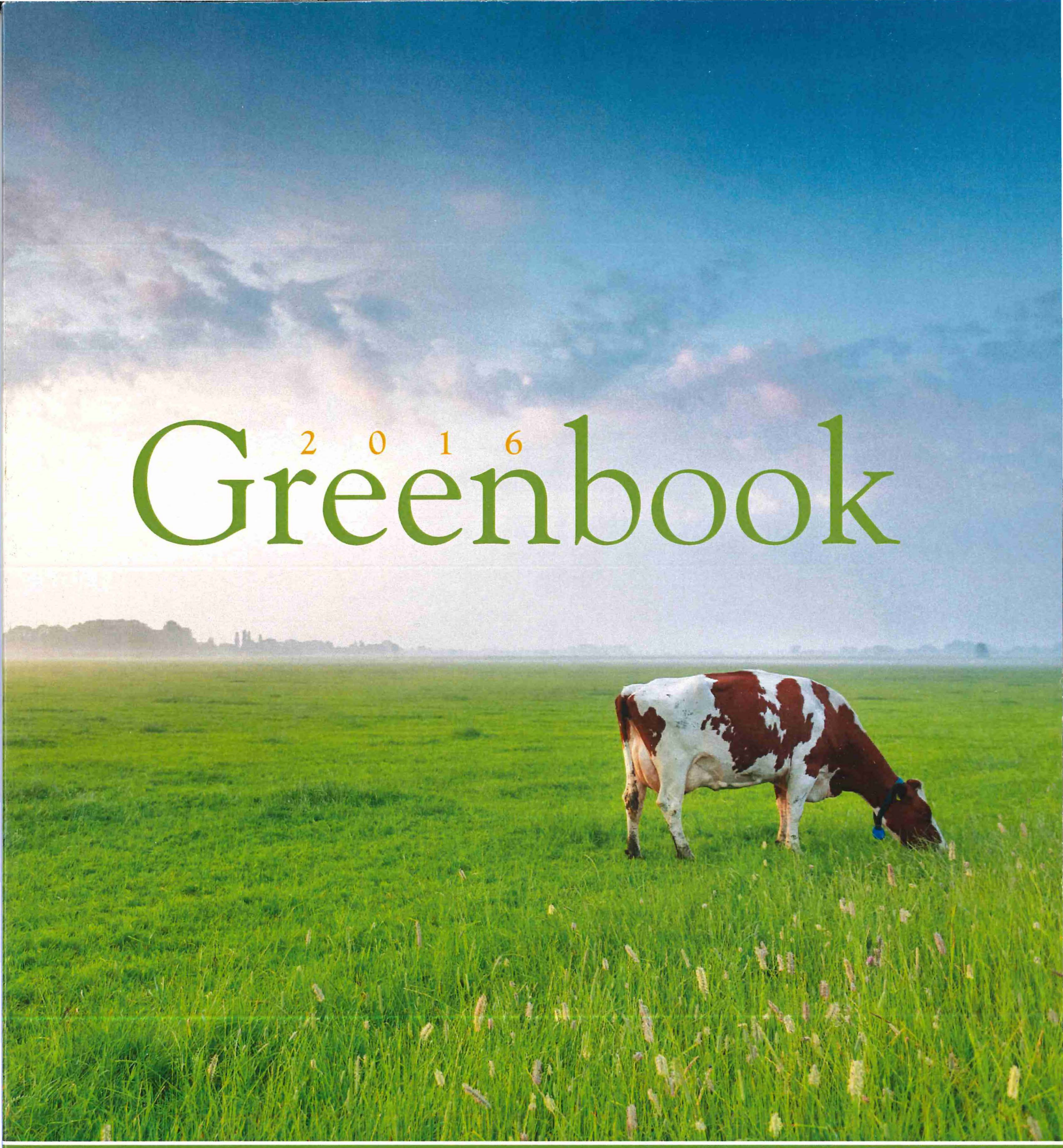
2016 Greenbook



Minnesota Department of Agriculture

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Greenbook 2016

Program Vision Statement

Agriculture in Minnesota will be based on dynamic, flexible farming systems that are profitable, efficient, productive, and founded on ethics of land stewardship and responsibility for the continuing vitality of local rural communities. Minnesotans will strive to understand and respect the complex interconnectivity of living systems, from soil to people, so as to protect and enhance all natural resources for future generations. Minnesota agriculture will sustain an abundance of food and other products as well as meaningful, self directed employment that supports the quality of life desired by farmers and rural communities. Agriculture will foster diversity in all its forms of production, products, markets, and cultures.

Program Mission Statement

To work toward the goal of sustainability for Minnesota agriculture by designing and implementing programs that meet the identified needs and support the creativity of Minnesota farmers.

Inclusion of a trade name does not imply endorsement of that product by the Minnesota Department of Agriculture, nor does exclusion imply non-approval.

Minnesota Department of Agriculture

June 2016

Thank you to the MDA's Agricultural Marketing and Development Division Staff who helped to make *Greenbook 2016* a reality. They include: Cassie Dahl, Alison Fish, Alatheia Stenvik, Meg Moynihan, Julie LaClair, and Mark Zumwinkle.

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Introduction to the Greenbook 2016

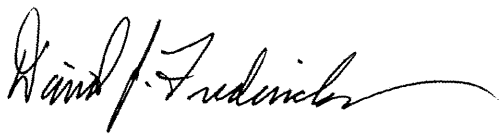
The Minnesota Department of Agriculture's annual *Greenbook* is back again with another great edition showcasing the creative projects funded by the Sustainable Agriculture Demonstration Grant Program. This year, we're highlighting 29 projects by farmers, ranchers, and researchers who have invested these grant dollars to explore practices that will make farming in Minnesota more sustainable. We are very proud of this program and the many ways it has impacted farmers and rural communities in Minnesota for the past 26 years.

New and better farming methods evolve through innovation. We believe the ideas these farmers and researchers are testing are integral to the future of agriculture. Many of the Sustainable Agriculture Demonstration Program's past projects have since become widely adopted such as integrated pest management and cover cropping.

In the *Greenbook*, you will find the results from currently funded demonstration projects. The grantees are focusing on ways to increase energy and labor efficiency, reduce purchased inputs, and improve both the environment and their bottom line.

Greenbook 2016 compiles all the farmers' research trials and their hard data into an informative and interesting read. To learn more about any of the projects, please don't hesitate to get in touch with the grantee. You'll find contact information listed at the beginning of each project summary.

The MDA funded 11 new projects and will be accepting applications again next fall, so if there's a sustainable farming idea you'd like to try, please keep that opportunity in mind.



Dave Frederickson, Commissioner

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Sustainable Agriculture Grant Program

Program Purpose

The Grant Program provides a unique opportunity for farmers, educational institutions, individuals at educational institutions, or nonprofit organizations residing or located in the state for research or demonstrations on farms across the state to work together to explore ways of enhancing the sustainability of a wide range of farming systems.

Program Description

The Department has received over 1,130 grant applications and approved over $3.6 million in funding for 324 projects since the program began in 1989. Project categories include: Alternative Markets and Specialty Crops, Cropping Systems and Soil Fertility, Energy, and Livestock. The grant projects, located throughout the state of Minnesota, are described in *Greenbook 2016*.

Grants provide a maximum of $25,000 for on-farm demonstrations that last up to 3 years. The projects demonstrate farming methods or systems that increase energy efficiency, reduce agricultural chemical usage, and show environmental and economic benefits. A Technical Review Panel evaluates the applications on a competitive basis and makes recommendations to the Commissioner of Agriculture for approval. The Technical Review Panel includes farmers, university agricultural researchers, extension agents, and educators with assistance from the Agricultural Marketing and Development staff.

Summary of Grant Funding (1989-2016)

Year	Number of Grants Funded	Total Funding	Average Grant Size	Ranges
1989	17	$280,000	$16,500	$3,000-25,000
1990	14	189,000	13,500	4,000-25,000
1991	4	46,000	11,500	4,000-23,000
1992	16	177,000	11,000	2,000-25,000
1993	13	85,000	6,000	2,000-11,000
1994	14	60,825	4,000	2,000-10,000
1995	19	205,600	11,000	2,000-25,000
1996	16	205,500	12,900	4,000-25,000
1997	20	221,591	11,700	1,000-25,000
1998	19	210,000	11,100	1,000-24,560
1999	23	234,500	10,200	3,000-21,000
2000	17	150,000	8,800	4,600-15,000
2001	16	190,000	11,875	5,000-25,000
2002	18	200,000	11,000	4,300-20,000
2003*/2004*	---	---	---	---
2005	10	70,000	7,000	2,000-11,600
2006	8	70,000	8,750	4,600-12,000
2007	9	70,000	7,777	2,700-12,000
2008	10	148,400	14,800	4,500-25,000
2009	7	103,000	14,700	5,000-20,000
2010	11	77,000	7,000	3,600-10,000
2011*/2012*	---	---	---	---
2013	6	66,000	11,000	5,300-20,300
2014	13	205,000	15,770	7,800-25,000
2015	13	236,000	18,200	6,700-25,000
2016	11	$177,030	$16,094	$9,765-24,980
Total Funded	324	$3,677,446		

**No grants were awarded in 2003, 2004, 2011 and 2012.*

New Demonstration Grant Projects 2016

Alternative Markets & Specialty Crops

Trials to Overwinter Nucleus Colonies with a Pause in Brood Rearing

Grantee: Joseph Meyer, Four Seasons Apiaries, LLC
Duration: 3 years
Award Amount: $13,030
County: Hennepin, Carver

Project Objectives:

1. The practice of overwintering small colonies, called "nucs", has been gaining traction in other parts of the country. One of the few people to produce guidelines for our cold climate is Adrian Quiney, and he has backed them by success. This project will test if overwintering smaller honeybee colonies in Minnesota can be done reliably and profitably by attempting to replicate his success and evaluate his methods.

2. The parasitic Varroa mite has plagued North American bees for decades. It reproduces inside the cells alongside developing honeybee pupae. I will test the hypothesis that instigating a pause in brood rearing within a honeybee colony reduces Varroa mite infestation levels.

Using Juneberries as a Cold Hardy Rootstock for Minnesota Pears

Grantee: Thaddeus McCamant, Central Lakes College
Duration: 2 years
Award Amount: $14,121
County: Todd, Chisago, McLeod

Project Objectives:

1. Determine if common Minnesota pear varieties are as compatible with Juneberries as they are with other common pear rootstocks.

2. Compare flower bud production on pears grafted to Juneberry rootstocks with pears grafted onto commercial pear rootstocks.

3. Compare growth rates of pears grafted to Juneberry rootstocks with pears grafted onto regular pear rootstocks.

Evaluation of Hybrid Hazel (Corylus) Woodchips as Mushroom Substrate

Grantee: Susan Wiegrefe, Wholesome Harvest
Duration: 2 years
Award Amount: $9,765
County: Fillmore

Project Objectives:

1. Will winecap and shiitake mushrooms use hazel woodchips to grow and fruit?

2. Is mushroom production on hazel woodchips equal to, better, or worse than other standard substrates (straw for winecaps and oak for shiitake)?

3. What level of production and what timing of fruiting can be expected using hazel-based substrates?

Demonstrating Vermicomposting for Soil Health in the Upper Midwest

Grantee: Caroline Devany, Stone's Throw Urban Farm
Duration: 2 years
Award Amount: $18,459
County: Hennepin

Project Objectives:

1. Build and maintain a vermicompost system adapted to the challenges of a northern climate.
2. Investigate effects of vermicompost on transplant quality and development time compared to purchased inputs in commercial potting soil mix.
3. Analyze economic feasibility of the vermicompost system, including cost of construction and maintenance, cost savings, and plant health gains.
4. Organize a two part vermicompost workshop that will engage organic growers, rural farmers, and subsistence growers and gardeners to demonstrate our system and share results.

Cropping Systems & Soil Fertility

How Much Can You Afford to Pay for Hay?

Grantee: John Mesko, Lighthouse Farm
Duration: 2 years
Award Amount: $9,829
County: Mille Lacs

Project Objectives:

1. To determine the value of hay litter to the soil after winter bale grazing.
2. To determine the true value of purchased hay to help farmers with decisions about expanding production, partnering with neighboring farmers, and adding cattle to an existing crop farm with better predictability and success.

Inter-seeding Cover Crops and In Season Nitrogen Application in One Pass

Grantee: Keith Hartmann
Duration: 3 years
Award Amount: $12,500
County: Nicollet, Sibley

Project Objectives:

1. I want to demonstrate to farmers how they can incorporate cover crops into their farming operation in a fast, efficient, and cost effective manner. Time is very valuable, showing how one tool performs two applications in one pass is powerful. Return on seed investment is also very important. Seeding after corn or soybean harvest in Minnesota does not allow seeds time to germinate and seeding success in August is moisture dependent. By incorporating seeds in June, it limits those risks.
2. Using replicated, side-by-side treatment strips, I will use a weigh wagon to measure corn grain yield across entire fields to determine if there is any statistical yield difference between the inter-seeding and check strip treatments.

3. I will be taking corn stalk nitrate tests and soil nitrate tests. The stalk tests will be used to ensure that the corn had a sufficient amount of nitrogen. Soil nitrate tests taken late in the season will measure the amount of nitrate that the cover crop has absorbed from the soil.

Inter-seeding Cover Crops into Standing Corn in June

Grantee: Brad Frazier, Cannon River Watershed Partnership
Duration: 2 years
Award Amount: $24,400
County: Rice, Goodhue

Project Objectives:

1. Can cover crops be effectively inter-seeded into standing corn in June (at V5 to V7 stage) by broadcast seeding and which cover crop species perform best?

2. Does seeding cover crops at V5 to V7 stage corn in late June produce a yield drag on the current year's corn crop?

Perennial Wheatgrass and Legumes for Cropping, Grazing, and Soil Health

Grantee: Mike Jorgenson
Duration: 3 years
Award Amount: $10,000
County: Big Stone

Project Objectives:

1. Testing how Kernza performs when inter-seeded with various legumes. Determine the yield of Kernza and forage in this inter-seeded trial.

2. Determine the forage production and forage quality for beef cattle. We want to demonstrate the viability of a continuous living cover for both crop production (Kernza), grazing beef cattle and having legumes to help meet the soil nitrogen needs of the crops.

Livestock

Goat Grazing During Winter in Minnesota: Controlling Vegetation while Saving on Feed Costs

Grantee: John Beckwith, Hiawatha Resource Conservation & Development
Duration: 3 years
Award Amount: $24,980
County: Rice

Project Objectives:

1. Explore the benefits and limitations of grazing goats during winter: We seek to increase our knowledge of electric mesh fence effectiveness, water supply maintenance, and movable winter shelters as these issues pertain to a wintering goat herd in Minnesota. In addition, we seek to quantify the economic benefit of winter grazing that may be achieved through reduced feed and supplement costs as well as the potential season extension for services of controlling undesirable vegetation.

2. Assess winter grazing system potential for protection and release of native plant species while controlling

invasive and undesirable plants: We intend to monitor grazing habits in order to ascertain whether goats will focus on woody plants over grubbing and digging out grasses or forbs. Further, we will attempt to influence their preference for all woody vegetation toward undesirable plants such as buckthorn or sumac through use of deterrents, wrapping, and fencing of native species.

3. Monitor indicators of livestock comfort and health: We propose to make available several low-cost shelter designs, to determine whether a preference is shown by the goats. We will also measure high-low temperatures outside and within each shelter to try to quantify differences between systems. In addition, we will monitor the herd's reliance on feed and supplements, general condition and weight change - and anecdotal comparisons to critters wintered in a confined yard.

Integrating Silvopasture Practices into Perennial Fruit Production

Grantee: Harry & Jackie Hoch, Hoch Orchard
Duration: 3 years
Award Amount: $15,000
County: Winona

Project Objectives:

1. Establish the infrastructure for a rotational grazing system including the following: constructing fences, installing a watering system, and building one additional portable shelter using lessons learned from previous shelters built on-farm.

2. Record the establishment and production costs for this system including the following: the material and labor to build fences, install a watering system, build a specialized portable shelter, and to operate the grazing system.

3. Create a document that reports the actual costs of setting up and using this system and compare it to other established systems with published reports on costs and returns.

Breeding, Selecting, and Assessing Organically Grown Nutrient Dense Corn for Poultry Production

Grantee: Sue Wika, Paradox Farm
Duration: 2 years
Award Amount: $24,946
County: Otter Tail, Becker

Project Objectives:

1. Organically grow 20 lines of high carotenoid/protein quality corn and determine which lines produce the best yield and standability in Northern Minnesota. Share this information with extension educators and local farmers.

2. Determine which of the 20 lines have the highest protein quality (methionine and lysine) and carotenoid content.

3. Determine whether poultry prefer organically grown high nutrient research corn adapted to MN over commercial organic corn in terms of palatability. Share this information with extension educators and local farmers.

Principal Investigator

Becca Carlson
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Northfield, MN 55057
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Rice County

Project Duration

2014 to 2016

Award Amount

$24,152

Staff Contact

Meg Moynihan

Keywords

biological activity, compost, compost tea, fruit, microorganisms, soil health, vegetables

Using Compost Tea in Organic Farming

Project Summary

We are testing the effects of compost tea on vegetables, fruit bushes, pasture, cover crops, and hay ground. Compost tea inoculates the soil with microorganisms, including bacteria, fungi, protozoa, and nematodes, enhancing the soil food web. The six farms participating in this project grow vegetables, fruits, or pasture/hay, and are each comparing treated areas (compost tea applied) to similar control areas (no compost tea applied). Our overall goal is to determine whether applying compost tea to our crops can improve farm profitability. Reducing fertilizer needs, increasing yields, and/or increasing produce quality are all possible benefits of compost tea, but we are particularly interested in the potential for reducing purchased fertilizer.

Project Description

Compost tea is a liquid produced by extracting bacteria, fungi, protozoa, and nematodes from compost. The idea is to extract and replicate the beneficial biology and diversity of compost in a liquid form. Nutrients extracted from the compost (and/or added to the tea) grow beneficial organisms. Tea (extract) can be applied directly to the leaf surface of a plant as a foliar spray or used as a soil drench to improve root systems. Together, the beneficial bacteria and fungi result in a variety of many different species in the compost tea.

The value of compost tea is related to the importance of the soil food web. The soil food web is the community of micro-organisms living all or part of their lives in the soil, which includes bacteria, fungi, protozoa, nematodes, and earth worms. This community of organisms transfers nutrients through the soil, makes other nutrients into forms plants can use, and helps protect crops from soil-borne pathogens. The very structure and health of our land is directly influenced by this complex set of biological and chemical interactions that decompose, retain, and recycle nutrients within the soil.

The two key reasons to use compost tea are:

1. Impart microbial life into the soil or onto the foliage of plants.

2. Add soluble nutrients to the foliage or to the soil to feed the organisms and the plants present.

Note: The project leaders provided these descriptions of compost tea and the soil food web from information at rodaleinstitute.org and earthfort.com

Brewing compost tea is relatively inexpensive – a batch of compost tea to treat 5 acres costs under $50. If applying compost tea allows a farm to reduce the amount of fertilizer it needs to buy, that would be a significant boost to profitability and would be of great interest to many farmers in Minnesota. Reducing fertilizer usage would also save energy (less energy needed to produce fertilizer and equipment time to spread it) and improve water quality by reducing the possibility of nutrient runoff.

This project includes six farms in the Northfield/Nerstrand Minnesota area. Each participating farm in the project chose one crop (vegetables, fruit bushes, pasture, cover crops, or a hayfield) to spray with compost tea. Our plan is to apply the tea to one or more areas while leaving an unsprayed area to serve as a control so that we can observe and measure any effects from the compost tea. We are evaluating yield, brix levels, plant health (through plant tissue analysis), and soil health (by analyzing the number of micro-organisms living in the soil).

Seeds Farm shared the following story that illustrates why so many of us perceive a need to boost soil microbial activity: A college student buried dead squirrels in our vegetable fields, a nearby forest, and a nearby prairie. When she dug the squirrels up at the end of the season she found that the squirrel in the vegetable field had only barely decomposed, while the squirrels that had been buried in the forest and prairie were completely decomposed. These results showed us that agricultural practices can discourage soil microbes.

Part of our project includes figuring out how to brew and apply compost tea effectively and efficiently. Brewing consists of suspending a bag filled with biologically active compost in a container of water and using forced air to physically knock off the microorganisms and suspend them in the water. Bacteria, molasses, fish hydroloslate, kelp, steel cut oats, and/or humic acid, can be added to encourage these populations of microorganisms to grow. The tea must be kept aerobic and must be applied within 2 days of brewing. Foliar spraying, putting through drip irrigation lines, and gravity feeding behind a subsoiler can all be used to apply the compost tea, as we learned in year one of the project.

2014 Results

In the first year of this project, most cooperating farms didn't anticipate how difficult it is to reliably brew a useful beneficial compost tea. Two farms (Cherry Leaf Farm and Seeds Farm) managed to both build their own compost tea brewers and apply tea.

The other participating farms bought compost or compost extract the first year and applied it to their blueberry bushes, carrots, and cover crop. None of the farms observed any plant or soil effects of compost tea in 2014.

Table 1. 2014 Participating Farms and Their Methods				
Farm	**Crop**	**Product**	**Application Strategies**	**Notes**
Little Hill Berry Farm	Blueberries (certified organic)	Purple Cow Organics compost plus fish emulsion, humic acid, and Purple Cow "activator"	Sprayer, drip irrigation	Soil analysis by Carleton College students found no significant differences between treatment and control
Open Hands Farm	Assorted fruits and vegetables (certified organic)	Purchased compost extract.	Brass nozzle boomless broadcast sprayer	Interested in potential of compost tea to control fungal pathogens as well as building soil microbial communities
Seeds Farm	Tomatoes (unexpected crop failure due to disease)	Purple Cow Organic compost or Living Soil Labs compost plus molasses, fish hydroloslate, and steel cut oats. See 2015 Greenbook for recipe.	Applied May, July, October - first with boom sprayer, but nozzles clogged. Preferred gravity feeding through PVC pipe behind single subsoiling shank or with waterwheel transplanter.	Built a 275 gal brewer. Tried using microscopes to assess quality of the compost tea, but found this difficult – need additional training
Cherry Leaf Farm	Cherries	Built a brewer and used own compost to make the tea.	Applied to only a few plants.	Built own brewer, from purchased aeration tank and a borrowed agitation blower
Simple Harvest Organics	Heavy rains prevented demonstration this year.			

We were not too disheartened at the lack of immediate results because we understand that soil microbes can take a while to become established in the soil. We expect that with better compost tea brewing and applying, we'll be able to understand the relationship between soil microbial health and plant health with greater confidence.

2015 Results

Little Hill Berry Farm

In 2015 we modified the methods and design of our project slightly. We applied compost extract to two varieties of blueberry plants, Patriot and Bluegold, (both 2 and 4-year old plants).

Little Hill Berry Farm used colored flags to mark high treatment, low treatment, and control areas.

We made the compost tea by agitating 4 lb compost contained in a fine nylon mesh bag in 20 gal of water for 4 min. Our treatments included: control (no compost tea, no extra water), low (four applications between May-October), and high (11 applications between May-October). Each application consisted of one quart of compost tea poured at the base of each plant. Each variety/age pairing had five replicates of each treatment.

To quantify soil microbial activity we measured soil nitrogen mineralization. To quantify plant growth, we measured leaf carbon fractions.

Figure 1 shows the results for N mineralization. We found that N mineralization was higher in the "high" treatment compared to the control. We did not find a statistically significant difference for the "low" treatment.

Neither variety nor plant age had any effect on N mineralization within treatments, and we found that compost extract alone (without any of the other ingredients frequently added, such as fish fertilizer, humic acid, kelp, molasses, etc.) produced a measurable increase in soil microbial activity.

The effects of compost extract on leaf carbon fractions were not as clear (Figure 2). We found the "low" treatment plants had less leaf carbon compared to the control, while the "high" treatment had no effect compared to control. We thought increased N mineralization by the soil microbes would lead to increased plant uptake of nitrogen and a corresponding increase in leaf carbon. The fact that we found no increase in the leaves may indicate that the microbes consumed the N before the plants could take it up. This nitrogen should be available to the plants in the future, so it is possible we will see an increase in leaf carbon next year.

Figure 1. 2015 Microbe N Mineralization, Little Hill Berry Farm

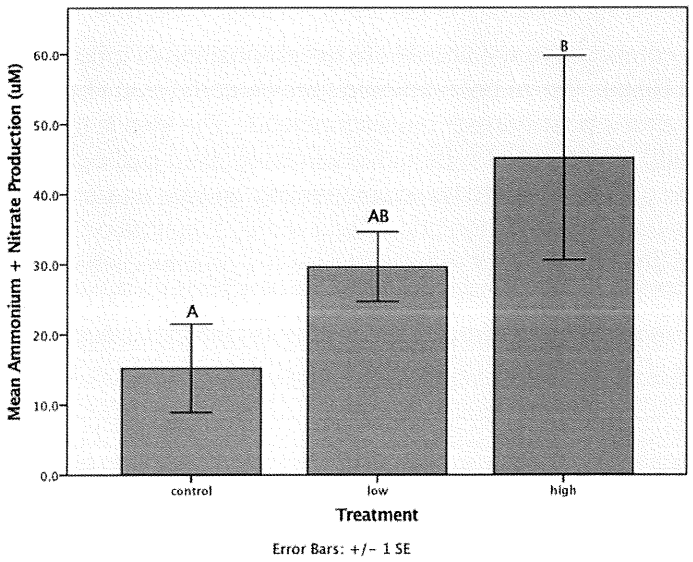
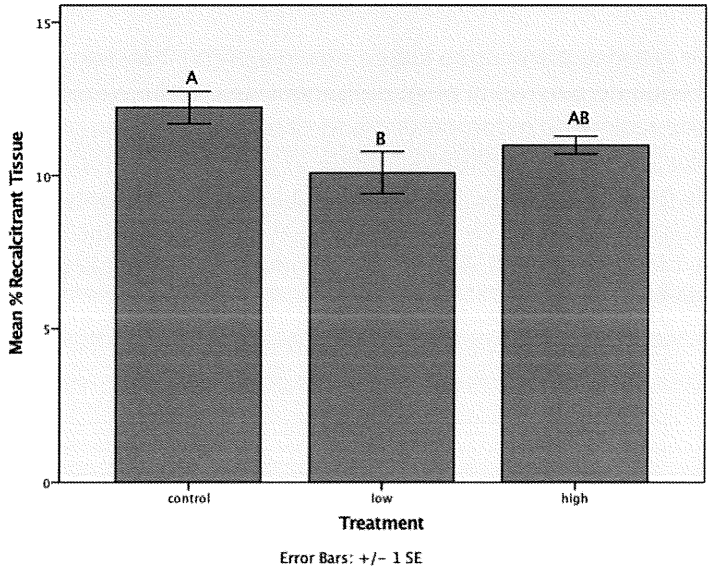


Figure 2. 2015 Leaf Carbon Levels, Little Hill Berry Farm



We plan to continue with this experimental design next year, using the same plants, same treatment levels, application methods, etc. Repeating our experiment should help us see whether N continues to be greater in the high treatment. We will also look for an increase in plant growth, which we hope would translate in future years to increased yield.

Spring Wind Farm

In 2015, we tested compost tea on six plots in a field that had been farmed conventionally the year before. We applied compost extract weekly to three plots in July and August, and applied water to three plots as a control. We made the compost tea on our farm, using compost from Maharishi University in Fairfield, IA. The compost was created specifically for making teas and extracts that have high microbe counts. We used the same "recipe" as Little Hill Berry Farm, put the compost in a mesh bag, and swirled it in the spray tank for 1 min. We applied the compost tea with a backpack sprayer in a single pass, trying to simulate the amount of spray that would have been applied with a tractor-mounted sprayer. We lightly incorporated the compost tea into the soil with a hoe.

After the last application, we took soil tests and sent them to Microbe Inotech Labs to test the soil samples for glyphosate levels. We were surprised to find the control pots had glyphosate levels of 67.75ppb while levels in the treated plots were higher (80.42ppb). Last year's results were similar; soil samples from the control had 63.69ppb glyphosate and those that got the extract treatment had 84.17 ppb. This is exactly opposite of what we expected; we thought that applying compost extract would boost soil microbial activity, and that this activity would reduce glyphosate levels. We're eager to repeat this experiment again next year to see whether we get similar results. We've also begun to wonder if the higher rates of glyphosate on the experimental plots could suggest that there is glyphosate in our water. Our wells are 360' deep, so this is concerning; next year we will test the water.

Also this year, a student from Carleton College conducted some experiments in our vegetable fields using the same compost extract. She applied the extract to potatoes, tomatoes, carrots, broccoli, and spinach. In each crop she had three plots that received "high" doses of extract, three that received "low" doses and three controls (no application of any kind). The student took both soil and leaf tissue samples. We'll be able to report her findings next year.

Cherry Leaf Farm

This year, we sprayed a few trial runs of compost. I examined some of the finished compost tea under a microscope for biological activity, and applied it to a few rows of cherries.

Next year, I plan to apply compost tea on designated rows of cherries, with the remaining rows serving as a control group.

Open Hands Farm

We were unable to conduct any compost tea experiments or demonstrations this year, as we were unusually busy. We plan on conducting summer experiments related to control of fungal plant pathogens in 2016.

We are also planning to start a new experiment testing whether compost tea will accelerate decomposition of crop residue (to survival of plant pathogens) and reduce the need for tillage. We've been advised that we could skip tilling crop residue to incorporate it and apply compost tea or extract after a post-harvest mowing instead. The idea is that the microbes would multiply all winter to decompose crop residue and would out-compete overwintering plant pathogens. We have struggled with *Alternaria* (a fungus) in brassica crops on our farm, so will be experimenting on kale and/or Brussels sprouts. We plan to do quantitative microbial soil tests before application and after a winter's incubation; test for presence of *Alternaria* pathogens before application and after winter; and visually assess the decomposition of residue.

Seeds Farm

This year we focused our efforts on brewing, applying, and analyzing our compost tea. We brewed and applied compost tea on our farm four times: May 8, June 10, July 30, and November 26. (Figure 6). We brew in a 275 gal tote with a ½ horsepower regenerative pump blowing air through a 1.5" tube through the bottom of the tote at full force, right underneath a suspended bag of high quality compost. We used 3 gal of activated compost, 0.5 gal fish emulsion, 16 oz kelp, 16 oz molasses, and 0.5 cup sea salt (with minerals). We brewed the mixture for 24 hr and applied at 20 gal/A with a 100 gal boom sprayer.

We applied compost tea with a 100 gal tractor-mounted boom sprayer.

Applying compost tea in a cabbage field.

We bought our compost and other ingredients from Crop Services International in Michigan. They also analyzed our samples and told us our compost tea was good quality, with bacteria, fungi, and protozoa all in the desired levels for good compost tea. We're still trying to interpret the specific data on the laboratory analysis report.

In 2015 we also began exploring the idea of using compost tea to rejuvenate disturbed land. Our township is going to excavate a 10' deep pond across the road from our farm. Their plan is to strip the topsoil off our land, move subsoil (but no topsoil) over to our farm from the excavation site, and then put our topsoil back on.

The soil will arrive in spring of 2016, so that's when we're starting the experiment. We had hoped to test several tillage methods both with and without compost tea, to see whether there were any effects on microbial biomass and aggregate stability. We've decided that it's not possible to include tillage treatments, so are planning to focus on compost tea. We will spray an area with compost tea four times over the course of the season. We will also have a control area that will never be sprayed. We plan to take multiple samples each location (treated and control) to see if compost tea has an effect on disturbed land.

Woodskeep Orchard

Woodskeep Orchard joined the compost project as a new partner in 2016. We have a high density apple orchard with nearly 30 varieties that we grow primarily for cider. We are interested in becoming certified organic and would like to see whether we can meet many of our fertility and disease management needs through foliar compost tea applications. Not only could this system be beneficial for the orchard's fertility and health, but it would also reduce the cost and practical difficulties of yearly compost or fertilizer applications.

We brewed compost tea in a homemade brewer and sprayed two rows four times in 2015, leaving two rows of varieties unsprayed as a control. We compared soil tests, disease/general appearance, and fruiting in the treated and control rows. We also used a microscope to assess the strength of tea. This is a skill we think will be crucial to the system, but it will take practice.

Woodskeep is a high density apple orchard.

Like some of the other farms, Woodskeep Orchard constructed its own compost tea brewer.

The results from our 2015 soil tests and visual observation were inconclusive. While we saw no differences between the treated and control rows for the same variety and location this year, apples are a perennial crop, and many of the benefits of compost tea may not be seen for a couple of years. We think the health of the orchard in general is very good, but it is difficult for us to quantify.

Management Tips

1. Plan ahead. Making compost tea is a multi-step process, so start brewing 1-2 days before you plan to apply the tea.
2. Assess the quality of your compost tea before applying, either by looking at it through a microscope or sending the sample in to a lab. There's no use misting water!
3. Compost tea has large enough particles to clog a sprayer. We recommend using a boomless brass nozzle.

Cooperators

Dane Terill, Crop Services International, Portage, MI
Andrew Ehrmann, Spring Wind Farm, Northfield, MN
Molly Haviland, Living Soil Lab, Fairfield, IA
Dan Hernandez, Carleton College, Northfield, MN
Erin Johnson and Ben Doherty, Open Hands Farm, Northfield, MN
Tracy Jonkman and Nate Watters, Woodskeep Orchard, Dundas, MN
John Porterfield, Cherry Leaf Farm, Northfield, MN
Aaron Wills, Little Hill Berry Farm, Northfield, MN
Kathy Zeman, Simple Harvest Farm, Nerstrand, MN

Project Location

This project is taking place on seven Northfield/Nerstrand, MN area farms. To reach any of the participants, contact project leader Becca Carlson, whose information is provided on the first page of this article.

Principal Investigator

Kathy Connell
Redfern Gardens
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Wadena County

Project Duration

2014 to 2016

Award Amount

$7,953

Staff Contact

Cassie Dahl

Keywords

blueberries, mulch, soil health

Evaluating Different Depths and Types of Mulches in Blueberry Production

Project Summary

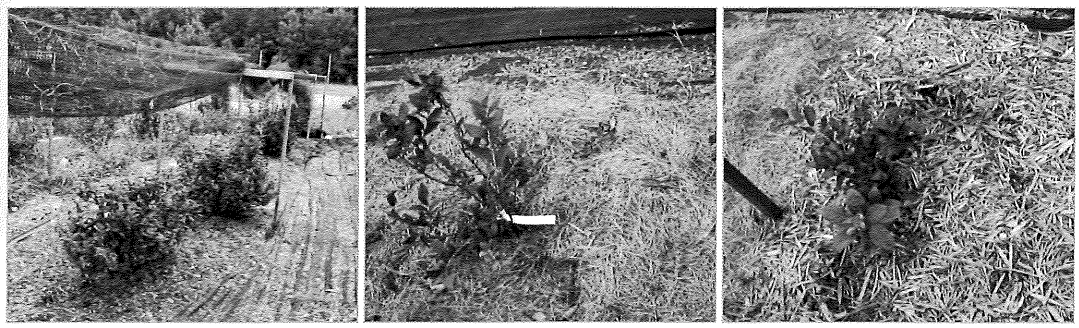
We are examining two aspects of blueberry production while utilizing organic growing techniques. One aspect is to determine the optimum depth of woodchip mulch and the other is a comparison of woodchip mulch, chick litter mulch, and grass clipping mulch. We will look at soil moisture retention, pH, fertility, temperature, and biological activity of the soil beneath the mulch. We believe it is important for the future that we maximize our farm and local resources in order to strengthen the sustainability of our farms. In addition, we believe we must share our experiences in order to strengthen our communities.

Project Description

We want to find ways to decrease and possibly eliminate herbicide usage, eliminate or reduce chemical nitrogen application, decrease wind and water erosion, and decrease water runoff. These will all benefit the environment.

The use of mulch will hopefully conserve energy by reducing fuel used in tillage for weed control and reducing electricity used by the irrigation pump. The project may also show ways to increase farm profitability by decreasing energy use for equipment, decreasing labor needed for weed control, decreasing the amount of off-farm purchases for fertility. There may also be an increase in the profitability of the berries if the farm is certified organic and can market the crop as such. The mulches to be used are normally considered waste products, including: grass clippings, chick pen cleanings, and forestry by-products in the form of woodchips.

The project may benefit the local community if the blueberry grower chooses to purchase woodchips from a local forestry operation. Other blueberry producers may find the information useful and it may benefit organic growers by eliminating herbicide usage and decreasing labor for weeding while increasing the use of on-farm sources of organic fertility and mulching materials. In addition, it may resolve a long standing question, which is how woodchip mulch affects the nitrogen content of the soil beneath it.



Blueberry plants growing in different mulches. From left to right, woodchips, grass clippings, and chick litter.

2014 Results

We prepared the planting area, which took longer than we thought because of perennial weeds. Other plans had to change slightly, because we weren't able to purchase a woodchipper and had to purchase woodchips from a local supplier. Fertilizer was applied in the form of blood meal, and then the mulch was applied according to the plan.

The plants did not do well after the first couple of weeks. Their coloring indicated the soil was not as acidic as we thought it would be. We had Glen Borgerding perform soil tests in each of the four beds. To our surprise the beds were at 6.8 and 7. We really don't understand how this happened and obviously should have checked the pH earlier. Our original pH on this land was 5.5 and the area used has not had lime applied. Maybe someone had used that particular area to dump wood ash in the past? Anyway, this caused another change in plans. We had to acidify the area quickly in order to assure the survival of the plants we had planted. Our original plan was to use only organically approved amendments. However, using elemental sulphur to adjust the pH may take up to a year and we wanted the adjustment this growing season, so we used iron sulphate. I researched the University of Minnesota website to determine the rate of application. All other practices will remain organic. After using this product, we will have to allow a transition period of 3 years before we could certify the crop as organic.

The intent is to track soil pH, moisture, temperature, and fertility, but it has taken me a little time to learn how to use the equipment for testing and set up a good tracking method. This should improve the next two seasons. After a consultation with Glen Borgerding we have also decided to track the biological activity in the soil. Glen will be testing for this and fertility once a year.

Regular maintenance has taken place, removing blossoms, weeding, etc. Application of the iron sulphate required the mulch be pulled back and the sulphate applied to the soil. Using the moisture meter we decided to irrigate when one of the beds was at 70% moisture. The beds only required three irrigations this season. Interestingly, the first bed to show low moisture was the bed mulched with the chicken litter. The moisture test is very general, shown as a percentage of available moisture, but that should be good enough to allow us to compare one bed to another.

Observations this year are very interesting to me because they did not come out as I anticipated. We had four beds, one with 6" of woodchips, one with 3" of woodchips, one with 3" of grass clippings, and one with 3" of chick litter (wood shavings and chick droppings). I really thought the 6" of woodchips would prove to be the most weed free. However, quack got into and thrived in the deep woodchips, and turned out to be the most vulnerable to that perennial. On the other hand the bed that had the least perennial and annual weeds was the bed mulched with grass clippings. The original 3" of clippings had reduced to only about 1", but seemed to resist annual seed germination. It may have been a fluke that the quack thrived in the woodchips but hopefully the next 2 years will help us determine this. If the grass clippings prove to be the most useful they will also be the least costly and most readily available. It also makes one consider the possibilities of planting a particular seed mix in the pathways, then mowing them for mulch. An exploration of which seed mix would be best would have to be done. I assume there is already some research available addressing that, though I wonder if any has been done with the idea of producing the most biomass. This winter will allow time to research this further.

It's very obvious to me now that it is necessary to track this project for 3 years. It takes the first year just to get the kinks out. I have a list of things I should have done differently starting with planning and bed preparation the year before planting.

2015 Results

Last year, the first year of the project, we had difficulties that were caused by our lack of preparation. We should have tested the soil pH before planting and we should have kept the bed area black for a year to get rid of perennial weeds. The pH has been corrected, however we are still having problems with quackgrass, especially in the woodchip beds.

This year the problem we faced was beyond our control. The unusual open winter damaged most of our plants severely. In our area we had little fall rain and no snow to speak of. I believe we continued to lose soil and plant moisture throughout the winter. We watered one last time in the beginning of November and all plants were covered with Agribon 19. This included the mature blueberry plants that were 3' tall and as wide. In spring, I examined the plants and it was obvious that

the stems were desiccated. As the weeks progressed, I noticed that there was significant dieback in all plants, mature and immature. To say the least I was incredibly discouraged.

I hoped that plants would recover and come back from the roots and many did. However, only 9 of the 24 project plants recovered. Some plants sent out small shoots, but they died mid-summer. I am assuming there was not enough root system left to support them. Several times throughout the growing season I decided to stop the project, but then would change my mind. As the season concluded I am glad I did. There was interesting information to share.

We applied blood meal to the surface of the soil twice, once in mid-April and once in mid-May. Weeding took place several times throughout the summer and as needed, water was applied with a sprinkler. After finding that the pH was still a little high for blueberries we applied small amounts of elemental sulfur to the surface of the mulch around all plants. Soil amendments were applied to all the planting areas because we decided to replace the plants that had winterkilled, next spring.

So, what did the test actually look like this year?

Bed 1: This bed and all other beds had six plants. It was mulched with shavings that had small quantities of chick manure mixed in. All the plants in this bed had good growth in 2014 (12-14"), but only one plant survived this winter. Ag Resource Consulting Inc. tested the soil in all beds during mid-summer.

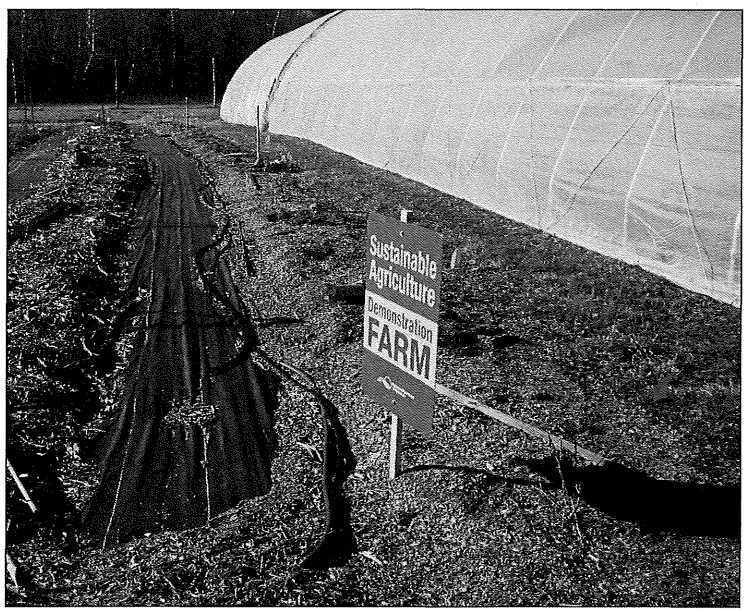
2014 and 2015 Soil Measurements								
	Bed 1 2014	Bed 1 2015	Bed 2 2014	Bed 2 2015	Bed 3 2014	Bed 3 2015	Bed 4 2014	Bed 4 2015
pH	6.8	5.3	7.2	5.4	7.0	4.8	6.8	4.1
Organic matter (ppm)	2.9	3.1		2.9	2.6	2.9	2.8	3.5
Phosphorus (ppm)	136	200	156	152	99	152	148	154
Potassium (ppm)	289	408	199	210	98	267	207	204
Nitrogen (lb/A)		312		150		200		138

This was a small sampling but one must wonder if the small amount of chicken manure may have stimulated growth that was too tender to make it through the winter. The shavings also seemed to shed water like shingles on a roof. After next spring, I will not use this product again on blueberries.

Bed 2: This bed was mulched with grass clippings. We attempted to keep the layer at several inches thick but they matted and broke down quickly. All the plants had growth of 6-8" in 2014 and the five surviving plants had an additional 6-8" of growth this year. I find it interesting that only one plant in this group of six winterkilled. Again, it is a small sample, but survival of five plants was surprising when losses were so much higher in the other beds. Interestingly, this bed was the most weed free of all the beds. Weed seedlings did not germinate easily here and for some reason, perennial weeds were also easier to control in this bed, maybe just a happy coincidence.

Bed 3: This bed mulched with approximately 3" of mixed woodchips and this spring it only took one application to bring the bed back to that level. All the plants had good growth last year, 12-14". However, only one plant in this bed survived the winter. This plant had 12-14" of new growth this summer. We definitely had more problems controlling weeds in this bed, particularly quackgrass. No matter how much time we spent carefully hand digging out the roots it would come back with a vengeance.

Bed 4: This bed was mulched with 6" of woodchips and it only took one application to bring it back to the 6" level this year. All of the plants had good growth in 2014; most shoots were 12" long or longer. The plants in this bed sent more shoots up from the root systems than the other beds, making them thicker plants. Two of the six plants survived the winter in this bed. These two plants each had 18-24" of new growth. Interestingly, organic matter increased the most in this bed, nitrogen was the lowest, yet these plants showed the most growth. This bed was a little easier to control the weeds in and intrigued me to see what was going on at soil level. I moved aside the mulch and was surprised to see about a 1" layer of broken down black material between the chips and the soil.



Bed preparation for blueberry plants.

Last year we had an additional soil test done in Bed 3, the bed with the 3" of woodchips. The Solvita Carbon Burst Test is used to measure biological respiration and therefore biological activity in the soil. The test last year showed a measure of CO2 at 4.69. This year the same bed was tested in the same place and the biological respiration measure was 41.5. This is a tenfold increase and if I understand the concept correctly, it means there was a tenfold increase in carbon sequestration.

To say the least, it has been an interesting year. Spring of 2016, we want to replace the plants that were winterkilled and I am hoping for a better survival rate than the winter of 2015-16. In addition, I would like to have each of the beds tested for biological respiration. I wish I had utilized the Solvita Carbon Burst Test before, because it may actually be the most interesting measurement we get.

