grants management policies.

**Activity Status as of December 12, 2016:**

Southeast Minnesota Technical Service Area (TSA) 7 Joint Powers Board staff worked with landowner participants to sign up to be involved with the program and to establish cover crop demonstrations on their farming operations. Matt Drewitz worked with Dean Thomas and other JPB staff to ensure that local contracts were developed correctly. Dean Thomas worked with landowners in establishing the cover crops and helping trouble shoot any problems. A total of 16 sites working with 13 different landowners were implemented for the fall of 2016 covering 1,049 acres. Later in the fall, Dean Thomas went on each site to certify that cover crops has been established according to their landowner contract. All sites met the criteria for successful establishment of

cover crops. Payments to landowners for cover crop establishment occurred after the cover crops were certified as established. The Southeast Minnesota Technical Service Area 7 staff are responsible for processing payments to landowners/local partners and submitting invoices to BWSR for reimbursement for work.

With cover crops established, there is a plan to have one or more field days this spring to look over wintering of the cover crops. Also, Dean Thomas will be working with the farmer cooperators over the winter to discuss their plans for cover crop establishment in 2017 for the project. As of the date of this report, BWSR has received one invoice for work completed in the fall from TSA 7. BWSR will receive another invoice in mid-December for the cover crop incentives for the remaining costs for the fall 2016 work, and BWSR anticipates that approximately \$50,000 will be spent by January 1, 2017 for this project component.

**Activity Status as of June 21, 2017:**

All the project sites from last year were certified and payments processed with the farmer cooperators in late December 2016. As of the last report, the sites were all certified, but all of the invoices had not been submitted to BWSR before December 1, 2016. TSA 7 staff used a process defined by BWSR grant programs for contracting with landowners, project documentation, project certification, and invoice of bills to BWSR. The process went well for fall 2016, so no additions or changes to the process working with landowner cooperators will be made. All 13 cooperators have signed contracts for 2017 and will be putting in cover crops in the summer and fall of 2017. **Table 2** below shows the cover crop mixtures that were used for all of the landowner demonstration sites.

For project match, USDA-NRCS certified that \$674,950 of EQIP payments have been made from the federal government to landowners in southeast Minnesota during the duration of this project to install cover crops. Dean Thomas, TSA 7, was instrumental in signing these other landowners from TSA 7. There is a strong bond among the partnerships of farmers and local, state, and federal government staff and programs.

<b>Table 2A: Fall 2016 Seeding Information for Cover Crop Cost Share Demonstration Sites</b>					
<b>Landowner or Farm Name</b>	<b>Address and County</b>	<b>Acres</b>	<b>Primary Crop Planted</b>	<b>Cover Crop Species Mixture</b>	<b>Number of Plant Species</b>
Bonde Farms	16751 Kane Ave, Nerstrand, MN, Goodhue County	147	Soybeans	Winter cereal rye	1
Anthony Rossman	7000 70 <sup>th</sup> Street, Oronoco, MN, Olmsted County	61.5	Peas/grazing	Winter cereal rye, triticale, turnip	3
Brian Hazel	27919 State HWY 250, Lanesboro, MN, Fillmore County	46.2	Corn silage	Winter cereal rye, peas, oats	3
Gerald Nelson	34440 Cty 14 Blvd, Cannon Falls, MN Goodhue County	85	Corn	Winter cereal rye	1
JR Larson	PO Box 87, Clarks Grove, MN, Freeborn County	62.5	Soybeans	Winter cereal rye, annual rye, rapeseed/canola, sweet clover	4
Kaleb Anderson	12535 335 Street, Goodhue, MN, Goodhue County	50	Corn	Winter cereal rye, hairy vetch, radish	3
Patrick Clemons, Site 1	8702 Country Road 10 SE, Chatfield, MN, Olmsted County	24.8	Peas	Cowpeas, berseem clover, hairy vetch, red clover, pearl millet, triticale, winter cereal rye, radish, rapeseed/canola, buckwheat	10
Patrick Clemons, Site 2	Same as above	20.2	Peas	Hairy vetch, berseem clover, crimson clover, red clover, pearl millet, annual ryegrass, barley, winter cereal rye, triticale, turnip, radish, buckwheat, yellow mustard	13
Randall Gronseth	23185 Dodge Mower Road, Sargent, MN, Mower County	77.6	Soybeans	Triticale, annual ryegrass, cowpeas, rapeseed/canola	4
Scott Lightly	22238 880 <sup>th</sup> Ave, Albert Lea, MN, Freeborn County	65	Corn	Winter cereal rye, triticale, turnip, rapeseed/canola	4

Simon Farms	15318 Cty Road 17, Preston, MN, Fillmore County	90	Soybeans	Winter cereal rye, wheat	2
Tom Pyfferoen, Site 1	53249 275 <sup>th</sup> Ave, Pine Island, MN, Dodge County	47.6	Peas	Winter cereal rye, wheat, peas	3
Tom Pyfferoen, Site 2	Same as above	49.3	Corn	Winter cereal rye, rapeseed/canola, turnip	3
Tom Pyfferoen, Site 3	Same as above	53.9	Corn	Winter cereal rye, wheat, rapeseed, canola	3
Tony Tentis	19220 641 <sup>st</sup> Street, Kellogg, MN, Wabasha County	40.1	Corn	Winter cereal rye	1
Travis Wilford	33568 Cty 30, Harmony, MN, Fillmore County	85.4	Soybeans	Winter cereal rye, wheat, triticale	3

**Activity Status as of December 27, 2017:**

Southeast Minnesota Technical Service Area (TSA) 7 Joint Powers Board staff worked with landowner participants to sign up to be involved with the program and to establish cover crop demonstrations on their farming operations. Dean Thomas worked with local SWCD staff and landowners with seed mix planning, establishing the cover crops, and helping trouble shoot any problems during establishment. A total of 16 sites working with 13 different landowners were implemented for the fall of 2017 covering 1,049 acres (see Table 2B below for more detail). Later in the fall, Dean Thomas went on each site to certify that cover crops has been established according to their landowner contract. All sites met the criteria for successful establishment of cover crops. Payments to landowners for cover crop establishment occurred after the cover crops were certified as established. The Southeast Minnesota Technical Service Area 7 staff were responsible for processing payments to landowners/local partners and submitting invoices to BWSR for reimbursement for work. Dean will be working with landowners in the spring as well at planting time trouble shoot any issues or concerns. At time of report, all funds have been expended for this specific activity.

<b>Table 2B: Fall 2017 Seeding Information for Cover Crop Cost Share Demonstration Sites</b>					
<b>Landowner or Farm Name</b>	<b>Address and County</b>	<b>Acres</b>	<b>Primary Crop Planted</b>	<b>Cover Crop Species Mixture</b>	<b>Number of Plant Species</b>
<b>Bonde Farms</b>	16751 Kane Ave, Nerstrand, MN, Goodhue County	147	Corn	Winter cereal rye (1/2 of field) and annual rye, radish, turnip (1/2 of field)	3
<b>Anthony Rossman</b>	7000 70 <sup>th</sup> Street, Oronoco, MN, Olmsted County	61.5	Sweet Corn	Winter cereal rye, oats, turnip	3
<b>Brian Hazel</b>	27919 State HWY 250, Lanesboro, MN, Fillmore County	46.2	Corn silage	Winter cereal rye, hairy vetch, oats	3
<b>Gerald Nelson</b>	34440 Cty 14 Blvd, Cannon Falls, MN Goodhue County	85	Soybeans	Winter cereal rye	1
<b>JR Larson</b>	PO Box 87, Clarks Grove, MN, Freeborn County	62.5	Corn	Winter cereal rye, radish, rapeseed/canola, red clover	4
<b>Kaleb Anderson</b>	12535 335 Street, Goodhue, MN, Goodhue County	50	Soybeans	Winter cereal rye, winter wheat	2
<b>Patrick Clemons, Site 1</b>	8702 Country Road 10 SE, Chatfield, MN, Olmsted County	24.8	Soybeans	Winter cereal rye, Triticale, winter wheat, rapeseed/canola	4
<b>Patrick Clemons, Site 2</b>	Same as above	20.2	Soybeans	Winter cereal rye, Triticale, winter wheat, rapeseed/canola	4
<b>Randall Gronseth</b>	23185 Dodge Mower Road, Saregent, MN, Mower County	77.6	Soybeans	Triticale, winter rye, winter wheat, rapeseed/canola	4
<b>Scott Lightly</b>	22238 880 <sup>th</sup> Ave, Albert Lea, MN, Freeborn County	65	Corn	Winter cereal rye, triticale, winter wheat, rapeseed/canola	4
<b>Simon Farms</b>	15318 Cty Road 17, Preston, MN, Fillmore County	90	Soybeans	Winter cereal rye, winter wheat	2
<b>Tom Pyfferoen, Site 1</b>	53249 275 <sup>th</sup> Ave, Pine Island, MN, Dodge County	47.6	Soybeans	Winter cereal rye, rapeseed/canola, turnip	3

<b>Tom Pyfferoen, Site 2</b>	Same as above	49.3	Soybeans	Winter cereal rye, rapeseed/canola, turnip	3
<b>Tom Pyfferoen, Site 3</b>	Same as above	53.9	Soybeans	Winter cereal rye, wheat, rapeseed, canola	3
<b>Tony Tentis</b>	19220 641 <sup>st</sup> Street, Kellogg, MN, Wabasha County	40.1	Soybeans	Winter cereal rye	1
<b>Travis Wilford</b>	33568 Cty 30, Harmony, MN, Fillmore County	85.4	Corn	Winter cereal rye, winter wheat, triticale	3

<b>Table 2C: Annual Pollution Reduction Estimates based on Literature Values*</b>				
<b>Landowner or Farm Name</b>	<b>Address and County</b>	<b>Acres</b>	<b>Sediment Reduction in tons/year</b>	<b>Phosphorus reduction in lbs/year</b>
<b>Bonde Farms</b>	16751 Kane Ave, Nerstrand, MN, Goodhue County	147	24.99	5.88
<b>Anthony Rossman</b>	7000 70 <sup>th</sup> Street, Oronoco, MN, Olmsted County	61.5	10.46	2.46
<b>Brian Hazel</b>	27919 State HWY 250, Lanesboro, MN, Fillmore County	46.2	7.85	1.85
<b>Gerald Nelson</b>	34440 Cty 14 Blvd, Cannon Falls, MN Goodhue County	85	14.45	3.40
<b>JR Larson</b>	PO Box 87, Clarks Grove, MN, Freeborn County	62.5	10.63	2.50
<b>Kaleb Anderson</b>	12535 335 Street, Goodhue, MN, Goodhue County	50	8.50	2.00
<b>Patrick Clemons, Site 1</b>	8702 Country Road 10 SE, Chatfield, MN, Olmsted County	24.8	4.22	.99
<b>Patrick Clemons, Site 2</b>	Same as above	20.2	3.43	.81
<b>Randall Gronseth</b>	23185 Dodge Mower Road, Saregent, MN, Mower County	77.6	13.19	3.10
<b>Scott Lightly</b>	22238 880 <sup>th</sup> Ave, Albert Lea, MN, Freeborn County	65	11.05	2.60
<b>Simon Farms</b>	15318 Cty Road 17, Preston, MN, Fillmore County	90	15.30	3.60

