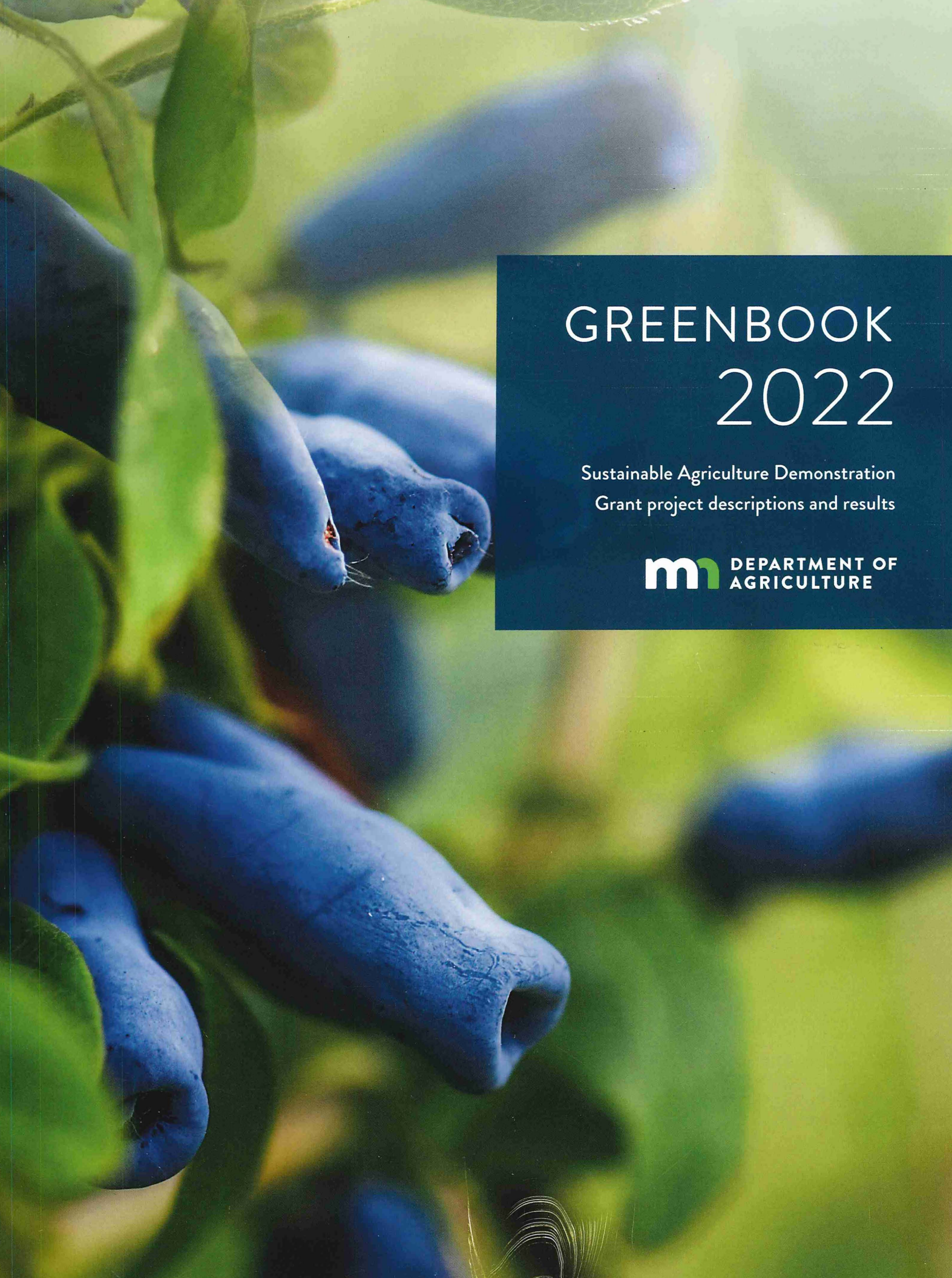
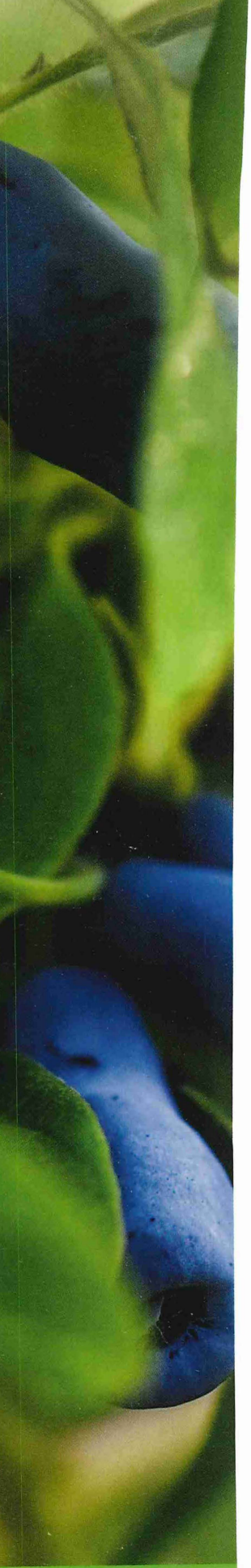


GREENBOOK 2022

Sustainable Agriculture Demonstration Grant project descriptions and results

DEPARTMENT OF AGRICULTURE



GREENBOOK
2022

On behalf of the Minnesota Department of Agriculture (MDA), it is my great pleasure to introduce the 2022 edition of the annual Greenbook. As Commissioner of Agriculture, I'm proud to highlight the important work of the Sustainable Agriculture Demonstration Grant Program, a component of the Agricultural Growth, Research, and Innovation (AGRI) Program. The projects presented here are great examples of the innovative ideas Minnesota farmers and researchers are exploring and testing to make farming in Minnesota more productive and sustainable, and I've been a long-time supporter of them.

This year's recipients were awarded a total of $241,757.28 for forward-thinking initiatives that promote sustainability in agriculture. Much as I would love to, I can't highlight every project here. But if you read further, you'll see that from interseeding clover into pumpkins, to solar grazing ground cover development, to trialing alternative crops that grow well in the north, to conducting cropping system on-farm research, these projects are fundamental to the future of agriculture. The Sustainable Agriculture Demonstration Grant Program is dedicated to improving and shaping the future; many previous grant projects have focused on practices that have become widely adopted, such as integrated pest management and cover cropping.

In *Greenbook 2022*, you'll learn about the successes and challenges an enthusiastic group of grantees have encountered while finding ways to increase energy and labor efficiency, reduce purchased inputs, and improve both the environment and farmers' profitability. In addition to descriptions of new projects, this year, the Greenbook will present final reports on 2018, 2019, and 2020 projects, as well as brief updates on the progress of ongoing projects from 2020-2021. To learn more about any of them, please don't hesitate to get in touch with the grantee. You'll find contact information listed at the beginning of each project summary.

If there's a sustainable farming idea you'd like to try, please keep this opportunity in mind. To apply, please submit all application materials via the AGRI Sustainable Agriculture Demonstration Grant webpage at:
www.mda.state.mn.us/sustagdemogrant.

Thom Petersen

Thom Petersen, Commissioner
Minnesota Department of Agriculture

Minnesota Department of Agriculture | 625 Robert Street North | Saint Paul, Minnesota 55155

October 2022

Agricultural Growth, Research, and Innovation (AGRI) Program

MISSION STATEMENT

The Minnesota Department of Agriculture's mission is to enhance Minnesotans' quality of life by ensuring the integrity of our food supply, the health of our environment, and the strength of our agricultural economy.

Our Sustainable Agriculture Demonstration Grants support innovative on-farm research and demonstrations. They fund projects that explore sustainable agriculture practices and systems that are likely to make farming more profitable, resource efficient, and personally satisfying.

In the Greenbook, we share the recommendations, observations, and experiences collected by grantees so that the public can use this growing collection of information to improve their decision-making on their own farms. We welcome growers with research questions to apply for our grants so that we can address the emergent and on-going challenges facing local agriculture.

ABOUT AGRI

The Minnesota Legislature created the Agricultural Growth, Research, and Innovation (AGRI) Program in 2013 to advance the state's agricultural and renewable energy industries.

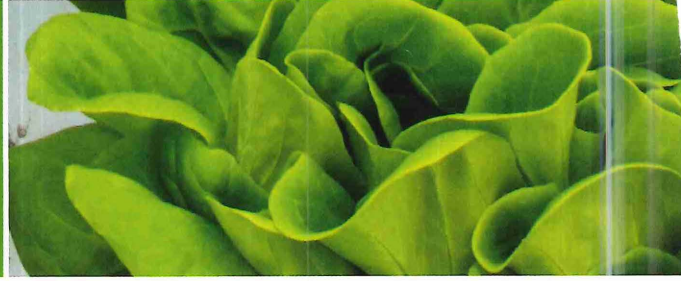
The AGRI Program awards grants and other types of financial assistance to create agricultural jobs and profitable businesses. Farmers, agricultural businesses, schools, researchers, and county fairs can apply to several different AGRI grant programs.

AGRI grants focus on areas of greatest opportunity and potential economic impact. These investments have resulted in increased production, employment, market expansion, and improved production and processing efficiencies since the program launched in 2013.

Contents

Contents

Sustainable Agriculture Grant Program



PROGRAM PURPOSE

The Sustainable Agriculture Grant Program is designed to demonstrate and publicize the energy efficiency, environmental benefit, or profitability of sustainable agriculture techniques or systems from production through marketing. Grants fund research or demonstrations on Minnesota farms. Funding is from the AGRI Grant Program.

PROGRAM DESCRIPTION

The Minnesota Department of Agriculture has received over 1,255 grant applications and approved over $4.9 million in funding for 376 projects since the program began in 1989. Project categories include: Alternative Markets, Specialty Crops, Cropping Systems, Soil Fertility, Energy, and Livestock. This Greenbook will showcase research that was conducted in the 2021 growing season. These projects are in various stages of completion.

Grants last for two or three years with a focus on on-farm research or demonstration projects. Grantees may receive a maximum of $50,000, with a dollar for dollar match required on the amount over $25,000. These projects by Minnesota farmers, educational institutions, individuals at educational institutions, or nonprofit organizations demonstrate farming methods or systems that increase energy efficiency or production, reduce adverse effects on the environment, or show economic benefits for a farm by reducing costs or improving marketing opportunities. 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 soil scientists, agronomists, postsecondary educators, agriculture marketing specialists, sustainable and organic farmers, and other agricultural experts.

GRANT SUMMARIES

The following project summaries are descriptions of project objectives, methods, project activities, and results. To find out more details about these projects, contact the principal investigators directly through the listed telephone numbers and email addresses.

Sustainable Agriculture Demonstration Grant Program

SUMMARY OF GRANT FUNDING (1989-2022)

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
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
2013	6	$66,000	$11,000	$5,300-20,300
2014	13	$205,000	$15,770	$7,800-25,000
2015	13	$236,000	$18,200	$6,700-25,000
2016	11	$177,030	$16,094	$9,765-24,980
2017	7	$103,682	$14,812	$5,397-25,000
2018	11	$223,099	$20,282	$12,167 - 25,000
2019	9	$239,772	$26,641	$11,952-50,000
2020	8	$160,145	$20,018	$11,158- 25,137
2021	9	$256,891	$28,543	$9,644-46,937
2022	8	$241,757	$30,220	$7,314-38,629
Total Funded	**376**	**$4,902,792**	**$13,756**	**$1,000-50,000**

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

New Sustainable Agriculture Demonstration Grant Projects 2022

The following new demonstration grant project introductions describe the summaries and objectives for projects in the first year of the grant.

Alternative Markets and Specialty Crops

Developing the Right Seed Mix for Solar Grazing in Minnesota
Grantee: Cannon Valley Graziers, Arlo Cristofaro-Hark

Baseline Carbon Market Value of Intermediate Wheatgrass
Grantee: Great River Greening, Brad Gordon

Specialty Crop and Season Extension Research by Emerging Farmers
Grantee: Prairie Rose Farm, Verna Kragnes

Diverse Crop Production in Northern Markets
Grantee: The Village Agricultural Cooperative, Amanda Nigon-Crowley

Documenting Temperatures on Fruit Trees in Winter Protection
Grantee: Daniel Sheild

Cropping Systems

Farming Practices for Improved Soil Health
Grantee: University of Minnesota-Crookston, Katy Chapman, Lindsay Peace

Evaluating Soil Health and Farm Profitability with Perennials and Poultry in Corn Production Systems
Grantee: Minnesota State University, Mankato, Mriganka De

Interseeding Clover into Pumpkins
Grantee: University of Minnesota, Charlie Rohwer

2022 New Demonstration Grant Projects

Developing the Right Seed Mix for Solar Grazing in Minnesota

Principal Investigator

Grantee: Arlo Cristofaro-Hark
Organization/Farm: Cannon Valley Graziers
Email: info@cannonvalleygraziers.com
Counties: Dakota, Rice, Steele, Fillmore, Waseca

Project Duration

2022-2025, 3 years

Award Amount

$24,396.90

PROJECT SUMMARY

Over the last five years, "Solar Grazing," (the practice of using sheep to manage vegetation on utility-scale solar sites) has become widely and rapidly adopted across the United States. Through paid contracts with solar developers, solar grazing has the potential to have a tangible, positive impact on the viability of both large- and small-scale sheep farms in the Upper Midwest.

Our project seeks to advance the widespread adoption of solar grazing in Minnesota by developing and testing a ground cover seed mix for use in solar grazing systems. Over a three-year period, we will compare four distinct seed mixes on four separate test sites and measure their effectiveness in four categories: a) ease of establishment; b) cost effectiveness; c) climate resilience; and d) benefits to pollinators and sheep. Evaluation will occur on each respective site three times throughout year (pre, during, and post-grazing). The overall objective of this project is to provide the public with an effective, Minnesota-specific solar grazing seed mix that can be used across the state in a variety of applications.

PRIMARY OBJECTIVES

1. Evaluate the cost, cost effectiveness, establishment, and climate resiliency of different seed mixes.
2. Measure the benefits of seed mixes for sheep, pollinators, and the environment using the "Pollinator Scorecard."
3. Develop "MN Fuzz and Buzz" seed mix for solar developments.

2022 New Demonstration Grant Projects

Baseline Carbon Market Value of Intermediate Wheatgrass

Principal Investigator

Grantee: Brad Gordon
Organization/Farm: Great River Greening
Email: BGordon@greatrivergreening.org
Counties: Nicollet, Scott

Project Duration

2022-2025, 3 years

Award Amount

$34,655.45

PROJECT SUMMARY

Eastern Nicollet County has become a hub for new crops and rotations trialed in Minnesota. One of those crops is Intermediate Wheatgrass (Kernza®). Many local growers desire more confirmation of market opportunities before growing this new crop themselves. A new market that has come to the forefront recently is carbon. This project will demonstrate the profitability of Kernza® when including carbon payments. Before this market is applicable, measurements of carbon sequestration in soil are foundational for setting expectations for revenue per acre. To date, there is very little data on Kernza's® carbon sequestration in the soil surrounding its deep roots. This project will measure changes in soil carbon over three years in four Kernza® fields and one control corn/soy field. The results will be conveyed to interested farmers, community members, the scientific community, and carbon buyers. If farmers can have a baseline value of what they could potentially make per acre from selling Kernza's® sequestered carbon, they will have a better idea of return on investment for this crop, compared to others. Adding carbon to Kernza's® grain and hay/grazing value could make it even more competitive.

PRIMARY OBJECTIVES

1. Measure and calculate carbon tons per acre to determine how much Kernza® sequesters in its first year and in later years of growth.
2. Evaluate the tonnage of carbon stored, communicate with carbon buyers, and determine whether a profitable market could be established for Kernza® growers.
3. Consider the interest of farmers in the area to grow Kernza® and community members to buy and support it.

Specialty Crop and Season Extension Research by Emerging Farmers

Principal Investigator

Grantee: Verna Kragnes
Organization/Farm: Prairie Rose Farm
Email: verna.kragnes@gmail.com
County: Clay

Project Duration

2022-2025, 3 years

Award Amount

$47,002.34

PROJECT SUMMARY

Refugee immigrant farmer members in New Roots Farm Incubator Cooperative working with Prairie Rose Farm will 1) develop skills in season extension methods, 2) trial and produce African eggplant, white sorghum as grain or flour, and sweet sorghum syrup as high value crops, and 3) develop, test, and market these valued-added products of interest in Asian and African communities. The focus of the first year is trial and selection of both white and sweet sorghum seed to be grown in the context of three individual farms. Four open-pollinated varieties of white sorghum, selected from previous work by Dr. Burton Johnson, North Dakota State University, reviewing 106 genotypes and three distinct varieties of sweet sorghum from research done by Dr. Thomas Michaels, University of Minnesota, will be selected for agronomic and syrup characteristics. Individual farmers will evaluate and integrate preferred new crops into their farming business. Year two will be an expansion of farmers' preferred seed(s) and first yield of syrup and flour for market sales. Year three will be an expansion of production and direct marketing of grain, flour, and syrup through individual farms or farmer cooperatives. Outreach will showcase immigrant leadership and voice as educators and mentors for their peer farmers, and as presenters for digital media, field days, hands-on workshops, and conferences.

PRIMARY OBJECTIVES

1. Trial and select seeds of white and sweet sorghum for agronomic and syrup characteristics.
2. Process African eggplant, white sorghum grain or flour, and sweet sorghum syrup as high value crops.
3. Expand production and direct marketing of grain, flour, and syrup through individual farms or farmer cooperatives.
4. Evaluate project benefits and impacts including income and profitability, market opportunities, business enterprise opportunities, implications for crop production, and farm management, while increasing access to culturally significant foods.

2022 New Demonstration Grant Projects

Diverse Crop Production in Northern Markets

Principal Investigator

Grantee: Amanda Nigon-Crowley
Organization/Farm: The Village Agricultural Cooperative
Email: amandanc@rochvillage.org
County: Olmsted

Project Duration

2022-2024, 2 years

Award Amount

$37,500.00

PROJECT SUMMARY

The Village Agricultural Cooperative supports farmers who wish to identify the best staple varieties of plants from their specific diet which can be grown effectively in northern climates. The objective is to identify the best plants for cultivation, in addition to pest management strategies in our climate. This includes tomatillos for salsa production, bok choy and Asian greens, and managu. Managu is a leafy nightshade vegetable commonly grown in Kenya and East African countries and is special to the Kisii community in Rochester. Unfortunately, most managu grown is lost to pests.

PRIMARY OBJECTIVES

1. Grow and research tomatillo varieties for salsa production in northern climates.
2. Grow bok choy and Asian greens to research pest resistance, climate tolerance, storage capabilities, and best practices to scale up local production.
3. Use pest management strategies, including trap crops, mowing around the area, and a row cover to hopefully increase the yield of managu and increase profitability for organic production.

Documenting Temperatures on Fruit Trees in Winter Protection

Principal Investigator

Grantee: Daniel Sheild
Email: grafted73@gmail.com
County: Chisago

Project Duration

2022-2025, 3 years

Award Amount

$7,314.29

PROJECT SUMMARY

This project will use the data logger and heat sensors inside two existing tunnels to determine the minimal amount of energy input through a heat source (electric heat tape) to protect peach flower buds throughout the winter.

The data kept through the night during descending temperatures will indicate when the heat source is activated, allowing us to thermostatically control temperatures above the kill zone, -16 to -23 degrees Fahrenheit. This will also help determine how quickly supplemental heat must be applied inside the tunnel and the lowest amount of energy needed for heating to ensure fruiting. If the use of electricity can be reduced from 12 to three hours, for instance, this would save 75 percent of cost and energy. Both inside and outside temperatures will be monitored in two high tunnels and in two outdoor locations near the tunnels to determine the lowest indoor and outdoor temperatures under which the system works. This data could reveal what other parts of Minnesota could grow peaches, apricots, and plums consistently with this system.

PRIMARY OBJECTIVE

Document the data from the data loggers and sensors monitoring the electrical input to determine the lowest possible use compared to fruiting ability and crop success.

2022 New Demonstration Grant Projects

Farming Practices for Improved Soil Health

Principal Investigator

Grantees: Katy Chapman, Lindsay Peace
Organization/Farm: University of Minnesota-Crookston
Emails: katys@umn.edu, lpease@umn.edu
County: Polk

Project Duration

2022-2025, 3 years

Award Amount

$38,629.00

PROJECT SUMMARY

Understanding how agronomic practices impact the soil microbiome is critically important as our society transitions to a technologically rich agronomic environment. Intensive tillage is a solution to two management challenges: 1) it reduces pesticide spraying and slows the development of pesticide resistant weeds; and 2) it incorporates fertilizer into the soil to prevent nutrient loss into the environment. However, use of tillage comes at a cost. It results in the degradation of soil health and the soil microbiome. This project seeks to identify solutions for growers wishing to balance these considerations. In this project, we will establish an on-farm trial for a wheat-soybean rotation to compare soil health, weed pressure, and yield in response to differences in tillage, herbicide application, and fertilizer placement. Determining which practices best support soil health will provide the information growers need for best practices to meet multiple goals. This will contribute to lower carbon footprints of farm production and reduce the cost for weed control, while promoting soil health, thus making it easier for emerging small farms, including emerging farmers to be successful.

PRIMARY OBJECTIVE

The overall goal is to compare the effects of different tillage, herbicide application, and fertilizer placement strategies on crop yield and soil health in wheat rotations.

Evaluating Soil Health and Farm Profitability with Perennials and Poultry in Corn Production Systems

Principal Investigator

Grantee: Mriganka De
Organization/Farm: Minnesota State University, Mankato
Email: mriganka.de@mnsu.edu
County: Faribault

Project Duration

2022-2025, 3 years

Award Amount

$37,474.30

PROJECT SUMMARY

Corn growers are always looking for new management techniques to improve soil and environmental health, while also improving farm profitability. Integrating perennial ground cover (PGC) and poultry (P) in corn production systems has the potential to achieve that goal. The proposed project will determine the impact of corn grown with PGC alone and/or PGC–P systems (60" row width) on soil health, crop yield, and farm profitability over three growing seasons in an on-farm setting. We hypothesize that corn grown (60" row width) with PGC and/or PGC–P systems will increase soil health, grain yield, and farm profitability compared to conventionally grown corn (30" row width) without PGC and P. The knowledge gained will be shared with producers and researchers via field days, social media, extension blogs, presentation at an ag-based conference, and a peer-reviewed journal publication. The proposed project hopes to increase the adoption of an innovative and sustainable corn production system with PGC and P suitable for Minnesota corn growers to serve our communities and customers better, while positively impacting soil and environmental health.

PRIMARY OBJECTIVES

1. Quantify and evaluate the changes in physical, chemical, and biological soil health indicators with PGC and P integration.
2. Quantify and evaluate the impacts on crop performance.
3. Conduct a cost-benefit analysis to compare the return on investments among the treatments and determine the success of the financial aspect of the study.

2022 New Demonstration Grant Projects

Interseeding Clover into Pumpkins

Principal Investigator

Grantee: Charlie Rohwer
Organization/Farm: University of Minnesota
Email: rohw0009@umn.edu
Counties: Waseca, Brown

Project Duration

2022-2024, 2 years

Award Amount

$14,785.00

PROJECT SUMMARY

Pumpkins are grown at six-to-twelve-foot row spacing. Wide alleys between rows are typically either covered with killed rye as mulch or maintained bare with cultivation or herbicides. Wide alley spacing may be useful for growing a living cover crop (intercrop), sown before pumpkin vines spread. Legume cover crops that fix atmospheric nitrogen, like clover, reduce the need for fertilizer inputs in the following crop. However, they may also compete with the pumpkin crop and be impacted by common pumpkin herbicides. Knowledge of clover intercropping in corn (two-and-a-half-foot row spacing) may not translate to pumpkins. We are proposing to study twelve species of clover and three clover mixtures to identify one or two treatments best-suited to intercropping in pumpkins based on nitrogen fixation and biomass production, competition with pumpkins, and herbicide tolerance. We will seed clover between pumpkin rows in June, measure clover biomass and nitrogen content in fall, and assess overwintering. We will measure pumpkin yields and tolerance of clover to common pumpkin herbicides. Knowledge demonstrated by this grant may extend beyond pumpkins, and will be shared at a virtual extension event in fall 2023.

PRIMARY OBJECTIVES

1. Generate and share information about and demonstrate use of clover as a nitrogen-fixing interseeded 'living mulch' cover crop, with specific relevance for cucurbit growers.
2. Assess pumpkin yield when intercropped with common clovers just prior to vine elongation.
3. Assess impacts of pumpkin-labeled herbicides on clover germination in two soil types.

Sustainable Agriculture Demonstration Grant Project Updates 2020-2021

The following 2020 and 2021 project updates describe the project design and activities conducted during the first and/or second year of the grant project. To find out more details about these projects, contact the principal investigators.

Alternative Markets and Specialty Crops

Diversity Agriculture and Its Feasibility in Minnesota: Sustainable Practices and Marketing
Grantee: University of Minnesota, Dean Current

Increasing Harvesting & Processing of Wild Rice & Other Small Grains for Small-Scale Growers, NE MN
Grantee: Friends of Finland, Honor Schauland

Cropping Systems

Comparison of Variable to Uniform Rate Irrigation for Impacts on Groundwater Quality and Quantity
Grantee: University of Minnesota, Vasudha Sharma

No-Till Vs. Conventional-Till for Alfalfa Hay Establishment and Production for a 3-Year Stand
Grantee: McCormick Farm, Connor McCormick

Fruits & Vegetables

Expanding the Effectiveness of Non-Chemical Pest Control in Organic Strawberry Production
Grantee: Twin Cities Berry Co, Andrew Petran

Growing and Evaluating Perry and Dessert Pears on a Tall Spindle System
Grantee: Sweetland Orchard, Gretchen Perbix

Trialing High Tunnel Raspberries to Increase Yield and Reduce Spotted Wing Drosophila Pressure
Grantee: Little Berry Hill Farm, Aaron Wills

On Farm Research on Honeyberry Production
Grantee: Walking Plants Orchard, Philip Stowe

Tomato phosphorus removal rates with high- or low-phosphorus transplant solutions and grafting
Grantee: University of Minnesota, Charles Rohwer

Livestock

Control of Wild Parsnip Through Rotational Sheep Grazing
Grantee: Radicle Heart Farm, Heidi Eger

Determining Effects of Prescribed Sheep Grazing on Plant Diversity in Native Pollinator Habitat
Grantee: Minnesota Native Landscapes, Jake Janski

Evaluating the Impact of Feed on Animal Health, Growth Rates and Meat Quality in Pastured Poultry
Grantee: Grassfed Cattle Co, Valerie Luhman

Soil Fertility

Crop & Livestock Farmers Building Biodiverse, Aerobic Composts Using the Johnson-Su Method
Grantee: Land Stewardship Project, Shona Snater

Evaluating Erosion, Yield, and Economics in Different Tillage Regimes After a Winter-kill Cover Crop
Grantee: Jason Miller

Understanding the Possibilities of on Farm Compost to Reduce or Eliminate Commercial Fertilizer.
Grantee: Olsen Custom Farms, Chad Olsen

Alternative Markets

Diversity Agriculture and Its Feasibility in Minnesota: Sustainable Practices and Marketing

Principal Investigator

Grantee: Dean Current
Organization/Farm: Regents of the University of Minnesota
Email: curre002@umn.edu
County: Ramsey

Project Duration

2020-2022, 3 years

Award Amount

$25,000.00

PROJECT SUMMARY

This project focuses on developing the capacity of minority farmers to engage in meaningful economic activities. The idea was to document Bhutanese refugees' indigenous knowledge of planting and processing organic vegetables. We were able to document that the responding farmers can grow 11 varieties of cereal, six varieties of lentils, and 34 varieties of organic vegetables. They know how to plant them, how to harvest, and how to restore them according to the season. Because of the COVID outbreak, the project could not produce the anticipated results. However, based on this experience and support expressed by others in the farming community, there is potential to mobilize the refugee farmers to diversify the agriculture in the state of Minnesota.

PROJECT DESCRIPTION

Contemporary science and technology alone are not enough to resolve our food problems. Diversity in the U.S. population is growing and so is the knowledge base. Modern technology allows greater production and enjoyment of material goods without considering the pressure on the natural environment. The purpose of this proposal is to gather and share common information about the varieties of crops that are grown in Nepal and Bhutan and that may be grown in Minnesota. This may guide policies promoting better health, environment, and social justice among every group of citizens. This way we may be able to develop a synergy to fight against increasing pressure on our natural resource base.

Green chilies are a favorite in the Bhutanese garden.