Management Tips

1. Get soil tests done the year before planting and prepare the planting bed then.
2. On very sandy soil overhead watering with a sprinkler system develops better root systems than drip irrigation. However, I wonder if deep mulch prevents good water penetration, but so far there has been little difference in soil moisture.
3. Covering the plants may not protect them from winterkill if there is insufficient moisture, no snow cover, and episodes of warming and deep cold. In other words, sometimes nature wins.

Cooperators

Thaddeus McCament, Central Lakes College, Staples, MN
Eric Nelson, Minnesota Department of Natural Resources, Brainerd, MN
Glen Borgerding, Ag Resource Consulting, Albany, MN

Project Location

Redfern Gardens is located at 18298-270th St. Sebeka, MN 56477. Take Cty. Rd. 12 from Sebeka and go east for 4 miles. At the intersection of Hwy. 23, turn right, or south. Go 1 mile to 270th St. and turn left onto 270th St. Go 1 mile and cross the Redeye River. The first driveway on the left after crossing the river is the farm.

Other Resources

eOrganic Website: www.eorganic.info

University of Minnesota Extension Website: www.extension.org

ATTRA. Blueberries, Organic Production. Website: www.attra.ncat.org

Developing Profitable Apple Production along Lake Superior's North Shore of MN

Principal Investigator

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Project Duration

2014 to 2016

Award Amount

$18,074

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Keywords

apples, trellis, integrated pest management (IPM), north shore

Trees at Stan Bautch's orchard.

Project Summary

Over 3 years, five sites along the north shore of Lake Superior will demonstrate high-density trellised apple production and trial different rootstocks with modern and historic apple varieties. The primary project objective is to support production of apples using organic, sustainable, and Integrated Pest Management (IPM) strategies among small farmers in northeast Minnesota. We will emphasize strategies to maximize production and profit in consideration to the climate, soil, and landscape constraints and the reduced pest pressure that north shore growers experience. Production, climate, and IPM data will be collected annually at each site and shared through workshops, field days, Clover Valley Farms website, and through collaborations with local and regional farming organizations.

Project Description

Cindy Hale and Jeff Hall of Clover Valley Farms, LLC operate a small, diversified farm on 25 acres just north of Duluth. Enterprises on the farm include direct sales of pastured poultry, hogs and sheep (fleece), a year-round solar greenhouse, and gardens and orchards for vegetable, herb and fruit production. In 2013, Cindy retired after working 20 years for the University of Minnesota Duluth (UMD) as an ecosystem ecologist and educator, where she helped found the UMD Sustainable Agriculture Project. Cindy works full-time on the farm, teaches, provides consulting services, and works with community organizations.

High-density apple orchards, using cold-hardy super dwarfing root stocks, can be used to develop profitable enterprises for small farmers along the north shore. Along the north shore, including St. Louis, Lake, and Cook counties, apple production was limited due to the unavailability of large tracks of land needed for traditional orchards. In addition, the soil and landscape conditions along the north shore did not create a desirable environment for apple production. A vibrant organic apple grower network in the region could support the development of local markets with the economic, ecological, and health benefits for farms and consumers, similar to benefits seen on the south shore in Bayfield, WI. Cindy, with the help of Diane Booth from Cook County Extension, is leading a 3 year project to provide annual field based trainings on high density apple production, implementing organic and IPM strategies, and assistance for producers to gain access to locally adapted apple varieties and other resources. These trainings will help to develop small-scale orchards, which are part of a more healthy and sustainable local food system.

Organically managed, trellised high-density orchards in other regions of the western Great Lakes are well established. Therefore, resources exist to help develop similar orchards along the north shore. Existing modern and heritage apple varieties provide disease resistance and fruit diversity for fresh eating and value-added products. Recently completed genetic work is beginning to identify undescribed, historic apple varieties that are well adapted to local conditions. However, a lack of grower support and organization has been an obstacle for small producers to implement high density orchard systems and to acquire historic apple varieties.

At Farmer-to-Farmer Exchanges held by Cook County Extension, more than 30 local farmers gathered in Grand Marais to discuss local food system needs and opportunities for the area. There was particular interest in issues related to climate change for small-scale agriculture along the north shore. Five issues emerged that relate to the project: (1) There has been an increase of ~3 weeks to the fall growing season, which appears to be fairly uniform along the north shore. A longer fall season, with micro-climates tempered by Lake Superior, may allow for longer season apple varieties. Research and demonstration of how these changes can lead to profitable apple enterprises in this area is needed: (2) The most economically damaging pests in traditional apple growing areas of Minnesota are not present along the North Shore, including coddling moth and plum curculio. Therefore, organic apple production, with fewer pesticide inputs and high quality products, may be easier to practice in this environment. However, as apple production increases and climate change continues, producers need a way to monitor and share information about production, pest and disease control in their area: (3) Producers and consumers want to increase profitable, local food production on small acreage farms in northeast Minnesota. Intensively grown apple trees fit this market niche well. For example, Cook County grows less than 1% of its food within the county while $14 million is spent on food imported from outside the county. Capturing even a small portion of that market through local production would provide healthier, more sustainable food and more agricultural opportunities for those interested in food production: (4) Farmers are eager to share experiences and strategies that help them succeed respective to the unique challenges associated with growing food along the north shore. A regionally specific grower's network supporting high density apple production and product marketing was highly recommended: (5) Conservation of energy and other resources would follow with the establishment of locally sourced apple products by reducing transportation costs associated with buying trees and getting fresh apples for local markets.

Project Objectives

- Develop high-density trial and demonstration orchards using modern and heritage apple varieties. This will include the collection of baseline data on production, climate, and pest and disease monitoring along the north shore. This information will be used to maximize production and profitability of apples used for fresh eating and value-added products.
- Identify, describe, and distribute historic cold-hardy apple varieties that are well suited for high-density production along Lake Superior. These varieties might serve local niche markets for fresh fruit, cider, jelly, sauce, and other value-added products.

2014 Results

Two existing orchards provided baseline IPM and production data as this project begins, including Clover Valley Farms (Cindy Hale), Duluth with ~ 1 acre in apple production using M-7 and Bud9 rootstock with six modern and 12 heritage varieties. Ray Block, on Lake Superior in Grand Marias, with a high density orchard containing 1, 2, and 3 year old blocks (162 trees) using Bud9, G11, G16, and G30 stock with Honeycrisp, Zestar! and Chestnut Crab on each.

IPM monitoring documented a very late and cold spring from which the region never fully recovered. Between April 1 and September 29, only 915 growing degree days (GDD) were documented at the Duluth site. Late establishment of the IPM data loggers in Grand Marais did not allow for seasonal GDD measurements. Anecdotal observations indicated a much cooler and shorter growing season in Grand Marais than was observed in Duluth. Apple scab models did not indicate high probability of infection until early June. Both established orchards chose not to spray for apple scab since little field evidence of primary scab infection existed and model predictions indicated that most of the scab spores had already been spent. Very low levels of primary and/or secondary apple scab were detected during summer scouting and fall harvest. In the 2014 season, the most economically impactful pest issue was seen in the Duluth site from Lesser Apple Worm. As an internal feeder, it is difficult to treat. Pest trapping indicated larger than average populations and at least two generations, which resulted in substantial damage to mature fruit. Future control options to address this pest need to be considered for future years. There were also very high populations and multiple generations of Oblique-Banded and Red-Banded Leaf Rollers. These pests were easily controlled with Bt sprays that were guided by trapping and GDD models to appropriately time applications. This resulted in no significant economic impacts.

Production in these orchards for 2014 varied with the seasonality of the varieties that were old enough to produce. For example, Zestar! are present but not yet in production. Despite the challenging weather, all of the early season apple varieties, such as Honeycrisp and Norland Red, produced high quality, mature crops suitable for the fresh eating market. Later season varieties, such as Frostbite and Haralson, did not reach full maturity before cold fall temperatures. However, these crops were still able to be used in value-added products such as sweet cider and sauces.

Four new high density orchards were established in 2014 with a total of 174 trees planted. Due to the late spring and other issues starting the project, these orchards were planted at different times and later than ideal. Even with these circumstances, all of the orchards seemed well established by fall. Trellising the orchards will be completed in spring 2015. Trees used in these plantings included approximately 80 that were bench grafted in March 2014. The rest of the trees used were purchased from a regional nursery.

In mid-June, Clover Valley Farms in Duluth planted 50 newly grafted trees on Bud9 rootstock. This included 15 described varieties (Redwell, Dutchess, Frostbite, St. Edmunds Russet, Hazen, Prairie Spy, Haralson, Northern Spy,

Ashmed Kernal, Blue Permian, Black Oxford, Whitney Crab, Wealthy, Famuse Snow, Parkland and Oriole) and four previously unnamed varieties ("Allure's Wild Red", "Barb's Bounty, "Justin's Jewel" and "Gitchee Gummi Golden"). Paul Kotz and Susanne Hoderried, in Grand Marais, planted a total of 50 trees using eight described varieties on various rootstocks including Honeycrisp (on rootstock Bud9 and G-16), Zestar! (on Bud9 and G-11), Snowsweet (on G-30), Sweet 16 (on Bud9, G-16 and G-41) and Dolgo and Kerr Crab Apples. The orchard was planted in early July and was irrigated well throughout the summer. All trees appeared to be in good condition at the end of the season. Dave Williams, in Grand Marais, planted a total of 46 trees using five described varieties on various rootstocks including Honeycrisp (on rootstock Bud9 and G-16), Zestar! (on Bud9), Snowsweet (on G-30), Sweet 16 (on Bud9, G-16 and G-41) and Kerr Crab Apple. These trees were planted July 18. Several of the spring grafted trees that had failed spring grafts were bud grafted in August. All trees appeared to be in good condition at the end of the season. Stan Bautch, in Grand Marais, planted a total of 28 trees including Honeycrisp (on rootstock G-16), Zestar! (on Bud9), and Whitney Crab or "Allure's Wild Red" (on Bud9). These trees were planted on August 11. All trees appeared to be in good condition at the end of the season.

2015 Results

In addition to the IPM monitoring stations in Duluth, two more stations, with data loggers and pheromone pest traps, have now been established in Grand Marais. Additional pest trapping data was collected by the City of Duluth and submitted to this project. Substantial differences in pest pressure and growing degree days were documented between Duluth and Grand Marais.

Pest trap data showed that coddling moth was detected in Duluth but not at Clover Valley Farms or Grand Marais, indicating that this pest remains geographically excluded from most of northeastern Minnesota. For the second year, large early summer populations of Oblique Banded Leaf Rollers (OBLR) were detected in Duluth. Organic Bt sprays were successful in limiting late season populations and preventing potential economic damage. Further, early detection of OBLR in Duluth gave Grand Marais growers the opportunity to watch out for early detections of the pest. Apple Maggot populations were low all season along the North Shore. However, it remains one of the most challenging pests to manage organically in the area and poses one of the most substantial economic threats to fresh eating apple production in the area. Lesser Apple Worm, an internal feeder that is difficult to manage, was detected again this year in Duluth and Grand Marais. However, 2015 saw much less fruit damage than 2014 with similar trapping rates. Consideration for future monitoring and control options to address this pest is needed in the future.

Growing degree day data, in stark contrast from the late and cool 2014 growing season where Duluth only accumulated 915 growing degree days, Duluth experienced early warmth. The warmth continued into November, which resulted in Duluth accumulating 1,750 growing degree days. Grand Marais accumulated approximately 1,300 growing degree days in the 2015 growing season.

Apple scab models indicated medium to high infection probability in early June through September. However, little apple scab was detected in the monitored Duluth orchards. The orchards did not spray for apple scab due to little field evidence of primary scab infection and model predictions indicating that a majority of the scab spores had been spent by that time. Very low levels of primary and/or secondary apple scab were detected during summer scouting and fall harvest.

Production in the orchards, which are old enough to produce a crop, was early and abundant. In Duluth, early season varieties were ripe in July. Mid-season varieties, such as Honeycrisp, were ripe in late September. The late season varieties, such as Honeygold and Haralson, ripened in October and November. In Grand Marais, the late season apple, with a very long window of ripening, did not reach full maturity before cold fall temperatures. However, these crops were still used in value-added products such as sweet cider and sauces.

Since this project started, 11 new high density orchards, that include around 480 trees total, have been established. The newly established orchards include the following:

- In 2014, four orchards, with a total of 174 trees, were established in Grand Marais. All wintered well and put on good growth in 2015.
- In 2015, seven orchards, with a total of 306 trees, were established. In Grand Marais, five were established. In Duluth, one was established. In Carlton County, one was established.

A total of 680 trees have been secured for this project so far, including the following:
- 500 trees that were bench grafted by project participants in February 2015;
- 80 trees that were bench grafted by Cindy Hale in 2014;
- 100 additional trees that were purchased from a regional nursery.

Those trees that were not planted directly are currently healed at Clover Valley Farms. They will be used by the project in 2016. Roostocks that have been established in these demonstration orchards include Bud9, G-11, G-16, G-30, G-41, and G-935.

There are 24 described apple varieties that have been established in the demonstration orchards. The varieties include Ashmed Kernal, Black Oxford, Blue Permian, Brown Snout (cider apple), Chestnut Crab, Dolgo Crab, Dutchess, Famuse Snow, Frostbite, Haralson, Hazen, Honeycrisp, Kerr Crab, Northern Spy, Oriole, Parkland, Prairie Spy, Redwell, St. Edmunds Russet, Snowsweet, Sweet 16, Wealthy, Whitney Crab, Yellow Transparent, and Zestar!. Five previously unnamed historic varieties that have been established in the demonstration orchards include Allure's Wild Red, Barb's Bounty, Justin's Jewel, Gitchee Gummi Golden, and Northern Exposure. The previously unnamed varieties were identified in local historic orchards and genotyped in 2013. They did not match any known variety in the USDA database available, so they were assigned new varietal names.

Heritage apple genetic samples were collected this year from over 50 trees. They were submitted to Dr. Briana Gross at UMD for genetic typing. The objective is to identify historic apple trees, which are trees that are over 100 years old, that may be potentially valuable, locally adapted, unnamed apple varieties that growers may want to propagate. Results are anticipated in spring 2016, which will give us the final year of the project to collect scions and preserve these historic apples.

Management Tips

1. Contrary to popular belief, cold temperatures are not the primary limiting factor for apple production in northeast Minnesota. Most of the "near the lake" north shore area of Lake Superior is Zone 4 for winter hardiness. However, growing season length is a limiting factor especially since it relates to which varieties can reach maturity.

2. There are numerous apple varieties that are hardy enough for this region. However, even some of the most cold hardy, such as Frostbite, require a longer season to mature than is consistently available along the north shore.

3. A major take home message from the growing degree data collected thus far is that northeastern Minnesota growers need to be prepared for wide variations in the beginning of the growing season (i.e. bloom date vs. latest frost date), the number of annual growing degree days, and how these two factors may affect production in any given year. Diversity of apple varieties and a focus on early to mid-season apples is recommended.

Cooperators

Diane Booth, CC Extension, Grand Marais, MN
Anton Ptak, President, Organic Fruit Growers Assoc./Mary Dirty Face Farm, Downsville, WI
Dave Williams, Rosebush Creek Ranch, Grand Marais, MN
Ray Block, Lake Superior Orchard, Grand Marais, MN
David Bedford, Senior Research Fellow, University of Minnesota, Excelsior, MN
Paul Kotz and Susanne Holderried, Grand Marais, MN
Stan Bautch, Grand Marais, MN
Erik Hahn, Grand Marais, MN
Cameron Norman, Grand Marais, MN
John Peterson, Hovland, MN
Nick Wharton, Good Nature Farm, Grand Marais, MN
Rick Dalen, Northern Harvest Farm, Wrenshall, MN

Project Location

Please contact the owners if you'd like to see their orchards.

To the Clover Valley Farms site, take 35 north from Minneapolis/St. Paul towards Duluth. Exit onto MN-61. Turn left on Homestead Rd.

Stan Bautch's Orchard is in downtown Grand Marais and easily visible from the road. On the corner of 5th St. and Cty. Rd. 7 in Downtown Grand Marais, MN.

To the Lake Superior Orchard site, take 35 north from Minneapolis/St. Paul towards Duluth. Exit onto MN-61. Bear right onto E. Rosebush Ln.

To the Paul Kotz & Susanne Holderried site, take 35 north from Minneapolis/St. Paul towards Duluth. Exit onto MN-61.

To the Rosebush Creek Ranch site, take 35 north from Minneapolis/St. Paul towards Duluth. Exit onto MN-61. Turn left onto Fall River Rd.

To the Erik Hahn site, take 35 north from Minneapolis/St. Paul towards Duluth. Exit onto MN-61. Turn left on Cty. Rd. 14. Turn right onto Caspers Hill.

To the Northern Harvest Farm site, take 35 north from Minneapolis/St. Paul towards Duluth. Take exit 227 towards Mahtowa/Wrenshall. Turn right onto Cty. Rd. 4. Turn left onto Mahtowa Rd. Turn right onto Military Rd. Turn right onto Cty. Rd. 102

Other Resources

University of Minnesota's Apples webpage: www.apples.umn.edu

MN Dept. of Agriculture's IPM Program: www.mda.state.mn.us/plants/pestmanagement/ipm

Michigan State University's IPM Program: www.ipm.msu.edu

Organic Fruit Growers Association: www.organictreefruit.org

University of Minnesota Extension Apples: www.extension.org/apples

Cornell's Growers Guide to Organic Apples: www.nysipm.cornell.edu/organic_guide

National Sustainable Agriculture Information System: www.attra.ncat.org

University of Wisconsin-Madison's Center for Applied Agricultural Systems: www.cias.wisc.edu

Maximizing Profitability in Modular Movable Hoop Houses

Principal Investigator

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Project Duration

2015 to 2017

Award Amount

$18,642

Staff Contact

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Keywords

vegetables, hoop house, season extension

Project Summary

Sundogs Prairie Farm will build and field trial mobile modular hoop houses with the goal of maximizing mixed vegetable production. Hoop houses are a proven method of increasing farm productivity and profitability by maximizing solar gain, reducing pest pressure, enhancing yield and quality, and extending seasons. However, a limiting factor has been the small growing area the stationary structures provide. A recent innovation from Eliot Coleman's Four Season Farm in Maine are mobile modular hoop houses which can be easily 'split' into short segments, moved around the garden by hand, and reassembled in a new location. This unique mobility allows one structure to cover many field plots in the same growing season.

Project Description

We are inspired by Eliot Coleman's farming technique where mobile hoop houses have been employed successfully for many years. Mobile modular hoops allow producers to move the structure over and around existing plantings and buildings which greatly increases the options for placement. The total growing area covered each year is larger in size, allowing producers to do more crop rotations, utilize placement of the hoop house during critical growth stages of many crops in different locations on the farm, and greatly increase the overall farm benefits provided by the investment.

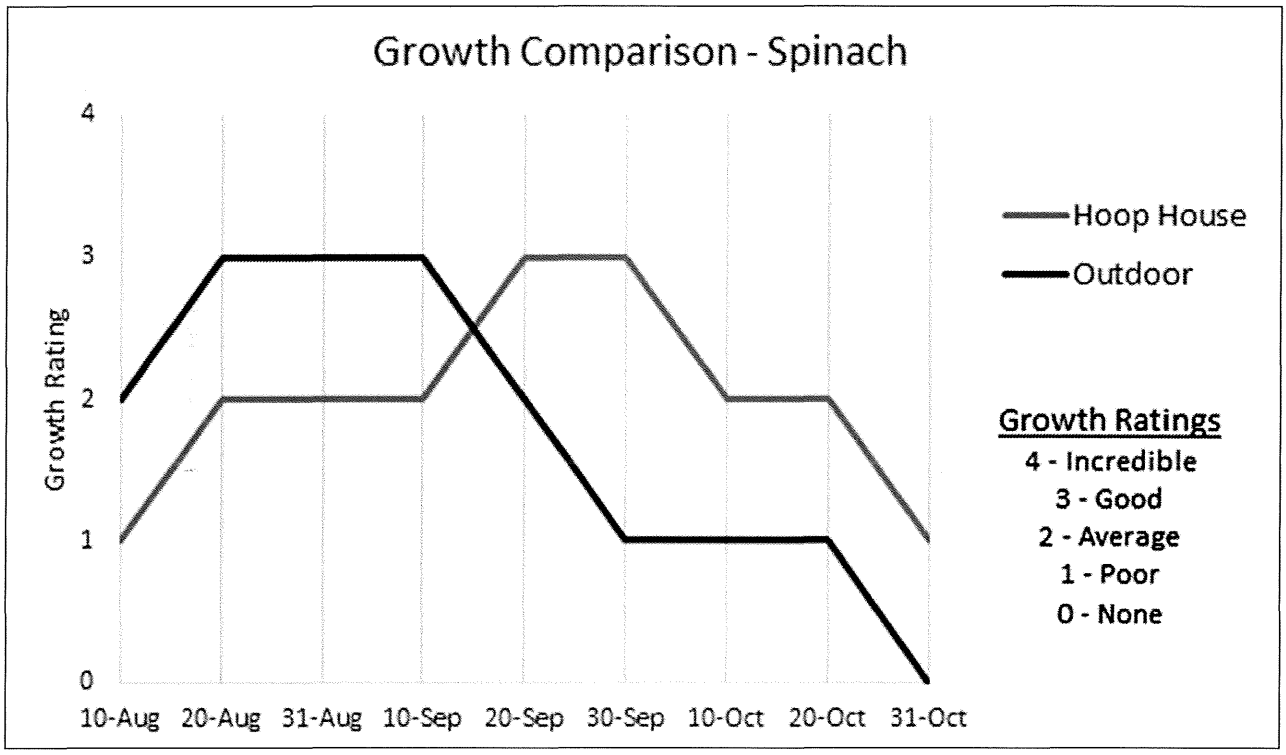
Sundogs Prairie Farm produces diverse vegetables on 5 acres for delivery to a local food hub, online market, two farmers markets, and several local restaurants. We currently utilize a hoop house, low tunnel, and row covers for season extension and to increase farm profitability. Our cropping system includes open field and plasticulture techniques depending on crop, market, and field conditions. Our farm includes 50 acres of land in conservation programs, 17 acres of pollinator planting, and 60 acres of organic alfalfa rented by our neighbor who operates an organic dairy. We employ extended family members for a significant portion of the labor on our farm and depending on our needs we employ up to five additional workers.

New for 2016, Sundogs Prairie Farm will be operating a Farm Stand and 2 acres of raised beds in the City of Alexandria. We have found a location with frontage along a low-speed segment of a major roadway which is traveled by our target market. We hope to use our new location to better engage our local community, raise awareness of small farm viability, and demonstrate mobile modular hoop houses.

2015 Results

The cropping strategies we used in 2015 focused on maximizing fall crop yields, season extension, and profitability. Comparison of direct seeded plantings were made at 10 day intervals with three treatments per planting. The three treatments were: outside planted crops that remained outside all season, outside planted crops that are covered with a mobile modular hoop house, and crops planted inside a hoop house that stayed covered all season. We monitored seedling establishment, plant condition and growth,

re-growth, yield, and management complexity. The warm late fall probably helped plant growth and condition across all treatments thru September and into October. With steady fall temps the effects of shorter day length on growth were very apparent in October with growth essentially stopping in early November (see chart).

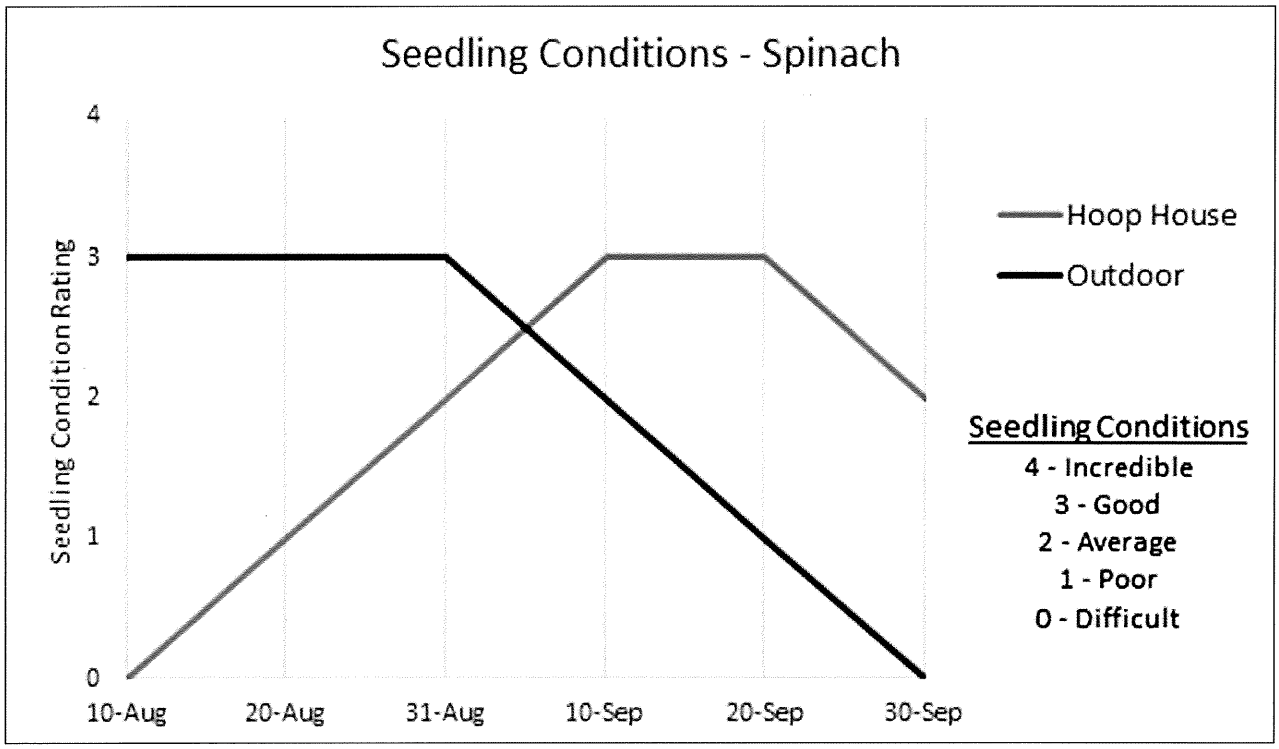


Outdoor plantings before September 10 performed well but occasionally were difficult to establish due to excess soil moisture. Protecting beds by covering them with old greenhouse plastic prior to planting stimulated weed seeds and maintained good seedbed conditions. Seedling establishment was significantly slowed when direct seeding outdoors after early September. Once established, outdoor plantings grew very well thru late September, then growth of most species slowed. By late September most crops had grown an excess of standing product. At this point we covered some beds with the mobile modular hoop house.

The outdoor seedlings that were covered by the mobile modular hoop house had less disease and much better re-growth than unprotected beds. The fast re-growth allowed for an additional harvest of spinach and leaf lettuce from the protected beds. The protection provided by the mobile modular allowed crops like Hakuri Turnips to retain marketability much longer than the outdoor beds.

Spinach - Cumulative Growth - Planted August 10th				
Treatment	**1st**	**2nd**	**3rd**	**Total Yield**
Outside All Season	Good	Fair	None	2nd
Outside Then Mobile Modular	Good	Fair	Fair	Highest
Hoop All Season	None	Fair	Fair	3rd

Direct seeding in the hoop house was surprisingly difficult in August and finally improved in September. The hoop house proved to be a stressful environment for seedlings and those that did establish in August grew poorly until heat levels subsided. Once we removed the main hoop house crop of tomatoes around September 1, ventilation improved and seedlings performed better. In September all our direct seeded seedlings in the hoop house performed very well with most species actively growing until late October and some even later. Densely seeded kale and mizuna beds started on September 1 were harvestable by early October and regrew enough for an additional harvest in late October/early November. Many species germinated and grew rapidly in the short, cool, fall days. Hoop house beds that were direct seeded on September 20 with French Breakfast radishes, Tokyo Bekana, Mizuna, Arugula, and kales were harvested by November 1.



In summary, our most profitable fall plantings in 2015 were planted outside and covered with a mobile modular hoop house for extended growth and harvest. Better plant establishment and conditions of the outdoor beds enabled those plants to regrow rapidly after harvests. Bed preparation, stale seedbed techniques, seeding, and watering were all significantly easier outside the hoop house which saved a lot of management time and effort. Because adjoining beds were planted with a 10 day sequence we were able to shift the mobile modular hoop house onto crops at the optimal growth stage. Based on our experiences direct seeding in the hoop house in August 2015, we plan on leaving the 2016 primary hoop house crops growing until September 1. Leafy greens and radishes direct seeded in early September 2015 were harvestable 4 to 5 weeks later. We feel this schedule will allow us to maximize our primary crop (tomato/cucumber) yields while leaving sufficient growing season for the fall crop to provide a good harvest.

Management Tips

1. Always use germination blankets for speedy even sprouting; every day saved is another growth day. For example, coco fiber blankets protect the seeds and soil from pounding rains or irrigation, and excess sun both indoors and out.
2. Tarping outdoor beds by covering them with used greenhouse plastic or silage bags will provide a stale seedbed treatment and will maintain seedbed conditions despite adverse weather.
3. Precision Seeders pay for themselves; profitability is diluted when plantings aren't precise.
4. Plan your beds and plantings to allow the mobile modular hoop house placement to be shifted over a bed as needed during unpredictable fall weather and for optimal plant development.
5. Earth anchors for winter moves of the mobile modular hoop house should be installed before the soil freezes.

Cooperators

Ryan Pesch, UMN Extension
Stearns DHIA Labs
Dave Birky, Ag Resources, Inc.
Deep Winter Producers Association
Local Harvest Market Online Cooperative

Project Location

Sundogs Prairie Farm is located at 10737 Burn Rd. NW, Brandon, MN. From Brandon, go north on Cty. Rd. 7 for 7 miles, then turn right onto Cty. Rd. 5 and go east 1 mile to Chippewa Heights Rd. Turn right onto Chippewa Heights Rd. and go south 1.5 miles to Burn Rd. Turn left (east) onto Burn Rd., which ends at Sundogs Prairie Farm.

Sundogs Farm & Market Stand is in Alexandria, MN at 2200 N. Nokomis (Cty. Rd. 42), adjacent to the Alexandria Golf Course and Voyager Elementary School.

Other Resources

The Market Gardener.
Website: www.themarketgardener.com

Deep Winter Producers Association.
Website: www.facebook.com/DeepWinterProducers

Eliot Coleman's Farm.
Website: www.fourseasonfarm.com

Dr. John Biernbaum.
Website: www.hrt.msu.edu/john-biernbaum/pg4

SARE Season Extension Topic Room.
Website: www.sare.org

MOSES Conference Recorded Workshops.
Website: mosesorganic.net

Jean-Martin Fortier workshop on Youtube.
Website: www.youtube.com/channel/UCFF20WbbyKSiYQe0J6a7HTQ/feed

Principal Investigator

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Project Duration

2014 to 2016

Award Amount

$12,573

Staff Contact

Alatheia Stenvik

Keywords

pollinator, insect habitat, underutilized land

Creating Beneficial Habitat for Weed Management & Wildlife Enhancement on Farm Waste Land

Project Summary

My project will test methods to convert land that is generally not utilized on my farm, such as wooded areas, grass and weed areas around bins, and grass land into beneficial pollinator habitat. This project includes documenting the types and numbers of beneficial insects, which I hope will increase as a result of this project. The Monarch butterfly and bumblebee will be used as sentinel insects, but I also recorded recognized bug species as well. After the habitat is established, I will also document the best methods to prevent undesirable plant species encroachment on the habitats.

Monarch caterpillar found in year 2 pollinator habitat.

Project Description

My farm is currently a cattle grazing operation with limited cropland. In the past few years, I became concerned about the alarming decline in beneficial insects, especially pollinator species. Since I have underutilized "waste" land on the farm that is not amendable to be grazed, I decided to convert this land to long-term, permanent pollinator habitat.

This project consists of three zones of pollinator habitat. The zones are as follows:

Zone 1: This is an east-west strip alongside steel grain bins. Prior to converting this land to pollinator habitat, it consisted of a stand of bromegrass and noxious weeds. This area is very hard to mow or properly maintain due to the bins, a hedgerow, and the current south boundary of fences.

Zone 2: This is another east-west strip, which adjoins Zone 1. It was primarily mowed prior to conversion into pollinator habitat. It had short grasses, so it was never hayed or grazed.

Zone 3: This is the wooded area between the current farm grove and the driveway.

In each zone, I measured out a random one square foot area for approximately every 100' by 20' area of pollinator habitat. In this one square foot area, I measured insect diversity. While measuring, I primarily concentrated on monarchs and bumblebees, but noted other insects in the sampled areas as well. I counted insects every month from May through October.

On my Facebook page (The Pollinator Project: www.facebook.com/thepollinatorproject), I actively update the community and other interested parties with project results.

2014 Results

As this year was a preparation year, I do not have any hard numbers to share for this project. I had people who generously volunteered their time to help clean up the toughest project site: the overgrown woodlot with a lot of dead trees.

This volunteer day took place on May 10, with a small follow-up day on May 11 to haul away remaining tree debris. On the first day, we cut down dead trees, chopped them up, and hauled the loads of lumber to a dump site on the farm. Buckthorn was chopped back as well and the debris hauled away. It was a long day to clear this spot. We were rewarded with the discovery of a couple of Viceroy butterflies—not the Monarch I am monitoring in the study but it was the first butterfly sighting of the year.

Prior to the first spray down in June, I took random samples of the plot to measure insect and plant diversity. Zone 1 had primarily brome and quack grasses and burdock weeds. I counted five honeybees in this zone. Zone 2 had primarily orchard and quack grasses, clover, and burdock weeds. I counted 14 honeybees and one bumblebee in this zone. Zone 3 had burdock and buckthorn weeds. The only insects were Asian beetles, in a bunch of approximately 35, and two Viceroy butterflies.

The rest of the spring and summer was spent fighting the rains in order to timely apply herbicide that would kill off the predominant grasses (brome and quack) and weeds (cocklebur and buckthorn). I did manage to get a good kill down of these grasses and weeds by fall despite the rain issue. In early September I spotted a couple of large roosts of Monarch butterflies in the trees in Zone 3, which was a nice treat.

In late fall I used a disk harrow set at a shallow depth to lightly till the soil in the plots. After consultation with the experts at MN Native Landscapes, my seed supplier, I waited to broadcast seed the pollinator mix. I was timing it for a substantial likelihood of no chance of germination of the seeds; so I had to wait until November due to the warm days in October. Unfortunately, by the time the weather cooperated we had a major 12+ inch snowfall on November 10, followed by drifting snow. Therefore, my prepared habitat was covered by a heavy snow cover.

I was able to plow the snow off approximately half of the project area. The rest was impractical due to building layout and trees. Through the action of the sun melting the snow and de-frosting the top layer of the soil, I was able to broadcast seed on November 25. The rest of the habitat will be planted in early spring; as soon as the snow melts enough to safely plant the light seeds without fear of them blowing away in the harsh winds we receive out here.

2015 Results

Zone 1 Pollinator Habitat Year 2.

The biggest challenge this year was the timing of mowing and weeding in order to eliminate noxious weeds while encouraging the growth of the pollinator mix. At the beginning of the season, there was very little insect activity. I suspect that this was due to the disturbance of soil in the previous year, which caused few seeds to sprout. If I saw any insects at all, they were mainly flies and ants.

In June, I noticed some bumblebee activity in Zones 1 and 2. In August, I found Monarch butterflies in Zones 2 and 3. As the season progressed, I began to see more insect activity and plant growth, which was a good sign.

This year, Zone 1 was a resounding disappointment. Only a few Black-eyed Susan plants struggled out of the heavy and persistent brome grass that failed to yield to any mowing or attempt to thwart. I hope that my pollinator seed mix will show itself in this zone next year.

2015 Zone 1 Insect Counts by Month						
Insect Type	**May**	**June**	**July**	**August**	**September**	**October**
Monarch butterfly				1		
Bumblebee		3				
Honeybee		6	3	4		
Fly	3	9	7	6		
Ant	5		4	12	7	
Asian beetle						7
Cricket			1		1	
Grasshopper				1		1
Spider		1				

Zone 2 was successful with an abundance of Black-eyed Susan plants making a showy appearance in late summer alongside some of the grasses. Honeybees frequented Zone 2, which was likely due to commercial hives on a neighboring farm. Abundant numbers of Sulfur butterflies and Cabbage butterflies were found in Zone 2 this year as well.

2015 Zone 2 Insect Counts by Month						
Insect Type	**May**	**June**	**July**	**August**	**September**	**October**
Monarch butterfly				3	5	
Bumblebee		2	1			
Honeybee		7	12	22	5	
Sweat bee			1			
Carpenter bee		2	4			
Sulfur butterfly				18	7	
Cabbage butterfly		2		6	4	
Fly	3					
Black carpenter ant			2		3	
Ant		17				
Asian beetle						4
Boxelder bug					3	1
Cricket		1				
Grasshopper					4	
Spider						1

In Zone 3, I had some success in growing pollinator friendly plants. In September, there were Monarch butterflies overnighting in the trees in this area. In the previous year, I found a large roost of them, which I did not find this year. I am not sure why they were not there this year. I only found one Monarch caterpillar on a milkweed plant in this zone as well. The milkweed did not grow well in this zone this year, which is why I am not comfortable with calling this zone a success. I am hoping that next summer and fall, I will have better results.

2015 Zone 3 Insect Counts by Month						
Insect Type	**May**	**June**	**July**	**August**	**September**	**October**
Monarch butterfly				2	7	
Carpenter bee			1			
Sulfur butterfly				3	1	
Fly	2			4		
Black carpenter ant		1				
Ant	3		16		1	
Asian beetle				2		4
Boxelder bug					3	7
Junebug	2					
Cricket			2		1	
Spider		2	1	5	2	

Management Tips

1. If you have a heavy stand of noxious grasses or weeds, take an entire year to prepare the area. Thoroughly till the soil, allow roots and weeds to regrow, and then till again.
2. Since my Zone 1 planting was stymied by noxious grasses and weeds, I would recommend tilling the brome roots deeper and removing them by hand. The second year after planting, these plantings will look like a horrible weed plot. Do not be discouraged! All sources say the plants should take off in the third year.
3. Make sure that everyone who works on your farm is aware of the boundaries of your plot. One of my employees, who was mowing the lawn, almost took a small swath right through my planting. Luckily, I caught it in time before any real damage was done.

Cooperator

Wendy Caldwell, National Program Coordinator, Monarch Joint Venture, St. Paul, MN

Project Location

From Ortonville MN intersection of Hwy. 12 and Hwy. 75: Travel north on 75 approximately 3 miles. Turn right (heading east) onto Cty. Hwy. 12. Travel for 3½ miles to 700th Ave. Turn left. Travel 1 mile, farm is on the left.

Other Resources

Xerces Society: www.xerces.org

Monarch Joint Venture: www.monarchjointventure.org

Pollinator Partnership: www.pollinator.org/pollination.htm

U.S. Fish and Wildlife Service's Pollinator Page: www.fws.gov/pollinators

Developing a Network for Environment and Weather Applications

Principal Investigator

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Project Duration

2015 to 2017

Award Amount

$19,465

Staff Contact

Cassie Dahl

Keywords

apple, climate, scab, codling moth

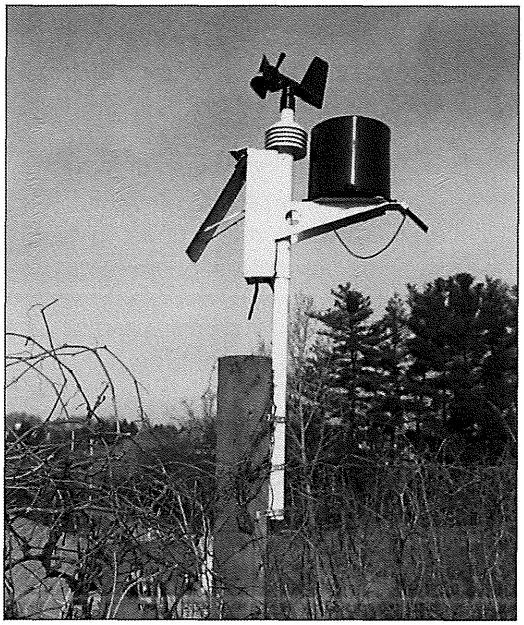
Project Summary

The Minnesota Apple Growers Association (MAGA) is currently evaluating the performance and efficacy of an electronic weather monitoring network that would standardize the data throughout Minnesota. In order to utilize the network 12 weather stations have been distributed to apple growers around the State. These stations connect to the internet via Wi-Fi and upload data to the Network for Environment and Weather Applications (NEWA) website (www.newa.cornell.edu). Growers may then view the data collected by the weather station nearest their orchard and use the data to forecast different insect and disease models.

We are also evaluating the efficacy of the forecast models to determine if they can accurately predict insect life cycles and disease maturation in the different apple growing climates within Minnesota.

Project Description

Apple growers in Minnesota are located in many different growing regions across the state. For example, growers are located in La Crescent which is in the southeastern part of the State, Grand Rapids which is in the northern part, and many locations in-between. In the past, organizations have used weather stations to collect and evaluate data, but this is problematic. The data may have been formatted differently, corrupt if the weather station malfunctioned, or not shared for proprietary reasons. In order to best serve the growers, a publicly accessible and standardized weather collection system is needed.



RainWise® weather station.

The RainWise® weather stations are all calibrated and function identically. The stations connect via the internet to the NEWA network, and can be accessed by anyone. NEWA is maintained by Cornell University, an industry leader in insect and disease forecast models. These weather based forecast models allow the growers to predict different plant and insect diseases from emergence to maturation. Proper prediction allows the grower to use chemicals more effectively by applying them at times when the insect or disease is more susceptible to control.

The evaluation of these models is important for the apple growers in Minnesota. Since the forecast models were developed in other areas of the United States, they need to be researched for accuracy with Minnesota's climate. The weather stations automatically

calculate and keep a running total of growing degree days (GDD). They are used to determine the emergence and maturation of plant and insect diseases. Growing degree days are calculated by taking the high temperature for the day adding it to the low temperature, dividing that by 2, and then subtracting the base temperature per the disease or insect. For example, codling moth egg laying occurs at 100 GDD and then first generation eggs hatch at 250 GDD, while the second generation starts at 1,060 GDD. The type of control a grower uses is based on the GDD total which lets the grower know whether to control for eggs, larva, or moths. In addition to using GDD we will use pheromone traps for codling moths and apple maggots, so we can compare the two.

Apple Scab (AS) is another pest that MAGA has been collecting and charting the ascospores for the past 20 years. The progress of the ascopores is done by placing last years infected leaves under an apple tree. Then, each week leaves are then collected and sent for scientific evaluation to chart the progress of the disease. In comparison, a grower using the NEWA weather network, can click on the weather station closest to their orchard and run the "Apple Scab" forecast model using the data collected by that station. The forecast model will then predict the current level of AS ascospores and recommend if the grower needs to act. The electronic process eliminates many variables in testing, including contamination of samples, improper handling, and delays in testing. The electronic process also allows the growers to check thresholds on a daily basis rather than weekly.

2015 Results

Scab Testing

During this first year of our study one of the issues we had with the NEWA model is that it relies on tree phenology when determining spore development and maturity instead of the dissection of a spore to do so. Crop protection is needed for AS when the disease reaches an activity level of 5% active spores or greater.

The NEWA model has the grower input the date at which McIntosh trees are at 50% Green Tip. This serves as the starting point for the predictive model. NEWA presents this data in a cumulative format. The grower would start protecting at pre-5% and proceed until 95% of the spores had been ejected. Versus the dissection method, which tells the grower the percentage of spores that are currently active on the leaf surface.

Typically the first cover spray would occur when the active spores reach around 3%, thinking that with the next rainfall disease maturity of 5% would be achieved. The grower will need to keep the crop protected until the levels drop back below 5%.

Results from leaf collection and dissection testing (highlighted = currently active)								
Location	**4/15/15**	**4/21/15**	**4/28/15**	**5/5/15**	**5/12/15**	**5/19/15**	**5/27/15**	**6/2/15**
Tree Stage	**GreenTip**	**TC**	**PrePink**	**Bloom**	**Full Bloom**	**PetalFall**	**8-12MM**	**20-25MM**
White Bear Lake	0.5	7.1	14.3	13.4	11.8	5.3	14.5	12.1
Webster	Na	1.4	2.2	0.4	25.6	16.9	32	10.7
La Cresent	0.3	2.5	11.6	14.1	26.1	19.8	1.7	0.5
Lake City	na	0	5.2	3.3	24.5	8.5	3	0.9

NEWA Scab forecast model (highlighted = cumulative percentage of mature spores released)								
Location	**4/15/15**	**4/21/15**	**4/28/15**	**5/5/15**	**5/12/15**	**5/19/15**	**5/27/15**	**6/2/15**
Tree Stage	**GreenTip**	**TC**	**PrePink**	**Bloom**	**Full Bloom**	**PetalFall**	**8-12MM**	**20-25MM**
White Bear Lake	2%	6%	16%	41%	78%	95%	99%	NA
Webster	NA	7%	18%	59%	88%	97%	100%	NA
La Cresent	2%	6%	19%	54%	87%	97%	100%	NA
Lake City	2%	5%	13%	50%	85%	97%	100%	NA

There are some fundamental differences in the analysis of these types of scab testing, both of which have positive and negative attributes. Leaf collection and dissection samples show "real-time" activity of spores, they do not show the potential risk for future infection periods. The spores mature during wetting periods, if it doesn't rain the spores do not mature. Looking at the table using the leaf collection method in Webster, it shows the spores jumped dramatically from 0.4% to 25.6%. This could have had severely damaging consequences if the grower had not anticipated a wetting period and the risk of severe infection. The NEWA model did not accurately predict the end of the scab season. As of 5/19/15 the NEWA model was predicting that 95+% of the scab spores had been released. However, the leaf collection samples proved that the active percentage of scab spores was still greater than 5%. Overall, analysis for more than one season is needed to provide a better basis of comparison.