<b>Tom Pyfferoen, Site 1</b>	53249 275 <sup>th</sup> Ave, Pine Island, MN, Dodge County	47.6	8.09	1.90
<b>Tom Pyfferoen, Site 2</b>	Same as above	49.3	8.38	1.97
<b>Tom Pyfferoen, Site 3</b>	Same as above	53.9	9.16	2.16
<b>Tony Tentis</b>	19220 641 <sup>st</sup> Street, Kellogg, MN, Wabasha County	40.1	6.82	1.60
<b>Travis Wilford</b>	33568 Cty 30, Harmony, MN, Fillmore County	85.4	14.52	3.42
<b>Totals Reductions</b>			171.04 tons sediment per year	40.24 lbs of phosphorus per year
*Research from Michigan State University determined that on average cover crops reduce sediment 340 lbs/acre of and .04 lbs/acre of phosphorus based on analysis of RUSLE2 values				

### Final Report Summary for ACTIVITY 3: Cover Crop Implementation Projects

Below is a summary of work that has been completed between December 28, 2017 and June 30, 2018:

This financial assistance portion of the project was completed as of December 2017 and no new activity occurred between January 2018 and June 2018. For the match component, USDA-NRCS certified that total \$1,236,299 in Federal EQIP cost share funds were expended on cover crops within the focus area of this project in the 2016 and 2017 growing seasons.

### Overall Project Summary

Through this project, a total of 13 landowners were brought in as project partners to implement cover crops on their farms, provide access to soil sampling, provide economic data to the U of M, and assist with field days and workshops when practicable. These landowners worked closely with Dean Thomas, regional technician, and the local SWCDs to ensure that the cover crop were implemented according to their seeding plans. Without the assistance of Dean, this portion of the project would not have been able to get off the ground. In the original application we had planned 3 years of cover crops, but because of timing of the project were able to have 2 years work of cover crop implementation. This actually worked out better for the project, as we were able to sign up additional landowners in a wider geographic spread, which helped getting additional SWCDs involved and provided better data for the U of M economics report. Over the two years of cover crop demonstration sites, 2098 acres of cover crops were planted. These cover crop sites helped reduce 171 tons of sediment and 40 lbs of phosphorus from entering nearby water courses (see Table 2C).

Before this project started, BWSR did not allow cover crops as a practice for our State Cost Share program and did not have a policy in place to guide Clean Water Funded projects. This project allowed BWSR to develop a framework for implementing these projects locally and helped informed the policies that BWSR has now implemented for our grant programs. Also, the local SWCDs involved, along with SE MN Technical JPB, worked together to help implement a regional program for financial assistance on cover crops. This partnership will be important to adopting practices like cover crops for future watershed based projects based on the One

Watershed One Plan program. Hence, this project helped blaze the trail for current and future BWSR grant programs to provide financial assistance for cover crops.

## **V. DISSEMINATION:**

**Description:** This project will be working with U of M Extension staff (Activity 1) to help facilitate the majority of the dissemination of project results and education and outreach to conservation practitioners, farmers, and agricultural industry representatives. One-on-one exposure of cover crop techniques through field days and training events will be one of the primary methods of dissemination of information. BWSR will leverage the knowledge and time of our Training Coordinator and our Communications Director to ensure that information about this project is disseminated effectively and that we are connecting with our target audiences. These BWSR staff will help with dissemination via social media and technical forms of communication. BWSR will also work with the U of M Applied Economics Department staff (Activity 2) to provide training on the results of the economic analysis and any tools developed from this activity.

### **Status as of December 1, 2015:**

Project planning was begun for over project dissemination. The U of M Extension and BWSR staff are leads of developing the overall strategy.

### **Status as of June 1, 2016:**

As mentioned in Jill Sackett-Eberhart's report in Activity 1, there has been significant outreach and dissemination so far for this project. A diligent effort was made to publicize the March 8<sup>th</sup> workshops, which helped inform a wide audience about this project and its purpose. Also, the workshops themselves helped reach a number of farmers and Ag professionals and was a great venue to tell the story about this project and to get quality feedback from them on what future topics they would like to see for future field days and workshops.

Future plans include dedicating a webpage on the BWSR website for this project. BWSR would like to develop a few short videos regarding this project, along with providing information about this project through social media outlets (i.e. Facebook, Twitter).

### **Status as of December 12, 2016:**

This project was showcased at two field days in August and September 2016. Also, this project was discussed and presented at several special events, such as the Mower County Fair, Minnesota Land Trust for SE Minnesota, and local staff meeting for SWCD staff in southeastern Minnesota. There was a wide net of publicity for the field days to various stakeholder groups in the region. Print media attended both field days and published stories in the *AgriNews*. Also, Dean Thomas was able to talk about the importance of cover crops and demonstrated the rain fall simulator on the local TV news at the Mower County Fair in Austin, Minnesota. Lastly, Jake Overgaard with the U of M is working on developing a video for the rainfall simulator that should be available early in 2017.

I have included a PowerPoint entitled "Attachment B: Photo Library" that will be used to catalog images from the field days, workshops, and webinars over time.

### **Status as of June 21, 2017:**

The April 12 field day at the Tom Pyfferoen farm was highlighted in an article in the Rochester Post Bulletin the day before the event. Jake Overgaard, U of M Extension, was interviewed for this article. The article can be found here: [http://www.postbulletin.com/life/lifestyles/greenspace-you-can-judge-a-field-s-health-by-its/article\\_b526c671-4f10-5ffd-8c8f-b85bf6a2cec3.html](http://www.postbulletin.com/life/lifestyles/greenspace-you-can-judge-a-field-s-health-by-its/article_b526c671-4f10-5ffd-8c8f-b85bf6a2cec3.html).

BWSR had dedicated a web page for this project: <http://www.bwsr.state.mn.us/soils/index.html>. Earlier this year, information about the winter workshop and the spring field days were posted on this web page. BWSR is currently going through a total website redesign in 2017 and this specific webpage will be enhanced with additional project information once the new overall BWSR website has been deployed.

We are getting interest from a number of other groups in southeast Minnesota about partnering on field days this summer. This will help expand the soil health and cover crop network in the region.

#### **Status as of December 27, 2017:**

Jake Overgaard, U of M Extension, developed or assisted project partners in developing flyers for the various field days in 2017. Jake also utilized the U of M cover crop networks to get information about the various field days out to farmers as well. BWSR also utilized our local government network to help publicize events.

For the September 19<sup>th</sup> Plowville event, Dodge SWCD did a very good job of getting the word out for this event and posted information about this project on Facebook. Local media did attend this event and spoke with Dodge SWCD staff and some of the farmers in attendance. Also, the Minnesota Association of Soil and Water Conservation Districts (MASWCD) Board held their annual summer meeting nearby and their board members attended part of the event to learn more about cover crops and how SWCDs can promote this practice.

BWSR is working with the U of M to create an Office of Soil Health. A new U of M Extension faculty member, who will also work for BWSR as well, will be starting in early 2018. The project team will be working with this new staff person to help decimate information about this project to the public as part of that person position.

#### **Final Report Summary of Project Dissemination Activities**

Below is a summary of work that has been completed between December 28, 2017 and June 30, 2018:

Jake Overgaard, U of M Extension, worked with BWSR, U of M, and local staff to plan the three (3) winter workshops for this project. Input from participants from past field days and workshops drove the agenda for the winter workshop development. Jake used the U of M cover crop and soil health networks to get the word out about the workshops. Also, Jake worked with the Land Stewardship project (LSP) to promote the four (4) Ray Archuleta talks in SE Minnesota as well. These talks were very well attended and brought in a wide ranges of citizens in to learn about soil health.

Jake also assisted other Extension staff, include Dr. Bill Lazarus who also a contributor on this project, in beginning the development of a new U of M Extension publication regarding cover crop and grazing management.

#### **Overall Project Summary**

This project was able to educate many people about soil health and cover crops through in person workshops and field days in Southeast Minnesota. One of the primary lessons learned through this project is importance of collaboration regarding soil health outreach events. Over the course of this project, many existing and new groups have taken strong roles regarding the promotion of cover crops and soil health practices in this part of Minnesota. This was evident in the fact that this project was able to partner on many of the outreach events, which helped reduce the projects overall costs and helped market the events to a larger audience. Two of the most highly attended events for this project were the Plowville Field day in the fall of 2017 and the Ray Archuleta talks in the spring of 2018. Nearly 700 people attended these events, which was a real tribute to the wide range of sponsors and the great network capabilities of all the project sponsors involved.

One valuable resource for providing information on soil health is the U of M Soils page. Because this page is updated frequently and provides a single portal on soil health issues, a completely new web site was not need to be developed (see link: <http://www.extension.umn.edu/agriculture/soils/>) to publicize outreach events for this project. BWSR is also in process of developing a new overall website for the agency and the plan in the future is to have a dedicated soil health page as well. Because of delays in the development of the new BWSR website, this work will be done after this project is completed.

It is the hope that this project will help inform and provide a framework for outreach activities related to cover crop and soil health practice adoption. Specifically, this project provides a basis for future outreach stemming from the newly formed Minnesota Office for Soil Health. This joint venture between BWSR and the U of M Water Resource Center will be a major hub of soil health outreach.

**VI. PROJECT BUDGET SUMMARY:**

**A. ENRTF Budget Overview:**

Budget Category	\$ Amount	Overview Explanation
Personnel:	\$ 0	
Professional/Technical/Service Contracts:	\$ 223,000	Three Contracts: U of M Extension, U of M Applied Economics, and the SE MN Technical Joint Powers Board
Equipment/Tools/Supplies:	\$19,236	Soil test analysis
Capital Expenditures over \$5,000:	\$10,764	Purchase portable rain fall simulator
<b>TOTAL ENRTF BUDGET:</b>	<b>\$ 253,000</b>	

**Explanation of Use of Classified Staff:** No BWSR staff will be paid with this appropriation. BWSR staff services will be in-kind.