Objectives

The overarching objective of this project is to conserve the environment by producing healthy and diverse food for public consumption. Minnesota immigrant communities bring important agricultural skills that are often not utilized due to the lack of opportunities for those communities to access land and resources needed to produce and market agricultural products. This project aims to demonstrate the production of lesser-known traditional agricultural products to improve the contemporary diets available in the marketplace. Another aspect of this project is to diversify agriculture in Minnesota and create and strengthen a strong model of community enterprises.

Evaluation

Interaction with representatives of the Bhutanese Community Organization in Minnesota and some Bhutanese refugees, the author observed new community needs. In the Bhutanese Refugee Community, older adults have immense knowledge and understanding of how to live a sustainable lifestyle. In their homeland, these subsistence farmers had enjoyed cultivating healthy foods and vegetables for their families as well as trading the surplus produce. Bhutanese, Nepalese, Hmong, and Karen communities share the same agricultural and environmental knowledge. Utilizing and managing this diverse knowledge is a way to generate pro-environmental practices.

2021 RESULTS

A final report was drafted and submitted to the University of Minnesota with the complete data collection. We were able to develop a list of the horticultural crops of interest in the Bhutanese community that can be used to follow up on the results of this project. We had hoped to have a field day, but communication with our Bhutanese partners became difficult and we were not able to coordinate that event. Apparently, there were some organizational issues within Bhutanese Community Organization in Minnesota which further complicated organizing the field day. A future plan to host a field day is in the works.

ADDITIONAL RESOURCES

The production systems practiced by the Bhutanese farmers could be adopted by other farmers but that should be done through a farmer-to-farmer interchange so that farmers can see for themselves how the systems work and make an informed decision about adoption. It is early in the process to make a recommendation, but an interchange would allow farmers to evaluate and decide to adopt or not.

Innovative technique growing long gourd.

Bhutanese farmers picking eggplant from the garden.

Increasing Harvesting and Processing of Wild Rice and Other Small Grains for Small-Scale Growers in Northeastern Minnesota

Principal Investigator

Grantee: Honor Schauland
Organization/Farm: Friends of Finland
Email: honor@friendsoffinland.org
Counties: Cook, Lake, Saint Louis

Project Duration

2021-2024, 3 years

Award Amount

$35,769.00

PROJECT SUMMARY

Traditional wild rice harvesters and processors are getting older, retiring, and/or passing on, taking with them generational knowledge and skills. Consequently, wild ricers are traveling further afield for processing, leading to a reduced interest in wild rice harvesting. Harvesting wild rice requires knowledge of wild rice populations, identifying the correct stage for harvesting, knowing diseases to avoid, and practicing sustainable harvesting techniques. Similarly, processing wild rice requires precision to dry, parch, and de-hull the rice while ending with a quality product. The Finland Food Chain was a project formed in 2018 with the goal to support the development of a comprehensive local food system for the Finland area and the greater Arrowhead region of Minnesota. It will cultivate a new generation of sustainable wild ricers and processors through classes, mentoring, and apprenticeships while exploring dual-economic benefits of off-season small grain processing. In this work we will facilitate intergenerational transfer of knowledge, skills, equipment, and cultural appreciation for the economic, physical, and spiritual sustenance that wild rice provides for future generations.

Hand-made wild rice/manoomin knockers.

PROJECT DESCRIPTION

The project is intended to support small-scale diversified farms in northeast Minnesota that aspire to add wild rice (also known as manoomin in the Anishinaabe language) and other small grains to their farm enterprises. Wild rice enterprises can be added via sale of unprocessed rice to processors, sale of processed rice (retail/wholesale) and/or as a processor. Small grains for human consumption are in great demand, however, growers are limited by access to local processing. Grain production is a critically important part of local food systems. Wild rice is a high-value, high-quality grain that most northeast Minnesota growers are limited in their ability to integrate into their operation due to lack of knowledge (economic and technical), skills, and access to processing. Tribal and non-tribal elders are the repositories of knowledge related to wild rice ecology and the skills needed for harvesting and processing. The passing of this generation is ongoing, leading to an increasing interest and demand to facilitate the intergenerational transfer of knowledge, skills, and processing capacity before it is lost. Small-grain production was once a part of northeast Minnesota agriculture and regional food resilience requires them to be once more. One limiting factor is a lack of grain processing capacity for small producers. This project will test and demonstrate the technical and financial feasibility of utilizing wild rice processing equipment to also process other small grains with particular emphasis on small scale growers.

OBJECTIVES

1. Initiate and facilitate a mentor/apprenticeship program. Based on traditional transfer of wild rice skills and knowledge, a group of expert mentors will provide firsthand experience as personal guides for young producers to learn wild rice harvesting and homestead-scale processing skills. For those who wish to develop their skill set further, the apprenticeship program will give aspiring processors a deeper hands-on experience around the technical skills of processing wild rice as a business.
2. Research and test the feasibility of wild rice processing equipment to process small grains with support from regional growers. The dehulling, winnowing, and sorting equipment used for wild rice is similar to that used for small grains, and because the seasonality of processing small grains differs from that of wild rice, there is the

potential for one facility to support multiple small grain crop processors.

3. Develop education modules to further reinforce the transfer of intergenerational knowledge and skills and ensure continuity into the future. The diversity of methods and equipment used by wild rice harvesters and processors, along with personal and cultural perspectives, will be reflected in learning modules. Modules will include: a) benefits of wild ricing on individual and community health and economics, b) the natural history and ecology of wild rice, c) technical skills for harvesting and processing wild rice, and d) historic and modern ways of cooking and building meals around wild rice.

2021 RESULTS

Mentor/Apprenticeship Program

The wild rice harvesting season in the Arrowhead Region of Minnesota proved challenging due to extreme drought conditions leading up to harvesting season. Although the weather did not impact the quality or quantity of the ripened wild rice, it severely limited access to wild rice lakes due to low water levels and the Greenwood Lake Fire restricted vehicle access to annual harvesting locations. Although these challenges resulted in fewer ricers harvesting less rice, we paired three wild rice mentors with three apprentices.

In 2022, we will continue to focus our efforts on identifying and inviting apprentice participants who currently have a farm business and are looking to add wild rice to their product offerings. We will utilize our established education modules to provide additional experience and training for apprentices and include modules that inform participants on marketing and selling wild rice as a product of the farm.

Small Grain Processing

In fall 2021, the Finland Food Chain procured a full line of wild rice processing equipment to establish the Finland Wild Rice House/Manoomin Waakaa'igan/Villirisi Talo. Utilizing shop space in a historic Finland school building, we secured funds and contracts for electrical upgrades, a cement slab, and a timber-framed shed roof. We installed processing equipment purchased from retiring ricers (large and small parchers, de-huller, seed and grain fanning mill, and gravity table). At the end of the season our processing team had parched, de-hulled, and separated over 2,000 pounds of wild rice for 18 different harvesters.

With the support of Kaare Melby of Finnskogen farm, we utilized the de-huller and fan mill to run experiments on processing oats and mustard. Our initial efforts to process the oats through the de-huller demonstrated

Pouring green wild rice (manoomin) into a large parcher to dry.

that the oat hulls were too resilient to produce a finished product through the processing equipment. Additional experiments will need to be conducted to improve efficiency of using the de-huller to process oats. The fan mill worked effectively to separate the mustard seed from pods and other debris. We have identified farms to grow additional experimental grains to continue testing the processing equipment in summer of 2022 and will further conduct research into the value of adding small grain growing and processing to farm operations. We plan to run tests on oats, barley, winter camelina, winter wheat, flax, and Kernza®.

Wild Rice Education Modules

In 2021, we worked to begin development of wild rice education modules for use in public education, targeted training for the mentor/apprenticeship program, and school curriculum. We identified the following domains for education modules to inform and guide our efforts:

- Wild Rice Basics/Background
- Wild Rice Harvest
- Wild Rice Processing
- Wild Rice Nutrition/Health
- Small Grains Processing

Farm-to-Fork

Under these domains we hosted three focused webinars on the following topics: 1) Nutrition of Manoomin with Dr. Emily Onello of University of Minnesota-Duluth, 2) Virtual Cooking Class: Wild Rice Stuffed Squash with Dan Cahill Mathews of Finland Food Chain, and 3) Manoomin/ Wild Rice: Biology, Conservation, and Monitoring with Darren Vogt of 1854 Treaty Authority.

Comparison of Variable Rate Irrigation to Uniform Irrigation for Impacts on Groundwater Quality and Quantity

Principal Investigator

Grantees: Vasudha Sharma, Taylor Herbert (nee Becker), Grant Anderson

Organization/Farm: Regents of the University of Minnesota

Email: vasudha@umn.edu

County: Stearns

Project Duration

2021-2023, 2 years

Award Amount

$38,000.00

PROJECT SUMMARY

Two critical challenges face Minnesota's agricultural watersheds: nitrate leaching into groundwater supplies, and competition over limited groundwater resources. The majority of Minnesota communities depend on groundwater for their drinking water supply, which is threatened by increasing concentrations of nitrate. Variable rate irrigation (VRI) has the potential to improve water use efficiency and reduce the risk of nitrate leaching into groundwater. We are conducting a field study in Stearns County to evaluate the impact of VRI in comparison to conventional uniform rate irrigation (URI) management on nitrogen (N) leaching, grain yield, and water use efficiency. The project will also focus on extension through field days and conversations with farmers to disseminate the research results, promote the VRI technology, and develop actionable strategies for adoption.

PROJECT DESCRIPTION

More than 25 percent of groundwater in the state of Minnesota is pumped for irrigating agricultural crops. This makes irrigation the second-largest user of groundwater in the state (Freshwater Society, 2013). Currently, Minnesota has approximately 600,000 acres of irrigated agricultural cropland, a number that increased by four percent from 2007 to 2012 (USDA NASS 2012). Many of these irrigated acres are in Minnesota's Central Sands region. The coarse-textured (sandy) nature of the region's soils means that they have a low water holding capacity and a rapid drainage rate. At the same time, many communities in this region depend on groundwater as their sole drinking water source. Balancing agriculture's economic needs while protecting rural drinking water supplies leads to two critical challenges in agricultural watershed management. First, is groundwater quality. Water percolates through the soil profile quickly in the coarse-textured soils of central Minnesota. This means that agricultural chemicals (fertilizers) can also leach quickly through the root zone and into groundwater. Fertilizer loss represents a financial loss to the farmer as nutrients are leached beyond the root zone. Further, fertilizer leaching poses environmental, human health, and economic risks to communities that use groundwater for drinking. Many irrigated regions of the state have groundwater with nitrate-nitrogen concentrations exceeding the 10mg per liter health standard for drinking water. Second, is water quantity. High groundwater withdrawals during the crop growing season can temporarily reduce the discharge of groundwater into nearby streams and lakes, impacting aquatic ecosystems (Watson et al. 2014; MN Department of Natural Resources 2016) as well as causing interference with nearby private and municipal wells.

A meaningful way to address these issues is by implementing proven advanced irrigation management techniques and technologies such as VRI. Our project focuses on addressing both groundwater quality and water quantity by implementing precision irrigation technology and developing an integrated agricultural water management research and extension program in Minnesota.

In this research, we are evaluating the impact of VRI technology on water and nutrient savings, corn yield, and N leaching in comparison to uniform water management. The information gained from the project will address the applicability of VRI technology in Minnesota soils and climate, its ability to reduce N loading to groundwater, and its ability to reduce total water use in comparison to URI. VRI technology addresses the reality that soil physical properties can vary significantly within a single

field–from rapidly draining sands to poorly drained clays. URI does not account for this variability leading to potential over- or under-application of irrigation water. By addressing spatial variability with VRI, we will optimize irrigation for each management zone within a field, maximize crop growth, and minimize negative environmental consequences.

A secondary goal of this project is to evaluate the use of nitrate quick test strips to measure nitrate concentration in lysimeter water samples as compared to traditional lab values. Lab testing for nitrate can be expensive as well as time consuming. A quick test strip provides instantaneous information about the nitrate concentration in a water sample and will allow farmers to make quick, well-informed decisions about nutrient and water management. A quick test strip alone is also significantly less expensive than a lab test. Part of this project will focus on using a nitrate quick test strip to measure nitrate concentration, while sending a subset of water samples to an analytical lab to get an exact value. The quick test values and lab values for nitrate concentrations will then be compared to see how accurate the test strips are and to generate a calibration curve that could be used for farmers and other agricultural stakeholders to approximate nitrate levels in real-time.

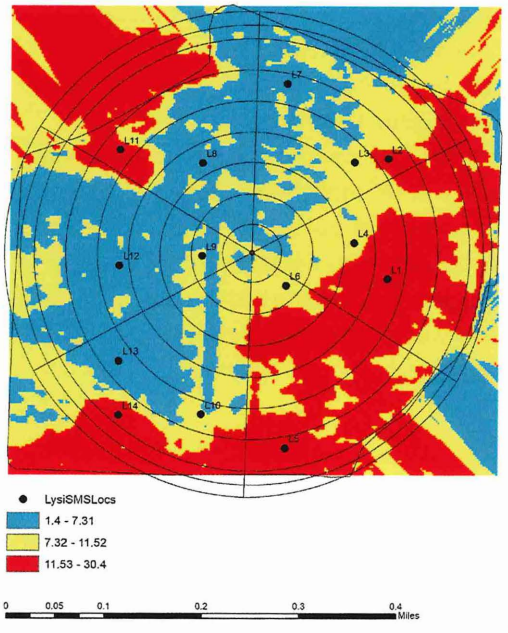
OBJECTIVES

1. Quantify and evaluate the impact of VRI in comparison to conventional URI on N leaching, grain yield, and crop water use at the field scale. A secondary goal of this objective is to evaluate the use of nitrate quick test strips to approximate nitrate concentration in water samples compared to a lab method.
2. Understand the economics of VRI in comparison to URI in an on-farm setting in MN and compare corn crop water productivity to net income.
3. Facilitate extension and engagement through field days, irrigation and drainage workshops, and conversations with farmers to disseminate the project results, promote VRI technology among growers, and develop actionable and practical strategies for adoption.

DESIGN

The study was conducted on a 120-acre field in Stearns County near Belgrade, MN for 2021 corn growing season. The field was located within the coarse-textured soils area defined by the Minnesota Department of Agriculture, but still has spatial variability of soil types that will make the site uniquely suited for investigating the fundamentals of site-specific irrigation management.

The spatial variability of soil electrical conductivity (EC) within the field is shown in Figure 1 with the dominant soil type being a somewhat excessively drained sandy loam. The experiment included two irrigation application strategies. Two treatments were assigned in three blocks in a randomized complete block design resulting in six individual experimental units (2 treatments replicated 3 times). The two irrigation treatments were VRI management, and URI management. The research site has advanced hydraulic and variable-rate sprinkler irrigation systems in the field.



OID	Name	Lat	Long
0	L1	45.458601	-95.031362
1	L2	45.460407	-95.031427
2	L3	45.460339	-95.032133
3	L4	45.459131	-95.03209
4	L5	45.456047	-95.033413
5	L6	45.458463	-95.0335
6	L7	45.461499	-95.033609
7	L8	45.460271	-95.035345
8	L9	45.458875	-95.035295
9	L10	45.456514	-95.03521
10	L11	45.460439	-95.0371
11	L12	45.458699	-95.037038
12	L13	45.457281	-95.036987
13	L14	45.456472	-95.036957

Figure 1. Field map representing different irrigation zones based on the soil electrical conductivity. The black dots are the lysimeters locations. The soil moisture sensors were installed at locations 1, 3, 5, 6, 7, 8, 10, 11, and 12. Different colors represent different electrical conductivity ranges. URI stands for uniform rate irrigation plots and VRI stands for variable rate irrigation plots.

Management zones for VRI management were created based on soil EC, soil type, elevation, and previous yield. As shown in Figure 1, EC range from 1.4-7.31 is Zone 1, EC range from 7.32-11.52 is Zone 2 and EC range from 11.53-30.4 is Zone 3. Irrigation events were scheduled based on the soil moisture sensors installed in each treatment. When sensor-measured water content in the lowest EC (Zone 1) locations (sandy soils and low water holding capacity) drops close to 50 percent of available water holding capacity, irrigation was triggered. In each irrigation event the irrigation amount was based on the water holding capacity as well as irrigation system capacity. From the literature we know that the management zone with lowest EC requires the most water, so the irrigation trigger was based on the soil

moisture measurement from those zones and then were reduced accordingly for other management zones within the VRI treatment. The two higher EC zones (Zone 2 and Zone 3) received 70 percent and 50 percent irrigation, respectively, until the end of June and then 50 percent and 20 percent, respectively after that. An irrigation rate of 100 percent was applied across the entire URI plots regardless of the soil variability. The 100 percent irrigation replenished the root zone to 100 percent field capacity when the soil water level in the lowest EC zones dropped to 50 percent of available water holding capacity. In each URI plot 2-3 suction cup lysimeters at a depth of 1.2 m below the root zone were installed to capture any N leaching from the root zone. In each VRI plot, 1 lysimeter per management zone was installed except one plot where area under Zone 2 within that plot was very small. A water sample from each tube was collected on a weekly basis and was measured for nitrate concentration using a nitrate quick test strip and spectrophotometer in the lab. The two datasets were used to generate a calibration curve for the nitrate quick test values. We will use a water balance approach to model drainage volume and estimate nutrient loads.

Soil moisture sensor installed in the field.

2021 RESULTS

Table 1 shows corn yield with various irrigation treatments and management zones. The yield varied from 250 bushels per acre to 259 bushels per acre in management Zone 1, 243 bushels per acre to 259 bushels per acre in Zone 2 and 234 bushels per acre to 255 bushels per acre in Zone 3. Comparing three zones, the lowest yield was obtained in Zone 3 which was a high EC zone with loamy soil and very low elevation (depressional). Because of lower elevation in Zone 3, the soil was mostly above the field capacity both in VRI and URI plots that resulted in lower yield in these areas. The highest yield was obtained in management Zone 1 in both VRI and URI. Our results indicate that the yield distribution within each irrigation treatment followed a similar pattern in that the management zones with lower EC had higher yield. Overall, because of very dry conditions in the growing season (below average precipitation), higher irrigation in URI plots did not cause any significant grain yield loss as the water use (crop evapotranspiration) by the crop was high. However, if the weather conditions would have been normal or precipitation would have been in the normal range, we would have expected higher yields in VRI plots and lower yield in URI. The results presented in this report are from one year of data and are not analyzed statistically yet, so final conclusions will be made after the completion of the project.

In terms of irrigation water application (table 1), on average VRI treatment used 43 percent less water as compared to URI while producing almost similar yield. On average, the URI treatment produced 258 bushels per acre and VRI produced 242 bushels per acre while using 11.6 inches and 6.6 inches water. Partial economic analysis with corn price to be $5 per bushel and irrigation price to be $16 per acre-inch showed that both VRI and URI had almost the same net income (Table 1). These results indicate that VRI could be beneficial in terms of saving water and reducing irrigation induced environmental pollution. Irrigation water productivity (IWP) in the VRI and URI treatments was also calculated. The IWP equals the amount of grain produced (bushel per acre) by the irrigation water divided by the amount of irrigation water applied (inches). In 2021, the IWP in VRI treatment was 65 percent higher than the IWP in URI treatment. On average, the IWP was 37 bushel per acre-inch in the variable rate irrigation treatment and 22.2 bushel per acre-inch in URI.

Analysis of water samples collected in lysimeters did not show a statistically significant difference between the nitrate-N concentrations in the VRI vs URI zones. Averaged across the entire season, soil water in the VRI

treatment contained 59 ppm while that in the URI treatment contained 54 ppm. Although the nitrate concentrations in the VRI zones were slightly higher, this could be explained by several factors. The VRI zones received less irrigation than the URI zones (Table 1). The nitrate levels are a concentration measurement, so less water entering a system with the same amount of nitrogen in the soil, would be expected to have higher concentrations of nitrate in the water leaving that system. The volume of water percolating the soil in the URI system is much higher and might have a reduced concentration of nitrate, but the net nitrate loss might be higher under URI. Also, due to the prolonged drought conditions, yields were reduced in the VRI system compared to URI. Both treatments received the same amount of nitrogen fertilizer but may have had different utilization efficiencies due to the different yields, leaving more nitrogen available for loss in the VRI treatment.

Another goal of this project was to compare nitrate concentrations from the use of nitrate quick test strips to the lab analysis. The colorimetric scale of the nitrate test strips is limited to a maximum concentration of 50 ppm so for the sake of analysis, only data with lab nitrate values under the threshold of 50 ppm were used. For those select values, there was a linear relationship and 70 percent of the variation in the lab nitrate values can be explained with the readings by the nitrate test strips. This suggests that nitrate test strips might be useful for making management decisions as an alternative to time-consuming and expensive lab tests, but more research is needed.

Table 1. Seasonal irrigation amounts (inches) applied, yields (bushel per acre), Irrigation water productivity (IWP), gross income ($) and net income ($) in each irrigation treatment and zone.

	Uniform Rate Irrigation (URI)				Variable Rate Irrigation (VRI)			
	Zone 1	Zone 2	Zone 3	Average	Zone 1	Zone 2	Zone 3	Average
Irrigation (in)	11.6	11.6	11.6	**11.6**	11.6	5.8	2.3	**6.6**
Yield (bu/ac)	258.9	258.8	255.5	**257.7**	250.2	242.7	234.2	**242.4**
IWP (bu/ac-in)	22.3	22.3	22.0	**22.2**	21.6	41.8	101.8	**36.7**
Gross income ($)	$1,295	$1,294	$1,278	**$1,289**	$1,251	$1,214	$1,171	**$1,212**
Net income ($)	$1,109	$1,108	$1,092	**$1,103**	$1,065	$1,121	$1,134	**$1,106**

No-Till Vs. Conventional Till for Alfalfa Hay Establishment and Production for a Three-Year Stand

Principal Investigator

Grantee: Connor McCormick
Organization/Farm: McCormick Farm
Email: mccormic.38@gmail.com
County: Houston

Project Duration

2021-2023, 3 years

Award Amount

$9,644.00

PROJECT SUMMARY

The purpose of this project is to determine if alfalfa can be successfully established and productive using a no-till drill in corn and bean ground. Many of the farms in our area in Southeast Minnesota grow alfalfa for their livestock, but very few have tried no-till as a method for establishing their alfalfa stand, as they still rely on tillage equipment to prepare the soil for seeding. If no-tilling can be an effective way to establish an alfalfa stand that will last and be productive for at least three years, farms could save several hours, gallons of fuel, and tons of soil loss from having to till their ground two or three times before seeding alfalfa. Southeast Minnesota generally has steeper slopes and a lot of water runoff, so it is especially important that we continue to improve our soil management. Also, if we can improve our soil health through practices like this, we will make our soils more productive, resilient to extreme weather, and more profitable and attractive for farmers adopting more sustainable practices.

PROJECT DESCRIPTION

If this study continues to show that alfalfa can be successfully established and productive over a three-year span by using solely no-till equipment, this will significantly improve farmers profit margins, fuel consumption, soil loss minimization, and overall soil productivity. In addition, if we can determine a difference in success between planting into corn or bean ground, this will help farmers plan their crop rotations and may open more flexibility for diverse crop rotations rather than the normal corn-bean-corn-hay rotation.

Tests will be conducted on the same day for all fields and testing dates will be as follows:

- August 15, 2021
- June 1, 2022
- July 1, 2022
- June 1, 2023
- July 1, 2023

The first and last test dates (August 15, 2021, and July 1, 2023) will begin with collecting 10 random soil cores from each of the eight field parcels in order to conduct a Haney Soil test. This test will give us a comparison of general soil health and biology activity between the fields and will show us if the no-till had an effect on our soil health and biology over the three-year period. The 10 soil cores will be mixed for each of the eight fields, labeled, and sent into Ward Laboratories in Kearney, Nebraska.

All five test dates will complete the following:

1. Alfalfa Stand Count

We will use five random plot locations, at least 100 feet apart, throughout each field. At each location, we will use a square yard rectangle and place it on the ground. We will then count the number of individual alfalfa plants in this square yard. This will give us a way to compare the alfalfa germination and survival between the fields throughout the three-year study.

2. Alfalfa Biomass

We will use the same random square yard plot as the Alfalfa Stand Count test. After the alfalfa plants are all counted, we will then cut all the stems off at two inches above ground level, place the cuttings in a labeled bag, and weigh the net contents of each bag in order to determine the wet alfalfa mass. We will then air dry the samples for a minimum of 72 hours and then weigh the dry samples once again. We will calculate moisture weight of each sample using the following formula:

(fresh weight - dry weight / fresh weight) × 100 = moisture weight

After calculating moisture weight, we will subtract that weight from fresh weight of plants in each plot of each treatment to estimate dry weight and actual biomass of alfalfa for each location. After calculating alfalfa biomass, we will be able to calculate approximate tons per acre that each field has on it.

3. Alfalfa Nutrient Analysis

On or near each test date, we will collect a random sample of alfalfa for an Alfalfa Nutrient Analysis in each of the fields. These samples will be labeled and sealed in bags and then sent to the University of Minnesota Labs for analysis. We will record this data and will use it for comparing alfalfa feed value, nutrient uptake and availability, and overall profitability for each field over the course of the study.

PRIMARY OBJECTIVES

1. Determine how well alfalfa germinates, establishes, and grows in a conventionally tilled field compared to a no-till field over a three-year lifespan.
2. Determine if a no-till alfalfa stand is more successful in previous bean ground or corn ground.
3. Determine if no-till practices improve general soil health, soil biological activity, and soil nutrient retention in comparison to conventional tillage.

2021 RESULTS

Our initial results were rather close in comparison for our first data set. Ten random soil cores were taken from each of the eight field parcels and sent in for the Soil Haney Test. Alfalfa stand counts, biomass production, and oat yield were measured and recorded as shown in the graphs below. This data will be used as the baseline for our research and used as a comparison for the remainder of the project.

A side by side comparison of the alfalfa planting in bean ground. On the left is where the bean ground was tilled prior to planting, and on the right is where the bean ground was no-tilled.

ADDITIONAL RESOURCES

Land Stewardship Project's Ear to the Ground Podcast, Episode 267,
www.landstewardshipproject.org/podcast/ear-to-the-ground-267-bringing-science-back-to-the-farm

Alfalfa Stand Assessment,
www.fyi.extension.wisc.edu/forage/alfalfa-stand-assessment-is-this-stand-good-enough-to-keep

Checking in on those new alfalfa seedings,
www.hayandforage.com/article-2671-checking-in-on-those-new-alfalfa-seedings.html

Evaluating Alfalfa Stands Part 1,
www.cropwatch.unl.edu/2020/evaluating-alfalfa-stands-part-1-using-hay-square-method

A side-by-side comparison of no-till (left) vs. tilled (right) oats and alfalfa seeding in July 2021. Both fields grew very well, and it was difficult to distinguish any major differences in apparent growth at this time.

Expanding the Effectiveness of Non-Chemical Pest Control in Organic Strawberry Production

Principal Investigator

Grantee: Andrew Petran

Organization/Farm: Twin Cities Berry Company

Email: a.petran@tcberries.com

County: Dakota

Project Duration

2021-2023, 2 years

Award Amount

$22,349.47

PROJECT SUMMARY

In addition to their high cost and questionable effects on pollinator health, organic sprays are proving an unfit solution to effectively control the recent increases in pest, disease and environmental pressures facing organic small fruit farms in the Upper Midwest. However, non-chemical management alternatives are beginning to show promise for local fruit production. Our farm has observed significantly higher total and marketable organic strawberry yields under insect netting compared to open field controls that are managed with traditional organic sprays. This is mostly due to the complete physical exclusion of pests. However, the netting could not protect against disease and rains in 2019, the wettest water year in Minnesota since recording began in 1871. Our project compares our current netting against a new hybrid net/plastic system that can cover more area than a traditional high tunnel at a lower cost, exclude pests and potentially also reduce disease, all without using sprays.

PROJECT DESCRIPTION

The idea for this project began as part of the mission of Twin Cities Berry Company - designing and researching high yield, environmentally benign cultural practices that are resilient against the increasing environmental pressures of climate change. We strive to make organically approved small fruits that are not reliant on sprays to combat growing pest and disease pressures in the Upper Midwest. We successfully tested the use of insect netting for multiple years (www.youtube.com/watch?v=JTSkQI9mt4k) and were happy with its performance as a non-chemical practice to significantly reduce pest pressures in strawberries. However, the netting was unable to combat the increased disease pressures that are becoming more prevalent in the open field. Therefore, we designed this project to test insect netting (resistant to pest pressure) against caterpillar tunnels modified for pest exclusion (resistant to both pest and disease pressure). This two-year project is ongoing and is proposed to determine if the increased costs of tunnel production are benefitted by increases in total and marketable yields compared to netting production.

The project was initially slated to begin in the 2020 field season, but due to COVID constraints with suppliers we pushed the project back by one year. We completed the first year of the project in 2021 and will follow through with year two in the 2022 field season.

