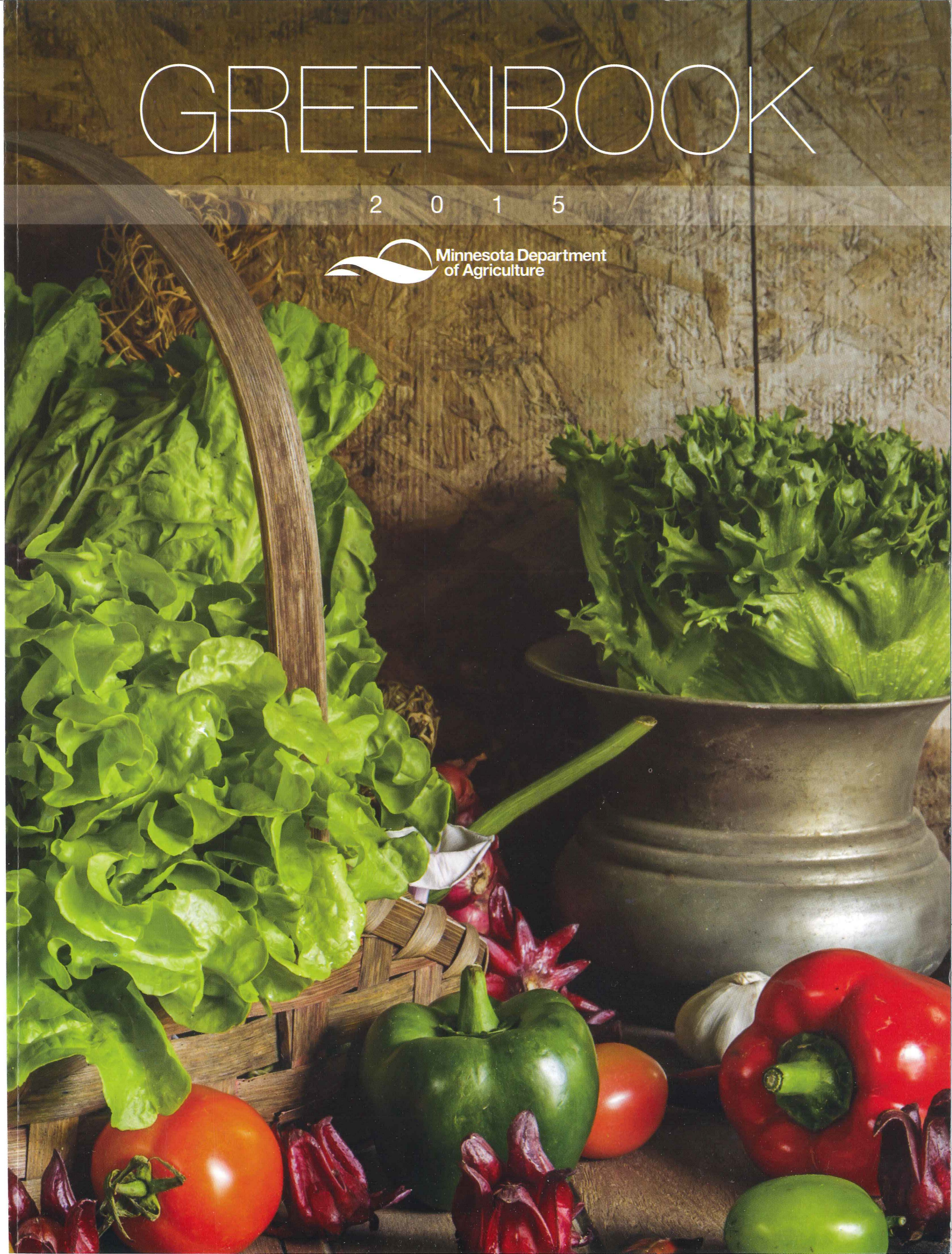
GREENBOOK

2015

Minnesota Department of Agriculture



Greenbook 2015

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.

June 2015

Thank you to the MDA's Agricultural Marketing and Development Division Staff who helped to make *Greenbook* 2014 a reality. They include: Cassie Dahl, Alison Fish, Alatheia Stenvik, Meg Moynihan, and Mark Zumwinkle.

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Introduction to the Greenbook 2015

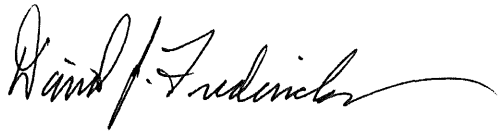
This year, the Minnesota Department of Agriculture's Greenbook is stacked with articles about 19 creative projects funded by the Sustainable Agriculture Demonstration Grant Program. For 25 years farmers, ranchers and researchers have invested these grant dollars to explore practices that will make farming in Minnesota more sustainable. We are very proud of this program and the many ways it has impacted farmers and rural communities in Minnesota.

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.

We believe the ideas these farmers and researchers are testing will help shape future decisions and farming methods. Past projects explored "new" practices that have since become widely adopted, like cover cropping, integrated pest management, managed grazing for dairy and beef cattle, and farrowing hogs on pasture or in deep bedded pen systems.

Whether you're more interested in the farmers' stories, the hard data, or simply want to read about new ideas, you'll find Greenbook 2015 a great page turner! 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 13 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 1,100 grant applications and approved over $3.5 million in funding for 313 projects since the program began in 1989. Project categories include: Alternative Markets and Specialty Crops, Cropping Systems and Soil Fertility, Energy, Fruits and Vegetables, and Livestock. The grant projects, located throughout the state of Minnesota, are described in Greenbook 2015.

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.

Grant Summaries

The project summaries that follow are descriptions of objectives, methods, and findings of individual grant projects funded in 2013. To find out more details about these projects, contact the principal investigators directly through the listed telephone numbers, addresses, and email addresses.

Summary of Grant Funding (1989-2014)

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
Total Funded	300	$3,059,416		

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

Alternative Markets & Specialty Crops + Fruits and Vegetables

Minnesota Propolis: Potential Enterprise and Sustainable Disease Management Tool

Grantee: Victoria Ranua
Duration: 3 years
Award Amount: $25,000
County: Scott & Hennepin

Project Objectives:

1. Establish a baseline of propolis production from colonies in east-central Minnesota looking at two races, the typical Italian hives and the new Caucasian bees that have a reputation known for heavy propolis collection.
2. Evaluate if/how the presence of propolis traps affects colony health.
3. Determine a schedule for harvesting propolis traps that maximizes 1) harvestable propolis and/or 2) colony health. Includes three trial groups: control (no traps), fall-harvested traps, and early spring-harvested traps (traps with propolis left on colonies over the winter).

Developing a Network for Environment and Weather Applications

Grantee: Minnesota Apple Growers Association
Project Duration: 3 years
Award Amount: $19,965
County: Dakota, Rice, & Washington

Project Objectives:

1. Upgrading the monitoring system and expanding it to include more growing sites around the state giving growers more technical information about disease and insect control.
2. To show how the New York State Agriculture Experiment Station in Geneva, NY degree day models for a number of insects of plant diseases correlate to the weather conditions in Minnesota.
3. Correlate data collected from the weather station and spore maturity testing of apple scabs leaves to check for accuracy.

Cropping Systems & Soil Fertility

Evaluating Harvest Methods for Intermediate Wheatgrass as Perennial Edible Grain

Grantee: Carmen Fernholz
Project Duration: 3 years
Award Amount: $16,106
County: Lac Qui Parle

Project Objectives:

1. Determine optimum time to harvest intermediate wheatgrass seed for maximized grain yield.
2. Measure grain moisture changes related to grain harvest timing.
3. Measure grain harvest and de-hulling efficiency of intermediate wheatgrass at different maturity stages.

Evaluation of Winter Annual Small Grain Cover Crops for Forage Production

Grantee: Daniel Ley
Project Duration: 3 years
Award Amount: $25,000
County: Stearns

Project Objectives:

1. Determine if harvesting winter annuals for silage is practical and if it will adequately offset the cost of planting these cover crops and not wind up with a net loss of feed and quality at the end of the season.
2. Compare the performance of various species of winter annual small grains in both yield and forage value. To find out which cover crop scenario best fits into the growing season and weather parameters that are dealt with and how to best adapt to these challenges with management.
3. Investigate the impact of planting and harvesting winter annual small grains for silage on soil health in a no-till system.

Three-Crops in Two Years for Farm Profit and Water Quality

Grantee: Daryl Patnode
Duration: 2 years
Award Amount: $6,716
County: Hennepin

Project Objectives:

1. The feasibility of planting winter rye after corn silage in the fall on Minnesota livestock farms as a cover crop for meeting the State's sediment and nutrient reduction goals.
2. The feasibility of planting winter rye after corn silage in the fall on Minnesota livestock farms as a source of low cost, high quality forage harvested in the spring prior to planting the full season crop.
3. Demonstrating the benefits and challenges of growing and harvesting three crops in 2 years and expanding the use of profitable, practical cover crops on more Minnesota farms by sharing results based on real farm conditions.

Soil Health Research in Southwest Minnesota

Grantee: Jerry and Nancy Ackermann
Duration: 3 years
Award Amount: $16,814
County: Jackson & Nobles

Project Objectives:

1. Determine cover crop effects on soil health in southwest Minnesota farmland.
2. Verify cover crop effects on soil nutrients in southwest Minnesota farmland.
3. Provide educational opportunity for southwest Minnesota farmers.

Cover Crops to Replace Fall Tillage in the Chippewa Watershed

Grantee: Land Stewardship Project (Robin Moore)
Project Duration: 3 years
Award Amount: $22,579
County: Chippewa & Swift

Project Objectives:

1. To provide a local example to demonstrate the use of tillage radishes in a cover as a viable option to fall tillage in the heavy clay loam soils of the Chippewa watershed.
2. To demonstrate that cover crops are a financially viable practice by reducing compaction, sequestering nutrients thus reducing the need for inputs, and building soil health, structure, and organic matter.
3. To build and foster community around conservation values in the Chippewa watershed beginning with a network of farmers experimenting with cover crops and learning about soil health together.

Planting Short Season Corn for Cover Crop Success

Grantee: Land Stewardship Project (Caroline van Shaik)
Project Duration: 2 years
Award Amount: $20,977
County: Fillmore

Project Objectives:

1. Field test early maturing (78-82-day) corn as an economically viable option for cover crop establishment in southeast Minnesota.
2. Introduce and reinforce soil health concepts to farmers and landowners with practical, visible applications.
3. Stimulate local interest in cover crops by addressing their many assets as well as farmer concerns through the leadership of local farmers.

Use of Sub-Surface Irrigation to Increase Crop Profitability

Grantee: Russell V. Martie
Project Duration: 3 years
Award Amount: $11,937
County: Wright

Project Objectives:

1. More efficient use of water in irrigation systems and improve fertilizer use efficiency by comparing subsurface drip irrigation to non-irrigated and conventional center-pivot. Improve energy use of irrigation systems.
2. Check efficacy of and make adjustments to evapotranspiration-based irrigation scheduling by comparing data from in ground soil sensors to current recommendation modeling. This data will allow improvement to resource conservation and profitability and lessen ground water impact.
3. Demonstrate to local farmers that this type of irrigation can be effective at conserving water and using less fertilizer while maintaining or increasing yields and being cost-effective leading to improved profitability.

Raising Soil pH Effectively in Acid Soils

Grantee: Wolf Ridge Environmental Learning Center (David Abazs)
Project Duration: 3 years
Award Amount: $19,583
County: Lake

Project Objectives:

1. Test and demonstrate how to raise the soil pH using lime, wood ash, and biochar, in six field plots, 1) lime only, 2) wood ash only, 3) biochar only, 4) biochar + wood ash, 5) biochar + lime, and 6) control plot where no lime, wood ash, or biochar will be applied.
2. Measure soil health by testing a. nutrient retention, b. organic matter, and c. biological health of the six field plots.
3. Evaluate and compare bio lime, wood ash, and biochar, as they relate to farm costs and time within the context of success/failure of soil pH, nutrient retention, organic matter, and biological health. Cost/benefit analysis.

Maximizing Profitability in a Modular Move Created Hoop House

Grantee: Megan Henry
Project Duration: 3 years
Award Amount: $18,318
County: Washington, Dakota, & Rice

Project Objectives:

1. Modular Moveable Cathedral Hoop Houses.
2. Sequences of hoop house rotation that maximizes the diverse benefits of the structure. Soil heating, crop protection, pest exclusion and quality.
3. Cropping systems that utilize Modular Movable Hoop Houses to their maximum potential. Inter-cropping, over-wintering, hoop in a hoop, farming the backside of the calendar, deep winter greenhouse, etc.