**Explanation of Capital Expenditures Greater Than \$5,000:** Portable rainfall simulators are teaching tool used at field days, workshops and other education and outreach events. The rainfall simulators demonstrate the differences in soil erosion across different cropping systems and management techniques. For the purposes of this project, the rainfall simulator will demonstrate in real time the soil quality benefits of cover crops. The rainfall simulator will be used at all 9 demonstration site events and 6 workshops. After this project is completed, the University Extension and BWSR will continue to use the simulator in education and outreach events.

**Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation:** None.

**Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF**

**Appropriation:** Jill Sackett/Jack Overgaard .1 FTE, Department of Applied Economics graduate student .37 FTE each year for 2 years.

**B. Other Funds:**

Source of Funds	\$ Amount Proposed	\$ Amount Spent	Use of Other Funds
<b>Non-state</b>			
USDA-NRCS EQIP financial assistance to landowners	\$ 50,000*	\$1,236,299	*Potential for EQIP funds to leverage LCCMR funds for implementation of cover crops by local landowners. The funding amount for EQIP is dependent on the Federal Budget for the Farm Bill and allocations for the future are not set at this time. The level of funding may be more or less depending on future funding levels and NRCS priorities.

			<p>In 2016, Dean Thomas, Southeast Minnesota Technical Joint Powers Board, has helped secure \$1.4 M in landowner contracts with EQIP that were secured in southeastern Minnesota for cover crops. BWSR staff will confirm how much of these payments went to workshop or field day attendees and report a more accurate match amount through the June 1, 2017 semiannual report.</p> <p>Carissa Spencer with USDA NRCS reported back to BWSR on how many EQIP payments have been made to landowners as of May 23, 2017, which has been noted in the match column for the June 21, 2017 report.</p> <p>Carissa Spencer provided an updated amount of EQIP funds for practice 340 (cover crops) implemented in the project are over the duration of this LCCMR project. A total of 129 contracts covering 19,483 acres with \$1,236,299 in Federal cost share funds were implement in the project area.</p>
<b>State</b>			
BWSR staff in-kind time	\$ 30,000	\$ 30,189	BWSR employee in-kind time. Matt Drewitz and <del>Megan Lennon</del> , 5% time each, fringe and benefits. Other BWSR field staff and central office staff will assist as needed. Total match is \$30,000.
Landowner in-kind time	\$ 20,000	\$ 30,127	Landowner Time associated with cover crop field days, implementation projects, and training. 10 landowners at 50 hours each \$40 per hour.
FY 2014 BWSR Clean Water Fund Grant	\$ 250,000	\$ 250,000	The Southeast Minnesota Technical Joint Powers Board has received a Clean Water Fund Accelerated Implementation grant to employ a regional cover crop and soil health staff person (Dean Thomas) to work with landowners and local staff in implementing cover crops projects in the region. This grant is \$250,000 for 4 years and will complement the timeframe of the LCCMR grant. No LCCMR funds will be used to fund this position.

BWSR Clean Water Funds for Rainfall Simulator	Not budgeted in original work plan	\$3,475	The total cost of the Rainfall Simulator was \$14,239. The work plan budget is for \$10,764. The entire \$10,764 of LCCMR funds were spent on the rainfall simulator and BWSR used our own funds for the remaining balance for the equipment purchase.
<b>TOTAL OTHER FUNDS:</b>	<b>\$ 350,000</b>	<b>\$ 1,550,090</b>	

## VII. PROJECT STRATEGY:

### A. Project Partners

- *Project Partners receiving LCCMR funds:*
  - **University of Minnesota Extension** (\$80,000): ~~Jill Sackett~~ Jake Overgaard, Extension Educator working with cover crops, and other technical support staff with Extension, will help develop and conduct workshops, develop and conduct field days, coordinate participation of local and regional experts for educational events, and develop and disseminate educational materials.
  - **University of Minnesota Applied Economics Department** (\$43,000): Dr. William Lazarus, Agricultural Economist, will work with a graduate student to develop an economic analysis of cover crop implementation in Southeast Minnesota target area.
  - **Southeast Minnesota Technical Service Area 7 Joint Powers Board** (\$100,000): The LCCMR funding will be utilized by this organization for establishing demonstration sites. In addition, project match will be provided by staff who will assist in training, work with landowners, implement on the ground projects, and assist with summer field days.
- *Project Partners assisting in the implementation of the project, but not receiving LCCMR funds:*
  - **Minnesota Board of Water and Soil Resources:** ~~Megan Lennon, State Soil Scientist, and Matt Drewitz, Hydrologist, will assist in managing~~ manage the overall project, provide technical assistance, ensure project goals and objectives are being met, and report project outcomes to LCCMR. Also, the Communications Coordinator and Training Coordinator for the Board of Water and Soil Resources will be assisting with this project. ( All BWSR staff are unpaid)
  - **University of Minnesota Forever Green Initiative:** Dr. Don Wyse and/or his associates with the Forever Green Initiative will provide advice the to project partners in the development of field days and works shops, along with species selection for on the ground practices. Additionally, informaton and resources from Forever Green will be distributed to the targeted audiences through the outreach component of this project.
  - **Soil and Water Conservation Districts within the project area:** Staff from member SWCDs apart of the SEMN Technical Service Area 7 JPB will assist with workign with landowners and setting up field days. (Unpaid)
  - **United States Department of Agriculture-Natural Resource Conservation Service (NRCS):** Carissa Spencer, NRCS State Agronomist, and local USDA-NRCS Staff will assist with guidance and training efforts at the local level work with landowners, potentially provide EQIP funds to supplement the implementation coponent of this project, and assist with training and field days. (Unpaid)
  - **Minnesota Department of Agriculure (MDA):** Mark Zumwinkle and other staff as assigned with the Minnesota Department of Agriculture will assist with training and field days for this project. (Unpaid)

**B. Project Impact and Long-term Strategy:** This project will help Minnesota work towards meeting the goals established in the recently published Nutrient Reduction Strategy. Over the next 30 years, a 45% reduction in nitrogen and phosphorus will be necessary in the Mississippi River basin to meet Minnesota goals of this strategy to curb these nutrients from entire our rivers and streams. Cover crops are identified as one of the key practices needed to meet the goals of Minnesota Nutrient Reduction Strategy.

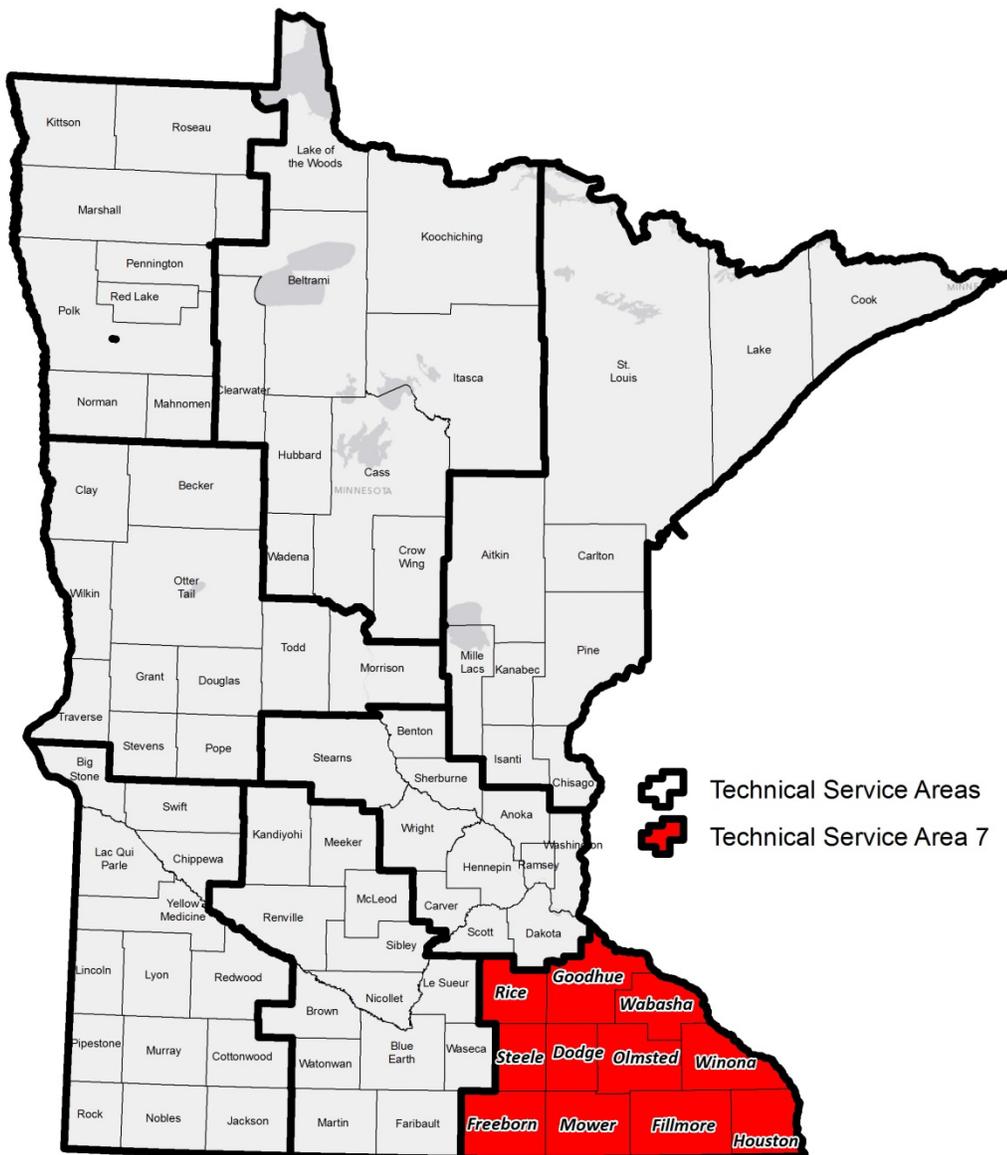
**C. Funding History:** LCCMR has not funded this project in the past.

**VIII. FEE TITLE ACQUISITION/CONSERVATION EASEMENT/RESTORATION REQUIREMENTS:**

**A. Parcel List:** Does not apply, as land acquisition is not a part of this project.

**B. Acquisition/Restoration Information:** Does not apply, as land acquisition is not a part of this project.

**IX. VISUAL COMPONENT or MAP(S):** See map below of the project area (Technical Service Area 7 in Southeastern Minnesota).



**X. RESEARCH ADDENDUM:** Not applicable to this specific project.

**XI. REPORTING REQUIREMENTS:**

Periodic work plan status update reports will be submitted no later than December 1, 2015, June 1, 2016, December 1, 2016, June 1, 2017, and December 1, 2017, and June 1, 2018. The Board of Water and Soil Resources will be responsible for all reporting to the LCCMR and will work with project partners to effectively report back on project outcomes. A final report and associated products will be submitted between June 30 and August 15, 2018.