Codling Moth Lifecycle Evaluation

A codling moth (CM) life cycle model has been developed, and used by growers in different areas across the country for many years. This model utilizes grower insect trap counts to determine a "biofix" date, as a basis to begin a GDD lifecycle tracking program. When a grower traps 5 CM the tracking begins. Using this model the grower can predict the hatch of the CM eggs. The eggs begin to hatch at approximately 220 GDD post biofix. Implementing this model into IPM practices, has allowed many growers to target CM during the peaks of their lifecycle changes. A grower can now target codling moth eggs, larva, or adults at the most opportune times, therefore only spraying the necessary insecticide.

The NEWA website asks the grower to input the date of their first CM catch and then begins running a GDD based model to track the CM lifecycle. While it does not predict how many moths you will catch in your trap, it does track GDD extremely well. It also provides accurate information about what lifecycle stage the insects are in and different pest management strategies.

Currently we are checking our insect traps once a week and recording the trap count numbers. If a grower has a trap with 3 CM on Monday morning, they may not re-visit the trap until next week and this could affect the biofix date. If there is a mid-week heat wave, more moths will emerge and there could be 5 CM by Thursday afternoon, but the biofix date will be the following Monday. In addition, there are many different factors that can influence grower trap counts, such as improper trap placement, pheromone mating disruption, or application of different pesticides. If these trap counts are interpreted improperly the efficacy of pest control will diminish. The NEWA website collects weather data many times throughout the day and applies it to the forecast model, therefore setting the biofix date more accurately. For CM, utilizing accurate weather data and then applying the forecast model may provide a better understanding of what is happening in the orchard.

Management Tip

Be patient when changing data collection methods and realize it will take more than one year to fully integrate the new system.

Cooperators

Weather Station Locations
Pine Tree Orchards, White Bear Lake, MN
Whistling Well Farm, Hastings, MN
Pepin Heights Orchard, Lake City, MN
Ocheda Orchard, Worthington, MN
Apple Jack Orchard, Delano, MN
Plum Crazy Orchards, Buffalo, MN
U of MN HR Station-Grand Rapids, Grand Rapids, MN
Fruit Acres, La Crescent, MN
Pleasant Valley Orchards, Shafer, MN
Country Blossom Farm, Alexandria, MN
McDougall's Apple Junction, Hastings, MN
Nelson's Apple Farm, Webster, MN
Juliet E. Carroll, PhD, NEWA, Geneva, NY
Linda Treeful, PhD, Plant Pathologist, White Bear Lake, MN
Christopher Phillips, PhD, Entomologist, St. Paul, MN

Project Location

Please contact John Jacobson for directions to the many orchards.

Principal Investigator

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Project Duration

2015 to 2017

Award Amount

$25,000

Staff Contact

Meg Moynihan

Keywords

bee, hive, honeybee,
propolis

Minnesota Propolis Production: A Potential Enterprise and Sustainable Honeybee Disease Management Tool

Project Summary

Propolis, the sticky plant resins that honeybees collect, has long been recognized for its human health benefits. This project is investigating whether propolis can serve as a sustainable disease management tool that improves honeybee colony health while reducing outside, purchased inputs. It also explores whether adding a propolis enterprise could generate meaningful revenue for beekeeping operations in Minnesota.

Project Description

I have been a commercial beekeeper in Minnesota since 2000. I run Eagle Creek Honey Farm, which is based in rural Shakopee, and sell honey and bee-pollinated fruits and vegetables. It has been getting more and more difficult and expensive for commercial beekeepers, who earn money from providing pollination services and/or honey sales, to keep bees healthy. Many of these increased costs are associated with the purchase and application of miticides and antibiotics. Diseases seem more prevalent today, and while these management practices are now routine, they still cost beekeepers time and money.

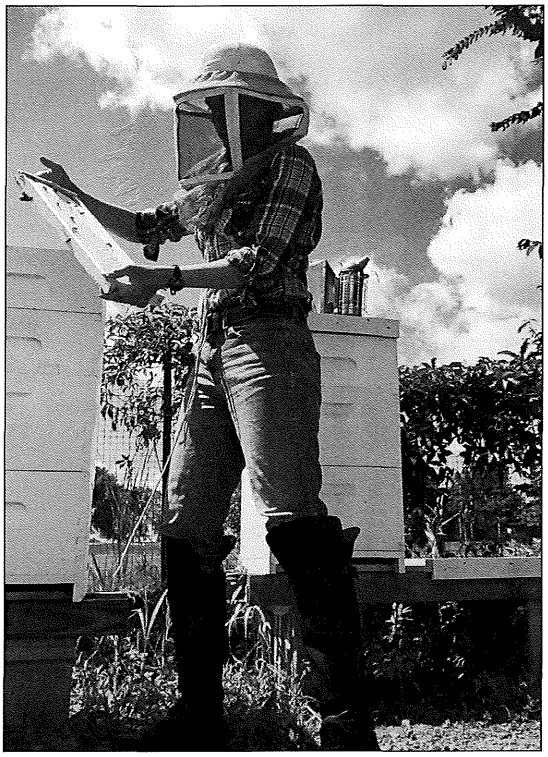
I first became interested in propolis's potential to help sustainably manage honeybee diseases after hearing a talk from Renata Borba, a PhD. candidate in Entomology at the University of Minnesota (U of M). Renata presented preliminary results of a study showing that colonies in propolis-encased hive boxes had lower instances of American foul brood and chalkbrood diseases when compared with colonies in typical un-propolized hive boxes.

Propolis are sticky plant resins that honeybees collect from evergreen and/or poplar trees. They use it to seal up cracks and crevices in their hives. Scientific literature is rich with information about antifungal, antibacterial, and antiviral properties of poplar tree-sourced propolis. It is used in the food, pharmaceutical and cosmetics industries, and is now a nearly $1 billion industry worldwide. While people have long recognized that propolis has human health benefits, only very recently have researchers suspected that it may also have similar benefits for honeybee colony health.

In many other countries, collecting propolis with in-hive traps is a standard enterprise, but it is not common in Minnesota or elsewhere in the U.S. After hearing Renata's talk, I wondered if adding a propolis enterprise to a beekeeping operation would make for healthier colonies, compared to typically-managed colonies. Honey production is a business for me, and I am motivated to keep bees healthy and reduce my per hive expenses while not jeopardizing my per hive revenue. I hypothesized that encouraging propolis production could prove to be good for the bees, good for those who depend on healthy bees to provide pollination services, good for humans who would like to obtain and use local propolis, and good for the beekeeper's bottom line.

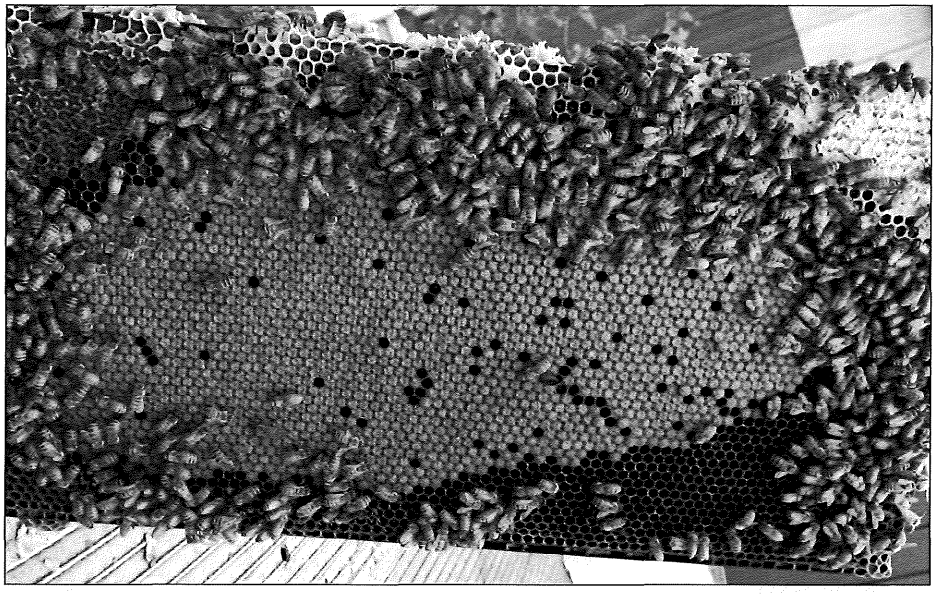
I used 130 of my honeybee colonies for this study, some with propolis traps and some without. I put propolis traps on the tops of colonies, which is where they are typically placed, I also mounted custom-cut traps inside, as Renata had done.

I used two races of honeybees: Italian and Caucasian. Renata had warned me that the Italian bees typically used by Minnesota honey producers might not gather enough propolis to show meaningful results. The Caucasian bee, which was re-introduced into the United States in 2013, has the highest propensity to gather propolis. While Caucasian bees are noted for their disease resistance and cold-tolerance, their honey production capacity in Minnesota is currently unknown. I decided to include Caucasian bees in my study along with the Italians.



Beekeepers like Victoria check their hives on a regular basis.

Propolis traps mounted inside the hive.



Beekeepers typically assess colony health by colony size (frames of bees), and visually observe disease symptoms (chalkbrood mummies, dysentery, unhealthy looking larvae) and bees with viral disease symptoms such as deformed wing virus, hairlessness, and spasms.

In September, I sampled 100 colonies for disease and sent the samples to be analyzed by the U.S. Department of Agriculture (USDA) Agriculture Research Center's Bee Research Laboratory in Beltsville, MD. I also collected each full propolis trap and weighed the harvest to get a per colony yield. This data will give other beekeepers a sense of the production potential per colony. Furthermore, it will tell us whether Caucasian bees do collect more than Italian bees.

Propolis consumers generally use it for health reasons. Understanding that levels of pesticides in the propolis are relevant to this market, I sent two samples of my 2015 propolis harvest to the USDA National Scientific Laboratory in North Carolina for pesticide residue analysis.

2015 Results

I first observed honeybees returning to the hive with propolis in April. In July, I began noticing that the bees were depositing large amounts of fresh propolis being between colony frames. However, this observation did not translate into propolis deposition on the traps. Instead of filling the top with propolis, they filled top trap with beeswax! While I had known this was a possibility, I wanted to see how early I could put traps on a colony and potentially get multiple propolis harvests. What really surprised me was that none of the 86 colonies with interior traps had propolis (or beeswax) deposits either!

Bees transpost the sticky propolis residues on their legs, much the way they carry pollen.

I contacted Renata, who suggested that spacing might be the problem. She told me the propolis traps must be flush with a solid surface (like the hive wall) because if there is a gap of air between the trap and a solid surface, the bees' propolis deposition response may not be triggered. I run my colonies with an inner cover, which have a lip that left a ¼ inch gap between the propolis trap and the solid surface of the cover. So I removed all the inner covers and just ran colonies with either a migratory cover, which is a flat type of cover that commercial beekeepers commonly use or a telescoping cover; both allowed me to mount the propolis traps flush with the top (no gaps). After making this change, the bees started depositing propolis in the top traps.

I first used Velcro® strips to attach the interior traps to the hive wall, but then realized that while this method would have allowed for easy harvest, it also created that dreaded gap that prevented bees from depositing propolis. So I swapped out all the Velcro® strips for tacks. This change increased my management time, as the colonies were quite large by that time, but in the end I had no gap. Unfortunately, after getting all the traps flush, my colonies still only deposited propolis in their top traps! This was a very different result from Renata's original experiment; she had also placed custom-cut propolis traps inside the hives and got her bees to deposit there.

I had originally intended to separate the propolis trap colonies into two additional treatments—fall-harvested and spring-harvested traps—to see if propolis improved the propensity of the hives to overwinter. However, because none of the colonies deposited propolis in the interior of the colony, I combined the results of all the colonies of each race of bees into one treatment. I removed all of the top traps, since leaving them on over the winter would have created a moisture barrier, which could lead to colony death and moldy propolis in the trap.

Table 1. 2015 Propolis Yield from Hives With and Without Propolis Traps

	Italian Bees		Caucasian Bees	
	No Trap	Trap	No Trap	Trap
N =	22	43	22	43
Avg Propolis Yield (oz)	0	4.1	0	4.2
Mean Propolis Yield (oz)	0	3.5	0	4.0
Min Propolis Yield (oz)	0	0	0	0
Max Propolis Yield (oz)	0	5.0	0	12.6

The average yield of propolis per hive was lower than I expected. In 2014, I ran a test on five colonies and got an average of 6.0 oz of propolis per trap. The traps I used this year were a different brand, and seemed to hold less propolis than my older traps, a difference that I suspect affected the yield. Colonies that produced propolis on the top trap generally only gave me one trap full of propolis, put there were several colonies that gave me two full traps. I had one Caucasian colony that filled three traps.

Table 2. 2015 Colony Health Snapshot

	Italian		Caucasian	
	No Trap	Trap	No Trap	Trap
N (# hives)	22	43	22	43
Brood frames (avg mid-August)	9.5	10	11	11
Mite count (avg mid-August)	20	13.5	14	14.5
Chalkbrood	0	0	1	0
Dysentery	3	3	2	1
Deformed wing virus	5	4	3	3
Hairlessness	1	0	0	2
Unhealthy larvae	6	4	4	4

Note: Numbers indicate the number of colonies displaying symptom, unless it is noted as an average.

Colony health data from my observations and the samples I sent to the USDA Bee Research Lab in Beltsville are reported in Table 2. There did not appear to be any significant differences in colony health results between the hives with traps and those without, perhaps probably because none of the colonies deposited propolis in the interior traps (Table 2). In addition, some of the Italian colonies without propolis traps had older queens and, I think this fact may have contributed to the fact that we saw the slightly higher mite and disease counts in the Italian no-trap treatment. Next year, I will provide every colony in this study with a first year queen so I can eliminate that age variable. On another note, it seemed to me that by mid-August, the Caucasian colonies were stronger than Italian colonies.

When I prepared my 2015 report about the project, results from the USDA lab tests for pesticide residue were not back yet (they take 5 to 6 months to report). At Eagle Creek Honey Farm, we were still working on packaging solutions for propolis, so do not have sales data to report. We will expect to launch the propolis product in Summer 2016.

Management Tips

1. Make sure that propolis traps are flush against a solid surface. Positioning them this way will trigger the bees' propolis deposition response.
2. To prevent bees from depositing beeswax on your traps, place propolis traps only after major honey flow has stopped.
3. If you are using wax paper to prevent propolis from sticking to the wooden hive components, watch out for increased moisture levels in the hive. If you start noticing mold, remove the wax paper.

Cooperator

Renata Borba, U of M Department of Entomology, St. Paul, MN

Other Resources

Marla Spivak. 2013. Honeybee Health, the benefits of propolis. Beecraft. March. 95:3. http://naturalingredient.org/wp/wp-content/uploads/benefits-of-propolis.pdf

Reducing Chemical Use and Inputs in a Cold Climate Grape Harvest by Creating New Uses Other than Wine

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Project Duration

2013 to 2015

Award Amount

$10,950

Staff Contact

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Keywords

grape products, verjus (verjuice), vineyard, wine

Project Summary

We want to maintain overall vineyard health and yield while spraying less and making fewer passes through the vineyard. We do not want to see significant production loss but need to compare the difference of the value of grapes produced and the costs of more sprays and bird control.

By managing the vineyard for verjus (green grape juice) production, fewer trips across the vineyard is possible due to less need for insecticides. Bird protection is not necessary due to picking the grapes in an under-ripe state, which is before the birds are interested in grapes. This verjus can be used as an acid to produce food products that are available in stores and to chefs. One of the main goals of this project is to develop these products and recipes.

Project Description

Our family is trying to decide how best to pass the family farm into the next generation. It has been in the family since 1931 and three generations have lived here. The farm had been used for diverse crop and livestock operations. In the last 15 years, it has moved more toward a corn and soybean rotation. We planted a small vineyard on land that was underutilized; it was rarely used for grass hay. The remainder of the farm is rented out for row crop production. The farm is located along Buffalo Ridge in SW Minnesota, just south of Holland, and is the highest elevation vineyard in the state. Prior to this project our grapes had been sold to a winery. We want to make more dollars per pound for our grapes but do not wish to run a retail farm winery ourselves. We also have a greater interest in culinary applications than wine production.

Grapes need a certain amount of spraying to maintain vine health and lower disease pressure. We have generally found we have lower disease pressure than much of the state (possibly due to the wind on Buffalo Ridge) but we still need to spray insecticide more than we would like. By harvesting the green grapes earlier, we eliminate more spraying across the vineyard. We also reduce chemical cost and environmental exposure to these chemicals. Also, due to an earlier harvest, bird netting is barely needed.

There are many vineyards in Minnesota and more are being planted all the time. There are also many existing and new wineries opening to utilize these grapes. However, as with any "new" industry, there are wild fluctuations in the supply and demand of the production. By developing verjus and products made from verjus, we give greater value to our grape.

For the second year of the project the number of grape rows exposed to the lower spray method was expanded. The winter of 2013-14 was difficult for Locust Lane Vineyards with yields down nearly 85% in some varieties. The lower yields occurred both in low spray and regularly managed rows. This led to results similar to those found in year one. Year two also brought more of our products to market including the addition of two varieties of jelly, which expanded the number of stores that carry our verjus spiced almonds, and selling verjus through a distributor in Chicago.

We compared the number of inputs as input costs (for example, three sprayings utilized as opposed to five lowers the input cost by 40%). We compared "traditional" best practices for cold climate grapes versus a reduced spray regimen in adjacent rows. With some positive evidence from year one, in year two we expanded that to include groups of two rows and one block of four rows. The reduced yields due to weather from the previous winter created a very limited sample size. Therefore, we tested on different areas of our vineyards.

This project helps us diversify the production of the farm and is our first venture into the "direct to consumer/food service" wholesale business. In terms of juice produced from ripe vs. under-ripe grapes there was very little difference (which surprised us). We anticipated a lower yield of juice in the under-ripe grapes. In reality, by picking the grapes with the desired sugar levels, a similar amount of juice was found as would be found in wine grape production. The same result has occurred over three years now, which we now believe is the norm.

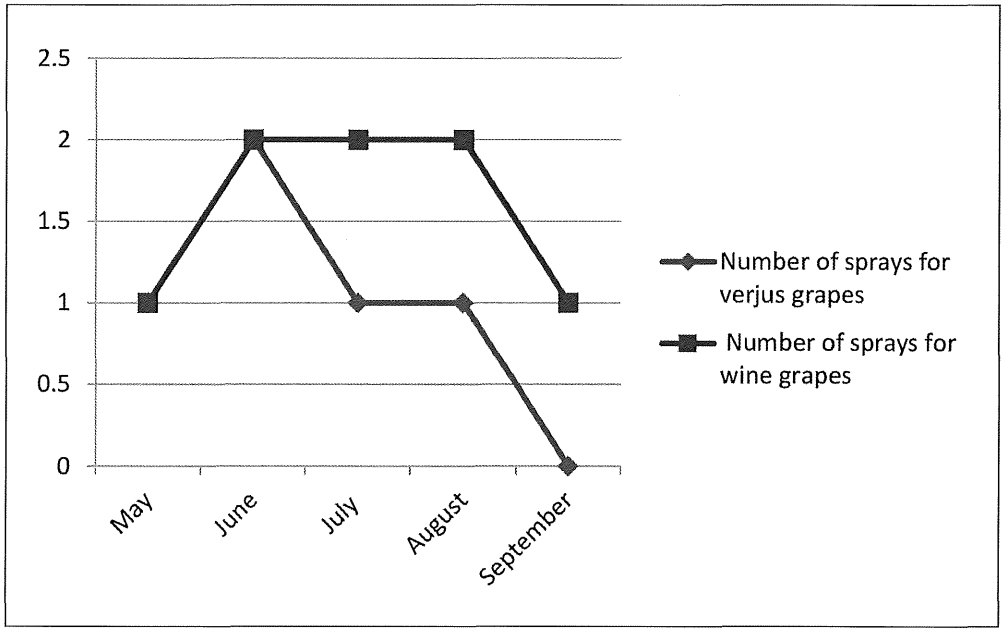
2013 Results

Input costs were considerably reduced (40% in 2013). In a year with management for wine grapes, we usually spray five times for diseases and one time for insects and then net the grapes for bird protection. With managing for verjus, we eliminated two disease sprays, one or two insecticide sprays (none were necessary in 2013), and did not need bird netting as the birds are not interested in the grapes when harvested this early. This left us with no need to replace and/or repair netting or maintain other forms of bird control (usually $50.00/A in our system). The time and money savings gave us more time for the culinary applications of the project. Fewer trips spraying the grapes uses less gas and less sprays into the environment.

2013 had an extremely late spring in southwestern Minnesota. We had snows into May and freezing temperatures well into June. From the growing grapes perspective this delayed bud break and therefore had no ill effect on the grape crop. Since it had remained cold the plants had not broken dormancy and therefore there was no late frost that impeded the grape crop.

The late spring did cause a problem by pushing back the harvest considerably – as much as three weeks. While not a problem in terms of the plants, it did make for a reduced labor force available at harvest time in terms of community volunteers and school groups to help pick.

Number of pesticide sprays used on verjus vs. wine grapes



Vine health and production will be more fully seen in subsequent years thereby allowing an evaluation of overall vine health. The reduced spray format did lower yield by as much as 8% but that profit loss was easily made back on lower input costs and labor savings.

The food products have had a positive impact on our income from the grapes produced. We made 70% more than marketing the grapes to a winery. This is based on $1,300/ton grape price and yield of juice worth $6.50/gal. This is partially skewed however due to the added costs of making the food products. Kitchen rental, licensing, and packaging costs must be figured in which lowered the 70% but still we netted a 27% increase when considering these costs.

The grape products have been met with a positive response when being sold to consumers at food shows and demonstration tables at specialty markets. When we sample out the items to customers, sales increase as opposed to simply having the items on shelves in stores. We were short on the number of markets we were able to get the products into in 2013, 43 markets rather than the 50 we'd hoped for. With more time in the colder winter months, we plan to gain back some ground there. Repeat sales have been strongest at the twin cities co-ops with three of the five having made multiple orders of the standalone verjus product. All restaurants using our verjus have reordered at least twice but have started buying in bulk so no greater income has been seen there.

2014 Results

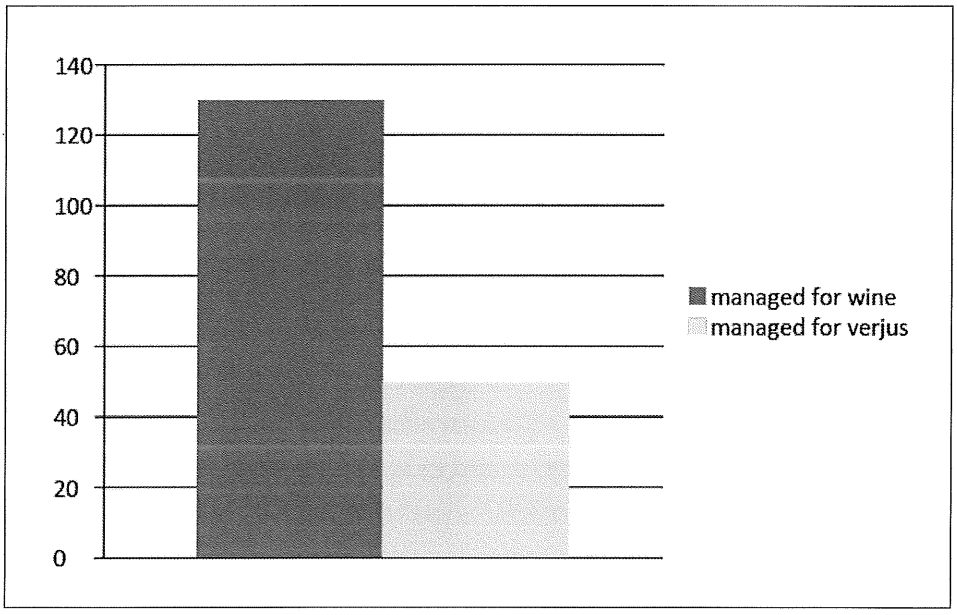
A particularly long cold spell in the winter reduced yields this year in many varieties by as much as 90%. The grape plants survived but with severely reduced yield.

With the data from the last two years, we were able to reduce spraying by 40%. Depending on the weather, the reduction could be slightly less. Regular production typically requires about five sprayings, while verjus production requires three. Spraying less creates less environmental exposure to both insecticides and herbicides. For instance, a very wet spring would require additional fungus sprays, regardless of verjus or matured wine grape production. With fewer trips across the field, we are in the vineyard less. This gives us more time for other pursuits. The vineyard is slightly less picturesque but we are making more money. We need to let the grass grow between the rows earlier in the fall. This will help hold more snow and with winter hardiness. It will also reduce trips across the field for mowing in the fall.

This project is to show that reduced spraying can create similar income by generating higher value grapes. We have seen a great increase in 2014 with the development of new products in the Locust Lane Vineyards food product line. Reducing the number of trips across the vineyard and spraying less simply reduces costs. Increasing market awareness and chef awareness has helped increase income in comparison to the income we would have received from simply selling grapes to a winery.

For market research, we mostly spoke with chefs to discover what the level of interest in verjus was. We simply asked and pursued.

Comparing costs of managing grapes for wine vs. verjus



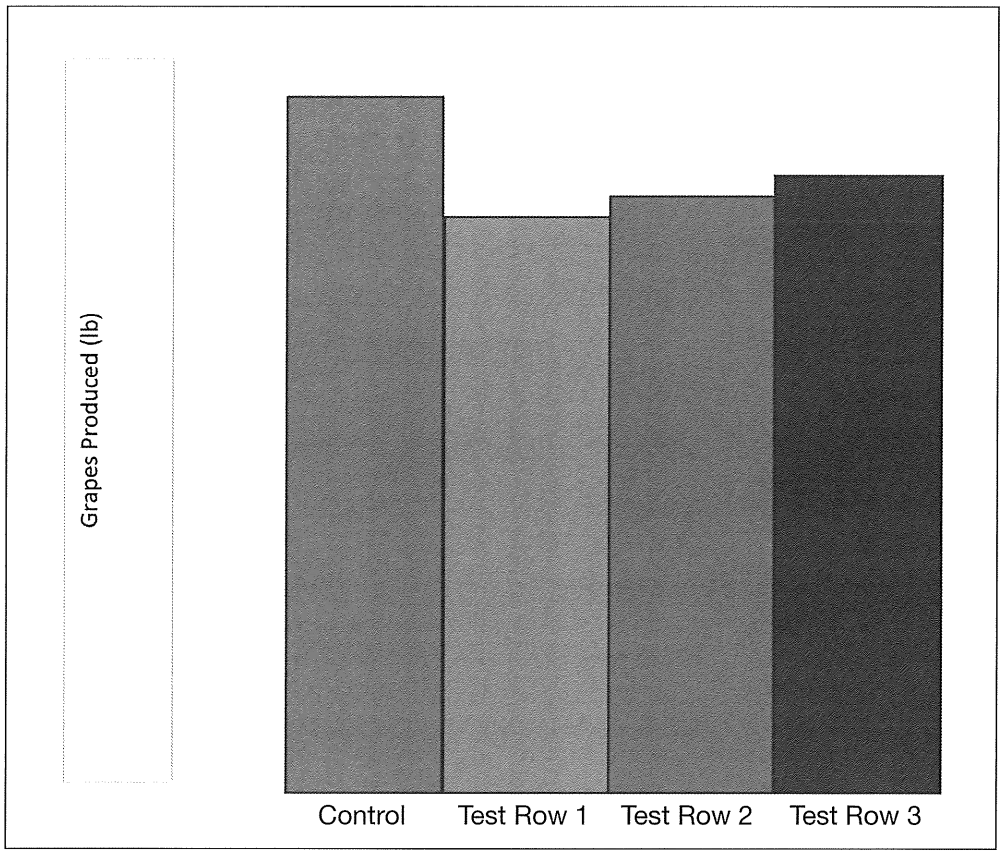
2015 Results

In terms of volume of grapes produced, 2015 was as close to a "normal" year as I could imagine. We were able to prune vines into April without much sap running, which seems to be a workable scenario for us. Budbreak occurred in mid to late May with no late spring frosts, which could have limited our potential yields. Rain was consistent and adequate from May through early August. Veraison occurred in the second week of August. The verjus crop was harvested over two weeks in order to produce juice with differing brix levels, which can be blended to specific acidity and tartness for verjus products. The first frost was very late but did not affect us since we had already harvested our crop.

Input costs were lower again this year due to the reduced spray schedule on test rows. Since we expanded the number of rows and grape varieties tested, overall costs reduced as well. This year, spray input in the test rows was 60% lower than in control rows. The test rows yielded approximately 85% of the traditionally sprayed rows, which was similar to the previous two years. We have seen no noticeable damage to the test rows but plan to maintain an approach of spraying as necessary. By managing for verjus, we can eliminate two disease sprays, one or two insecticide sprays (none were necessary in 2015), and bird netting as the birds are not interested in the grapes when harvested this early. We did not need to replace, repair, or maintain any forms of bird control (usually $50.00/A in our system). By making fewer trips spraying the grapes, we use less gas and decrease the environmental impact. There seems to be no greater loss or benefit with the reduced spraying in terms of winter damage to the vines.

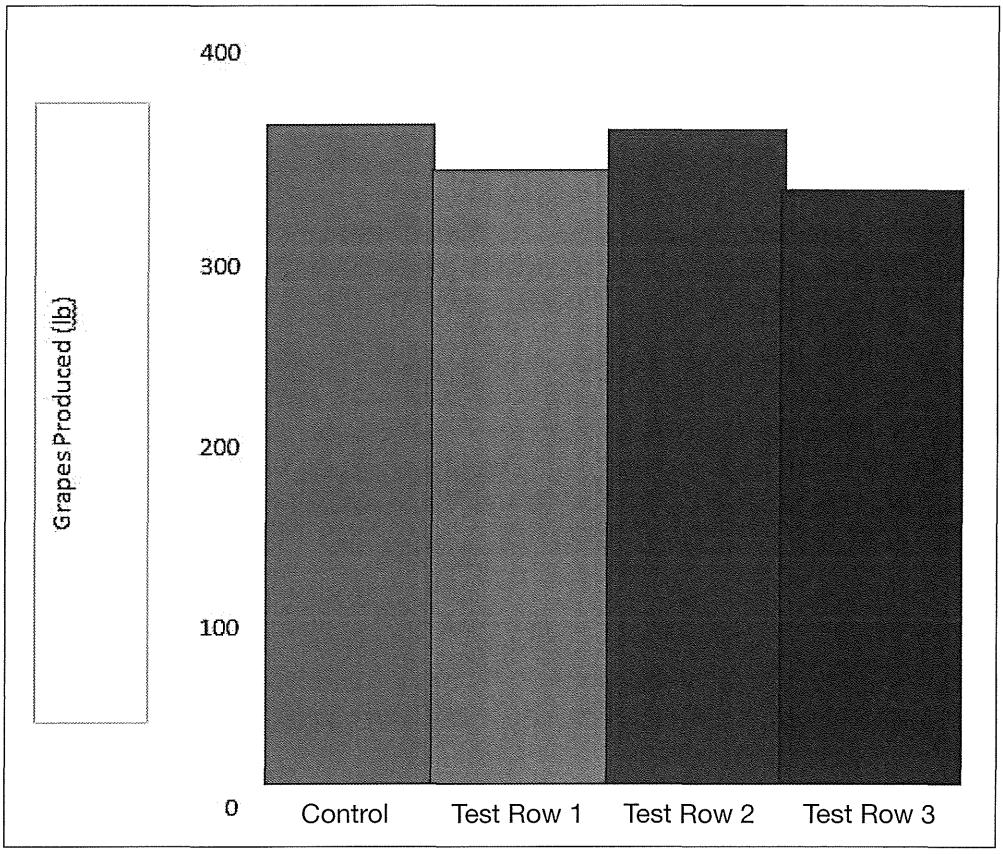
This year we also compared different varieties and blocks of rows versus control rows. We did this to look at varietal sensitivity to the lower spray model. The varieties Marquette, Frontenac, and Frontenac gris were tested. Rows that were in year three of the trial, the Marquette varietal only, yielded 84% of those in a more traditional spray format. This must be compared to an actual dollars used in terms of fuel and spray costs compared to actual yield to compare in terms of income per acre.

2015 Individual Rows of Marquette Grapes (Test Year 3)



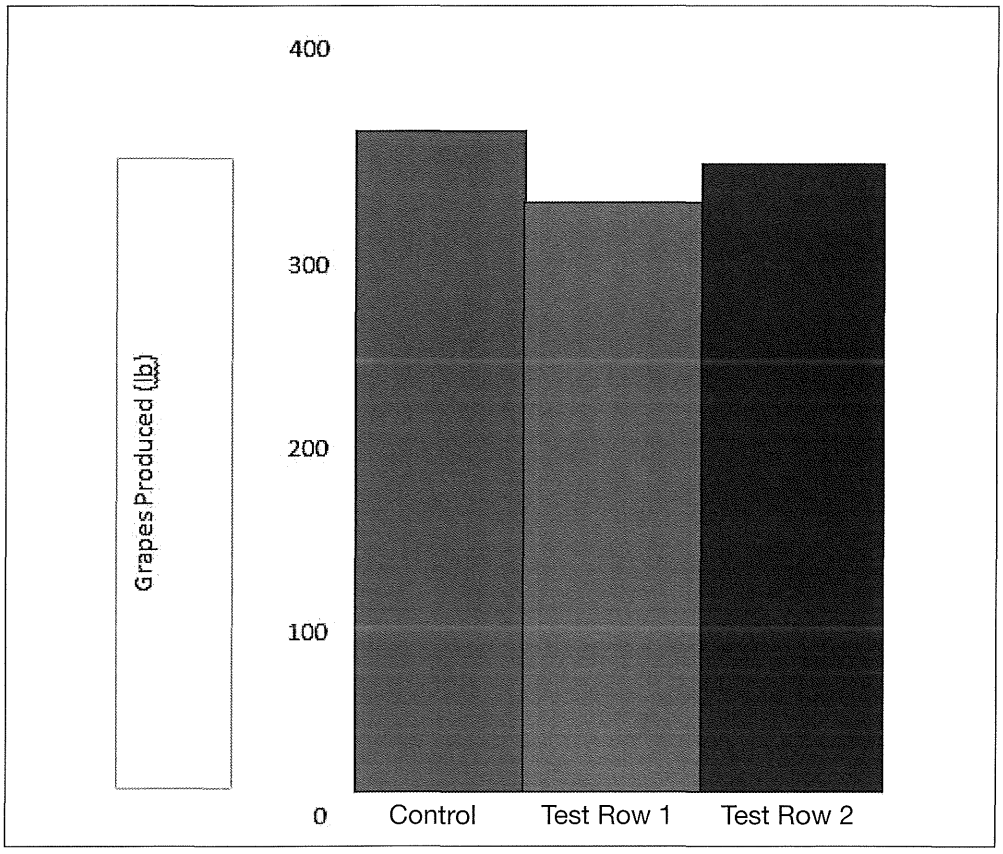
2015 Individual Rows of Frontenac Gris (Test Year 1)

For the variety Frontenac gris, the percentages from this season were similar to the year three data above. This was the first year for the Frontenac gris in the trial. The Frontenac gris control rows produced 363 and 356 pounds while the low spray rows produced 338 and 327 pounds.



2015 Marquette Blocks (Test Year 2)

This graph shows Marquette grapes in blocks of two rows.



The food products made from the grapes have had a positive impact on our income. The food products increase our income 70% more than marketing the crop to a winery. This is based on $1,300/ton price and yield of juice worth $6.50/gal. However, this is partially skewed due to the added costs of making the food products. When commercial kitchen rental, licensing, and packaging costs are figured in, it is less than a 70% increase. With this, we still netted a 29% increase when considering these costs, which is up from 27% as previously reported. The verjus products have received positive responses from consumers at food shows and demonstration tables at specialty markets, but not as much when we aren't sampling the items. When we sample the items to customers, sales increase as opposed to simply having the items on shelves in stores. In 2015 we had 61 markets and a distributor in Chicago, which has helped with restaurant sales and retail markets outside Minnesota. Repeat sales have been strongest with the distributor, which excites us.

Before this system is adopted by other Minnesota farmers, I would recommend they first try the reduced spray methods in different parts of the state and see if it works. Our vineyard is located in the Buffalo Ridge, which helps to lower disease pressure due to the unique weather patterns of the area. We plan to continue expanding this method throughout our vineyards and with the producers we work with. Due to this project, we are forming a network of growers who are interested in using this method. We are interested to see if the reduced spray method works for their needs and markets as well. It is a little harder sell to the neighbors since the vineyard is not as tidy as it would be with increased chemical usage; but the decreased chemical usage helps to protect the water table and our product, which they seem to understand.

Management Tips

1. Grape pickers are a premium. Figure out how many you can get and for how long prior to harvest beginning. Mechanical harvesters are available but are limited for verjus production due to fruit damage, which is worse for grapes in food production as opposed to wine production.
2. Finding a cooler or access to cooler storage that can handle bins full of grapes would be helpful.
3. Grapes are actually easier to handle for pressing after being frozen.

Cooperators

Nick Smith, Department of Horticultural Science, University of Minnesota, Excelsior, MN
Jennifer Anderson, Minnesota Small Business Development Center, Marshall, MN
Paul Bertolli, Fra' Mani, San Francisco, CA

Project Location

From the Twin Cities: Take MN Hwy. 23 South to Holland, turn left (south) on 140th go 2.5 miles turn right (west), go 1 mile to 130th Ave., turn left. 1371 is the farmstead, the vineyards are just south of the farmstead on the west side of the road. Smaller vineyard is at farmstead on east side of road .5 mile further south. The commercial kitchen space we rent for production of our food products is located at: GIA, 955 Mackubin, St. Paul, MN, 55117.

Other Resources

Cooking with Verjuice. 2003. Maggie Beer. Penguin Books. ISBN: 10-14-300091-8 (pbk)

Maggie's Verjuice Cookbook. 2012. Maggie Beer. Penguin Books. ISBN-13:9781921382628

The Cooking of Southwest France. 2005. Paula Wolfert. John Wiley and Sons. ISBN: 10-7645-7602X

Navarro Vineyards' Verjus Cookbook. 2003. Ted Bennett. Deborah Cahn.

Preserving and Attracting Native Bees while Providing a Habitat that Adds Value to Small Acreage

Principal Investigator

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Project Duration

2014 to 2016

Award Amount

$13,257

Staff Contact

Alatheia Stenvik

Keywords

pollinators, native bees, insect habitat

Project Summary

There are over 400 types of native bees found in Minnesota ranging in size from the bumblebee to the very small green sweat bee. The native bees are more effective pollinators than honeybees. For example, only three native bees are needed to pollinate an apple tree versus a whole hive of honeybees. Native bees also tend to visit plants earlier than honeybees. Habitats for native bees consist of mud, clay, and wood, which are cheaper and require little maintenance in comparison to habitats built for honeybees. For honeybees, it costs about $300 for boxes, which does not include the honey extractor and the bee work clothing needed. Also, the native bees are not as aggressive with stinging, which is an added bonus.

Dr. Bishop next to a bee habitat.

This project will figure out which areas are suitable habitats for native pollinators and also provide an income stream for farmers. Often native bees are confused with honeybees, which are imported from Europe and produce honey. If this project is successful, it will be a win-win for farmers and the broader community. Currently, farmers are encouraged to attract native bees. Despite this encouragement, little is known about providing a habitat in agricultural areas.

Project Description

We live in the Red River Valley on a certified organic farm just north of Moorhead. We grow row crops, hay, and cover crops including a small acreage of apple trees, certified organic hay and wheat, oats, rye, barley, and food grade soybeans. We also have small livestock including Icelandic sheep, chickens, and ducks. Carsten Thomas, our son, grows pumpkins for assisted living and hospice facilities in the area.

The project will address questions such as once native bees are released and populous, what keeps them in the area? What habitat works best: wood, clay, or mud? Which set up works best for the bee homes? What plant vegetation keeps the highest numbers

of bees throughout growing season? What produces revenue from plant habitat and what is yield/A? What is the most effective habitat for changing weather systems such as rain or drought?

Design: The area of the field used for the test study is a 25' x 5' strip. The area is sunny and includes areas for native bees to nest undisturbed once planting has started. We had Chokecherry trees along one side of the border and Juneberry trees along the other side of the border. There were 25' of herbs, annual flowers, pumpkins, and wildflower mixtures. Weed control was a must; this was done by side weeding mostly. It was also done by hand with a mower on cool days with cloud cover, since the bees were disturbed less this way. The native bee homes were made of clay, wood, and mud. We want to see which cone was visited the most and which bees, once released, stayed in the area. Water saucers were also provided in the event of drought conditions. Signs stating "bees at work" and "no spray zone" were also posted in sight of the area. Mid-summer bees were released for first and second plantings.

The main question we are trying to answer with this project is what amount of income can be generated by planting herbs, annual flowers, pumpkins, and wildflower mixtures? Although these plants are beneficial to native bee habitat, the financial benefit of the habitat to the farmer needs to be determined as well.

2014 Results

The spring was cold, wet, and long. I think the mason bees and leafcutters were released too early with the prolonged spring arrival. I think waiting and keeping them in a cold refrigerator until later in the spring would be better. The bees in a refrigerator will hatch later once we let them out into room temperature. They will also have more food available in nature in the event of another long spring.

For bee activity, we did see bumblebees. They were most abundant on bachelor buttons. The wildflowers had a higher amount of bumblebees than the other areas. The bees are very fast and trying to take a photo with a camera is a problem. The neighboring honeybees seemed to move to the zinnias. The real test will be overwintering and seeing what the native bee activity will be in the spring and summer of 2015.

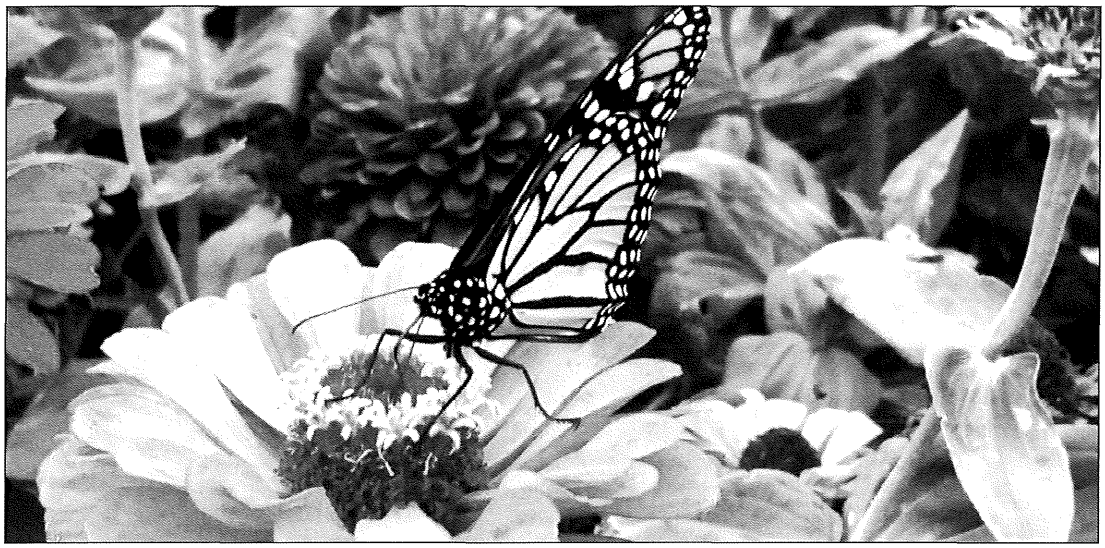
Income Received from Habitats	
Zinnias and mixed flowers	$1,200.00 (for Girl Scouts plus one wedding)
Teas	$0.00 (none in the first year)
Wildflowers	$0.00 (none in the first year)
Lavender	$0.00 (did not grow)
Pumpkins	$400.00 (towards assisted living)
Total Income	**$1,600.00**

2015 Results

The weather was good except for a late spring freeze, which caused some early flowers to freeze out. Due to the freeze out, some flowers did not provide nectar for the bees. The lavender did not come up well this year and most of the pumpkins we started froze as well. We should have planted later or purchased hardier plants.

We saw more bumblebees than all prior years. The bumblebees visited twice as many flowers as honeybees, which is due to the fact that bumblebees can work in 50°F temperatures. The highest native bee activity was found on the wildflowers, while the zinnias had the most bumblebee activity. Chamomile, which blooms nonstop, attracted a constant amount of small beneficial bees. Peppermint was the least attractive to native bees, which is likely due to the fact that it does not flower continuously.

Previously, we constructed several wooden bee habitats to overwinter the bees. This is the last year we will provide habitat for them to overwinter as research indicates that the solitary bees that nest together may have more disease issues due to their close proximity to each other. In 2015, some bees took up nesting and leafcutters were present in the spring and all through summer. We also saw leafcutters in the overwintering stage, which we had not seen before. The soybeans planted in a nearby field had more circular cutouts due to leafcutter activity.



Monarch butterfly in the research plot area.

The chamomile came back from the 2014 planting. It grows slowly, but the flavor is rich and full compared to imported chamomile. The herbal teas range from calming chamomile and mint mixture to herbs such as peppermint. Flowers had a positive outcome as well. The zinnias were popular among brides looking for a rustic look. The wildflower bouquets, which we were careful not to over pick, were sold for $12 to $15 with little hesitation.

Income Received from Habitat	
Zinnias	$108
Wildflowers	$96
Herbal peppermint and chamomile	$42
Dried chamomile, lemon balm, mint	$42
Total Income	**$288**

Note: These numbers represent the average income received from a 6' x 5' area of habitat.

The benefits of having a pollinator habitat that consists of herbs is that the herbs can be dried and sold all year round. The dried herbs allow us to sell in the spring at farmers' markets and to have product to place in a Community Supported Agriculture box before the current crops are ready. We made herbal teas from the herbs. We found that if the teas were packed in smaller amounts, such as 2 oz sample amounts at farmers' markets, the income was higher. The 2 oz packages sold for $2.50 each, which equals $40/lb of dried herbs compared to $12/lb when sold in larger packaging.