Nitrogen Capture using Cover Crops in a Cash Grain Rotation

Principal Investigator

William Bronder
14855 Hwy. 10
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Sherburne County SWCD

Project Duration

2014 to 2016

Award Amount

$19,570

Staff Contact

Mark Zumwinkle

Keywords

cover crops, interseeding, nitrogen

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.

Bill hand seeding plot.

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.

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. 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.

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.

Nitrogen Scavenging Mix

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.

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

Nitrogen Capture using Cover Crops in a Cash Grain Rotation Results

Location of Plot	Crop	Description	Varieties Included	Date Measurement Taken	Soil Nitrate-Nitrogen
Olson Brothers Farm	Early Harvest Potatoes	Field after harvest	-	8/20/14	220 lb/A
		Cover Crop Basic Mix	Oats, Radish, Winter Pea	9/30/14	80 lb/A
		Compaction Mix	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	10/23/14	128 lb/A
	Green Beans	Field after harvest	-	7/30/14	117 lb/A
		Rye (Planted 9/1/14)	Rye	10/23/14	118 lb/A

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.

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.

Cooperators

Steve Johnson, Triple J Farms, Land Owner, Becker, MN

Rick Olson, Olson Farms, Grower, Becker, 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 16 ¼ miles. 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. efotg.sc.egov.usda.gov/references/public/NE/NE340.pdf

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

Principal Investigator

Jim Chamberlin
Happy Dancing Turtle
2331 Dancing Wind Rd. SW, Ste. 1
Pine River, MN 56474
218-587-2001

Project Duration

2014 to 2016

Award Amount

$20,385

Staff Contact

Cassie Dahl

Keywords

agroforestry, native plants, nurseries

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

Project Summary

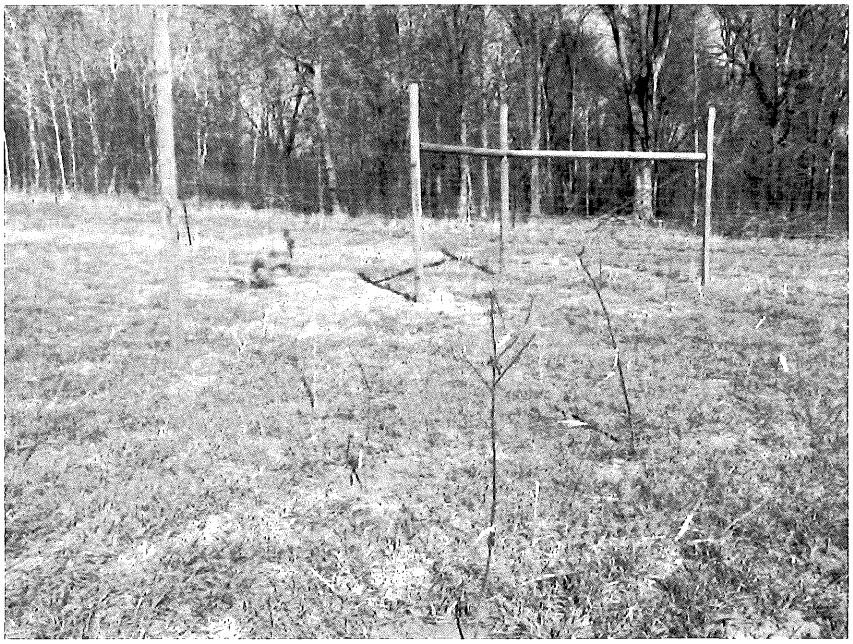
This project is to demonstrate how to establish productive and profitable agroforestry land-use systems. Agroforestry focuses on proven ecological and environmental benefits. This project is to explore methods of establishing agroforestry systems using on-farm propagation to produce native plant species,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

Project Description

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.

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.



Nursery on Early Boots Farm.

Site prep at Happy Dancing Turtle.

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.
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 com-mon.	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.

Management Tips

Ecological Classification surveys showed that larger landscapes can have inclusions of richer or poorer NPC's within them. Also that land use history and previous disturbances can possibly play a role in NPC determination.

Cooperators

Tyler Carlson, Producer, Early Boots Farm

Stephen Briggs, Producer, Camphill Village

Diomy Zamora, UMN 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: www.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

Floyd Hardy
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Crow Wing County

Project Duration

2013 to 2014

Award Amount

$5,331

Staff Contact

Meg Moynihan

Keywords

cereals, organic, rocks, soybeans, triticale, vernalization, weeds, winter triticale

Using Spring-planted Winter Cereals to Control Weeds in Organic Soybeans

Project Summary

Raising soybeans on my North Central Minnesota farm has been difficult because of the many small rocks in my fields. Even if I pack the fields at planting time, cultivation disturbs the rocks, and they play havoc with my equipment when I combine the crop.

I am testing a strategy of planting winter triticale in the spring of the year. When planted in spring, winter triticale stays vegetative and does not produce grain. I want to see if the triticale will control weeds until the beans shade the ground, so that I don't have to cultivate and can reduce the risk of rock damage to my combine.

Project Description

I have farmed organically for 13 years – mainly small grains, clover for hay and seed, and hairy vetch for seed. I use hairy vetch as the legume to fix nitrogen, and buckwheat to control quack grass in my crop rotations. I am interested in putting soybeans back into my crop rotation, but because my fields have small rocks, cultivation of a row crop like soybeans moves the rocks into the crop row and makes for a difficult harvesting situation.

In 2007, I visited another organic farmer who had planted soybeans in a rye field. I noticed how clean (weed-free) his field was. He told me later that he did end up with some rye grain in his beans at harvest.

This farmer's experience got me to wondering if I could try something similar, but my idea was to use winter triticale as a smother crop that I would plant in the spring, instead of the fall. When you plant a winter cereal like winter triticale, winter wheat, or winter

Floyd Hardy (L) and cooperator Glen Borgerding.

rye in the fall, it goes through a process called vernalization (exposure to cold temperatures), which triggers it to produce grain the next spring. However, when you plant winter grains in the spring, vernalization does not occur, and the plant stays vegetative; it never produces grain. My idea was that the triticale would control broadleaf weeds but would not produce any triticale grain that would end up in my soybeans. I wouldn't have to cultivate (and stir up rocks), and combining would also be much cleaner and easier.

2013 Results

The field I used had been in red clover for 2 years. I plowed, disked and multiweeded the field in the spring. Then, I planted the winter triticale at different seeding rates: 1, 1.5, and 2 bu/A on May 13.

The triticale was about 2" tall when it was time to seed the soybeans. However, it had been raining almost every day and a third of my field was underwater – to where geese and swans had taken up residence! After a 10 day delay, I drilled the soybeans in 12" rows on the high ground on May 23, using a seeding rate of 190,000/A. Then I packed the field to suppress the rocks. The triticale looked awful, and I wondered if it would survive, but it did. About a week later, I planted beans on some of the acres that had been flooded. The triticale there was in very poor condition. This area did not have to be packed because there are no rocks on this lower land.

On July 12, my advisor Glen Borgerding and I walked the field. Just a few of the beans were starting to bloom. They were about 10" high and nodules were starting to form on the roots. The triticale was about 14" high and turning brown. Glen and I walked for some time before we found a broadleaf weed. However, we found a lot of quack grass on the low ground because of all the rain.

Then things dried up, and from July 4 on, not a drop of rain fell. By August 30, when I held a field day, the soybeans were in very poor shape. The low ground that I never planted was armpit high with volunteer grass. Where I did plant beans, they didn't grow big enough to shade the ground, and common ragweed was everywhere! A neighbor volunteered to cut and bale everything as he needed hay for his beef cattle.

2014 Results

Glen and I worked out a different strategy for 2014. Glen suggested getting the triticale in as early as possible, and then no-till drilling the beans into the triticale after it had emerged, using 6" rows so they would canopy sooner, and I agreed to try it.

Cold, wet weather delayed field work until May. I tilled and rolled the field on May 13, and planted the triticale at 1.25 bu/A on May 23. On May 24, I planted an early variety of soybeans at 205,000 seeds/A in 6" rows.

I do not recommend this strategy; it turns out the back-to-back planting was a big mistake. The beans grew way faster than the triticale and shaded it out to the point that it never provided any weed control at all. After the cold, wet spring, the rest of the growing season was fine, but that field had so many weeds that I swathed it on September 21 and combined it four days later. The soybeans yielded not quite 10 bu/A. I had no other beans on the farm, so nothing to compare that yield to, but in a good year, I can expect about 15 bu/A of beans on my sandy ground.

While the project didn't work out the way I imagined it would in either year, I still believe it has potential and I plan to keep trying it. I am sorry the grant is over; I wish I had requested a three year project instead of just two. However, I'm going to try again in 2015. I plan to get the triticale in early and will wait at least 2 weeks between planting the triticale and planting the beans in 6" rows. I swear I know it's going to work.

The beans grew way faster than the triticale.

Management Tips

1. Don't try this on sod ground.
2. Let the triticale emerge before you drill in the beans.
3. Drill the soybeans in 6" rows.

Cooperators

Glen Borgerding, Consultant, Ag Resource Consulting, Albany, MN

Project Location

From Brainerd, go east on State Hwy. 18. Continue east for 2.5 miles. Turn right onto Cty. Rd. 144 Go south 3.5 miles, turn left on Narrow Lane Rd. Look for fire number 14743.

Legume Cover Crops

Principal Investigator

Paul Kruger
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Project Duration

2014 to 2017

Award Amount

$14,919

Staff Contact

Mark Zumwinkle

Keywords

cover crops, legumes

Project Summary

Paul Kruger is leading a 3 year study and will track 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 will be planted between the corn rows in this experiment. Since cover crops reduce soil erosion and enhance soil organic carbon, the study will track soil health properties, which include nutrient holding capacity (CEC) and the rate of rain water infiltration. With more rain water infiltrating the soil, we predict there should be less runoff. With less runoff, fewer nutrients, including nitrogen, will be lost to erosion.

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 will monitor:

1. Yield
2. Nitrogen credits and carryover (spring nitrate test)
3. Soil temperature
4. Erosion and weed pressure (visual)
5. Appearance (crop stress, yellowing or green leaves)

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 is using Roundup® Ready legumes. Paul planted them early in order to encourage nodule production. On July 9, he broadcasted the seed on 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 crops.

Year 1- (Spring 2014)

Corn was planted for grain in May. The entire field was fertilized the same. Cover crop species were planted with a drill 5 days after the corn had been planted.

Varieties Included and Costs per Acre:

Plot 1 (4 Species – 50 lb/species/A) Broadcasted July 9	
Legume	Cost per 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 3 (2 Species – 50 lb/A for Soybeans, 14 lb/A for Alfalfa)	
Roundup® Ready Alfalfa	$49
Roundup® Ready Soybeans	$56
Total Cost/A	$105

Plot 4 was the Control Plot. The corn sold for grain.

Results

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 has decided that there is no difference in the cover crop plots and the control plots. He came to this conclusion due to the fact that the plots yielded approximately the same. 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.

From the first year of the experiment, Paul learned to make sure the field is even in its entirety. Next year, he will also make sure the soil samples are taken in a timely manner. His soil samples were taken in the spring. He did not receive the soil sample results soon enough to fertilize the field with potassium, which was low in all plots. By working with an agronomist, Paul will fix this problem in the next growing season.

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 interseeded in corn.

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 four feet 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.

Cooperators

Wabasha Soil and Water Conservation District, Wabasha, MN

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

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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Hennepin County

Project Duration

2013 to 2014

Award Amount

$10,292

Staff Contact

Alatheia Stenvik

Keywords

basil, cucumber, high tunnel, quick hoops, row cover, tomato

Comparing the Production and Profitability of Heat-loving Crops in High Tunnel and Quick Hoop Systems

Robin standing in a high tunnel.

Project Summary

Unheated structures, such as high tunnels or quick hoops, are commonly used to extend vegetable production. However, for many beginning vegetable farmers season extension structures, such as a high tunnel, are a cumbersome investment. This project is an attempt to compare the interaction of production and profitability differences between two unheated season extension systems, a high tunnel, and quick hoops.