**Final Attachment A (Budget Sheet): Environment and Natural Resources Trust Fund  
M.L. 2015 Project Budget**



**Project Title:** Southeast Minnesota Cover Crop and Soil Health Initiatives

**Legal Citation:** M.L. 2015, Chp. 76, Sec. 2, Subd. 04e

**Project Manager:** Matt Drewitz

**Organization:** BWSR

**M.L. 2015 ENRTF Appropriation:** \$253,000

**Project Length and Completion Date:** 3 Years, June 30, 2018

**Date of Report:** Final Report August 17, 2018 (revised Feb 25, 2019)

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Revised Activity 1 Budget 06/01/2016	Amount Spent	Activity 1 Balance	Activity 2 Budget	Amount Spent	Activity 2 Balance	Activity 3 Budget	Amount Spent	Activity 3 Balance	TOTAL BUDGET	TOTAL BALANCE
<b>BUDGET ITEM</b>	<b>Training, Education, and Outreach on Cover Crop Methods and Techniques</b>			<b>Cover Crop Economic study for Southeastern Minnesota</b>			<b>Cover Crop Implementation Projects</b>				
<b>Professional/Technical/Service Contracts</b>											
<b>University of Minnesota Extension Service (Sole Source PT Contract):</b> The University of Minnesota Extension service will lead local workshops and training on cover crop establishment and techniques. Jill Sackett, Extension Educator and Cover Crop Expert, will be the staff lead for this effort.	\$80,000.00	\$50,566.50	\$29,433.50							\$80,000.00	\$29,433.50
<b>University of Minnesota Applied Economics Department (Sole Source PT Contract):</b> Contract with Dr. William Lazarus and 1 graduate student to conduct the economic analysis to determine the economic feasibility of cover crop implementation and barriers for adoption in Southeastern Minnesota.			\$0.00	\$43,000.00	\$38,210.51	\$4,789.49				\$43,000.00	\$4,789.49
<b>SE MN Technical Joint Powers Board (Sole Source PT Contract):</b> Funds will be for implementation dollars to establish cover crops in targeted locations that will help improve soil health, protect water quality, and be accessible for field days and on-farm demonstrations. Funds will also be used to establish a cover crop mentor program. The SE MN Technical Joint Powers Board is a coalition of Soil and Water Conservation Districts that will administer the funds and develop local contracts with landowners to implement practices on the ground.			\$0.00				\$100,000.00	\$100,000.00	\$0.00	\$100,000.00	\$0.00
<b>Equipment/Tools/Supplies</b>			\$0.00							\$0.00	\$0.00
Soil Test Analysis: Approximately 400 soil tests, at \$50 dollars per test will be conducted in conjunction the cover crop demonstration sites for this project.	\$19,236.00	\$14,768.64	\$4,467.36							\$19,236.00	\$4,467.36
<b>Capital Expenditures Over \$5,000</b>			\$0.00							\$0.00	\$0.00
Portable Rainfall Simulator : The simulator will be used at field days and at demonstration sites to effectively demonstrate the preventative effects of cover crops on soil erosion and runoff on small plot scale.	\$10,764.00	\$10,764.00	\$0.00							\$10,764.00	\$0.00
<b>COLUMN TOTAL</b>	<b>\$110,000.00</b>	<b>\$76,099.14</b>	<b>\$33,900.86</b>	<b>\$43,000.00</b>	<b>\$38,210.51</b>	<b>\$4,789.49</b>	<b>\$100,000.00</b>	<b>\$100,000.00</b>	<b>\$0.00</b>	<b>\$253,000.00</b>	<b>\$38,690.35</b>

# How healthy is your soil?

August 2018

The Minnesota Board of Water and Soil Resources (BWSR) received \$253,000 in 2015 from the Minnesota Environment and Natural Resources Trust fund. This purpose of these funds is to accelerate the adoption of cover crops with the goal of reducing pollution runoff and sedimentation, improve water quality, and improve soil health in southeast Minnesota through education, outreach, and research. This project concluded in June 2018 and marks the beginning of BWSR's work to promote conservation through cover crops and soil health. Throughout this project, everyone involved learned about the benefits of cover crops, the opportunities and challenges associated with them, and the benefits of enhancing soil health over time.

Producers throughout the area worked with Soil Health Technician Dean Thomas, who works out of the Fillmore Soil and Water Conservation District office in Preston. Thomas has established approximately 2,000 acres of cover crop demonstration projects to show their effectiveness in reducing soil erosion and runoff, improving water quality, improving the health of the soil, and providing secondary benefits of increased wildlife habitat. Thomas completed a cover crop seeding and management plan for each producer and then payment is provided to offset additional costs of incorporating cover crops into routine cropping systems for two or three years.



*Field day held in Oronoco at one of the project demonstration sites.*

Thirteen producers planted cover crops in the fall of 2016 and 2017 as part of this project. University of Minnesota staff spoke to these producers about the benefits they have observed on the main crops that followed those cover-cropped fields this year, along with the costs of terminating cover crops before planting. One producer has a dairy farm where the cover crop followed corn silage, with the field planted back to corn silage in a rotation with alfalfa. Two producers raise peas for canning along with corn and soybeans. Two producers have beef cattle, and one was able to graze the cover crop in the fall of the year. The rest of the producers raised corn grain and soybeans.





*Spring emergence of cover crops on one of the projects demonstration sites*

A total of thirteen landowners participated in the project with cover crops located at sixteen different sites over a two year time frame. During the first year, four of the producers planted a mix of four or more cover crop species, six went with two or three species, and three planting winter cereal rye. The specific seed mixes varied. Rye, triticale, turnip, rapeseed, and wheat were the most common species, but 24 different species were planted on at least one farm. There were eight different legume species, four brassicas, and twelve grains or non-legumes. Most of the producers used a drill or row planter to plant the cover crop. One broadcast it and worked it in with a light tillage operation and two used an aerial applicator. Participating landowners experimented with similar seed mixes in the second year of the project.

Dr. William Lazarus with the University Of Minnesota's Department Of Applied Economics analyzed the costs and benefits in order to show the diversity of situations in southeastern Minnesota and the issues that producers face in managing cover crops that are economically beneficial. The goal is to help producers make informed choices about cover crop adoption and management. A recent report outlining the findings of the project can be found [here](#).



*Left: Dr. Bill Lazarus, U of M Applied Economics, talks about cover crop economic results.*

Over the course of the project, 11 winter workshops attended by 832 people and nine field days attended by 575 people were held to provide guidance on cover crop use from researchers, agriculture professionals, and farmers.



*Left: Dan Nath, USDA-NRCS, talk about soil health and the positive impacts of cover crops/no till.*



*Dr. Scotty Wells, University of Minnesota, talks about the Forever Green Initiative*

These field days and workshops provide farmers and others with information on the benefits of cover crops, establishment recommendations, species selection, and termination logistics, on-farm benefits to producers, and benefits to soil health and water quality. These events have been well attended, demonstrating the interest in cover crops and the need for these efforts.

A rainfall simulator was purchased for this project to provide a portable station where demonstrations of different land management practices during a rain event can be provided at field days, workshops, and other educational events. This simulation is beneficial in illustrating the effectiveness of cover crops in reducing soil erosion and runoff in a region of the state where cover crops are greatly needed and can have significant positive environmental impacts.



*Rainfall simulator in use at the field day in Eyota.*

Additional project partners include the University of Minnesota Extension, which is helping develop and conduct the workshops and field days, coordinate the participation of local and regional experts for additional educational events, and develop and disseminate educational materials. The University of Minnesota Forever Green Initiative, Natural Resource Conservation Service (NRCS), and Minnesota Department of Agriculture (MDA) have all assisted with guidance, resources, and training efforts.

In the fall of 2016 and 2017, soil samples were taken after harvest on demonstration project fields with cover crops as well as adjacent non-cover crop fields to measure differences in soil biological activity. Both the Phospholipid Fatty Acid (PLFA) test and Haney test were run to give producers an idea of the microbial community in their fields when cover crops are incorporated. These tests are not done frequently and will provide an additional measurement in the benefits of cover crops.



*Left: BWSR staff Adam Beilke collects soil samples from cover crop field*

Future Steps: BWSR is working with the University of Minnesota through the recent formation of the Minnesota Office for Soil Health. The project was instrumental in setting the groundwork for this new venture. Click [here](#) to learn more about the Minnesota Office for Soil Health.

For more information on this project, contact Matt Drewitz (507-344-2821) or Adam Beilke (507-206-2892) at the Minnesota Board of Water and Soil Resources.





Economic Analysis of Cover Crops on Farms Participating in the Southeastern Minnesota Cover Crop and Soil Health Initiative<sup>1</sup>

By William Lazarus and Andrew Keller<sup>2</sup>

May 8, 2018

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<sup>1</sup> Funded under the Environment and Natural Resources Trust Fund (ENRTF), M.L. 2015, Chp. 76, Sec. 2, Subd. 04e

<sup>2</sup> Professor and Extension Economist, and Graduate Research Assistant, Department of Applied Economics, University of Minnesota.



Economic Analysis of Cover Crops on Farms Participating in the Southeastern Minnesota Cover Crop and Soil Health Initiative

By William Lazarus and Andrew Keller

May 8, 2018

## Introduction

The Minnesota Board of Water and Soil Resources received \$253,000 from the Minnesota Environment and Natural Resources Trust fund in 2015 to accelerate the adoption of cover crops in order to reduce pollution runoff and sedimentation, improve water quality, and improve soil health in southeastern Minnesota through education, outreach, and research. Part of the funding (\$100,000) was used to provide incentives for a group of participating producers to each plant cover crops on at least one field of their farm in the fall of 2016 and again in the fall of 2017. Thirteen producers participated and planted cover crops on a total of 1,050 acres. In return for the incentives, three of the producers hosted field days for other producers to learn from their experiences, and all of the producers supplied various kinds of data including data on the costs they incurred and the benefits they observed. Those costs and observed benefits are summarized in this report.

Everyone involved with the project has been keenly aware that two years is not a very long timeframe for evaluating cover crops. Past research has generally shown that it takes longer than two years for such practices to result in observable soil health changes. Nevertheless, two years was what the project funding allowed, and the information gained over even such a short period has been very helpful in expanding our knowledge base. We greatly appreciate the producers' willingness to share their information and insights.

## Information Utilized in this Report

Three of the cooperating farms were visited in August, 2016 by the authors and Dean Thomas, Southeast SWCD Technical Support JPB Soil Health Technician. We attended a field day at another cooperating farm in September, 2016. The seeding costs for the cover crops were obtained from those four producers and seven of the other producers in the study group over the winter of 2016-17. We were unable to reach the other two of the 13 cooperating producers at that time. We attended field days at two of the farms in April and June of 2017. A mail questionnaire was sent to the producers in December, 2017 to ask for information on three main topics: 1) practices and costs of terminating the 2016 cover crops before planting the main crops in 2017, 2) how the cover crop affected practices, costs, benefits and/or drawbacks affecting the following main crop, and 3) practices and costs for seeding the 2017 cover crops. The questionnaire is included as an appendix to this report.