OBJECTIVES

1. Test and demonstrate effectiveness and profitability of improved exclusion environments for local strawberry production.
2. Measure environmental benefits of our proposed system by documenting every spray event in each plot (current and proposed) and comparing those to average spray events in an open field system, based on previous documentation of spray events in open field plots at our farm in 2018 and 2019.
3. Compare labor energy savings by documenting total construction time in labor hours for each system and comparing it to labor hours needed to maintain open field plots, such as spray events and walkway maintenance through mowing or weed whacking.

Exterior of 2020 tunnel modified for pest exclusion (left); Interior of 2020 tunnel, harvest on November 11, 2020 (right).

EVALUATION

We are evaluating our project by measuring total and marketable yields, number of spray events and construction time of the netting and tunnel treatments in 2021 and 2022. The data collected will also be compared against historical yields and spray events in our open field plots in 2019. With this data we hope to demonstrate if modified caterpillar tunnels can be a viable method of small fruit production that is resilient against increasing climate instability for small farmers.

2021 RESULTS

In 2021 we constructed four 16-foot by 100-foot Gothic Pro Caterpillar Tunnels acquired from Farmers Friend and modified them for insect exclusion by constructing netted endwalls on each tunnel. Each tunnel contained approximately 900 plants, with three 100-foot flat beds, each bed containing three rows of strawberries planted at 12-inch spacing.

The netting treatment consisted of approximately a half-acre of raised bed plasticulture strawberries; 14 beds of 220-foot length, at 5-feet bed spacing and each bed containing two rows planted in a staggered-row formation at 12-inch plant spacing. Construction of the netting consists of a perimeter of 2-inch galvanized steel poles, 10-foot length placed 3-feet into the ground at 15-foot pole spacing. The interior poles are PVC to reduce overall cost, and polyamide wire is strung among all poles to form a grid support system for the top of the netting. The net is then pulled over the entire plot, supported by the poles and wires, and held in place with sandbags around the perimeter of the field. Videos documenting the construction process were made for the project, uploaded to the Twin Cities Berry Company YouTube page, and can be found here:

- Insect netting for spray-free pest control on fruits and veggies, www.youtube.com/watch?v=JTSkQI9mt4k
- Installing pest exclusion netting to a strawberry field, www.youtube.com/watch?v=m79ob9CsrtY

Yield

Summary statistics for total and marketable yields can be seen in Table 1.

Table 1. Total and marketable yields of caterpillar tunnel and netting treatments, 2021.

	Total Yield (lbs)	Yield (lbs/plant)	Yield (lbs/sq. ft)	Average % Marketable Yield
Tunnel 1	287.25	0.33	0.18	81.49
Tunnel 2	341.16	0.39	0.21	84.48
Tunnel 3	236.94	0.25	0.15	84.98
Tunnel 4	111.75	0.13	0.07	81.33
Net	2184.25	0.75	0.14	83.41

By looking at total and per plant yields, it appears that the netting treatment resulted in significantly higher and more beneficial yields compared to the tunnels, making the extra cost of the tunnels unviable. However, it must be considered that planting within the tunnels has a considerably higher density than what is possible inside the net. This is due to being able to utilize flat bed plasticulture instead of a raised bed, meaning three

rows of plants can be placed within each bed row instead of two (Photo 1). Measuring total yield on a per-foot basis instead of per-plant controls for this difference in planting density, and Table 1 shows that analyzing the yields this way shows a total yield advantage in three out of the four tunnels compared to the netting treatment. Percent marketable yield was high among all treatments.

2021 environmental considerations must be made when looking at the yield data in Table 1. First, temperatures were incredibly high, especially at the beginning of the field season, including several days with highs above 100 degrees Fahrenheit in May and June and many more above 90 degrees Fahrenheit. These high temps caused over 80 percent of the first flush of flowers to abort, resulting in suppressed early-season yields, especially among the tunnel treatments where temperatures were even higher. It can be assumed that in seasons with more normal, lower early-season temperatures, total yields would be considerably higher.

2021 was one of the driest growing seasons in Minnesota history; a stark contrast to the 2019 season which was the wettest on record. It can be assumed that in years with more precipitation the disease pressure in the netting treatment would be higher, leading to a greater separation in average percent marketability between the tunnel and net treatments. If 2022 has a more normal precipitation we may observe this separation.

Finally, we believe that a stark difference in soil quality can explain a large amount of the difference in yields among the tunnel treatments seen in Table 1. The soil these strawberries are growing in is of poor agricultural quality, being classified as pastureland by the MDA. Specifically, the soil where Tunnel 4 was located has a crop productivity index of 31 out of 100, likely leading to its poor yield performance observed in Table 1. In better quality soils it can be inferred that higher yields with lower variability could easily be achieved.

Spray Events

Each tunnel and the netting treatment was sprayed exactly three times throughout the 2021 field season, for an average of 0.125 spray events per week. This is considerably less than the one to two sprays per week frequency needed to maintain completely open field management on the same plot as recorded in the 2019 field season. It can be inferred that both the netting and tunnel treatments offer value as a strong non-chemical control option for pest management in small fruits. Sprays utilized were Pyganic 5.0 mixed in a backpack sprayer, applied at the rate of 3 ounces Pyganic per acre for every spray event.

Labor/Energy

Total labor time for constructing and maintaining the modified caterpillar tunnels and netting will be compiled and compared at the conclusion of the 2022 field season. Preliminarily we can state that the tunnels take more time to initially construct, while the netting takes more time to maintain throughout the season. The tunnels also provide greater resilience against high winds than the netting treatment, something many growers must consider when growing within the windy prairie lands of the Upper Midwest.

Growing and Evaluating Perry and Dessert Pears on a Tall Spindle System

Principal Investigator

Grantee: Gretchen Perbix
Organization/Farm: Sweetland Orchard LLC
Email: sweetlandorchard@gmail.com
County: Scott

Project Duration

2020-2022, 3 years

Award Amount

$22,593.70

PROJECT SUMMARY

The purpose of this project is to establish, grow, and evaluate a high-density dessert and perry pear planting (perry is the pear equivalent of fermented cider). Although pears have been historically grown in Minnesota, they are rarely grown at high densities with the commensurate higher yields and greater profits. The project will commence in spring 2020 with a planting of 300 pear trees on the OHF87 semi-dwarfing rootstock and will include 10 dessert varieties and eight perry varieties. A five-wire trellis will be constructed to support aggressive training of the pears in an attempt to limit size and induce precocious fruiting. The trees will be trained and managed in 2020, 2021, and 2022. The project will evaluate hardiness, growth, disease, and yield.

PROJECT DESCRIPTION

The purpose of this project is to establish, grow, and evaluate a dessert and perry pear high-density planting. The project will be assessed in terms of hardiness, growth, disease, and yield. Key findings will indicate if the rootstock/variety combination is hardy, how well the trees are suited for the tall spindle high-density system, and if the trees yield a crop in year three.

This project is important because pears are not usually planted on a high-density system, though there seems to be promise in doing so (Robinson, "High Density Pear Production: An Opportunity for New York Growers"). This project can provide a proof of concept and a feasibility study for Minnesota apple and pear growers. Since a number of pear varieties are hardy in Minnesota – including those varieties developed by the University of Minnesota – the key takeaway points for growers will be in the hardiness of rootstock that many haven't yet worked with, how well the planting worked in the high-density system on a trellis, and the hardiness of varieties not commonly grown in Minnesota.

Demonstrating rootstock hardiness is important and has been a key limiting factor to the expansion of pear growing. An eight-year project in New York state demonstrated the hardiness of the OHF87 rootstock being used in this project (Robinson). New York is not Minnesota, however, and so a documented project in Minnesota will help growers better understand their risks in using this rootstock.

Demonstrating the feasibility of the tall spindle planting system is important too. Tall spindle systems crop earlier and harvest higher yields. For example, the aforementioned New York project had an eight-year cumulative yield of 1,000-2,000 bushels of Bosc pears on a low-density central leader system (242 trees per acre) contrasted to 3,000-3,800 bushels of Bosc pears on a high-density tall spindle system (908 trees per acre).

The timing of the project is significant because the growing cider industry provides a new consumer for pear crops. Cidermakers and distillers are currently importing pears and pear juice from out-of-state. Since the law specifies that cidermakers use a majority of Minnesota-grown produce to sell cider in a retail operation, Minnesota-grown pears will be a valuable crop to this industry.

Growers accustomed to operating an apple orchard can easily add pears to their operations since most growing principles and management practices are the same. For those interested in permaculture in general and new to perennial fruit tree crops, pears are a relatively uncommon specialty crop with excellent marketing possibilities.

OBJECTIVES

1. To evaluate the tall spindle growing system for pears, which is characterized by the following attributes: planting large, feathered trees; row spacing of 12 to 14 feet; tree spacing of 3 to 4 feet; and use of dwarfing or semi-dwarfing rootstocks. Pears grown in Minnesota are not being grown in high-density systems and so the first objective is specifically to assess rootstock hardiness and if the close spacing of the trees provides a sufficiently dwarfing effect.
2. To evaluate a number of pear varieties in terms of suitability for Minnesota. In particular, perry pear varieties are unproven in the state. Perry varieties that will be evaluated include Barland, Blakeney Red,

Brandy, Butt, Gin, Normanishen Ciderbirne, Thorn, and Yellow Huffcap. Dessert varieties that will be evaluated include Bierschmidt, Blake's Pride, Dabney, Gourmet, Harvest Queen, Luscious, Magness, Sanguinole, Sucree de Montlucon, and Summercrisp.

DESIGN

The pears will be planted in an 80-foot x 300-foot section of the orchard that has been prepared for planting.

All pears will be planted on the OHF87 rootstock, which is semi-dwarfing and cold hardy. Trees will be planted in a tall spindle system. Row spacing will be 12 feet. In-row spacing will be 3 to 4 feet.

Table 1. Pear variety, type, and whether Minnesota hardiness is known.

Number	Pear Variety	Type	Minnesota Hardiness
4	Summercrisp	Dessert	known
4	Sanguinole	Dessert	unknown
4	Dabney	Dessert	unknown
4	Luscious	Dessert	known
4	Magness	Dessert	known
4	Harvest Queen	Dessert	known
4	Bierschmidt	Dessert	known
4	Sucree de Montlucon	Dessert	unknown
4	Blake's Pride	Dessert	unknown
32	Gourmet	Dessert	known
4	Beurre Giffard	Dessert	Known
4	Romanian	Perry	unknown
24	Blakeney Red	Perry	unknown
24	Brandy	Perry	unknown
24	Normanishen Ciderbirne	Perry	unknown
12	Thorn	Perry	unknown
36	Yellow Huffcap	Perry	unknown
24	Butt	Perry	unknown
24	Gin	Perry	unknown
24	Barland	Perry	unknown

To accommodate topographic variations in the site, the placement of all of the pear varieties except Gourmet have been randomized by row. Gourmet, as an exception, will be planted in each environment (high, middle, and low elevation). Tree 13 in each row serves as a control and will not be measured as part of the dataset.

EVALUATION

The first objective of the project is to evaluate the tall spindle growing system for pears, specifically to assess OHF87 rootstock hardiness and if the close spacing of the trees provides a sufficiently dwarfing effect.

To evaluate rootstock hardiness, I will observe the trees in spring to early summer to note tree death and to measure tree dieback.

To evaluate the tall spindle system, I will measure the trees in two ways: trunk cross-sectional area and height. I will measure the shortest and tallest trees of each variety per row and, from these measurements, will be able to address this growing system for the trees' ability to fill, but not exceed the space allotted to them.

The second objective of the project is to evaluate the suitability of pear varieties for Minnesota. Perry varieties that will be evaluated include Barland, Blakeney Red, Brandy, Butt, Gin, Normanishen Ciderbirne, Thorn, and Yellow Huffcap. Dessert varieties that will be evaluated include Bierschmidt, Blake's Pride, Dabney, Gourmet, Harvest Queen, Luscious, Magness, Sanguinole, Sucree de Montlucon, and Summercrisp.

To evaluate hardiness, I will observe the trees in spring to early summer to note tree death and to measure tree dieback.

To evaluate disease, I will scout the planting once per week during the growing season for disease concerns. If potential disease is noted, I will diagnose it and, if needed, send it to the University of Minnesota's plant pathology lab for diagnoses.

To evaluate the growth of the varieties, I will measure the trees in two ways: trunk cross-sectional area and height. I will measure the shortest and tallest trees of each variety per row and, from these measurements, be able to address this growing system for the trees' ability to fill but not exceed the space allotted to them.

Finally, at the end of the third growing season, I will measure each tree's fruit production in terms of fruit count per tree and total harvest weight per tree.

2021 RESULTS

No results yet. We will have project results in 2022.

Trialing High Tunnel Raspberries to Increase Yield and Reduce Spotted Wing Drosophila Pressure

Principal Investigator

Grantee: Aaron Wills
Organization/Farm: Little Hill Berry Farm
Email: info@littlehillberryfarm.com
County: Rice

Project Duration

2020-2022, 3 years

Award Amount

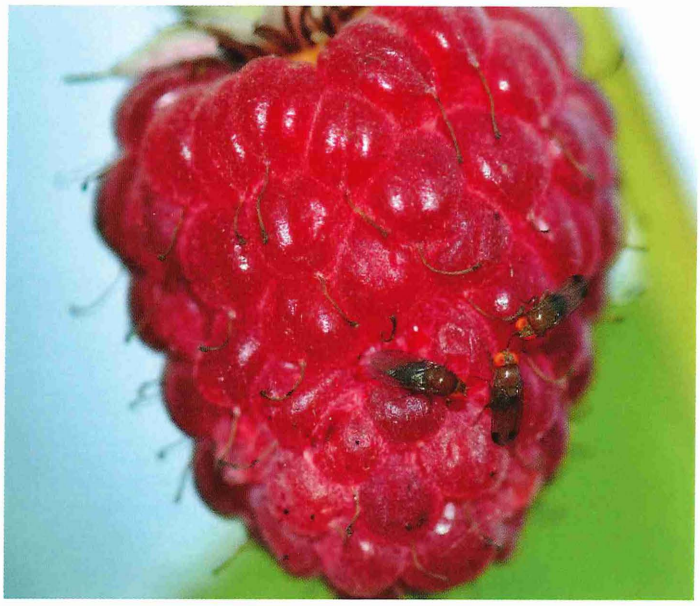
$17,535.00

PROJECT SUMMARY

This project will test and demonstrate the benefits of growing raspberries in a high tunnel versus traditional open field growing. (A high tunnel is a hoop structure with plastic over the top and sides to protect the plants.) Our goal is to determine if high tunnel raspberries produce greater yield compared to traditional open field raspberries and if pest pressure, specifically Spotted Wing Drosophila, is reduced. Currently the Spotted Wing Drosophila (an invasive fruit fly) is a significant challenge for growing raspberries in Minnesota. According to data gathered by the University of Minnesota, in 2017 raspberry growers in Minnesota lost $2.3 million in sales to Spotted Wing Drosophila damage. We will trial four different raspberry varieties, growing them in both a high tunnel and in adjacent open field production. The information from this project will allow Minnesota growers to assess whether high tunnel-grown raspberries justify the added expense of building a high tunnel for raspberry production.

OBJECTIVES

1. Determine if growing raspberries in a high tunnel increases yield over traditional field-grown raspberries and which of the four popular varieties we trial will benefit the most.
2. Determine if Spotted Wing Drosophila populations and fruit infestation are reduced in high tunnel raspberries versus traditional field-grown raspberries.



Spotted Wing Drosophila on raspberry (photo courtesy of UMN Extension).

DESIGN

We planted five varieties of primocane fruiting raspberries (fall-bearing raspberries) in both the high tunnel and open-field rows that are located right next to the high tunnel in the spring of 2019. The varieties we planted are Polana, Joan J, Anne, Crimson Night, and Crimson Treasure. Each of the five varieties will be in two plots in both the high tunnel and the open field to ensure that results aren't skewed due to better soil or better care in one part of the high tunnel or open field versus another.

2021 RESULTS

This was the second year of our project. However, it was the first year for harvesting raspberries and being able to compare yield and Spotted Wing Drosophila pressure in the high tunnel raspberries versus raspberries grown outside. Overall, the yields in the high tunnel were nearly 2.5 times higher! We harvested the equivalent of 1,365 one-pint clamshells (0.5 pounds each) in the high tunnel versus 574 from the outside rows.

Here are some factors that contributed to the dramatic yield advantage for the high tunnel versus outside:

1. The number of canes in the high tunnel is much higher. Even after thinning canes, there was approximately double the number of canes per row-foot in the high tunnel.
2. Harvest started in the high tunnel July 27, 2021, compared to outside, which started on August 23. Each variety started yielding three to four weeks

High Tunnel with raspberry plants.

earlier in the high tunnel. Starting harvest for each variety three to four weeks earlier provided a longer harvest window before the fall freeze that ends berry harvest, which happened around October 22.

3. In the outside rows, significant yield was lost due to damaged berries. Damage is caused by mold or soft berries from morning dew, wind blowing berries off the canes, and Japanese beetles. The high tunnel mitigates all these issues. I estimate that there were 1.5 times as many overall berries produced in the high tunnel, but as stated above, marketable yield was 2.5 times higher in the high tunnel because some yield was lost to damaged berries.

There are some challenges with the high tunnel that are worth noting. For harvesting, it gets very hot. We would try to be done harvesting in the high tunnel by 10 a.m. because we found that after this time it would be uncomfortably hot inside (even with the sides rolled up and the ends open). On our farm we found that bee activity is really high in raspberries. Outside there is a lot more space for bees and people to coexist, but in the high tunnel you are in very close quarters. For some of our employees it was uncomfortable to be harvesting in the tunnel after 10 a.m. because as the temperature warmed up bee activity increased.

Pest Pressure

Overall, 2021 was a lower pressure Spotted Wing Drosophila year on our farm. However, we still saw Spotted Wing Drosophila pressure in the raspberries. Our general observation was that Spotted Wing Drosophila pressure was about half as much in the high tunnel versus outside.

Japanese beetles were a more significant pest this season than Spotted Wing Drosophila. We tried the bio-insecticide "beetleGONE!" in 2020 and found it ineffective. The beetles just kept coming! We resorted to hand picking beetles off the plants. We would do it two to three times per week. While effective, it was very labor intensive. Japanese beetle pressure was significantly less in the high tunnel. As opposed to picking outside two to three times per week, we would only pick beetles once per week in the high tunnel. At the end of the 2021 season, we trialed using a small handheld ShopVac to suck the beetles off the plants. This was very effective and much quicker, so we plan to trial this as a primary management strategy in 2022.

Variety Data and Observations

Our highest yielding variety both in the high tunnel and outside was Polana. Next was Joan J, Crimson Night, and then Anne. The lowest yielding variety by a significant

amount was Crimson Treasure. The order of highest to lowest yielding varieties was the same in the high tunnel and outside.

Polana is the earliest of the four varieties. The canes are strong and so it needs less trellis support and is easier to harvest. It was the highest yielding variety. The flavor is good, but not as good as the other varieties.

Joan J. has fantastic flavor. The canes are very floppy, which makes it hard to keep contained in a trellis and hard to harvest. We had mold issues in the outside rows, which floppy canes likely contribute to because the plant falls in on itself and so the berries do not dry out from the sun and wind. The floppy canes also made it the most difficult to harvest.

Crimson Night is one of the newest varieties in Minnesota. The flavor is wonderful and the berries are very attractive. The canes are strong so it grows upright and is easy to harvest. Its only downside is that it has significant thorns. Some of our employees did not like to harvest it because of the thorns.

Anne, like Joan J, is very floppy. It also had mold issues outside (and a small amount of mold in the high tunnel). The flavor is nice and many customers really like having some yellow raspberries mixed in the container. It did not perform as well in the high tunnel as the other varieties. Outside, its yield was similar to Crimson Night, but inside the high tunnel it was 25 percent less than Crimson Night.

Crimson Treasure is another new variety to Minnesota. It has possibly the best flavor of all the raspberries we are trialing. It also is shorter, almost bushy, which makes it very easy to harvest. However, it is probably too late of a variety for Minnesota. We didn't start harvesting it until September 3, 2021 in the high tunnel and September 29 outside. Consequently, its yields were much lower than the other varieties.

Based on one year's data and observations, I would recommend Polana, Joan J, and Crimson Night for high tunnel growing. I would recommend Polana and Crimson Night and possibly Anne for growing outside.

ADDITIONAL RESOURCES

For anyone interested in growing raspberries in a high tunnel, I would recommend the Michigan State Extension Bulletin Organic Raspberry Production in Three Season High Tunnels and the High Tunnel Production Guide for Raspberries and Blackberries 2019 published by Tunnel Berries (a group of universities including Michigan State, Cornell, the University of Minnesota, etc.).

On-Farm Research on Haskap/ Honeyberry Production

Principal Investigator

Grantee: Philip Stowe
Organization/Farm: Walking Plants Orchard
Email: phil@walkingplants.com
Counties: Carlton, Douglas, Washington

Project Duration

2021-2023, 3 years

Award Amount

$16,500.00

PROJECT SUMMARY

Haskaps or honeyberries are a new crop for Minnesota fruit producers. Over three years, the project will gather and compare production data from three different farms. The farms are in three different Minnesota locations: west-central, east-central, and northeast Minnesota. Cultivar yields and other production data will be collected and compared.

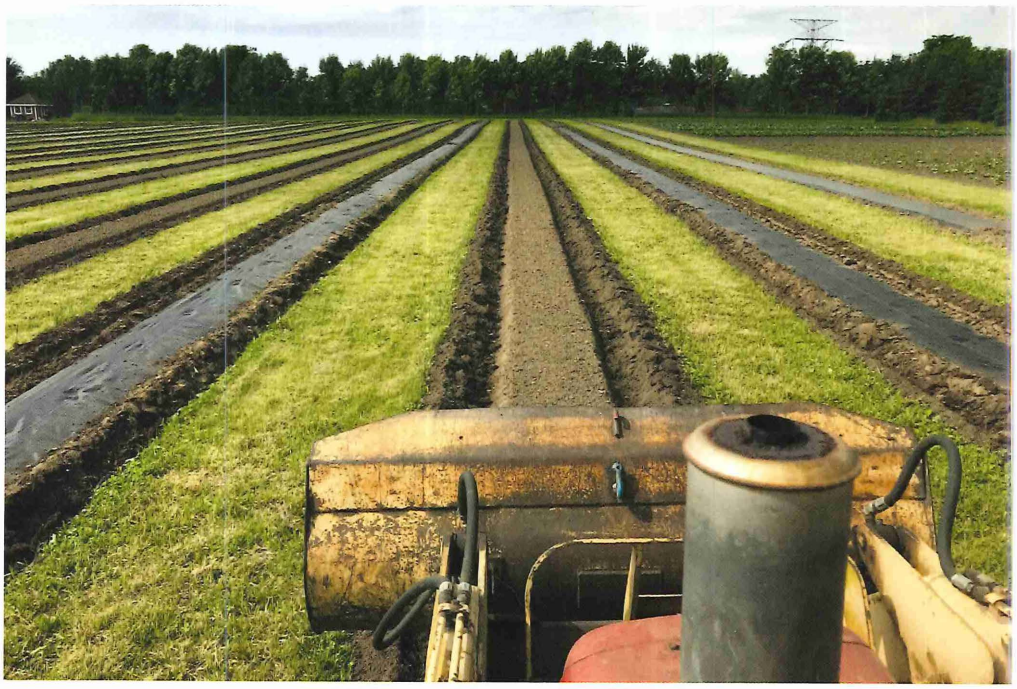
PROJECT DESCRIPTION

The haskap species is circumboreal with many of the plants being introduced to North America having origins in Russia or the northern islands of Japan. The name "haskap" is derived for the Japanese word for the crop. The name "honeyberry" refers to the fact that the species is a type of honeysuckle. The small, dark blue fruit are acidic and intensely flavored. The earliest cultivars ripen in June, before strawberries, and provide growers the opportunity to sell local fruit when there are few alternatives. Some cultivars ripen in mid to late July.

Honeyberries thrive in Zone 3 and are one of the few fruit crops with frost tolerant flowers. As with all crops, growers are trying to develop the most efficient growing techniques and ways to increase their yield. Minnesota honeyberry growers lack yield data for our area. If yields are lower than expected, we do not know if the low yields are due to poor growth, poor flower formation, poor pollination, or fruit loss prior to harvest. Honeyberry growers do not know how often the plants should be irrigated. There are a dizzying number of cultivars that produce differences in flowering time, pollination compatibility, fruit size, fruit shape, yield, flavor, ripening times, and growth habit.

Three established honeyberry growers from three different growing regions in Minnesota are participating in this project. Walking Plants Orchard is near the town of Osakis in central Minnesota and has eight cultivars on 1.5 acres with a silty clay loam soil. Haskap Minnesota is near Stillwater and has two cultivars on 2 acres with a silt loam soil. Farm Lola is near the town of Wrenshall in northeast Minnesota and has 14 cultivars on 11 acres with a sandy loam soil. All three farms have blocks that are mature enough to record production data starting with the 2021 growing season.

Being a new crop, we are hoping to learn more about fertilizing, irrigating, and harvesting honeyberries. Soil tests were taken at all three sites. Throughout the summer, leaf samples were taken and sent to Midwest Laboratories for tissue nutrient analyses. We wanted to see if there was a relationship between soil and leaf nutrients. Weather stations from Spectrum Technologies were installed at all three sites to record temperature, relative humidity, dewpoint, and soil moisture throughout the growing season.



Installing weed barrier for new orchard rows at Haskap Minnesota.

To record yield, a subset of cultivars of roughly the same age were selected for the study at each participating farm. Haskap Minnesota recorded yields on the cultivars Beauty and Beast planted in 2018. Walking Plants Orchard recorded yields on Beauty, Beast, Blizzard, and Honeybee planted in 2018. Farm Lola recorded yields on Aurora planted in 2016, Blue Banana planted in 2019, and Strawberry Sensation planted in 2019. All three farms recorded the amount of time spent harvesting.

Overhead Smartnet system, Indigo Supertek Waxwing Harvester, three-year-old haskap, and three-year-old Lydia.

2021 RESULTS

Yield was calculated by dividing the total pounds harvested for a cultivar and dividing it by the number of plants. For 2021, yields varied from 0.32 to 2.2 pounds per plant. Yields were similar at Walking Plants Orchard and Farm Lola, while yields at Haskap Minnesota were lower. As expected, older plants produced more than other plants. Differences in yields between cultivars are expected. We will have more comparison data in 2022. The highest recorded yield was on a row of Indigo Gem planted in 2014 at 3.5 pounds per plant.

Table 1. Yield of different cultivars in 2021.

Orchard	Cultivar	Year Planted	Lbs/ Plant
Farm Lola (Wrenshall)	Aurora	2016	2.2
Farm Lola	Blue Banana	2019	0.80
Farm Lola	Strawberry Sensation	2019	0.85
Walking Plants (Osakis)	Blizzard	2018	0.93
Walking Plants	Beauty	2018	1.22
Walking Plants	Honeybee	2018	1.97
Walking Plants	Beast	2018	1.29
Haskap Minnesota (Stillwater)	Beast	2018	0.32
Haskap Minnesota	Beauty	2018	0.32
Walking Plants	Aurora*	2015	2.16
Walking Plants	Indigo Gem*	2014	3.54

**T Plants were not officially part of the study.*

Most of the plants we are monitoring in this study were in the ground approximately three years in 2021, we expect the yields to increase over the next two years. One objective of this project is to compare production data and identify opportunities that may increase yield.

Poor pollinator activity does not appear to explain the difference in yields between farms. All three of us walked the fields during bloom to look for bees, and we all found about four large bumblebees as well as numerous smaller bees and honeybees. We will continue to monitor pollination patterns in coming years.

Bumblebees appear to be one of the best haskap pollinators.

Overall, 2021 precipitation was close to average at all three sites, but there was a severe drought during the growing season that hurt the plants. In Osakis, the drought peaked in May and June, while in Wrenshall the drought peaked in August. Like all trees and shrubs, honeyberries do almost all their growing in early summer, and the early season drought is a bigger problem than a late season drought. Early season drought can hinder berry growth and slow the growth of the canes, which could cause crop reductions in future years. In Spring 2022, we will measure cane growth to see if there are any noticeable differences between locations.

Table 2. Rainfall (in inches) at the three sites during the 2021 growing season.

Farm	April	May	June	July	August	Total
Osakis	3.88	0.86	1.54	1.81	5.07	13.16
Stillwater	3.13	2.96	1.95	1.37	6.72	16.13
Wrenshall	3.08	2.63	2.55	1.77	2.77	12.80

In 2022 and in 2023, we will continue to monitor rainfall and compare shoot growth, plant size, and blossom set between the farms.