The flowers generate more income but timing is very important. When the flowers are ready to sell, the window of time to sell them is very small. With each of these varieties, plantings will be perennial if you are careful during the next year. You can save seed from the zinnias as well.

We think this grant is important to encourage the use of native bees as pollinators. For farms, honeybees can be another layer of work at the peak of the season when workloads are already heavy. Our farm has berries and we introduced fruit trees, which makes this grant important for our pollinating efforts going forward. Due to this grant, we have adapted some of these practices outside of the test area including planting wildflowers and pumpkins around our fruit tree bases.

Management Tips

1. Make sure to mark the research area since it is best to allow the habitat to exist without disturbance. I would recommend having friendly talks with your neighbors to help avoid spray drift as well.
2. Combining herbs for teas was successful for us. For example, we sold more peppermint when we combined it with chamomile. We also found ways to use peppermint by adding a sprig to coffee before brewing.
3. Pay attention to the type of chamomile you are buying. The choice between annual and perennial chamomile can be expensive.

Cooperators

Dr. Bryan Bishop, Ph.D. Entomologist, Concordia College, Moorhead, MN
Carsten Thomas, Worker Bee, Moorhead, MN
Concordia College Environmental Study Students, On-Farm Assistance, Moorhead, MN

Project Location

Hwy. 75 and 108 intersection. A quarter mile straight west on Hwy. 108 in Kragnes township. Flowers also planted at Kragnes 15 section in Clay Cty., MN.

Other Resources

University of Minnesota Bee Lab:
www.beelab.umn.edu

Minnesota Department of Agriculture:
www.mda.state.mn.us

Raising Soil pH Effectively in Acid Soils

Principal Investigator

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Lake County

Project Duration

2015 to 2017

Award Amount

$14,483

Staff Contact

Meg Moynihan

Keywords

amendments, biochar, fertility, lime, pH, soil, soil health, wood ash

Project Summary

Soil health, productivity, climate change, and the need to sequester carbon are challenges to building food and farming systems that will be sustainable long into the future. We farm in northeast Minnesota, a region where acid soils are common and present agricultural production challenges. Our goal is to simultaneously raise soil pH and increase soil health on our farm using organic methods. We're specifically interested in comparing the labor, cost, and effectiveness of applying mined lime, wood ash, biochar, and combination applications.

Project Description

The Wolf Ridge Environmental Learning Center started an organic farm in 2009. Our goal is to provide all of the vegetables needed to serve 136,000 meals a year at our school cafeteria. We have built a processing facility for cleaning, cooling, and preparing the vegetables for the cafeteria, and we have kitchen gardens and an outdoor timber frame educational space for classes, workshops, and meals. This soil pH project we are undertaking is an essential part of our efforts for a productive, ongoing, price-stabilized local food source for the school children, teachers, and parents who attend Wolf Ridge each year.

Our soils here are very acidic—the typical pH is less than 5.0. Our need to find a cost effective and sustainable way to raise the soil pH and improve soil health motivated us to do this project. We are currently farming a small parcel of cleared land, and most of our production is in large commercial high tunnel greenhouses. This season, we tripled our high tunnel greenhouse growing area 2,880 ft^2 to 8,640 ft^2. We also cleared 3.25 acres of land, where we will grow potatoes, carrots, onions, beans, broccoli, and squash, and is where we'll be conducting our soil amendment demonstration. We are surrounding this area with deer fence, which is essential for field production of vegetables in our area.

Besides testing pH and soil chemistry, we are measuring nutrient retention, organic matter, and biological health to help us assess overall soil health. We are going to use five different amendment treatments (plus a "no treatment" control) on 50 x 50' plots (Figure 1).

Figure 1. Amendment treatments. Each plot measures 50' x 50'

1. Lime only	2. Wood ash only	3. Biochar only	4. Biochar + lime	5. Biochar ash	6. Control (no treatment applied)

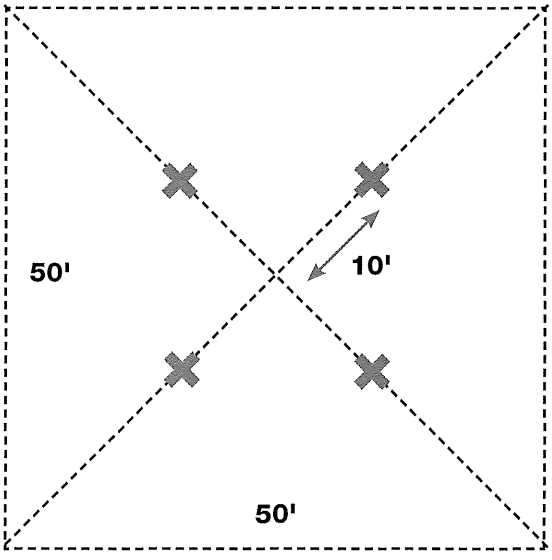
In this first year of our project, we established the field and conducted baseline soil testing. We cleared trees and brush, using a chain saw to cut the trees and a backhoe to dig out the stumps. We buried the logs and stumps below the future plow line. We removed large rocks and dug the entire area 3' deep, sifting the soil with the hoe. Then we marked out the six test plots and pulled soil samples for physical, chemical and biological analyses.

We used a backhoe to clear 3.25 acres of land.

Caitlin Jean Coughlan uses a soil probe to take samples for testing.

Our soil sampling method is illustrated by Figure 2. We took all soil samples on October 15, 2015. First we ran strings from corner to corner of each plot and marked the center. Then we measured 10' out from the center along each string and took a soil sample, combining all four of them into one single sample for each plot. The full baseline soil chemical analysis is reported in Table 1.

Figure 2. Soil sampling scheme.

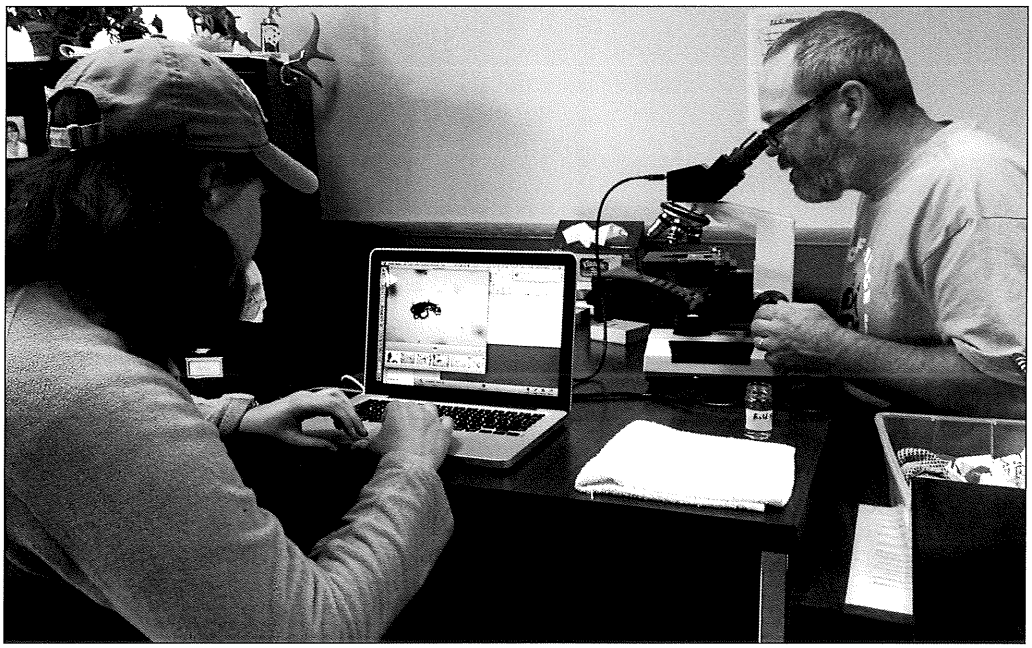


2015 Results

Soil tests confirmed that our entire demonstration field is uniformly acidic, with soil pH between 4.3 and 4.7 (Table 1). We hope this uniformity will help us see any clear and dramatic differences between some of the treatments we plan to test. We expect these fields, which have never been farmed, will provide a great template to help us and other farmers who are trying to find soil amendments that will help them simultaneously meet pH goals and enhance soil health.

Table 1. 2015 Baseline Soil Test Results						
	Plot-1	Plot-2	Plot-3	Plot-4	Plot-5	Plot-6
% Organic Matter	10.5	10.3	11.1	10.8	11.1	12.9
CEC	8.50	7.1	7.7	6.9	6.5	6.1
pH	4.3	4.7	4.5	4.6	4.7	4.7
P1 (ppm)	13	25	8	8	10	6
P2 (ppm)	16	26	12	12	12	13
K (ppm)	2.6	3.4	3.3	2.8	2.3	2.8
Mg (ppm)	6.4	9.2	7.3	9.4	9.7	10
Ca (ppm)	23.9	35.5	29.7	32	36.6	35.3
Na (ppm)	0.8	1.7	1.6	1.5	1	1.5
S (ppm)	26	34	28	23	20	25
Zn (ppm)	7	6.8	10.1	7.8	6.7	4.3
Mn (ppm)	8	7	14	15	9	2
Fe (ppm)	220	201	251	195	221	360
Cu (ppm)	1.1	0.4	1.8	1.1	0.8	0.3
B (ppm)	0.6	0.5	0.8	0.7	0.5	0.4

Now that we have established our demonstration area and have baseline measurements of the physical, chemical, and biological basis of the soil, we can move forward with the soil amendment treatments and subsequent testing in 2016 and beyond.



Meredith J. Loring and Davaid Abazs use a microscope to look for soil arthropods and other organisms.

Even though we are still in the early stages of this demonstration project, project leader David Abazs has already started talking about it during field trips to the Center and has included it in a "Food and Farming" talk he gives to university students, community groups, and others.

Management Tips

1. Set up soil testing protocols to systematically sample locations toward the middle of your test plots. This way, soil amendments that "bleed" from an adjacent plot are less likely to confound the results. This approach will give you the best chance of being able to explain your results.
2. Choose a soil testing lab that offers thorough testing and offers to help you understand the results.
3. University, Extension, Natural Resources Conservation Service, and Soil and Water Conservation District Staff can help you select soil testing equipment and protocols that will maximize your chances of success.

Cooperators

Will Bomier, USDA Natural Resources Conservation Service, Duluth, MN
Pat Farrell, Dept. of Geography, Urban and Environment Sustainability Studies, U of M, Duluth, MN
Midwest Laboratories, Omaha, NE
Midwestern BioAg, Blue Mounds, WI

Project Location

From Duluth MN, follow Highway 61 north for 66 mi. When you see a large sign marking the turn to Wolf Ridge, take a left on Cty. Rd. 6. Travel 4 miles to Wolf Ridge Rd. Go .7 miles further; the farm will be on your right.

Other Resources

Meyer, John. 2013. Kwik-Key to Soil-Dwelling Invertebrates. Raleigh: Vision Press. www.cals.ncsu.edu/course/ent525/soil/ident.html

Lowenfels, Jeff and Wayne Lewis. 2010. Teaming with Microbes: The Organic Gardener's Guide to the Soil Food Web by Jeff Lowenfels & Wayne Lewis. Portland: Timber Press.

Smillie, Joe and Grace Gershuny. 1999. The Soul of Soil. 4th Ed. White River Junction, VT: Chelsea Green Publishing, Inc.

Soil Health Research in Southwest Minnesota

Principal Investigator

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Jackson County

Project Duration

2015 to 2017

Award Amount

$16,814

Staff Contact

Alatheia Stenvik

Keywords

cover crops, soil health, soil nitrate

Project Summary

This project was designed to provide southwestern Minnesota farmers with soil health and fertility data to show how cover crops can bring value to their farm operations. This research focuses on four farms that have established 50 acre cover crop plots specifically for cover crop research. Soil samples collected and analyzed from the plots over three growing seasons will provide sufficient data points to statistically analyze the economic and environmental impacts of cover crop management. The Haney Soil Health Test (Haney Test) and the Nitrate Soil Test are being utilized to collect and measure baseline data as well as the changes in soil health and fertility that can be attributed to cover crop impacts. At the end of the project, the project partners will host a field day to present the research.

Project Description

Fall strip till application on the Christoffer property.

The project is located on four farm sites; two in Jackson County and two in Nobles County. The cooperators on this project consist of four farmers, the Heron Lake Watershed District, and Extended Ag Services, Inc., all of whom are working under an Environmental Protection Agency (EPA) 319 Grant. Through the EPA 319 project, each farmer established 50 acres of cover crops. Tillage transects, infiltration measurements, and soil samples are being taken to gauge cover crop success. The benefits of cover crops, which include reduced soil erosion and compaction, increased water infiltration to prevent runoff, nitrogen translocation back to the root zone, increased organic matter, and improved wildlife habitat are well documented. We are unaware, however, of any first-hand data about cover crop effects on soil fertility and soil health for southwest Minnesota. The need for first-hand data about cover crop effects is the main reason we applied for this grant.

In 2015, Andy Nesseth, with Extended Ag Services, Inc., collected soil samples from each of the four cover crop sites. Three control samples were taken in order to develop baseline data. Soil samples were taken from the following sites on each farm:

- a non-agricultural site with perennial grass cover. This site should provide us with optimal soil health characteristics, which provides an indication of where we want our soil health characteristics to be;
- an agricultural site with no cover cropping history. This will provide soil characteristic data similar to our starting point; and
- four agricultural sites with 4-5 years of cover crop history.

Samples from these sites will provide information on the long-term results of cover crop management. All soil samples were tested by the Haney Test and the Nitrate Soil Test. The Haney Test was developed to not only test for basic soil nutrient parameters, but also to determine the level of microbial activity in the soil. The different soil parameters tested in the Haney Test are analyzed mathematically to give a Soil Health Condition. The Soil Nitrate Test is an accepted Best Management Practice utilized to make accurate nitrogen fertilizer recommendations.

Our collaborators consist of the following farmers:

1. Principal investigators, Jerry and Nancy Ackermann, have been farming for 38 years and are active in pursuing on-farm research and test plot opportunities. Their crop rotation includes corn, soybeans, and alfalfa on 1,050 acres. For the past 11 years, the Ackermann's have incorporated 350 acres of no-till soybeans and 350 acres of strip-till corn in their rotation. They utilize the alfalfa as a cash crop and nutrient management tool in their alfalfa-corn rotation.

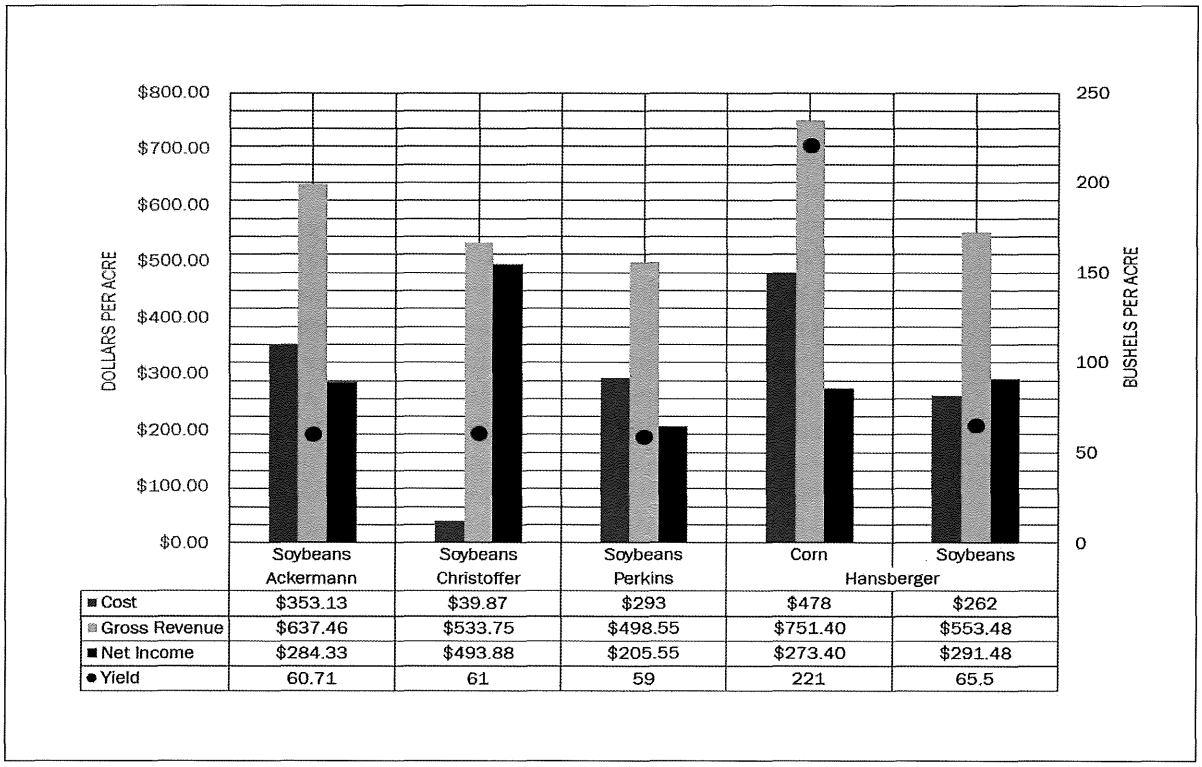
2. Dave Christoffer has been farming for 43 years. He farms 220 acres that he converted to strip-till production in 1992. He also rents 300 acres to two different individuals and works with them to incorporate conservation tillage and cover crops in their production systems.

3. Jerry and Terry Perkins have been farming for 40 years. Their farm consists of 627 acres of land. They rent 415 acres to a young farmer who utilizes no-till practices in his soybeans and strip-till practices in his corn crop.

4. Tim Hansberger has been farming for 10 years. His educational background includes a degree in Agronomy Production from the University of Minnesota. He farms 645 acres of no-till soybeans and strip-till corn.

2015 Results

Table 1. 2015 Cover Crop Yield Data



	Soybeans Ackermann	Soybeans Christoffer	Soybeans Perkins	Corn Hansberger	Soybeans
Cost	$353.13	$39.87	$293	$478	$262
Gross Revenue	$637.46	$533.75	$498.55	$751.40	$553.48
Net Income	$284.33	$493.88	$205.55	$273.40	$291.48
Yield	60.71	61	59	221	65.5

Notes: We received 6" of rain in the 10 day period following harvest. There was no ponding of water on the fields where cover crops had been utilized, even on areas heavily impacted by trucks and grain carts. Neighboring fields showed ponded water on areas that had been tilled to relieve compaction.

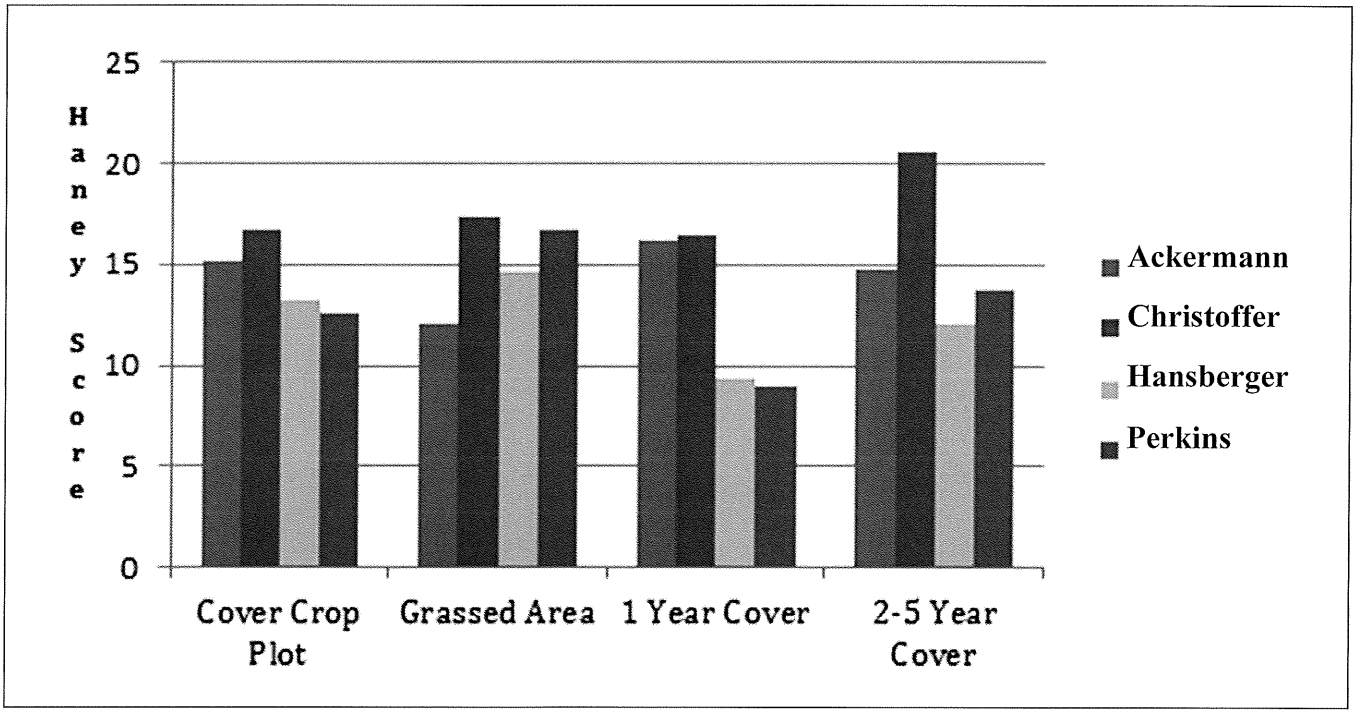
Soil Test Protocol

A minimum of six soil zones were sampled from the cover crop sites on all four farms. Three different control sites were sampled as well including a grass covered site, a site with less than one year of cover crop history, and a site with 2 to 5 years of cover crop history.

Haney Test Results

The Haney Test results are reported using a Soil Health Calculation Score. A score greater than seven indicates adequate soil health. Soil Health Calculations from the cover crop plots on the four farms ranged from 6.7 to 18.9 with an average score of 14.2. Scores from the grass covered control samples ranged from 9.0 to 16.7 with an average score of 15.2. Scores from the fields with less than 1 year of crop history ranged from 9.0 to 16.4 with an average of 12.7. Scores from fields with 2 to 5 years of cover crop history ranged from 12 to 20.6 with an average score of 15.3. All Haney Test data is summarized in the following table.

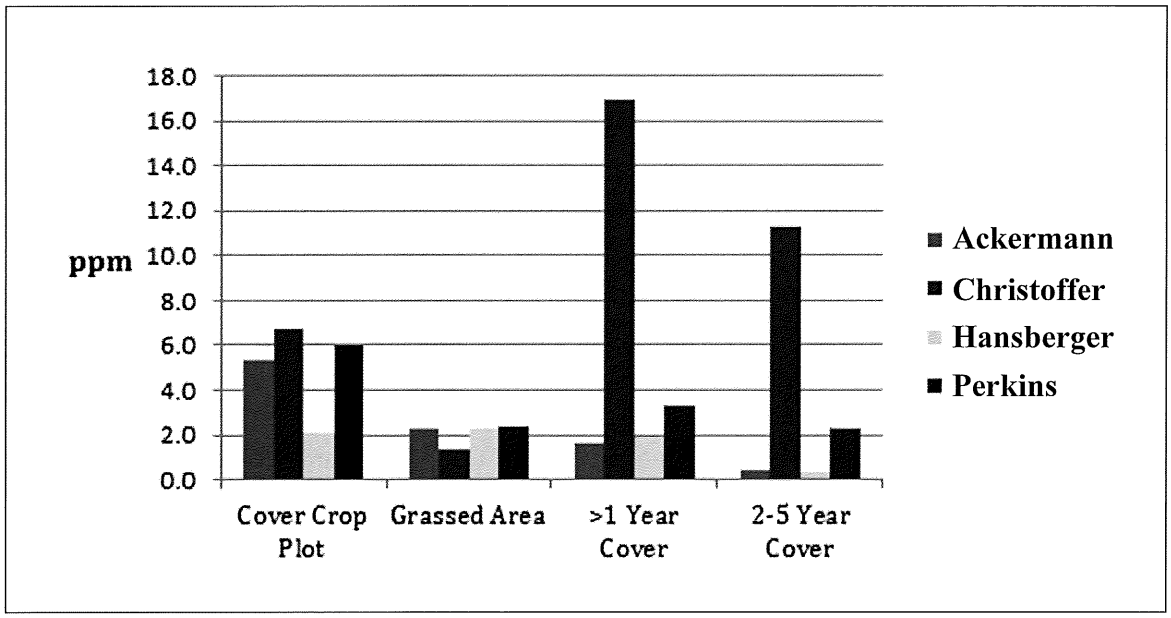
Table 2. Haney Test Results



Soil Nitrate Results

Samples for soil nitrate testing were collected from surface to 6" depths. Nitrate test results are reported as parts per million (ppm). Reported values were extremely variable across zones on all four farms, which is typical for nitrate sampling. Nitrate concentrations from the cover crop plots ranged across the farms from 1.4 ppm to 12.4 ppm with an average of 5.0 ppm. Nitrate concentrations from the grass covered control sites ranged from 1.4 ppm to 2.4 ppm with an average of 2.1 ppm. Nitrate concentrations from the sites with less than 1 year cover crop history ranged from 1.6 ppm to 16.9 ppm with an average of 5.9 ppm. Nitrate concentrations from the sites with 2 to 5 years of cover crop history ranged from 0.4 ppm to 11.3 ppm with an average of 3.6 ppm. Nitrate test data is summarized in table 3.

Table 3. Soil Nitrate Results



Management Tips

1. Plant multi-species blends to help ensure establishment and provide benefits to the soil biota.
2. Cover crops seem to establish best when planted in early maturing varieties of soybeans. The early leaf drop in these varieties helps in establishment.
3. Cover crop seeding should be done when the soybean leaves are yellowing or during the last week of August.

Cooperators

Dave Christoffer, Okabena, MN
Jerry and Terry Perkins, Worthington, MN
Tim Hansberger, Worthington, MN
Andy Nesseth, Extended Ag Services, Inc., Lakefield, MN
Jan Voit and Catherine Wegehaupt, Heron Lake Watershed District, Heron Lake, MN

Project Location

Jerry and Nancy Ackermann: From Lakefield, travel 5¼ miles west on Jackson Cty. Hwy. 14 (820th St.). Go ¼ mile north. Cover crop site is on the left.

Dave Christoffer: From Brewster, travel 2 miles south on Hwy. 264. Go east on Jackson Cty. Rd. 14 (820th St.) for 3 miles. Turn north on 340th Ave. The cover crop site is on the right, extending for a mile.

Jerry and Terry Perkins: From Worthington, go 8 miles north on US Hwy. 59. Then travel 1¾ miles west on 170th St. Cover crop site is on the left.

Tim Hansberger: From Worthington, at the intersection of Oxford St. and Hwy. 59, go 4 miles north on Hwy. 59. Go west for ½ mile. The cover crops are seeded on both sides of the tree line in the south half of the field.

Other Resources

No-Till Farmer. Website: www.no-tillfarmer.com

Farm Journal. The High Yield Conservation section. Website: www.agweb.com/farmjournal

Sustainable Agriculture Network. Managing Cover Crops Profitably: Third Edition. Beltsville, MD. 301-504-5236. Website: www.sare.org/publications/covercrops/covercrops.pdf

Nitrogen Capture using Cover Crops in a Cash Grain Rotation

Principal Investigator

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Elk River, MN 55330
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Sherburne County

Project Duration

2014 to 2016

Award Amount

$19,570

Staff Contact

Mark Zumwinkle

Keywords

cover crops,
inter-seeding, nitrogen

Bill seeding cover crop plot using a hand broadcaster.

Project Summary

The purpose of this project is to show the effectiveness of cover crops to scavenge left over nitrogen fertilizer and reduce nitrate leaching on irrigated sandy soils in Sherburne County. Several cover crop mixes are being tested for their ability to take up residual nitrogen after removal of field corn, potatoes, and green beans. Results from this project will be transferrable to other irrigated cropland in Minnesota.

Project Description

Planting cover crops to control wind erosion is a well-established conservation practice for irrigated cropland in Sherburne County. However, the potential for nitrogen to leach into the ground water is greatest when there is no growing crop on the field such as after fall harvest and before next spring's planting. The short growing season, which runs from after harvest to before freeze-up, has limited farmers' cover crop choices to cereal rye or oats. The short growing season also limits the effectiveness of these two species to capture nitrogen and other nutrients in the soil.

This project will attempt to match a cover crop mix to the cash crop being grown. For example, many farmers do include a short season crop in their rotation such as early harvest red potatoes or green beans. During these years, a diverse cover crop mix including grasses, legumes, and brassicas could be planted. These diverse mixes can also address other farmer objectives such as reducing field compaction, increasing soil organic matter, and improving soil health.

In the years when full season crops such as corn or soybeans are grown, this project will try to determine which cover crops can be successfully inter-seeded into the growing crop. These mixes will need to be both shade and herbicide tolerant.

Cover crop seeding mixes and methods will follow the Natural Resources Conservation Service's (NRCS) Cover Crop Standard 340, which will be described in the results section. We are also using the Midwest Cover Crop Council's selector tool for designing our cover crop mixes.

2014 Results

This year's demonstration project began in an irrigated corn field to be harvested for grain. Field corn was no-till planted on May 15 into a spring rye cover crop that hadn't over-wintered. Due to a wet spring, planting occurred about 10 days later than normal. The plant population was 34,000 plants/A on 30" rows. A total of 187 lb of nitrogen fertilizer was added as ammonium sulfate starter and anhydrous ammonia.

Nitrogen Scavenging Mix.

Lysimeters, or soil water samplers, were installed on June 1 at four different locations: the field, the planned cover crop plot, a windbreak along the field edge, and in a restored prairie. All lysimeters were at a depth of 48". Our logic was that any nitrogen found at that depth would be beyond the plant roots and lost to the ground water. Soil water samples were taken weekly and tested for nitrate-nitrogen. The two lysimeters in the non-crop areas would give a fertilizer free background nitrate readings.

The cover crop was seeded on June 19 when the corn was at the 8-leaf stage. Seeding was done using a hand broadcast seeder. This simulated broadcast seeding with a high-boy or by air. The plot size was 20' by 75' with one of the lysimeters in the middle of the plot. According to NRCS guidelines, when seeding at the 6-10 leaf stage in corn, there should still be enough sunlight for the seed to germinate and begin growing before the canopy closes. Our cover crop mix consisted of oats, Berseem clover, and Tillage® radish. By this time, most of the spring rye residue had decomposed, so the seed was falling on bare soil.

With the 30" row spacing and plant population, the canopy closed quickly. Little of the seed germinated even though the field was irrigated shortly after planting. Meanwhile, the soil water samples from the lysimeters seemed to be unreliable. For example, we were able to withdraw water samples from the field edge for 5 weeks and then nothing—even after re-installing the lysimeter twice. The two lysimeters in the field, that were meant to determine the effectiveness of the cover crop in scavenging nitrogen not being used by the corn crop, also did not work. Since the cover crop did not grow well, there was little useful data being collected.

When it became apparent that the over-seeding of this cover crop mix into corn was not going to be successful in 2014, we decided to change our tactics. In addition to corn and soybeans, Triple J Farms also raises green beans and potatoes; both of which are harvested early. The green beans were harvested at the end of July and the potatoes were harvested the first week of September. Both fields were planted to cover crop, including spring rye following green beans and an oats and radish mix following potatoes, and were sampled for soil nitrate-nitrogen after harvest. The fields were sampled again on October 20, which was after the cover crops were well established.

On August 16, red potatoes were harvested in a neighbor's field and then planted to one acre strips of five different cover crop mixes. Soil nitrate samples were taken in the field after harvest and then 40 days later (October 1) both in the field and for each of the cover crop mixes. The table shows how a diverse cover crop mix will scavenge left over nitrogen fertilizer that will be released as the cover crop decays.

Nitrogen Capture using Cover Crops in a Cash Grain Rotation					
Location of Plot	**Crop**	**Description**	**Varieties Included**	**Date**	**Soil Nitrate-Nitrogen**
Olson Brothers Farm	Early Harvest Potatoes	Field after harvest	-	8/20/14	220 lb/A
		Cover Crop Basic Mix (Planted 8/16/14)	Oats, Radish, Winter Pea	9/30/14	80 lb/A
		Compaction Mix (Planted 8/16/14)	Oats, Radish, Turnip	9/30/14	105 lb/A
		Legume Mix (Planted 8/16/14)	Oats, Winter Pea, Berseem Clover, Crimson Clover	9/30/14	90 lb/A
		Nutrient Scavenging Mix (Planted 8/16/14)	Oats, Radish, Canola, Spring Barley	9/30/14	64 lb/A
		Pollinator Mix (Planted 8/16/14)	Oats, Buckwheat, Mustard, Phacelia	9/30/14	104 lb/A
		Rye (Planted 8/16/14)	Rye	9/30/14	191 lb/A
Triple J Farms	Early Harvest Potatoes	Field after harvest	-	9/15/14	108 lb/A
		Oat Radish Cover Crop (Planted 9/15/14)	Oats, Radish		128 lb/A
	Green Beans	Field after harvest	-	7/30/14	117 lb/A
		Rye (Planted 9/1/14)	Rye		118 lb/A

We hosted a field day for local growers on October 16. About 20 farmers and agency members attended.

The results of the soil nitrate sampling show the nitrogen scavenging benefits of cover crops when they have time to grow. The difficulty with full season crops such as corn or soybeans is that there is little or no time after harvest to establish the cover crop. In 2015, we plan to overseed cover crops again into corn. We will also increase the diversity of the cover crop mix to try and find more shade tolerant plants.

2015 Results

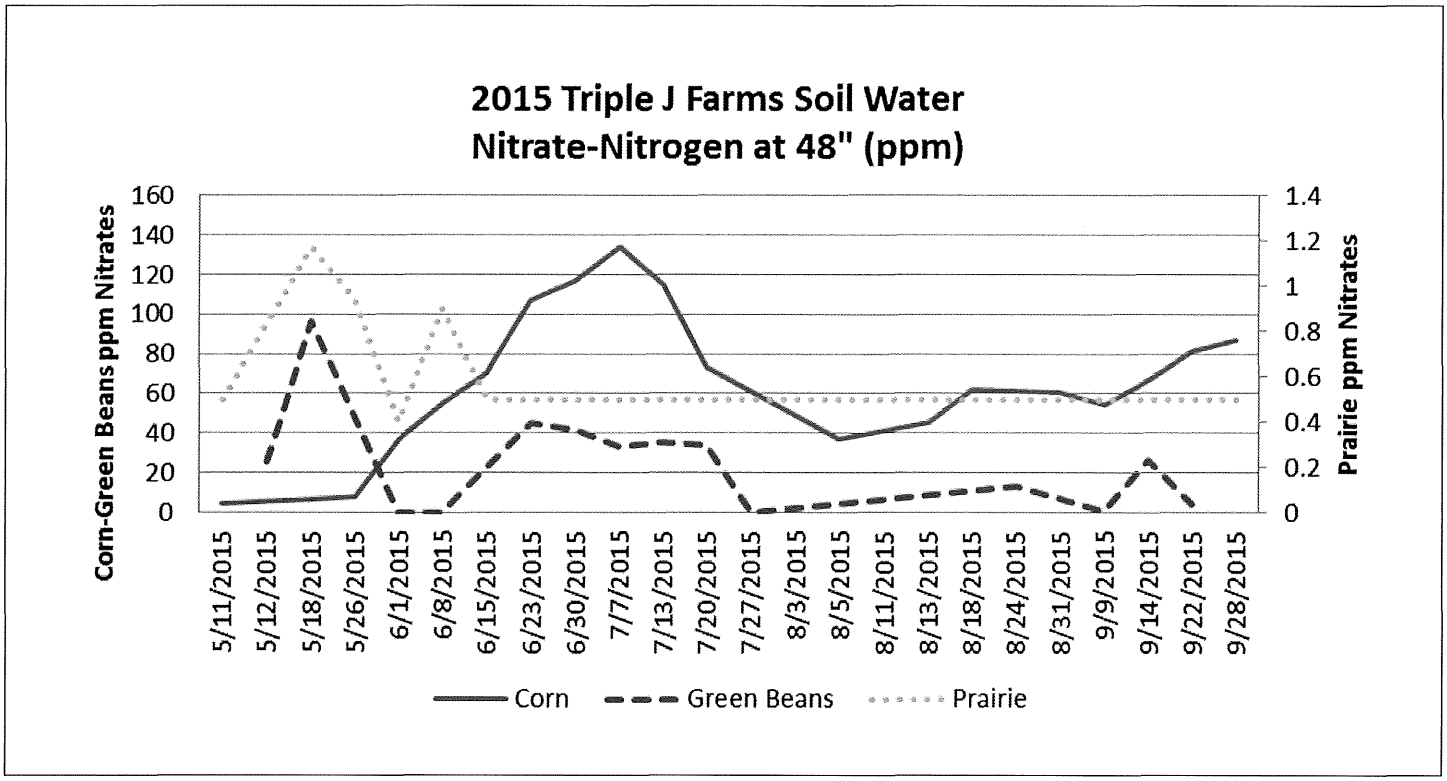
On June 16th, we inter-seeded a cover crop into corn that was planted on May 1st. The corn was at the 5-6 leaf stage. In 2014 we attempted to broadcast the cover crop over the corn without success so this year we used a hand seeder. This method ensured good seed to soil contact. The cover crop varieties we planted were: Roundup® ready soybeans, spring barley, Tillage® radish, berseem clover, and lentils. All the varieties sprouted and were growing before the corn canopy closed. In November when the corn was harvested, only the Tillage® radish was still growing.

Radishes growing in the understory of corn before corn harvest.

The radish on the left was planted on June 16 and grew in the understory of corn. The radish on the right was planted in mid-August after green bean harvest.

The radishes had suffered from a lack of sunshine as can be seen when compared to radishes planted after the green beans were harvested in August.

The results of the soil water sampling are shown in the graph below.



Parts per million nitrates from the corn and green bean field are read on the left hand axis and nitrates from the native prairie are read on the right hand axis.

The nitrate readings for the prairie remained constant at .5 ppm for most of the growing season. The nitrate readings in the cornfield started to peak shortly after applying 230 lb/A N as anhydrous ammonia and later in the season after applying additional nitrogen through the irrigation system. Due to the poor growth of the inter-seeded cover crop, it is unlikely that the cover crop had any effect on the movement of the nitrogen. The green beans followed a similar pattern only with lower nitrate sample results, probably due to less nitrogen fertilizer being applied.

An assortment of cover crops were planted on two green bean fields harvested in mid-August. The aboveground bio-mass for each plot was measured by clipping and weighing all the vegetation growing within a 1.92 ft^2 quadrant. Dry matter was estimated at 35% for each sample. The results are shown in Table 1.

Table 1. Results of Aboveground Bio-Mass Sampling

Cover Crop	Estimated Dry Weight lb/A	Plant Date	Weigh Date
Spring Rye	6,835	8/13/2015	10/14/2015
8 Species Mix (Barley, Kale, Lentil, Crimson Clover, Phacelia, Peas, Radish, Turnips)	8,575	8/26/2015	10/14/2015
6 Species Mix (Oats, Radish, Sunn Hemp, Kale, Crimson Clover, Peas)	8,137	8/26/2015	10/14/2015
Kale	4,550	8/26/2015	10/14/2015
Lentil	1,050	8/26/2015	10/14/2015
Triple J Farms (Spring Rye, Radish, Lentil, Turnip, Sunn Hemp, Kale)	2,975	8/13/2015	10/14/2015

Early harvested crops provide a substantial opportunity for cover crop species selection, building organic matter, and treating compaction. We held a Cover Crop Field Day at Diamond A Farms near St. Cloud.

Soil Samples were also submitted for a Haney Soil Health Analysis on the green bean fields prior to planting the cover crop, and after the cover crop was well established (Table 2).

Table 2. Soil Health Test Results

Sample	Date	Soil Health Calculation	Solvita Burst Test
Triple J Farms	4/22/2015	3.5	12.2
Green Beans	11/12/2015	3.86	23.0
Diamond A Cover	9/21/2015	6.30	22.1
Crop Demo Site	11/12/15	3.27	16.1

The Solvita Burst test measures the amount of carbon dioxide produced over a 24 hour period; the higher the amount, the greater the biological activity. This number in combination with the organic carbon to organic nitrogen yields the Soil Health Calculation. If the cover crop treatment on these fields is successful, this number should increase over time.

Management Tips

1. Keep in mind that most cover crop information and planting practices come from states with a longer growing season than Minnesota.
2. If possible, plant a diverse cover crop mix. Diversity amplifies cover cropping benefits.
3. The earlier you can plant your cover crop the better.
4. Select cover crop plant varieties that don't overwinter. There is no need to destroy the cover crop in the spring.
5. Seed to soil contact is important for starting the cover crop, especially if inter-seeding.
6. We have yet to find cover crop species other than radishes that will survive the shade of the irrigated corn crop without becoming a weed problem.
7. On sandy irrigated soils, do a split application of nitrogen to reduce leaching.

Cooperators

Steve Johnson, Triple J Farms, Land Owner, Becker, MN
Lynn Ayers, Diamond A Farms, Land Owner, St. Cloud, MN

Project Location

From Becker, go west on US Hwy. 10. Go 1 mile to MN State Hwy. 25. Then go north on Hwy. 25 for 5 miles to Sherburne Cty. Rd. 16. Go east on Cty. Rd. 16 for ¼ mile. The planting site is on the right.

Other Resources

United States Department of Agriculture Agricultural Research Service. Cover Crop Chart. www.ars.usda.gov/Main/docs.htm?docid=20323

Natural Resource Conservation Service. Conservation Practice Standard. Cover Crop Code 340. January 2014. https://efotg.sc.egov.usda.gov/references/public/NE/NE340.pdf

Midwest Cover Crops Council. Cover Crop Decision Tool. www.mccc.msu.edu/selectorintro.html

Ward Laboratories, Inc. Biological Soil Analysis. www.wardlab.com

Developing Low-cost Planting Materials and Establishment Methods to Accelerate Agroforestry Adoption for Function and Profit

Principal Investigator

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Project Duration

2014 to 2016

Award Amount

$20,385

Staff Contact

Cassie Dahl

Keywords

agroforestry, native plants, nurseries

Project Summary

This project is to demonstrate how to establish productive and profitable agroforestry land-use systems. Agroforestry focuses on proven ecological and environmental benefits. This project is to explore methods of establishing agroforestry systems using on-farm propagation to produce native plant species, productive cultivars, and hybrids of species suited to site specific ecological conditions and the succession patterns of native plant communities.

Project Description

Nursery on Early Boots Farm.

Agroforestry combines agriculture and forestry to create integrated and sustainable land-use systems. Agroforestry takes advantage of the interactive benefits of trees and shrubs grown with crops and/or livestock. Considered agroforestry practices, riparian buffers and windbreaks' conservation benefits are well known. Other agroforestry practices such as silvopasture (integrating trees, forage and livestock together), alley cropping (rows of trees/shrubs with space between for agronomic crops), and forest farming (manipulating forest canopy to allow production of specialty crops such as medicinal herbs and mushrooms) are less known and researched, but have potential for similar conservation benefits and increased farm profitability. Species of both trees/shrubs and crops suitable for agroforestry systems in Minnesota are very limited. Similarly, there are few working examples of productive and profitable agroforestry systems in Minnesota. This project aims to determine species that are best suited to the specific site condition, are cost effective to establish, provide early return on investment, and provide long-term farm profitability. Targeted at marginal farmlands, these systems have the potential to provide the greatest conservation

benefit. Programs like Reinvest in Minnesota (RIM) and Continuous Conservation Reserve Program (CCRP), though valuable for their conservation efforts, do little or nothing to provide for the growing societal needs for food, fuel, and fiber. Well-designed agroforestry land-use systems have the potential to provide these same conservation benefits and provide diversified products for local food security.

Newly planted hazelnut.

In order to reduce startup costs and have a supply of replacement stock, we will establish on farm plant propagation nurseries. We will use ecological classification and natural plant succession to determine possible multistory cropping systems. We want these systems to provide early marketable products and long-term income as they mature. Ecological classification models are not new and use soil, vegetation, and other landscape variables. For example, habitat types (Daubenmire, 1952) and plant community types (Hall, 1973) have been used in US Forest Service Regions. The Minnesota Department of Natural Resources has practiced silviculture using an Ecological Classification System (ECS) on state managed lands since 2000. We are proposing to examine and determine the feasibility and practicality of using ECS in the establishment of agroforestry projects. The focus of this project will be on mimicking ecological systems with similar cultivars and hybrids to increase productivity and producer income. We hope this design strategy will show that diverse plantings based on ECS can be used to establish agroforestry systems that conserve resources, are low maintenance, productive, and profitable.

2014 Results

Forested areas adjacent to cooperators sites were surveyed using the Minnesota Department of Natural Resources, Field Guide to the Native Plant Communities of Minnesota: The Eastern Broadleaf Province (2005).

The sites were described and classified as follows:

Location	Soils	Forb	Overstory	Subcanopy	Notes
Early Boots Farm	Forest soils were sampled to 16". Loamy to 12" with light-colored clay to 16".	More mesic species at ground layer: Bloodroot abundant, sweet cicely common, jack-in-the pulpit scattered. Other common species: wild sarsaparilla, bedstraw, false Solomon seal, violets, large leaf aster.	Canopy is heavy to trembling aspen and green ash with large scattered bur oak.	Large ironwood, elm, green ash, boxelder. Shrub layer has juneberry, arrowwood and prickly ash. Some red oak regeneration at 1-2' level.	Overstory and shrub layers indicate MHc 2-6. Forbs and soils indicate MHc 3-6. Following up with John Almendinger on the site classification, he says that it is common for forested sites to become somewhat drier following disturbances – (whether those are from logging, wind, grazing etc). Hence the move from a 3-6 toward a 2-6 is not unusual, it may be preferable to use forbs and soils for NPC determination on these sites for this reason.