In addition, we reviewed the soil maps for the project fields on each of the farms. This was done in order to obtain the information required to run the [RUSLE2](#) soil erosion estimating tool provided by USDA Natural Resources Conservation Service staff in order to gauge how much of an impact the cover crops may have on soil erosion on the fields (Renard, Foster et al. 1997, USDA National Soil Erosion Research Lab 2015). We also summarized the soil organic matter estimates from soil tests taken from each of the project fields by BWSR staff in late 2016.

Below are general observations to add context to the budgets provided in a later section.

## Crop and Livestock Enterprises and Tillage Systems

The cooperating farms are believed to be typical of southeastern Minnesota. However, they self-selected to participate and the size of the group is small, so it would be inappropriate to claim that they are representative of the area in a statistical sense. In terms of enterprises, the 13 farms included:

- One dairy operation with a rotation of corn silage and alfalfa hay
- Two operations with beef enterprises (one breeding herd and one with backgrounding animals)
- Four that grow canning peas along with corn grain and soybeans, including the farms with the beef enterprises
- Seven cash grain operations that only grow corn grain and soybeans
- One that grows corn grain, soybeans, and alfalfa

One way that the choice of crop and livestock enterprises in a farm operation affects cover crop economics is that the cover crop planting date can be much earlier following canning peas or corn silage than following soybeans or corn grain, if planted after harvest using ground equipment. For example, the one operation with canning peas and the beef herd planted a cover crop in early August, 2016 following the pea harvest. The earlier planting date allowed the use of cover crop species such as legumes that probably would not have grown successfully if planted after the soybeans or corn.

Another issue that came to the attention of the project team in 2017 was that the companies who were accepting the canning peas were reported to have notified the growers that small grain cover crops would not be allowed on fields to be planted to peas the following year, due to the risk of gluten contamination of the peas. Small grain cover crops would still be allowed following the peas, but that new rule will obviously limit the overall use of cover crops in the rotation.

The producer with backgrounding animals and a corn grain/soybean rotation planted a three-species cover crop mix after soybeans in 2016. The planting was successful, and he planned to graze part of his acreage in the spring. That grazing plan did not work out, however, because the cover crops were too mature by the time the animals were turned into the field so they refused to eat very much of it.

All of the producers used no-till or reduced tillage systems for planting their corn and soybeans. The canning peas are planted using conventional tillage.

## Cover Crop Species, Seeding Rates, Timing, Seeding Methods, and Costs

### Timing of Cover Crop Planting

The harvest timing of the main crop grown before the cover crop affects the choice of cover crop species and planting method. In 2016, four of the producers drilled their cover crops after a crop of canning peas, which allowed an August window for the cover crop planting (Table 1). The dairy producer planted the cover crop in September following corn silage while one other producer hired a custom applicator to fly on the cover crop on his entire field, and another producer used the aerial applicator for part of the field and broadcast the rest.

The other six producers planted their cover crops after a soybean or corn grain crop in a later time window. Four of these producers used drills while the other two broadcast the cover crop with a tillage tool or after one.

In 2017, eleven of the producers planted the cover crop after corn grain and four after soybeans. The dairy producer again followed corn silage, and one producer followed sweet corn. None of the producers followed canning peas in 2017.

The cover crop seeding and termination costs were tallied separately for fields that followed corn grain or soybeans in order to focus on the special challenges related to their harvest timing late in the fall. Termination costs were available for seven of the corn grain or soybeans on seven of the farms for the 2016-17 cover crops, and the ten farms where cover crops were seeded after these crops in 2017 (Table 2).

### Cover Crop Species

The many potential cover crop species each have pros and cons, and each fits best in particular situations. The species planted by at least two of the cooperating producers are listed in Tables 3 and 4. Average seeding rates are shown in Table 5. Cereal rye was planted alone by four of the producers in 2016 and three in 2017. The numbers of species planted by the other producers was about equally divided between 2 and 3 species and 4 or more, but overall they narrowed the number of species in 2017.

Eleven species were planted by at least two producers in either 2016 or 2017. Several producers experimented with mixes containing a large number of species in 2016, so including those would have added 13 more species to the list shown. Three of the producers used more than one mix on different fields. Cereal rye was the most popular species planted. Eleven of the producers planted cereal rye in 2016 while one used annual ryegrass and one used wheat. All 13 planted cereal rye alone or in a mix in 2017. One producer planted both cereal rye and Aroostook rye in 2017. Both of them are lumped together as “cereal rye” in the table.

Table 1. Tally of cover crop species mixes and planting time windows on 13 cooperator farms, fall 2016 and fall 2017

<u>Planting time window</u>	<u>Number of species seeded in 2016</u>				<u>Number of species seeded in 2017</u>			
	1	2-3	4+	All	1	2-3	4+	All
<u>Early planted</u>								
Drill/planter	0	3	2	5	0	2	0	2
Aerial	0	0	1	1	0	0	1	1
Aerial & broadcast	0	1	0	1	0	0	0	0
Interseeded into corn & broadcast	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>1</u>	<u>0</u>	<u>1</u>
All early planted	0	4	3	7	0	3	1	4
<u>Late planted</u>								
Drill/planter	2	0	2	4	2	1	1	4
Broadcast	<u>2</u>	<u>0</u>	<u>0</u>	<u>2</u>	<u>1</u>	<u>2</u>	<u>2</u>	<u>5</u>
All late planted	4	0	2	6	3	3	3	9
<u>Either planting period</u>								0
Drill/planter	2	3	4	9	2	3	1	6
Broadcast	2	0	0	2	1	2	2	5
Aerial	0	0	1	1	0	0	1	1
Aerial & broadcast	0	1	0	1	0	0	0	0
Interseeded into corn & broadcast	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>1</u>	<u>0</u>	<u>1</u>
All planting periods & methods	4	4	5	13	3	6	4	13

Table 2. Tally of cover crop species mixes and planting methods following or aerially-seeded into corn grain or soybeans on 13 cooperator farms, fall 2016 and fall 2017 (This table includes only the 2016 farms for which termination cost data was available.)

<u>Planted into corn grain or soybeans</u>	<u>Number of species seeded in 2016</u>				<u>Number of species seeded in 2017</u>			
	1	2-3	4+	All	1	2-3	4+	All
Drill/planter	1		2	3	2	1	1	4
Broadcast	2			2	1	2	2	5
Aerial		<u>1</u>	<u>1</u>	<u>2</u>			<u>1</u>	<u>1</u>
All	<b>3</b>	<b>1</b>	<b>3</b>	<b>7</b>	<b>3</b>	<b>3</b>	<b>4</b>	<b>10</b>

Table 3. Cover crop species planted by at least two producers in 2016 and 2017

Species planted	Farms 2016	Farms 2017
Rye, Winter Cereal	11	13
Triticale	5	5
Rapeseed/Canola	4	4
Turnip	4	3
Radish, Oilseed or Forage	3	3
Ryegrass, Annual	3	1
Clover, Crimson	2	0
Pea, Field	2	0
Vetch, Hairy	2	3
Wheat	2	5
Oats	1	3

Table 4. Cover crop species planted after soybeans or corn grain by at least two producers in 2016 and 2017

Species planted	Farms 2016	Farms 2017
Rye, Winter Cereal	7	10
Rapeseed/Canola	4	4
Triticale	3	4
Ryegrass, Annual	2	0
Turnip	2	0
Wheat, Spring or Winter	2	5

Table 5. Seeding rates used in 2016 and 2017

Planting method	<u>Number of species seeded in</u> <u>2016</u>				<u>Number of species seeded in</u> <u>2017</u>			
	1	2-3	4+	All	1	2-3	4+	All
Drill/planter	74	79	76	77	117	66	82	89
Broadcast	82			82	90	86	81	84
Aerial or aerial & broadcast		87	59	73			58	58
Interseeded into corn						<u>23</u>		<u>23</u>
All planting methods	78	81	72	77	108	65	81	81

## Seed Prices

Seed price is an important factor in overall cover crop cost. While variety, seed quality, and service are also important, the prices paid by the cooperating producers may be of interest. Some of the producers supplied us with prices by species while others just quoted a price for the mix or a cost per acre. Table 6 shows the average price per pound for the species planted by at least two producers in each year and reported to us. Seed costs averaged \$25.58 per acre in 2016 and \$20.24 per acre in 2017.

Table 6. Average prices paid for cover crop seed in 2016 and 2017

Species	2016 (\$/lb)	reports (farms)	2017 (\$/lb)	reports (farms)
Cereal rye	\$0.23	2	\$0.17	5
Winter wheat			\$0.29	2
Triticale	\$0.37	2		
Rapeseed	\$0.98	2	\$1.02	2
Annual ryegrass	\$0.70	2		

## Seed Costs per Acre

The producers spent less on the cover crop seed in 2017 than in 2016, possibly due in part because of the later fall in 2017. The average seed cost was \$25.00/acre in 2016 and \$21.49 in 2017 (Table 7). We did not obtain a seed cost estimate in 2017 from the producer who used aerial application, which was a more expensive method in 2016 than ground application. That may have been one reason that the overall average seed cost per acre was less in 2017. Beyond that, the average cost increased for the producers planting one species, but that was overshadowed by a lower cost for the group planting four or more species.

Table 8 shows the seed costs just for the corn grain and soybean fields for 2016 and 2017. The 2016 costs for these crops averaged almost exactly the same amounts as the overall average - \$25.07/acre compared with \$25.00. In 2017, the corn grain and soybean field costs were slightly less than the overall average - \$20.35/acre compared with \$21.49.

## National Surveys

Cover crops were planted on 10.3 million acres of U.S. cropland in 2012. This is 3.2 percent of the 315 million harvested acres reported in the 2012 Census of Agriculture (see tables 8 and 50 in (USDA National Agricultural Statistics Service. 2014)). Another agricultural census was conducted in 2017. When published, it should show how adoption of this important practice is changing over time.

The USDA National Agricultural Statistics Service and Economic Research Service conduct the Agricultural Resource Management Survey (ARMS). They collect data on crop production practices and costs and returns as well as whole-farm financial information. They follow a schedule where they survey

the major crops usually once every five years. The recent crop surveys have included a section where they select one field at random for each farm and ask a set of detailed questions about that field.