Other than birds, honeyberries have few major pests. Each farm has different bird protection. Walking Plants Orchard uses over the row netting. Haskap Minnesota has installed overhead netting. Farm Lola uses sonic deterrence aimed toward nearby trees.

Mildew is the only disease seen in Minnesota, however, none of the farms had powdery mildew prior to harvest. The Blizzard cultivar in Osakis had more mildew on the leaves after harvest than other cultivars. There has been similar mildew on the Aurora leaves in past years but didn't seem to affect the next year's crop.

Haskap Minnesota reported an infestation of a scale insect, which appears to be a species of Lecanium scale, most likely Parthenolecanium corni. The scale is weakening the plants and we will try to control it in 2022.

Most Haskap cultivars ripen before spotted wing Drosophila typically becomes a problem. All three farms have cultivars that ripen in mid-July, when spotted wing Drosophila numbers are peaking. Phil at Walking Plants Orchard was planning on using exclusion netting to control the flies on late ripening cultivars, but spotted wing Drosophila numbers were extremely low in 2021, probably due to the low humidity, and as a result, none of the three participants lost any crop due to spotted wing Drosophila.

ADDITIONAL RESOURCES

University of Saskatchewan's fruit program, www.research-groups.usask.ca/fruit/Fruit%20crops/haskap.php

LoveHoneyberry, www.lovehoneyberry.com/welcome-to-lovehoneyberry

Honeyberry USA, www.honeyberryusa.com

Tomato Phosphorus Removal Rates with High- or Low-Phosphorus Transplant Solutions and Grafting

Principal Investigator

Grantee: Charlie Rohwer
Organization: University of Minnesota
Email: rohw0009@umn.edu
County: Waseca

Project Duration

2021- 2023, 3 years

Award Amount

$24,831.00

PROJECT SUMMARY

Vegetable farmers often use manure and compost for fertility. Soil phosphorus (P) after manure and compost application can become high or even excessive because the ratio of nitrogen (N) to P in these fertilizers is often lower than plants require. Soil P in runoff can become an environmental pollutant. Maintaining soil P at a level useful to crops but below excess levels is important in limiting P pollution. In previous research, we found that when soil P was adequate for healthy plant growth, adding inorganic P at transplant using water-soluble fertilizer increased tomato yield. The primary hypothesis for this project is that adding organic P fertilizer in transplant solution will increase the soil P removal rate by a tomato crop through increased yield, even in soils with a history of organic fertilizer or high P. We also hypothesize that generative rootstocks will enhance P removal.

Grafted and not grafted tomato transplants used in this study.

Watering transplanted tomatoes with 'starter' fertilizer.

PROJECT DESCRIPTION

Phosphorus (P) from agricultural land contributes to P pollution in Minnesota waters. Vegetable growers and gardeners often over-apply P fertilizer as compost and manure. Understanding and improving how harvested produce removes P from the soil will help vegetable growers and gardeners to contribute to improved water quality throughout Minnesota.

The University of Minnesota Southern Research and Outreach Center (Waseca, MN) and Dan Zimmerli of Cedar Crate Farm (Waldorf, MN) are collaborating on the project and using both locations as study plots to obtain a more complete data set. Both locations have Webster clay-loam soil, but Cedar Crate has been fertilizing organically and the SROC has not.

OBJECTIVES

1. Test the impact of organic water-soluble 'starter' fertilizer on the amount of P harvested from tomato plants in a full season, considering the amount of P added by the fertilizer; and
2. Test the ability of a generative tomato rootstock to enhance tomato yield and P removal from the soil.

2021 RESULTS

Grafting ('Estamino' rootstock) and seedling production were done by Grafted Growers (Raleigh, NC). Starter fertilizers were Aqua Power 5–1–1 (JH Biotech, Ventura, CA) or Neptune's Harvest 2–4–1 (Neptune's Harvest, Gloucester, MA). Each were diluted and applied to the soil at transplant as 1 cup of solution immediately after transplanting.

The objectives were tested in replicated experiments at the two locations with three tomato variety scions ('Galahad', 'Mountain Fresh Plus', and 'Paisano'). P fertilizer broadcast prior to transplant was in excess based on soil test results and commercial recommendations at both locations. Cedar Crate Farm used 4–3–2 fertilizer from High Island Organics (100 pounds N per acre) and Southern Research and Outreach Center used 8–2–4 Sustane (200 pounds N per acre) with 0–46–0 (22 pounds P per acre).

Fruits at least 30 percent pink were harvested from 1 plant per plot (90 plots total) 5–7 times throughout the summer. For the final harvest just prior to frost, all fruits were harvested. Marketable fruit (no insect or disease damage, minimal scarring or cracking, no blossom end rot) and total fruit were counted and weighed at each harvest. A sample of total fruit from each plant at each harvest was blended and frozen until the end of the season. At that time, the blended samples from each plant were mixed proportionally to the yield from each harvest, then dried for determination of moisture and P content. Dried samples were submitted to the University of Minnesota Research Analytical Lab for determination of P concentration so that P removed from the soil by harvest could be calculated.

The total amount of P removed from the soil (beyond what was added by the transplant solution) was the greatest in 'Galahad' (2.3 grams per plant, 27.4 pounds P per acre) and smallest in 'Paisano' (1.8 grams per plant). This was at least partly due to higher P concentration in 'Galahad' fruit (26.6 vs. 21.8 grams P per 100 grams fresh weight). Yield of all three varieties were similar (16.7 to 17.6 pounds marketable fruit per plant). The type of starter fertilizer used didn't affect P removal from the soil, but grafted plants removed 18 percent more P from the soil than not-grafted plants, with 8 percent higher P concentration in the fruit. Based on our first year of data with tomatoes, grafting with 'Estamino' rootstock and variety selection seem to be effective ways to aid in removal of excess P from the soil.

ADDITIONAL RESOURCES

Nutrient management recommendations for fruit and vegetable crops in Minnesota, hdl.handle.net/11299/197955

Nutrient management for fruit and vegetable crop production: Using manure and compost as nutrient sources for vegetable crops, hdl.handle.net/11299/200639

USDA-funded vegetable grafting portal, with videos, www.vegetablegrafting.org

Ohio State University grafting guide, u.osu.edu/vegprolab/grafting-guide

Control of Wild Parsnip Through Rotational Sheep Grazing

Principal Investigator

Grantee: Heidi Eger
Organization/Farm: Radicle Heart Farm, LLC
Email: radicleheartfarm@gmail.com
County: Houston

Project Duration

2020-2022, 3 years

Award Amount

$18,154.00

PROJECT SUMMARY

Wild parsnip is an invasive species with an exploding population in southeastern Minnesota. Current recommended management strategies include carefully timed mowing and spraying with herbicide. Both methods can be costly, and neither is particularly successful. Organic farmers only have mowing or removal by hand as management options. Heidi Eger of Radicle Heart Farm has a flock of 100 percent grass-fed Katahdin/Dorper ewes that have shown enthusiasm for grazing wild parsnip plants. The purpose of this study is to measure the effectiveness of managed rotational grazing by sheep to control wild parsnip in a perennial pasture. Effectiveness will be judged by monitoring plant populations in grazed plots and comparing populations to control plots.

PROJECT DESCRIPTION

The purpose of this project is to measure the impact of a carefully managed sheep flock on a population of wild parsnip. Wild parsnip is listed as a noxious weed by the Minnesota Department of Agriculture and is on the "Control List." The state says, "efforts must be made to prevent the spread, maturation and dispersal of any propagating parts, thereby reducing established populations and preventing reproduction and spread as required by Minnesota Statutes, Section 18.78." Parsnip is a biennial plant. The first season it emerges early in the spring and grows as a short basal rosette of leaves. The second season it sends up a tall flower stalk. Parsnip spreads by producing many seeds per plant.

Wild parsnip is a growing problem across much of Minnesota, especially in the southeast. It outcompetes desirable species by being one of the first species to grow in the spring. When sap from the plant gets on skin, it causes large burn blisters. Wild parsnip is very hard to control. Mowing is expensive and only moderately effective. Spraying the plant with herbicide is expensive, can result in desirable nearby plants being accidentally killed, and is dangerous to grazing animals. Organic producers can't spray and can only mow accessible areas. If grazing by sheep provides good control of the plant, it would allow land managers an alternative that is beneficial to the environment and their bottom line.

Eger's sheep flock has shown a strong preference for parsnip leaves and frequently eats them before other plants in their paddock. Does grazing a plant two or three times in its first season of growth, plus grazing it as it sends up a flower stalk, weaken the plant enough to reduce the number of seeds blooming? Eger wants to test the hypothesis that sheep can kill some of the young plants through grazing. She also wants to see if trampling can weaken the surviving plants enough that the flowers will produce fewer, smaller, and thus lower quality seeds.

This project will benefit farmers in three ways. First, it would answer the question of whether sheep can impact parsnip populations over two grazing seasons. Second, it would give organic farmers who are unable to spray an effective management tool. Third, it would give sheep producers the option to get prescribed grazing contracts. This option would be especially powerful for beginning farmers without access to land. If shepherds were able to get paid to graze, rather than paying for access to pasture, it would allow them a faster way to a profitable, stable farm business.

METHODS

One 5-meter by 5-meter monitoring plot in each grazing paddock will be established. Monitoring plot location will be chosen strategically so that there is a similar population of parsnip and, as much as is practical, slope,

soil type, and surrounding vegetation. Three ungrazed control plots of 5-meters by 5-meters will also be established and monitored. Plants will be counted at the beginning of the grazing season and on a day during the blooming season.

Sheep will be in each paddock long enough to graze it evenly. This project will test only how sheep control the plant by choosing to graze it. Heidi will not make any effort to force the sheep to overgraze the parsnip. Much of the literature lists parsnip as toxic. Heidi's sheep show a preference for the plant so she is trusting that they know what they can eat. In 2019, she observed no signs of illness in her sheep and the entire season the flock continued to eat parsnip plants before other things in the pasture. She is still careful to give them paddocks with plenty of variety and to move them before all the available food is eaten.

2021 RESULTS

Parsnip rosettes were counted in May before grazing in both 2020 and 2021. Based on these counts, there appears to be a decrease in basal rosettes in the grazed plots. Based on additional observation, there were far fewer parsnip seedlings in the test plots than the control plots.

Ewe stands by stripped parsnip stalks with her lambs, June 2021.

In 2020, the plots were grazed every six weeks. In 2021, the plots were grazed only in the spring and in the fall. At the height of the summer and the height of the drought, a number of the ewes and lambs started to develop skin irritation on their ears and noses. The study cooperator, Dr. Charlie Wray, came out to inspect the flock. In his professional opinion, the afflicted sheep had severe sunburn. Only sheep that had been brought in from a new breeder were affected. As a result of the sunburn, the sheep were moved to graze under the shade of the trees instead of grazing the test plots when the plants were in full bloom. After a few weeks in the shade, the sheep's skin had healed. They returned to grazing areas with parsnip and had no further signs of sunburn. It is the vet's hypothesis that the parsnip caused the sunburn, but there was no way to tell for sure. It is possible the drought made the plants produce more of the phototoxic chemicals (furanocoumarins) or the new sheep may have had less genetic resistance or less built-up resistance to the plant than the original flock of sheep.

Some other items of note: During the summer, the valley where the sheep were grazing was rented land also being grazed by another farmer's herd of goats. The goat herd accidentally grazed a portion of Test Plot 2 since it was on the edge of the woods. In early spring, a hired forestry mower accidentally scraped down to the soil on Test Plot 3 even though it was 50 feet from the mowing area. In addition, there was inadvertent UTV (utility task vehicle) damage through all three control plots. As a result of this, there is no replicate data for the test plots.

At all plant stages, the sheep chose to eat the parsnip before eating anything else in their paddock. When the plants are in bloom, the sheep will eat every leaf and flower. The sheep had an impact on the parsnip plants, but there weren't end-of-season quantitative measures of what that impact was.

Determining the Effects of Prescribed Sheep Grazing on Species Diversity and Density in Restored Pollinator Habitat

Principal Investigator

Grantee: Jake Janski, Jeremy Gilbertson

Organization/Farm: MNL (formerly Minnesota Native Landscapes)

Email: Jake.Janski@MNLcorp.com, jgilber5@gustavus.edu

Counties: Chisago, Stearns, Wright

Project Duration

2020-2023, 3 years

Award Amount

$25,137.50

PROJECT SUMMARY

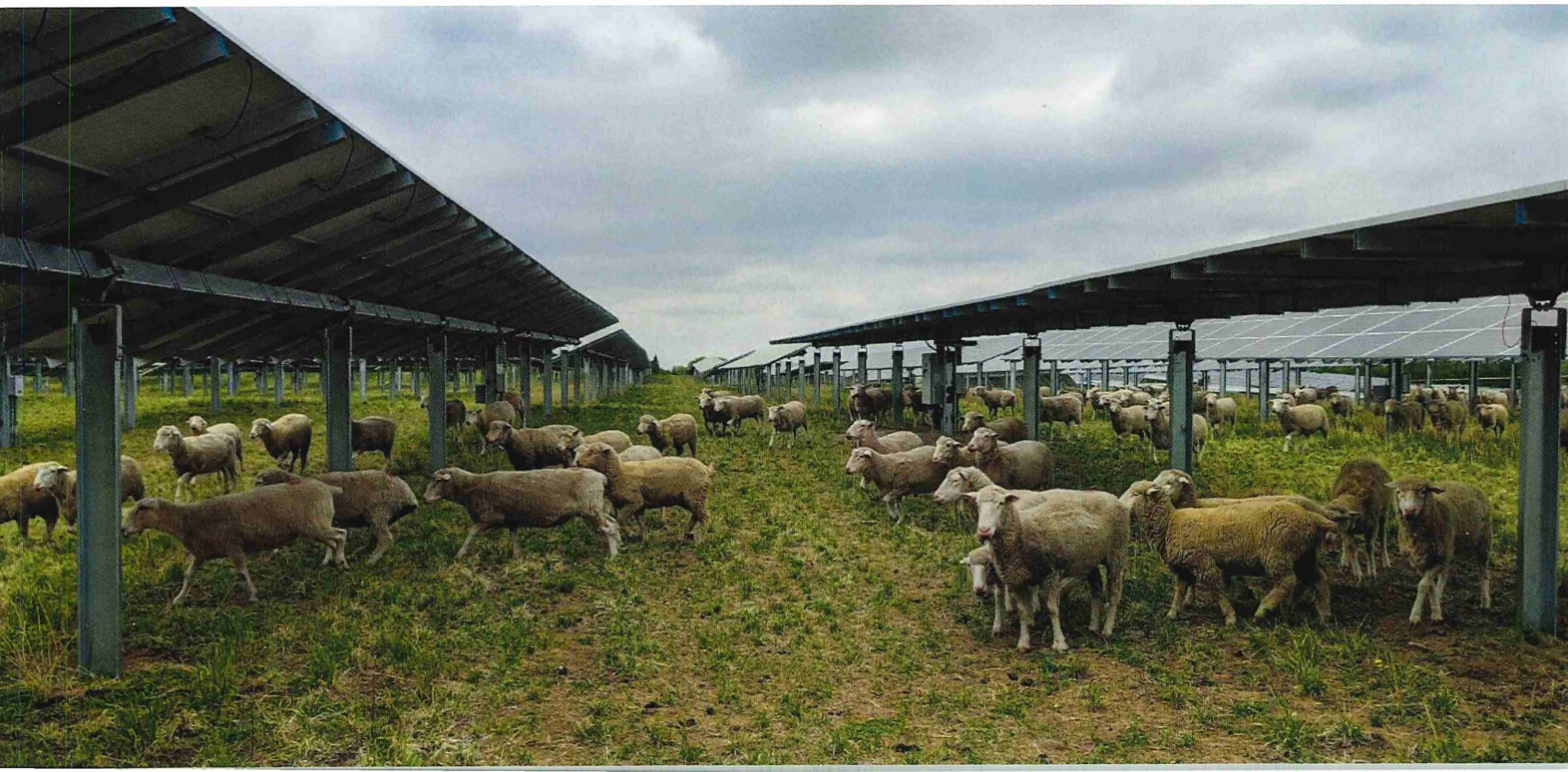
This project seeks to explore prescribed sheep grazing as an alternative management method for planted pollinator-friendly prairie on operational solar farms. Grazing has been shown to effectively control vegetation height at acceptable levels, but we wish to identify the effects of prescribed grazing on plant species diversity and overall prairie health within solar sites. We know that high-intensity, low-duration grazing can improve overall plant vigor in large pasture settings, but this practice has yet to be tested in pollinator habitat-friendly solar sites.

PROJECT DESCRIPTION

Due to public awareness, permit conditions, and other market factors, pollinator-friendly prairie installations on solar production facilities are increasing. While the prairie provides excellent habitat for birds and pollinators, prairie plants can exceed acceptable heights under solar panel arrays when left unmanaged. While mechanical cutting and herbicide applications sufficiently control plant growth, we seek to employ prescribed sheep grazing as a sustainable management method to provide an eco-friendly and cost-effective alternative. While prescribed sheep grazing has been shown to effectively control vegetation height, its effects on prairie plant species diversity in a controlled, enclosed area is unknown in this setting. As a restoration company, MNL strives to provide innovative, sustainable, and efficient management solutions for our clients while promoting healthier ecosystems. Research on larger ungulates such as bison and cattle have shown that prescribed grazing does increase prairie plant diversity. This study will evaluate sheep grazing on those same natural principles.

Six active, utility-scale solar power generation sites managed with sheep grazing were planted with pollinator-friendly native seed mixes. Each site has been actively managed with a variety of techniques for at least four full growing seasons and is considered properly established. Sample transects were established in plotted areas of each site and subjected to grazing in 2020 and 2021. A replicated set of transects were established within ungrazed control plots, isolated using electric

Demonstrating the effectiveness of sheep grazing for solar vegetation management. Sheep will reliably graze native and invasive forbs, including thistle, to manageable levels.



A clear look at grazed and ungrazed plots immediately after a high-intensity, short-duration grazing session.

fencing. The sites were grazed under high-intensity, short-duration conditions according to the site's operational and vegetation management goals. Vegetation sampling using the point-intercept method was conducted on each transect. Alpha diversity and diversity index (Shannon-Weiner) were calculated for grazed and ungrazed plots on each site. This process will be repeated two to three times each growing season for the duration of this grant, and likely beyond.

2021 RESULTS

2021 data was successfully collected in the same manner as in 2020 on all sites in June, July, and August. While we have collected a significant amount of data on this project to date, we believe it is still premature to examine trends in test plots as significant change in prairie ecosystem compositions expected to be a longer-term process. For this reason, 2021 results were not compared statistically with 2020 results. These plots illustrate Shannon-Weiner diversity (the Shannon-Wiener Index is a way to measure the diversity of species in a community) and total species present across our six plots in 2020 and 2021 in the month of June. We recorded this dataset, along with measures of vegetative cover in June, July, and August on each of the six study sites. As this study continues, we hope to see more significant changes in diversity, evenness, and vegetative cover between plots from year to year. The data collected in 2021 represents one of the first snapshots of this process.

Although it is too early to see trends in our data, MNL and our student interns have worked to present our research and hypothesized outcomes to industry and academia. We hope to increase the awareness of grazing as an ecologically friendly management alternative in industrial settings similar to this and hope to inspire future research.

Evaluating the Impact of Feed on Animal Health, Growth Rates, and Meat Quality in Pastured Poultry

Principal Investigator

Grantee: Valerie Luhman
Organization/Farm: Grassfed Cattle Co.
Email: valerie@grassfedcattleco.com
County: Goodhue

Project Duration

2 years, 2021-2022

Award Amount

$30,209.60

PROJECT SUMMARY

Evaluating the impact of corn and soy feed versus corn-free, soy-free feed in pastured poultry production helped us understand the impact the two feed rations have on animal health, growth rates and meat quality. After direct marketing over 1,000 pastured chickens directly to customers in the Twin Cities, many asked us to raise corn-free, soy-free chickens. Customers explained they choose not to eat pastured chicken because of food sensitivities to the meat after the chickens ate corn and soy feed. By assessing the animal health and growth rates between the two groups of chickens, we will provide research for other farmers on the profitability differences between feeding corn and soy feed versus corn-free, soy-free feed to pastured chickens. Lastly, understanding the differences in nutritional composition of the meat between the two groups of chickens, we will provide data for customers, marketing purposes and a potential new market for farmers.

RATIONALE

The purpose of this project is to provide meaningful economical, ecological, and social contributions to farmers and consumers of poultry products. It will improve the environment and landscape on which the chickens are raised, the lifestyle and economics of the farmers who implement these practices and the health and well-being of the consumers. The project will allow us to do these things in the following ways:

The use of the mobile range coop will benefit farmers by allowing them to run a higher quantity of chickens on pasture more efficiently, producing more meat to sell and generate more income from their labor and land. This system of raising chickens has a significantly lower investment cost to the farmer than an alternative commercial chicken barn and offers significantly less risk.

The portability of the mobile range coop allows farmers to target areas of land in need of animal impact. The natural impacts of chickens pecking and scratching provides a controlled disturbance on the soil encouraging the growth of new plant species and the density of the forage stand. Manure from the chickens will provide a valuable, natural, nutrient source to low fertility areas and can be a cost-effective way of improving fertility on the landscape. More fertile and productive soil will improve the nutrient density of the food and the profitability of the farm.

Our research on the use of corn-free and soy-free feed rations may also contribute to an increased demand for corn-free and soy-free grains and encourage farmers to include additional crops to their farming systems. One of the principles of soil health is diversity and encouraging a diverse crop rotation will improve the resiliency of individual farms and the agricultural industry.

There have been some studies on non-soy poultry production, however, very little data exists on corn-free and soy-free rations in pastured poultry production. As direct marketers, we have seen a tremendous demand from customers with food intolerances and allergies to soy and corn-fed meat products who desire products raised without corn or soy. This research and data are essential to the expansion of the soy-free and corn-free meat market to better serve our communities and customers.

The production system being experimented with in this study provides an enjoyable way of raising chickens that is healthy for both producers and chickens. It allows chickens to express natural behaviors and increase the diversity of their diets through the consumption of plants and insects while positively impacting soil health.

DESIGN

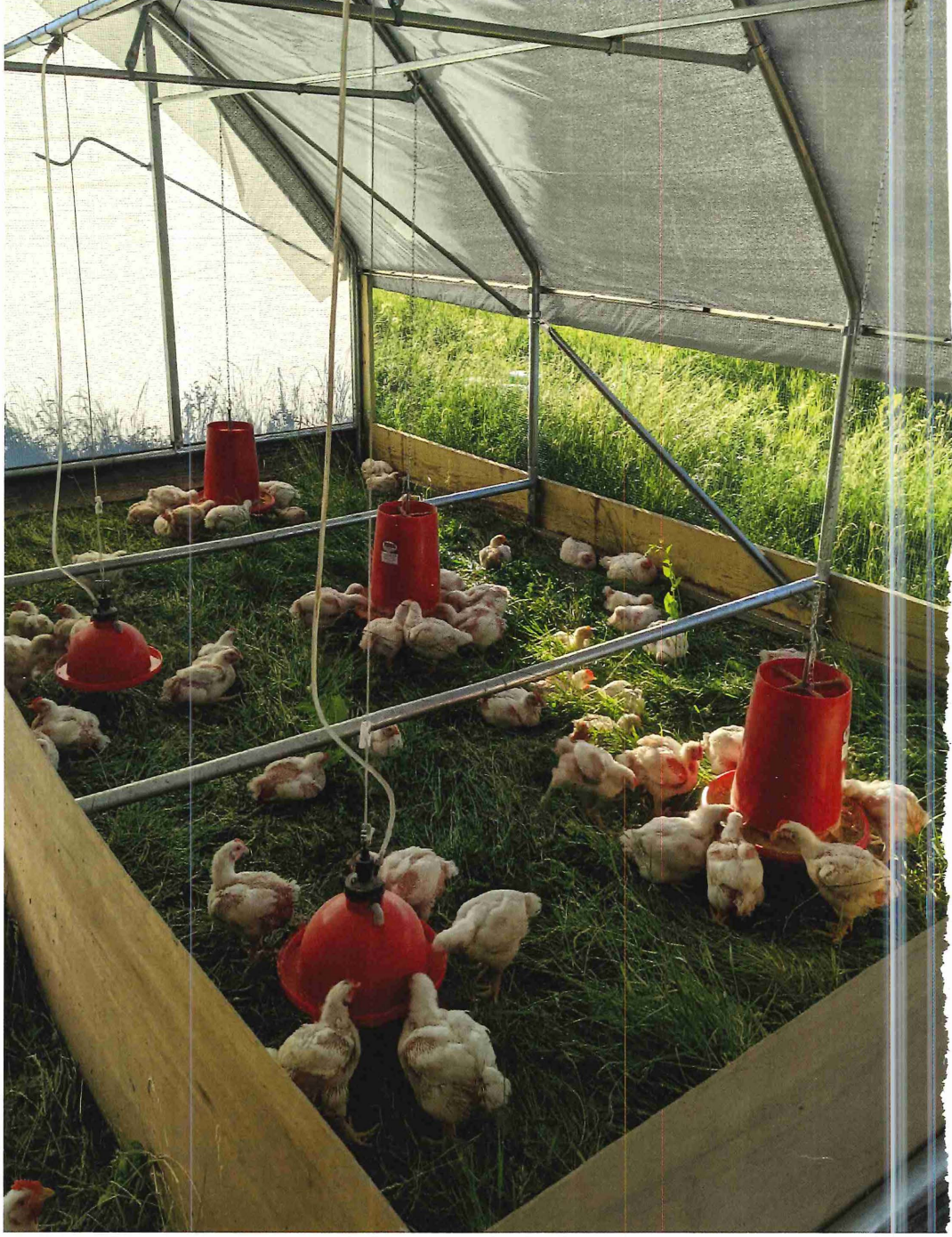
Three batches of chickens were raised on Dry Creek Farms in Goodhue, MN between April 29, 2021-October 22, 2021. Each batch consisted of 600 chickens and was split into four groups of 150 birds. Cornish Cross male chickens were purchased from Kruse Hatchery in Fort Atkinson, IA.

We intended for all variables for Groups 1 through 4 to be the same, except for the type of feed they were given. Groups 1 and 4 were fed Nerstrand Ag non-GMO corn and soy starter weeks 1 and 2 and Nerstrand Ag

non-GMO corn and soy grower weeks 3 through 7. Groups 2 and 3 were fed Hyview Feeds organic corn-free and soy-free starter weeks 1 and 2 and Hyview Feeds organic corn-free and soy-free grower weeks 3 through 7.

All groups were housed in the brooder weeks 1 and 2 with a divider splitting the shelter into four equal parts. The stocking density of the brooder was 1.09 square foot per bird. The brooder is an enclosed hoop building with cement floors. It has heat lamps and a thermometer to keep the chicks at the ideal temperature while they are young. Each group had one Plasson Broiler Drinker and two KUHL 35 pound Hanging Feeders. Both the drinkers and feeders were raised to the optimum height as the birds grew.

All groups were moved out to pasture between weeks 2 and 3. To reduce stress, we chose days that were moderate in temperature, wind, and precipitation. We loaded the chickens before the sun came up to allow them to adjust to the pasture in the mobile coop for a full day before the evening. We transported them to pasture in crates.



Chicks in the mobile coop in pasture.

They were housed in a Cobb Creek Mobile Range Coop, divided into four equal parts with a stocking density of 1.3 square feet per bird. All groups were moved to equal amounts of fresh perennial pasture each morning while inside the mobile coop. The mobile coop is a high tunnel on skids without a floor, designed to allow the chickens access to grass, bugs, seeds, etc. The sides of the mobile coop were rolled up for ventilation on warm days and rolled down to keep warm air in on cool days. Moving the mobile coop to new pasture each day kept the chickens clean and dry. All groups were given three KUHL 35 pound Hanging Feeders and two Plasson Broiler Drinkers. Both the drinkers and feeders were raised to the optimal heights as the birds grew.

All chickens were scheduled to be butchered at 7 weeks at AA Poultry Processing in Ridgeland, WI for human consumption. However, by week 4 we were confident the corn and soy-free groups would not be big enough to go to the butcher and produce a saleable chicken for Grassfed Cattle Co. Consequently, we had to find the next available butcher date, pushing back Groups 2 and 3 in Batch 1 to be butchered at 70 days, Batch 2 at 55 days and Batch 3 at 64 days when the butcher had availability.

We waited until the sun had fully set in the evening to load the chickens and avoid stress. We wore headlamps with dim, red lights. We used an open, flatbed trailer

when the weather was warm and did not show a chance of precipitation and an enclosed trailer when it was cold or raining to protect the birds while still allowing air flow for their well-being. The chicken crates were strapped down to avoid sliding during transportation.