Location	Soils	Forb	Overstory	Subcanopy	Notes
Camphill Village	Soils sampled to 16". Loamy first 8". Subsoil sandy to 16" with some fine particles. Rocks present.	Common forbs: columbine, sweet cicely, Canada mayflower, sedges.	Northern pin oak, bur oak, aspen common.	Shrub layer thick to prickly ash, grey dogwood.	Topography hilly with slope to west. Large bur oaks at top of hill have appearance of old savanna knoll. Small swale inclusion has black cherry and leatherwood= more mesic. General agreement that this site has all the earmarks of an FDs 3-7 site.
Happy Dancing Turtle	Soil map shows Menahga loamy sand. Soil probe was 5" of loamy material with brown sand beneath to the 16" soil probe depth.	Abundant forbs were bedstraw, blueberry, and Pennsylvania sedge. Other species were strawberry, starflower, wood fern, poison ivy, wild sarsaparilla, yarrow, violet, false lily with isolated red baneberry.	Common species were red pine, followed by pin oak and bur oak, some birch and scattered mountain ash. Jack pine scattered or absent.		The consensus was that the site was clearly FDc 3-4: likely subtype a. On the northern portion of the site inspection we encountered an area of ground pine, balsam fir and bracken fern, indicating that a portion of the site may tend toward FDn 3-3.

Go to the Minnesota Department of Natural Resources website for detailed descriptions and more information on native plant communities. Website: www.dnr.state.mn.us/npc/index.html

Propagation nurseries weren't established until late summer so little progress was made in propagating stock. Rooted cuttings from four different elderberry cultivars were planted at Early Boots Farm. Happy Dancing Turtle planted hybrid hazelnuts and currents that were propagated over the winter of 2013/2014. These were planted in late fall as a living snowfence along the entrance to the Hunt Utilities Campus.

2015 Results

We had enthusiastic plans when going into this project. Our goal was to use propagations from the nurseries when planting in the field, however we did not realize how long it would take for the plants to become established, so additional planting stock has been purchased. Species were selected based on marketing potential. The stock consisted of hybrid hazelnuts, Ashworth oak, juneberry, Shagbark hickory, apple (Chestnut, Dolgo, Centennial), cherry (Carmine Jewel, Crimson Passion), plum, Northrop mulberry, blueberries, strawberries, elderberry, American plum, aronia berry, false indigo, chokecherry (Black, Garrington), and honeyberry were split equally between the three sites, regardless of their suitability to the site. Camphill Village and Earlyboots Farm planted all varieties of stock in the nursery. The Camphill Village nursery was rooted up with hogs in the fall of 2014 and then tilled in the spring before planting. Then the stock was mulched with straw and weeded twice. The Earlyboots Farm site was planted into sod and mowed. At the Happy Dancing Turtle site, species suited to the site were planted together and those that were not were planted separately. A thin layer of composted leaf mulch was applied to both sites and they were mulched with a deep layer of wood chips and weeded once. All sites were irrigated only during extended dry periods.

The living snowfence at Happy Dancing Turtle was established using an existing garden that was set up as a small alley cropping system in 2006. Some of the purchased stock was planted into the existing perennial rows within the alley cropping system. Plants put into this system included select cross hybrid hazelnuts, plums, and crab apples. These had good survival and growth, but this area has amended soil and is fenced.

New plantings were established on two sites with poor, sandy, and somewhat compacted soil. One site was planted to species suited to the NPC, including hybrid hazelnuts, currents, bush cherries, bur oak (Ashworth cultivar), and blueberry cultivars. This planting was three rows, spaced 4' apart, and the plants were 6' apart within the rows. The hybrid hazelnuts were propagated from seed that was selected from established plantings on site and other sites in our region. The currents were propagated with cuttings sourced locally. Survival for all the species in this planting was good, but growth was poor and there was some predation over the winter. It is hard to say if the poor growth on the hazelnuts (compared to the select cross planted in the existing alley cropping system) was due to the genetics of the open pollinated propagation, the poor growing conditions, or a combination of the two. Propagation of the currents was easy and they had better growth.

The other site was planted primarily with species that are not found in the NPC database for our location. The plants included aronia berry, nannyberry, black walnut, Shagbark hickory, and hybrid hazelnuts. They were planted in two rows 6' apart and the plants were 6' apart within the row. Tall trees were planted on the ends of the rows at 10' spacing. Survival was poor in this planting with all of the nannyberry dying as well as all but one black walnut. The aronia berry fared better with only one plant dying.

The rest of the stock (juneberries and elderberries) were planted in the tree nursery for protection because they were small plants. None of the plants are producing fruit or nuts, although some of the select cross hazelnuts have set catkins.

Plans for spring of 2016 are to purchase additional planting stock to establish in field demonstrations at Early Boots Farm and Camphill Village of species that are suited to the site. They will be established as windbreaks, alley cropping systems, or incorporated into existing plantings. When practical we will be gathering materials and propagating plants on farm.

Site prep at Happy Dancing Turtle.

Management Tips

1. Land use history and previous disturbances can play a role in native plant community establishment.
2. Ecological Classification Systems and native plant communities play a role in plant selection for agroforestry plantings.
3. Consistent site preparation, management, and record keeping is important for data collection.

Cooperators

Tyler Carlson, Producer, Early Boots Farm
Stephen Briggs, Producer, Camphill Village
Diomy Zamora, U of M Extension Agroforester
Peter Bundy, Masconomo Forestry Inc.
John Almendinger, Minnesota Department of Natural Resources

Project Location

Happy Dancing Turtle is located on the Hunt Utilities Group Campus, 1/2 mile east of Pine River on Cass Cty. Rd. 2. Early Boots Farm is 6 miles north of Sauk Rapids on US 71, 1/2 mile west on Balsam Dr. Camphill Village is located 9 miles north of Sauk Center on US 71, 1 mile east on Cedar Lake Rd.

Other Resources

Field Guide to the Native Plant Communities of Minnesota: The Eastern Broadleaf Province. 2005.

Minnesota Department of Natural Resources. Website: www.dnr.state.mn.us/npc/index.html

Restoration Agriculture: Real-World Permaculture for Farmers. 2013. Mark Shepard. Website: www.newforestfarm.net

This Perennial Land: third crops, blue earth, and the road to a restorative agriculture. 2012. Lansing Shepard and Paula Westmoreland. Website: www.thisperennialland.com

Tree Crops: A Permanent Agriculture. 1950. J. Russel Smith

USDA National Agroforestry Center. Website: nac.unl.edu

Green Lands Blue Waters. Website: www.greenlandsbluewaters.net

Association for Temperate Agroforestry. Website: www.aftaweb.org

National Sustainable Agriculture Information Service. Website: www.attra.ncat.org/attra-pub/summaries/summary.php?pub=62

University of Missouri Center for Agroforestry. Website: www.centerforagroforestry.org/practices/ac.php

Principal Investigator

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Project Duration

2015 to 2017

Award Amount

$16,106

Staff Contact

Alatheia Stenvik

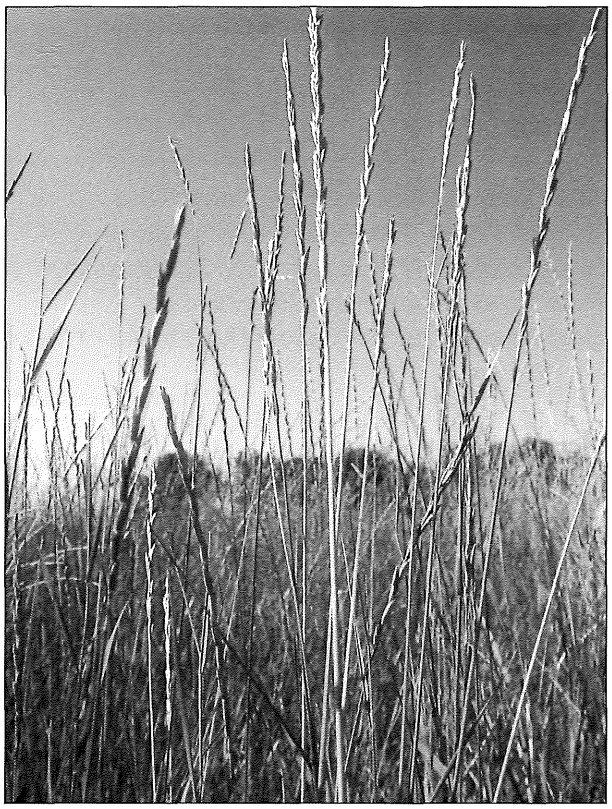
Keywords

grain, intermediate wheatgrass, yield, harvest, moisture content

Evaluating Harvest Methods for Intermediate Wheatgrass as a Perennial Edible Grain

Project Summary

The purpose of this project is to determine the optimum timing for intermediate wheatgrass grain harvest to maximize grain yield. Intermediate wheatgrass was mechanically harvested at three different stages of maturity and measured for grain yield, moisture content, harvest efficiency, and dehulling efficiency. Intermediate wheatgrass was also hand harvested to analyze grain yield potential.



Mature intermediate wheatgrass.

Project Description

I operate a 350 acre certified organic crop farm and currently raise barley, oats, wheat, flax, corn, soybeans, and alfalfa in my rotation. In 2012, I became aware of the success that Lee DeHaan, geneticist at The Land Institute and endowed chair at the Minnesota Institute for Sustainable Agriculture, was having in breeding intermediate wheatgrass as a perennial grain crop. Perennial grains grown in a crop rotation have potential to provide economic benefits to the producer by helping minimize the annual costs of reseeding and fertilization. Perennial crops also require fewer tractor passes over the field than annual crops, which decreases fuel and energy input costs. Perennial grains provide benefits to the soil ecosystem including:

- providing perpetual cover for the soil surface, which minimizes soil loss from wind and water erosion;
- the fibrous root system effectively sequesters soil carbon and available soil nutrients; and
- the fibrous root system also feeds and protects the soil's microflora which acts to improve and maintain the soil's biological health.

During the first 2 years of growth, I noticed some interesting characteristics of intermediate wheatgrass. The grass sward grew rapidly in the early spring, which allowed the crop to compete successfully with the cool season weed species that are

a major problem in annual small grain production. In 2014, I attempted my first grain harvest from the 2-acre test plot. While harvesting, I noticed that the maturity of the seed heads varied greatly across the field. The seeds developing on top of the seed head were dry and mature, while those at the base of the head were moist and soft. This observation complicated the decision as to when to harvest successfully. If I delay harvest to allow the soft seeds to mature, will I risk losing the early maturing seeds to shattering? If I harvest early, how much expected yield will I be giving up by losing the seeds, which are still maturing? I brought these questions to other researchers working on intermediate wheatgrass and came to the realization that the question had not yet been answered. This led to collaboration with University of Minnesota researchers to design an experiment to address the question of the optimum time of intermediate wheatgrass harvest to maximize grain yields.

Swathed intermediate wheatgrass

The experimental design developed to address the harvest issue included the following three treatments:

- early-season swath;
- mid-season swath; and
- late-season swath.

The experimental data collected in 2015 included:

- grain yield potential based on yield estimates from hand harvested grain;
- actual grain yields taken from grain harvested by the combine;
- moisture content of the grain at swathing;
- moisture content of the grain at combining; and
- yield loss from shattering while drying in the windrow.

2015 Results

The early-season plot was swathed on August 5. The grain was dried in the windrow until August 11 when it was combined. The mid-season plot was swathed on August 11 and due to multiple rain events was not harvested until August 24. I believe that there was significant shattering loss in the windrow. The late-season plot was swathed on August 24. The plot was combined on August 27. I attribute low yields to seed that shattered prior to swathing. Yield data is summarized in the following table. Next year, I will include the data for the hand harvested treatments as well.

2015 Harvest Dates and Yield Data

Treatment	Swath Date	Combine Date	Yield (lb)
Early-season	August 5	August 11	968
Mid-season	August 11	August 24	121
Late-season	August 24	August 27	403

Management Tips

1. This 1 year study indicates that an early-season harvest is recommended. The immature seeds found in the intermediate wheatgrass head at swathing dried adequately during the 6 days that the swath was dried.
2. Combining grain prior to forecasted rain events, even if the grain is not completely dry, may increase yields.
3. Direct harvest of the late-season plots may be recommended in order to avoid shattering losses in the windrow.

Cooperators

Jacob Jungers, University of Minnesota

Project Location

From Madison, go east on Hwy. 40. Continue for 1.5 miles.

The Effect of Cover Crops on Water and Soil Quality

Principal Investigator

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Project Duration

2014 to 2015

Award Amount

$24,990

Staff Contact

Mark Zumwinkle

Keywords

cover crops, vegetables, soil quality, immigrant farmers

Project Summary

The purpose of this project is to introduce the use of cover crops to Hmong American fresh market vegetable farmers. This will allow Hmong growers to realize the soil health and water quality benefits that cover crops provide.

Project Description

The Hmong are political refugees from Laos who immigrated to the United States after the Vietnam War. Upon their arrival, and with limited resources, many Hmong parents used their agricultural skills to raise their families. Now, Hmong farmers are a critical part of the Twin Cities' local foods economy, accounting for over 50% of all the farmers in the metropolitan area farmers' markets.

Hmong farmers commonly lack land tenure. This has made it difficult to make long-term investments in infrastructure and soil building practices such as irrigation and cover cropping. The outlook changed dramatically when the Hmong American Farmers Association (HAFA) purchased a 150 acre incubator and research farm on the perimeter of the Metro area in 2014, making it possible for the farmers to begin investing in sustainable practices. A typical Hmong fresh market vegetable farm plot consists of 5 or 10 acres and is farmed by a husband and wife. Hmong growers plant a great diversity of vegetables, herbs, and flowers. It is common for one farm family to produce between 30 and 50 different species of crops.

In early 2014, HAFA launched a cover crop education and research project that has trained 37 Hmong farmers on cover crop benefits and the principles of soil health. The farmers have participated in three intensive half-day training sessions.

2014 Results

One goal of this grant was to recruit six farmers to plant 1 acre of cover crops. Grower interest was so great that 11 have signed up to participate. Each farmer has worked one-on-one with a HAFA trainer to produce a map of their cropping sequence and to discuss where cover crops might fit in. The maps have been digitized for easy future reference.

Each farm family has been given full leeway to decide which cover crops fit their system. The most popular choice in 2014 was oats due to low cost and the fact that oats winterkill. Winter rye was the second choice. Several growers are interested in using winter rye to produce straw for strawberries and other perennials. Buckwheat was used for weed control on one farm.

Most of the farmers chose to broadcast inter-seed an oat cover crop into vegetables nearing maturity as a method of establishing the cover crop. A backpack broadcast spreader was used to lay down 20' wide swaths of oats at walking speed. Broadcast inter-seeding was successful in green beans, tomatoes, peppers, and sticky corn. The oats that were planted in mid-August produced a large amount of biomass. Oats planted in the first week of September had much less growth.

Bla Doua Yang had good results with oats overseeded in peppers (shown in mid-October).

Oats and winter rye were also seeded after cash crop removal where the soil would otherwise be bare through fall.

Mid-August is a very busy time for harvest and sales at farmers' markets. It was difficult to break away to plant cover crops. It remains to be seen how cover crop planting can fit into an already overloaded schedule. Work needs to be done to minimize the time it takes to plant the cover crops.

None of the cash crops were negatively affected by the cover crop. Surprisingly, the oats seeded in August provided frost protection to tomatoes and peppers in September and facilitated vegetable harvest by eliminating soil splash on the fruits. Harvested vegetables came out of the field much cleaner. Picking was easier in wet weather in the cover crop plots due to the support provided by the cover crop roots. One farm couple who have experienced such benefits are planning to overseed oats into their entire 10 acre operation.

Oat cover crop overseeded in sticky corn shows good growth in mid-October.

Many of the farmers now understand the environmental and soil health benefits of cover crops. They have seen reduced erosion and reduced weed pressure. Reducing weed pressure is extremely important to these farmers. They do not use herbicides and rely extensively on hand hoeing in the row for weed control.

Now, several growers are interested in trying tillage radishes with oats for compaction. Small areas that had low vegetable productivity will be sown to nitrogen alfalfa (annual alfalfa that winterkills) using an oat nurse crop as an attempt to jump-start soil health.

Beyond those participating directly in the grant, there is a groundswell of interest among other growers on the HAFA farm as well as on surrounding Hmong farms. Several of these farmers will be planting cover crops in 2015. HAFA has engaged a local photographer to document in pictures how the cover crops and equipment are being used in vegetable crops. Pictures will greatly help non-literate farmers understand cover crops.

Vinai Vang and Vang Moua inspecting an oat cover crop drilled after sugar snap pea harvest.

HAFA trainers are collecting soil samples for fertility, pH, organic matter and biological activity. Soil compaction is being measured on a 5 acre grid across the entire farm.

Soil compaction was measured across the farm using a constant readout penetrometer in the fall of 2014. Unfortunately, the soil was too dry to obtain accurate readings. The readings that were obtained seem to support the concern that there is extensive compaction. We will repeat the compaction tests in the spring and fall of 2015 when the soil is moist and at or near field capacity. In late fall, compaction will be measured both in mature cover crops and in adjacent fields without cover crops to determine if the cover crops are succeeding in loosening the soil.

The direct effect of cover crops on water quality will be tested using a rain simulator in the fall of 2015. Rain simulations will be performed in the cover crop and where no cover crop has been planted. This will occur in late fall when the cover crop is well established.

Overall, the first year of cover cropping with the Hmong growers has been a tremendous success. Farmer interest is high and growing. Cover crop acreage is growing and farmers are finding more creative ways to fit cover crops into their vegetable systems.

In early 2014, HAFA launched a cover crop education and research project that trained 44 Hmong farmers on cover crop benefits and the principles of soil health.

2015 Results

In 2015, HAFA resumed the second year of the education and research project. Farmers participated in four intensive half-day trainings including a series of rainfall simulations to test the effect of cover crops on water absorption. Farmers also participated in multiple one to one tutorials on varied topics such as choosing which cover crops to plant and how to plant them. Over 50 Hmong farmers were trained and nine families actively participated in planting and monitoring the effects of cover crops on water and soil health. The nine families planted over 19 acres of cover crops including such varieties as oats, buckwheat, winter rye, tillage radish, nitro alfalfa, and Dutch white clover. Eight of the nine families integrated the cover crops into other cash crops such as green bell peppers, tomatoes, potatoes, eggplant, cabbage, and asparagus and found the results to be very beneficial. One of the families decided to plant two entire acres entirely to nitro alfalfa in preparation for a crop rotation the upcoming year.

One of the original goals of this grant was to recruit six farmers to plant 1 acre of cover crops. In 2014, the interest from growers was so great that 11 signed up to participate. In 2015, after having heard about the benefits of cover crops from their peers, all 16 farmers renting land on the HAFA Farm planted cover crops of some type. Moreover, a HAFA research intern worked with the farmers to produce crop maps for all of their fields so that in the future the farmers could engage in crop rotation.

In the past, each farm family had been given full leeway to decide which cover crops fit their system. The most popular choice in 2014 was oats due to low seed cost and the fact that it winterkills. But in 2015, the farmers used the cover crops much more strategically. For example, Wang Ger Hang's family wanted to prepare their soil for a 2017 crop rotation, so they decided to seed 2 acres of nitro alfalfa and oats. Like Wang Ger Hang, other Hmong families planted different types of cover crops for different purposes. Some planted oats for the majority of their fields, but planted buckwheat near flowers to attract bees. At the end of the 2105 season, many farmers expressed to HAFA trainers that in 2016 they wanted to use more tillage radish to remedy the soil compaction on the farm.

Soil compaction continued to be a problem on the HAFA Farm. Even after successive plantings of mostly legumes and two full seasons of vegetable production, findings from the penetrometer tests suggest a problem. According to the Cornell Soil Health Assessment Training Manual, 175 psi is the penetration resistance that roots begin having trouble penetrating through. Based on our results from the penetrometer test, a number of plots at the HAFA farm showed 175 psi at a depth of 20 cm. That is 8" deep which also happens to be the depth of the plow layer. The shallowest plant roots on the HAFA Farm need at least 18" of soil depth for a healthy root system to access nutrients in the soil. The most they can get on many portions of the HAFA Farm is 12" so that is a problem. Furthermore, compacted soil at 8"

challenges subsoil water recharge. This causes water to stay on the surface longer which can lead to muddy roads, crop root rot or crop failure. Certainly, using deep, tap rooted crops such as tillage radish and alfalfa which has roots that are able to penetrate through small spaces will help. This will be a long-term goal.

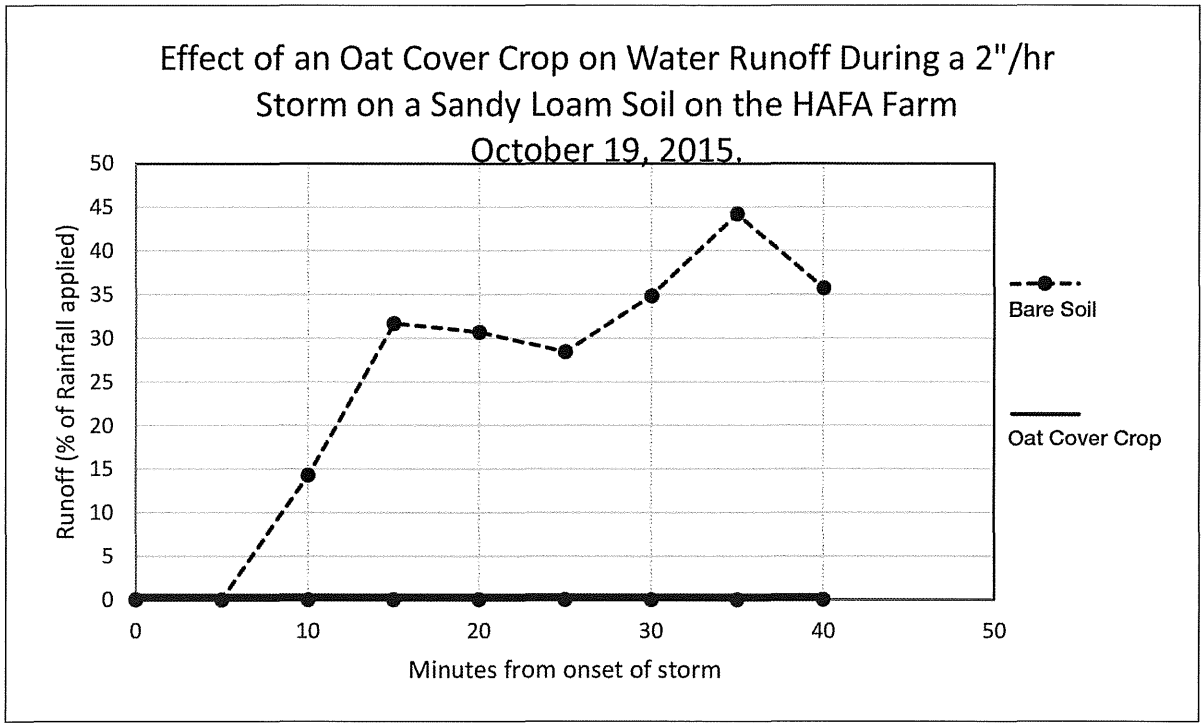
In 2015, HAFA and the Minnesota Department of Agriculture staff used a rainfall simulator to test the effect of cover crops on water absorption (infiltration). The immigrant farming community and area farmers were invited to participate in the training as well.

Yao Yang, HAFA Farm Trainer and Research Coordinator, with the rain simulator and oat cover crop.

Description of the rain simulator test:

1. A 2"/hr storm event was applied for 45 minutes to two oat cover crop plots and two bare soil plots where squash vines had frozen.
2. Water sampling immediately began when the first runoff was observed.
3. The runoff water was captured in a quart jar.
4. The overall time it took to fill up the jar was recorded.
5. Every 5 minutes, a new jar was used to capture the runoff.
6. After 45 minutes, the rain gage was measured.
7. The quart jars of water were weighed to calculate runoff rate over time.
8. The water was drained and the sediments were captured using coffee filters and oven dried.
9. The sediments were measured in grams.

The test revealed that there was no runoff in the fields planted with oats but runoff present in the fields with bare ground, suggesting that cover crops do increase water infiltration (see following page). The non-cover crop plots were losing 30% of the water applied only 15 minutes after the onset of the storm. This is water that should be captured for use by the vegetable crops. Sediment loss was minimal.



We measured the effect of the oat cover crop on soil health. Soil health improves slowly over time. To address this, we chose to use a test for active carbon, a test that can pick up on soil improvements before there is a measurable increase in total organic matter. We took soil samples in the same area where we did the rain simulations. Three replications of soil samples were taken in the oat cover crop and three were taken in the bare soil.

The oat soil averaged 199 parts per million active carbon and the bare soil averaged 173 parts per million active carbon. After just one rotation including the cover crop, the soil had improved in its ability to support soil biology. A healthy sandy loam would contain 400-600 parts per million active carbon. We have a lot of room for improvement with the soil on the HAFA Farm. Fortunately, we are headed in the right direction.

Overall, the second year of cover cropping with the Hmong growers has been a tremendous success. Farmer interest is very high and cover crop acreage is growing. Farmers are finding more creative ways to fit cover crops into their vegetable systems and using other types of crops such as mustard greens or pea blossoms not for harvest but to just cover their fields.

Management Tips

1. When introducing growers to cover crops for the first time, consider cover crops that winterkill such as oats or radishes.
2. Taylor cover crop selection to the specific needs of the grower.
3. Think of cover crops as a long-term strategy for improving soil health and farm productivity.
4. If a cover crop is too expensive, mix it with a less expensive cover crop and seed the two together.
5. Interplant cover crops with crops that are most susceptible to standing water

Cooperators

Chong Neng Xiong, HAFA Farmer, St. Paul, MN
Mao Moua, HAFA Farmer, St. Paul, MN
Ge Vang, HAFA Farmer, St. Paul, MN
Dia Her, HAFA Farmer, St. Paul, MN
Lucie Passus, HAFA Farmer, St. Paul, MN
Wang Ger Hang, HAFA Farmer, St. Paul, MN
Tha Xiong, HAFA Farmer, St. Paul, MN
Teng Thao, HAFA Farmer, St. Paul, MN
Teng Vue, HAFA Farmer, Minneapolis, MN
Jim Wichmann, Albert Lea Seed House, Albert Lea, MN
Janssen Hang, HAFA Farm Trainer, St. Paul, MN
Yao Yang, HAFA Farm Trainer, St. Paul, MN
Tong Xiong, HAFA Trainer, St. Paul, MN
Jeff Glowa, HAFA Trainer, St. Paul, MN
Jacy Yang, HAFA Research Intern, St. Paul, MN
Neith Little, University of Minnesota Extension, Farmington, MN
Mark Zumwinkle, Minnesota Department of Agriculture, St. Paul, MN

Project Location

From Downtown St. Paul, travel south on U.S. Hwy. 52 for 23 miles. After passing 200th St., the farm is on both sides of the highway. Turn right into the homestead for parking.

Other Resources

Cover Crops on the Intensive Market Farm. John Hendrickson. 2009. University of Wisconsin – Madison Center for Integrated Agricultural Systems. Madison, WI.

Sustainable Agriculture Network. Managing Cover Crops Profitably: Third Edition. Beltsville, MD. 301-504-5236. Website: www.sare.org/publications/covercrops/covercrops.pdf

Vegetable Farmers and Their Innovative Cover Cropping Techniques (video). Vernon Grubinger. 2006. University of Vermont Extension. www.uvm.edu/vtvegandberry/Videos/covercropvideo.html

USDA Agricultural Research Service. Cover Crop Chart. www.ars.usda.gov/SP2UserFiles/Place/30640500/CCC/CCC_v13_5_2012.pdf

Legume Cover Crops

Principal Investigator

Paul Kruger
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Wabasha, MN 55981
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Wabasha County

Project Duration

2014 to 2016

Award Amount

$14,919

Staff Contact

Mark Zumwinkle

Keywords

cover crops, legumes

Project Summary

Paul Kruger is leading a 3 year study and is tracking the amount of nitrogen produced by cover crops over time. This experiment will see if commercial nitrogen can be reduced or eliminated by the use of cover crops. The legume cover crops are being planted between the corn rows in this experiment.

Project Description

Paul farms 650 acres of corn and hay in the karst region of southeastern MN. The karst region of southeastern Minnesota is formed over layers of soluble bedrock, where sinkholes are common. Paul milks 300 dairy cows and raises 150 steers each year with his son and daughter.

For this project, Paul wants to reduce, and hopefully eliminate, the use of commercial nitrogen. Currently, he has to purchase commercial nitrogen for the acres he does not treat with manure. If he can get the cover crops to work, the results of this experiment will benefit Paul's operation and farms with similar growing conditions. The cropping system used in this study is corn for grain. Each plot is 1-2 acres, with all plots containing the same soil type.

He is monitoring:

- Yield
- Nitrogen credits and carryover (spring nitrate test)
- Soil temperature
- Erosion and weed pressure (visual)
- Appearance (crop stress, yellowing or green leaves)

2014 Results

In year 1 of the project, Paul planted three different plots of legumes into corn that was planted on May 30. On June 4, he planted Plot 2 and Plot 3 with a grain drill right into the corn field. Plot 2 and Plot 3 mixes are listed below. The planting depth was only half an inch for the cover crops and the corn was planted 2" deep, so he was not worried about damaging any of the corn.

For Plots 2 and 3, Paul used Roundup® Ready legumes. Paul planted them early in order to encourage nodule production. On July 9, he broadcast seeded Plot 1, which was 5 days after the corn was sprayed with herbicide.

Paul also tracked input costs and yield output. His economic analysis looked at net profit per acre under cover crops. With fewer fertilizer inputs, the economic analysis is an important element of determining the success of cover crop.

Plot 1 (4 Species – 50 lb/species/A) Broadcasted July 9	
Legume	**Cost/50 lb bag**
Austrian Winter Pea	$28
Lupine	$63
Hairy Vetch	$120
AC Greenfix	$39
Total Cost/A	$250

Plot 2 (1 Species – 50 lb/A seeding rate)	
Roundup® Ready Soybeans	$56
Total Cost/A	$56

Plot 2 (1 Species – 50 lb/A seeding rate)	
Roundup® Ready Alfalfa	$49
Roundup® Ready Soybeans	$56
Total Cost/A	$105

Twice each month, Paul hired the Wabasha Soil and Water Conservation District to inspect, document, and take pictures of each plot. Reviewing the notes, pictures, and his observations, he thought the plots would yield competitively with the control plot (Plot 4). On December 21 Paul harvested the corn. Yields were as follows:

Plot	Yield
1 (Austrian Winter Pea, Lupine, Hairy Vetch, & AC Greenfix)	152 bu/A
2 (Roundup® Ready Soybeans)	147 bu/A
3 (Roundup® Ready Soybeans & Roundup® Ready Alfalfa)	135 bu/A
4 (Control Plot)	157 bu/A
Extra Test (Control Plot)	144 bu/A

After looking at the results, Paul decided that there was no difference between the cover crop plots and the control plots. He tested one additional plot since Plot 4 was 5 to 10 bu higher per acre than the cover crop plots. The extra test was in the same range as the cover crop plots.

While harvesting the corn, Paul noticed weak spots in the field. These weak spots were apparent since the corn was shorter and had a poor appearance. Due to these conditions, the variation in yields is explainable. He was expecting a 170 bu average, which did not occur. Record rainfall was recorded in the 2014 growing season so a lack of rain was not the issue.

Overall, Paul was very impressed with the cover crop plots. Working with a soil scientist, Paul discovered that every variety of legumes planted had nodules on their roots. Therefore, his goal of planting the cover crops between the corn rows has been met. For the next growing season, he will apply less commercial nitrogen and see if the cover crops from the previous year are providing residual nitrogen.

Legume cover crops growing in understory of corn.

2015 Results

In year 2 of the project, Paul planted the same cover crop mixes that were used in 2014. The corn was planted on May 16. On May 27, the cover crops were planted in Plot 2 and Plot 3 with a grain drill right into the corn. Roughly 15% of the corn had sprouted and was less than 1" tall. Rainy conditions delayed the process of getting Plots 2 and 3 planted earlier. On June 25, the cover crops for Plot 1 were broadcast seeded, which was 5 days after the corn was sprayed with herbicide.

Paul fertilized with 170 lb of commercial nitrogen, 58 lb of phosphate, and 113 lb of potash. The cover crop plots received no nitrogen. In theory the legumes planted last year would provide some extra nitrogen to feed the corn crop this year.

On November 20th we harvested the corn for year 2. Yields were as follows:

Plot	Yield
1 (Austrian Winter Pea, Lupine, Hairy Vetch, & AC Greenfix)	114 bu/A
2 (Roundup® Ready Soybeans)	92 bu/A
3 (Roundup® Ready Soybeans & Roundup® Ready Alfalfa)	81 bu/A
4 (Control Plot)	155 bu/A
Extra Test (Control Plot)	148 bu/A

It is clear that the cover crop plots suffered compared to the control plot by almost 60 bu. The yield drag was due to the lack of nitrogen. You could see the difference in the field where I did and did not apply anhydrous. I was hoping that the legumes planted from the year before would produce nitrogen that would have helped feed this year's corn crop.

As in 2014, every variety of legumes planted had nodules on their roots. Therefore my goal with planting the cover crops between the corn rows has been met. Overall I was disappointed with the cover crop plots. I was expecting better yields. It seems like the legumes did not have any carry over nitrogen and did not help feed the corn crop.

In 2016, I will apply the same rate of commercial nitrogen as last year to find out if the cover crops from the previous year are providing residual nitrogen.

In another part of the study, Paul is working with Winona State University. They helped him install two lysimeters on each plot. The lysimeters were placed 4' below the soil surface in order to capture water leaving the rooting zone and heading for the ground water. A water sample was taken every week to capture nitrogen content. Paul does not have the results of this test yet.

Management Tips

1. Small seeded cover crops can be drilled at a shallow depth behind a deeper planting of a large seeded cash crop.
2. Dig up your legume seedlings to track nodulation.
3. When broadcasting cover crops, try to seed before a rainfall.
4. Experiment on a small acreage.

Cooperators

Wabasha Soil and Water Conservation District, Wabasha, MN

Dan Nath, Soil Scientist, Natural Resource Conservation Service (NRCS), Rochester, MN

Project Location

From the Twin Cities: Head east on I-94. Take US-10 E for 22 miles. Turn right onto Great River Rd. and continue for 19 miles. Turn right onto Cty. Rd. VV. After about a mile, turn right onto US-63 S. Turn right onto Plum St. Turn right onto US-61 S/Main St. and follow for 30 miles. Turn right onto Cty. Rd. 30. Turn right toward T-504. After 2 miles, destination will be on the left.

Other Resources

Sustainable Agriculture Network. Managing Cover Crops Profitably: Third Edition. Beltsville, MD. 301-504-5236. Website: www.sare.org/publications/covercrops/covercrops.pdf

USDA Agricultural Research Service. Cover Crop Chart. www.ars.usda.gov/SP2UserFiles/Place/30640500/CCC/CCC_v13_5_2012.pdf

Principal Investigator

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Stearns County

Project Duration

2015 to 2017

Award Amount

$5,089

Staff Contact

Cassie Dahl

Keywords

no-till, cover crops, soil health

Evaluation of Winter Annual Small Grain Cover Crop for Forage Production

Project Summary

The focus of our project is to demonstrate the potential economic value of winter annual cereal grains planted as cover crops in the fall and harvested in the spring as silage, prior to planting that year's production crop. The differences in growth rate, silage yield, and forage value of cereal rye, winter wheat, winter triticale, and winter spelt will be measured and recorded. I hope to determine if it is economical, from a production standpoint, to add these cover crops to my rotation and which winter annual small grains are most practical. I am also assessing soil health including, physical, chemical, and biological change.

Project Description

For years I have been interested in building soil health. In 2006, my wife, Crystal and I took over full ownership of our family's Century Farm. The farm consists of 321 acres, 50 dairy cows with about 16 replacements, and 33 young stock and calves. We grow corn, small grains, alfalfa, and soybeans. In 2008, we began incorporating cover crops into our already no-till rotation.

In 2013 and 2014, we hosted a cover crop research and demonstration project on our farm funded by Minnesota Corn Research and Promotion Council and the Sustainable Agriculture Research and Education Program. We studied different ways of establishing cereal rye, and demonstrated the performance of a variety of fall planted cover crop mixes. The project was developed and managed by the Stearns County Soil and Water Conservation District (SWCD) and the University of Minnesota Extension. That project made me thirsty for more knowledge and answers. A recurring question that we heard from previous field day attendees was, "How do we make cover crops cost effective?" I was motivated to partner with Stearns County SWCD and others to continue to research cover crops. The purpose of this project is to evaluate the short-term economics of winter annual small grains that are planted in the fall as cover crops and harvested in the spring for silage. In addition, we want to achieve soil health benefits from these cover crops in a no-till system.

This project will hopefully show that cover crops provide resource protection without short-term economic hardship. The following are soil and water resource issues that I believe the winter annual cover crops will address on my farm and the surrounding area.

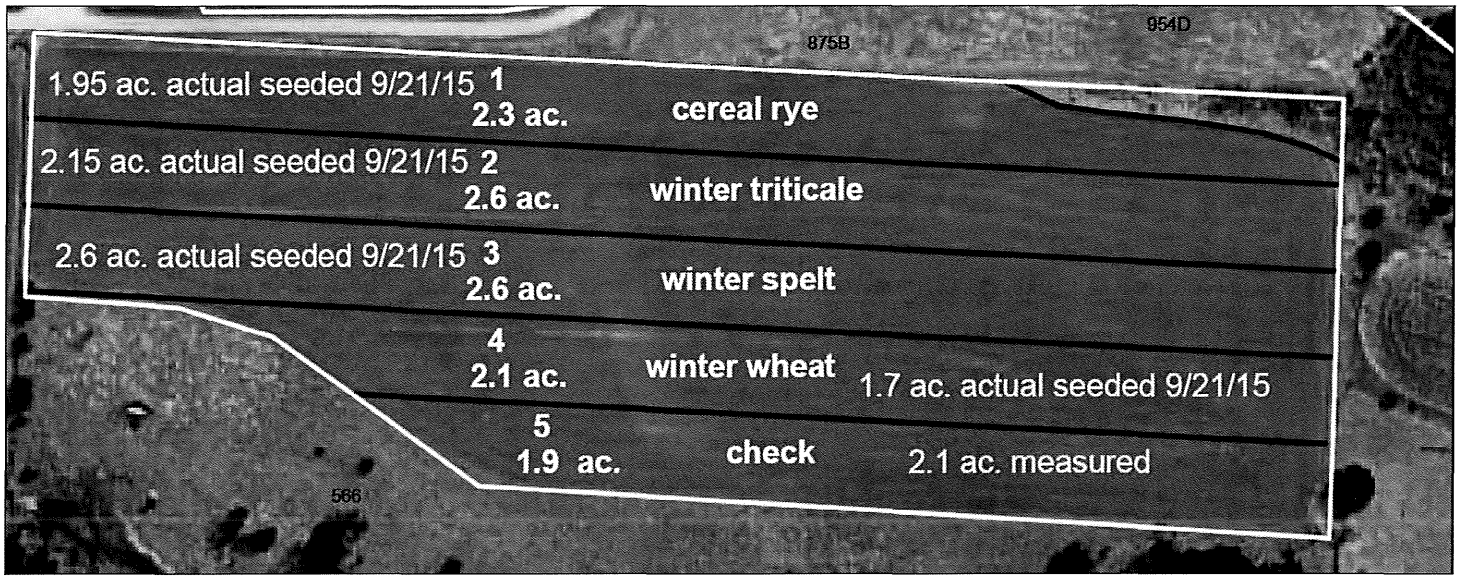
Nitrogen Immobilization - Much of my farm and the surrounding area is listed as having "very high" sensitivity to ground water pollution with bedrock within 50' of the land surface. I am very interested in using winter annual cover crops, with their fibrous root systems, to help immobilize nitrogen.

Increasing Soil Carbon - The winter annual grasses we are planting have a high potential to increase soil carbon. The sandy soils in our area are typically low in soil organic matter and increased organic matter will improve nutrient cycling, increase water holding capacity, and reduce wind and water erosion.

Erosion Control - The cover crops that we are planting will be actively growing in the spring. This is important because that is when we get our most erosive wind and rain events and having established plants will protect the soil during these periods. We will use no-till methods for minimal soil disturbance and to protect the residue cover.

The project is right on track, I have planted nearly equal sized strips of cereal rye, winter triticale, winter wheat, and winter spelt this fall after harvesting the production crop on a 12 acre field near my farmstead. In the spring, I will harvest the cover crop for silage at the appropriate time to maximize yield and quality. A check strip has been included in my project and does not have a cover crop. We will monitor the yield and forage value of the cover crop silage in each strip and convert this data to monetary value. We will also monitor the yield and forage quality of the following production crop to determine if the cover crop affected these factors based on the check strip values.

Our partner, Ag Resource Consulting (ARC), has collected soil samples for standard soil series tests for phosphorus, potassium, soil organic matter, pH, and the Soil Health Tool (Haney test) for both inorganic and organic nutrient availability, and soil carbon for our baseline data. We will continue sample throughout the project to monitor changes. We have also collected other soil factors, such as soil moisture, water infiltration rate, and compaction. In addition, we will also measure surface residue cover prior to planting the production crop. A crop consultant will monitor weed pressure in the production crop to see if the cover crop has any effect on weed species and abundance. The production crop following the cover crop will likely be corn harvested for silage.



Plot layout with cover crop locations.

2015 Results

This year soil samples were taken on June 4, 2015. Field monitoring for soil moisture was conducted throughout the growing season. Additional base data including, soil compaction, water infiltration rate, and soil temperature was also collected. It will be interesting to see how the data changes as the project progresses. Corn silage was harvested on September 17, 2015 and manure was applied two days later at 5,895 gal/A. Spreader calibration was completed and cover crops were seeded on September 21, 2015.

Management Tips

1. Keep an open mind when working with cover crops and no-till. I firmly believe the largest obstacle is having the right mindset.
2. Talk to your neighbors, consultants, and feed guys to find out what others are doing; that way you can build off of each other's ideas. Another way to be involved is to attend local field days.
3. Be prepared to change your herbicide program because your weed make up will change.

Cooperators

Stearns County Soil and Water Conservation District (SWCD), Waite Park, MN
Ag Resource Consulting, Inc., Albany, MN
John Dockendorf, Greenwald Elevator, Greenwald, MN

Project Location

The nearest town is Roscoe, MN. From the intersection of Cty. Rd. 10 and 1st St. (Cty. Rd. 114) in Roscoe head east on 1st St. for 1 mile, turn left onto 246th Ave. for 0.7 miles. Turn right onto 222nd St. for 0.7 miles, the field is located at the end of the road on the south side of the mailbox.

Other Resources

Midwest Cover Crop Council (MCCC).
Website: www.mccc.msu.edu

No-till Farmer Magazine.
Website: www.no-tillfarmer.com

Principal Investigator

Russell V. Martie
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Wright County

Project Duration

2015 to 2017

Award Amount

$11,937

Staff Contact

Alatheia Stenvik

Keywords

irrigation, soil moisture, water efficiency

Sub-surface Irrigation for Field Crop Profitability and Water and Fertilizer Efficiency

Project Summary

This project will compare three types of irrigation: 1) Subsurface Drip Irrigation (SDI), which was installed in an existing field in 2014, 2) a non-irrigated field, and 3) a center-pivot field. The objective of this project is to improve yields and profitability while utilizing irrigation water more efficiently and decreasing energy inputs.

Project Description

Russ has been farming for 42 years and currently operates about 400 acres. He grows several crops including corn, hay, and tiff grass. He is enrolled in the National Resource Conservation Service (NRCS) Conservation Stewardship Program (CSP), which includes the following activities: multi-species native perennials for biomass and wildlife habitat, wildlife friendly fencing, energy enhancement, water quality enhancement, and soil quality enhancement.

The idea for this project came from reading about SDI projects in Nebraska and other Great Plains states. Russ understands that rain is not guaranteed. He also knows he could do a better job with controlling the water he can access, which is ground water. Russ' farm is in the sand, which makes it difficult to use water efficiently. Water efficiency is important to Russ in terms of his long-term economic goals and his desire to make the farm more sustainable for the next generation. He is interested in growing 200 bu/A corn while being more efficient with water and electric use. He wants to provide area farmers with a data set that will allow them to improve resource conservation, improve profitability, and lessen ground water impact.