The 2016 corn questionnaire asked about whether the previous crop planted in fall 2015 was a cover crop, and if so, “What was the seed cost per acre for the cover crop?” The results for that question have not been broken out in the published cost and return reports, but Dr. William McBride provided a tally for this report. There were not enough responses for Minnesota to provide a useful estimate, but 32 responses for the ARMS Heartland farm resource region averaged \$12.81/acre for those reporting a cost (McBride 2018). Thirty one responses for the Northern Crescent region averaged \$14.39/acre. The Heartland region includes southern and southwestern Minnesota along with Iowa, Illinois, Indiana, most of Missouri, and parts of South Dakota, Nebraska, Ohio, and Kentucky. The Northern Crescent includes central Minnesota and the states to the east through Pennsylvania, New Jersey, and the New England states (USDA Economic Research Service 2010). Those 2016 ARMS corn cover crop cost estimates are less than the corn and soybean averages for the project farms that are shown in Table 8. For example, the Heartland average of \$12.81/acre is only half as much as the \$25.07/acre 2016 overall average in Table 8.

Another source of cover crop seed costs is the 2017 CTIC Cover Crop Survey (Conservation Tillage Information Center 2017). The seed costs in that report are more difficult to interpret because they are provided only as ranges. Nearly half of the respondents paid \$11 to \$20/acre in 2016, with 25 percent paying \$11 to \$15 per acre and 22 percent paying \$16 to \$20. Smaller percentages paid more or less than those ranges.

The reasons for the higher average costs on our project farms may be partly due to the fact that the project farms followed species mixes and seeding rates detailed in a plan developed with the project technician following guidelines provided by the Midwest Cover Crop Council. The producers were encouraged to purchase quality cover crop seed from reputable commercial seed companies. Because the project budget provided incentives to the producers that covered most of the cover crop planting costs, the producers were not forced to scrimp on seed costs due to financial constraints. Information is not available on how many of the ARMS or CTIC respondents planted cheaper bin-run seed or seeded lower rates. This does beg the question of whether the benefits observed by the project producers and documented in this report are greater than the benefits of the ARMS and CTIC respondents who spent less on seed. The available data does not provide an answer to that question.

### Total Seeding Costs with Equipment and Labor per Acre

The planting equipment and labor was valued using the actual custom rates or rental rates paid where they were used. Owned equipment was valued using the Iowa Custom Rate Survey. Equipment and labor costs averaged \$18.94/acre in 2016 and \$15.31/acre in 2017 (Table 9). The total cover crop establishment costs for seed, equipment, and labor averaged \$43.93/acre in 2016 and \$36.80/acre in 2017 (Table 10).

Table 7. Average cover crop seed costs/acre on cooperator farms, fall 2016 and fall 2017

<u>Planting method</u>	<u>Number of species seeded in 2016, 12 farms</u>			
	1	2-3	4+	All
Drill/planter	\$10.04	\$21.82	\$35.40	\$25.49
Broadcast	\$18.00			\$18.00
Aerial			\$36.00	\$36.00
Aerial & broadcast		\$25.14		\$25.14
All	\$14.28	\$22.68	\$35.50	\$25.00
	<u>Number of species seeded in 2017, 11 farms</u>			
	1	2-3	4+	All
Drill/planter	\$20.93	\$21.32	\$21.37	\$21.17
Broadcast	\$18.75	\$21.23	\$20.42	\$20.24
Aerial			\$34.00	\$34.00
All	\$18.75	\$21.23	\$23.81	\$21.49

Table 8. Average seed cost following or aerially-seeded into corn grain or soybeans by cover crop species mixes and planting method, fall 2016 and fall 2017

<u>Planted into corn grain or soybeans</u>	<u>Number of species seeded in 2016, 7 farms</u>			
	1	2-3	4+	All
Drill/planter	\$11.62		\$34.15	\$26.64
Broadcast	\$9.33			\$9.33
Aerial & broadcast		\$25.14	\$36.00	\$30.57
All	\$10.48	\$25.14	\$34.77	\$25.07
	<u>Number of species seeded in 2017, 10 farms</u>			
	1	2-3	4+	All
Drill/planter	\$11.86		\$19.94	\$17.25
Broadcast	\$17.75			\$17.75
Aerial		\$21.18	\$34.00	\$27.59
All	\$15.78	\$21.18	\$24.63	\$20.35

Table 9. Equipment and labor costs/acre on cooperator farms, fall 2016 and fall 2017

<u>Planting method</u>	<u>Number of species seeded in 2016, 12 farms</u>			
	1	2-3	4+	All
Drill/planter	\$9.68	\$17.35	\$22.84	\$18.27
Broadcast	\$23.00			\$23.00
Aerial			\$17.00	\$17.00
Aerial & broadcast		\$18.55		\$18.55
All	\$16.77	\$17.66	\$21.81	\$18.94

	<u>Number of species in 2017, 11 farms</u>			
	1	2-3	4+	All
Drill/planter	\$15.35	\$16.00	\$15.00	\$15.54
Broadcast	\$13.55	\$13.18	\$14.65	\$14.01
Aerial			\$16.00	\$16.00
All	\$16.20	\$14.63	\$15.32	\$15.31

Table 10. Average cover crop establishment costs/acre for seed, equipment, and labor, fall 2016 and fall 2017

	<u>Number of species seeded in 2016, 12 farms</u>			
	1	2-3	4+	All
Drill/planter	\$19.71	\$39.17	\$58.23	\$43.76
Broadcast	\$41.00			\$41.00
Aerial			\$53.00	\$53.00
Aerial & broadcast		\$43.69		\$43.69
All	\$31.05	\$40.34	\$57.31	\$43.93

	<u>Number of species seeded in 2017, 11 farms</u>			
	1	2-3	4+	All
Drill/planter	\$36.28	\$37.32	\$36.37	\$36.71
Broadcast	\$32.30	\$34.41	\$35.07	\$34.25
Aerial			\$50.00	\$50.00
All	\$34.95	\$35.86	\$39.13	\$36.80

Table 11. Average seed and planting cost following or aerially-seeded into corn grain or soybeans by cover crop species mixes and planting method, fall 2016 and fall 2017

<u>Planted into corn grain or soybeans</u>	<u>Number of species seeded in 2016, 7 farms</u>			
	1	2-3	4+	All
Drill/planter	\$27.32		\$49.56	\$42.15
Broadcast	\$24.32			\$24.32
Aerial & broadcast		<u>\$43.69</u>	<u>\$53.00</u>	<u>\$48.34</u>
All	\$25.32	\$43.69	\$50.71	\$38.82
	<u>Number of species seeded in 2017, 10 farms</u>			
	1	2-3	4+	All
Drill/planter	\$36.28	\$34.10	\$36.37	\$35.76
Broadcast	\$32.30	\$34.41	\$35.07	\$34.25
Aerial			<u>\$50.00</u>	<u>\$50.00</u>
All	\$34.95	\$35.86	\$39.13	\$36.80

### Termination Timing and Costs and Extra Insecticide and Nitrogen

An issue discussed at recent field days is how far the cover crop needs to be terminated ahead of planting the main crop, especially in the case of corn following cereal rye and the possibility of an allelopathic effect. Extension guidelines suggest terminating 7 to 14 days ahead (Eberhart 2016), and there are specific requirements for EQIP funding and crop insurance (USDA NRCS). On the other hand, some producers at field days reported success planting corn into rye before terminating it.

Each producer terminated his cover crops in either April or May. The earliest termination date was April 12. The latest termination dates were May 12 (for a corn field) and around May 20 (for a bean field). The “average” termination date was April 30. The responses showed a wide range of the heights of cover crops, owing largely to the differing species used among the producers. The shortest crop at termination was 4 inches, while the tallest crop was 38 inches. The average height was 13 inches.

Five of the nine producers who planted corn into a cover crop this year waited at least 11 days between termination and planting, with an average wait of 15 days. The other four producers only waited between 2 and 6 days. Four of the producers followed the cover crop with soybeans. Three of them waited two weeks or more, while the fourth only waited three days. There did not seem to be any relationship between the wait time and yield of the corn crop, as discussed later.

Five of the producers in this survey required an additional terminating-round of herbicide for their cover crops—the other six producers were able to terminate the cover crops with the chemicals and rates that they were planning to use otherwise, since they were using no-till or reduced tillage and so needed to apply a burndown chemical anyway. Each producer used glyphosate as their primary termination

chemical. Three producers supplemented that with 2,4-D. Two added ammonium sulfate and three producers used a surfactant.

The overall 2016 cover crop cost for seed and planting equipment was \$52.76/acre for those 11 producers who provided 2016 planting costs and 2017 termination cost data and who did not apply a separate termination chemical, insecticide, or extra nitrogen (Table 12). The producers who incurred a cost for a termination chemical spent less on planting, at \$35.83/acre. The additional burndown chemicals and the extra equipment cost an average of \$16.30/acre for those making an extra termination pass, bringing the total cost for seed, planting, and termination to \$52.13, so it is interesting that there was not much difference in the total cost for those who applied an extra chemical and those who did not. The overall average cost for seed, planting, and termination for the 11 producers was \$52.48/acre. Note that these costs are based on the 2016 planting costs, and for only 11 operations rather than the 12 operations included in Tables 8-10.

Two producers reported other costs related to the cover crops. One applied insecticide costing \$5/acre. The other applied an extra 90 pounds of nitrogen to compensate for nitrogen tied up as the rye biomass breaks down. At a nitrogen price of, say, \$0.35/lb, this would cost an additional \$31.50/acre. This would be an added cost item that would need to be attributed to the cover crop. None of the other nine producers reported any changes in their rates. Adding the insecticide and extra nitrogen brings the overall cost for the seed, planting equipment, and termination to \$55.79/acre.

Table 13 shows that the cover crops on the corn grain and soybean fields cost an average of \$42.82/acre for seeding and termination, or around ten dollars/acre less than the overall average shown in Table 12, not including the insecticide that one producer applied. The insecticide on that one farm would increase the average by \$0.72 per acre.

Table 12. Average cover crop costs/acre for seed, planting equipment and labor, termination, and insecticide on 11 cooperator farms seeded in fall 2016 and terminated in spring 2017

	Farms	Seed & planting	Termination	Seed, planting, & termination
Relied on normal no-till burndown herbicide	6	\$52.76		\$52.76
Applied an extra herbicide application to terminate	5	\$35.83	\$16.30	\$52.13
Overall average	11	\$45.06	\$7.42	\$52.48
Overall average, including insecticide & N	11	\$45.06	\$10.73	\$55.79
Corn yield increase required to cover the overall cost at \$3/bushel		15 bu	4 bu	19 bu
Soybean yield increase required to cover the overall cost at \$9/bushel		5.0 bu	1.1 bu	6.1 bu

The cover crop seeding costs were lower in 2017 than in 2016. We of course do not now know what it will cost to terminate the 2017 cover crops in spring 2018, but Table 14 shows what the total costs will be if termination costs the same as in spring 2017.