After all chickens were transported to pasture, we removed all shavings, manure, and other debris from the brooder between each batch. After scraping and brushing all remaining materials, we applied water. Then we used disinfecting detergent according to the directions and scrub. After carefully rinsing all surfaces with water, we allowed the area to dry completely. A new batch of chickens was not housed in the same area for at least 48 hours. The same process was used for disinfecting the sides of the mobile coop, feeders, drinkers, crates, and all other supplies. The drinkers were checked daily and scrubbed, rinsed, and cleaned as needed.

EVALUATION

Animal Health - Assess the impact on mortality, feather growth, and animal health between the corn and soy groups and corn-free and soy-free groups. Data Collection will include mortality, feather growth, labor, expenses, stocking density, temperature, and significant weather changes.

Growth Rates - Assess the differences in feed consumption, rate of gain, feed conversion ratios, live weights and processed weights between the corn and soy feed groups and the corn-free and soy-free feed groups. Data collection includes pounds feed, live bird weights, processed bird weights, and pasture growth.

Meat Quality - Evaluate the nutritional composition differences of the meat between the corn and soy feed groups and corn-free and soy-free feed groups to gain data for meeting customer demand, marketing statistics, and potential for farmers to add a pastured poultry enterprise.

Nutritional testing will be done at Eurofins Scientific Inc. on breast and thigh meat pooled together from a random sampling of three birds per group per batch. A total of 36 birds will be used for nutritional composition testing. Nutritional testing includes Cholesterol, Vitamin E, Eicosapentaenoic acid (EPA), Docosahexaenoic acid (DHA), Alpha-Linolenic acid (ALA), Omega-6 fatty acids, Omega-3 fatty acids, Monounsaturated Fat, Polyunsaturated Fat, and Saturated Fat.

2021 RESULTS

We evaluated the impact of corn and soy feed versus corn-free, soy-free feed in pastured poultry production on animal health, growth rates, and meat quality. Total mortality was 282 chickens for the corn and soy-free groups and 168 chickens for the corn and soy groups. It is important to note that Batch 1 had a higher overall mortality due to health issues at the hatchery. Group 3 in Batch 1 had 43 percent mortality because the corn and soy-free groups and 168 chickens for the corn and soy groups.

Group 3 in Batch 3 had 48 percent mortality because one of the three heat lamp bulbs burned out overnight causing the temperature to drop unexpectedly. When we arrived to do morning chores, 25 chicks were dead and an additional 26 chicks died within 48 hours, which accounts for about 70 percent of the mortality in Group 3 from Batch 1.

When observing the health of the chickens fed the two types of feed while in the brooder and on pasture, the corn and soy fed chickens overall appeared much healthier than the corn and soy-free chickens. The corn and soy chickens grew feathers and matured much quicker than the corn and soy free chickens. By week 3, the corn and soy chickens had full feathers, but the corn and soy-free chickens still had some down and appeared bald in other places. When the first batch of chicks arrived on the farm, they were struggling due to sickness at the hatchery. While it impacted all four groups in Batch 1, Groups 2 and 3 that were fed the corn and soy-free started experienced higher mortality than Groups 1 and 4 that were fed corn and soy feed.

When moving the chickens to pasture between weeks 2 and 3, we observed the corn and soy-free chickens were more vigorous than the corn and soy chickens; they chased, hunted, and pecked more bugs and moved much quicker.

The corn and soy-free chickens consumed 5.2 pounds more feed per chicken than the corn and soy chickens. Note that these are based on total feed consumed divided by total chickens harvested and does not account for feed fed to chickens that died or take into consideration the different length of times fed for each group of corn and soy-free chickens. Batch 1 was fed for 70 days, Batch 2 for 55 days and Batch 3 for 64 days.

The corn and soy chickens had an average 2.84 pounds of feed per pound of chicken produced and the corn and soy-free chickens had an average 4.2 pounds of feed per

pound of meat. Note that the length of time the chickens were on feed for the corn and soy-free groups affects the accuracy of this feed conversion ratio. The feed consumed per chicken was done for total chickens of each feed type, not broken down per batch. Due to the length of the corn and soy-free groups being different for each batch the feed consumption is not precise. It only gives us an idea. These feed numbers also do not remove feed fed to chickens that died.

The corn and soy chickens were all fed for 48 days, whereas the corn and soy-free chickens were fed between 55 and 70 days. The corn and soy chickens averaged 5.37 pounds after butchering. The corn and soy-free chickens averaged 4.88 pounds after butchering.

In total, the corn and soy-free chickens took 50 extra hours of labor compared to the corn and soy chickens. This was largely due to the extra days added for the corn and soy chickens before sending them to processing, because of their size. Moving the chickens to new pasture each morning took about 45 minutes.

Method of Analysis

A complete fatty acid profile was conducted on the chicken meat. Most of the values were below detectable levels except those reported.

Other Factors

Because the corn and soy groups grew slower, we had to keep them for a longer amount of time. The difference in ages at sampling may have influenced the composition of the meat. Having access to pasture may also modify the omega-3 fatty acid composition in the meat. We were unable to get the breakdown of diet components in each of the feed types. Having a breakdown of the diet components may have helped us analyze the differences in the meat further. A composite meat sample made up of breast and thigh was used for analysis. The proportion of breast to thigh meat is unknown and also could have influenced the meat composition.

Omega-3 Fatty Acids

The two feed treatments had limited significant effect on one of the three main omega-3 fatty acids, alpha-linolenic acid, EPA and DHA in the meat. EPA and DHA were not present at detectable levels in the meat. In the meat of the corn and soy-free groups, alpha-linolenic acid was 0.128 percent and 0.03 percent in the corn and soy groups. Omega-3 fatty acids are important to human health. Higher levels of Omega-3 fatty acids aid in heart health, lowers triglycerides (fats) in blood, and has antithrombotic, anti-inflammatory, and antiarrhythmic properties. The closer the Omega-3 to Omega-6 ratio is to 1 the better. A lower ratio of Omega-3 to Omega-6 fatty acids is commonly accepted as being better for health. The ratio of the meat from the corn and soy-free chickens was 1:1.3 whereas the meat from the corn and soy chickens was 1:11.

Alpha-Tocopherol (Vitamin E)

The two feed treatments also showed a difference in alpha-tocopherol (Vitamin E) content in the meat tissue. Alpha-tocopherol is the most active form of Vitamin E for animals. The corn and soy-free groups had 1.33 mg per 100 g of alpha tocopherol in the meat compared to 0.68 in the corn and soy-fed groups. The Vitamin E contents in the corn and soy-free starter is 50 IU per pound minimum and 35 IU per pound minimum in the grower whereas the Vitamin E in the corn and soy starter and grower is 5 IU per pound. The higher levels of Vitamin E in the corn and soy-free feed is one reason there are higher amounts of Vitamin E in the meat tissue samples in the corn and soy-free chickens. However, because we were unable to get the specifics of the feed rations, it is unclear if the higher levels of Vitamin E is caused by the major ingredients such as organic peas, barley, and flax meal, or if the Vitamin E levels were higher in the premix compared to the corn and soy feed. The increased amount of Vitamin E in the meat tissue from the corn and soy-free chickens could also be due in part to the flax seed in the feed.

Feathering Observations

The methionine levels were higher in the corn and soy starter feed compared to the corn and soy-free feed. The corn and soy-free feed are organic, and the organic standards allow 2 pounds of synthetic methionine per ton of feed. This could explain the poor feathering in Groups 2 and 3 fed the corn and soy-free feed. It can also lead to lower growth rates and lower carcass weights.

Seasonal Differences in Nutrition Testing

After breaking down results by both treatment (type of feed) and batch (time of year), there were no statistical differences in any of the categories based on season with the exception of cholesterol. The cholesterol in Batch 3 Treatment 2 appeared to have a significant interaction between batch and treatment.

MANAGEMENT TIPS

1. Understand Customer Demand. We found that raising corn and soy-free chickens takes over 30 percent more time, 30 percent more feed, 12 percent higher mortality rate, and 88 percent more per pound for corn and soy feed. These issues all lead to the cost of production being significantly higher. Consider sending a survey to customers and/or pre-orders with deposits required before raising corn and soy-free chickens to ensure that you have adequate demand before investing in the chickens.
2. Invest in Efficient Infrastructure. We invested in a mobile range coop which is essentially a 20 by 36-foot hoop house on skids that houses up to 600 chickens. We moved it forward to fresh pasture every day with a pickup truck. Inside the coop we have large bulk feeders and automatic waterers plumbed in from the waterline we use for the cattle. Prior to this, we used two Salatin style chicken pens that each held 100 chickens. With the current setup we can move 600 chickens faster than we were able to move 200 in the previous setup. The reduction in labor, however, comes with a significantly higher upfront infrastructure cost. If you are only hoping to raise a few chickens for a small number of customers, then this is not necessary. However, if you have a goal of scaling the pastured chicken enterprise, we are glad we invested in infrastructure to utilize our time more efficiently.
3. Raise Chickens on Areas in Need of Fertility. While raising three batches of chickens we covered around two acres of pasture with this hoop house. We use this system as a way to import fertility in the form of chicken feed that is consumed by the chickens and applied naturally in the form of chicken manure. It is unsurprising but there was a clear and significant impact to grass production where the chickens had been. Even though 2021 was an extremely dry year, the pasture where the chickens were was significantly more productive and stayed green later into the fall when the rest had gone dormant. We look forward to seeing how it impacts soil and forage production in years to come. This can be an excellent way to improve soil health on low fertility areas of the farm. Additionally, composted wood shavings and chicken manure from the brooder makes great fertilizer for a garden or field.

COOPERATORS

Sally Noll
Professor and Extension Poultry Specialist
University of Minnesota
1364 Eckles Avenue Saint Paul MN 55108
612 624 4928 (Office Phone)

Professor Noll helped us design our research project and analyzed the nutrition information for the chickens. She helped us understand how the feed ingredients impact the composition of the chicken meat.

Randy Kleinman
22390 Rum River Blvd NW
Oak Grove, MN 55303
612-567-7826

Randy received an AGRI Sustainable Agriculture Demonstration grant in 2018 for his study titled, "Comparison of Mobile Confinement and Day-range Production System for Pastured Broiler Chickens." He provided feedback on the design of our project and our nutritional testing.

Crop & Livestock Farmers Building Biodiverse, Aerobic Composts Using the Johnson-Su Method

Principal Investigator

Grantee: Shona Snater
Organization/Farm: Land Stewardship Project
Email: ssnater@landstewardshipproject.org
Counties: Scott, Mower, Winona

Project Duration

2021-2023, 3 years

Award Amount

$46,937.22

PROJECT SUMMARY

The Land Stewardship Project is working with four farms in Minnesota over 2.5 years to build biodiverse composts using the Johnson-Su method using materials readily available on farms. Revitalizing the soil with a wide range of beneficial microbes holds many environmental potentials as well as economic savings for the farmer. The goals of this project are to:

- utilize ingredients commonly found on farms, develop and test compost recipes that promote the growth of beneficial soil microbes in an aerobic, static compost system that undergoes a full heating cycle.
- compare our Johnson-Su test results to standard, industrial-turned composts to show the difference in soil microbial make-up.
- conduct outreach to hundreds of farmers to promote the Johnson-Su method and share our detailed recipes and best practices to help interested farmers enhance the biology of their soils using a tested and accessible method.

PROJECT DESCRIPTION

Compost that is microbially-diverse and fungally-dominant can serve as an "inoculant" rather than a soil amendment or fertilizer. Even a small amount of compost can impact large acreages either by coating seeds or applying a liquid extract in the seed trench during planting. Currently, there are many private companies offering "microbial inoculant" products to farmers. We at Land Stewardship Project and the farmers-members with whom we work are interested in ways to make high-quality, bio-diverse products on our own farms. One of the most promising methods is Biologically Enhanced Agricultural Management, developed by Dr. David Johnson and his wife Hui-Chun Su, which centers on the use of a Johnson-Su Bioreactor to create a static aerobic compost that requires limited management and very little use of large equipment, water, and energy, can produce microbially-diverse and fungally-dominant communities.

The Johnson-Su Bioreactor method was developed in New Mexico with locally sourced materials. Therefore, it creates a need to test recipes using materials available to Minnesota farmers. It is important that the compost have a balanced carbon to nitrogen ratio adequate for a full heating cycle up to 165 degrees Fahrenheit, but not so nitrogen-heavy as to cause anaerobic conditions. Compost must undergo a heating cycle to kill pathogens, terminate weed seeds, and promote the growth of beneficial microbes. Farmers currently using this system are having difficulty finding this balance.

Land Stewardship Project's project seeks to fill in this missing information by developing multiple, measurement-specific compost recipes that utilize materials available to Minnesota farmers and will result in an aerobic, thermal, biodiverse, and bio-dense compost. The clear and proven recipes developed under this project will reduce the learning curve for farmers seeking to implement the Johnson-Su method in our state.

DESIGN

Staff of Land Stewardship Project's Bridge to Soil Health program, along with five farmer-members of the organization, will construct static, aerobic compost bioreactors following the Johnson-Su Composting Bioreactor method. Four of the five farmers/couples—Tom Cotter, Dale and Carmene Pangrac, Jon and Ruth Jovaag, and Wazupi Tribal Gardens, —live and farm in Minnesota and will be using compost starting materials geographically accessible to their farms. With the help of Land Stewardship Project soil health organizers,

each farmer will build two Johnson-Su Composting Bioreactors on their farms in 2021 and two more in 2022 resulting in 10 compost recipes replicated twice for a total of 20 compost bioreactors over the course of the grant. Analysis of the resulting composts will include direct microscopy and genetic sequencing at about the 4th or 5th month of the composting process and after one year.

Loading the bioreactor at Jovaag farm on June 23, 2021.

PRIMARY OBJECTIVES

1. Develop Johnson-Su compost recipes using locally available materials.
2. Compare biodiversity of microbes in composts developed under this project with commercially available composts.
3. Promote the findings of the project among farmers in Minnesota.

2021 RESULTS

In March 2021, Land Stewardship Project staff and participating farmers met with composting consultants Clifford Johnson and Maks Sandor Kopish compost consultants to receive training in bioreactor set-up, develop initial compost recipes, and standardize sampling protocols for temperature, moisture, and lab analysis.

In early to mid-July, Land Stewardship Project and farmers set up two bioreactors on each of the five participating farms. Each bioreactor consists of a 40-inch x 48-inch pallet base with a cylindrical frame made of 6-inch x 6-inch 10-gauge wire re-mesh and lined with landscape fabric. To create airways through the compost, six 4-inch diameter perforated sewer/drainpipes are set vertically in each composter as it is built. These are removed after the compost has settled for a day.

On an ongoing basis after the bioreactors were built, farmers took the temperature of compost in both bioreactors daily and monitored moisture levels through the thermophilic phase. Consultants were on hand to troubleshoot and offer strategies for modifying tactics. Physical samples taken in August were sent to composting consultant Maks Sandor Kopish for soil microbiology photography. Physical samples taken in December were sent to Maks Kopish, University of Minnesota Genomics Center, and Soil FoodWeb New York Inc.

For ease of use on the part of the farmer, temperature and moisture logs were maintained using paper log sheets. Unfortunately, two of the participating farms lost these log sheets. Anecdotally, farmer participant Jon Jovaag reported that one of his composts reached a high temperature of about 140 degrees and the other reached 100 degrees. The compost in his bioreactors stayed consistently moist though he watered as needed. Tom Cotter reported that one of his composts reached 140 degrees, but that moisture fluctuated significantly, potentially due to underwatering. Moving forward, Land Stewardship Project will ask farmers to record daily temperatures and moisture levels digitally or share photos of paper temperature and moisture logs on a weekly basis to avoid future data loss.

ADDITIONAL RESOURCES

For more information about this project, please see the following resources:

LSP Ear to the Ground Podcast #266: Activating Soil Life, www.andstewardshipproject.org/podcast/ear-to-the-ground-266-activating-soil-life

LSP Blog: Getting a Bio-Reaction from Soil, www.landstewardshipproject.org/getting-a-bio-reaction-from-soil

Ear to the Ground 271: Focusing on Fungi, www.landstewardshipproject.org/podcast/ear-to-the-ground-271-focusing-on-fungi

Evaluating Erosion, Yield, and Economics in Different Tillage Regimes After a Winter-Kill Cover Crop in Southwest Minnesota

Principal Investigator

Grantee: Jason Miller
Organization/Farm: Miller Farms
Email: millerme@yahoo.com
County: Murray

Project Duration

2021-2023, 3 years

Award Amount

$30,000.00

PROJECT SUMMARY

Jason and Monica Miller of Miller Farms has already invested in structural improvements to reduce erosion, including three catch basins installed in 2020, in addition to extensive gully and drainage repair. To further reduce erosion, Miller Farms is turning to in-field practices such as cover crops and reduced tillage. Vertical till was used for the first time in spring 2020 and strip-till was used for the first time in spring 2021. An oat cover crop was planted following the 2020 soybean crop. Our project investigates soil movement with different tillage practices, especially during the spring and fall when wind and water erosion are extensive on southwest Minnesota's fine-textured soils. Here, we install replicated strips of two tillage practices, field cultivation and strip-tillage, and measure soil movement using small mats to collect soil blowing or washing across the land surface. In addition to the erosion data, we track yield and expenses for two crop seasons to estimate the partial budget for each system.

OBJECTIVES

Evaluate the partial budget of each tillage system: We are tracking inputs including tillage costs and labor, seed and fertilizer, and crop yield. The partial budget consists of income-expenses.

Evaluate the soil loss in each tillage system: We are using small mats, that are placed and removed seasonally, to estimate soil movement across the field. Soil collected on the mats is analyzed for total soil carbon and nutrients.

Mat with soil movement collected. Photo taken on collection day of mats.

2021 RESULTS

Miller Farms measured yield (corn) in the combine via a yield monitor. There was no statistical difference in yield, though the average of tilled fields was slightly higher (205 bushels per acre) than strip-tilled (201 bushels per acre).

Professors Jason Stahl and Anna Cates from the University of Minnesota (technical cooperators on the project) measured sediment movement as an indicator of erosion in three subplots of each tillage treatment. The method used was erosion mats, pinned to the ground between planting and post-emergence herbicide application (approximately once every four weeks). Sediment was dried and weighed in Professor Cates' lab at the University of Minnesota and scaled to estimate pounds per acre of sediment moving. There was more sediment moving in tilled plots (1,074 pounds per acre) than strip-till plots (449 pounds per acre), a difference that was marginally statistically significant ($P = 0.06$, 2-sample T-test).

Understanding the Possibilities of On-Farm Compost to Reduce or Eliminate Commercial Fertilizer

Principal Investigator

Grantee: Chad Olsen
Organization/Farm: Olsen Custom Farms LLC
Email: colsen@olsencustomfarms.com
County: Lincoln

Project Duration

2021-2023, 3 years

Award Amount

$25,000.00

PROJECT SUMMARY

Methods to reduce synthetic fertilizer use on broadacre crops like corn can provide many benefits to the farm and landscape such as higher net returns to the farmer, less nutrient loss to surface and ground water, and a lower carbon footprint through energy savings related to production and transport of synthetic fertilizer. On-farm composting of livestock manure and carbon residues could provide all or most of a farm's fertilizer needs, but understanding the limits or possibilities are not well understood due to few operations currently using on-farm compost over hundreds of acres. This study aims to find out how far our compost can go towards eliminating commercial fertilizer for our farm's broadacre crops and improving soil health.

PROJECT DESCRIPTION

This project is very important to our farm because we are transitioning our entire broadacre crop fertility program from the traditional synthetic nitrogen (N),-mineral, potassium (P), and Phosphorus (K) system to a carbon-based approach through compost and cover crops. The farm has actively been using cover crops for five years after small grain seed crops to increase active soil carbon and provide for following crop nutrients. The initiation of producing compost from our feedlot manure was the next step to close the loop on imported crop nutrients and increase carbon additions into our farm's soils.

By carrying out this project we hope to gain the understanding of what the possibilities and limits our compost will have to adopting our new broadacre crop fertility system. We also hope this will inspire our peers to consider composting and or using compost to localize some or all of their farm's fertility. By localizing crop fertility, we can move away from the problems of nutrient export into surface waters and improve broadacre crop production stability with healthier soils. Localizing crop fertility saves on energy needed to manufacture N, mine P and K, and transport commercial fertilizer long distances. By sharing our findings on carbon-based fertility with farmers throughout the region hopefully provides a path to produce and use compost on their farms' soils.

Two field locations are being used for the study, one with fall and spring tillage and the other mature no-till (5 plus years). The conventional tillage field is in a three-crop rotation: Corn/Oats (2021) to Soybeans/Corn (2022) to Oats/Soybeans (2023). The no-till field is also in a three-crop rotation: Soybeans (2021) to Oats (2022) to Corn (2023).

Recording soil moisture and temperature in cover crop after oats.

2021 RESULTS

The first year of our field study was successful despite a very warm, droughty summer in Lincoln County, MN. The impact of above normal temperatures was evident already in June with many days above 90 degrees Fahrenheit, elevating bare soil temperatures and reducing plant available soil moisture.

To evaluate the impact of compost versus commercial fertilizer during year one of our project we applied liquid compost extract as a foliar/streamed on soil since our first solid compost wouldn't be ready until August.

Rains were very infrequent most of the summer, one observation that was encouraging was seeing soil moisture levels remain at a higher level in compost applied plots. As expected, the no-till field plots had the lowest soil temperature and moisture extremes the entire growing season despite being a very sloped field.

The drier-than-normal summer was advantageous for producing quality compost on our farm. We produced 5,400 tons of compost and applied that to about 4,000 acres variable rate for an average of 1.35 tons per acre.

The AGRI Sustainable Agriculture grant-funded fields received their compost applications after harvest of each crop, the oats field had compost applied and then a multi-species cover crop was seeded. Soybean and corn fields just received compost with no cover crops in fall of 2021.

The compost application rate to plots was 2 tons per acre. We settled on this rate based on the economics of $50 per ton delivered and spread along with associated nutrient value equivalent to fertilizer. A complete economic analysis will be reported at the conclusion of our grant project.

Our learning curve is a little less steep as we enter 2022 on producing a consistent compost from our feedlot bed pack manure. To grasp the limits of the modest amount of compost applied to our study crops, only the compost and cover crop residues (corn year) will be additive fertility compared to our traditional fertilizer program based on fall soil analysis and University of Minnesota recommendations. Additional dry fertilizer requirements for the study plots will be weighed individually and broadcast applied pre-planting. Due to individual plot soil test results and spatial variation the amount of fertilizer applied may differ by plot to get to the recommended amount for the crop yield goal.

One takeaway on the importance of our project was revealed with soil test data suggesting higher levels of biological active carbon and lower residual nitrogen levels post-harvest (corn & oats) in the compost treated plots. These outcomes support the idea of carbon-based fertility to minimize crop nutrient loss and improve soil health, we are optimistic this will prove to be true the remainder of our project.

Sustainable Agriculture Demonstration Completed Project Articles

The following articles are project summaries with descriptions of the project's purpose, activities conducted to achieve the objectives, and final evaluation results of the completed grant project. To find out more details about these projects, contact the principal investigators directly through the listed contact information.

Integrated Hemp and Heritage Farm

Animal drawn equipment used to spread organic material on a field.

PRINCIPAL INVESTIGATOR

Winona LaDuke
Anishinaabe Agriculture Institute
46042 Highway 34
Osage, MN 56570
218-280-1720
winonaashemp@gmail.com
Becker County

PROJECT DURATION

2019 to 2021

AWARD AMOUNT

$46,682.00

KEYWORDS

Integrated indigenous hemp

PROJECT SUMMARY

We are deeply interested in Indigenous and reduced petroleum agriculture, and adaptation in a time of climate change. Our work is paired with work on hemp, a plant which we see is critical to moving into a post-petroleum economy. This project provides the foundation for a replicable integrated model of sustainable community agriculture in the northland, working with Anishinaabe foods and hemp varieties. During this grant, we conducted significant research, and in mid-February 2022 launched the first Indigenous Hemp class, a remote class serving tribal members on eight reservations, and, as we write this final report, we continue to vet the value-added technologies for hemp.

PROJECT DESCRIPTION

Our objectives are to develop medium scaled replicable farming operations utilizing integrated crop planning, equipment, hemp varieties, and inputs. Our secondary goals were to develop research and educational programs on hemp aimed primarily at fiber hemp producers. Working with four different parcels of land, we applied various fertilizers, including fish fertilizers and manure, to improve soil health and life, as well as, developing a crop rotation which would enhance health of the plants as well. Working with state and federal permits, we grew hemp in various conditions, and differing varieties, determining how soil fertility worked with hemp production while working with the University of Minnesota and other interests to track specific varieties. We also used organic processed fertilizers. We documented the health of plants and amounts of harvests in

each year, noting in some cases, the varietal differences in times of extreme drought (summer of 2021), and in terms of resilience to pests like the potato bugs.

We also did significant research into value-added processing techniques for hemp and hemp products, enabling us to put together a Hemp 101 Class for tribal growers to be offered in the spring of 2022.

2019 RESULTS

Soil samples indicated that we needed to work on building organic matter in the Ponsford Prairie field, as well as amend other areas with nutrient rich fertilizers like fish guts. We saved our own potato seed and have replanted and saved each year since.

2020 RESULTS

Soil samples showed high amounts of organic matter, but some fields were still lacking in various nutrients, especially the Ponsford Prairie field. The Skov hemp field showed good soil health. We had an incredible corn harvest this year and stored at least a half-ton of Mandan corn to re-plant, give away, and sell. We also had a large potato, bean, and squash harvest, considering the small plots we grew on.

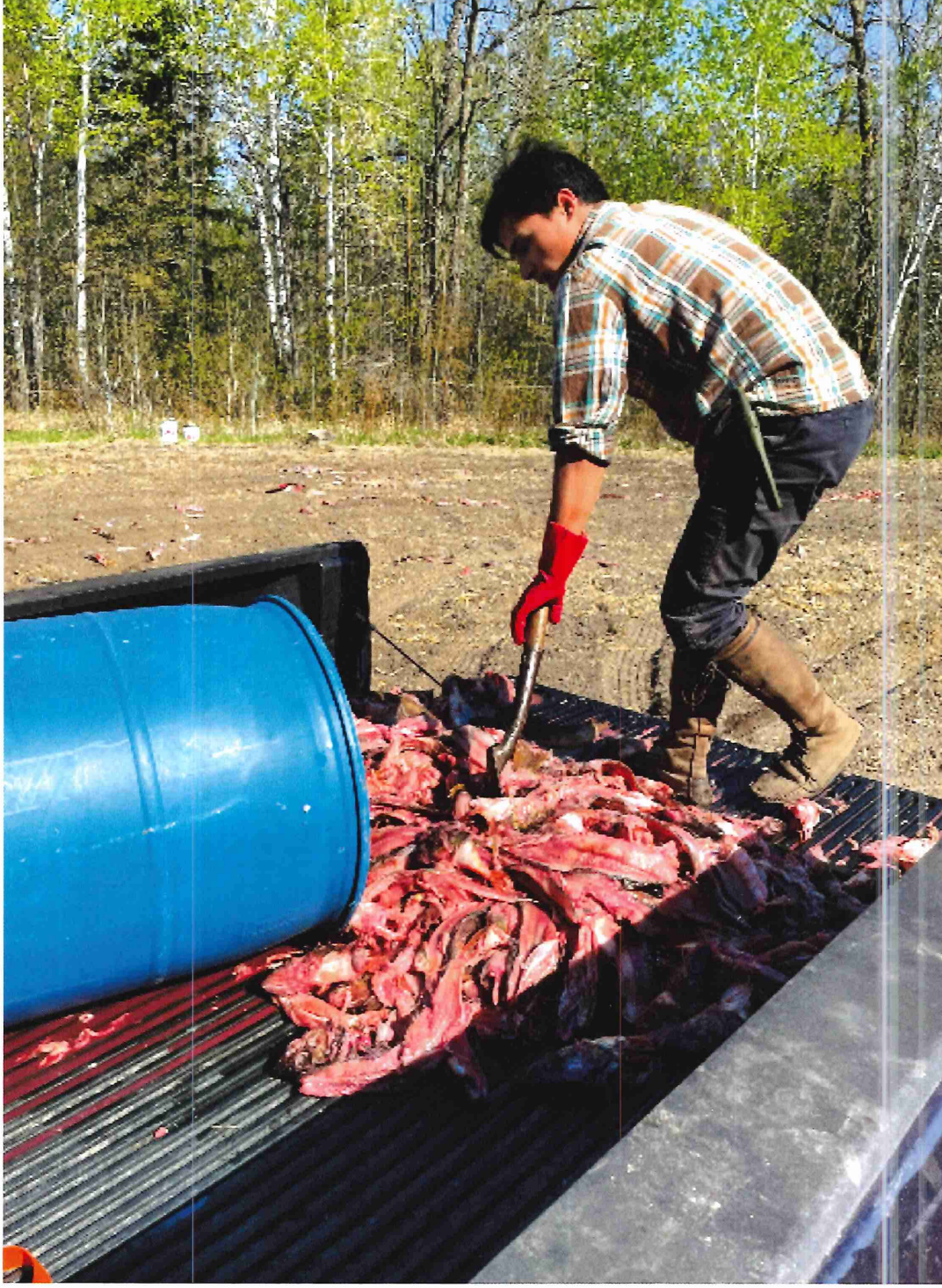
2021 RESULTS

Soil sample results show good soil health in the fields that we have been amending with fish guts and crop rotation since 2019. The Skov field had a drop in soil health, which could have been due to the timing of our soil test and the early harvest and replanting of cover crop mid-season. Despite one of the worst droughts in recent history, we had an incredible harvest. The corn crop was significantly smaller this year, in part, because we planted about one acre less than in 2020. We still had a good harvest and probably have between 300-400 pounds of corn that will be shelled over the winter. Our potato harvest was the best it has been yet. We estimate that there were about 600 pounds of potatoes harvested. Our large harvest owes itself to the diligence of staff, youth, and volunteers picking potato bugs and hilling up the sides of rows over the course of

the season - not to mention the healthy amount of fish guts that were spread and incorporated into our potato fields.