The following pieces of data are collected for this project:

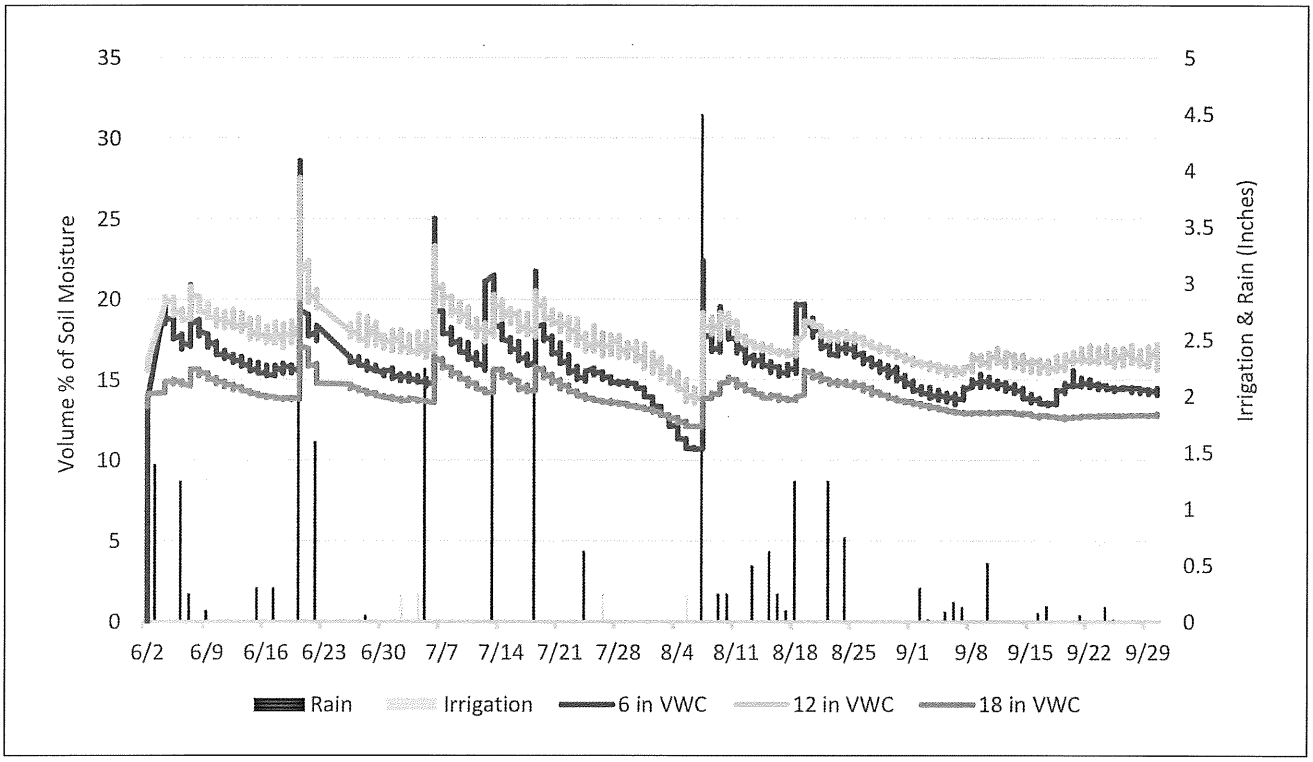
- water used;
- electricity used;
- soil moisture (3 probes per field that are buried at 6", 12", and 18");
- yield rates per field;
- air temperature;
- rainfall per field (rain gauge);
- planting date/rate, and;
- fertilizer rate (same for all 3 fields).

The timeline for this project runs from April through October. In April, the soil moisture sensors are installed when the soil temperature is suitable, which is around 45°F. In May, the sensors in each field are checked for water balance prior to planting. This data is inputted into the "ET Checkbook" to track daily information such as rainfall, irrigation, and air temperature. This information will provide other producers with an idea of soil moisture levels and water needed based on the stage of their crop for the upcoming summer months. This is the point where farmers can start to be smarter with water and energy usage but can still get the proper moisture to their plants in different stages of need. In October, yield rates are collected, final water and electrical use rates are documented, and fields begin to be compared.

2015 Results

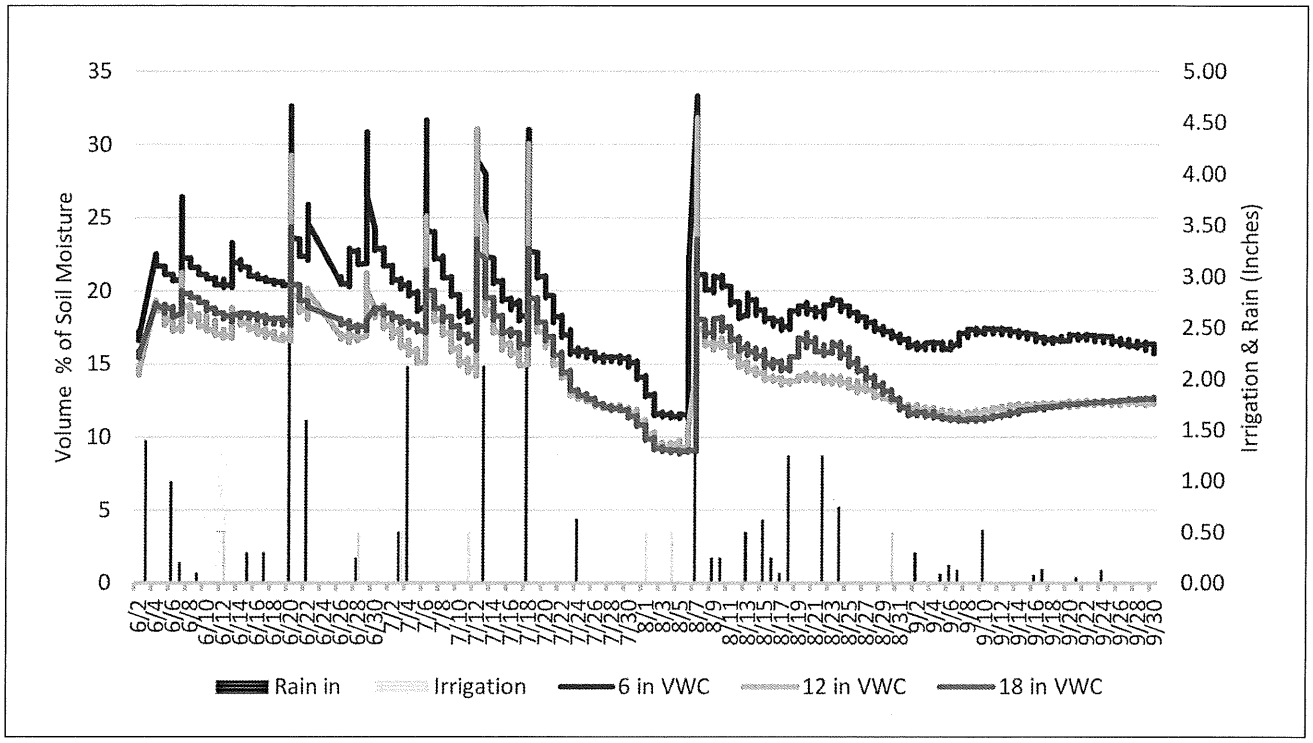
Russell believes the SDI style of irrigation was the most efficient in this past year. With SDI, the moisture level of the soil was controlled best so that it was saturated but not dry. This can be seen in the graph below. When SDI was utilized, the spikes in soil moisture levels did not vary as greatly throughout time as the other systems.

SDI Soil Moisture Rates 2015



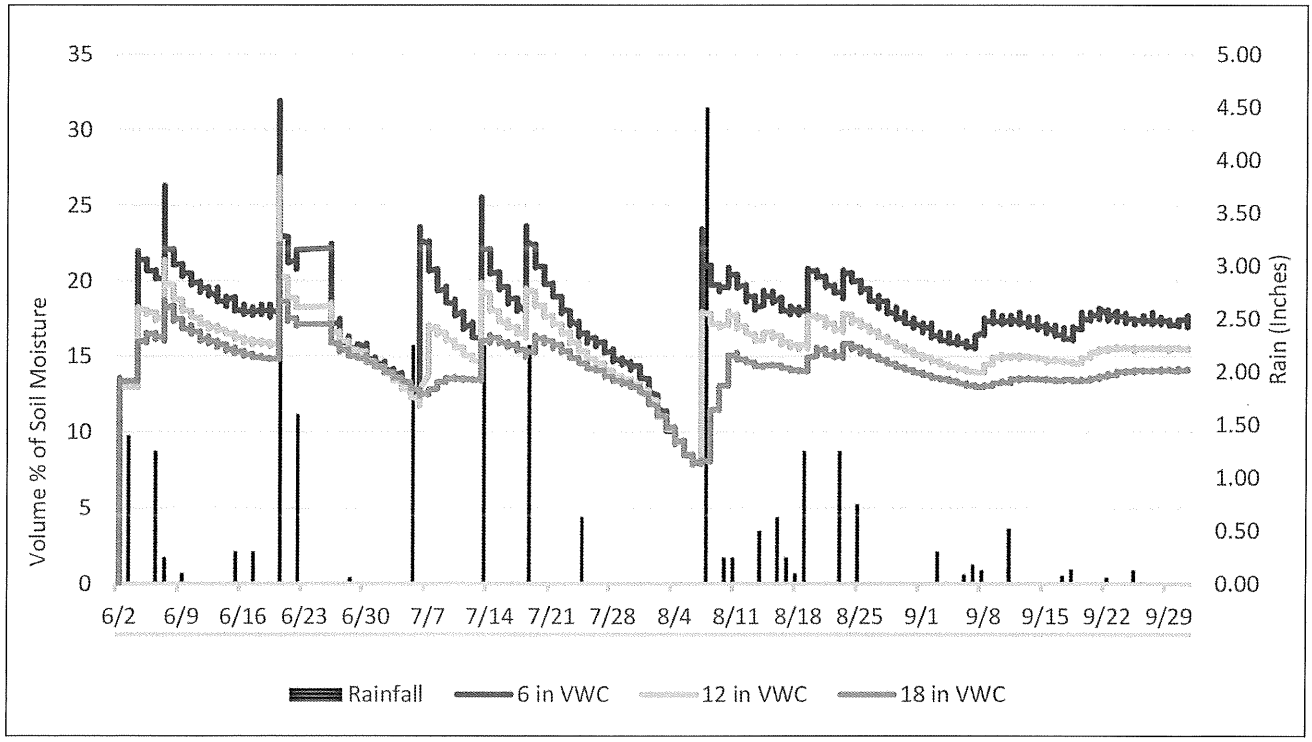
The center pivot system created some soil moisture consistency, but was not as consistent as the SDI system. In between rainfalls, when a center pivot system was used, this field consistently had higher levels of soil moisture than the non-irrigated field. The moisture was substantially more variable in the center pivot system than in the SDI system, which leads us to believe it is not as effective as the SDI system.

Center Pivot System Soil Moisture Data



The non-irrigated field had the lowest levels of soil moisture overall and the most variability in soil moisture levels. With this said, the center pivot system showed similar variations. When the last sample was taken, the non-irrigated field had higher levels of moisture at all depths than the center pivot system and similar levels to the SDI system. The SDI system had a higher level of moisture at the 12" mark, while the non-irrigated field had a higher level of moisture at the 6" mark. This means that the SDI system penetrates water into the soil more efficiently, which is important to consider at different stages in the crop's lifecycle.

Non-Irrigated Field Soil Moisture Data 2015



Management Tips

1. Have background information, such as data on your operation's current water and electrical usage, prior to investing in SDI so you know where it can help.
2. Installation of a well, especially in sandy soils, makes sure the flow of water is constant.
3. Install soil sensors as early as possible in order to have good base moisture information. It will help set up the year and understand what your newly planted field will need if it does not rain.
4. If you plan to incorporate fertilizer with your SDI system, start early with your agronomist as there is a learning curve.

Cooperators

Scott Wicklund, MIDC Enterprises, Roseville, MN
Johan Oostenbrink, Netafim Irrigation, Fresno, CA
Rod Greder, Extension Educator, University of Minnesota, Buffalo, MN
Josh Stamper, Irrigation Specialist, University of Minnesota, St. Paul, MN
Dan Nadeau, Wright SWCD, Buffalo, MN
Julie Reberg, Wright County NRCS, Buffalo, MN
Katie Evans, Wright County NRCS, Buffalo, MN

Project Location

From Minneapolis/St. Paul, go west on I-94. Exit onto Cty. Rd. 8. Turn right onto Cty. Rd. 8. Take the second right onto 150th St. Site is 1 mile down on the left.

Cover Crops to Replace Fall Tillage in the Shakopee Lake Bed

Principal Investigator

Robin Moore
Land Stewardship Project
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Chippewa County

Project Duration

2015 to 2017

Award Amount

$22,578

Staff Contact

Alatheia Stenvik

Keywords

cover crops, soil health, tilling

Project Summary

The Land Stewardship project developed this study to analyze the effects of cover crops on soil compaction in the Shakopee Lake Bed area of west central Minnesota. Specifically, the project will determine if including tillage radish in a multi-species cover crop blend, planted in 2 consecutive years, can alleviate root zone compaction and reduce the need for primary fall tillage. The change in biological activity in the fields will also be tracked utilizing the Haney Test.

Project Description

In the initial year of this project, the Land Stewardship Project enlisted two farmer cooperators faced with soil compaction issues in different agronomic situations.

Mark Erickson runs a grass-fed beef operation and was concerned about a poorly performing pasture. Initially, Mark thought that he should till and replant this pasture. The tillage history of this field consisted of decades of moldboard plowing, which had likely contributed to a deep compaction layer that conventional tillage methods would not correct. He hoped that the inclusion of tillage radish in a cover crop blend would improve the condition of his soils, reduce the compaction, and create conditions that would allow him to reseed the pasture without further tillage.

Jess Berge has a diversified farming operation, including cattle, sheep, and row crops, that he is transitioning into no-till. The field that Jess is evaluating was an alfalfa field with heavy, poor soil. It had suffered substantial winterkill during winter 2014/2015. This field has heavy, poor soil. Spring field preparation consisted of a shallow tillage pass and herbicide application to weaken the existing alfalfa crowns. Silage corn was then seeded with a no-till planter. The corn crop was harvested as baleage and on the next day, August 20, the oats-radish-forage turnip blend was drilled in.

2015 Results

Mark Erickson

In order to prepare the pasture for seeding, Mark mowed and baled the grass 1 week before seeding. He then drilled the radish mix, which also contained clover and oats, into the pasture on August 23. Then he turned the cattle into the field with the intention of grazing to keep the competition down until the mix germinated. He kept the cattle there for a while and even fed some hay, but unfortunately, due to dry conditions, he had to remove the cattle after a short time. Before seeding, the pasture received 7/10" of rain on July 27 and 1" on August 7. It didn't rain again until September 20, at which point the grass had begun to grow again (although not well). Germination seemed very poor. Mark is not sure whether things germinated and died due to competition for moisture or whether it simply did not germinate at all. He assumes that will be clear next

spring; if the radishes germinate in the spring, he will see their white flowers when they inevitably bolt. When taking soil samples in mid-October, the radishes only had some spotty germination. He was very disappointed and next year plans to both seed much earlier, in the first week of August or the end of July, and he will have the ability to irrigate if the dry trend continues. Mark plans to continue drilling and will not till the pasture.

Jess Berge

The field that Jess used had been in alfalfa. Due to the open winter of 2014/2015 and poor soils, this field suffered from heavy winterkill. In the beginning of the year, Jess did some shallow tillage to set back the alfalfa crowns and then applied the herbicide Clarity®, which has a 3 month residual that should not have affected the cover crop. He applied Clarity® to a different field that he seeded with cover crop 1 week before the demonstration field, which did not affect germination. When he no-till planted corn there was still some alfalfa. Since Jess had been hearing about diversification from farmers like Gabe Brown and Jerry Doan and had had some good experience with companion planting the year before, he decided to no-till silage corn directly into the weakened alfalfa. The corn and the alfalfa seemed to flourish and Jess said that yields in the demonstration field were comparable to yields in his other fields.

After baling the silage, Jess drilled a tillage radish mix including radish, oats, and forage turnips on August 20, which was the day after silage removal. Unfortunately, it did not rain again until late September, similar to Mark. In December 2015, Jess reported that he had two silage fields planted into a radish mix, one for this grant and one on another farm. The other farm, that he seeded 2 weeks before the demonstration field, had very good results with the tillage radish. The demonstration field did not perform, leading us to believe that moisture was the main problem. When Jess and his project cooperator went out for fall soil samples, the ground was so hard that the soil probe would barely enter the soil and the radishes were just starting to germinate. By December, there was a little growth on the field, about 2" at best. He put cattle on the field for a week to get some forage from the oats he seeded in with the radishes and the alfalfa, which was re-growing a little. Jess had hoped that the use of no-till would help with soil structure and provide more residue, giving the radishes a better chance.

Next year Jess plans to plant a mix for haylage with oats and peas. He uses haylage in his livestock operation and thinks that the earlier harvest will allow him to plant much earlier, giving the radishes a better chance to work on the intense compaction in that area. He plans to keep no-tilling in that field, hoping that it will help with moisture retention since irrigation is not an option for him.

We will not have any reportable measurements until spring of 2016, which is when we will conduct a field test for compaction and compare it to the baseline from this year. Although we conducted both spring and fall Haney tests on the fields, they did not provide any information involving the cover crops since they were either not present or barely germinated. Next year, we will provide a comparative set of data to start measuring any effects. Finally, the farmer's knowledge and experience of the field will give good anecdotal response to any changes they see in the field after the radishes.

Management Tips

1. Try and plant cover crops earlier to get a better crop.
2. Moisture retention is key in establishing a cover crop. Next year, both farmers will work harder to keep the ground covered and moist.

Project Location

Mark Erickson: from Morris, go 8 1/2 miles north on Cty. Rd. 5. Go 1/2 mile west on 140th St. to 50114 - 140th St.

Jess Berge: from Sunburg, go west 2 miles on Cty. Rd. 9. Go north on 170th Ave. to 480 – 170th Ave.

Cooperators

Jennifer Hoffman, Chippewa River Watershed Project, Montevideo, MN
Sharon Weyers, Research Soil Scientist, North Central Soil Conservation Research Lab, Morris, MN

Principal Investigator

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Hennepin County

Project Duration

2015 to 2016

Award Amount

$6,716

Staff Contact

Alatheia Stenvik

Keywords

cover crops, corn silage-soybean rotation, forage

Three-crops in Two Years for Farm Profit and Water Quality: Winter Rye after Corn Managed for Spring Forage

Project Summary

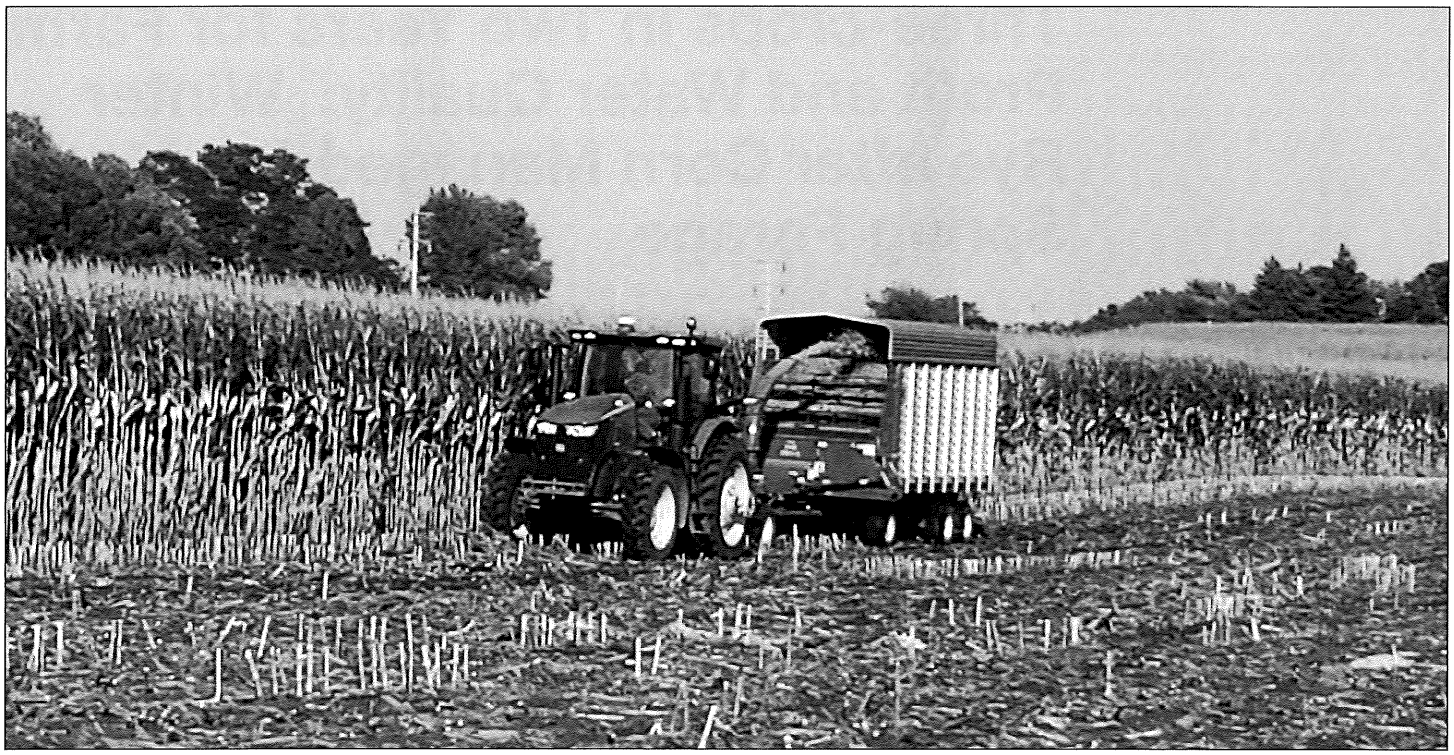
Our 2 year project will assess the feasibility of including winter cereal rye as a cover crop in a corn silage-soybean rotation on a dairy farm. The timing of a winter rye cover crop planting is a challenge for livestock farmers who are considering the possibility of including a third crop into a corn silage-soybean rotation. Successfully establishing a cover crop is largely dependent on planting during the small window of time following corn harvest and fall manure application.

Corn silage, as opposed to corn harvest for grain, gives dairy farmers a better opportunity to plant winter rye early in the fall. This allows the winter rye to establish well. Timing the spring forage harvest is also critical since the rye needs to be harvested at a maturity that optimizes forage quality and does not delay planting the soybean or subsequent crop. The feed quality of winter rye harvested as forage quickly diminishes as the plant enters boot stage. Any delays due to weather or field conditions can mean the difference between harvesting feed of high quality and feed that is low quality. We will track the quantity and nutrient value of the forage harvested. The performance of the dairy herd will be assessed by monitoring milk production and the body condition of the cows. Palatability of the forage will be assessed by monitoring how readily the herd consumes the rye silage. At the end of the project, a cost benefit analysis will be conducted on the incorporation of the rye cover crop into the corn silage-soybean rotation.

Project Description

The land that we farm has been in our family for nearly 100 years. We live on this land and want to be good stewards not only to benefit our family, but also to provide environmental benefits for the neighbors surrounding us. The importance of improving and maintaining our land's soil health and productivity was magnified when my son joined my wife and me as the sixth generation to farm this land. Our operation consists of a 70 cow dairy herd raised on the 400 acre farm, which includes 30 acres of pasture. We utilize a corn-soybean-alfalfa rotation in our crop production system. We rely on soil testing data to develop our soil fertility program and to determine appropriate manure application rates.

The use of winter rye or other winter grains as cover crops is a proven but underutilized cropping system in beef and dairy operations. Winter grains planted as cover crops have the potential to bring added value to a livestock operation by providing a low cost, high quality feedstock for a dairy or beef herd. The use of cover crops allows farmers to significantly reduce sediment and nutrient runoff from their operations, which protects the surface waters that we enjoy in Minnesota. Cover crops also protect our valuable soils from wind erosion losses.



Silage Harvest on September 15, 2015. Photo by Daryl Patnode.

2015 Results

Our project began on September 15, 2015 when we chopped our corn silage crop. Our average silage yield for 2015 was 27 tons/A. On September 20, manure was applied at a rate of 1,000 gal/A and incorporated using a field cultivator. The next day, we seeded the winter rye cover crop at a rate of 120 lb/A. On December 7, the rye was 4" tall and looked good. In next year's article, the results will be reported.

Winter Rye Cover Crop on December 7, 2015. Photo by Karl Hakanson.

Cooperators

Karl Hakanson, University of Minnesota Extension, Hennepin County
Kent Solberg, Dairy Farmer, Cover Crop Practitioner and Livestock and Grazing Specialist, Sustainable Farming Association of Minnesota, Verndale, MN
Dale Hanson, Agronomist/Seed Sales, Luxemburg Feed, St. Cloud, MN
Rod Gustafson, Agronomist, Federated Co-op, Albertville, MN

Project Location

From the intersection of Hwy. 55 and Cty. Rd. 19 in Loretto, drive north on Cty. Rd. 19 to the intersection with Cty. Rd. 50. Turn right and drive 1 block east. Our dairy farm is located on the southeast corner of the intersection of Cty. Rds. 19 and 50. The project site is in the field on the east side of the farm.

Other Resources

1. Sustainable Agriculture Network. Managing Cover Crops Profitably: Third Edition. Beltsville, MD. 301-504-5236. Website: www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition
2. Midwest Cover Crops Council. Website: www.mccc.msu.edu
3. Minnesota Department of Agriculture. Cover Crops Research and Demonstration. Website: www.mda.state.mn.us/protecting/conservation/covercrops.aspx#soilhealth
4. USDA-NRCS. Cover Crops and Soil Health. Website: www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/landuse/crops/?cid=stelprdb1077238
5. USDA-NASS. 2015 State Agriculture Overview. Minnesota. Website: www.nass.usda.gov/Quick_Stats/Ag_Overview/stateOverview.php?state=MINNESOTA
6. Minnesota Pollution Control Agency. Nutrient Reduction Strategy. Website: www.pca.state.mn.us/index.php/water/water-types-and-programs/surface-water/nutrient-reduction/nutrient-reduction-strategy.html
7. Minnesota Pollution Control Agency. Sediment Reduction Strategy for the Minnesota River Basin and South Metro Mississippi River. Website: www.pca.state.mn.us/index.php/view-document.html?gid=20703
8. University of Wisconsin-Madison Extension. Planting Winter Rye after Corn Silage: Managing for Forage. Website: http://ipcm.wisc.edu/download/pubsNM/Rye_090507_final.pdf
9. Journal of Soil and Water Conservation. Vol 47. No. 1. 14-16. Why farmers adopt production technology. Overcoming impediments to adoption of crop residue management techniques will be crucial to implementation of conservation compliance plans. Website: www.jswconline.org/content/47/1/14.extract

No-till Cover Crop Rotation vs. Intensive Tillage in Corn-soybean Rotation

Principal Investigator

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Project Duration

2014 to 2016

Award Amount

$15,809

Staff Contact

Cassie Dahl

Keywords

no-till, corn, soybean, soil health

Project Summary

My project is to compare the soil health and economics between cover cropped no-till plots with a wheat-corn-soybean rotation, and intensively tilled plots with a corn-soybean rotation. The corn-soybean rotation is the most common rotation used in west central Minnesota. Most of these rotations involve aggressive tillage to bury residues and make the fields "black".

Project Description

My farming operation consists of 474 acres in Grant County of west central Minnesota. My soils are classified as loam and clay loam. These soils are fairly drought resistant. The last couple of years my plantings have consisted mostly of a tilled corn-soybean rotation. However, I was noticing a lot of soil erosion and wanted to try and slow that down, so I started using no-till production methods on some of my soybean fields. For the typical corn-soybean rotation I have always used a chisel plow after soybeans and a disk chisel after corn. For equipment, I have a John Deere 1590 no-till drill with 7.5 or 15" row spacing and a Great Plains Turbo Till vertical tillage tool for keeping residue on the soil surface. I found that I was getting good yields from the no-till soybeans and soil erosion was less on these fields compared to my tilled fields. From this research I want to determine if no-till production methods with cover cropping can be profitable, improve soil health, and slow erosion off my fields.

For the experiment, I set-up ten plots each slightly over an acre in size within a field that was planted with soybeans the year before. Four of the plots will be in a tilled corn-soybean rotation. The other six plots will be in a no-till wheat-corn-soy rotation with cover cropping. This year two of the tilled plots were in corn and two were in soybeans. The no-till plots had two in spring wheat, two in corn, and two in soybean. I am continuing with this rotation for the second year of the experiment.

Winter wheat plot that was seeded with cover crop mix in early November.

I have three objectives for the project. The first is to improve soil health. The second is to show that the economics of a wheat-corn-soybean rotation utilizing no-till and cover cropping is as profitable as or more so than the tilled corn-soybean rotation. Lastly, I would like to successfully demonstrate that we as farmers can reduce the erosion of our soils from winter winds and summer rainstorms by protecting it with cover cropping and no-till management.

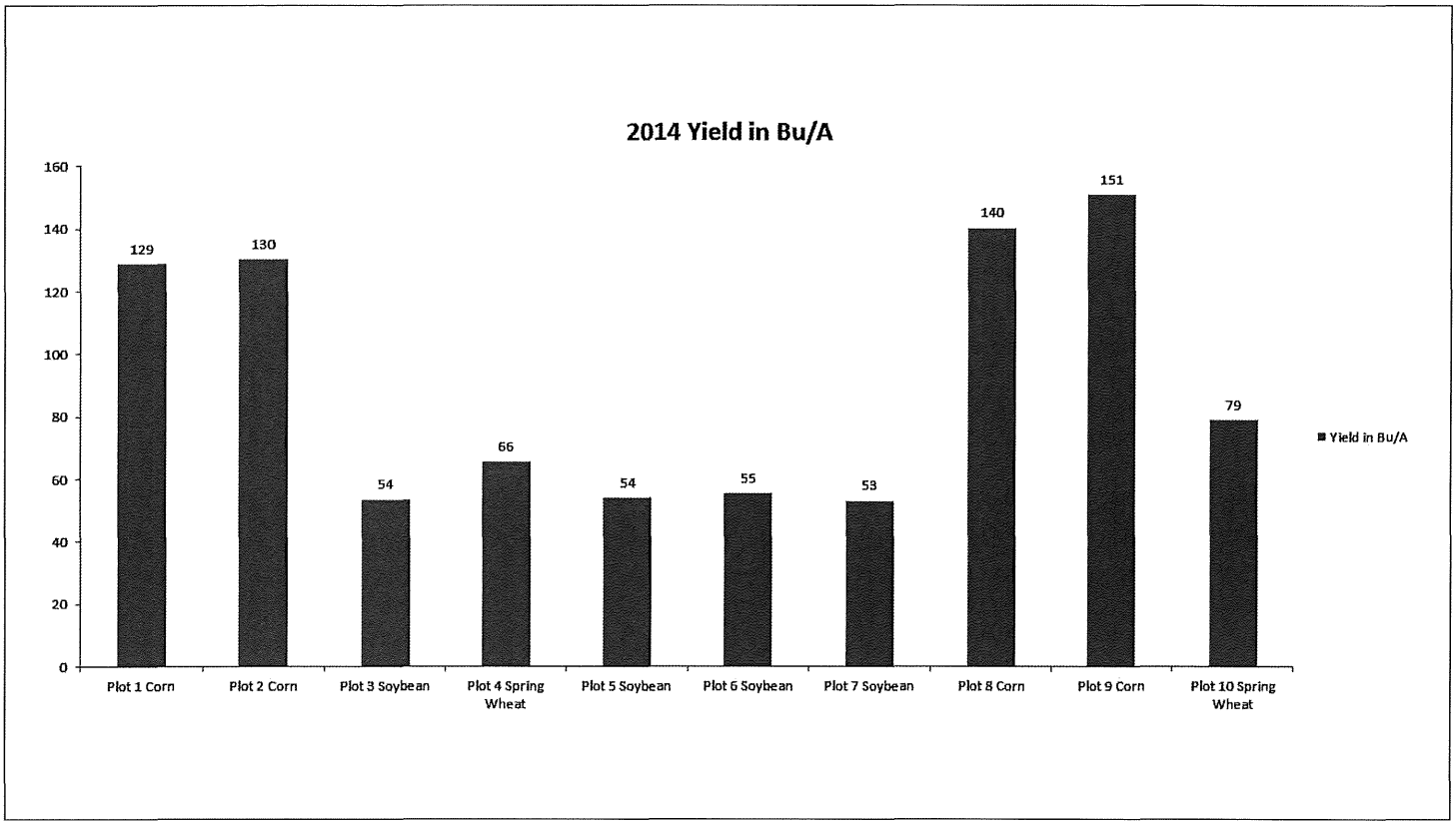
This project is important to me because I see soil as one of the most overlooked resources. I hate to see our most valuable resource end up as black snow in road ditches and waterways, or carried off our fields by heavy rains and flow into our lakes and rivers. Keeping the soil in our fields is important to all of society and my children because it can help with sustainable food production and clean water. If I can show that no-till cover cropped fields in wheat-corn-soybean rotations, not only benefit the environment and society, but is also economically viable for Minnesota farmers, it would be a win-win situation.

After laying out the plots this spring, Paul Groneberg took soil samples from all ten plots. We wanted to create a baseline of soil health and nutrient levels for each plot. We sent soil from each plot to Cornell Labs, Ward Labs, and Agvise Labs. Agvise did a general soil test for nutrients, pH, salts, and organic matter. Ward and Cornell labs each had a different soil health test. Paul also took residue counts after planting. During the summer Paul took tissue tests to monitor crop health. Then this fall I kept track of yields from all ten plots, measured aboveground biomass from the cover crop plots, and again Paul took soil samples from all ten plots and then sent them this time only to Agvise for the general nutrient test. I also kept track of inputs and field work activities.

2014 Results

The focus of the first year of this project was to gather baseline data. This data will serve as a reference point in a long-term study beyond this grant period. The soil in the plots is a Barnes-Svea loam soil. The ten plots have 25-39% sand, 41-49% silt, and 20-26% clay. The baseline overall quality scores from Cornell were all in the medium range with the most limiting factors coming from available water capacity, aggregate stability, ACE soil protein index, and respiration. Tillage can negatively impact these factors. The Ward Labs results for soil health showed that four of the plots scored below seven while the other six plots scored above seven. Also from Ward Labs, the Microbial Biomass test showed that seven plots fell into the average category, one plot fell into the slightly above average category, and the other two plots were in the good category. Agvise was used for both spring and fall soil sampling to measure nitrogen, phosphorus, potassium, zinc, salts, organic matter, and pH. The pH averaged 7.5 across all ten plots while the organic matter averaged 4.4% across the ten plots. Phosphorus and potassium increased from west to east or from plot 1 to 10. This is because the farm had cattle who contributed manure to the farm more than 10 years ago.

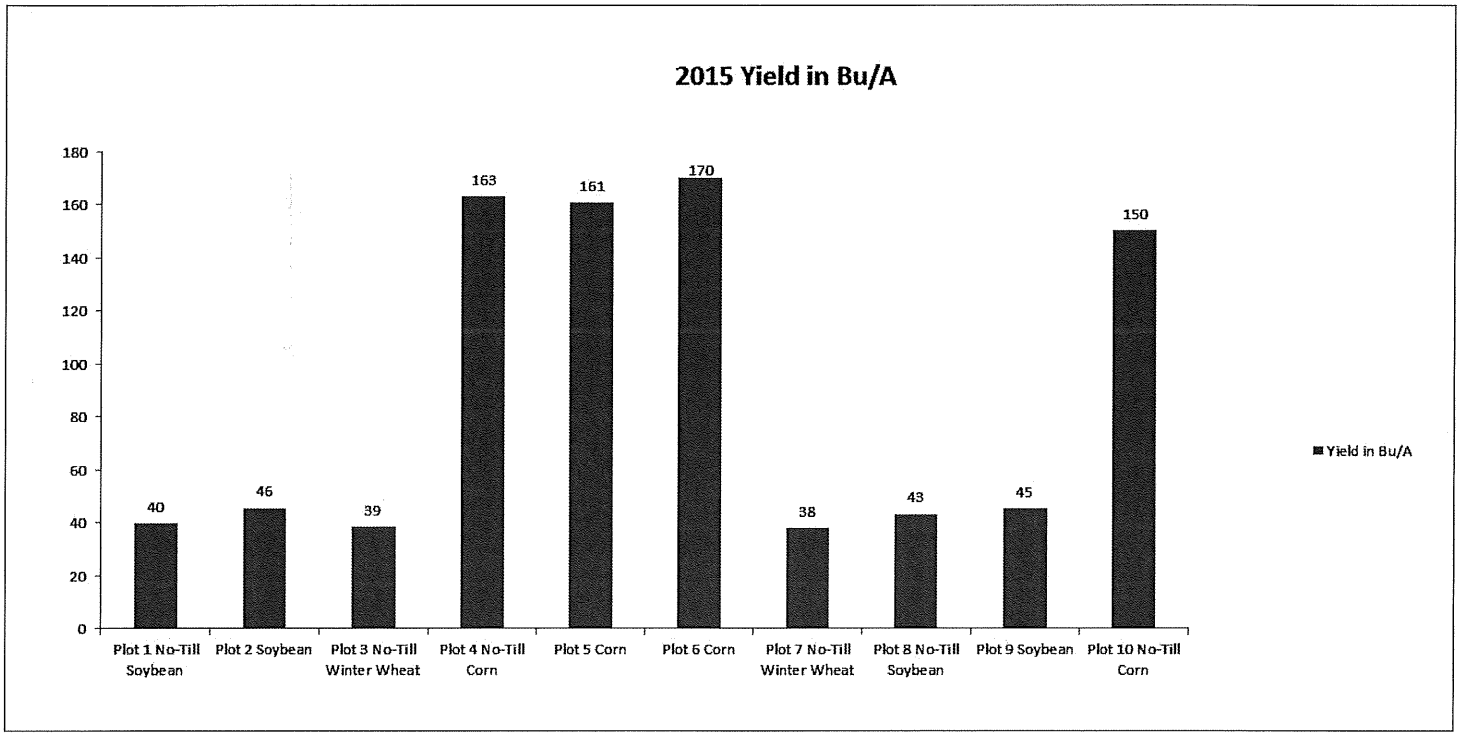
The plots averaged 31% residue cover after one pass with a field cultivator, a pass with a Great Plains Turbo Till, and the planting pass. This will be the last time six of the plots will be tilled for the duration of this study. The economic results are being tracked and will be summarized after the third year. See the graph below for yields in year one. Corn yields were below average and suffered from nitrogen being lost due to excessive spring rainfall. Cool summer temperatures also lowered corn yields as did the late planting date due to spring's cold wet conditions. Soybean yields were very good in the mid 50 bushel range for a 0.5 maturity soybean. An early soybean was chosen for early harvest to give time to plant winter wheat into plots 3 and 7 after the harvest. Wheat yields were quite good, although the late May planting date was a month behind normal.



The no-till cover cropping system had costs for cover crop seed that was $23/A for plots 1 and 8 and $22/A for plots 4 and 10 along with the costs associated with running the tractor and no-till drill on plots 4 and 10. The four tillage plots had costs that are associated with the two passes with a sunflower disk chisel this fall. All spring tillage costs were the same for each plot. Aboveground cover crop growth was less than normal this year, after the spring wheat harvest, in plots 4 and 10 due to the late harvest of the wheat on September 5, 2014. The cover crop seed mix was from Millborn Seeds and contained 30% cover crop radish, 20% annual ryegrass, 15% common vetch, 15% crimson clover, 15% lentil, and 5% sunn hemp. Cover crop growth in corn plots 1 and 8 was small but emergence was very good, due to really nice rains that occurred after I hand spread the seed into the corn. Hand seeding was used to simulate aerial application. The mix was from Millborn Seeds and contained 30% annual ryegrass, 20% crimson clover, 20% cover crop radish, 20% turnip, and 10% dwarf essex rape. The two winter wheat plots had good emergence although growth was limited due to the late planting on September 26, 2014. Time will tell if this affects winter survival. The one thing I did not count on for the first year of this study was the late wet spring and the cool growing conditions. I am excited to go into year two of this study with the no-till cover crop plots in place.

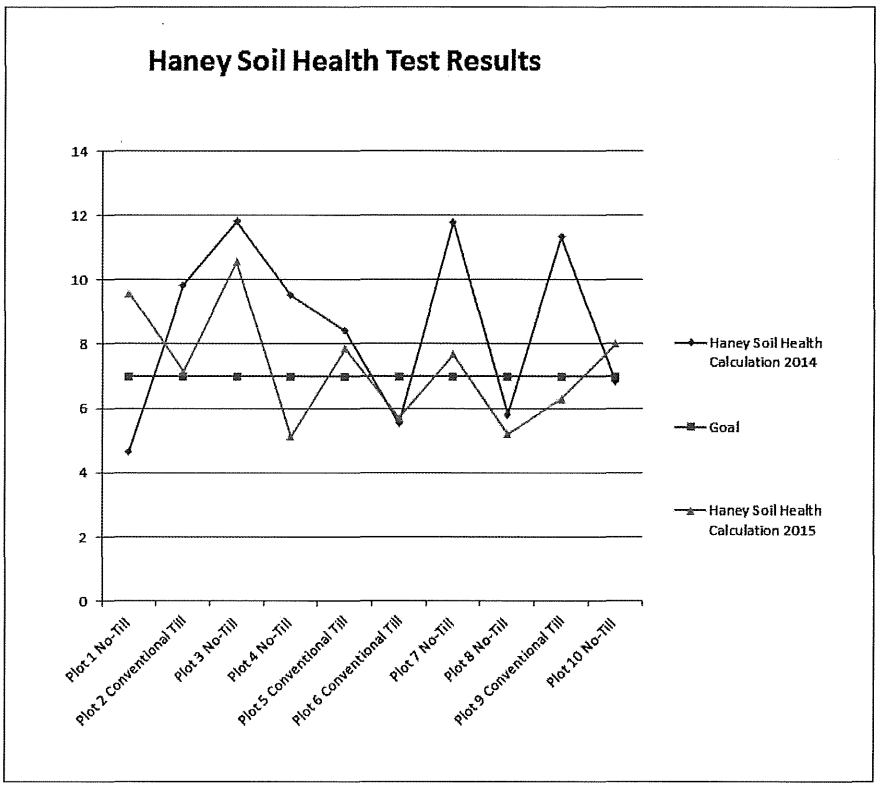
2015 Results

Year two of this study got off to a great start with an early spring. Winter wheat survival was good but not great as we had an open cold winter season. As it was though, the stand was adequate and was soon top dressed with 100 units of nitrogen. Corn planting in all the plots took place in the last days of April and the soybeans soon followed in the first days of May. All planting conditions were good. Crop growth was good with only one of the no-till corn plots a little "slow" due to a lot of wheat residue.

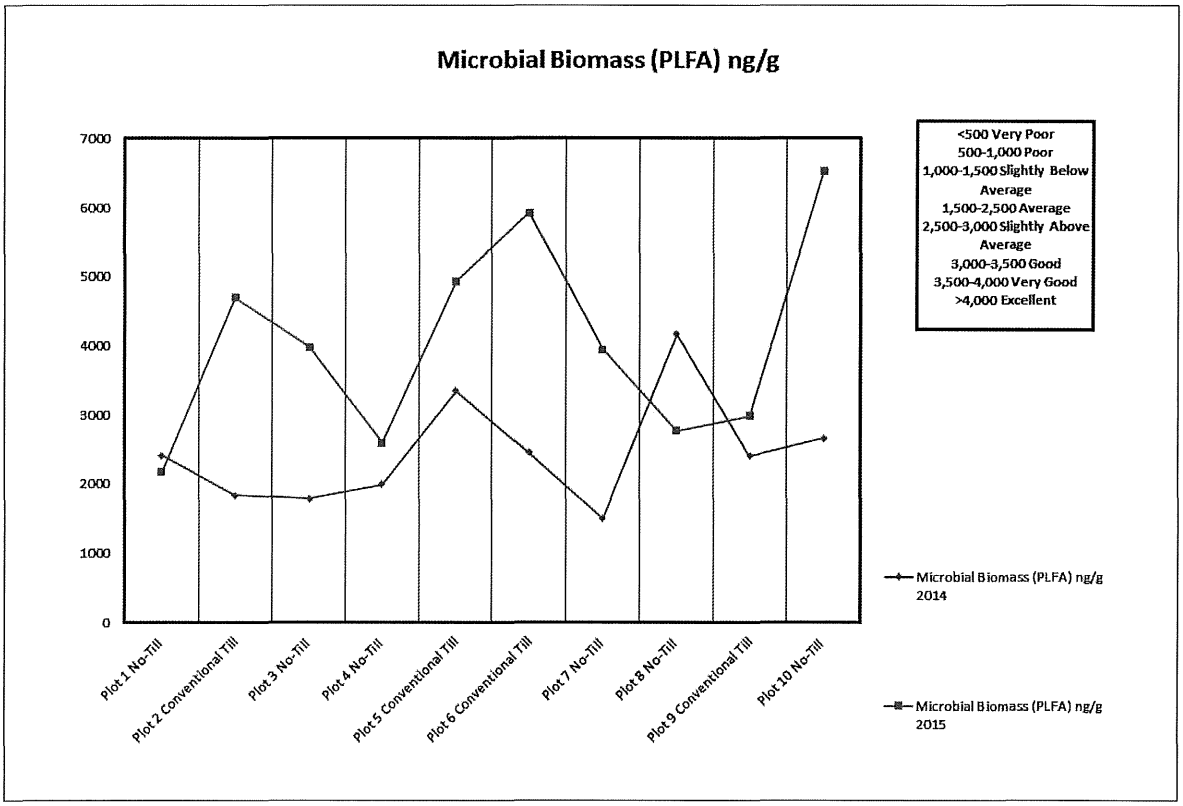


There was a severe hail storm on all of the plots on July 12th along with 3.5" of rain. Estimates were 20 bushels of wheat were lost to shelling and broken stems and 20-30 bushels of corn were lost due to plant damage. The soybeans had some yield taken also although they compensated the most of the three crops. You can see in the yield results that the no-till soybeans yielded slightly less than the conventional tillage soybeans, the winter wheat plots yielded similar to each other, and in the corn the lowest yielding plot was the plot with the most wheat residue while the other three corn plots all yielded similarly.

With the early harvest of wheat, I had excellent cover crop growth on those plots. The cover crop mix was from Millborn Seeds and contained 30% cover crop radish, 20% annual ryegrass, 15% common vetch, 15% crimson clover, 15% lentil, and 5% sunn hemp. The late fall also allowed the cover crop growth in the corn plots to grow more than last year. That mix was also from Millborn Seeds and contained 30% annual ryegrass, 20% crimson clover, 20% cover crop radish, 20% turnip, and 10% dwarf essex rape. Winter wheat establishment was also excellent with better fall growth than last year. Plenty of rain fell with a total of 21.3" falling from planting to freeze up.



I did notice some trends in regards to the soil health parameters. In general, the Haney soil health measurements were lower in 2015 than in 2014, and in general the Microbial Biomass and Cornell Quality scores were higher in 2015 than in 2014. I cannot say that I see any big differences yet between the no-till cover crop plots and the conventional tillage plots, but I suspect these differences will appear slowly and even beyond the 3 years of this study. However, one difference in year two was the greater amount of residue remaining on the no-till plots with significantly less appearing on the conventional tillage plots. The soil is being protected in the no-till plots.