We want to determine if quick hoops, which are cheap and portable, are more profitable than high tunnels, which are costly yet highly productive. As vegetable farming operates on such tight margins, a quick hoops system that is inexpensive yet lower-yielding may in fact be more desirable due to lower overhead cost. If the project is successful, it will provide Stone's Throw Urban Farm and other vegetable farms with an understanding of profitability expectations for high tunnel and quick hoop season extension systems.

Project Description

Stone's Throw Urban Farm's South Minneapolis site.

Stone's Throw Urban Farm is a 3-acre urban vegetable operation located on 14 rented lots in South Minneapolis and the North End and Frogtown neighborhoods in Saint Paul. The farm sells food through its 100 CSA shareholders, at one farmers' market, and to restaurants in the Twin Cities. As beginning farmers with no land permanency, we strive to identify investments that will directly increase income or decrease expenses.

Season extension systems offer many benefits for increasing production earlier and later in the season. However, beginning farmers need more information to discern the best way to improve low-input season extension systems. With little start-up capital, many beginning vegetable farmers need to know how much additional income high tunnel crops will bring compared to working with quick hoops. Quick hoops are impermanent structures made by placing row covers or plastic over lightweight metal wickets 3' in height. This project aims to explore the following questions: At what point do high

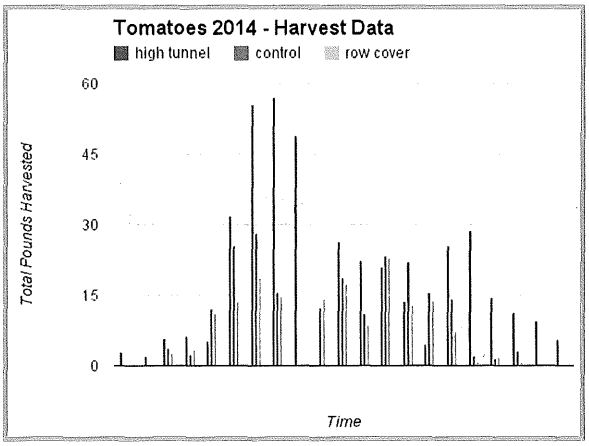
tunnels become more profitable than quick hoops? What are the production differences between systems? How much time will high tunnels extend the season compared to quick hoops?

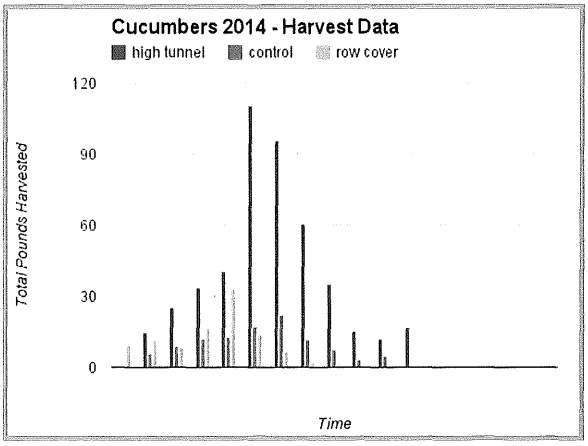
We compared the profitability and productivity of three crops, tomatoes (var. Cherokee Purple), cucumbers (var. Bushy), and basil (var. Genovese), in three treatments: high tunnel, quick hoops, and outdoors (control). The demonstration size differed by crop but is consistent between the high tunnel, quick hoops, and outdoor treatments. All crops were planted in 55' long beds per treatment. The quick hoop protective row cover was removed when the crops outgrew the 3' quick hoops (July 22 for cucumbers and basil, and June 25 for tomatoes). We kept track of all costs associated with the investments for the season extension systems as well as the growing costs (seeds, soils, etc.) and the labor required for production. We recorded first harvest dates and harvest amounts for each crop.

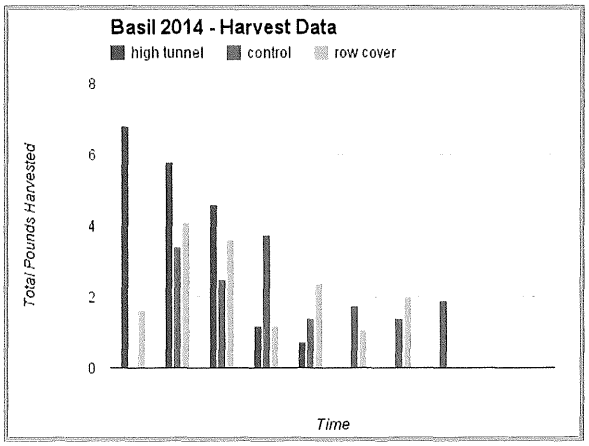
To evaluate the profitability for each treatment we used the following formula:

(Yield in Pounds * Price per Pound) minus Input Costs (materials, labor, tunnel/hoop maintenance, crop requirement costs) equals Net Return.

In June, our log book was stolen from the site containing the control and row cover treatments, so recorded labor and harvest data from before that point was estimated. This is the second and final year of the project experiment.







Results

Tomato, Cherokee Purple: As in year 1, the high tunnel treatment grew a noticeably higher quantity and better quality tomato; fewer cracks and blemishes were present and the tomatoes had an overall larger average size. Additionally, the high tunnel treatment produced earlier and later in the season than the other treatments. Finally, the plants in the high tunnel treatment were noticeably healthier and larger. Out of 30 tomato plants per treatment, three control, one quick hoop, and zero high tunnel plants died. There was minimal difference in plant health between row cover tomatoes and control tomatoes.

Harvest data shows little doubt that high tunnels are a much more productive environment for tomatoes. By the end of the season the control produced, on average, more tomatoes per plant (7.2 lb/plant) than the quick hoop tomatoes (5.5 lb/plant). The high tunnel yielded more than the quick hoop and control tomatoes combined (13.3 lb/plant). The high tunnel tomatoes grew to over 7' tall, while the control and quick hoop treatments did not grow over 5'. The graph showing overall yield data by date clearly illustrates that the high tunnel produced consistently more than other treatments, especially later in the season.

Cucumber, Bushy: All treatments were direct seeded on June 16 and the quick hoop and control cucumbers started to produce 7 days after the high tunnel. Overall, the high tunnel produced consistently more than the other treatments, producing up to five times more weight per harvest during the peak of the season (the biggest one-day harvest from the high tunnel was 110.5 lb on 8/22, compared to a peak control harvest of 22.2 lb on 9/1 and peak row cover harvest of 33.3 lb on 9/1). Also, high tunnel cucumbers reached harvestable size much more rapidly after fruit set, and would have benefitted from a 3

times/week harvest schedule in comparison to the 2 times/week schedule that was used, as some harvested fruit was larger than is ideal for market.

Basil, Genovese: All treatments of basil suffered greatly in 2014 from fusarium wilt and/or downy mildew, which greatly affected the results of the experiment. All experiments began to show signs of these diseases around the first harvests of late July, and by mid-August 75-90% of the crop across all treatments were un-harvestable due to disease. The high tunnel treatment was especially hit hard, likely due to reduced air circulation inside of the structure.

Besides the growing environment, we recognize there were a number of outside factors that also may have contributed to differences in plant health and yields between all experiments, including but not limited to:

- Variation in soil health and growing conditions: The high tunnel treatment was conducted at a different growing site than the control and row cover treatments. Because the soil health and growing conditions can vary considerably between urban lots, this may account for difference in plant health and productivity, disease pressure, and other subtle factors affecting experiment results.

Basil			
Expenses (Year 2)	High Tunnel	Control	Row Cover
High tunnel maintenance	$66.67		
High tunnel maintenance labor	$20.00		
Seedling labor + heat + materials	$8.00	$8.00	$8.00
Soil	$18.00	$18.00	$18.00
Fertilizer	$2.00	$2.00	$2.00
Irrigation	$8.00	$5.00	$5.00
Row cover supplies (wire wickets + row cover)			$20.00
Mulch	$6.00		
Labor for season	$60.80	$42.40	$49.00
Total Expenses	$189.47	$75.40	$102.00
Income (Year 2)			
Market price @ $4/lb	$247.80	$236.40	$250.20
Net Profit:	$58.33	$161.00	$148.20

Cucumbers			
Expenses (Year 2)	High Tunnel	Control	Row Cover
High tunnel maintenance	$66.67		
High tunnel maintenance labor	$20.00		
Seed	$4.00	$4.00	$4.00
Soil	$25.00	$25.00	$25.00
Fertilizer	$2.00	$2.00	$2.00
Irrigation	$8.00	$5.00	$5.00
Row cover supplies (wire wickets + row cover)			$20.00
Labor for season	$65.20	$58.36	$65.36
Total Expenses	$190.87	$94.36	$121.36
Income (Year 2)			
Market price @ $1.20/lb	$552.60	$127.38	$130.32
Net Profit:	$361.73	$33.02	$8.96

Tomatoes			
Expenses (Year 2)	High Tunnel	Control	Row Cover
High tunnel maintenance	$66.67		
High tunnel maintenance labor	$20.00		
Seedling heat + materials	$8.00	$8.00	$8.00
Soil	$25.00	$25.00	$25.00
Fertilizer	$3.00	$3.00	$3.00
Irrigation	$8.00	$4.00	$4.00
Trellis	$10.00	$25.00	$25.00
Row cover supplies (wire wickets + row cover)			$20.00
Mulch	$12.00	$0.00	$0.00
Labor for season	$198.20	$124.40	$139.40
Total Expenses	$350.87	$189.40	$224.40
Income (Year 2)			
Market price @ $4/lb	$1,591.60	$866.16	$664.20
Net Profit:	$1,240.73	$676.76	$439.80

- Mulch: In 2014, high tunnel treatments received a layer of straw mulch for weed control, while the other treatments were not mulched.
- Irrigation Practices: High tunnel treatments were watered using drip irrigation, while other treatments were irrigated using overhead sprinklers. This variation could account for subtle differences in disease susceptibility and plant health.

Conclusion

More focused research would be useful around ideal planting dates in high tunnels for heat-loving crops, as compared to typical planting dates outside of structures. In the same thread, it would be great to have research around which crops complement heat-loving crops in high tunnels for early spring and fall plantings in order to maximize productivity of high tunnels by allowing for three productive harvests per growing season. Additionally, since conditions inside a high tunnel vary greatly from outdoors, we would like to see more research around best practices for heat-loving crops inside of high tunnels, especially around disease control, irrigation, and fertility systems as it uniquely applies to high tunnel environments.

We will definitely continue growing tomatoes in high tunnels and will likely continue growing basil in high tunnels as well. We do not feel like cucumbers are enough of a high-value crop for high tunnels, and will not continue to grow those in tunnels. Additionally, we did not see any significant improvement in profitability with the use of row cover versus control treatments, and will not continue using row cover for heat-loving crops.

I would recommend the investment of high tunnels for all farmers. Based on our experience, the increased productivity and season extension that high tunnels offer nearly immediately pays back for the up-front investment. However, this payback will only be achieved if the farmer is growing higher-value crops and maximizing the use of space through succession planting. I would not recommend the use of a row cover and quick hoop system for heat-loving crops since the added material and labor costs are not covered by a marginal, if any, increase in productivity.

Being a farm located in the heart of an urban area, our neighbors consist of mainly consumers in the food system rather than producers. Therefore, the impact of this project on neighbors and visitors has mainly been an increase in awareness among the general food consumer around the functionality and effectiveness of high tunnels on a productive and profitable farm. Neighbors and visitors to our farm have been able to visually witness the productivity that a high

tunnel can offer and have become advocates for progressive high tunnel policy in urban municipalities. Through official field days and other on-farm events, over 300 visitors have witnessed this project, including many local policymakers and educators.

Management Tips

1. Apply a foliar compost tea or other liquid fertilizer application just before fruit begins to set, and again 1 month after first fruit set. We noticed a drop in production about 1 month after first harvest and this may help plants sustain productivity throughout the season.
2. Rather than letting crops live out their full productive life in high tunnels, take out plants about 1-2 weeks before last anticipated harvest to plant a succession of late fall hearty greens (spinach, head lettuce, arugula, salad mix, kale, etc.). The anticipated profitability of late fall/early winter high tunnel production with hearty greens outweighs the diminishing harvests of heat-loving crops during their last few weeks of productive life.
3. We experienced great results with pruning tomatoes to two main stems in all treatments. In year one, we pruned to one stem, which seemed to thin the plants out too much. With two stems, fruit size was still considerable, plants were able to set more fruit overall, and harvest was still relatively manageable.