MANAGEMENT TIPS

1. Plant several varieties of potatoes to see how each one responds to adversaries in the field. There are so many varieties available, and they are so resilient, it is easy to document fertilizers and adversaries with potatoes.
2. Have good help to keep records. Each year, this will improve. And don't get caught up in the technology, it's fine to write it down with pen and paper.
3. Invite people over, that's how they get questions answered and get excited about farming.



Waste from fish processing used as a fertilizer and soil amendment.

COOPERATORS

Winona LaDuke's farm was the central farm for the first round of fertilizer with fish guts and manure. That farm continues as the center research farm for smaller plots, and in 2021, hosted the University of Minnesota research into feral hemp plants.

Don Wedll cooperated with his farm until 2021, when with COVID-19 and so much more it was difficult to do a much larger project. Wedll continues to provide farm support for this project.

OTHER RESOURCES

It is helpful to have a network of growers nearby. A lot of our time and effort has been spent on building relationships with others who are undertaking similar pathways, like horse farming, closing waste loops. Several local producers are putting time and energy value into the cultural lifeways that come along with growing and processing food and fiber. We also try to support our local food, land, and water systems as much as possible in order to ensure that we are growing the local economies and protecting our natural resources.

Exploring Hull-Less Seed Pumpkins as a Specialty Crop

The three varieties of pumpkins grown in 2020, from left to right: Naked Bear, Styrian, and Godiva.

PRINCIPAL INVESTIGATORS

Rachel Sannerud
Pluck Flower Farm
14841 140th Avenue
Milaca, MN 56353
630-335-5106
pluckflowers@gmail.com
Mille Lacs County

PROJECT DURATION

2020 to 2021

AWARD AMOUNT

$11,162.42

KEYWORDS

hull-less seed pumpkin, pepitas

PROJECT SUMMARY

This project explores growing, processing, and marketing hull-less seed pumpkins, or pepitas, as a value-added product to see if it is a profitable crop for small farmers to grow as a means of diversifying their farm and adding profitability to their farm business.

PROJECT DESCRIPTION

This project explores growing, processing, and marketing hull-less seed pumpkins, or pepitas, as a value-added product to see if it is a profitable crop for small farmers to grow as a means of diversifying their farm and adding profitability to their farm business.

Rationale: The project will demonstrate the viability of growing hull-less seed pumpkins on small farms and processing them for pepitas to be sold as a value-added product for local markets. This will demonstrate if hull-less seed pumpkins can be successfully grown in Minnesota, if they can be processed as pepitas by the farmer to be sold as a value-added product, and if the whole process will turn a profit. With these results, farmers can make informed decisions on if hull-less seed pumpkins are a crop they would like to grow themselves. If successful, this will open up another specialty crop opportunity for small farms that will boost their profitability.

Objectives:

- Assess growing methods of pumpkins: seed variety trials, pest and disease pressure monitoring, plant and fruit performance under cultivation and mulched plots.

- Assess pumpkin varieties upon harvest: fruit size, quality, quantity, and seed to flesh weight ratio.
- Evaluate harvesting, processing, and packaging of the seeds.
- Evaluate marketing and pricing of the value-added product, pepitas, through market channels: direct to consumer, wholesale.

Design: Three different varieties of seed pumpkins were started in our on-farm greenhouse and transplanted out to the field plot after danger of frost in June. Each variety was divided among two weed management strategies in the plot, either into bare ground for mechanical cultivation or into hay mulch.

From June through October, the field plot and trials within it were monitored and tended weekly upon transplanting. Evaluations and plant growth, weed pressure, pest pressure, and disease pressure were made weekly. Measures used to combat these pressures were performed and recorded weekly. Plant development, flowering, and fruit set and development was monitored weekly throughout the growing season.

Prior to harvest in October, each trial variety and weed management strategy were evaluated for plant size and growth habit, fruit quantity, size, and quality. Through two growing seasons, best practices and equipment for management and harvest of the pumpkin crop were identified and made into a report.

Upon harvest, pumpkins were put in the greenhouse to cure and for pumpkin seeds to continue to mature within the pumpkins. Curing of pumpkins was monitored daily for progression in maturity and was protected from freezing temperatures as needed.

Once pumpkins were cured in October, pumpkins were brought to the Sprout MN Marketplace to be processed. Each harvested variety of pumpkin was weighed whole, and percentage of seeds identified as they were processed.

Evaluation:

How did each seed variety perform? Germination, susceptibility to pest and disease pressure, plant and fruit performance in both cultivation and mulched plots.

Are any seed varieties suitable or better for a good crop? fruit size, quality, quantity, and seed to flesh weight ratio.

How did harvesting go? What tools were needed? How long did it take to harvest?

How did processing go? What tools were needed? How long did it take to process and package?

Are pepitas a value-added product that is in demand in wholesale markets? Direct to consumer? What price was the product sold at in each setting? Is it profitable?

2020 RESULTS

Crop Trials: Growing the three varieties under two cultivation conditions went, for the most part, as planned. The crop was relatively low maintenance; there were no serious disease or pest pressures. The mechanical cultivation crop had to be weeded with hand tools due to rapid plant growth preventing the tractor from fitting between rows. As a result, rows had to be spaced further in 2021 to allow for mechanical cultivation. The mulched plot only required two hours of hand tool weeding mid-season and yielded greater fruit yields in comparison to the un-mulched plot.

Processing in Commercial Kitchen: Processing took much longer than expected and without clear guidelines on how to process seeds successfully, yielded no high quality, value-added seed product for sale. The dehydration guidelines from USDA were likely made for seeds with hulls rather than hull-less seeds and as a result all processed seeds had too high of moisture content and were therefore not shelf stable or saleable. Dehydration also took significantly longer than expected and as a result created the greater time spent processing. The yield of pumpkins overall was also higher than expected.

Variety Trials: We were impressed to find the high percentage of seeds in the Naked Bear pumpkin variety and less impressed with the Godiva and Styrian varieties, which had a low percentage of seeds but were easier to process

The mulched plot, after second cultivation of the pumpkin field in 2021.

overall. In 2021 we will take these results and select varieties that have closer characteristics to Naked Bear, keeping a Govida and Styrian variety in the trial as well as a representative. The Godiva and Styrian varieties were so similar we feel we do not need to trial both for a second season.

Marketing & Crop Profitability: At the end of processing the total yield of seeds was 120 pounds. We anticipate higher seed yield in total in 2021 due to more productive variety trials with increased percent of seeds in trialed varieties. We anticipate this will be an improvement on the profitability of growing hull-less seed pumpkins for value-added pepita product overall, and will know more at the conclusion of the project. As a result, marketing was not explored this year and will be done with the 2021 crop when processing has more clear guidance provided by AURI. AURI will provide guidelines for safely roasting the pumpkin seeds, and for testing for shelf stability, to yield a value-added product that can be marketed in 2021 and early 2022.

2021 RESULTS

Crop Trials: Changes were made to which varieties were grown this season (dropped Godiva due to its similarities to Styrian, added Pie-Pita, Beppo, and HSC151 to expand on overall variety trial results). Changes were also made to row spacing within both plots to allow for successful mechanical cultivation. Rows were spaced six feet apart with plant spacing remaining the same as in 2020. The crop was again relatively low maintenance; some cucumber beetle pressure but nothing that caused sustained damage to the crop. Both plots were mechanically cultivated twice before mulch was applied to one plot. Following mulching, both plots were hand weeded once to remove velvet leaf, which took 15 minutes in each plot. Both plots yielded approximately the same quantity of fruit, likely due to the drought conditions. While I feel the mulch allowed for greater moisture retention under the soil, the trials do not reflect any advantage this growing season.

Disease pressure was greater in 2021 due to the ongoing drought - this made for stressed plants more susceptible to powdery mildew. In August, we had a hail storm which caused damage to a small percentage of fruit. Not the whole crop but between 12-25 percent. Fruit was shielded by leaves but fruits that were damaged had shortened storage potential. The damage to the skin created weak spots that accelerated the breakdown of the pumpkin skin and flesh.

Processing in Commercial Kitchen: Processing was made possible and successful with help from AURI, who provided technical assistance to determine proper roasting conditions that would yield an adequately food-safe product and also have desirable flavor and taste. AURI recommended 12 different combinations of drying conditions, temperature and time requirements for drying. These were trialed and samples were sent into the lab for moisture testing, while I performed sensory analysis for a desirable taste and texture. We narrowed drying conditions down based on low product moisture and desirable taste and texture, and these were again trialed and sampled. We ultimately chose roasting the raw seeds at 350 degrees Fahrenheit for 20 minutes to be optimal, making for a nicely roasted and crunchy uniform pepita. This process required forethought but allowed for successful processing and much more time efficient processing this season. Pepitas were scooped from the pumpkins, rinsed, dried, and roasted in the convection oven at the Sprout commercial kitchen. See tables which outline drying condition trials and moisture test and sensory results.

Variety Trials: We changed up some of the varieties grown this season. I see the varieties divided into two categories: "traditional Styrian" and "hybrid."

The traditional Styrian varieties: Styrian, Beppo, HSC151

Hybrid varieties: Naked Bear, Pie-Pita

The traditional Styrian varieties, which I added two 'Beppo and HSC151' into to see how they'd compare to Styrian, are universally large pumpkins with low seed yield. Their large size also made them difficult to open and extract seeds from.

The hybrid varieties, Naked Bear and new this year 'Pie-Pita', were similar in that they had similar high seed yield, but I found the pie pita pumpkins to be easier to open and extract seeds from. Pie-Pita had the occasional pumpkin where the seeds were not hull-less and therefore not good for roasting, but this was a small percentage of the crop.

See table for more information on individual varieties.

Marketing and Crop Profitability: At the end of processing total seed yield was 50 pounds. While we believe the trial was overall more productive, the drought certainly affected yields, hence the decrease of seed overall.

The real improvement this season was the decreased processing time, with more efficient use of time and a marketable product to boot. We found processing this season was feasible and a reasonable process for a farmer to take on, even for a small harvest of pumpkins.

Marketing possibilities were limited in 2021 due to the continued pandemic. We had originally planned to take the seeds to farmers' markets. Instead, the final product was sold to Sprout MN for inclusion in their winter community supported agriculture and was marketed directly to customers through word of mouth. In particular, we reached many other small farmers, who already grow specialty crops and appreciate trying new local products and eating locally through the winter months when there is less variety in options. This was a welcome surprise and we found that a wholesale price of $1.50 an ounce was acceptable and a scale of $1.50-2.00 per ounce depending on quantity sold was acceptable for direct marketing to consumers.

It is difficult to objectively evaluate the value-added crop for profitability because of the added costs and labor that go into exploring all the possibilities of the grant. Managing the crop, harvesting, and processing it is all reasonable and can be successfully done on a small scale by a singular farmer; I managed the crop, harvesting, and processing solo in the 2021 season. I cannot evaluate the profitability of growing the hull-less seed pumpkins as a vegetable crop - my gut feeling says they are too nice of a product that will be difficult to sell to consumers and wholesale alike. The value-added product of pepitas makes the profitability piece more likely for the crop, and is largely dependent on the yield. With the limited crop yield in 2021, largely affected by drought, it is not a profitable year. Had the yield been closer to that of 2020 with successful processing, I would consider the crop profitable. Further research, with the project being evaluated for cost of goods sold would allow for conclusions about profitability to be formed.

MANAGEMENT TIPS

1. Have a dedicated notebook for your notes on the project. I'm not the most organized farmer and this helped me monitor the progress of the grant and make sure I was keeping track of what I needed to be, and to have all the data in the same spot to compare and track over time.
2. Especially if working with growing a crop, look at it with notebook and camera in hand once a week to evaluate it and assess if it needs attention and what kind. I did this each Sunday and addressed needs of the crop on Monday.
3. Think ahead. It was important for the grant to keep progressing on time and that I thought ahead to ensure I had supplies for whatever stage of the grant I was in. It was also beneficial to think ahead to the next stage of the project, ahead of whatever stage I was in, to cooperate with grant partners and be prepared to continue the work rather than being caught off guard.

Raw pumpkin seeds ready to be roasted in the oven at the commercial kitchen.

COOPERATORS

Fallon Ryan, Community Engagement Coordinator, Sprout MN, 609 - 13th Ave NE #8, Little Falls, MN 56345, 320-412-3081

Sprout MN provided commercial kitchen space for processing and storage space for supplies and the pepitas. Sprout MN also provided assistance with initial marketing plans and worked with us on setting a price for the pepitas and marketing in 2021. This allowed us to successfully market the product we had produced in 2021.

Lorrene Occhino, Scientist of Food and Nutrition, AURI, 510 County Road 71, Suite 120, Crookston, MN 56716

Lolly and AURI provided technical expertise to develop procedures for processing the pepitas, making it possible to produce a consistent, food-safe, and desirable value-added product of roasted pepita seeds. We developed a consistent and reliable process for taking the raw seeds to the final product of roasted pepita seeds which any farmer with access to commercial kitchen space could implement.

OTHER RESOURCES

conservancy.umn.edu/bitstream/handle/11299/141134/MiscR156.pdf?sequence=8

digitalcommons.uri.edu/cgi/viewcontent.cgi?article=1029&context=riaes_bulletin

irda.blob.core.windows.net/media/2463/richard-boisclair-2014_fiche_citrouilles_cultivars_implantation-eng_01.pdf

hort.purdue.edu/newcrop/proceedings1990/V1-403.html

edis.ifas.ufl.edu/pdf/HS/HS132300.pdf

Exploring North Star Farm Tour as a Sustainable Agri-Tourism Model for Smaller Producers

PRINCIPAL INVESTIGATORS

Melodee Smith & Wendy Wustenberg
North Star Farm Tour
31139 County 7 Boulevard
Welch, MN 55089
651-212-8099, 651-246-6332
northstarfarmtour@gmail.com

Dakota, Faribault, Fillmore, Goodhue, Olmstead, Ramsey, Rice, Scott, and Wright Counties

PROJECT DURATION

2019 to 2021

AWARD AMOUNT

$25,000.00

KEYWORDS

agritourism, sustainability, profitability, farm-to-consumer, farm tour, nonprofit, education, farm safety

PROJECT SUMMARY

Exploring North Star Farm Tour as a Sustainable Agri-Tourism Model for Smaller Producers

North Star Farm Tour is a 501c3 learning community of family-owned farms with the mission: **"Connecting people with agriculture through safe, fun, and educational agritourism."**

North Star Farm Tour is a pioneer in developing professional, entrepreneurial approaches to agritourism because an educated citizenry is fundamental to a sustainable future for agriculture. Small-scale farmers and agritourism operators run on notoriously thin margins, yet face increasing pressures to improve facilities, ensure product quality, and professionalize their businesses to meet consumer demand and regulatory requirements. North Star Farm Tour is busy networking to find experts, knowledge and resources that can prevent redundant investments or costly mistakes. We will continue to self-fund our annual activities and direct 100 percent of this remarkable grant to the benefit of participating members. Unrestricted block grants will allow members to invest in projects that are important to their farm operation. Longitudinal evaluation administered under the auspices of Vermont Law School's Center for Agriculture & Food Systems and the University of Minnesota Tourism Center are tracking these investments and analyzing how involvement with our nonprofit experiment influences the profitability and personal wellbeing associated with agritourism. Our intention is to figure out how agritourism can earn its place as a trusted, sustainable agricultural product beneficial to producers and consumers as well as the State economy.

PROJECT DESCRIPTION

North Star Farm Tour is an all-volunteer, educational organization founded in 2017, funded by membership fees, donations, sponsorships, and grants. In 2019, our 20 members produced a wide variety of quality raw, processed, and finished fiber products, as well as food and artisan goods, livestock, forages, and other income-producing goods that were sold independently. Members collaborated under the North Star Farm Tour banner to accomplish three special educational projects and host an annual farm tour in September 2019. The 2019 tour drew over 5,000 people from over 80 Minnesota cities, five states and seven countries to our 16 tour sites. In our 2019 report, we discussed the great demand from visitors for more North Star Farm Tour programming: farm dinners; wedding venues; events; open-air concerts; farm stays; demonstrations; classes; youth camps; locally grown, sustainably raised products; spring birth experiences; and more.

The Covid-19 pandemic compelled North Star Farm Tour to pivot program priorities, but fortunately that process had begun voluntarily in the fall of 2019. The Minnesota Department of Agriculture's 2019 Agricultural Grown, Research & Innovation Sustainable Agriculture Demonstration Grant survey revealed that the greatest barriers to farm profitability were access to markets and commercializing products. To address those challenges, North Star Farm Tour

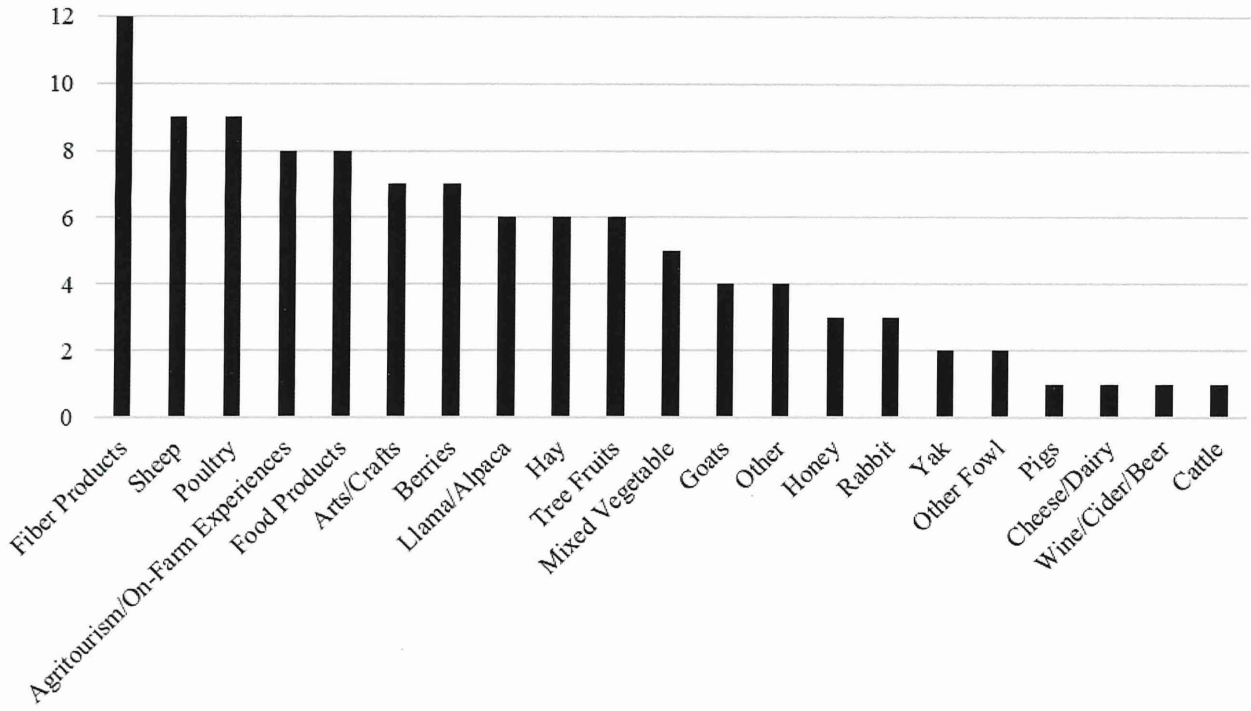


Figure 1. Number of farms producing, 2019-2021.

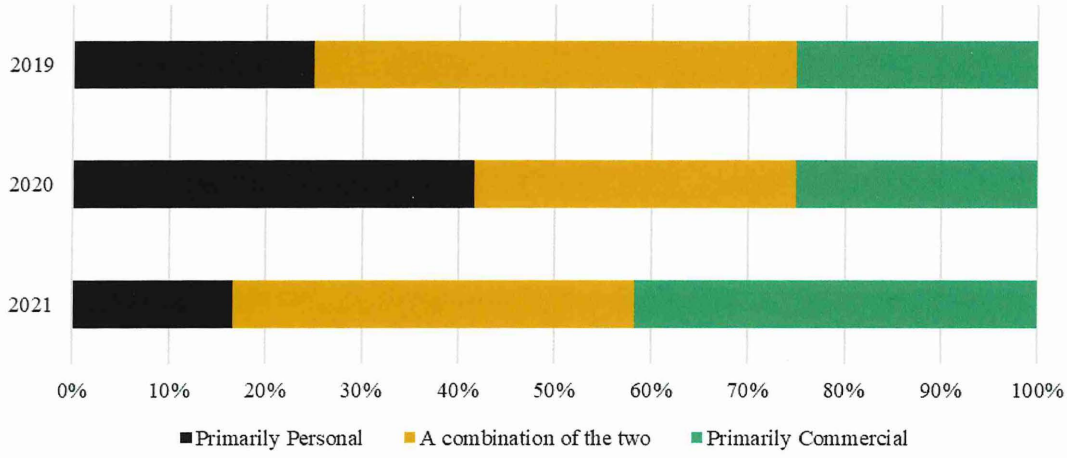


Figure 2. Do you consider your farm to be more focused on producing commercially or for personal use?

contracted with the University of St. Thomas Enactus Club to study entrepreneurship and with Cromie Creative Consultants to survey needs of members and consumers and redesign a new high-profile website. Research was well under way when the pandemic forced closure of public programming in March, and that allowed fast implementation of a three-phase plan that will soon include an e-commerce marketplace and interactive calendar tied to reservations and payments. The expandable website could also feature educational content that is central to the nonprofit mission to serve the public good.

North Star Farm Tour was evolving into a welcoming watering hole for agritourism hosts interested in professionalizing agritourism as a sustainable, profitable, and enjoyable product in the Upper Midwest. Technology became the best answer for serving the needs of agritourism members and the public without expensive overhead. We benefitted from the active involvement of farm members who joined the grant as cooperators before the Dec. 12, 2018 application deadline. Each member received an unrestricted micro-grant of $615 each of three

years to invest in projects beneficial to the agritourism operation on their farm. In return, each recipient agreed to be on the annual tour, serve on at least one North Star Farm Tour committee, attend the annual meeting, and participate in evaluations. The grant also provided three annual speaker stipends of $200 for member education at the mandatory annual meeting. In 2020, with state permission, we opted to reallocate funds from two members who resigned from North Star Farm Tour toward website consulting services. The Board of Directors consulted with the remaining grant recipients to inquire whether they would rather receive a larger block grant or invest those funds in the expert consulting services of cooperator Alison Cromie. To a person, they voted to invest in the interactive calendar.

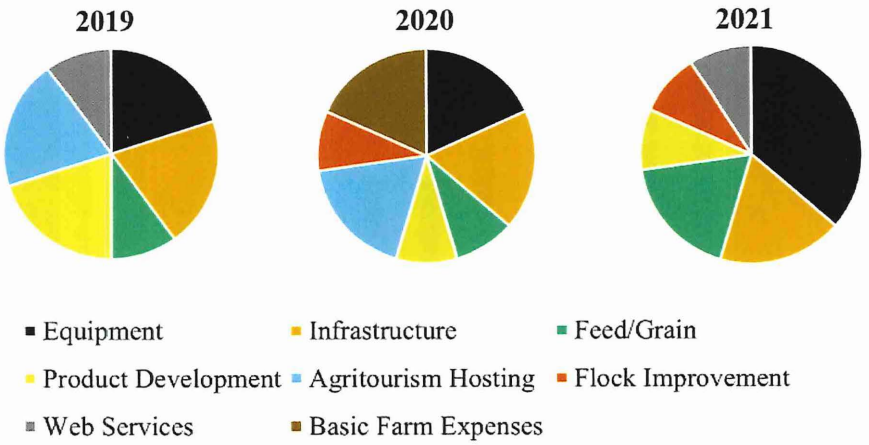


Figure 3. Microgrant Investments by category, 2019-2021

2019 RESULTS

In the first year of this grant, North Star Farm Tour was an active, public-facing organization engaged in multiple partnerships with state agencies and professional organizations to provide resources and innovative opportunities to its members. Internally, it was an organization undergoing transformation to adapt to the needs of its members and the public at-large. At the start of 2019, North Star Farm Tour's mission was "Connecting People, Farms & Fiber."

Throughout the year, members collaborated under the North Star Farm Tour banner to accomplish two special educational projects that were honored with funding and co-labeling from Minnesota Grown.

- *"The Sock Project"* produced 500 pairs of farm-raised wool/alpaca blend socks, spun and knit by two Minnesota mills, and featured in Minnesota Grown's display at the Minnesota State Fair.
- *"Farm2Fashion"* created two couture garments from donated fiber from nine North Star Farm Tour farms. Custom textiles were crafted by Tracy Krumm of Textile Center for designers Tim and Thom Navarro of TIM+THOM. The couture garments were eligible for the Minnesota Grown label, debuted during MN Black Fashion Week, and were featured at Textile Center's 25th Anniversary Gala and the 2020 Uncommon Thread Exhibition.

In addition to the marketing partnerships with Minnesota Grown, North Star Farm Tour engaged in a major health and safety initiative in collaboration with the Minnesota Department of Health (MDH). In May 2019, several members attended an MDH "Fun on the Farm Dinner," where Carrie Klumb, Senior Epidemiologist at the Minnesota Department of Health (MDH), presented on the liability concerns facing agritourism operators from potentially exposing the public to zoonotic diseases during farm visits. Following that event, North Star Farm Tour engaged in conversation and eventually a partnership with MDH to determine best practices for preventing zoonotic disease outbreaks before they happen. In service of this goal, North Star Farm Tour designed and built modular, transportable handwashing stations for every member to keep on their farm for use by visitors. North Star Farm Tour also became the first agritourism organization in the country to require that every member be certified through the Safer Farm Animal Contact Exhibits (Safer FACEs) Training.

The other major organizational development during 2019 was North Star Farm Tour's adoption of a diversity and inclusion policy. In early 2019, the Minnesota State Arts Board, began a rulemaking to amend its grant evaluation criteria to require applicants to address diversity, inclusion, and equity in their organization. In response, the North Star Farm Tour membership discussed at length what a commitment to diversity, equity, and inclusion looks like for agritourism operations and what steps the organization could take to be welcoming and inclusive to all. The adoption of that policy drove North Star Farm Tour to secure grant funds through the Mayo Clinic and Upper Midwest Agricultural Safety and Health Center (UMASH) to pay for the translation of MDH's handwashing posters into 21 different languages. The translated versions of the poster are available online through the North Star Farm Tour website, which can be easily accessed through a QR code

available on the sign. This initiative grew out of North Star Farm Tour's recognition that the public its members serve is diverse and their commitment to providing safe agritourism experiences requires them to "Reach and Teach Everyone."

In Fall 2019, North Star Farm Tour also entered a partnership with the University of St. Thomas Enactus Club, a student organization focused on entrepreneurship and creative problem-solving to help others get business ideas off the ground. Through this partnership, the University of St. Thomas business and entrepreneurship students began working with North Star Farm Tour members to conduct a Member Needs Assessment and entrepreneurship training. Through their collaboration, North Star Farm Tour decided as a first step to change its mission to make it more accessible to the public. At the close of 2019, North Star Farm Tour began 2020 as "a 501c3 educational nonprofit organization dedicated to connecting people with agriculture through safe, fun, educational agritourism."

2020 RESULTS

After the flurry of activity in 2019, 2020 was the year no one saw coming. When COVID-19 hit in March of 2020, North Star Farm Tour was just beginning to plan for its 2020 Fall Tour. After consulting with the MDH, North Star Farm Tour decided early in the year to cancel the 2020 tour and refocus all efforts into digital asset development, virtual educational opportunities, and organizational development.