Management Tips

1. Plan extra time to set-up your row cleaners when no-tilling corn into wheat stubble.
2. Pay attention to the set-up on the no-till drill when seeding soybeans into no-till corn stalks.
3. Be patient with a thin strand of winter wheat because it will tiller out much more than spring wheat.

Cooperators

Paul Groneberg, Crop Consultant; St. Hoffman, MN
Jodi DeJong-Hughes, Regional Extension Educator, Wilmar, MN

Project Location

The plots are located on the north side of Cty. Rd. 2 approximately 3 miles east of Barrett in Grant Cty. MN. They are in Elk Lake Township, section 16. Visitors are welcome.

Other Resources

Jill Sackett's Minnesota Cover Crops email list, email: mn-cover-crops@lists.umn.edu

Principal Investigator

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Project Duration

2014 to 2016

Award Amount

$17,663

Staff Contact

Mark Zumwinkle

Keywords

hazelnut, high bush cranberries, chokecherries, juneberries, honeyberries

Developing an Integrated Perennial System

Project Summary

We are creating an integrated perennial system combining plantings of hybrid hazelnut seedlings and native berry plants (choke cherries, cranberries, juneberries, and honeyberries) on a plot of land with low soil quality to study the capacity of the system to revitalize soil nutrient and add economic value for farmers in northern Minnesota (zone 3b). The system is being initiated using cover crops to prepare the land for the perennials

Fish fertilizer from the Akina Red Lake Fishery will be applied using a traditional indigenous method to half of the plot. We will conduct soil testing and leaf nutrient concentration testing to ascertain data on soil nutrient quality and plant nutrient uptake during the course of the research project. This initiative will aid farmers in our zone who are looking to implement a traditional and sustainable agricultural model that may both improve their soil nutrient quality and augment the economic value of their operations.

Project Description

The cropping system for the White Earth Land Recovery Project farm includes many enterprises and community services. We cultivate traditional annuals such as corn, beans, and squash as well as producing maple syrup. On this project, we are focusing on the educational research and development of growing hybrid hazelnuts in our zone. We will be using a drip irrigation system with liquid fertilizer of fish emulsion as well as tilling in fish guts.

The soil in which we have chosen to plant our hybrid hazelnuts and berry plants consists of a desirable well-drained sandy loam. We still need to work on raising the nutrient concentration of the soil on this plot during our first year.

In the second year of the project, we will obtain bare-root dormant hazelnut seedlings for our system from two sources: Forest Ag Enterprises and Lois Braun (research associate with the University of Minnesota College of Food, Agricultural and Resource Sciences). These hazelnut seedlings are hybrids between the European hazelnuts and two species native to North America. Hybrid hazelnuts grow as bushes rather than trees.

Woody perennial crops, such as hybrid hazelnuts, provide farmers with economic and ecological benefits. They improve the health of the surrounding ecosystem by reducing soil erosion, improving water quality, improving wildlife habitat, and reducing inputs. Planting hazelnuts on marginal lands may provide farmers with a means of obtaining economic returns without incurring further ecological damage. Finally, hazelnuts have the potential to diversify our terrain and serve as an economic stimulus to the Upper Midwest.

Our native berry species, juneberries, and honeyberries, have historically been used as important sources of nutrients, require few inputs, and show potential for cultivation as commercial crops in our region.

2014 Results

The first year of this project was intended as a preparation year, mainly to build up soil fertility and prepare the ground for planting the perennials. This year, we accomplished most of our goals. Our soil test recommendation showed minimal need to add phosphorus and potassium so we only added fish guts. We applied fish guts to half of the field and tilled them in. The other half of the field was left as a control. We then broadcast seeded buckwheat in the middle of July. The buckwheat grew nicely and evenly throughout the designated area for the integrated perennial system, which is roughly one acre. The buckwheat competed well with weeds.

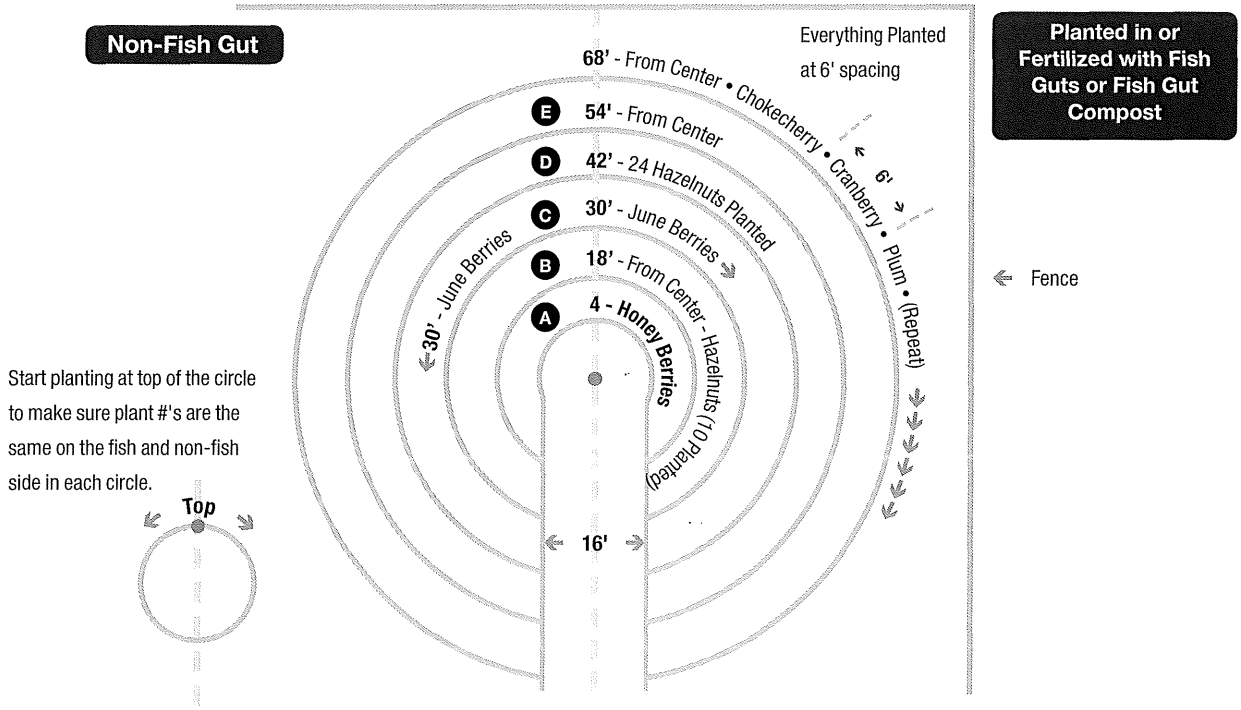
We mowed the buckwheat in the early flowering stage and broadcast seeded a mix of winter rye and hairy vetch on September 1. The rye and vetch did not visibly germinate before snow cover. Perhaps they needed some more ground cover. We will see what happens in the spring.

The buckwheat did a good job of competing with weeds.

Nearly all analysis and experimentation for this project will come in year 2 and 3 when we plant the majority of our perennial crops and perform leaf nutrient concentration tests and further plant and soil analysis.

2015 Results

The soil tests taken in 2014 and 2015 reveal the nutritional benefits of applying buckwheat, rye, vetch cover crops, and fish guts. Bray Phosphorus has been raised from 58 parts per million in 2014 to 65 parts per million in 2015. Potassium has been raised from 97 parts per million in 2014 to 120 parts per million in 2015. We planted 78 fruit trees in the spring of 2015 in a circle pattern (see diagram below). We altered the original design to better fit the lay of the land. Fish guts were only applied to the right side of the circle. We are working on our irrigation system to deliver fish fertilizer. In order to accomplish the tree plantings we hand shoveled fish guts at least one foot below each plant on the right side of the circle. We planted each plant carefully with instruction from our advisors on the project.



Row D was planted in the fall of 2014, and rows A, B, C, and F were planted in late May 2015 as shown. Row E will be planted in the spring of 2016. We used a 6' spacing, because we want a hedgerow effect. The trees were ordered through the NRCS Detroit Lakes Field Office. We ordered an additional 50 raspberry plants from Ag Resources in Detroit Lakes and planted one row in fish gut fertilized soil and the second row in unfertilized soil.

All trees grew well and produced leaves. Trees that received fish fertilizer had significantly darker green foliage. We placed landscape fabric around all trees in the late fall to protect from frost and reduce weed pressure.

We are building a fence to protect the trees from deer as there was some damage done to the trees. The fence posts were ordered in late September and we were only able to get up about half the posts. We will finish in the spring of 2016. All materials are ordered so the remainder of the fence will go up fast.

Management Tips

1. Buckwheat works well as a warm season cover crop. It works well in our northern climate and adds a lot of beneficial nutrients to the soil when mowed, tilled in, or grazed.
2. Rye and vetch grow rapidly in spring so be prepared to till them under early.
3. Test your cover crop seeds for germination if you are unsure of how they were stored.
4. When you are using fish guts, till them in immediately before they start to rot. The soil dampens the scent more than if they were in open air.

Cooperators

Lois Braun, University of Minnesota, St. Paul, MN
John Munter, Hazelnut Grower, Warba, MN
Adam Woltjer, USDA-NRCS Tribal Liason, Mahnomen, MN

Project Location

Contact Margaret Rousu for directions to the farm site.

Other Resources

Restoration Agriculture. Mark Shepard. 2013.

Gaia's Garden: Second Edition. Toby Hemenway. 2009.

Hybrid Hazelnuts. Lois Braun and Jeff Jensen. Rural Advantage, Fairmont, MN
www.extension.umn.edu/environment/agroforestry/components/hybrid-hazelnuts.pdf

A Demonstration of Biological Primers on Drought Prone Soils

Principal Investigator

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Project Duration

2013 to 2015

Award Amount

$20,300

Staff Contact

Mark Zumwinkle

Keywords

cover crops, biological primers, grazing, water holding capacity, soil health

Project Summary

A large number of demonstration projects in Minnesota have evaluated the use of cover crops using one, two, or three cover crop species such as annual ryegrass, oats and turnips. Recent work in central North Dakota has focused on cover crop "cocktail" mixes that include eight or more species. These cocktails (also known as "biological primers") have demonstrated their efficacy in improving soil health. They have the potential to increase producer profitability by:

- reducing soil erosion;
- conserving soil moisture;
- reducing cropping input costs; and
- reducing livestock feed costs by providing forage during droughts.

The potential for biological primers to impart drought tolerance has been particularly evident in recent research. Trials in Ohio and North Dakota indicate that biological primers have tremendous potential even under adverse cropping conditions. Biological primers dramatically outperformed cover crops made up of one, two, or three species in side-by-side trials in North Dakota during the drought year of 2006. Corn grain trials during the 2012 drought in Ohio showed a 30 bu/A advantage using biological primers when compared to a two species cover crop blend.

Many producers in central Minnesota who farm on drought prone sandy soils have added irrigation systems to minimize drought risk. Biological primers have demonstrated efficacy during drought or in drought prone soils and may prove to be an alternative to capital intensive irrigation systems. Sandy soils also have high rates of nutrient leaching. Biological primers can be designed to sequester soil nutrients, thus reducing crop inputs by holding surplus nutrients for subsequent crop use. Producer profitability may be increased through lower fertilizer cost, while reducing the potential for high nitrates in the ground water.

Work in North Dakota indicates that biological primers appear to be most cost effective when crop and livestock systems are integrated, and when included as part of a broad crop rotation program.

Our goal is to demonstrate the efficacy and versatility of biological primers in integrated crop and livestock systems. We hope to show their capacity to improve soil health, produce forage, and reduce producer input costs in drought prone soils in central Minnesota. We want to introduce producers to biological primers and develop a core group of experienced producers that can serve as a resource to others.

Project Description

No two farming operations are the same. This project was developed to demonstrate the adaptability of biological primers based on individual farm needs and goals. Four integrated crop and livestock farms in central Minnesota were identified: two dairy related operations (one dairy and one custom dairy heifer grazier) and two beef operations. All farms are dominated by sandy soils. One farm has irrigation. Two farms are certified organic.

The design of individual biological primer mixes was customized to each farm and field. Each farm intends to plant between 5 and 20 acres of biological primers each year as an extension of their current crop rotation. Each producer developed a biological primer mix comprised of eight or more species of annual crops customized to meet the needs of their operation.

The cover crops were harvested for livestock feed via managed grazing and/or mechanical harvest depending upon farm needs and goals. Each producer will plant the biological primers on a different field each year as the cover crops are incorporated into a broader crop rotation. We will follow planting, management, harvest methods, yields, soil health, crop rotations, and costs on the sites over the course of the 3 year project.

2013 Results

The 2013 growing season provided interesting weather as we tracked the response of the cover crop demonstration plantings. The year began with low soil moisture and the spring was late. Snow was still on the ground on May 1. Rains in June and early July kept central Minnesota just ahead of severe drought status. There was a 6 week window without rain from early July until September 8. Several inches of rain fell in the area in September, and October (above average precipitation for this time period).

Due to extremely dry conditions on his farm in the spring of 2013, one of the beef operators did not feel it worth the risk or expense of planting his cover crop mix. This producer plans to participate in future years. Therefore, the results from the first year of the project reported here are from the remaining three farms.

Larry Heitkamp was looking for added high protein feed for his grazing replacement heifers. He also wanted maximum diversity to jump-start his soil biology. He planted his cover crop mix on June 12, 2013 into 25 acres after the heifers had grazed down a cereal rye and hairy vetch mix planted in the fall of 2012. The diverse cover crop mix included turnips, oilseed radish, mustard, white millet, sorghum-sudangrass, soybean, cowpea, red clover, flax, buckwheat, sunflower, and phacelia. This field was harvested as baleage on August 13, 2013 yielding 1,700 pounds of dry matter. In addition, the field was grazed before and after mechanical harvest.

On August 24, a cool season cover crop mix was no-till planted in this field. The mix consisted of field peas, oilseed radish, turnips, lentils, hairy vetch, flax, buckwheat, barley, oats, and emmer wheat. After planting the cover crop, a second crop of the warm season mix was put up for baleage on September 4. The cool season mix did not grow well and 50 head of dairy heifers were allowed to graze the field for 1 week in the fall to glean what growth was there.

Dan Middendorf planted a 30 acre field to his cover crop mix on June 29, 2013. Dan runs an organic dairy. Unfortunately, organic cover crop seed choices were limited this year which limited the diversity of the mix. Dan's field had been in cool season grasses for many years. Dan's mix included significant warm-season cover crops in an attempt to diversify his soil biology. The mix consisted of turnips, white millet, BMR (high digestibility) corn, soybean, cowpea, red clover, buckwheat, and sunflower. The field was harvested as baleage on August 31, yielding approximately 1 ton/A dry matter. This field was then no-till planted to an alfalfa-grass mix on September 7.

Marcus Edin planted 10 acres to a cover crop mix on July 10, 2013 after taking a first crop of hay. The field was sprayed with herbicide prior to planting due to a heavy thistle infestation. The field was then plowed and disked to level pocket gopher mounds. Marcus planted a cover crop mix of turnips, oilseed radish, rape, pearl millet, sorghum-sudan, cowpea, red clover, winter pea, buckwheat, and sunflower. Sixteen beef cows were allowed access to this planting on November 13 after grazing other fields planted to oats, oilseed radish, and turnips. As of December 19, the cattle were still utilizing this field. The cattle were offered free choice grass/alfalfa hay in addition to the cover cropped field. Marcus estimates

that the cattle were getting about 90% of their feed from the cover cropped field until 12" of snow fell on December 3-4. Since December 4, Marcus estimates that the cattle have gotten about 50% of their feed off this field. The cover crop mix germinated and grew with little rain. The majority of growth, however, came after rains began in September. Marcus feels he could have put the cattle into the field 2 weeks sooner than he did.

2014 Results

The spring of 2014 was unusually late and damp. July was cool and dry. August and September were cool and damp. The overall lack of growing degree days in 2014 made it difficult for warm season crops. All producers that used warm season annuals in their cover crop mix noted less growth than in 2013.

Larry Heitkamp planted 32 acres of cover crops on May 5. The field was fertilized with a split application of 6 ton of poultry manure during the growing season. The cover crop mix included Italian ryegrass, barley, forage oats, kale, buckwheat, field peas, berseem clover, and crimson clover. One hundred twenty-five bales of baleage were harvested on July 6. On August 6, 29 dairy heifers and 2 horses then strip grazed the same field for 30 days. On November 1, 23 dairy heifers grazed the field a second time for 19 days. Finally, Larry outwintered the heifers on this field beginning on November 19 using baleage harvested from the same field in July.

Dan Middendorf planted 10 acres of a complex cover crop mix on July 4 into a field of cereal rye that had been planted in 2013 and harvested in 2014 as baleage. The cover crop mix consisted of purple top turnips, sorghum-sudangrass, grazing corn, cereal rye, white millet, soybean, cowpea, red clover, buckwheat, and sunflower. Thirty dairy cattle were allowed to graze the field from October 1 until November 1. The cattle received approximately 14 lb of dry matter per day from grazing the cover crop and were supplemented with corn silage.

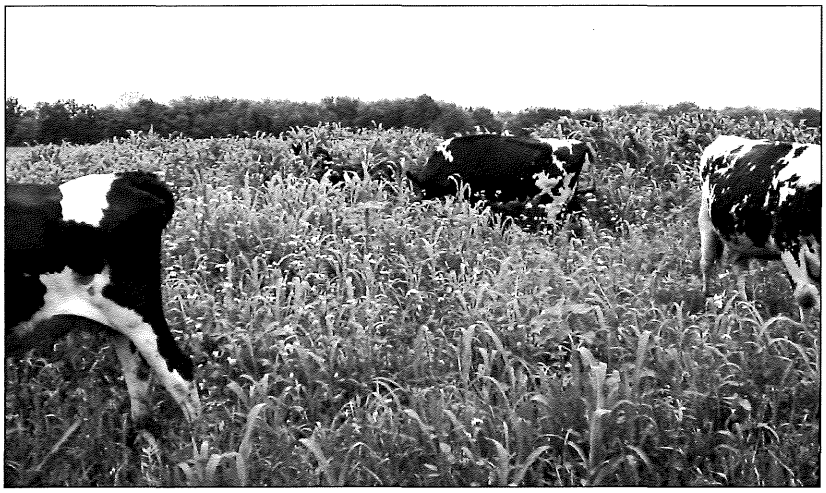
Marcus Edin planted 19 acres of cover crops on April 26. Marcus chose a mix of oats, field peas, crimson clover, red clover, purple top turnips, oilseed radish, and kale. On July 1, 103 bales of cover crop baleage were harvested. This was followed on July 5 with a seeding of a cover crop blend consisting of crimson clover, cowpea, sunn hemp, Austrian winter pea, sorghum-sudangrass, pearl millet, forage rape, oil seed radish, purple top turnips, forage collards, sunflower, and buckwheat. Beginning on August 10, the cover crop field was grazed by 15 cow-calf pairs, 3 steers and a bull, plus the animals were also able to take advantage of regrowth from the previously harvested spring cool season cover crop mix. Gazing continued until December 8.

Marcus' field that had been in a complex cover crop mix in 2013 was planted to corn on May 10, 2014. This dryland field yielded 98.5 bu/A of corn using only a starter fertilizer. Typical dryland corn yields for this area are 85-90 bu/A. According to a local crop insurance agent 60-70 bu/A yields were average for dryland corn in this area for 2014. This puts Marcus' yield at least 40% higher than most neighboring dry land corn producers.

Diverse mix of grasses, legumes, and forbes on July 1, 2014 on the Solberg farm.

Our fourth producer had to bow out of the project due to farm and family issues. We added a new producer, Kent Solberg, for 2014. Kent operates a mixed grass based dairy and livestock farm. Kent planted 7 acres of a complex cover crop mix on July 3, 2014. This field has been in grass pasture and hay for 10 years. It was grazed in May 2014 and a cutting of

hay was harvested in late June. The 12 way cover crop mix consisted of crimson clover, cowpea, sunn hemp, sorghum-sudangrass, pearl millet, grazing corn, forage collards, radish, purple top turnip, sunflower, buckwheat, and phacelia.



Grazing a diverse cover crop mix on the Solberg farm.

This site was lightly grazed August 23-27, 2014 and then again October 20-November 12, 2014 by 12 dairy cattle. No supplemental feed was provided during these times. Kent noticed a drop in milk production after the cows were taken off cover crop and put on dairy quality grass/legume hay.

Several soil measurements are being tracked to document the effect of the cover crop mixes on soil health. Measurements include water infiltration, bulk density, and respiration (Solvita test).

These farmers are finding that complex cover crop blends are an excellent addition to the rotation on a crop-livestock farm.

2015 Results

May, 2015 brought over 7" of rain. In contrast, June through October precipitation was approximately 6" below average with only 1"of rain in June. Purple top turnips did not grow well and buckwheat grew very well.

Larry Heitkamp seeded 32 acres to a nine species cover crop blend on May 30. Beginning August 4 he grazed 80 dairy replacement heifers across this field for 14 days. While this field had irrigation, we noted a marked lack of fertility, primarily nitrogen, suppressing growth.

Dan Middendorf planted an eight species blend into rye on June 15 after rye baleage harvest. The blend included sorghum sudangrass, soybeans, oats, wheat, barley, field peas, and kale. No manure or other fertilizer was spread on this site in 2015. This 10 acre field was grazed for 9 nights in mid-September by 100 dairy cows. This field was a borrow site for fill when the adjoining county road was upgraded about 20 years ago leaving little topsoil. Dan has been renting this site as part of a larger field for the past 10 years. He feels 2015 produced the most forage he has ever grown on this site due to the use of biological primers.

Marcus Edin planted 19 acres of a complex cover crop mix on July 3 after grazing in June. Marcus planted an 11 species blend of pearl millet, rapeseed, daikon radish, purple top turnip, crimson clover, Winfred turnip, cowpea, sunflower, buckwheat, sunn hemp, and winter pea. Approximately 8 acres were harvested as baleage on August 18. Approximately 1 ton/A dry matter was harvested. The entire field was grazed from September 20 until October 5 by 16 cow/calf pairs, 7 heifers and a bull.

Kent Solberg planted 5 acres of a four cover crop blend in 2015. This was the second year of covers in this field. The field was planted to barley, triticale, field pea, and common vetch on April 29 after 3 ton/A composted cattle bedding pack was applied. The cover crop was harvested on July 3 as baleage, yielding only 0.5 ton/acre. Extremely dry conditions in June likely reduced yield.

On July 9, Kent planted a species mix consisting of pearl millet, crown millet, sorghum-sudangrass, sunflower, corn, crimson clover, buckwheat, purple top turnip and daikon radish. The field was grazed from October 25 until November 8 by 12 dairy cattle.

Forage Quality. Complex cover crop blends are often utilized as late season pasture to extend the grazing season. Typically, these are grazed after a hard freeze. Many forages begin to lose quality after a freeze. Others, like some brassicas and annual ryegrass, require temperature to go below 15°F or lower for several consecutive days to kill the plant. We were able to take forage samples at one site on October 26 and the other on November 12. Sampling attempted to mimic what the cattle were eating based on visual observation of the cattle in an adjoining paddock.

Table 1. Fall Cover Crop Forage Quality on the Kent Solberg Farm (fall, 2015).

	Suggested (dairy)	Sample 1	Sample 2
Crude protein	15-19	11.3	17.6
NDFd	60-70	49.0	62.0
TDN	>60	63.0	65.0
NE/L	.65-.75	0.60	0.68
RFQ	140-170	164.0	179.0

The feed quality of the complex cover crop approached or equaled dairy quality feed (see Table 1). When cattle graze less than 50% of the aboveground biomass of a cover crop that has greater than eight species, they have the opportunity to select for quality. The cattle likely consumed a higher feed quality than shown in the samples.

We feel that the use of biological primers over the last three years has shown great benefit to the participating farmers. The benefits include feed cost savings, manure handling savings, increased forage production, and increased drought resistance (reducing the need for expensive irrigation).

Management Tips

1. Secure a cover crop seed source well in advance. Cover crops are increasing in popularity and seed supplies may be limited. This is particularly true of organic cover crop seed.
2. Taylor your cover crop mix to compliment the crops that have dominated your rotations in the past.
3. On low fertility soils, a fertilizer program may be necessary to achieve optimum cover crop growth until time allows soil health to improve.
4. Livestock are an efficient and cost-effective means of harvesting cover crops.
5. Livestock performance on complex cover crop blends is high if the animals are allowed to take no more than 50% of the above ground biomass.
6. Design cover crop blends to fit your resource goals.

Cooperators

Larry Heitkamp, Organic Farmer, Sebeka, MN
Dan Middendorf, Organic Dairy Farmer, Verndale, MN
Marcus Edin, Beef Farmer, Verndale, MN
Kent Solberg, Livestock and Grazing Specialist, Sustainable Farming Association, Verndale, MN
Ivan Reinke, NRCS Technician, Wadena, MN

Project Location

Contact Kent Solberg for directions to specific cooperating farm locations.

Other Resources

ATTRA. No-Till Case Study, Miller Farm: Restoring Grazing Land with Cover Crops. November 2012.

Sustainable Agriculture Network. Managing Cover Crops Profitably: Third Edition. Beltsville, MD. 301-504-5236. Website: www.sare.org/publications/covercrops/covercrops.pdf

Late Grazing Cover Crops. John Dhuyvetter, 2011. NDSU North Central Research Extension Center. Website: www.ag.ndsu.edu/northcentralrec/livestock-extention/articles/late-grazing-cover-crops

Midwest Cover Crops Council. Website: www.mccc.msu.edu/

USDA-ARS NGPRL Cover Crop Chart. Website: www.ars.usda.gov/main/docs.htm?docid=20323

Midwest Cover Crop Field Guide, Website: ag.purdue.edu/agry/dtc/Pages/CCFG.aspx

Burleigh Co. Soil Conservation District Soil Health Website: www.bcscd.com/?id=23

Sustainable Farming Association: sfa-mn.org/webinar-archive

Sustainable Farming Association: sfa-mn.org/sfa-cover-crop-fact-sheet/

Planting Short Season Corn for Cover Crop Success

Principal Investigator

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Project Duration

2015 to 2016

Award Amount

$20,977

Staff Contact

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Keywords

cover crops, forage, soil health, corn, yield, water quality

Project Summary

Southeastern Minnesota farmers recognize that establishing cover crops can provide for forage needs, improve soil health and water quality, and increase the profitability of their farming operations. Successful fall cover crop establishment is a major challenge for those farmers that want to incorporate cover crops into their production systems. The late maturing corn hybrids typically planted in this region of Minnesota are not ready to harvest in time for cover crops to be seeded in that critical August to September window which allows for fall cover crop germination and growth. By planting earlier maturing corn varieties, farmers may be able to attain good corn yields and yet be able to get valuable cover crops established.

The goals of this project are to compare the yields of early maturing corn to the more typical late maturing varieties while monitoring the effects of cover crops on soil biological health by using the Haney Soil Test. The project will provide information to farmers to aid them in selecting corn varieties based on maturity ratings that will help guarantee cover crop establishment. The Haney Soil Health Scores reported by the cooperators will encourage farmers to utilize cover crops to improve the health of their soils.

Cover Crops Established in Standing Corn on the Smith Farm.

Project Description

The project is being conducted on farms operated by three experienced local farmers. Olaf Haugen is a grass-based dairyman interested in extending his grazing season with cover crops. Marty Malin grazes Polled Hereford cattle on his farm, while growing crops for feed on long-term rented ground, and is striving to reduce both fertilizer and tillage use by implementing cover crops into his rotation. Stan Smith raises certified organic beef cows, feed, and seed corn and is determined to integrate cover crops to build his soil and decrease his tillage passes.

Each farmer selected and planted 83-96 day corn in the spring of 2015 on plots ranging in size from 5 to 50 acres. Cover crop seed blends were planted either by inter-seeding in July at the V-5 corn stage (when the leaf collar of 5th leaf is visible), aerial seeding before mid-September forage harvest, or drilling after September grain harvest. Soil samples were collected in early summer and late fall and analyzed by Ward Labs in Nebraska.

2015 Results

Corn yields ranged from 75 to 175 bu/A. Significant yields losses on two of the farm sites were blamed on blight and weed pressure. Haney Test results showed the expected increase in the Solvita 24-hour Burst Test values and in the Carbon:Nitrogen (C:N) ratio. The Solvita Test represents soil microbial populations and helps determine the potential for nutrient cycling in the soil. The C:N ratio determines the ability of the soil bacteria to decompose organic matter which also affects the potential for nutrient cycling. All of the soils sampled yielded Haney Soil Health calculations above the desired level of seven, which indicates good soil health. Desired C:N ratios below 20 were indicated in all of the soils sampled. More significant results from year 1 of a multiyear study may have more to do with farmer's attitude and engagement than with corn yields and soil testing results.

Table 1: Crop Information and Yield Data Summary

Farm	Corn Maturity	Planting Date	Harvest Date	Yield (bu/A)
Olaf Haugen	96	May 10	October 27	175
Marty Malin	85	April 26	September 24	108
Stan Smith	83	May 20	October 11	142
Stan Smith	88	May 20	October 11	100

Left: Cover crop established. Right: Control. On the Malin farm.

Management Tips

1. Develop cover crop goals for your farm and individual fields. Goals might include soil erosion control, extending your grazing season, or weed control.
2. Be brave, imaginative, and innovative. Start small and utilize the equipment that you have available. Talk to other experienced farmers and attend field days as you develop your cover crop program.
3. Extensively research cover crops for such traits as shade tolerance, termination, timing of anthesis, and potential effect on the following crop. If possible, use multispecies blends as opposed to a monoculture. The beneficial effects of multispecies blends on soil health are well proven.

Cooperators

Martin Malin, Farmer, Peterson, MN
Olaf Haugen, Farmer, Harmony, MN
Stan Smith, Farmer, Lewiston, MN
Dan Nath, Area Resource Soil Scientist, Natural Resource Conservation Service, Rochester, MN
Jim Paulson, Forage/Cover Crops Specialist University of Minnesota Extension, Rochester, MN

Project Location

Martin Malin's farm is located 11 miles south of Peterson, MN on Cty. Rd. 25.

Olaf Haugen's farm is located 15 miles south of Rushford, MN on Hwy. 43.

Stan Smith's farm is located 8 miles south of Lewiston, MN on Hwy. 29.

Oat, pea, radish, and ryegrass on the Malin Farm.

Increasing Dairy Farm Profitability with Energy Efficiency Improvements

Principal Investigator

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**Note: this grant was originally awarded to The Minnesota Project in 2013.*

Project Duration

2013 to 2015

Award Amount

$9,999

Staff Contact

Meg Moynihan

Keywords

dairy, conservation, efficiency, energy, profitability, savings

Project Summary

The Minnesota Project and Hastings Cooperative Creamery Company (HCCC) collaborated to develop and deliver a program that helps dairy farmers learn about and adopt energy efficient technologies on their farms. On average, Minnesota dairy farms use between 800 to 1,200 kWh/cow each year. This is a significant amount of energy consumption, and reducing it would help: 1) dairy farms increase profits by reducing energy costs; and 2) electric cooperatives make progress toward their energy conservation mandates and goals. Rural electric cooperatives cover many miles with few customers and have limited time capacity to work with dairies in an intensive manner. By contrast, milk cooperative field people know their dairy farmers well and are better positioned to discuss and promote smart energy behavior practices, energy efficient technology, and available funding programs. Other co-ops are already beginning to replicate this model elsewhere in Minnesota.

Project Description

In its first year (2013) our project assembled a group of certified energy managers and professional engineers, milk haulers and HCCC field staff, who collaborated to develop and distribute an energy survey to 57 dairy farms in Dakota, Goodhue, Scott, Rice, and Carver counties. All responded, and our team conducted an energy audit at 30 of the operations. The team created individualized recommendations for equipment changes and upgrades, and provided payback calculations based on energy dollars that could be saved per year.

In year 2, we followed up with phone calls and farm visits to tell the farmers about funding mechanisms available to help them pay for the energy efficiency recommendations. For example, we coordinated with local utility account managers and USDA Natural Resource Conservation Service field offices, to let farmers know about the Conservation Improvement Program (CIP) utility rebates, the USDA Environmental Quality Incentives Program's Ag Energy Management Plan (AEMP), and the Minnesota Department of Agriculture's Livestock Investment Grant Program.

2013 Results

The most common recommendations were lighting upgrades (e.g., replace incandescent bulbs with compact fluorescent or LED fixtures), and installation of refrigeration heat recovery units, refrigeration compressors, and/or water heaters. Efficient lighting, variable speed drives for milk receiver jar pumps, and water heater upgrades frequently presented the best energy savings opportunities.

- Efficient lighting recommendations had a simple payback average of 2.2 years across 29 farms with an average of $802 in energy cost savings.
- Milk receiver jar pumps had simple paybacks averaging 6.6 years across 10 farms with an average of $588 in energy cost savings.
- High efficiency water heaters had simple paybacks averaging 6.2 years across 19 farms with an average of $589 in energy cost savings.

2014 Results

Many of the farmers indicated they are using the audits to plan for upgrades over the next 2 or 3 years. Three have installed three high-volume, low-speed fans, one installed a plate cooler. Six more producers are thinking about investing in upgrades that include lighting, refrigeration heat recovery units, plate coolers, and variable speed motor drives. Most older vacuum pumps are overbuilt to handle a theoretical maximum demand, while a variable speed drive calibrates the motor so that it doesn't run at 100% all of the time.

Several producers applied for USDA-NRCS funding with the help of their local USDA officials. We also coached several to work through their rural electric associations to apply for CIP utility rebates, though many utilities simply have the installing electrician fill out the paperwork. We found that many farmers appear to be interested in applying to only one program, and several indicated they were not impressed by the dollar amounts of the CIP rebates.

Paperwork for any of these programs is manageable with some guidance. The primary barrier for farmers appeared to be lack of time and unfamiliarity with the documents and process. Coordinating across funding programs could help farmers realize the lowest cost and fastest payback of implementing energy efficient equipment. In our experience, however the programs all have different deadlines, which makes matching up the funding difficult.

We developed a free, online Dairy Farm Energy Benchmarking Tool so dairy farmers in the Midwest can benchmark energy use against their peers. We held an outreach event at People's Energy Co-op in Ornonco that attracted 43 people in late 2014. Dairy farmers, agriculture specialists, and electric cooperative personnel learned about the energy savings paybacks for technology such as LED lighting, variable frequency drive pumps, high efficiency water heaters, and dairy free water heaters (waste heat recovery units). It was a participatory event, and attendees shared their opinions about barriers to implementing energy efficient technology and about changing technologies.

2015 Results

After doing this project that linked a Southeast Minnesota dairy co-op and energy co-op, we think it's a great model that has potential to work well in other places, too. In fact, People's Energy Co-op in Southeast MN, Land O' Lakes, the Stearns County Dairy Board, and the Stearns Electric Co-op are all either interested or moving forward to adopt and adapt our model. Encouraging energy efficiency benefits farmers, energy co-ops, and processors, too. Some vendors in the dairy industry are concerned that not addressing their energy footprint could bar them from selling products to large retailers who have corporate social responsibility standards that extend to purchasing.

Rural electric cooperatives cover many miles with few customers and have limited time capacity to work with dairies in an intensive manner. By contrast, milk cooperative field people know their dairy farmers well and are better positioned to discuss and promote smart energy behavior practices, energy efficient technology, and available funding programs like a local electric utility's conservation improvement rebates, MDA Livestock Investment Grant Program, and USDA Rural Energy for America Program (REAP).

One positive outcome of our effort was better communication and information sharing among rural electric cooperative staff, USDA program staff, and dairy cooperative staff. All of these entities have the goal of thriving dairy farms and positive economic development, but they do not always know what each one is doing or offering to the dairy community. Improved coordination and program timelines could do much to enhance dairy technology adoption. More detailed information about energy usage on Minnesota dairy farms would also improve our benchmarking ability and help determine the best ways to lower energy use and its associated production costs.

Management Tips

1. Start with the low-hanging fruit. Most producers are interested in low-cost, straightforward technology improvements. Frequently, lighting is the most cost-effective upgrade.
2. Use existing networks. Much of our project's success was due to Hastings Cooperative Creamery Company's field staff and milk haulers.
3. In-person conversations are the best way to communicate. Schedule farm visits whenever possible.
4. Timing is important. Many farmers are interested in technology upgrades, but have not had time because of planting or harvesting. The winter months are the best times to focus on farm improvements.

Cooperators

Meghan Romo, Field Officer, Hastings Cooperative Creamery Company, Hastings, MN
Joe Schultz, Agriculture Energy Specialist, GDS Associates, Neillsville, WI
David Zwart, President, Hastings Cooperative Creamery Company, Hastings, MN

Project Location

This project took place on farms in Carver, Dakota, Goodhue, Rice, and Scott Counties.

Other Resources

Dairy Energy Efficiency Program
www.cleanenergyresourceteams.org/dairy

USDA-NRCS Dairy Energy Self-Assessment Tool
www.ruralenergy.wisc.edu/conservation/dairy/default_dairy.aspx

Solar-powered Rainwater Catchment and Distribution System Using Drip Irrigation

Principal Investigator

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Project Duration

2014 to 2015

Award Amount

$7,568

Staff Contact

Cassie Dahl

Keywords

irrigation, solar, water conservation

Project Summary

For 4 years on our farm in southeastern Minnesota, we have experienced climatic conditions that leave us spinning, from floods to drought in any one season. Inconsistent rainfall, well-water salinization, and ground water depletion issues triggered the need for this project. Our plan ensures a renewable, sustainable water resource for crops and livestock by collecting, storing, and distributing rainwater using solar-power. In addition, we added drip irrigation for further water conservation and to reduce disease potential on wet foliage.

End-of-project demonstrated that the system is transferable, adaptable, and scalable for any size farm or residential/small business application. During the 2014 season, we experienced some setbacks so the full design and installation were completed in early 2015. With the new system in place and an ideal rainfall during the 2015 growing season, we experienced bumper yields.

Project Description

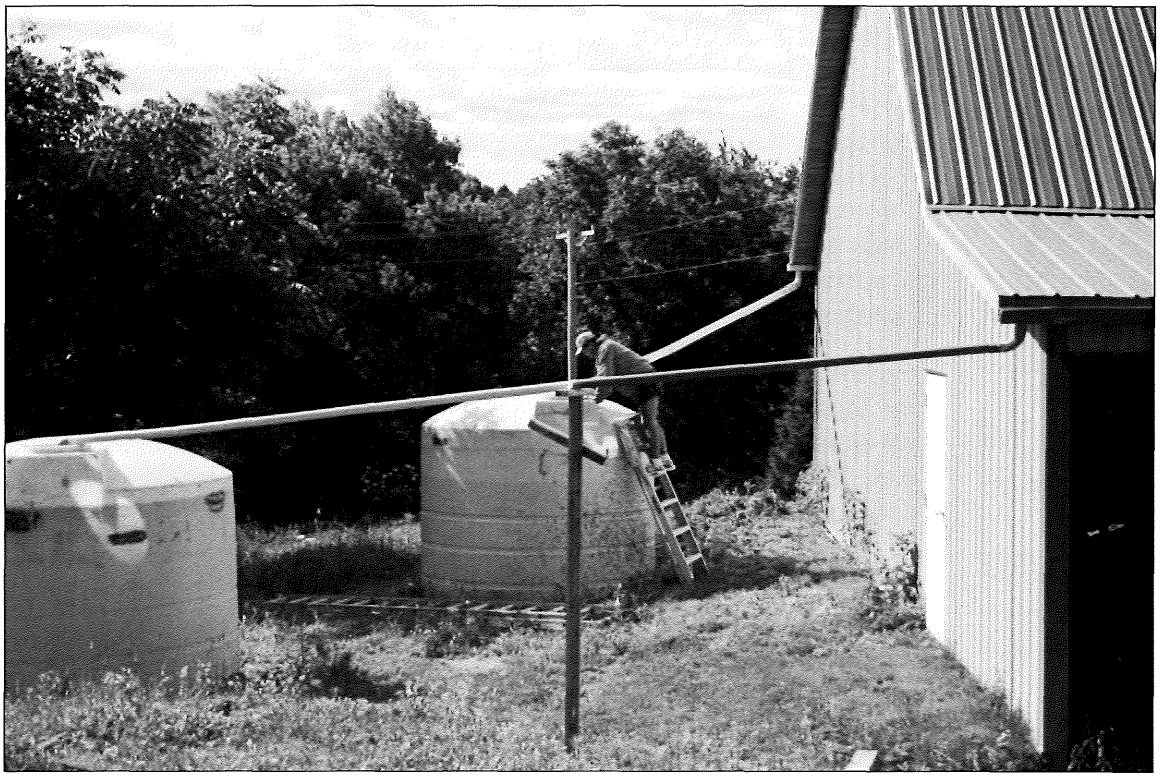
Our farm is located in Minnesota bluff country near the small farming community of Chatfield. We grow organic perennial crops, including a variety of berries, asparagus, and seed cover crops. In 2014, we added heritage turkeys and wild pheasants to the farm and also maintain a big bluestem grass prairie that is in the Conservation Reserve Program (CRP). Our goal is to add more livestock in the near future. Currently we rely on rainfall and household well-water for all of the farm's watering needs, which are not reliable or desired. Our goal is to have a watering system in place that is environmentally and economically achievable.

During the last ice-age glaciers stopped just to the north of our farm and then melted. The run-off formed bluffs, valleys and rivers known as the "driftless" area, which is seen today. The remaining soil helped to form a "Karst" topography, which is a landscape created by ground water dissolving sedimentary rock and forming sinkholes, caves, and sinking streams. Unfortunately, this also makes the terrain very fragile, prone to erosion and pollution, particularly the aquifers (once again a reason to find crop and livestock watering alternatives).

We designed the system to collect and distribute water to our fields first and then livestock. To test the efficacy of drip-tape irrigation, we have designated a 1/8 acre of crops as the control plot that does not have drip-tape or any other irrigation method.

2014 Results

We designed the system to collect water primarily from our existing 40' x 50' barn, with the ability to add collection from other outbuildings in the future. Additionally, during the previous year we purchased four 2,300 gal tanks for collection and an on-farm computerized weather station.



Rainwater storage tanks with the gutter system coming off the 40' x 50' barn.

After the long winter of 2014, we were finally able to install the gutters in May, nearly a month behind schedule. Unfortunately, with the late wet spring we were not able to pour cement pads for the tanks, so we went ahead and moved them into place to begin collecting water. The other two tanks were moved to position, near the fields. We then had to buy submersible electric pumps because the solar pumps had manufacturing issues, they were back-ordered and we couldn't locate another similar source. The solar pumps did not arrive until September, so we will install those next spring. Trenching to lay pipe also occurred way past schedule because of the extremely mucky ground.

All in all, we were still able to collect water and get it to the fields, albeit manually, at the most critical times. Our spring asparagus and garlic crops were in need, because we only received 1.63" of rain in May, when the average is 3.86". Likewise, our fall-bearing primocane raspberries, which require additional moisture during July fruiting, only received 1.32" of rain and the average is 4.37". During September and October we came close to the average monthly rainfall which filled the tanks and allowed us to slowly saturate the fields before season freeze-up. In the past several years we have entered winter with a considerable soil-moisture deficit, so this should benefit root growth for next spring.

2015 Results

The 2015 growing season brought about nearly ideal rainfall events. The early spring months finished with over 3" of rain above average. July and August were 2-1/2" below the average and temperatures were 3°F and 7°F cooler than normal, respectively. The rain events that did occur throughout the spring and summer were slow, all-day events. Therefore we had nearly full collection tanks for most of the season and with the cooler weather, we did not experience the normal ground water evaporation.

With the almost perfect climatic conditions, it wasn't necessary to irrigate our crops on a regular basis. Unfortunately, it didn't do much for demonstrating this project as a control for irrigating vs. not irrigating. However, as a demonstration project for installing and implementing a simple, reliable water collection/solar pumping system, we achieved those goals entirely.

When we did operate the system, we pumped 220 to 240 gal of water/hour. From the barn roof collection tanks to the field tanks, water traveled 650' with a 20' vertical lift pumped by a 24-volt DC inline Solar Slowpump (8amp maximum rating). A 185-watt solar panel with a controller and battery back-up powered the pump. Another identical pump system was installed for field irrigation using 1/2" drip-tape and averaged a flow-rate of 3.5 gal/minute. At the end of the growing season, we still had full collection tanks, so we watered the fields thoroughly before freeze-up, gaining ground for next springs' growth.

Management Tips

1. With any alternative energy project, verify that you have a back-up plan, especially when purchasing and installing equipment. Some manufacturers and/or suppliers can be unpredictable with their product delivery.
2. Again with water pumping, piping, and irrigating; plan to add more time for labor. Since weather plays a large part of the installation; you may be working in deep mud and your equipment jams up, or your soil is hardpan and just as difficult to work with.
3. A good thing to do is to plan to collect much more water than you originally calculated. The "rainwater harvesting calculators" found online are a good rule of thumb, but they are based on other regions. More research regarding rain collection in the Upper Midwest would be a good thing.
4. Thoroughly research what you are getting when purchasing a packaged solar pumping system. Many of the items could be homemade or bought separately for much less.

Cooperators

Jim Riddle, Organic Farmer; Winona, MN
Caroline van Schaik, Land Stewardship Project; Lewiston, MN

Project Location

Hammers Green Acres is located 25 miles SE of Rochester, MN. We are located 4 miles south of Chatfield on Hwy. 52 and then 2 miles east on Cty. Rd. 6 and Indigo Rd.

Other Resources

Irrigation Scheduling and Tensiometer Tips for Trickle Irrigation. Dr. Henry G. Taber, Department of Horticulture, Iowa State University. May 2010.