Cooperator

Courtney Tchida, University of Minnesota, St. Paul, MN

Project Location

Our farm address is 3217 - 17th Ave S. Minneapolis, MN 55407.

The high tunnel treatment is located on 15th Ave S. between 28th and 29th St. in South Minneapolis. The control and row cover treatments were located on 11th Ave S. between 28th and 29th St. in South Minneapolis.

Resources

The Winter Harvest Handbook. March, 2009. Elliot Coleman. Chelsea Green Publishing Company. ISBN: 978-1-60358-081-6

Cornell High Tunnel Website: www.hort.cornell.edu/hightunnel/

Correcting Soil Structure to Reduce Erosion by Using a Cover Crop Mix with Diverse Root Systems

Principal Investigator

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Project Duration

2013 to 2015

Award Amount

$9,277

Staff Contact

Mark Zumwinkle

Keywords

cover crops, compaction, soil health

Project Summary

Brian Rinke is doing a 3-year test adding a diverse cover crop mix to his row crops that will hopefully lead to reduced input costs, better water management, and higher row crop yields. The cover crop mix is being designed specifically to improve soil physical, chemical, and biological characteristics. The only expectation after 3 years is a measured improvement in soil physical structure. Showing a real improvement in biology and fertility will likely take longer.

Brian farms 1,800 acres of field corn and soybeans on silty to clayey textured soils in the Red River Valley. Slopes are 0-5% and soils are mapped at somewhat poorly to very poorly drained.

It is widely accepted in the Red River Valley that deep fall tillage and residue incorporation is needed to obtain a dark soil surface color to increase early spring soil temperature. This practice goes against the principle of disturbing the soil as little as possible to start building structure and biology.

Brian has already started working to improve water management on his farm. He is using conservation drainage on some fields and wants to assess whether spring drainage can be even further improved with cover crops, leading to a soil profile that has better structure and water infiltration.

Project Description

In this first year of the project, we aerially seeded a diverse cover crop mix into standing corn on 10 acres. The 3 year plan is to experiment with soil improvement practices while maintaining the cash crop cycle.

In order to track changes in soil structure, the following soil measurements are being made:

- water infiltration bulk density;
- aggregate stability;
- slake test (a measure of soil stability); and
- spring soil temperatures.

Organic matter is also being tested in the laboratory at the beginning of Year 1 and at the end of Year 3.

2013 Results

In year 1, the initial soil evaluation showed a soil organic matter level of 1.9% at the 0-6" depth and 3% at the 6-12" depth. This suggests a plow layer with a potentially negative impact on soil physical structure.

The information was used to choose between two commercially available ten and nine way cover crop seed mixes. The consultant explained cover crop functional differences to assist in the choice of a cover crop mix. The nine way mix described in Table 1 was chosen specifically to enhance soil structure.

Nine Way Cover Crop Mix for Improved Soil Structure on Brian Rinke Farm, 2013.		
Cover Crop	% of Overall Mix	Functionality
Forage oats	54%	Cool season, deep fibrous root system
Forage peas	15%	Cool season, nitrogen
Hairy vetch	7%	Cool season, nitrogen
Foxtail millet	7%	Warm season, shallow fibrous root system
BMR sorghum/sudan	7%	Warm season, deep fibrous root system
Berseem clover	3%	Warm season nitrogen
Sunflower	2%	Micorhizal stimulant
Forage radish	3%	Taproot
Pasja Brassica (a forage turnip)	2%	Taproot

The cover crop mix was aerially seeded in early September into a standing corn crop in a level field without tile drainage. The seeding resulted in 95% of the seed contacting soil. On the same day, the pilot seeded the same mix into another farmer's corn field and adjacent wheat field 20 miles north of the Rinke farm.

An early October evaluation of the cover crops showed negligible establishment in both corn fields and high success in the wheat field (see photo of root growth in wheat field during September). The poor establishment in the corn was explained by residual activity of a moisture activated herbicide applied in August. In early October, soil samples were taken and a 'Dixie cup' germination test showed no residual herbicide effect. After germination, the seedlings were observed for 1 week without water which demonstrated a distinct difference in seedling vigor (see photo). We had intended on determining the extent of root biomass in the field at the end of the fall cover crop growth but this was not possible due to the herbicide damage.

Seedling vigor after 1 week without water. The Rinke soil is on the left. Potting soil is on the right.

Brian spent $250 on seed for 10 acres and $150 for application. Farm-wide implementation would have cost Brian $475 for seed and application.

Pilots in the area are getting more requests for aerial seed application as a new part of their business. The timing of next year's aerial seeding is being planned after the pilots finish their rounds of bug spraying. They will then switch the applicator for the purpose of seeding.

August has been dry for two years and would not have been a good time to aerially seed. We have learned from the good stand of cover crop in the wheat this year that an early September seeding might not be too late for our northern area.

The land will be grazed in late fall or winter in cooperation with nearby animal producers if the cover crop yield is adequate next year. This would provide a low cost nitrogen application to the field through manure. The cash crop residue would be partially incorporated through animal impact instead of being tilled so as to begin working on a system with minimal soil disruption. As of this report, the plan for Year 2 is to drill seed soybean cash crop into Year 1 corn residue. Planning for Year 2 and 3 will be accomplished by adapting each decision to the outcome of the previous practice.

2014 Results

Corn residue from the previous year averaged 14" in depth in the demonstration plot. The soil temperature under the residue averaged 10°F colder than in tilled fields. This dramatically affected soybean planting dates. Fields that were tilled and tiled were planted on May 3. Fields that were tilled but not tiled were planted on May 15. The demonstration plot with high residue was planted on June 1.

August weather was not excessively dry or wet so the residue did not offer any advantage as it may have in an excessively dry, hot season.

August 4, 2014 - 74°F sunny			
Sample Site	Soil Depth (inches)	Soil Temperature (Fahrenheit)	Soil Moisture (%)
No tillage, heavy stalks, poor beans	2	70	70
	6	67	80
No tillage, good beans	2	68	60
	6	66	100
Conventional tillage, good beans	2	67	80
	6	64	90
August 12, 2014 - 80°F sunny, 7/10" rainfall 3 days before			
No tillage, heavy stalks, poor beans	2	84	65
	6	74	100
No tillage, good beans	2	75	65
	6	68	90
Conventional tillage, good beans	2	76	65
	6	68	90

Water hemp was poorly controlled in the demonstration plot due to poor herbicide-soil contact and the presence of herbicide resistant populations. Only 75% of the water hemp population was controlled. Unfortunately, the need to control the water hemp precluded any planting of cover crops. In the future we will address cover crop issues prior to addressing tillage issues.

Soybean yields in the high residue demonstration plot averaged 56.8 bu/A, a 7.3 bu/A reduction compared to 64.1 bu/A in the tilled and tiled field. We estimate profits were $93.70/A less in the high residue plot compared to conventional tillage. This incorporates the reduced cost of not tilling, the increased cost of herbicide, and reduced income from lower yield.

Management Tips

1. Avoid herbicide carry-over by tracking recent rainfall.
2. Start with a soil health goal and use cover crop functional groups to plan a cover crop mix.
3. Sufficient rainfall is necessary for a successful cover crop catch when aerial seeding.

Cooperators

Brian Rinke, Farmer, Wheaton, MN

Jon Roeschlein, Bois de Sioux Watershed Manager, Wheaton, MN

Matt Waterworth, NRCS Area Office Staff and District Conservationist, Wheaton, MN

Project Location

The Brian Rinke farm is located 9 miles SE of Wheaton. From Wheaton, go south on US Hwy. 75 for 6 miles to Cty. Rd. 6. Go East 3 miles to the farm on the north side of the road.

Other Resources

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

Midwest Cover Crops Council. Midwest Cover Crops Field Guide. 2012. Website: ag.purdue.edu/agry/dtc/Pages/CCFG.aspx

USDA ARS. Cover Crop Chart. Website: www.ars.usda.gov/SP2UserFiles/Place/54452000/CCC/CCC_v13_5_2012.pdf

For ongoing research, extension, and workshops in soil health related to northwest Minnesota, go to North Dakota State University Extension Soil Health Group. Website: www.ndsu.edu/soilhealth/?page_id=37

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

Principal Investigator

Chad Rollofson
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Grant County

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.

Plot 10 with spring wheat with cover crop mix.

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.

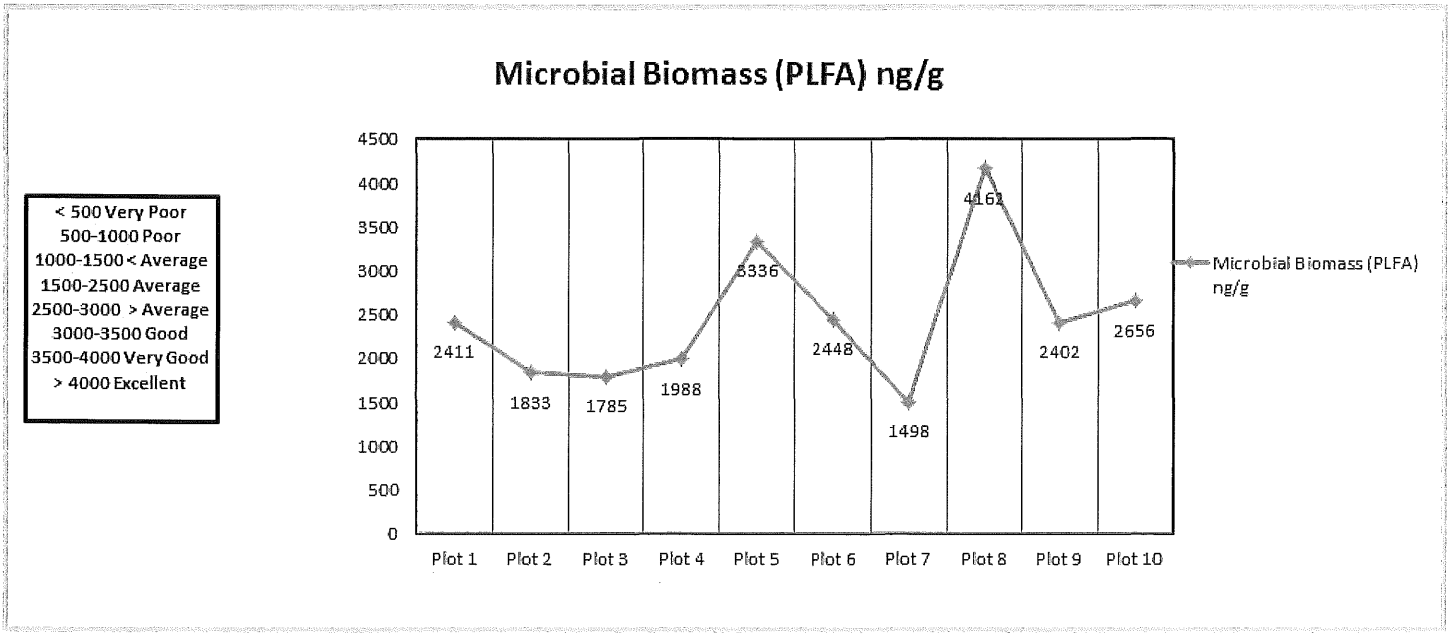
This project is important to me because I see soil as one of the most overlooked resources. I hate to see our most valuable resource end up as black snow in road ditches and waterways, or carried off our fields by heavy rains and flow into our lakes and rivers. Keeping the soil in our fields is important 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. Then this fall I kept track of yields from all ten plots, measured above ground 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.