Table 13. Average seed, planting and termination cost following or aerially-seeded into corn grain or soybeans by cover crop species mixes and planting method, fall 2016

<u>Planted into corn grain or soybeans</u>	<u>Number of species seeded in 2016, 7 farms</u>			All
	1	2-3	4+	
Drill/planter	\$41.17		\$49.56	\$46.76
Broadcast	\$31.40			\$31.40
Aerial		\$43.69	\$53.00	\$48.34
All late planted	\$34.65	\$43.69	\$50.71	\$42.82

Table 14. Average cover crop costs/acre for cover crops seeded in fall 2017 if termination and insecticide and extra nitrogen in spring 2018 costs the same as in spring 2017, 11 cooperator farms

	Farms	Seed & planting	Termination	Seed, planting, & termination
Relied on normal notill burndown herbicide	6	\$38.09		\$38.09
Applied an extra herbicide application to terminate	5	\$35.26	\$16.31	\$51.56
Overall average	11	\$36.80	\$7.41	\$44.21
Overall average, including insecticide & N	11	\$36.80	\$10.73	\$47.53
Corn yield increase required to cover the overall cost at \$3/bushel		12 bu	4 bu	16 bu
Soybean yield increase required to cover the overall cost at \$9/bushel		4.1 bu	1.1 bu	5.2 bu

## Benefits and Other Considerations

### Yield Impacts of the Cover Crops

A corn yield increase of around 19 bushels per acre would be required to cover the average cost of the cover crops at \$3/bushel if no other benefits are achieved for the cover crops seeded in the fall of 2016 (Table 12). At a soybean price of \$9/bushel, a 6.1-bushel soybean yield increase would suffice to cover the average cost.

At the lower 2017 seeding costs, the breakeven yield increases are lower if the termination costs turn out to be similar to last year – 16 bushels of corn or 5.2 bushels of soybeans (Table 14).

The 11 producers who returned our mail survey in December, 2017 reported a wide range of impacts on yields of the 2017 main crops following their cover crops. Three said that they did not have a way of comparing the yields because they did not have check strips or similar fields to compare against. Six of the others grew corn and three grew soybeans on those fields (two of them grew both corn and soybeans following the cover crops). Of the seven, three did not see a difference. Two of the others found yield increases. In the “lessons learned” category, the other one tried cutting corners on the burndown herbicide and ended up reducing the corn yield.

Another source of information on yield impacts is the national surveys that have been carried out for several years by the Conservation Tillage Information Center (CTIC) (Conservation Tillage Information Center 2017). They reported in their 2017 report that between 13 and 20 producers returned their survey from Minnesota.

We need several more years of data and data from more farms before we will feel comfortable saying anything very definitive about yield impacts. Our best estimate planning number for the corn and soybean yield impacts based on this one year of data from the project farms along with the CTIC survey results, we would assume a corn yield increase of four bushels/acre and a soybean yield increase of one bushel/acre.

### Grazing or Harvesting Cover Crop Forage

As mentioned earlier, one cooperator has a cow-calf herd and was able to graze a cover crop in the fall of 2016 after it had been planted in August after canning peas. A mix of seven species was planted in one field and three species on another field on that farm. The cover crops produced lush growth estimated at 3,000 pounds of dry matter/acre by the time of a field day held there in late September. That field was grazed that fall, with the feed value estimated at \$112/acre based on avoided hay or cornstalk grazing. That producer planted a seven-species cover crop mix on that field which cost more than average for the group, but the grazing value was more than enough to cover the establishment cost.

Another producer reported baling a cereal rye cover crop for hay in 2016 and selling it for around \$40/acre. Mowing and baling would probably cost around half of that, but the net revenue would still cover much of the cover crop seed cost.

### Differences in Visible Signs of Erosion or Runoff Sediment

Nine of the producers noted less erosion or runoff sediment on the demonstration field compared to similar fields that did not have cover crops.

## Getting on the Field Earlier

Comments were made at field days to the effect that the mulch from the killed cover crop may sometimes support field equipment so as to get on the field earlier in the spring after wet conditions. Three of the producers responded that they were able to get on the field earlier. The others did not observe a difference.

If earlier access is possible in a given growing season, it is not entirely clear how to put an economic value on the extra working days. Yields might be increased due to more timely planting or other operations. Or, perhaps more acres could be covered with the equipment available. The extra days would be valuable in either of these cases, but it would depend on the situation.

## Increased Soil Organic Matter

Soil tests taken in late 2016 on the project fields averaged 3.1 percent soil organic matter (SOM), with a range from 0.9 to 6.1 percent. The dairy producer in our group reported increases in SOM after cover crops, but that land also received dairy manure so it is difficult to know how much of the increase was due to the cover crops.

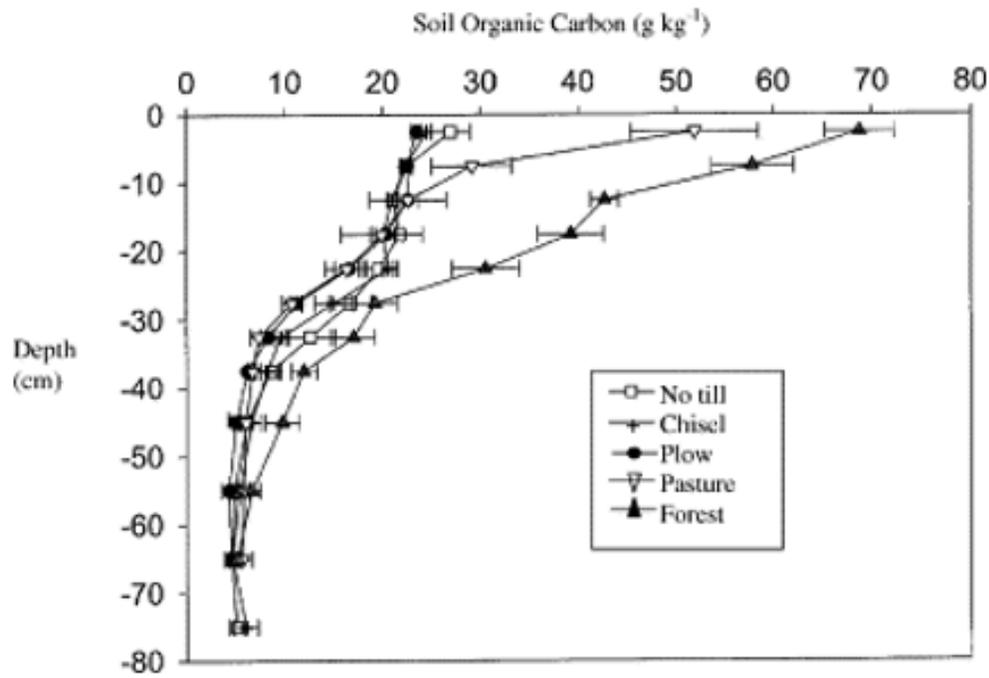
Another indication of the potential SOM increase is the difference between SOM after eight years under pasture compared to a corn-soybean rotation using three different tillage systems in eastern Ohio, shown in Figure 1. The SOM under pasture was around 5 percent near the surface compared with around 2.5 percent with the row crops. Since our producers are using no-till or reduced tillage, it is interesting that there was little difference in the SOM under no-till compared with tillage in that trial while a ten-year study in Alabama showed greater SOM under no-till (Figure 2).

Soil organic matter has many potential benefits. We have only tried to put economic values on two of those potential benefits: extra mineralized nitrogen supplied to the main crop, and additional soil water holding capacity. The rule of thumb on nitrogen is that a 1 percent increase in SOM will mineralize over time to generate 20 pounds of nitrogen per year. One source for that number is a 1952 bulletin from Missouri that is cited in a recent NRCS cover crop economics decision tool (Unknown 1952, Cartwright and Kirwan 2018). The NRCS spreadsheet also assumes that a 1 percent increase in SOM holds 1 acre-inch of water.

The one year of soil tests available under our project does not establish how the SOM may have increased due to the project's two years of cover crops. Soil organic matter is mentioned here mainly as one factor that may help to explain the yield increases that were observed by the cooperating producers, as mentioned above.

It should be noted that the nitrogen contribution of the SOM referred to above is different from the nitrogen fixed by a legume cover crop grown in the immediately preceding year. It is also unclear how long the additional SOM contributed by a given year's cover crop will persist in the soil. The SOM that mineralizes and contributes nitrogen in a given year will not be there to contribute more in later years. Also, it is expected that the additional water holding capacity will be most valuable in drought years.

Figure 1.

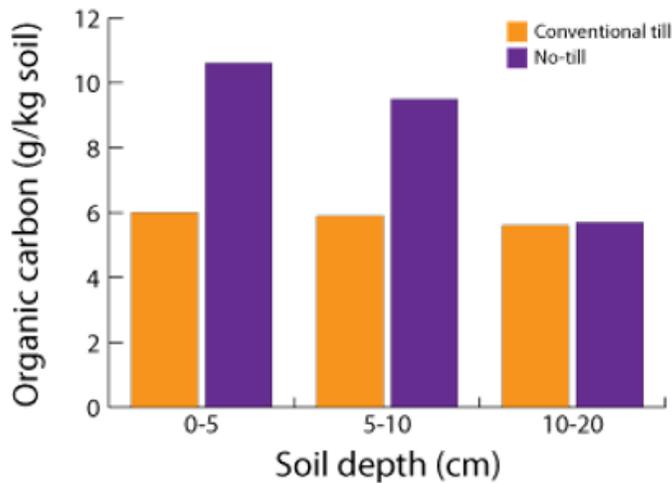


Soil profile organic carbon concentration under plow till, chisel till, no till, pasture and forest.

Source: (Puget and Lal 2005)

Figure 2.

## Effect of 10 years of conventional till and no-till on OC (calculated from SOM data in Edwards et al., 1999).



Source: (Edwards, Wood et al. 1992)

### Reducing Soil Erosion

One of the main rationales for adopting cover crops is to minimize soil erosion. Water-related erosion is most likely to be a problem on sloping land, so the soil maps for the project fields were reviewed in order to identify areas with slopes that were steep enough and long enough to result in soil losses in excess of T values under the crop rotations and tillage systems in use on the farm (T stands for “soil-loss tolerance”).

RUSLE2 is the software that NRCS staff use to estimate water erosion rates for conservation planning purposes (Renard, Foster et al. 1997). RUSLE2 was used here to arrive at rough estimates of soil erosion on the project fields that might be expected with and without a cover crop. The estimates are considered “rough” because we did not utilize as much information as NRCS staff would normally use.