Instead of hosting a 5,000 plus person farm tour, North Star Farm Tour:

1. Presented at the Upper Midwest Agricultural Safety and Health regional conference.
2. Coordinated with Upper Midwest Agricultural Safety and Health to laminate and distribute our handwashing farm safety poster (which is translated into 20 languages) for free distribution.
3. Produced free digital blueprints and an explanatory video on how to build a modular handwashing station that met public health recommendations.
4. Self-funded a complete rebuild of the North Star Farm Tour website, guided by the advice of a professional web consultant, entrepreneurial advice from the University of St. Thomas Enactus Club, and a Covid-compliant planning retreat

   The website transitioned from GoDaddy to WordPress and is now hosted on a new server. Content on the farm safety page is now linked to the agencies that are distributing that information, our YouTube channel, and other social media. The new website has capacity to house an infinite number of videos and other resources to be made available to our members, other farmers, agricultural organizations, public agencies, private corporations, and specific target audiences.

2021 RESULTS

In the second year of COVID-19, North Star Farm Tour remained closed with its public-facing events shuttered. The organization's focus on digital entrepreneurship and programming continued in this second year, with the goal of helping farms adapt to the new circumstances of the pandemic. In 2021, North Star Farm Tour:

1. Deepened its partnership with the University of St. Thomas.
   a. The Enactus Club engaged in further entrepreneurship training of farm members and further analyzed the 2020 Member Needs Assessment to direct North Star Farm Tour programming.
   b. The University of St. Thomas Business 200 Class formally accepted North Star Farm Tour as one of its case-study organizations. This allows North Star Farm Tour to benefit from having students in that class work with North Star Farm Tour throughout the semester to satisfy the students' practicum requirements. Through this class, two students worked with North Star Farm Tour to begin working with farms one-on-one to create business plans and to create a social media plan for North Star Farm Tour.
2. Created a classroom segment with Minnesota Agriculture in the Classroom.

   Minnesota Agriculture in the Classroom provides free curricula, educational resources, grants, outreach, and professional development opportunities to increase agricultural literacy through K-12 education. The content

creators at this organization collaborated with North Star Farm Tour to create an educational video about natural fiber production and processing that will be freely available on the Minnesota Agriculture in the Classroom website.

3. "The Sock Project 2.0" produced 500 pairs of farm-raised wool/alpaca/yak blend socks, spun and knit by two Minnesota mills, and co-labelled with Minnesota Grown for sale through North Star Farm Tour members' farms.

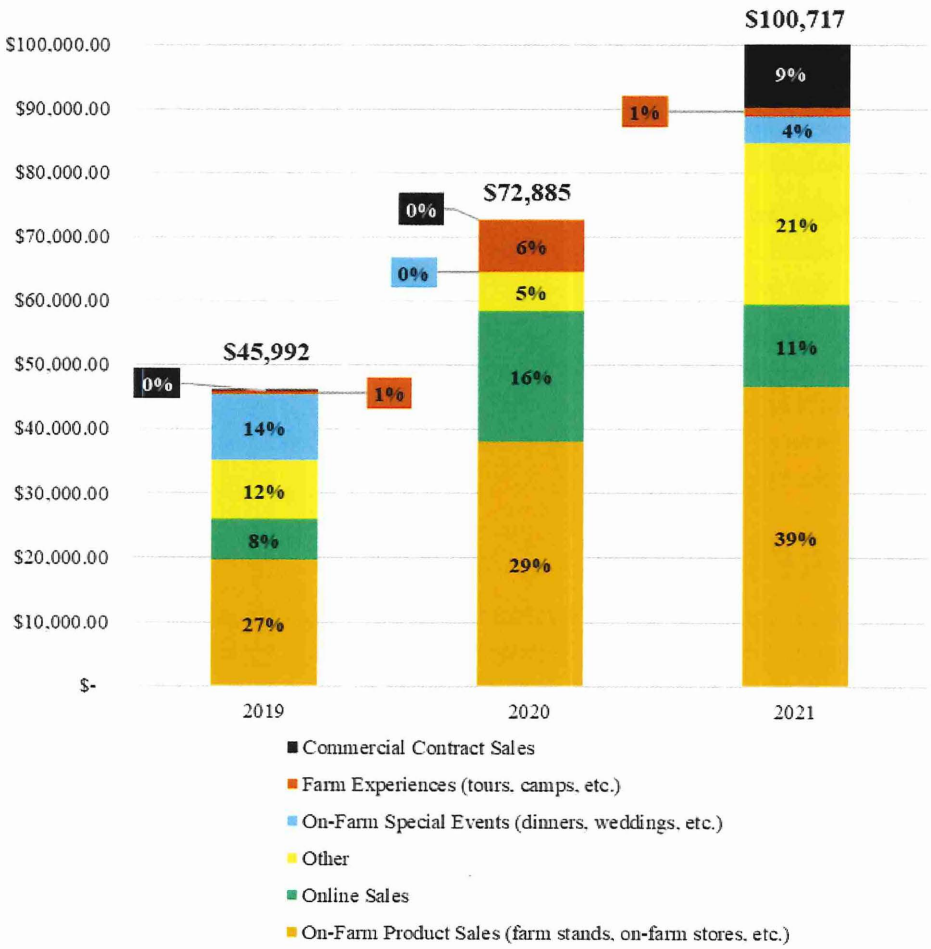
In late 2021, North Star Farm Tour self-funded the expansion of the website to include a calendar feature where member farms can collectively list upcoming on-farm events and the public can easily register online and direct the registration fees to the farm hosting the event with North Star Farm Tour to create an educational video about natural fiber production and processing that will be freely available on the Minnesota Agriculture in the Classroom website.

DISCUSSION OF RESULTS

This study provided a unique opportunity not only to examine how farmers chose to invest microgrants to benefit their agritourism operations, but also provided a snapshot of how diversified, smallholder agritourism operators responded and adapted to the Covid-19 pandemic in 2020 and 2021. Despite the ongoing disruptions and pressures of the pandemic and an organizational decision to stop all coordinated public-facing events, the members involved in this grant reported increased profits over the three years. This demonstrated that one contingent of farms became significantly more dedicated to commercializing their operations across the study period. Farms that did not begin this grant process dedicated to profit-generation, generally, continued to report lower levels of profits across all three years of the study.

Almost all farms reported increased satisfaction from and personal enjoyment of running their farm in 2020 than in 2019 or 2021. One hypothesis for this, based on the qualitative results given in the surveys, is that the shutdowns of 2020 provided farmers an opportunity to focus their time and attention on their farms, whether to enjoy them or to expand on their businesses depending on their motives for owning their farm. One of the biggest barriers to profitability and enjoyability that farmers cited in 2019 and 2021 was external time constraints that limited their opportunity to enjoy their farm, process fiber and produce new products, or run the business activities in addition to daily farm tasks. In 2020, the pandemic largely removed those external time constraints and allowed farmers to focus their attentions closer to home. Even during a year when farmers were experiencing severe disruptions to their lives, their farms proved to be a haven that helped individuals be resilient in the face of unpredictable change.

After three years of distributing microgrants and tracking investment decisions, the main lesson is that providing farms with small amounts



Note: Amounts represent total gross farm income reported, by category of farm activities, across all 11 farms that disclosed income data by category in the 2019-2021 surveys. In 2020 and 2021, farms reported a blurred line between "online sales" and "on-farm sales," as many sales happen online with on-farm pick-up as an option.

Figure 4. Total farm income by category, 2019-2021

of capital can (1) help mitigate the financial risks that prevent farmers from investing in new product lines or activities, (2) survive through extreme financial and social hardship in a pandemic, and (3) undertake necessary improvements (in infrastructure, marketing, etc.) in a way that improves the outcomes of those investments for the farms.

To read the full results of the three-year longitudinal study that evaluated this SADG Grant project, download the full report on the "Resources" page of the North Star Farm Tour website. The report is listed under the following name: Wustenberg, Lauren R. *Exploring North Star Farm Tour as a Sustainable Agri-Tourism Model for Small Producers, Final Grant Evaluation* (2022), North Star Farm Tour.

MANAGEMENT TIPS

1. Agritourism must always be safe. Certify yourself by completing the Safer FACEs Training Program available on umash.umn.edu and then working to adopt those best practices on your farm with training for everyone who will work or volunteer in your agritourism activities.
2. Consumer demand for fun agritourism activities has never been higher and there are many well-tested tactics to meet that demand safely and affordably with in-person and virtual events. Membership in organizations like North Star Farm Tour that focus on agritourism hosting can help you save time and money figuring out ideas that work for you.
3. Education is the bridge between what we farmers know and 99 percent of people who know precious little about agriculture. Prepare yourself with research-based information to answer countless questions about yourself, your farm, your agricultural practices, the natural world, animal care, food production, arts and crafts, and experiences that we as farmers sometimes take for granted. View everything you do, including casual conversation, as an educational activity.

COOPERATORS

The Berryhill Farm – Pine Island, MN

Cannon Valley Graziers – Northfield, MN

Clear Spring Farm – Welch, MN

Frosty Acres Alpacas – Bricelyn, MN

Harvest Hill Acres – Dennison, MN

Pauley Alpaca Company – Rochester MN

Prairie Haven Farm – New Prague, MN

Prairie Plum Farm – Mabel, MN

The Farmer & The Rancher – Vermillion, MN

Wildflower Farm – Cokato, MN

Windswept Hill Farm & Studio – Farmington, MN

OTHER RESOURCES

northstarfarmtour.org – The Evolving Website of North Star Farm Tour

northstarfarmtour.org/project/farm-safety-and-health – Visit this page of the North Star Farm Tour website to:

- Access our important farm health & safety information
- Download posters about handwashing, which is translated into 20 languages to make farm safety information accessible to all visitors
- Download professional blueprints for our custom-designed, modular handwashing station for improving farm visit hygiene.

For a fantastic video on how to build the handwashing station, visit www.youtube.com/watch?v=UuT7CBnPsi4

www.health.state.mn.us/saferfaces – Link to Farm Safety Training & Certification

umash.umn.edu/resources – Excellent Resources for Agritourism Hosts

www.misa.umn.edu/resources/blazing-trails – Food Regulations Training in 2020

Grazing Intermediate Wheatgrass (Kernza®) as a Dual-Use Crop for Forage and Grain Production

Kernza® Grain Harvest – August 2020 Anderson Farm

PRINCIPAL INVESTIGATORS

Alan Kraus
Cannon River Watershed Partnership
710 Division Street
Northfield, MN 55057
507-786-3913
alan@crwp.net
Rice and Goodhue Counties

PROJECT DURATION

2018 to 2021

AWARD AMOUNT

$24,965.00

KEYWORDS

Kernza®, grazing, forage, grain yields

PROJECT SUMMARY

This demonstration grant addressed the needs of grain and livestock managers in the Cannon River Watershed (and SE Minnesota) with an interest in grazing Kernza® on their farms for biomass production and crop diversification, as well as the larger grower audience throughout the upper Midwest. We collected Kernza® grain and forage biomass production and quality information from two farms each with six to seven acres of Kernza®. We measured grain and forage production in grazed and un-grazed (controls) systems. We used actual (current) market values of harvested grain and long-term market values of forage to create an enterprise budget of a Kernza® cropping system.

The development of data sets and enterprise budgets made publicly available on the web will enable easy access to information important for livestock managers and land use decision makers. Our findings show that the dual use of Kernza® for both grain and forage production could increase the financial returns for Kernza® growers, encouraging adoption of a crop with great potential to increase the productivity and sustainability of Minnesota cropping systems.

PROJECT DESCRIPTION

This project tested and demonstrated the viability of Kernza's® dual use for grain and forage production on two Minnesota grain and livestock farms. The effect of grazing, versus no grazing, on grain production and net returns was evaluated by comparing forage and grain yields among the grazed portion of the field and exclosures (non-grazed areas within the field).

Prior to Kernza® grain harvest each year, we collected hand samples by clipping two 0.5-m2 quadrats in each exclosure, and six randomly place 0.5-m2 quadrats in the grazed portion. Grain spikes were hand threshed, and grain weighed to determine grain yields. Grain was harvested with an at-scale combine in August of each year.

After grain harvest, the Kernza® crop regrowth was grazed in late October or early November. The early spring regrowth of the Kernza® crop was grazed in May. Forage biomass production was estimated by randomly placing 0.5-m2 quadrats and hand cutting to a stubble height of two inches. The biomass was weighed wet, dried in an oven at 55 degrees Celsius, and weighed dry to calculate dry matter yields and moisture content. Dry biomass was ground and analyzed for forage quality using NIRS. Biomass yield estimates determined the grazing stocking rates and duration. Livestock grazing was managed to leave a short stubble height (less than two inches) by rotation throughout the field via planned paddocks. Livestock behavior while grazing was observed and recorded by the

Table 1. Grazing timeline and other field activities at each farm.

Grazing Intermediate Wheatgrass (Kernza®) as a Dual-Use Crop for Forage and Grain Production, Grazing Timeline										
	Fall 2018	**Spring 2019**	**Summer 2019**	**Fall 2019**	**Spring 2020**	**Summer 2020**	**Fall 2020**	**Spring 2021**	**Summer 2021**	**Fall 2021**
Anderson	Sprayed Glyphosate Sep 2	Sprayed 2,4-D Jul 3	Grain harvest Aug 23	**Grazed Oct 15-20**	**Grazed May 15-22**	Grain harvest Aug 8	**Grazed Nov 1-10**	**Grazed May 10-16**	Grain harvest, planned	**Grazing planned, Oct/Nov**
Anderson	Planted no-till Sep 10	Rested, no grazing	Applied 5000 gal liq dairy manure		Applied 5000 gal liq dairy manure	Applied 5000 gal liq dairy manure		Applied 5000 gal liq dairy manure	Apply 5000 gal liq dairy manure, planned	
Honken	Tilled, disc 2x	Stand failed, mowed & tilled	Tilled new plot	Sprayed 2,4-D Sep 19	Rested, no grazing	Grain harvest Aug 18	**Partially grazed Oct 19-20**	Applied 90 lbs Urea/ac Apr 15	Cut & harvest forage only Aug, planned	**Grazing planned, Oct/Nov**
Honken	Planted Sep 14		Planted Aug 12					**Grazed May 7-13**	Apply 90 lbs Urea, planned	

farmers and proper health management was performed while grazing (water, nutrient block, etc. available as necessary for livestock health). Forage utilization was estimated post-grazing by randomly placing quadrats and collecting remaining biomass to two inches. Forage laboratory procedures were as described above.

Kaleb Anderson's 2018 Kernza® plot established well by spring 2019, allowing grain and straw harvests along with spring and fall grazing in 2019 and 2020. Spring grazing occurred in 2021 with grain, straw and fall grazing planned at the time of this report (August 2021).

Dan Honken's 2018 Kernza® plot did not establish well by spring 2019, demanding early termination and causing planting a new plot in summer 2019. Grain and straw harvests on this new plot in August 2020 were followed by a truncated grazing in October 2020 due to heavy snow accumulation. Spring grazing occurred in 2021, however drought conditions and forage needs led to harvesting only the Kernza® forage (no grain) in 2021.

RESULTS

Forage yields

Forage yields varied by season but there were inconsistencies in seasonal variation across years and across farms. At the Anderson farm, forage yields increased from the fall of 2019 to the fall of 2020. Forage yields were relatively low in the fall of 2019, which may have been attributed to lower plant populations observed during the establishment year. Forage yields peaked in fall 2020, which may have been related to increases in stand density as stands aged. Although forage yields decreased from fall 2020 to spring 2021, this was expected as previous studies have shown more forage availability in fall compared to spring. This seasonal trend was evident at the Honken farm.

After grazing was initiated in the fall of 2019 at the Anderson farm, there was no difference in forage yield in grazed versus ungrazed stands until spring 2021, where forage yields were lower in grazed compared to ungrazed stands. This suggests that grazing may have limited to no effects on subsequent forage availability for the first year of dual-use management.

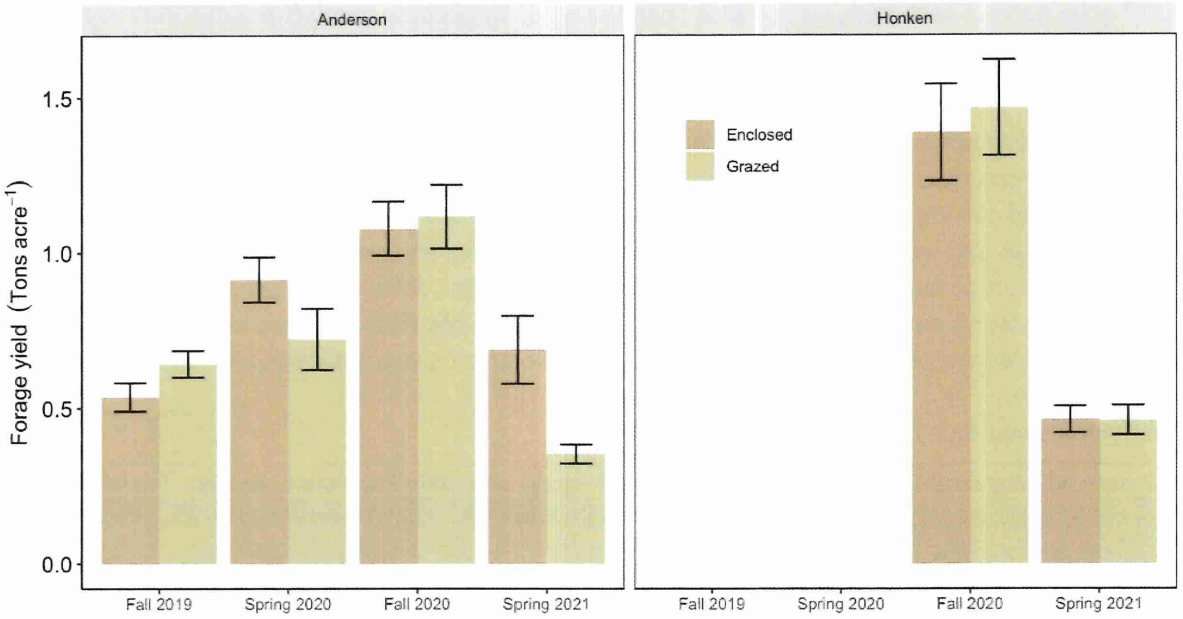


Figure 1. Kernza® forage yield measured in the spring and fall.

Forage quality

Forage quality was measured using the Relative Feed Value (RFV) calculation, which considers the protein, acid detergent fiber (ADF), and neutral detergent fiber (NDF) contents of the forage. These variables were measured using near-infrared spectroscopy.

The RFV was relatively higher than expected in fall 2020 at the Anderson farm but measured during the other seasons were as expected. The seasonal pattern showed that RFV was greater than 100 in the spring and less than 100 in the fall, with the exception of the fall 2019 values at the Anderson farm. There was no effect of grazing on RFV until spring 2021, where RFV was greater in the grazed vs. ungrazed plots. This suggests that the effects of grazing, although delayed until after the first year, generates less but higher quality forage in the spring.

Grazed and ungrazed stands of Kernza®

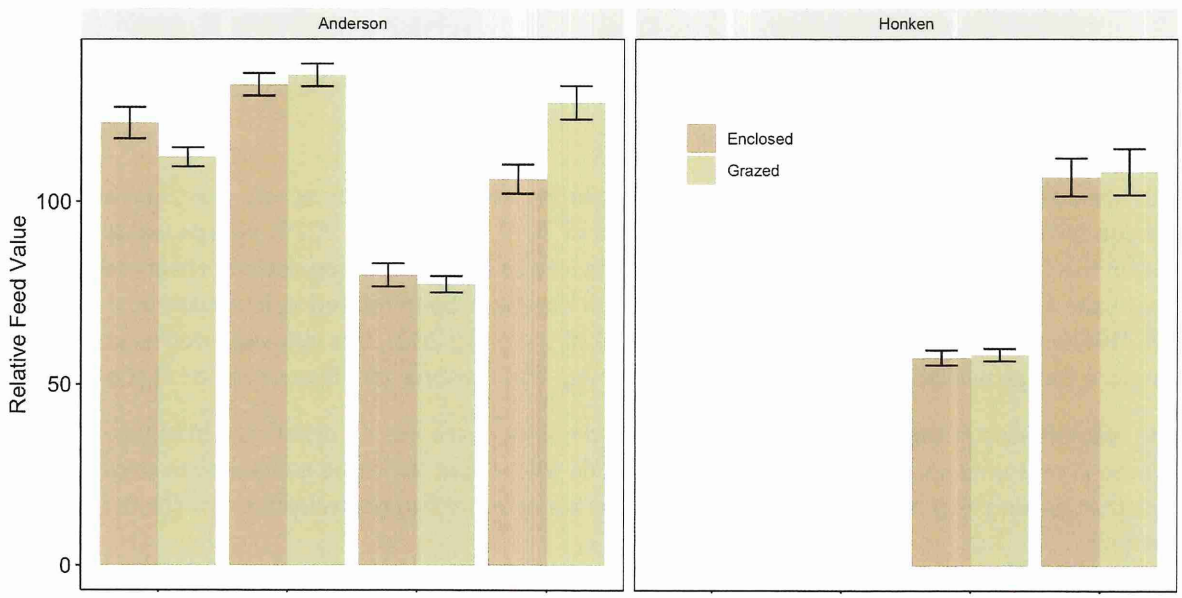


Figure 2. Relative feed value of Kernza® forage measured in the spring and fall.

Effects of grazing on IWG grain yields

Grain yields declined by 29 percent in stands that were grazed the spring and fall previous to harvest compared to ungrazed stands. Grain yields from the Anderson farm in 2020 were similar to those observed from other year 2 stands, and greater than realized yields obtained during production scale harvest. This difference in potential yield versus realized yield is similar to observations from previous production fields and indicates that research is needed to better define the timing and techniques used for production scale Kernza® harvest to maximize yield and profitability.

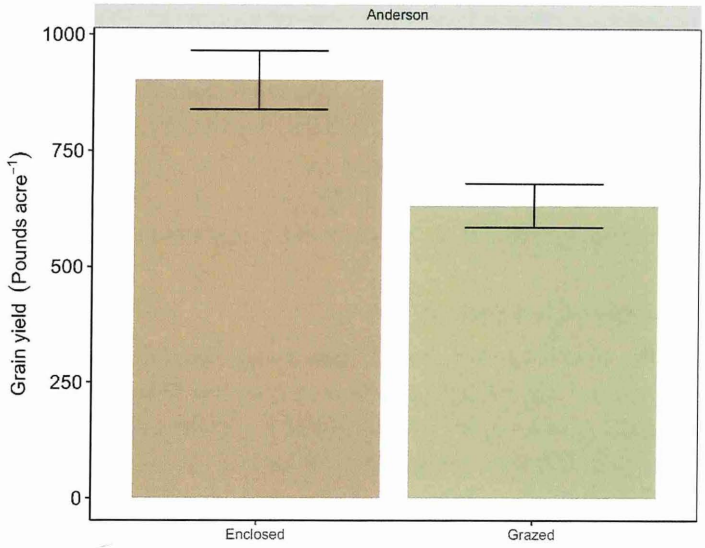


Figure 3. Kernza® grain yield in 2020.

600 pounds per acre uncleaned. Photos: Alan Kraus

Straw yields

Straw yields declined by 41 percent in stands that were grazed the spring and fall previous to harvest compared to ungrazed stands. Straw yields of 4,500 pounds (83 percent dry matter) were similar to previous studies and represent additional revenue for growers.

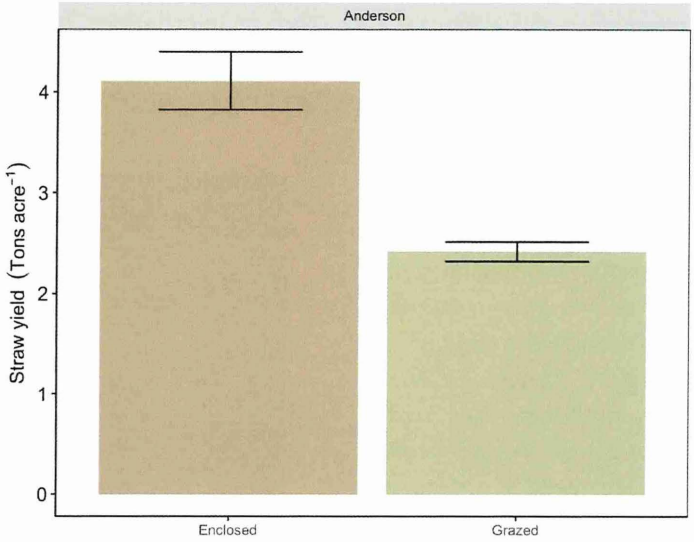


Figure 4. Kernza® straw yield in 2020

Forage utilization

Forage utilization was determined by measuring forage availability after the grazing event and is represented as a percent of forage availability prior to grazing. Forage utilization varied by season and by year at the Anderson farm. Stocking rates and the duration of the grazing event greatly influence utilization. Utilization was greatest in fall 2020 when yields and quality were greatest. Low forage availability in spring 2021 may have reduced utilization potential.

Soil

All the soil data presented are from the Anderson farm. There were no changes in pH, Nitrogen (N), or organic matter from the start of the experiment to the end, and no differences across the grazing versus control treatments. There was a significant difference in soil available total Phosphorus (P) in grazed versus control (ungrazed) stands. Soil P averaged 56.5 parts per million from 0-15 centimeters prior to the start of the study. Soil P dropped significantly to 38.8 and 30.0 parts per million in the grazed and ungrazed areas, respectively.

Grazing also affected soil available Potassium (K). Prior to the start of the study, soil K averaged 422.5 parts per million. At the end of the study, soil K decreased to 372.7 ppm in the grazed area and further to 294.9 parts per million in the ungrazed area. Manure from grazing cattle may have deposited P and K back to the soil, thus allowing for higher levels compared to ungrazed areas.

Table 2. Changes in soil pH, organic matter, Phosphorus, and Potassium during experiment.

	Baseline	Final grazed	Final ungrazed
pH	7.4	7.3	7.3
OM	3.8	3.9	3.8
P	56.5	38.8	30.0
K	422.5	372.7	294.9

Financial Outcomes

Readers of this report should note that while the financial outcomes in this case study showed growing Kernza® was profitable, the Kernza® grain market is just now being developed. The Kernza® grain price points (actual or estimated) used in this analysis were contracted (in part) prior to the start of this project. Aspects of Kernza®'s value profile that have potential to increase the price of Kernza® grain - such as groundwater protection, carbon sequestration, and the social infrastructure of rural communities - all could be linked to scaling Kernza® production but were not a focus of this study. It is not yet clear if these early-market pricing estimates accurately capture all these aspects. As such, this study's profitability analysis should not be interpreted as a comprehensive quantification of the positive externalities that could be attributed to Kernza® production at scale on the landscape.

Post grain forage – Straw harvest – Anderson Farm 2020. Photo: Alan Kraus

Furthermore, although this case study found that growing Kernza® is profitable, production risks associated with weather and crop protection (weed and insect management products are not yet licensed), and marketing risks associated with Kernza® being a new entrant into a highly competitive food grain market, provide a balance to the profit metrics reported.

To determine financial outcomes, production inputs and outputs from each farm were recorded from August 2018 through the time of this report (August 2021). Actual input expenses from August 2018 through August 2021 were used in enterprise budgets, and then were estimated for the remainder of 2021. Actual output (Kernza® grain) revenues were used for 2019 and 2020 from the Anderson farm. The Kernza® grain value for the

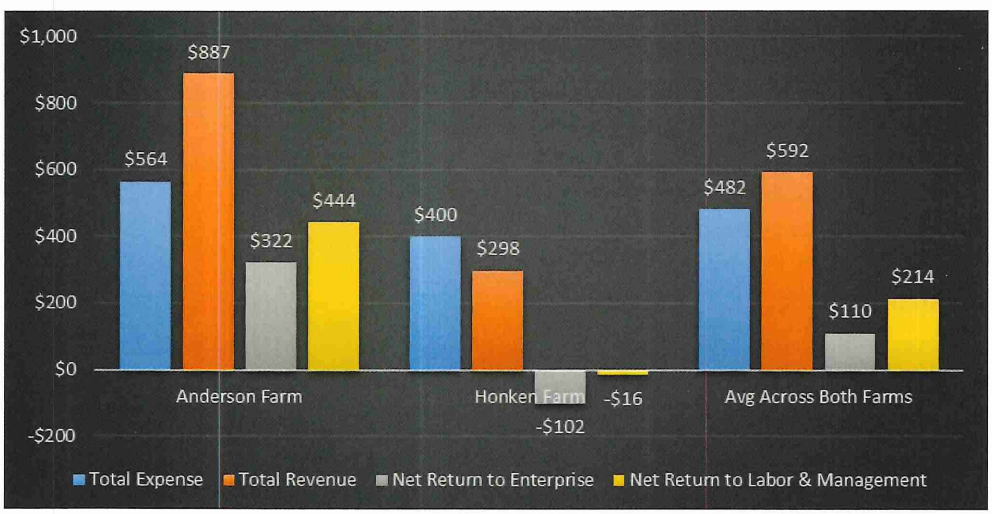


Figure 5. Financial outcomes per acre per year Kernza® dual use 2018-2021. (Includes one failed crop and one year grain not harvested on one farm.)