Results

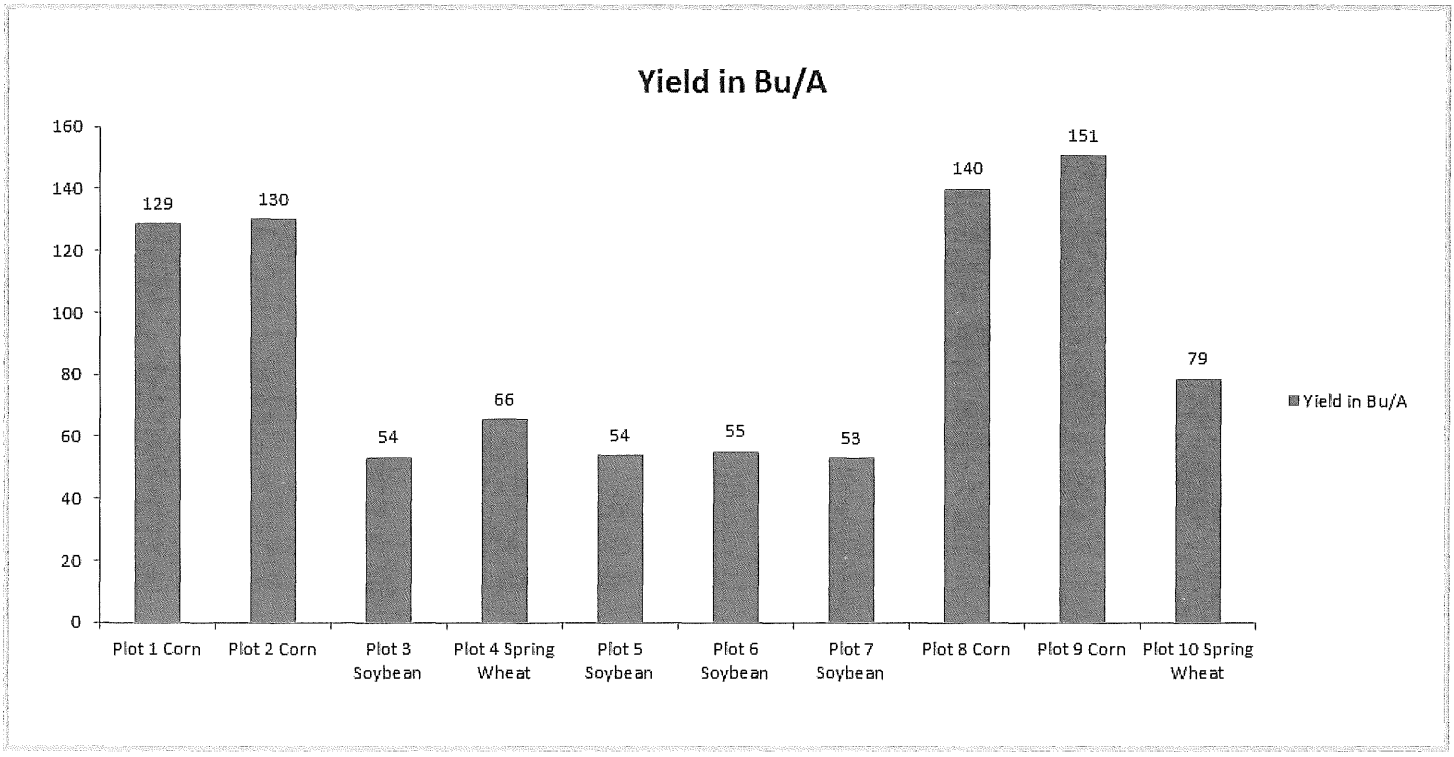
The focus of the first year of this project was to gather baseline data. This data will serve as a reference point in a long-term study beyond this grant period. The soil in the plots is a Barnes-Svea loam soil. The ten plots have 25-39% sand, 41-49% silt, and 20-26% clay. The baseline overall quality 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 ten 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. Above ground 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.

Management Tips

1. Do not count on the weather cooperating with you the first time you try something. With farming we are always at the whim of the weather.
2. Do not be afraid to try this approach on some limited acres or just one field to start with.
3. Find some way to leave more crop residue on the soil surface to protect our soils from erosion.

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

Developing an Integrated Perennial System

Principal Investigator

White Earth Land Recovery Project
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Project Duration

2014 to 2016

Award Amount

$17,663

Staff Contact

Mark Zumwinkle

Keywords

hazelnut, buffaloberries, juneberries, honeyberries

Project Summary

We are creating an integrated perennial system combining plantings of hybrid hazelnut seedlings and native berry plants (buffaloberries, 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, buffaloberries, 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.

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.

The buckwheat did a good job of competing 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.

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.

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. Test your cover crop seeds for germination if you are unsure of how they were stored.
3. 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

Principal Investigator

Sustainable Farming Association of Minnesota
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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

A Demonstration of Biological Primers on Drought Prone Soils

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 had above average precipitation.

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-sudan grass, 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. Grazing continued until December 8.

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

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.

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 x sudan, pearl millet, grazing corn, forage collards, radish, purple top turnip, sunflower, buckwheat, and phacelia. 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.

Grazing a diverse cover crop mix on the Solberg farm.

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.

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.

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

Principal Investigator

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St. Paul, MN 55108
Carver, Dakota, Goodhue, Rice, and Scott Counties

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

Project Duration

2013 to 2016

Award Amount

$9,999

Staff Contact

Meg Moynihan

Keywords

dairy, conservation, efficiency, energy, profitability, savings

Increasing Dairy Farm Profitability with Energy Efficiency Improvements

Project Summary

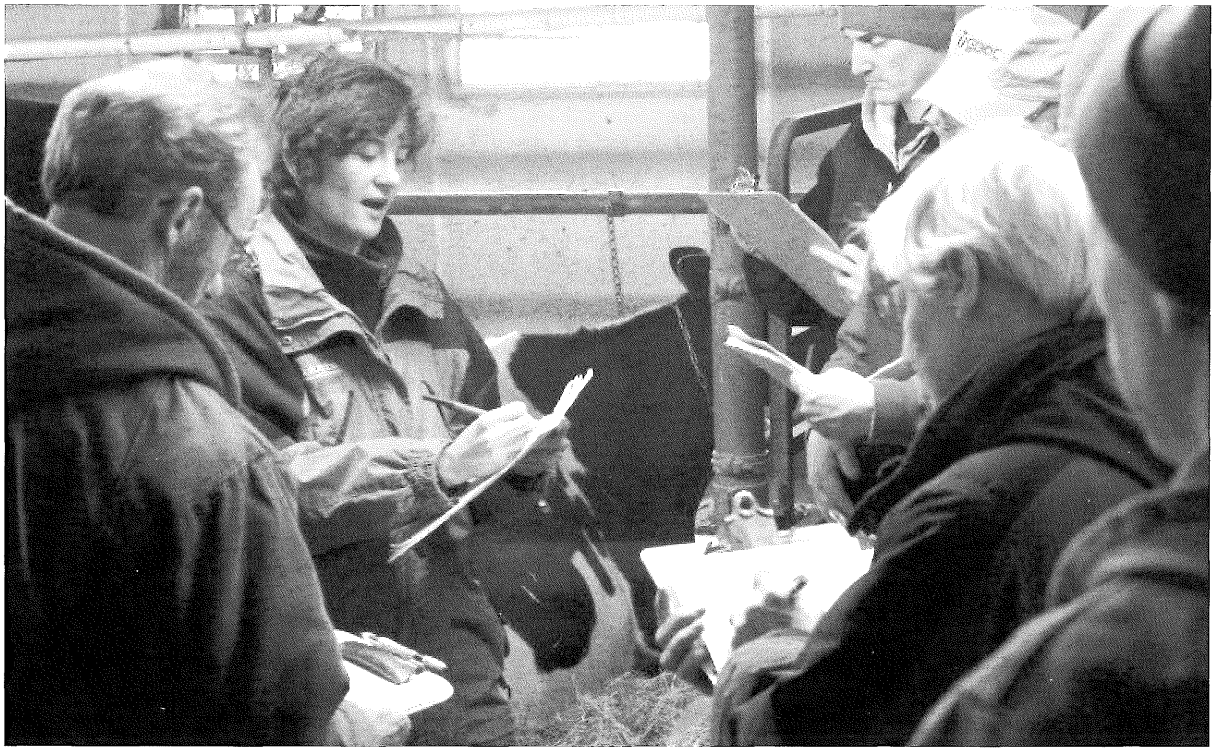
The Minnesota Project and Hastings Cooperative Creamery Company (HCCC) have been collaborating to develop and deliver a program that helps dairy farmers learn about and adopt energy efficiency technologies on their farms. On average, Minnesota dairy farms use between 800 to 1,200 kWh/cow each year. This is a significant amount of energy consumption, and reducing it would help achieve two goals: 1) increase dairy farm profitability by reducing energy costs, and 2) help electric cooperatives make progress toward their energy conservation goals. We hope the approach we develop in this project will be used to promote energy efficiency for other types of livestock operations as well.

Project Description

In the first year of the project (2013), we worked with certified energy managers and professional engineers from GDS Associates and milk haulers and HCCC field staff to develop and distribute a 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. 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. Though each participant farm was unique, efficient lighting, variable speed drives for milk receiver jar pumps, and water heater upgrades 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.



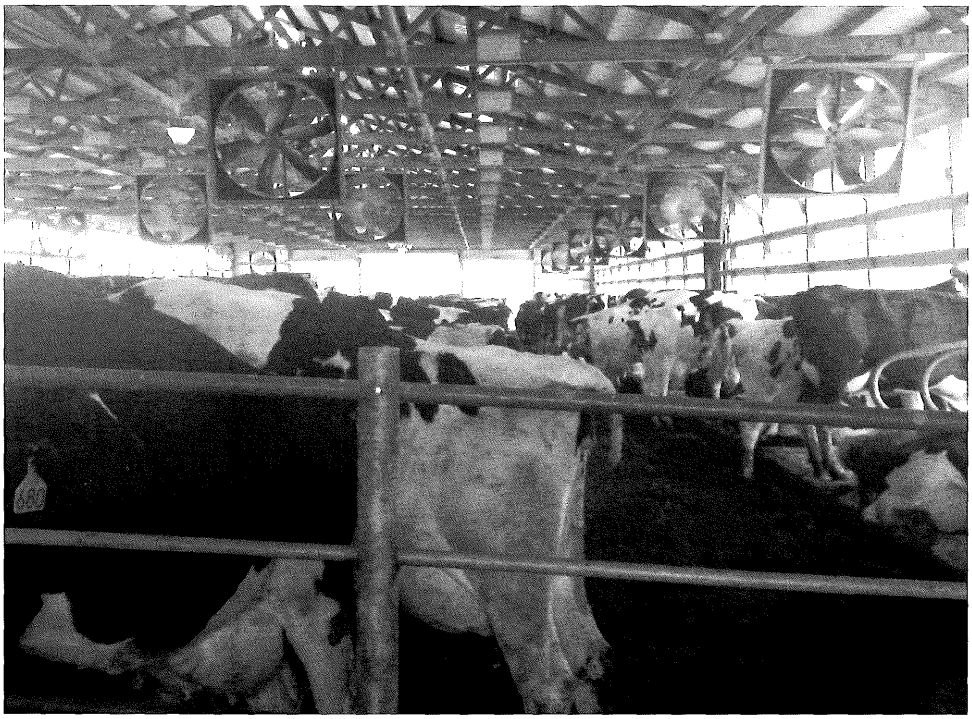
A team of energy auditors visits Howe Holsteins.

During the second year of the project, 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 Livestock Investment Grant Program.

Coordinating across these 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. 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. 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. However, the primary barrier for farmers appeared to be lack of time and unfamiliarity with the documents and process.

Results

Many of the farmers we worked with indicated they are using the audit reports as planning tools for upgrades over the next 2 or 3 years. Thus far, three participating farmers have installed three high-volume, low-speed fans and one 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 during the 2014-15 winter months. A variable speed drive calibrates the motor so that it doesn't run at 100% all of the time. They have special sensors, on the vacuum lines, for example, that tell how much negative static pressure is needed for milking (i.e., 3 cows requires less power than 6 cows). Most older vacuum pumps are overbuilt to handle a theoretical maximum demand.



Emery Dairy is considering a switch from 250-watt metal halides fixtures to T8, 4', 4-bulb tubular fluorescents.

We have developed a free, online Dairy Farm Energy Benchmarking Tool so dairy farmers across Minnesota can compare their energy consumption to that of similar dairies in the Upper Midwest (see Other Resources). The tool estimates dairy cooling energy and considers equipment such as well water pre-coolers, refrigeration heat recovery units, scroll refrigeration compressors, water heaters, and variable speed vacuum pump controls and milk pumps. Energy usage calculations are based on hundreds of Midwest dairy farm energy audits completed by project partner GDS Associates. The cooling energy usage calculations in the benchmarking tool determine where a dairy falls on the spectrum of energy efficiency.

This project will wrap up in 2015, when we will focus on refining the service model according to farmer and electric utility staff recommendations. We will quantify the energy savings across participating farms. We will conduct a presentation at the Minnesota Dairy Expo in December 2015 to share our approach and findings with the broader dairy community. We also plan to present our program at the Minnesota Clean Energy Resource Teams conference in early 2015, so rural electric cooperatives can learn about and use the approach we developed.