Principal Investigator

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Project Duration

2015 to 2016

Award Amount

$24,565

Staff Contact

Meg Moynihan

Keywords

acclimation, behavior, cows, dairy, handling, heifer, pressure zone, stress

Acclimating Heifers to Improve Cow Flow on Dairy Farms

Project Summary

Milking heifers for the first time can be stressful to both animal and human worker alike. However, familiarizing pre-fresh heifers with the milking parlor and handling by humans is rarely feasible on dairy farms. In the beef industry, a handling strategy called "acclimating" is commonly used to de-stress newly arrived animals in their pen. We designed this study to evaluate whether acclimating pre-fresh heifers to being handled will decrease stress levels and improve cow flow and behavior during the first times those heifers are milked.

Project Description

A common area of frustration and high injury risk on dairy farms is milking fresh heifers, those "teenage" animals that have just had their first calf. On most farms, heifers are not handled much prior to calving. Yet then they are asked to go into the milking parlor, where they have never been. New sights, smells and sounds bombard them and they are suddenly handled in close proximity and touched in places they have never been touched before.

This experience can be overwhelming, and stressed heifers commonly react by balking at the parlor entry or kicking and defecating during milking. We speculated that reducing the number of new stimuli and making the parlor visit a pleasant experience would reduce stress on these animals. Ideally pre-fresh heifers should be moved through the parlor to prepare them to its sights, sounds and smells without the pressure of a milking schedule. Unfortunately, only very few farms can afford to do this, so other training approaches are needed.

One technique used to reduce stress in newly arrived animals on feedlots is called "acclimating" or "settling." When the animals arrive at the feedlot, a worker gently moves them as a group around the perimeter of the pen. The worker uses his or her body position to control the speed of animals and to move them along as desired.

Many dairy farms raise heifers at an off-site location, bringing them back to the main farm before they calve. We speculated that an acclimation approach similar to that used for beef animals could easily be used for dairy heifers – to decrease stress if they are coming from an off-site location and to prepare them for being handled more intensively after calving. Although this approach does require some investment of time, it does not require construction of new facilities, should be feasible on all dairy farms, and would ultimately save time and worker health once the heifers start milking. However, its effectiveness to prepare heifers to behave calmly during milking has not yet been tested.

Our objectives for this study are to a) Assess whether acclimating improves flow of heifers into parlor and their behavior during first 3 days of milking and b) Assess whether acclimating decreases stress (measured as serum cortisol, haptoglobin, serum amyloid A and substance P) and improves lying time in transported heifers.

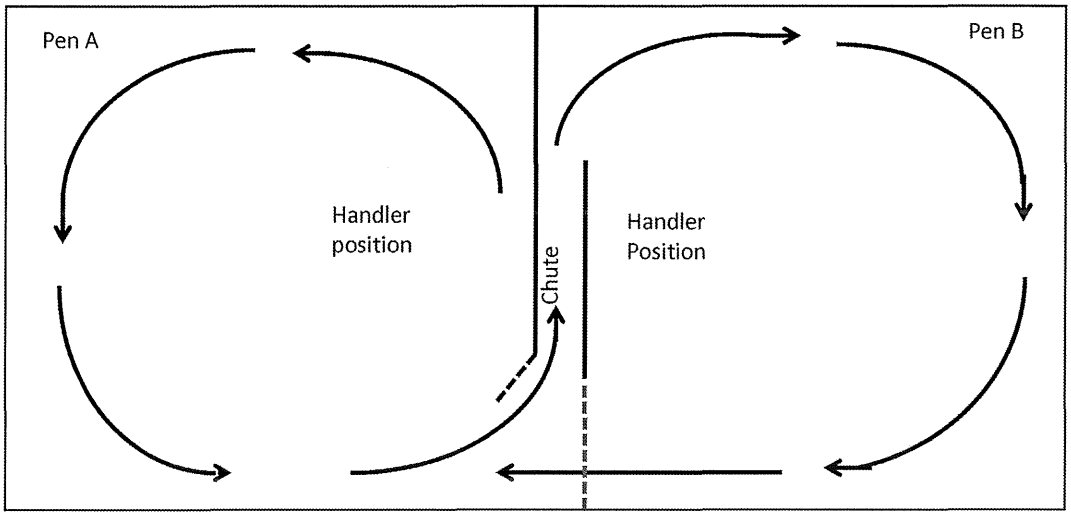
We are doing this study at Wolf Creek Dairy in Dundas, MN. Wolf Creek Dairy milks approximately 400 dairy cows and calves year round. Heifers are raised off-site until they come back roughly 2 mo prior to calving. We assigned each returning group assigned to be acclimated (treatment) or not acclimated (control). Our goal was to have 4 groups of 9 heifers each.

Upon arrival from the off site location, we attached an IceTag data logger to one hind leg of each heifer. This device records the number of steps they take and measures standing and lying time in 15 min intervals. Using the animals' natural pressure zone (if you move toward them, they move away from you) we moved the acclimation heifers through an outdoor pen and chute system several times per week.

We attached a data logger to one hind leg of each heifer in the study in order to monitor their activity.

Here's how we did it: the handler stood in the middle of one pen (A) and used body movement, stepping toward and away from the cattle, to encourage heifers to move around the perimeter of the pen circle and then single file past the handler through a narrow chute or short alleyway into another pen (B). The heifers then walked around the perimeter of pen B and back through to the chute to the gate (dashed line) into pen A. Since the handler stood in the middle of the pen with the heifers walking around her, the animals could always see where she was. We moved the heifers through the figure 8 pen and chute system 2 to 3 times per session, which took about 15-20 min.

Figure 1. Layout of the acclimating pens.



Dr. Sorge begins moving this group of heifers around pen A. They walk single file past her through a chute into to an adjoining pen (B).

In addition to the data collected by the IceQube, we collected blood serum samples for all 4 groups (2 acclimating and 2 control groups) when they arrived (day 0), on day 1 and again on day 7. The samples allowed us to measure serum stress markers (cortisol, serum amyloid A and haptoglobin) in the chute.

We also assessed the "avoidance distance" (how close can I get to the animal before she moves away) of all heifers on days 0, 1 and 7. As cows acclimate, the handler should be able to get closer to them before they move away. The normal, healthy avoidance distance for a mature dairy cow is about 3', or a little over an arm's length.

We installed cameras over the acclimating pen, over the holding pen, and in the parlor to document behavior. At calving, we had marked each back with large numbers using a liquid cattle marker, hoping this would make it easy for us to identify them on camera. We also attached a yellow leg band with the cow number to one hind leg. We found it was harder than we thought to identify the heifers going into the milking parlor. It seemed to work best for workers in the parlor to face the camera and use their fingers to signal each heifer's number. We are recording each heifer's milk production and observing their behavior during morning milking on the first 5 days they are milked.

2015 Results

So far, we have worked with 6 groups of 9 heifers each, alternating between acclimated and control groups. It is amazing to see how quickly the heifers learn to go through the chute. Often after just one exposure to the exercise, it is much easier to get them through again. On subsequent training days, they pretty much know what's going to happen. They still look for your guidance, but are relatively obliging.

As we prepared this report, the experiment was still ongoing and not that many heifers in the study have calved and started milking yet. Our data collection is still underway and we have not begun to analyze it, so we can't share any official results yet.

Management Tips

1. To move cattle, go in zigzag lines behind them – that way you are staying mostly out of their blind spot (right behind them) and put pressure on them from the side. This way they can easily see you and don't need to turn around to see where you are.
2. When moving a group of cattle out of an open area toward a gate, try to herd the cattle from the back at an angle. Approach the gate as if it were a 'T'. Your positioning/ the area of your zigzag walk is the top bar of the T. That pressure directs the cattle toward the gate (i.e., the bottom part of the T. It works remarkably well.
3. If a heifer hesitates to stick her head through a head gate, gently stroke her along her backline (front to back). Repeat if necessary, but that is generally enough to make her go forward without stressing her (or you) out.

Project Location

Wolf Creek Dairy is located in Rice County, southeast of the town of Dundas. To arrange a visit, please call 507-645-4297

Utilization of Building for Multiple Livestock Species

Principal Investigator

Steve Stassen
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Swift County

Project Duration

2015 to 2016

Award Amount

$9,458

Staff Contact

Alatheia Stenvik

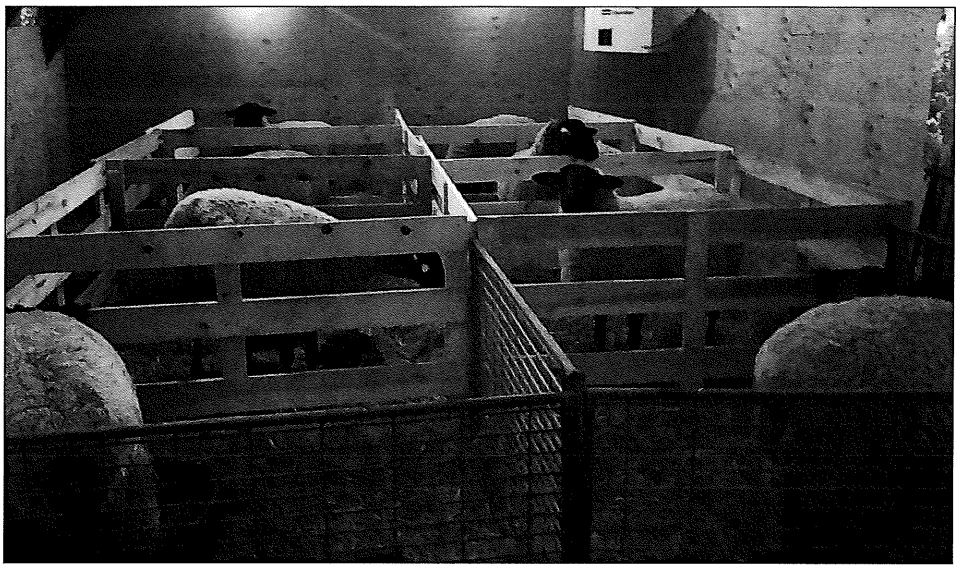
Keywords

hogs, sheep, lambing, nursery, profitability, efficiency

Project Summary

Steve has buildings on his farm that are not currently utilized. In this project, Steve will convert a building that was used for storage into a building for lambing and a nursery for pigs. The sheep and pigs will utilize the building at different times of the year to maximize usage.

Project Description



Ewes in pen designed for increasing lambing efficiency.

Steve has been farming for 30 years and is a part-time farmer. His operation currently consists of 32 acres of pasture and 18 acres of cropland. He raises purebred Suffolk sheep, Berkshire pigs, and beef cattle. The sheep are lambed in February or March and are raised for show and market. He also leases out several lambs a year to local 4-H families. The Berkshire pigs are farrowed to feeder pigs and sold as breeding stock for niche markets. The calves, from the beef cattle, are sold to local customers for butcher beef.

Steve will demonstrate how to maximize the use of buildings throughout the year in order to improve efficiency and farm profitability. He plans to provide shelter for different species, specifically hogs and sheep, at different times of the year to avoid having an empty building throughout the year. Steve designed a pen system for lambing sheep similar to the system used for farrowing sows. By using a pen system for ewes, Steve hopes to eliminate the need to check for lambs several times during the day and night, which is especially a problem for part-time farmers and farmers with off-farm jobs. Steve also recorded when the ewes were marked by the ram in the fall. The veterinarian conducted an ultrasound on the ewes to coordinate lambing in February.

Since each ewe will have her own pen, lambs will be isolated and therefore more easily accepted by the ewes. This solves the problem of multiple ewes lambing at once, which requires having to separate ewes and lambs into lambing jugs. After lambing is complete, the pens will be dismantled and Steve will let the ewes and lambs mingle until the building is needed for the pig nursery.

This dual purpose facility combines two enterprises to optimize profits and labor on Steve's operation. After lambing, the building will be used as a group bedded nursery pen for the weaned pigs. Steve chose this style of nursery due to the demand from niche markets to raise pigs on bedding and in groups.

2015 Results

In 2015, Steve spent his time setting up the building for this project. He insulated the building and poured a cement floor in order to increase heating and cleaning efficiency. He also set up the hog nursery with gates and feeders. He observed the ewes for markings by the ram and had the veterinarian conduct an ultrasound on the pregnant ewes.

After consulting with another farmer, Steve decided to increase the protein in the grain mix used for flushing the ewes. He did this to increase the ewes' conception rate, which was successful. The ultrasound results showed that 50% of the ewes were bred in the first week of the breeding season, which will be a good test for the lambing pens.

Steve has also received help from a fellow farmer to set up a three stage nursery ration system for the hogs. This system will be in place after the ewes have completed lambing. This three stage nursery program will be cost effective and performance driven.

Next year, Steve will report his results and observances for both systems. Steve will have completed a year round assessment of this system at that time.

Management Tips

1. While remodeling his building, Steve reconsidered the type of roof insulation. He recommends using TEKFOIL reflective insulation, since it has double bubble air spaces to accent the insulation by increasing the R factor. The silver color also brightens the room when the lights are on. It was easy to install and helps keep the room warm and quiet.
2. Install LED lights to increase brightness and efficiency.

Cooperator

Wayne Martin, Extension Educator, Alternative Livestock Systems Program, University of Minnesota-Extension

Project Location

From Minneapolis/St. Paul, go west on I-94. Take the I-394 W exit. Continue onto US-12 W. In Kerkhoven, take the second left onto Cty. Rd. 35. Continue for 1 ½ miles. Project site will be on the left.

Other Resources

Premier 1 Supplies Newsletter.
Website: www.premier1supplies.com/pages/newsletter.php?mode=archive

University of Minnesota Extension. Alternative and Small-Scale Livestock Systems Program.
Website: www.extension.umn.edu/food/small-farms/livestock/

Completed Grant Projects

Final Greenbook Article	Title of Project	Grantee
Alternative Markets and Specialty Crops		
2016	Reducing Chemical Use and Inputs in a Cold Climate Grape Harvest by Creating New Uses Other than Wine	Locust Lane Vineyards Chad Stoltenberg
	Evaluating Different Depths and Types of Mulches in Blueberry Production	Redfern Gardens, Kathy Connell
2012	Growing Cherries in Central Minnesota	Pat Altrichter
	Organic Mushroom Cultivation and Marketing in a Northern Climate	Jill Jacoby
	Feasibility of Small Farm Commercial Hop Production in Central Minnesota	Robert Jones
2010	Hardwood Reforestation in a Creek Valley Dominated by Reed Canarygrass	Timothy Gossman
	Introducing Cold-hardy Kiwifruit to Minnesota	James Luby
	Growing the Goji Berry in Minnesota	Koua Vang & Cingie Kong
2009	Dream of Wild Health Farm Indigenous Corn Propagation Project	Peta Wakan Tipi (Sally Auger)
2008	Developing a Saskatoon Berry Market in the Upper Midwest	Patricia Altrichter & Judy Heiling
2005	Creating Public Recognition of and Demand for "Grass-Fed" Dairy Products through the Development of Brand Standards and Promotion of These Standards to the Public	Dan French
2004	Collaborative Character Wood Production and Marketing Project	Cooperative Development Services, Isaac Nadeau
	Creating Consumer Demand for Sustainable Squash with Labels and Education	Gary Pahl
	Integrated Demonstration of Native Forb Seed Production Systems and Prairie Land Restoration	Michael Reese
	Pride of the Prairie: Charting the Course from Sustainable Farms to Local Dinner Plates	Kathleen Fernholz
2003	Demonstrating the Market Potential for Sustainable Pork	Prairie Farmers Co-op Dennis Timmerman
	Flour Corn as an Alternative Crop	Lynda Converse
2002	Increasing Red Clover Seed Production by Saturation of Pollinators	Leland Buchholz
	Propagation of Native Grasses and Wildflowers for Seed Production	Joshua Zeithamer
2001	Establishing Agroforestry Demonstration Sites in Minnesota	Erik Streed/CINRAM
	Managed Production of Woods-grown and Simulated Wild Ginseng	Willis Runck
	Midwest Food Connection: Children Monitor on Farms	Midwest Food Connection
	Phosphorus Mobilization and Weed Suppression by Buckwheat	Curt Petrich
2000	Converting a Whole Farm Cash Crop System to Keeping an Eye on Quality of Life and the Bottom Line in Sustainable Agriculture by Using Key Farm Economic Ratios to Aid in Decision-making	Red Cardinal Farm
	Dry Edible Beans as an Alternative Crop in a Direct Marketing Operation	Bruce & Diane Milan
	Native Minnesota Medicinal Plant Production	Renne Soberg
1999	An Alternative Management System in an Organic, Community Supported Market	Candace Mullen
	Cultural and Management Techniques for Buckwheat Production and Marketing	Tom Bilek
	Pond Production of Yellow Perch	John Reynolds

Final Greenbook Article	Title of Project	Grantee
1998	Establishing and Maintaining Warm Season Grasses (Native Grasses)	Pope County SWCD
	On-farm Forest Utilization and Processing Demonstrations	Hiawatha Valley RC&D
1996	Permanent Raised Bed Cultivation for Specialty Crops	Terry & Jean Loomis
1995	Cash Crop Windbreak Demonstration/Development	Phil Rutter
	Cutter Bee Propagation Under Humid Conditions	Theodore L. Rolling
	Red Deer Farming as an Alternative Income	Peter Bingham
	Wildflower Seeds as a Low-input Perennial Crop	Grace Tinderholt & Frank Kutka
1992	Alternative Mulch Systems for Intensive Specialty Crop Production	Ron Roller/Lindentree Farm
	Benefits of Crop Rotation in Reducing Chemical Inputs and Increasing Profits in Wild Rice Production	George Shetka
	Benefits of Weeder Geese and Composted Manures in Commercial Strawberry Production	Joan Weyandt-Fulton
	Common Harvest Community Farm	Dan Guenthner
	Mechanical Mulching of Tree Seedlings	Timothy & Susan Gossman
	Minnesota Integrated Pest Management Apple Project	John Jacobson
Cropping Systems and Soil Fertility		
2016	The Effects of Cover Crops on Water and Soil Quality	Hmong American Farmers Association
	Correcting Soil Structure to Reduce Erosion by Using a Cover Crop Mix with Diverse Root Systems	Bios de Sioux Watershed District
	A Demonstration of Biological Primers on Drought Prone Soils	Sustainable Farming Association of Minnesota
2015	Weed Control in Soybeans	Floyd Hardy
	Comparing the Productivity & Profitability of Heat-loving Crops in High Tunnel and Quick Hoops Systems	Stone's Throw Urban Farm
2013	Fertilizing with Alfalfa Mulches in Field Crops	Carmen Fernholz
	McNamara Filter Strip Demonstration	Goodhue SWCD, Beau Kennedy/Kelly Smith
	Optimizing Alfalfa Fertilization for Sustainable Production	Doug Holen
2010	Environmentally and Economically Sound Ways to Improve Low Phosphorus Levels in Various Cropping Systems Including Organic with or without Livestock Enterprises	Carmen Fernholz
2009	Establishing Beneficial Bug Habitats in a Field Crop Setting	Noreen Thomas
	Keeping It Green and Growing: An Aerial Seeding Concept	Andy Hart
	Rotational Use of High-quality Land: A Three Year Rotation of Pastured Pigs, Vegetable Production, and Annual Forage	Gale Woods Farm – Three Rivers Park District (Tim Reese)
2008	Field Windbreak/Living Snow Fence Yield Assessment	Gary Wyatt
2006	Gardening with the Three Sisters: Sustainable Production of Traditional Foods	Winona LaDuke
	Feasibility of Winter Wheat Following Soybeans in NW MN	Jochum Wiersma
2005	Chickling Vetch-A New Green Manure Crop and Organic Control of Canada Thistle in NW MN	Dan Juneau
	Treating Field Runoff through Storage and Gravity-fed Drip Irrigation System for Grape and Hardwood Production	Tim Gieseke
	Use of Rye as a Cover Crop Prior to Soybean	Paul Porter

Final Greenbook Article	Title of Project	Grantee
2004	Development of Eastern Gamagrass Production	Nathan Converse
	In-field Winter Drying and Storage of Corn: An Economic Analysis of Costs and Returns	Marvin Jensen
	Mechanical Tillage to Promote Aeration, Improve Water Infiltration, and Rejuvenate Pasture and Hay Land	Robert Schelhaas
	Native Perennial Grass - Illinois Bundleflower Mixtures for Forage and Biofuel	Craig Sheaffer
	Northwest Minnesota Compost Demonstration	John Schmidt & Russ Severson
	Potassium Rate Trial on an Established Grass/Legume Pasture: Determining Economic Rates for Grazing/Haying Systems	Dan & Cara Miller
	Woolly Cupgrass Research	Leo Seykora
	Yield and Feeding Value of Annual Crops Planted for Emergency Forage	Marcia Endres
2003	Aerial Seeding of Winter Rye into No-till Corn and Soybeans	Ray Rauenhorst
	Manure Spreader Calibration Demonstration and Nutrient Management	Jim Straskowski
	Replacing Open Tile Intakes with Rock Inlets in Faribault County	Faribault County SWCD
	Soil Conservation of Canning Crop Fields	Andy Hart
	Using Liquid Hog Manure as Starter Fertilizer and Maximizing Nutrients from Heavily Bedded Swine Manure	Dakota County SWCD Brad Becker/Johnson
2002	Agricultural Use of Rock Fines as a Sustainable Soil Amendment	Carl Rosen
	A Low-cost Mechanism for Inter-seeding Cover Crops in Corn	Tony Thompson
	Annual Medic as a Protein Source in Grazing Corn and Weed Suppressant in Soybeans	Joseph Rolling
	Dairy Manure Application Methods and Nutrient Loss from Alfalfa	Neil C. Hansen
	Evaluation of Dairy Manure Application Methods and Nutrient Loss from Alfalfa	Stearns County SWCD
	Increased Forage Production through Control of Water Runoff and Nutrient Recycling	James Sovell
	Land Application of Mortality Compost to Improve Soil and Water Quality	Neil C. Hansen
	Turkey Litter: More is Not Always Better	Meierhofer Farms
2001	Applying Manure to Corn at Agronomic Rates	Tim Becket & Jeremy Geske Dakota County Extension & SWCD
	Cereal Rye for Reduced Input Pasture Establishment and Early Grazing	Greg Cuomo
	Establishing a Rotational Grazing System in a Semi-wooded Ecosystem: Frost Seeding vs. Impaction Seeding on CRP Land and Wooded Hillsides Using Sheep	James Scaife
	Living Snow Fences for Improved Pasture Production	Mike Hansen
	Managing Dairy Manure Nutrients in a Recycling Compost Program	Norman & Sallie Volkmann
	Reducing Chemical Usage by Using Soy Oil on Corn and Soybean	Donald Wheeler
	Techniques for More Efficient Utilization of a Vetch Cover Crop for Corn Production	Carmen Fernholz
	Using Nutrient Balances to Benefit Farmers and the Environment	Mark Muller/IATP
2000	Forage Mixture Performance	Itasca County SWCD
	Growing Corn with Companion Crop Legumes for High Protein Silage	Stanley Smith
	Inter-seeding Hairy Vetch in Sunflower and Corn	Red Lake County Extension
	Legume Cover Crops Inter-seeded in Corn as a Source of Nitrogen	Alan Olness & Dian Lopez
	Surface Application of Liming Materials	Jane Grimsbo Jewett
	The Introduction of Feed Peas and Feed Barley into Whole Farm Planning	Ken Winsel

Final Greenbook Article	Title of Project	Grantee
1999	CRP in a Crop Rotation Program	Jaime DeRosier
	Evaluating Kura Clover for Long-term Persistence	Bob & Patty Durovec
	The Winona Farm Compost Strategies	Richard J. Gallien
	Timing Cultivation to Reduce Herbicide Use in Ridge-till Soybeans	Ed Huseby
1998	An Evaluation of Variable Rate Fertility Use on Ridged Corn and Soybeans	Howard Kittleson
	Farming Practices for Improving Soil Quality	Sustainable Farming Association of SC MN
	Sustainable Agriculture in Schools	Toivola-Meadowland School Jim Postance
1997	Converting from a Corn-Soybean to a Corn-Soybean-Oat-Alfalfa Rotation	Eugene Bakko
	Manure Application on Ridge-till: Fall vs. Spring	Dwight Ault
1996	Base Saturation of Calcium	Randy Meyer
	Biological vs. Conventional Crop Systems Demonstration	Gary Wyatt
	Building Soil Humus without Animal Manures	Gerry Wass
	Controlled Microbial Composting to Improve Soil Fertility	Howard & Mable Brelje
	Legumes as a Protein Supplement in Fall Grazed Corn Stalks	Grant Herfindahl
	Living Mulches in West Central MN Wheat Production	Dave Birong
	Making the Transition to Certified Organic Production	Craig Murphy
	No-till Barley and Field Peas into Corn Stalks, Developing Pastures on These Bare Acres	Jerry Wiebusch
	Weed Control and Fertility Benefits of Several Mulches and Winter Rye Cover Crop	Gary & Maureen Vosejpka
1995	Annual Medics: Cover Crops for Nitrogen Sources	Craig Sheaffer
	Integration of Nutrient Management Strategies with Conservation Tillage Systems for Protection of Highly Eroded Land and Lakes in West Otter Tail County	Harold Stanislawski
	Manure Management/Utilization Demonstration	Timothy Arlt
	Reducing Soil Insecticide Use on Corn through Integrated Pest Management	Ken Ostlie
	Taconite as a Soil Amendment	Donald E. Anderson
1994	Biological Weed Control in Field Windbreaks	Tim Finseth
	Energy Conserving Strip Cropping Systems	Gyles Randall
	Fine-tuning Low-input Weed Control	David Baird
	Flame Weeding of Corn to Reduce Herbicide Reliance	Mille Lacs County Extension
1993	Chemical Free Double-cropping	Jeff Mueller
	Cooperative Manure Composting Demonstration and Experiment	Rich Vander Ziel
	Early Tall Oat and Soybean Double Crop	Charles D. Weber
	NITRO Alfalfa, Hog Manure, and Urea as Nitrogen Sources in a Small Grain, Corn, Soybean Crop Rotation	Carmen M. Fernholz
	Nitrogen Utilization from Legume Residue in Western MN	Arvid Johnson
1992	Demonstration of Land Stewardship Techniques in the Red River Valley	Donald H. Ogaard
	Demonstration of Tillage Effects on Utilization of Dairy and Hog Manure in SE MN	John Moncrief
	Economically and Environmentally Sound Management of Livestock Waste	Fred G. Bergsrud
	Herbicide Ban? Could You Adapt on a Budget?	David Michaelson
	Improving Groundwater Quality and Agricultural Profitability in East Central MN	Steven Grosland & Kathy Zeman

Final Greenbook Article	Title of Project	Grantee
1992	Modified Ridge-till System for Sugar Beet Production	Alan Brutlag
	Soil Building and Maintenance	Larry H. Olson
	Strip-cropping Legumes with Specialty Crops for Low-cost Mulching and Reduced Fertilizer/Herbicide Inputs	Mark Zumwinkle
	Using Nitro Alfalfa in a No-till Corn and Soybean Rotation	Jeff Johnson
1991	Alternative Methods of Weed Control in Corn	Sr. Esther Nickel
	Hairy Vetch and Winter Rye as Cover Crops	Mark Ackland
Energy		
2016	Increasing Dairy Farm Profitability Through an Energy Efficiency Implementation Model	Fritz Ebinger
	Solar-powered Rainwater Catchment & Distribution System Using Drip Irrigation	Hammers Green Acres, Sharon Utke
2010	Evaluation of the Potential of Hybrid Willow as a Sustainable Biomass Enery Alternative in West Central Minnesota	Diomides Zamora
2009	On-farm Biodiesel Production from Canola	Steve Dahl
2007	Testing the Potential of Hybrid Willow as a Sustainable Biomass Energy Alternative in Northern Minnesota	Dean Current
Fruits and Vegetables		
2013	Extended Season Marketing of Asian and Latino Ethnic Vegetables Grown in Quick Hoops and a Moveable Greenhouse	Judy & Steve Harder
	Comparison of Strawberries Grown in a High Tunnel and Outside for Quality and Profitability	Debbie Ornquist
	Solar Energy Storage and Heated Raised Beds	Diane & Charles Webb
2012	Growing Blackberries Organically under High Tunnels for Winter Protection and Increased Production	Erik Gundacker
	High Tunnel Primocane Blackberry Production in Minnesota	Terrance Nennich
	Minimizing the Environmental Impact and Extending the Season of Locally Grown Raspberries	Steve Poppe
	Growing Fresh Cabbage for Markets Using Integrated Pest Management Strategies	Ly Vang (American Association for Hmong Women in Minnesota)
2011	Using Solar Energy to Heat the Soil and Extend the Growing Season in High Tunnel Vegetable Production	Dallas Flynn
	Extended Growing Season for Lettuce	Michael Hamp
	Organic Day-neutral Strawberry Production in Southeast Minnesota	Sam Kedem
	Winter Plant Protection of Blueberries in Northern Minnesota	Al Ringer
2010	Intercropping within a High Tunnel to Achieve Maximum Production	Mark Boen
2009	Chokecherry (Prunus virginiana) Production in Western Minnesota	Todd & Michelle Andresen
	Winter Harvest of Hardy Crops under Unheated Protection	Kelly Smith
	Insect and Disease Pressure in Unsprayed Apple Orchards in Central and Northern Minnesota	Thaddeus McCamant
2008	Apple Scab Control Project	Rick Kluzak
	Controlling Western Striped Cucumber Beetles Using Organic Methods: Perimeter Trap Crops and Baited Sticky Traps	Peter Hemberger
	Establishing Healthy Organic Asparagus While Utilizing Minimal Labor and Maintaining Proper Soil Nutrition	Patrick & Wendy Lynch
	Novel Preplant Strategies for Successful Strawberry Production	Steven Poppe

Final Greenbook Article	Title of Project	Grantee
2005	Organic Strawberry Production in Minnesota	Brian Wilson & Laura Kangas
2004	Root Cellaring and Computer-controlled Ventilation for Efficient Storage of Organic Vegetables in a Northern Market	John Fisher-Merritt
2003	Evaluating the Benefits of Compost Teas to the Small Market Grower	Pat Bailey
	Research and Demonstration Gardens for New Immigrant Farmers	Nigatu Tadesse
	Viability of Wine Quality Grapes as an Alternative Crop for the Family Farm	Donald Reding
2002	Development and Continuation of a Community Based Sustainable Organic Grower's Cooperative and Marketing System	Patty Dease
	Flame Burning for Weed Control and Renovation with Strawberries	David Wildung
	Good Eating with Little Healing: A Straw Bale Greenhouse	Linda Ward
	Integrating Livestock Profitably into a Fruit and Vegetable Operation	David & Lise Abazs
	Soil Ecology and Managed Soil Surfaces	Peter Seim & Bruce Bacon
	Value Adding to Small Farms through Processing Excess Production	Jeffrey & Mary Adelmann
2001	Bio-based Weed Control in Strawberries Using Sheep Wool Mulch, Canola Mulch and Canola Green Manure	Emily Hoover
	Biological Control of Alfalfa Blotch Leafminer	George Heimpel
	Cover Crops and Living Mulch for Strawberry Establishment	Joe Riehle
	Sustainable Weed Control in a Commercial Vineyard	Catherine Friend & Melissa Peteler
1999	Development of Mating Disruption and Mass Trapping Strategy for Apple Leafminer	Bernard & Rosanne Buehler
1998	Alternative Point Sources of Water	Joseph & Mary Routh
	Comparison of Alternative and Conventional Management of Carrot Aster Leafhoppers	MN Fruit & Vegetable Growers Association
	Jessenland Organic Fruits Project	MN New Country School
	Propane Flame Weeding Vegetable Crops	Jean Peterson & Al Sterner
	Soil Quality Factors Affecting Garlic Production	Tim King
	Wine Quality Grapes in Otter Tail County	Michael & Vicki Burke
1997	Community Shared Agriculture and Season Extension for Northern MN	John Fisher-Merritt
	Living Mulch, Organic Mulch, Bare Ground Comparison	Dan & Gilda Gieske
Livestock		
2013	Determining the Cost of Raising Pastured Pork on a Diet Including Whey and Finishing on a Diet Including Acorns	Lori Brinkman
	Determining the Pasture Restoration Potential and Financial Viability of Cornish Cross vs. Red Broilers for a Small Pastured Poultry Operation in Northeast Minnesota	Cindy Hale & Jeff Hall
2011	Fall Forage Mixture for Grass Finishing Livestock Late in the Fall	Troy Salzer
	Increasing the Profitability of Raising Livestock: An Evaluation of Two Methods to Extend the Grazing Season	Dean Thomas
	Methods to Establish Grazing of Annual Forages for Beef Cows on Winter Feeding Areas	Walker/Mathison
2010	A Comparison between Cornstalk and Soybean Straw for Bedding Used for Hogs and Their Relative Nutrient Value for Fertilizer	John Dieball
2009	Demonstration of How Feeding In-line Wrapped High Moisture Alfalfa/Grass Bales Will Eliminate Our Fall and Winter "Flat Spot" in Grass-fed Beef Production	Donald Struxness
	Diversified Harvest of Integrated Species	Joe & Michelle Bowman
2008	Comparing Alternative Laying Hen Breeds	Suzanne Peterson

Final Greenbook Article	Title of Project	Grantee
2007	Composting Bedded Pack Barns for Dairy Cows	Marcia Endres
	Managing Hoops and Bedding and Sorting without Extra Labor	Steve Stassen
2005	Performance Comparison of Hoop Barns vs. Slatted Barns	Kent Dornink
	Raising Cattle and Timber for Profit: Making Informed Decisions about Woodland Grazing	Michael Demchik
	Using a 24' x 48' Deep Bedded Hoop Barn for Nursery Age Pigs	Trent & Jennifer Nelson
2004	Comparing Performance of Hoop Buildings to an Older Conventional Building for Finishing Hogs	Kevin Connolly
	High Value Pork Production for Niman Ranch Using a Modified Swedish System	David & Diane Serfling
	Low Cost Fall Grazing and Wintering Systems for Cattle	Ralph Lentz
2003	Can New Perennial Grasses Extend Minnesota's Grazing Season	Paul Peterson
	Enhancement of On-farm Alfalfa Grazing for Beef and Dairy Heifer Production	Dennis Johnson
	Farrowing Crates vs. Pens vs. Nest Boxes	Steve Stassen
	Forage Production to Maintain One Mature Animal Per Acre for 12 Months	Ralph Stelling
	High Quality – Low Input Forages for Winter Feeding Lactating Dairy Cows	Mark Simon
	Pasture Aeration and its Effects on Productivity Using a Variety of Inputs	Carlton County Extension
	Potential of Medicinal Plants for Rotational Grazing	Management Intensive Grazing Groups, Dave Minar
	Programmatic Approach to Pasture Renovation for Cell Grazing	Daniel Persons
2002	Adding Value for the Small Producers via Natural Production Methods and Direct Marketing	Peter Schilling
	Grazing Beef Cattle as a Sustainable Agriculture Product in Riparian Areas	Frank & Cathy Schiefelbein
	Improvement of Pastures for Horses through Management Practices	Wright County Extension
	Increasing Quality and Quantity of Pasture Forage with Management Intensive Grazing as an Alternative to the Grazing of Wooded Land	Michael Harmon
	Supplement Feeding Dairy Cattle on Pasture with Automated Concentrate Feeder	Northwest MN Grazing Group
	Viability of Strip Grazing Corn Inter-seeded with a Grass/Legume Mixture	Stephen & Patricia Dingels
2001	Annual Medic as a Protein Source in Grazing Corn	Joseph Rolling
	First and Second year Grazers in a Year Round Pasture Setting Served by a Frost Free Water System	Don & Dan Struxness
	Low Input Conversion of CRP Land to a High Profitability Management Intensive Grazing and Haying System	Dan & Cara Miller
	Whole System Management vs. Enterprise Management	Dennis Rabe
	Working Prairie – Roots of the Past Sustaining the Future	John & Leila Arndt
2000	Converting a Whole Farm Cash System to Sustainable Livestock Production with Intensive Rotational Grazing	Edgar Persons
	Dairy Steers and Replacement Heifers Raised on Pastures	Melissa Nelson
	Establishing Pasture Forages by Feeding Seed to Cattle	Art Thicke
	Five Steps to Better Pasture in Practice: How does it really work?	Sarah Mold
	Grass-and Forage-based Finishing of Beef, with Consumer Testing	Lake Superior Meats Cooperative
	Low Cost Sow Gestation in Hoop Structure	Steve Stassen
	Reviving and Enhancing Soils for Maximizing Performance of Pastures and Livestock	Doug Rathke & Connie Karstens

Final Greenbook Article	Title of Project	Grantee
1999	Deep Straw Bedding Swine Finishing System Utilizing Hoop Buildings	Mark & Nancy Moulton
	Extending the Grazing Season with the use of Forage Brassicas, Grazing Corn and Silage Clamps	Jon Luhman
	Home on the Range Chicken Collaborative Project	Sustainable Farming Association of SE MN
	Hoop Houses and Pastures for Mainstream Hog Producers	Josh & Cindy Van Der Pol
	Learning Advanced Management Intensive Grazing through Mentoring	West Otter Tail SWCD
	Management Intensive Grazing Groups	Dave Stish
	Renovation of River Bottom Pasture	Jon Peterson
	The Value Added Graziers: Building Relationships, Community and Soil	Values Added Graziers
1998	Buffalo: Animal from the Past, Key to the Future	Richard & Carolyn Brobjorg
	Marketing Development - Small Farm Strategies Project	Sustainable Farming Association of NE MN
	Pastured Poultry Production and Riparian Area Management	Todd Lein
1997	Butcher Hogs on Pasture	Michael & Linda Noble
	Developing Pastures Using Various Low-input Practices	Ralph Lentz
	Grass Based Farming in an Intensive Row Crop Community	Douglas Fuller
	Grazing Hogs on Standing Grain and Pasture	Michael & Jason Hartmann
	Grazing Sows on Pasture	Byron Bartz
	Low Input Systems for Feeding Beef Cattle or Sheep	Dennis Schentzel
	Raising Animals for Fiber	Patty Dease
	Seasonal Dairying and Value-added Enterprises in SW MN	Robert & Sherril Van Maasdam
	Swedish Style Swine Facility	Nolan & Susan Jungclaus
1996	Dairy Waste Management through Intensive Cell Grazing of Dairy Cattle	Scott Gaudette
	Establishing Trees in Paddocks	Dave & Diane Serfling
	Evaluating Pasture Quality and Quantity to Improve Management Skills	Land Stewardship Project
	Expanding into Outdoor Hog Production	James Van Der Pol
	Grazing Limits: Season Length and Productivity	Doug & Ann Balow
	Rotational Grazing Improves Pastures	MISA Monitoring Team/Dorsey
1995	Backgrounding Rotational Grazing	Frank Schroeder
	Evaluating Diatomaceous Earth as a Wormer for Sheep and Cattle	David Deutschlander
	Intensive Controlled Grazing and Pasture Rejuvenation on Fragile Land	Lyle & Nancy Gunderson
	Intensive Rotational Grazing on Warm Season Grasses	Jim Sherwood
	Rotational Top-grazing as a Method of Increasing Profitability with a High-producing Dairy Herd	Alton Hanson
1994	Economics of Rotational Grazing vs. Row Crops	Harold Tilstra
	Low Input Range Farrowing of Hogs	Larry Mumm

Final Greenbook Article	Title of Project	Grantee
1993	A Comparison Study of Intensive Rotational Grazing vs. Dry-lot Feeding of Sheep	R & K Shepherds
	Controlled Grazing of Ewes on Improved Pastures and Lambing on Birdsfoot Trefoil	Leatrice McEvilly
	Farrowing and Raising Pigs on Pasture	Charles Cornillie
	Improving Permanent Pastures for Beef in SW MN	David Larsen
	Intensive Rotational Grazing	Chad Hasbargen
	Research and Demonstration of Rotational Grazing Techniques for Dairy Farmers in Central Minnesota	Stearns County Extension
	Winter Grazing Study	Janet McNally & Brooke Rodgerson
1992	A Demonstration of an Intensive Rotational Grazing System for Dairy Cattle	Ken Tschumper
	Intensive Rotational Grazing in Sheep Production	James M. Robertson
	Using Sheep and Goats for Brush Control in a Pasture	Alan & Janice Ringer

About the Staff

The Greenbook staff brings a broad range and many years of experience in sustainable agriculture areas. Each staff person focuses on individual topic areas where they have expertise and interest.

Cassie Dahl
State Programs Administrator Intermediate

Cassie assists with the Minnesota Organic Conference and Organic Cost Share Program. In addition, she coordinates the Fruit Integrated Pest Management Newsletter for the department. Cassie has a MS in Sustainable Horticulture from the University of Minnesota and she joined the Minnesota Department of Agriculture (MDA) in 2011.

Alison Fish
Administrative Support

Alison provides administrative support to the staff and the program. Alison joined the MDA staff in 1990.

Julianne LaClair
Grants Specialist Intermediate

Julianne works alongside Meg Moynihan to administer the Sustainable Agriculture Demonstration Grant. In addition, she is responsible for administration of the Specialty Crop Block Grant Program. Julie joined the MDA staff in 2014.

Meg Moynihan
Principal Administrator, Organic/Diversification

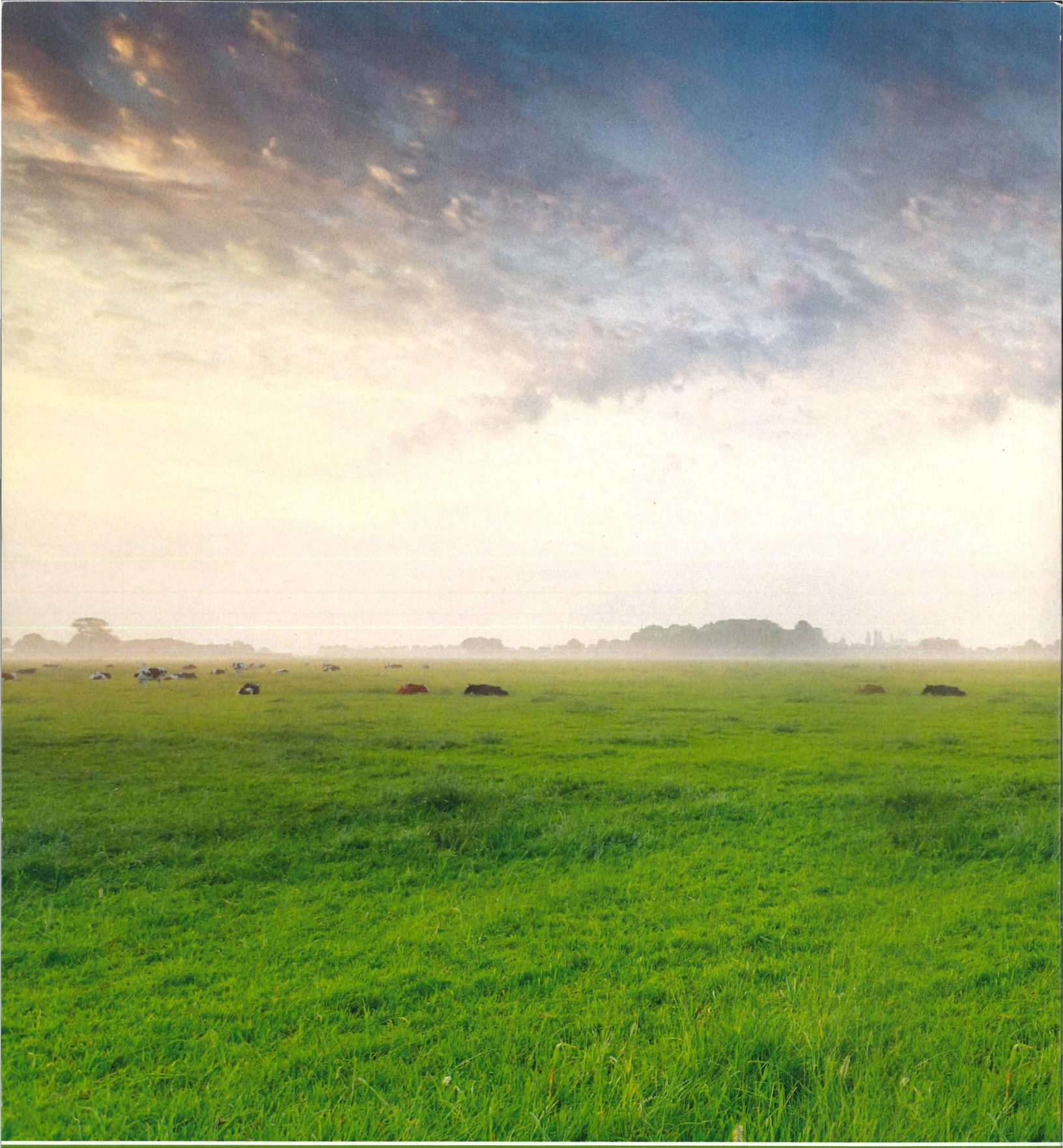
Meg helps farmers and rural communities learn about crop, livestock, management, and marketing options, including organic. She has worked professionally as an educator and evaluator and as a community development extension specialist with the U.S. Peace Corps in northern Thailand. She is also a certified organic dairy farmer. Meg joined the MDA staff in 2002.

Alatheia Stenvik
Ag Business Development Specialist

Alatheia helps administer the Sustainable Agriculture Demonstration Grant program through organizing the Greenbook and assisting with program activities. In addition, she helps administer State grant, scholarship, and business development programs. Alatheia joined the MDA staff in 2014.

Mark Zumwinkle
Sustainable Agriculture Specialist

Mark provides hands-on experience to farmers working on soil quality and acts as a liaison with university researchers and farmers coordinating the use of the rainfall simulator. Mark uses soil and cropping system health as focal points for farmers exploring management options and provides the non-farm community with access to soil health information. Mark is a vegetable grower from North Central MN with research experience in living mulches and plant nutrition. Mark joined the MDA staff in 1993.



Minnesota Department of Agriculture

The Greenbook is dedicated to the farming families of Minnesota.
Their innovation, cooperation, and persistence are creating
a more sustainable agriculture.

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