We reviewed the soil map for each field. The rule of thumb used by the NRCS for estimating soil erosion in a crop field using RUSLE2 is to consider the most restrictive soil that comprises at least 20 percent of the field. Soils are identified in the soil survey with letters denoting the slope. A “B” soil is between 2 and 6 percent slope while a “C” soil is between 6 and 12 percent and a “D” soil is between 12 and 20 percent. Our review of the soil maps suggested that two of the farms had at least one project field with at least 20 percent in the C slope category. Five other farms had fields with some C or D soils in the

project fields but less than the 20 percent cutoff. The other six farms did not appear to have soils in the project fields that were steeper than the B category of 2 to 6 percent.

We focused mainly on the fields containing C or D slopes. We estimated slope steepness and slope length for representative areas of the fields using the MNTPO web tool in lieu of actually walking the fields. RUSLE2 uses crop yields to estimate residues. We used crop yields from the producers themselves where we had that data, and default yields otherwise. We used default dates for the field operations.

The T value is five tons per acre for all of the soils we analyzed. Based on that five-ton benchmark, the fields in corn grain-soybean rotations and the corn silage-alfalfa rotation used on the dairy farm all had soil losses less than the T value whether or not they used cover crops, because the no-till practices used on the corn and soybeans were sufficient. Two situations where it appeared that the cover crop made the difference between excessive erosion and tolerable erosion were fields where conventionally-tilled canning peas were grown on land with a C slope. The C slope area was more than the 20 percent cutoff in the one field, and less than 20 percent in the other. Terraces had been installed in the steeper field along with using the cover crops to keep the erosion in check.

A conclusion we draw from the RUSLE2 calculations is that when balancing the costs and benefits of cover crops, there may be situations where the only way an erosive crop like canning peas can be grown and still stay within a tolerable soil loss is to plant a cover crop. One component of the economic value of the cover crop in that case would be the difference in profitability between the canning peas and whatever the next best alternative is, which would probably be a corn grain-soybean rotation in the case of the cooperator farms. We did pursue the calculation to the extent of actually comparing the profitability of those three crops.

While keeping within the T value is sufficient for conservation compliance, there are reasons to question whether it is too high. One concern is that T values are based on maintaining future soil productivity and do not consider water quality goals. Another issue is whether rainfall events have become more intense than when the T values were calculated in the 1980s. Finally, it is generally recognized that T values are higher than rates of soil formation and so include a certain amount of soil "mining" which may eventually exhaust the productive topsoil layer. The difference between the T value and the rate of soil formation depends on estimates of how much soil can be lost before yields would be reduced. Actually estimating the rate of soil formation is difficult, however. The logic behind T values and the formula used is presented in a 1982 publication by the American Society of Agronomy. (Skidmore 1982). I have made inquiries about the database of soil formation estimates that was used to calculate the T values currently included in the soil survey, but I have not so far been able to locate that database (Dobos 2018).

## Other Benefits Noted by the Producers

The producers noted a number of other benefits of the cover crops. The benefits listed, in the producers' own words, included:

- "better stand"
- "soil temperature"
- "earthworm population"
- "soil structure"
- "less erosion in spring"
- "better soil health"
- "less compaction"
- "corn growth didn't vary"
- "organic matter"
- "ground warmer"
- "don't have to till"
- "wild life in spring"

A soybean disease that some producers are concerned about on southeastern Minnesota is white mold or sclerotinia. At one of my farm visits in 2016 one of the project producers expressed an opinion that cover crops reduce the likelihood of white mold because the mulch prevents soil from splashing up on the plant. A 2001 paper by Maloney and Grau describes the impact of a small grain cover crop on soybean yields in Wisconsin over the three-year period 1998-2000 (Maloney and Grau 2001). But, that paper is so old, and there has been nothing on this since then. I had pretty much dismissed the idea until another of the producers at the Owatonna meeting mentioned a 12-bushel yield advantage for cover crops in one year. He attributed that difference to reduced white mold.

Other potential benefits not specifically mentioned by the producers but which others have mentioned include reduced soil compaction, especially in the case of radish; increased water infiltration; and cooler summer soil temperatures.

On the downside, risks and potential costs of cover crops include slug damage to emerging corn. Several of the producers expressed different opinions about the roles of chopping corn heads and vertical tillage tools on the likelihood of slug damage and on erosion potential. Other concerns are whether the cover crop will reduce the yield of the following main crop in a dry year due to competition for moisture; delayed planting due to cooler spring soil temperatures under the cover crop; and difficulty getting seed coverage with no-till equipment planting into a heavy cover crop mulch.

## Summary and Concluding Thoughts

These results show that planting and terminating cover crops involved a significant cost for these producers. The yield impacts were a mixed bag, which is not surprising given the one-year time frame and the small group size. Other studies suggest that several more years of data is needed to get a fix on yield impacts. The ideal situation for profitable cover crop use is where it can be planted early after a short-season crop like canning peas and then can be grazed, but of course not that many farms have both of those enterprises. Cover crops clearly reduce soil erosion, although most of the cooperator farms did not appear to have major erosion issues because they were also using no-till, reduced tillage, and/or terraces on their row crops. Increased soil organic matter is another likely benefit and may explain at least some of the yield improvements attributed to cover crops.

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**Appendix - Cover Crop Economics Questionnaire**  
**Cover Crop and Soil Health Initiatives in Southeastern Minnesota**

Please return in the stamped, self-addressed envelope to Andrew Keller, Department of Applied Economics, University of Minnesota. Thank you again for your participation. Please feel free to call us at 515-293-0486 or 612-625-8150 with any questions or concerns.

**Farm/Producer Name:** \_\_\_\_\_

**1. What are your typical crop rotations (for example, corn/soybeans or corn/corn)?**

\_\_\_\_\_

**Questions about the cover crop you planted in the fall of 2016 and terminated last spring (2017):**

- 2. When did you terminate it? (approximate date \_\_\_\_\_)**
- 3. What main crop did you plant on that field this year? (\_\_\_\_\_)**
- 4. How many days after termination did you plant your main crop? (\_\_\_\_\_ days)**
- 5. What was the height or growth stage when terminated? (\_\_\_\_\_ inches or stage)**
- 6. Did the cover crop cause you to do extra tillage or use more herbicides than you would have used for the main crop without a cover crop? Circle Y/N.**

**YES                  NO**

**If YES, how did you terminate the cover crop? Briefly describe the process you used.**

\_\_\_\_\_

**7. Describe what chemicals, if any, you used to terminate the cover crop and what they cost.**

<b>Chemical names</b>	<b>Rates applied (per acre)</b>	<b>Units for the application rate</b>	<b>Cost / unit</b>	<b>Purchase units</b>	<b>Date purchased</b>
1.					
2.					
3.					
4.					

8. If you harvested hay or forage from the cover crop, complete the following table.

Hay or forage yield (tons/acre)	Moisture %	Value (\$/ton)	Harvesting cost (\$/acre)

**Questions about the main crop you grew on the field this year:**

9. Did you change your herbicide program to accommodate cover crop seeding? *Circle Y/N.*

YES                      NO

If YES, what changes did you make? *Please explain.*

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10. What herbicides did you use on the main crop? *Complete the table below.*

Chemical name	Rate applied (per A)	Units for the application rate
1.		
2.		
3.		
4.		
5.		

11. Did you notice a difference in the yield of the main crop following the cover crop? *Circle Y/N.*

YES                      NO

If YES, how much of a difference did you notice? \_\_\_\_\_ bushels/acre

How did you measure that difference? *Check all that apply.*

\_\_\_\_\_ combine yield monitor

\_\_\_\_\_ counting and weighing wagon loads

\_\_\_\_\_ check strips in the field (how many strips or replications? \_\_\_\_\_)

\_\_\_\_\_ comparing against other fields

\_\_\_\_\_ other (*explain*) \_\_\_\_\_

12. Did you reduce or increase herbicide, insecticide, and/or fungicide inputs used for the main crop compared to fields that did not have a cover crop? *Circle Y/N.*

INCREASE                      DECREASE                      NO CHANGE

If INCREASE, what extra chemicals did you have to apply, and what did they cost/acre, including chemical and application costs? *Complete the table below.*

Cash crop treated	Names of the extra chemicals applied	Cost of the extra chemicals and applications (\$/acre)

If DECREASE, provide the estimated cost savings/acre, including chemical and application costs, for each category of chemical input. *Complete the table below.*

Cash crop that would have been treated	Names of the chemicals you were able to avoid using	Chemicals and application cost savings (\$/acre)

13. Did you adjust your nutrient application rates (up or down) due to the use of cover crops? *Circle Y/N.*

YES                      NO

If YES, how much did you reduce the nitrogen application rate on the main crop?

\_\_\_\_\_ lbs/A

14. Did you notice any difference in visible signs of erosion or runoff sediment on the demonstration field compared to similar fields that did not have cover crops? *Circle Y/N.*

YES                      NO

15. Were you able to get on the field earlier in the spring because of the cover crop mulch supporting the equipment?

YES                      NO

16. What other benefits did you realize by using cover crops? *Please explain.*

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**Questions about the cover crop you planted this fall:**

17. What cover crop species and varieties did you plant, and how much did they cost?

*Complete the table below with either individual seed species or seed mix information.*

Species or Mix	Variety and Brand Name	Seed supplier	Seeding rate (lb/A)	Seed cost (\$/lb) or Mix cost (\$/lb)	Date Purchased
1.					
2.					
3.					
4					

18. What seeding method did you use to plant the cover crop? *Circle all that apply.*

Drill / planter	Broadcast	Aerial into standing crop	Interseed with ground equipment into standing crop	Other

19. Describe the individual field operations involved in planting the cover crop. *Complete the table.*

Type of planter, drill, etc.	Tractor or power unit	Date performed	If Custom: cost/acre	Fuel or other inputs you supplied	Est. cost/acre of owned equipment
1.					
2.					

20. If interseeding with ground equipment, what was the crop stage or height?

\_\_\_\_\_ inches/stage

21. Was the cover crop seeding successful this fall (2017) from what you can tell so far? *Circle Y/N.*

YES            NO

22. Briefly explain what you consider important as you think of "success" of the seeding:

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23. Did you harvest forage from the cover crop for sale or for use in your operation this fall? *Circle Y/N.*

YES            NO

If YES, how much did it yield and what was the total amount of forage sold or used worth?

\_\_\_\_\_ tons/acre at \$\_\_\_\_\_/ton

24. Are you planning to grow peas for canning in 2018? *Circle Y/N.*

YES            NO

If YES, has the canning company placed any restrictions on planting peas following a cover crop that have affected your cover crop decisions? *Circle Y/N.*

YES            NO

If YES, please explain \_\_\_\_\_

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25. Please share any additional thoughts or concerns.