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 to date is due to help from 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

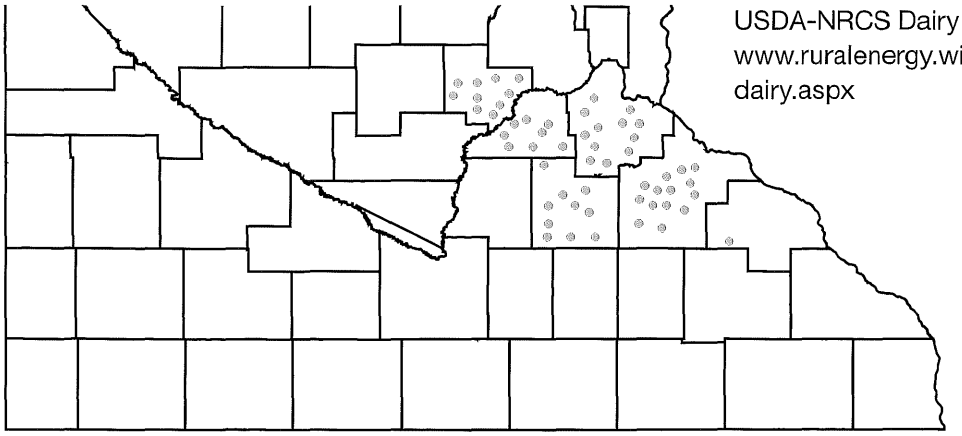
Meghan Romo, Field Officer, Hastings Cooperative Creamery Company, Hastings, MN

Joe Schultz, Agriculture Energy Specialist, GDS Associates

David Zwart, President, Hastings Cooperative Creamery Company, Hastings, MN

Project Location

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



Other Resources

The Minnesota Project Energy Benchmarking Tool: www.mnproject.org/e-BenchMarkingTool-Form.html

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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Fountain, MN 55935
507-208-9928

Project Duration

2014 to 2015

Award Amount

$7,568

Staff Contact

Cassie Dahl

Keywords

irrigation, solar, water conservation

Project Summary

For 3 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.

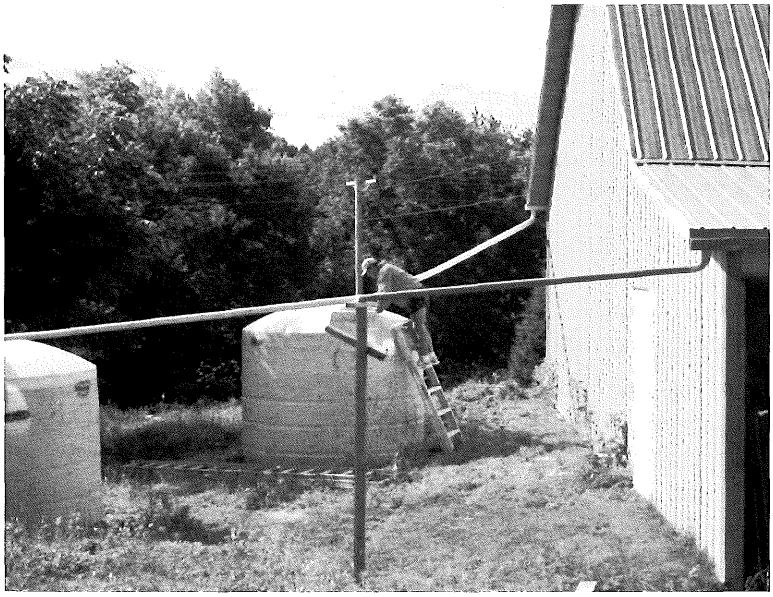
Next year we will demonstrate that the system is transferable, adaptable, and scalable for any size farm or residential/small business application. During the 2014 season, we experienced some setbacks so the full design and installation will be completed in early 2015. Fortunately, we were still able to collect and distribute water during the dry months of July and August, resulting in a bumper crop.

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 groundwater 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.



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

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 gallon tanks for collection and an on-farm computerized weather station.

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.

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.

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

2014 to 2016

Award Amount

$24,152

Staff Contact

Meg Moynihan

Keywords

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

Using Compost Tea in Organic Farming

Project Summary

Six farms are testing compost tea on vegetables, fruit bushes, pasture, cover crops, and a hayfield. Compost tea inoculates the soil with microorganisms for the soil food web, including bacteria, fungi, protozoa, and nematodes. Each farm will compare areas they spray with compost tea to similar areas that are not sprayed (control). We plan to measure yield, brix levels, plant health, and soil health.

Project Description

Six Northfield-area farms studied the effects of applying compost tea. Our overall goal is to determine if applying compost tea to our crops can improve farm profitability. Reducing fertilizer needs and increasing yields and/or increasing produce quality are all possible benefits of compost tea. Of particular interest to us whether compost tea can reduce fertilizer needs. 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 that 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.

Each participating farm chose one crop to spray with compost tea. These crops included vegetables, fruit bushes, pasture, cover crops, and a hayfield. Each farm sprayed one or more areas with compost tea and left an unsprayed area to serve as a control, so that the effect of the compost tea can be measured. Yield, brix levels, plant health (through plant tissue analysis), and soil health (by analyzing the number of micro-organisms living in the soil) were all measured.

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, are added to encourage these populations to grow. The tea must be applied within 2 days of brewing. Foliar spraying, putting through drip irrigation, and gravity feeding behind a subsoiler can all be used to apply the compost tea.

Participating Farms' Descriptions & Results

The individual participating farms' year 1 experiences are detailed below. Most project participants didn't anticipate how difficult it is to reliably brew a useful beneficial compost tea. Two farms (Cherry Leaf Farm and Seeds Farm) built their own compost tea brewers and applied tea on cherries and tomatoes, respectively. No statistically significant differences yield, brix, or soil microbial activity have been observed at either location yet.

Welding the Seeds Farm compost tea brewer.

The other participating farms bought compost or compost extract for this first year and applied to their blueberry bushes, carrots, and cover crop. There were no observable plant or soil effects on these farms in 2014, either.

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 in 2015 and 2016.

Little Hill Berry Farm

Little Hill Berry Farm grows 4 acres of certified organic blueberries. We sell our berries pick-your-own style, and 2014 was the second season we were open for picking.

We are testing compost tea on blueberries and evaluating its effectiveness by taking plant tissue samples after fruit harvest and doing a brix analysis of blueberries. We are also estimating yield by visually evaluating fruit load.

We were not able to get a compost tea brewer set-up before the 2014 growing season began, so, we purchased compost tea extract from Purple Cow Organics. To use the extract it must be "activated" by providing food for the microbes in the extract to wake-up. We added fish emulsion, humic acid, and activator mix provided by Purple Cow. After the extract sits for an hour, it is ready to be applied.

We applied compost tea on three 200' rows of two varieties, Patriot and Northblue. Another three rows of each variety functioned as a control (no tea applied). We made the first application with a sprayer and did not like how it performed, and so did the second application by injecting the compost tea into our drip irrigation system. This method appeared to work well; there was no evidence of clogging.

Our collaborator Dan Hernandez, who is a biology professor at nearby Carleton College, arranged for students to study the results of our compost tea experiment. They analyzed soil microbial activity to see whether there was a difference in soil microbial activity in the treated rows compared to the control rows. They also analyzed C:N ratios to see whether applying the compost tea would lower the C:N ratio. A lower ratio might indicate an increase in nitrogen uptake in the rows treated with compost tea. The students did not find any statistically significant differences between the treatment and control plots. We are going to try to apply compost tea more frequently in 2015, to see if that might make a difference.

Spring Wind Farm

Our farm is in transition to organic. We tested compost tea on three plots in a field planted to a cover crop mix of oats, barley, peas, clover and alfalfa. The field had been farmed conventionally last year. We made compost tea using Purple Cow Organics compost tea extract mixed with fish emulsion and applied it once in June and once in July. To three control plots in the same field, we applied just fish emulsion.

Students from Carlton College tested for soil nitrogen levels and soil biology. We also submitted soil samples to Microbe Inotech Labs to test for glyphosate levels. We had not received the results from the lab when we submitted our 2014 report to MDA. We will be interested to learn whether compost tea applications boost soil microbial activity and reduce glyphosate levels.

Open Hands Farm

We grow 12 acres of certified organic fruits and vegetables for CSA and wholesale markets. While we have had good yields overall, we have experienced some losses to fungal pathogens. We practice cover cropping, crop rotation, variety selection, good cultural practices, and address nutrient deficiencies with compost and mineral fertilizer applications, but want another tool to increase our plants' chances of success. We prefer not to use pesticides, which might compromise

beneficial fungal and bacterial populations in the soil and on the plants themselves. We want to see whether compost will help us control these tricky pathogens.

We also practice a lot of tillage (plowing, field cultivation, crop cultivation, disking, etc.), which has been shown to be hard on soil microbial communities. We want to find out whether or not compost tea applications increase the health and diversity of microbial communities in our soil.

We made our tea from purchased compost extract and used a brass-nozzle boomless broadcast sprayer to apply it.

Results from the initial soil sample (before compost tea and spring tillage) showed little microbial activity. At the time this report was prepared, we were waiting for analysis results from the fall soil test (after the spring application of compost tea and a season of tillage.) In 2015, we plan to apply compost tea in spring, right after we plow, and will again examine the soil for microbial activity. We'll also foliar apply to one or two crops and conduct tissue testing. We also plan to foliar spray one or two crops, and conduct tissue testing to measure the effects.

Starting a batch of compost tea. We put the compost in the bag, then put the bag in the brewer.

Seeds Farm

We are a diversified vegetable farm and have been growing for two years. Prior to the vegetables, the land was conventionally cropped (small grains, corn, soybeans). A previous study on our farm by a local college student found very little evidence of microbial activity in our soil. The student buried dead squirrels in our vegetable fields, a nearby forest, and a nearby prairie for a growing season. When she dug them 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. We are interested in increasing our soil microbial activity to improve soil aggregation, decrease erosion, make nutrients more available to our plants, and reduce our soil amendment costs.

We assess the microbial activity of our brew using a microscope. If the compost tea meets our standards, we apply it within a few hours.

We planned to test tomato beds treated with compost tea and compare them to an untreated control. However, due to some complications and a tomato crop failure due to disease, we were unable to complete our experiment.

Instead, we focused on the process of brewing compost tea and the logistics of applying it. We made a compost tea brewer consisting of a 275 gal water tank with a 1.2 hp regenerative pump blowing air through a 2" rigid tube in the bottom of the tank. Our recipe was: 250 gal water, 8 lb good quality compost (we tried Purple Cow Organics compost and Living Soil Labs compost), 1/2 C molasses, 1/2 C fish hydroloslate, and 4 C steel cut oats.

We brewed once in May, once in July, and once in October. We bought and learned to use two microscopes, but found it difficult to accurately assess the quality of our compost tea. We hope to attend future workshops to develop our skills.

Once a quality tea is brewed, it needs to be applied as soon as possible, but this also is no easy task and can be done in a number of different ways. We experienced several complications, including an equipment malfunction that prevented us from applying the tea before it went bad, and sprayers clogging due to the particle size of the compost suspended in the tea.

Next, we tried adding a PVC pipe behind a single subsoiling shank and using it to gravity feed compost tea along the profile of the soil. We found this was the most efficient way to distribute compost tea on our farm, although it can only be used when there are no crops in the ground. We also put compost tea in our waterwheel transplanter when we set out vegetable transplants. This, too, proved to be an efficient way to apply the tea. The most difficult application method was our boom sprayer, which clogged quickly. We are planning to use a boomless nozzle in 2015.

We sent a baseline sample (before any compost tea applications) of our soil to have its microbial activity assessed, and were not surprised to learn that there was little microbial activity. At the time of this writing, we didn't have results from our fall tests (after our compost tea applications). Next year we hope to be able to quantify the effects of compost tea on tomato yields.

Cherry Leaf Farm

This is a 2 acre orchard with 650 cherry bushes planted several years ago. The summer of 2014 brought the first significant cherry crop, which we sold through wholesale accounts and a u-pick operation.

This year, I bought an aeration tank and a microscope. I brewed compost tea in the aeration tank using my own compost and an agitation blower that I borrowed from Seeds Farm. I applied it to a few rows of cherries.

Next year I will begin the actual demonstration – applying the compost tea on designated rows of cherries, with the remaining rows serving as an untreated control.

Simple Harvest Farm Organics

This farm experienced heavy rains in June 2014, which made major modifications to the pasture and hayfields necessary and prevented any compost tea project work in 2014.

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. Quantify 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

Andrew Ehrmann, Spring Wind Farm, Northfield, MN

Molly Haviland, Living Soil Lab, Fairfield, IA

Elaine Ingham, Soil Food Web, Inc, Corvallis, OR

Erin Johnson and Ben Doherty, Open Hands Farm, Northfield, MN

Midwest Labs, Omaha, NE

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 at the six Northfield/Nerstrand, MN area farms listed above. To reach any of the participants, contact project leader Becca Carlson, whose information is provided on the first page of this article.

Evaluating Different Depths and Types of Mulches in Blueberry Production

Principal Investigator

Kathy Connell
Redfern Gardens
18298 - 270th St.
Sebeka, MN 56477
218-837-5332
Wadena County

Project Duration

2014 to 2016

Award Amount

$7,953

Staff Contact

Cassie Dahl

Keywords

blueberries, mulch, soil health

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.

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 two 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.

Management Tips

1. Even the plant and berry catalogs advise to do preparation for a year before planting, yet a person may still think they can get away without that preparation period. We thought of this project in January and did not give ourselves that preparation period. No matter how anxious one may be a year's preparation before planting will save much work and worry later.
2. Soil testing should be done a year before planting also in order to have time to make corrections. Don't make assumptions as I did! Every area has the potential of being different from surrounding areas.
3. Give thought to your irrigation method. I have not been happy with drip irrigation on blueberries in the past. On my very sandy soil the water spreads sideways very little. The roots of the blueberries are very fibrous and will spread wide with a good water supply. When I dug up plants to see what was happening with the drip irrigation, I found that the roots were not as plentiful as they should have been. This would not be as significant on soil with high organic matter or some clay. With overhead watering I found a very wide extended root system. However, with heavy mulches it appears there is a chance of the mulch either preventing water penetration or needing excessive watering in order to soak the mulch before the water reaches the soil.

Cooperators

Thaddeus McCament, Central Lakes College, Staples, MN

Eric Nelson, Minnesota Department of Natural Resources, Brainerd, 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. 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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St. Louis County

Project Duration

2014 to 2017

Award Amount

$18,074

Staff Contact

Alatheia Stenvik

Keywords

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

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 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.

Planting at Stan's Orchard.

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 (eggs and meat), 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 can be used to develop profitable enterprises for small farmers along the north shore using cold-hardy super dwarfing root stocks. Along the north shore, including St. Louis, Lake, and Cook counties, apple production was limited due to the unavailability of large tracks of land that are 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 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.

Planting at Dave William's Orchard.

At a recent Farmer-to-Farmer Exchange held by Cook County Extension, 28 local farmers gathered in Grand Marais. There was particular interest in issues related to climate change for small-scale agriculture along the north shore. Four 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, and 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.

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.

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 planting 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 B-9 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 B-9 and G-16), Zestar! (on B-9 and G-11), Snowsweet (on G-30), Sweet 16 (on B-9, 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 B-9 and G-16), Zestar! (on B-9), Snowsweet (on G-30), Sweet 16 (on B-9, 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 B-9), and Whitney Crab or "Allure's Wild Red" (on B-9). These trees were planted on August 11. All trees appeared to be in good condition at the end of the season.

Management Tips

1. Contrary to popular belief, cold temperatures are not the primary limiting factor for apple production. 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.

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 Bedfort, Senior Research Fellow, University of Minnesota, Excelsior, MN

Paul Kotz and Susanne Holderried, Grand Marais, MN

Stan Bautch, Grand Marais, 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.

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: attra.ncat.org

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

The Effect of Cover Crops on Water and Soil Quality

Principal Investigator

Hmong American Farmers Association
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Dakota County

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 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, the Hmong American Farmers Association (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.

Results

One goal of this grant was to recruit six farmers to plant one 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 interseed 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 interseeding was successful in green beans, tomatoes, peppers, and sticky corn. The

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

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.

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.

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.

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

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.

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.

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

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.

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.

Cooperators

Lillian Hang, HAFA Farmer, St. Paul, MN

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

Lucy Passus, HAFA Farmer, St. Paul, MN

Wang Ger Hang, HAFA Farmer, St. Paul, MN

Bla Doua Hang, HAFA Farmer, St. Paul, MN

Tha Xiong, HAFA Farmer, St. Paul, MN

Teng Vue, HAFA Farmer, St. Paul, MN

Xeng Thao, HAFA Farmer, St. Paul, MN

Jim Wichmann, Albert Lea Seed House, Albert Lea, MN

Vinai Vang, HAFA Farm Trainer, St. Paul, MN

Yao Yang, HAFA Farm Trainer, St. Paul, 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

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

Principal Investigator

Melissa Nelson
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Big Stone County

Project Duration

2014 to 2017

Award Amount

$12,573

Staff Contact

Alatheia Stenvik

Keywords

pollinator, insect habitat, underutilized land

Project Summary

My project is designed to test methods to convert land on my farm that is generally not utilized for any other purpose (around farm buildings, idle woodland, hard-to-utilize grassy areas) into beneficial insect habitat. In addition, it will document the types and numbers of beneficial insects using the Monarch butterfly and bumble bee as sentinel insects. After the habitat is established I will also document the best methods to prevent undesirable plant species encroachment on the habitats.

Melissa Nelson-Overgrown woodlot site in the process of being prepared for the project.

Project Description

My farm is currently utilized as a beef cattle farm with pasturelands, hay land, and some crop farming done by another farmer. I became concerned about the alarming decline in pollinator habitat in the past few years. As I have some 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.

As such I took three separate areas to study for this project: land around grain bins that are not used for grain storage due to poor accessibility, an old grassy area that was mowed and not harvested for hay or pastureland due to location, and woodlot edges currently not used for any farming purpose. This is year one of the project and time was mostly used to prepare the land for planting of a pollinator mix of wildflowers and native grasses.

Results

Melissa Nelson-Volunteers helping Melissa build habitat.

As this year was a preparation year, I do not have any hard numbers to share for this project. However, this project did generate a lot of interest in the local community; so much that I started a Facebook page (The Pollinator Project: www.facebook.com/thepollinatorproject). 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 (around the bins) had primarily brome and quack grasses and burdock weeds. I counted 5 honeybees in this zone. Zone 2 (grassy mowed area) had primarily orchard and quack grasses, clover, and burdock weeds. I counted 14 honeybees and one bumblebee in this zone. Zone 3 (wooded area) had burdock and buckthorn weeds. The only insects were the aforementioned 2 Viceroy Butterflies and Asian beetles in a bunch of approximately 35.

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 of 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.

Management Tips

1. While there isn't much one can do about the weather, I would have, in hindsight, planted the seeds a week earlier to beat the snow.
2. These seeds can be planted directly on snow provided it isn't too deep—the 12 plus inches we had was too deep to get out with the broadcast spreader. I am hoping to be able to get out in very early spring after the snow has melted or near melted.
3. The dark seeds can be planted on a small amount of snow as the action of the sun will heat the seeds enough to melt them through the snow layer to the ground.

Cooperators

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

Project Location

From Ortonville MN intersection of Highway 12 and Highway 75: Travel north on 75 approximately 3 miles. Turn right (heading east) onto Cty. Hwy. 12. Travel for 3 ½ miles to 700th Ave. Turn left. Travel one mile, farm is on the left.

Other Resources

Xerces Society: www.xerces.org

Monarch Joint Venture: www.monarchjointventure.org

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

Principal Investigator

Chad Stoltenberg
Locust Lane Vineyards
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Pipestone County

Project Duration

2013 to 2015

Award Amount

$10,950

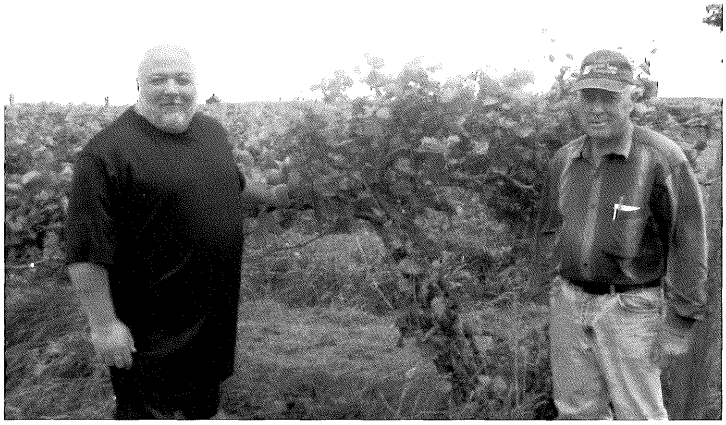
Staff Contact

Alatheia Stenvik

Keywords

grape products, verjus (verjuice), vineyard, wine

Project Summary



Chad standing with his father in front of their vineyard.

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.

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. Currently, these items are in 45 locations with an overall sales increase of 55% since the beginning of this project.

Project Description

Our family is trying to decide how best to pass the family farm into the next generation so it can remain a family farm. 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 don't 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.

Locust Lane Vineyards grape vine rows, grapes for verjus.

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. This particular year, grapes were in very high demand due to the bad winter leading up to the growing season. Growers I spoke with in southeast, central, and southwest Minnesota saw yields that were only 10% of their average yield. We saw similar reductions in some varieties, with the variety in year 1 of the test yielding about 30% normal.

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 1, in year 2 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 will try to do testing on different areas of our vineyards. We also have a grower that we purchase some grapes from interested in the system we use and he plans to try to manage his vines the same way as us. With another grower, we will be able to get feedback from different areas.

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. This is based on data from only 1 year.

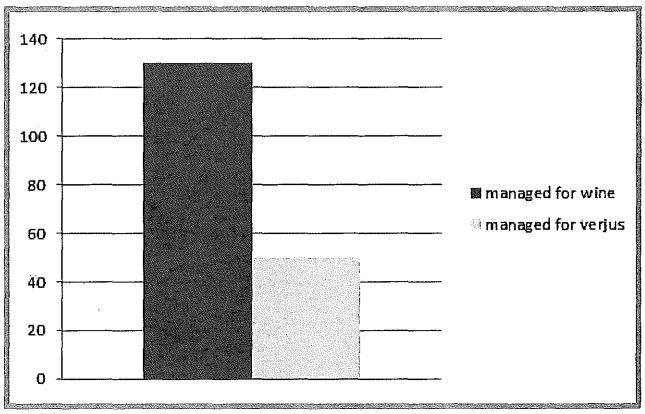
Results

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.

Management Tips

1. Get a clear picture of harvesting help – changes in harvest dates may not allow groups to help pick. With a late spring causing a later harvest, school groups were not able to help due to already being in school. In 2014 this was unnecessary due to lowered crop from weather.
2. While the local food movement is a popular term, a new product is still a new product and consumers must be showed how to use it.
3. Early establishment of a vineyard requires being down on the ground, not on a tractor. Once the vineyard is established, the hand work is less but winter/spring pruning still requires hand labor. Also, plant the whole thing or you will have different parts at different ages, which makes it tough to remember what row requires each treatment as you are in the field.

Cooperators

Beth Dooley, Chef, Food Writer, Minneapolis, MN

Beth Jones, Chef, University of Minnesota Campus Club, St. Paul, MN

Lukas Leaf, Chef, Al Vento restaurant, Minneapolis, MN

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 one 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 ½ 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.

Principal Investigator

Noreen Thomas
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Moorhead, MN 56560
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Clay County

Project Duration

2014 to 2017

Award Amount

$13,257

Staff Contact

Alatheia Stenvik

Keywords

pollinators, native bees, insect habitat

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

Project Summary

This project will figure out which areas are suitable habitats for native pollinators and also provide an income stream for farmers. 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.

The native bees found in Minnesota 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 have earlier visits to plants than honeybees. Habitats for native bees are not as expensive and require little maintenance in comparison to the habitats built for honeybees. The native bees live in mud, clay, and wood. 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.

Project Description

We live in the Red River Valley on a certified organic farm just north of Moorhead. We are a short drive from Concordia College. We grow blue corn, hay, wheat, squash, berries, some fruit trees, and grow local foods for restaurants. We have livestock including Icelandic sheep, chickens, and grass-fed cattle. We also provide tours for school groups, master gardeners, and the public. We just passed our 3,000th visitor to the farm. Carsten Thomas, our son, grows pumpkins for assisted living facilities in the area. He also provides Hospice, the Girl Scouts, and the Boy Scouts with access to our farm. The Girl Scouts helped plant and sell flowers at a community event; this worked well for both the outcomes and as a fundraising project for them.

The project plans to 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 about the second and third years? 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 25' x 5' strip. The area is sunny and includes areas for native bees to nest undisturbed once planting has started. Tea mixes include yarrow, red clover, mints, chamomile, and chicory. We had Chokecherry

Strip with wildflowers, lavender, tea flowers, and tall grasses.

trees along one side of the border and Juneberry trees along the other side of the border. There were 25' of lavender, tall grasses control, wildflower mix, and tea flower mixes.

The herb tea combination is being formulated yet this winter. I have the dried herbs and flowers and we are now on to seeing what the local market brings for these products. The lavender did not germinate and I am not sure why. Next year, I will try another variety. The Roman chamomile should reseed itself. I am hoping that it overwinters alongside the wildflowers well.

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 wanted 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.

In the second year, we will gather information and use it to focus on what does and does not work. We can order more bees if something happens.

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)

Management Tips

1. In the fall, when the zinnias started to die back, Carsten used a combine to harvest the zinnia seeds. Within 5 minutes, Carsten had a wheelbarrow full of seed, which would have cost about $500 to $700 to purchase.
2. I encourage others to purchase bees very soon in winter for spring. Bee for hatching and competition to buy bees allow no room for delay.
3. Always allow for backup for a way to water the habitat in drought times. This is essential for emerging flowers. A small water tank or 55 gallon drums for water on a pickup is great.

Cooperators

Dr. Bryan Bishop, Ph.D. Entomologist, Concordia College, Moorhead, MN

Carsten Thomas, Worker Bee, Moorhead, MN

Evan Thomas, Worker Bee, Outreach Coordinator Assistant, Moorhead, MN

Girl Scouts of America

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

Controlling Canada Thistle in Organic Blueberry Production

Principal Investigator

Aaron Wills
Little Hill Berry Farm
4339 - 320th St. W.
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Rice County

Project Duration

2014 to 2016

Award Amount

$8,413

Staff Contact

Meg Moynihan

Keywords

acetic acid, blueberries, Canada thistle, organic, vinegar, weeds

Project Summary

We are comparing three different methods for controlling Canada thistle on our certified organic blueberry farm in southeast Minnesota. Our goal is to find a thistle control strategy that has reasonable time requirements, is compatible with organic regulations, and significantly reduces Canada thistle pressure in our blueberry fields. The three strategies we are comparing are: concentrated vinegar, landscape fabric, and hand pulling.

Project Description

We farm near Northfield in Dakota County, where we grow 4 acres of certified organic "pick your own" blueberries. We planted our first blueberry field in 2011, and 2014 was our second season open for picking. We plan to scale up to 7-10 acres of blueberries within the next couple of years.

In 2013, we spent 45 hours hand pulling Canada thistle Cirsium arvense (L.) in a new, 1 acre blueberry field. Even after expending that much labor, at times our blueberry plants were overgrown by Canada thistle. We realized after the season that this was an unsustainable situation (for both us and the blueberries) and that we needed to find a better strategy for Canada thistle control.

Canada thistle is a perennial weed. It has a unique life cycle that requires a different set of control strategies than annual—and even most perennial—weeds. Canada thistle spreads both by seed and by underground rhizomes, eventually forming a thick mat of sprouts called a clonal patch (Figures 1 and 2). Within a clonal patch, every sprout is genetically identical to the mother plant, and most sprouts are interconnected. The majority of thistle biomass exists below the ground in the form of roots and rhizomes. Canada thistle rhizomes grow very deep in the soil, beyond the reach of even moldboard plowing. Once a thistle clone becomes established, it can live for decades and is difficult to kill by cultivation or even with many conventional sprays.

A typical blueberry row showing the edge of a thistle clonal patch.

A clonal patch of thistles shortly before we pulled weeds in late June.

We are testing three thistle control strategies that take into account Canada thistle's long life cycle. Our goal is to find a control strategy that has reasonable time requirements, is compatible with organic rules, and will significantly reduce Canada thistle pressure in our blueberry fields over time. We are testing the three control strategies within the 4' wide blueberry row. We have planted the area between the rows to grass, and mow it several times a summer.

We are tracking the time we spend per acre on each strategy, the cost per acre of each strategy, and the reduction in thistle pressure realized by each strategy. In order to estimate the reduction in thistle pressure, we are looking at the size of shoots as they emerge from the ground. Sprouting shoots rely on stored carbohydrate reserves from underground roots rather than photosynthesis. Shoots that sprout from a weak root system have smaller leaves and grow more slowly than shoots sprouting from a healthy root system.

Control Strategy #1- Vinagreen

We sprayed the Canada thistle repeatedly throughout the growing season with Vinagreen, a 20% acetic acid (concentrated vinegar) approved by our organic certifier for use in organic production. Unlike most conventional sprays, which are usually systemic, acetic acid is a contact weed killer. Systemic herbicides are best applied at the flower bud stage, but we sprayed Vinagreen when the thistle sprouts were quite small, at approximately the four leaf stage (Figures 3 and 4). We used a backpack sprayer, which allowed us to spray individual thistle sprouts without drifting onto and damaging the blueberry plants.

Thistles before spraying.

Thistles immediately after spraying.

Control Strategy #2 – Landscape Fabric as a Weed Barrier

We laid down DeWitt Weed Barrier Pro landscape fabric in the blueberry rows in the fields that we established in 2014. We planted the blueberries first, and then installed the landscape fabric. This type of material is allowed in organic production as long as it is removed from the field before it decomposes. The lifespan is approximately 15 years.

Control Strategy #3 – Hand Pulling

We allowed the thistle to grow to the flower bud stage (near the summer solstice) and pulled it just before it flowered. Pulling at this time is supposed to weaken the plant when it is most vulnerable. We then allowed the plant to regrow until it formed flower buds and pulled it again. Depending on the growing season, we may need to pull the plants a third time.

Table 1. Project Treatments	
#1 Vinagreen	Spray thistles repeatedly throughout the year with 20% acetic acid (concentrated vinegar).
#2 Landscape Fabric	Install landscape fabric barrier in the planting row.
#3 Hand Pulling	Allow the thistle to grow to the flower bud stage (around the summer solstice) and pull it just before it flowers. Pull it again a second time in early fall.

Results

Vinagreen

We sprayed the thistles 12 times from May through October. Spraying is fast and easy to do, and we ended up spending considerably less labor on the spray treatments than we did on the pulling treatment. We found that the biggest advantage of using Vinagreen was that the sprayed plants were smaller and weaker, even than those we pulled by hand (Figure 5). On August 14, our cooperator, Thaddeus McCamant, who is a specialty crops instructor at Central Lakes College, sampled sprouts from a clone where part was sprayed with Vinagreen and part pulled by hand. Although all the sprouts were at the six leaf stage, the biomass (dry weight) of thistle sprouts in the area sprayed with vinegar was 9.6 g dry weight while those in the area we had pulled by hand weighed 24.2 g. Although acetic acid is supposed to be a contact herbicide, the herbicide weakened the plants more than hand pulling did. We hope to spend fewer hours per acre controlling the sprayed rows in 2015 because the thistle plants will have been weakened.

Thistles that had been sprayed with Vinagreen. The small green thistle sprouts in the lower left hand corner were stunted from the repeated sprays.

Landscape Fabric

The landscape fabric provided nearly 100% control of Canada thistle. A few thistle plants were able to grow through the holes in the fabric that we had cut around the blueberry plants, but they were very easy to pull and removing them took very little time. Laying down and securing the landscape fabric was somewhat challenging, and required much more labor than we expected. We chose to plant the blueberry plants first and then lay the landscape fabric down. In retrospect, it would probably have been easier to lay the landscape fabric down first, cut holes in it, and then plant the blueberries into the holes.

We are concerned that the landscape fabric might be negatively affecting blueberry plant growth, because we observed that plants did not seem to grow as well in the landscape fabric rows. Perhaps the landscape fabric is changing the growing environment and/or creating a microclimate. At this point in the demonstration, it is too early to tell if putting down landscape fabric is something we would adopt for all our blueberry rows.

Hand Pulling

We planned to pull thistle in mid-June and in late summer, but ended up pulling it three times: mid-June, early August, and late September. Many people have claimed that pulling thistle when flower buds first form will permanently weaken the plants, but this did not appear to be the case on our farm. Pulling thistle provided protection for the blueberry plants, but did not appear to reduce vigor in the thistle plants, especially compared to the thistles sprayed with Vinagreen. Pulling thistle is much harder work than spraying it, which is another reason we preferred spraying.

Cost

Control costs for the first year of our demonstration are shown in Table 2. The cost of spraying with Vinagreen was roughly equal to the cost of pulling the thistles at flower bud stage. The landscape fabric cost four times as much as the Vinagreen or hand pulling, but the fabric and the labor cost to install it are one-time costs, whereas spraying and hand pulling will be ongoing.

Table 2. Cost Comparison of Canada Thistle Control Strategies in Blueberries – Year 1					
	Hours/A	Labor Cost/A (@ $10/hr)	Vinagreen cost/A	Landscape Fabric cost/A	Total cost/A
Strategy #1 Vinagreen	32	$320	$300		$620
Strategy #2 Landscape Fabric[1]	60	$600		$1,980	$2,580
Strategy #3 Pulling	55	$550			$550
[1] The costs for #2 are one-time expenses, whereas #1 (spraying) and #3 (pulling) will be ongoing.					

Our project has already received some local attention, with an article in the Northfield News. We are planning to hold a field day in the third and final year of the project, which will be 2016.

Management Tips

1. Vinagreen with an adjuvant seems to work much better than Vinagreen alone. We used CMR Organic Oil Adjuvant.
2. Vinagreen is most effective when the air temperature is 75°F or higher.
3. When blueberry plants are more than a couple years old, there will be a few thistle plants that are too intertwined with the plant to be sprayed, so you will have to come back through after spraying and pull a few thistles by hand.
4. Canada thistle keeps growing into October in our area - it is not killed by light freezes. Don't neglect thistle control in September and October, even after your crop is harvested, because you do not want the thistle plant to recover. Keep treating it!

Cooperator

Thaddeus McCamant, Central Lakes College, Staples, MN

Project Location

From Northfield, take Highway 3 north 2 miles. Turn left on 320th St. W. and about a ¼ mile. We are located on the right (north side of the road).

Other Resources

Alger, Jess. 2012. Organic control of perennial weeds with vinegar and biologicals. Stanford, MT. Final report. SARE project number: FW11-024. mysare.sare.org/MySare/ProjectReport.aspx?do=viewRept&pn=FW11-024&y=2012&t=1

Forsburg, Fred. 2014. Vinegar as a herbicide in organic garlic production. Livonia, NY. Final report. SARE Project number FNE03-461. mysare.sare.org/MySare/ProjectReport.aspx?do=viewRept&pn=FNE03-461&y=2004&t=1

USDA Agricultural Research Service has conducted research on the use of concentrated vinegar for weed control. Visit www.ars.usda.gov and use the search word "vinegar."

Completed Grant Projects

Final Greenbook Article	Title of Project	Grantee
Alternative Markets and Specialty Crops		
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
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

Final Greenbook Article	Title of Project	Grantee
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		
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
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

Final Greenbook Article	Title of Project	Grantee
2004	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
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

Final Greenbook Article	Title of Project	Grantee
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
	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

Final Greenbook Article	Title of Project	Grantee
Energy		
2010	Evaluation of the Potential of Hybrid Willow as a Sustainable Biomass Energy 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
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

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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
	Fall Forage Mixture for Grass Finishing Livestock Late in the Fall	Troy Salzer
2011	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	Ryon 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
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

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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
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

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1999	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
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 Program Administrator

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
Student Worker Paraprofessional

Alatheia assists the Agricultural Marketing and Development Division with the Sustainable Agriculture Demonstration Grant program, Farm Business Management Scholarships for Beginning Farmers, and other grant and cost share programs. Alatheia attends the University of Minnesota and is majoring in Food Systems. Alatheia joined the MDA staff in May 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.


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a more sustainable agriculture.