Honken farm in 2020 was estimated based on the Anderson farm actual prices. Straw actual output production from both farms was recorded through 2020 and estimated in 2021 based on these actuals. Grazed forage production was based on the forage sampling results through May 2021 and the Fall 2021 grazing forage was estimated based on these results. Because the Kernza® seed was planted in the early fall of 2018, we used 3.5 years to determine a per acre per year result. (Note: While this MDA Sustainable Ag Demonstration Project ended on June 30, 2021 we continued to collect data through August 2021. No MDA grant funds were used for this project beyond June 30, 2021.)

The financial results varied significantly between the two farms. Net Return to Enterprise (total revenues less total expenses including management and labor) for the period 2018-2021 ranged from a net positive (profit) of $322 per acre per year on the Anderson Farm to a net negative (loss) of $102 per acre per year on the Honken Farm.

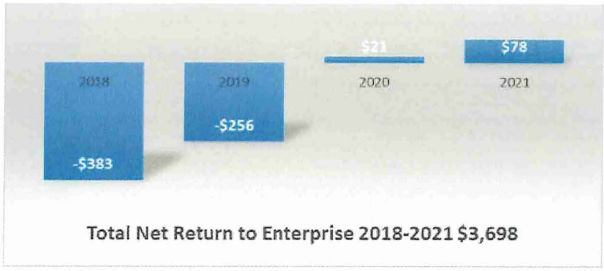


Figure 6. Kernza® production financial outcomes dual use cumulative net return to enterprise per acre across two SE MN Farms.

The net negative outcome on the Honken Farm was driven by the terminated crop in 2019 and a new Kernza® planting. Drought conditions and forage needs required the Honken Farm to harvest only the forage production in 2021 (no grain harvest) further impacting the financial outcome negatively. Grain sales of $3,070 (292 pounds per acre at $1.50 per pound) in 2021 would have yielded a breakeven for this farm. Averaged across both farms and given these conditions, the average net return to enterprise for Kernza® Dual Use was $110 (profit) per acre per year.

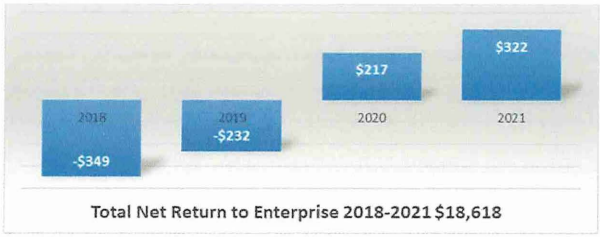


Figure 7. Kernza production financial outcomes dual use cumulative net return to enterprise per acre, Anderson Farm.

The computation for Net Return to Labor and Management accounts for all expenses except the operator labor and management. This computation provides the margin available to cover unpaid operator labor and management as well as profit.

Because revenue generation from Kernza® production (grain) harvest was delayed 11-12 months after planting, positive net returns were likewise delayed. On the Anderson Farm, a cumulative positive net return to enterprise was achieved with the sale of the Kernza® grain and the value of the straw (23 months after planting). The total net return to enterprise on the Anderson farm was $18,618 over the 3.5 years or an average positive net return of $322 per acre per year (graph right).

In this study, the failed crop on one farm reduced the cumulative net return to enterprise significantly when averaged across both farms, however, by 2020 the net return was basically at breakeven (graph right) even with the failed crop and no grain harvest in 2021 on the Honken Farm.

This study found that grazing Kernza® biomass in spring and fall reduced Kernza® grain production in the following year by 29 percent. Based on the data collected on these

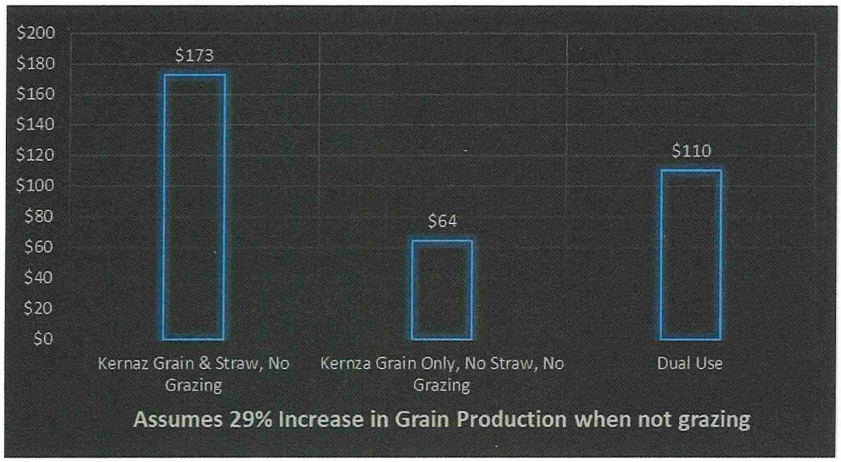


Figure 8. Comparing Kernza® production options average net return to enterprise across two SE MN farms, 2018-2021 per acre per year.

two farms (given the failed crop and no grain harvest on one farm in 2021), a 29 percent increase in grain production along with the straw value resulted in the highest net return to enterprise (graph on previous page). However, the Dual Use system (grain, straw and grazing) resulted in the highest return when the actual grain yields were applied with no increase in grain yield (graph right).

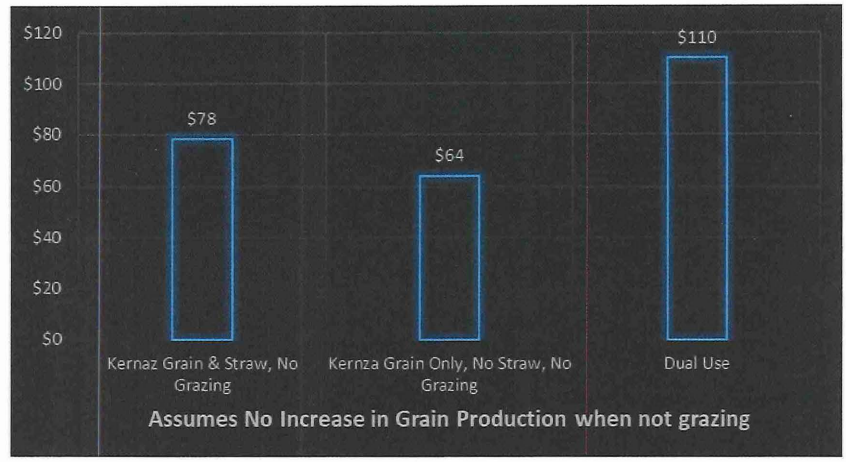


Figure 9. Comparing Kernza® production options average net return to enterprise across two SE MN farms, 2018-2021 per acre per year.

MANAGEMENT TIPS

1. Work closely with consultants that have expertise growing intermediate wheatgrass and specifically Kernza® or MN Clearwater.
2. Plant Kernza® or MN Clearwater prior to September – preferably mid-August – following seeding rate recommendations and avoid choosing soils that tend to be wet or have poor subsoil drainage.
3. Direct combine if the straw will be utilized on farm, in which case delay harvest until seedheads are brown and dry. Swath to maximize grain yields and provide flexibility in harvest timing but expect potentially lower straw yields. Graze or mechanically harvest vegetative regrowth late October.
4. Grain should be less than 35 percent moisture for direct combining and 50 percent or less for swathing. If swathed, use a draper head. For storage, grain should be at 13 percent moisture and grain drying may be needed.
5. If sown in late summer, Kernza® helps to control many spring-germinating weeds the following year. In subsequent years, however, perennial weeds can start becoming an issue in Kernza® swards. Research showed an 88 percent overall reduction of weeds over the course of three years.
6. Kernza® scavenges soil nutrients very effectively so soil tests probably should be considered after terminating a field of Kernza®. The amount of required N P K in such a field likely will be on the high side compared to amounts required after corn or soybean. Keep in mind that during the 3 to 4 years of the Kernza® stand's life, much less fertilizer would have been applied in comparison to a typical field in a corn-soybean rotation.

COOPERATORS

Dan Honken
5680 120th Street West
Faribault, MN 55021
507-339-1941

Kaleb Anderson
12535 335th Street
Goodhue, MN 55027
651-334-3366

Monitored spring/early summer Kernza® growth. Controlled weed growth with herbicide application 2019. Harvested Kernza® – direct combine in 2019 and swathed in 2020, baled Kernza® straw, dried and stored grain, set-up paddock exclosures and grazed cattle in the fall and spring.

OTHER RESOURCES

kernza.org

CRWP Kernza® Video: www.youtube.com/watch?v=_1WqKX-678k

Regenerative Agriculture: A Pathway for Greater Farm Profitability and Practice Adoption

Cover crop growth shown post-harvest at Jaeger Farm, fall 2021.

PRINCIPAL INVESTIGATOR

Alan Kraus
Clean Water Partners
710 Division Street
Northfield, MN 55057
507-786-3913
Alan@cleanriverpartners.org
Rice and Goodhue Counties

PROJECT DURATION

2019 to 2022

AWARD AMOUNT

$41,534.30

KEYWORDS

interseeding cover crops, wide row corn, biomass production, profitability

PROJECT SUMMARY

In 2019, Clean River Partners (CRP) was awarded a three-year Sustainable Agricultural Demonstration Grant (SustAg) from the Minnesota Department of Agriculture (MDA) to assess wide-row corn productivity trade-offs in a dual-use cropping system. This project tested the effect of corn row-width on cover crop biomass and corn grain yields and provided information about how to improve profit.

PROJECT DESCRIPTION

During the 2019-2020 growing seasons, four Southeast Minnesota farmers planted 16-20 acres of corn in four to five replicated plots using three different row widths and a control and then inter-seed a cover crop mix into the corn in late June. In 2021, three farmers planted 4.5-9 acres of corn in three replicated plots using two different row widths and a control. After corn grain harvest, the cover crop added to the corn stover to create a more nutritious forage that was grazed or harvested mechanically. Partial budget analysis utilizing the resulting grain and biomass results provided insights on each treatment's profitability relative to the control.

Associate Professor Samantha S. Wells, Department of Agronomy and Plant Genetics, University of Minnesota, and Professor William Lazarus University of Minnesota – Extension Economist collaborated extensively on this project. Dr. Wells guided project design and provided staff for field activities and data collection. Dr. Wells also provided analysis of the results. Dr. Lazarus led economic analysis and efforts designing an economic decision tool for farmers.

- Study treatments
  1. 30-inch row corn with cover crop
  2. 30-inch row corn without cover crop
  3. 0-inch row corn with cover crop
- Plant four 30-inch rows – Skip 2 (Balanced) with cover crop
- Test plots – constant for years 2019-2020; new test plots chosen in 2021
- Rotations – 2019 – corn following soybean; 2020 – corn following corn; 2021- corn following soybeans
- Tillage – conservation tillage technologies used across locations
- Corn varieties – varied across farms, relative maturities ranged from 92-102, three farms planted glyphosate tolerant, and one farm planted non-GMO (See attachment for planting dates)
- Corn populations – study design was to hold population per acre constant between treatments; however, the wide row treatments were 19 percent lower than the 30-inch treatments (See attachment for detail)
- Nitrogen management – applied in split applications per yield goals at 30-inches spacing across all treatments
- Cover crop mixtures – farmers selected the cover crop mixtures with the main goal of producing high forage yield and quality (e.g., annual ryegrass, clovers, kale, radish, turnip, and cowpea. See attachment for detail and planting dates)
- Inter-seeding cover crops – inter-seeded into V3-V6 corn in mid-June to early July with modified air-seeders; slight incorporation was used on three farms while one farm did not incorporate broadcasted seed.

RESULTS

The 60-inch wide-row corn and the balanced treatments reduced corn yields per acre overall by 17 percent relative to the 30-inch treatments, both with and without a cover crop. The amount of biomass supplied by the inter-seeded cover crop in the 60-inch row treatment averaged 1,126 pounds per acre of high quality (162 Relative Feed Value, 21 percent Crude Protein) dried forage over the three years but reached 1,764 pounds per acre in 2021. The amount of biomass supplied by the inter-seeded cover crop in the balanced row treatment averaged 1,592 pounds per acre of high quality (169 Relative Feed Value, 22 percent Crude Protein) dried forage over the three years. The total biomass also included weeds, which were higher in 2021 compared to 2019 and 2020, and did add to available grazing or mechanical harvest, but their amounts and nutritional quality were not measured separately from the cover crop species. After corn harvest, cattle grazed the fields, or the stover-cover crop mix was harvested mechanically. The farmers stated that cattle devoured the stover-cover crop forage very quickly.

The amount of biomass supplied by the inter-seeded cover crop in the 30-inch row treatment averaged 281 pounds per acre of high quality (157 Relative Feed Value, 22 percent Crude Protein) dried forage over the years 2019-2020. Corn grain yield for this treatment averaged 191 bushels per acre, nearly the same as the control's 194 bushels per acre.

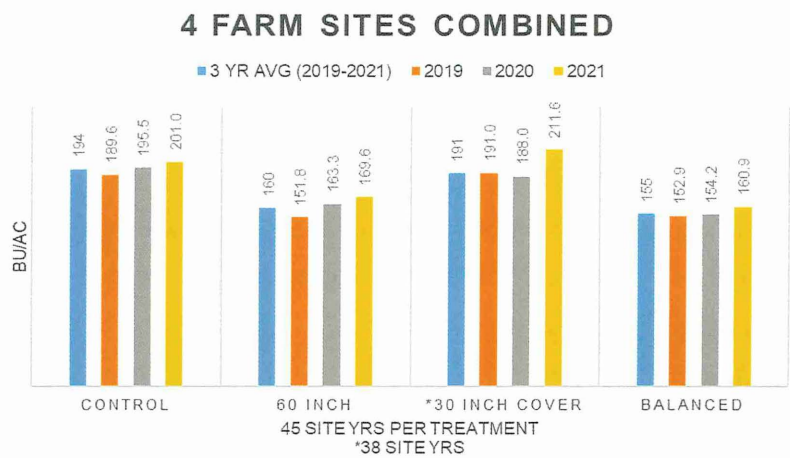


Figure 1. Corn grain yield among three treatments and a control during 2019, 2020, 2021, and average yield of the three years.

ECONOMIC ANALYSIS

Profitability of the wide-row system is most attractive in a situation where the corn stover was not previously utilized but will now be

utilized by either grazing or baling. In this situation, our analysis shows that high yielding, high quality cover crop forages (1,126 pounds per acre dry matter) can offset up to 14 percent of corn grain reductions through the production of milk and muscle, even without accounting for the soil health or environmental benefits. Wide rows are less attractive when the corn stover would have been utilized anyway. In this case, the cover crop improves the nutritional quality of the stover-cover crop mix, but the forage volume is not increased because the cover crop volume is offset by the reduction in stover volume due to the lower corn yield (Corn stover yield varies with corn grain yield). Other considerations in this analysis are: the cost of seeding the cover crop; reduced corn seed cost due to a lower seeding rate in the wide rows; fencing and watering costs; trampling losses; and the value of phosphorus and potassium removed with the corn stover and the cover crop harvest.

The decision tool is available in either a web version at wl-webtools.shinyapps.io/widerow, or a spreadsheet version at wlazarus.cfans.umn.edu/william-lazarus-spreadsheet-decision-tools. Some key results and inputs are shown below for a scenario where a cover crop yield at 1,126 pounds per acre dry matter per acre of cover crop is expected along with a 17 percent reduction in the corn grain yield. The stover-cover crop mix is grazed after corn grain harvest with 60-inch rows but not in 30-inch rows without a cover crop.

Table 1. Overall analysis of wide corn rows with a cover crop.

Analysis of wide corn rows with a cover crop			
	Main inputs		
Corn grain yield, bushels/acre - base, expected with normal row width	189		
Corn grain yield change scenario for wide spacing	-17.0%		
Cover crop yield - lb/acre before trampling or harvest loss, DM	1,126		
What normal-width row scenario would you like to compare the wide row scenario to?	don't graze or bale the corn stover		
Would you graze the cover crop-stover mix, or bale it?	graze the cover crop/stover mix		
Results for either grazing or mechanically harvesting the cover crop/stover mix:	Normal row width, no cover crop, stover NOT utilized	Wide rows, Grazed	Difference
Corn grain yield, bushels/acre	189	157	-32
Stover yield after trampling or harvest loss, tons/acre	0.00	2.18	2.18
Cover crop yield, tons/acre	n/a	0.33	0.33
Cover crop-stover mix yield, tons/acre	n/a	2.51	2.51
Stover or mix value, $/ton	$66	$94	$28
Revenue, $/acre	$1,257	$1,280	$23
Cost related to the stover or mix, $/acre	$0	$64	$64
Net return, $/acre	$1,257	$1,216	-$41
Breakeven corn yield reduction if the CC yield is: 1126 lb/acre	-14.1%		
Breakeven CC yield if the corn yield reduction is: -17.0%, lb/acre	1,625		

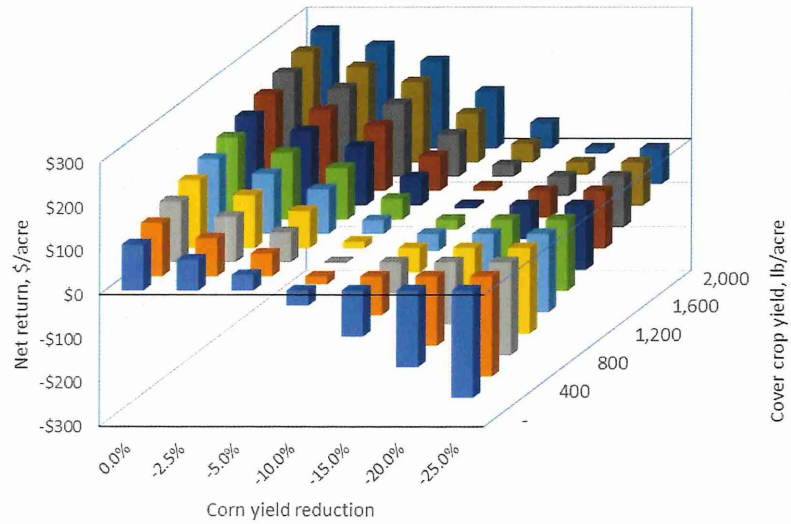


Figure 2. Net return difference from the base normal-row-width scenario of 189 bushels of corn grain without grazing or baling the corn stover.

MANAGEMENT TIPS

Tips for Corn Growth

1. Select early start, flex hybrid with high defensive capabilities.
2. GMO hybrids provide more opportunity to control weeds.
3. Row densities are important – confirm planter is accurate with limited doubles or skips of seed.
4. Research needed to define ideal populations per acre.
5. Stand establishment is critical: focus on seed placement and uniform emergence.
6. Nitrogen is important: focus the application on the corn row.

Tips for Cover Crop Growth

1. Select high yielding forages for your area, (annual ryegrass predominate, red clover, purple top turnip, kale).
2. Plant at V3-V4 corn growth stage.
3. Incorporated cover crop seed may be best, but timing with rain is important with incorporated a broadcast seed.

COOPERATORS

Farmers Cooperators

Jim Purfeerst, Faribault, MN

Ed McNamara, Goodhue, MN

Mark Comstock, West Concord, MN

John Jaeger, Red Wing, MN

All farmers:

- Attended a planning meeting – 2019-2021
- Assisted in test plot layout – 2019-2021
- Planted corn and cover crops according to treatment design – 2019-2021
- Monitored cover crop and corn growth – 2019-2021
- Attended two field days specifically for this group to view test plots – 2019-2020
- Attended a field day (hosted by one of the farmers) that was open to the public – 2020
- Harvested and scaled corn grain from the test plots – 2019-2021

Three of the farmers harvested stover-cover crop mix via grazing or mechanical (corn stacker) – 2019-2021.

Farmer cooperators who worked with Alan Kraus of Clean Water Partners and conducted grant-related farm trials.

One of the farmers hosted a Truterra site visit (Aug 2021) and also collaborated with CRP on a webinar (March 2021) and at a UMN Extension Soil Management Summit (Jan 2022).

Other contributors:

Rice SWCD – planted cover crops at Rice County location; assisted with cover crop biomass collection.

Goodhue SWCD – assisted with cover crop biomass collection; captured drone images of plots; documented GPS coordinates of plots.

Saddle Butte Ag – provided cover crop seeding recommendations; attended planning meetings & field day events.

Ag Partners Coop – provided scale wagon.

Haycreek Ag Service – provided scale wagon.

Minnesota Dept of Ag – Mark Dittrich – attended planning meetings & field day events; assisted with cover crop biomass collection.

OTHER RESOURCES

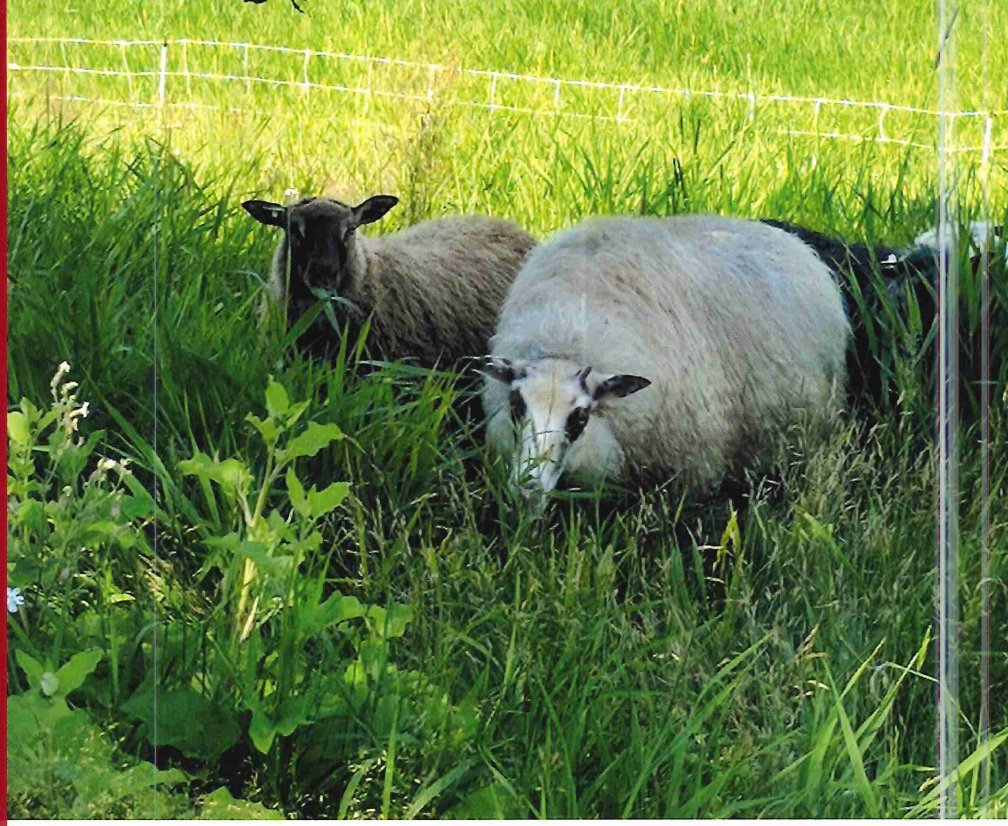
Clean River Partners, cleanriverpartners.org/wide-row-study

University of Minnesota, wl-webtools.shinyapps.io/widerow, or a spreadsheet version at wlazarus.cfans.umn.edu/william-lazarus-spreadsheet-decision-tools

Practical Farmers of Iowa, practicalfarmers.org/research/planting-corn-in-60-in-row-widths-for-interseeding-cover-crops

Associate Professor Joel Gruver, Western Illinois University, www.wiu.edu/cbt/agriculture/faculty_staff/gruver.php

Rotational Grazing in an Orchard to Improve Pasture Health, Reduce Energy Input, and Increase Profit



Sheep graze in one of the paddocks.

PRINCIPAL INVESTIGATOR

Robert Blair
Canosia Grove, LLC
5508 Martin Road
Duluth, MN 55811
218-341-0988
canosiagrove@gmail.com
St. Louis County

PROJECT DURATION

2019 to 2021

AWARD AMOUNT

$15,212 .00

KEYWORDS

soil health, pasture, sheep

PROJECT SUMMARY

This project is demonstrating that intensive rotational grazing within an apple orchard can improve pasture, soil, and orchard health, while decreasing manpower and energy inputs in the orchard understory. The synergy between the sheep and the orchard understory is important because it may have the effect of increasing profitability and simultaneously improving the overall health of our farm.

PROJECT DESCRIPTION

Canosia Grove is a northern Minnesota permaculture orchard and cidery specializing in on-farm production of small batch, traditional dry sparkling hard ciders made from local Northwoods apples. We have a small quarter acre of old trees, one-and-a-half acres of new orchard, and we are going to be planting an additional five acres of new apple trees. Our unique "North Shore" climate affords us with some of the fastest tree growth rates in Minnesota, and even our 30-year-old apple trees have no apple scab, apple maggot or codling moth. However, as we expand our orchard, we are struggling to convert existing fields from reed canary grass. The reed canary grass can choke out tree growth. We were trying to control the grass by mowing.

Mowing the orchard allows for increased light during establishment of the trees and allows air to circulate, which decreases fungal diseases. It also decreases pressure from rodents. Mowing, therefore, is a critical and valuable function in our orchard. However, it is also the most time-consuming aspect of our farm labor and has a high

opportunity cost. We hope that grazing sheep on the reed canary grass will provide an economically viable farm enterprise and cut our overall labor inputs dramatically while providing a new income stream for our farm through sales of wool and lamb. It also adds increased value to the pasture soil by adding nutrients and organic matter from trampling. The increase in soil health should lead to healthier and faster apple tree growth.

The project involves installing traditional sheep fencing for rotation of our Icelandic sheep flock and establishing an additional five acres of pasture within an existing apple orchard. We will assess soil health and forage quality within several paddocks prior to and during subsequent years of rotational grazing, and track labor hours related to mowing, understory management, and tree protection over time.

The results of monitoring forage quality and soil changes will help demonstrate how long it takes for pasture lands that have undergone succession to be re-established for rotational grazing. The improved forage quality will support an expansion of the flock, which will lead to additional capacity to build soil health over time.

2019 RESULTS

We started the year using temporary electric fence for the sheep and rotated the sheep over approximately 40 feet by 40 feet sized plots throughout the summer. The best control of reed canary grass came when we grazed the sheep in early spring. Plant diversity increased dramatically in the first paddocks grazed in spring 2019, with an increase in plants like goldenrod and hawkweed. While not desirable forage, the new plants will be better understory plants in the apple orchard than the solid mat of reed canary grass. Paddocks grazed in late summer are still over 95 percent reed canary grass.

In 2019, we acquired the materials needed for full enclosure of our summer and winter paddocks with four-foot-high, woven wire sheep fencing. We installed 3,200 lineal feet of fenceposts, 44 H-braces, and eight gates in late September. In October, we stretched 800 feet of fence for the winter paddock. The fence for the summer paddocks will be stretched in the spring of 2020.

In the summer and fall of 2019, we collected baseline data related to labor inputs, soil health, and forage quality. Approximately four hours per week (on average) were spent mowing the orchards.

Grass after grazing in Spring 2019, with more plant diversity.

Soil samples were collected in late October once the sheep were brought in from the pastures. We added some additional soil health parameters to the laboratory analyses based on sampling design review: the Haney test and the phospholipid fatty acid (PLFA) test. Samples were collected from the 0-6-inch interval using a soil auger; approximately 10-14 subsamples were collected from four different paddocks and composited into one sample representing each paddock. The subsample locations were recorded using a global positioning system. The Minnesota Valley Testing Laboratory provided chemical analysis. The baseline soil quality data indicate that we have generally excellent soil rating based on the test of total living microbial biomass, and slightly above average to good functional group diversity and a balanced bacterial community.

New fence for the winter paddock.

Our soils were generally found to have relatively low phosphorus and potassium. These nutrients are critical for orchards, which presents a paradox: why are we getting such good growth rates in these soils? Incidentally, sheep manure is an excellent source of both these nutrients; distribution of manure within the orchard may help with these deficiencies.

We hosted a Soil Health summer field day in summer of 2019 in collaboration with the Lake Superior Sustainable Farming Association. We will host an additional field day at the end of the project in 2021 to review the results of soil and forage analyses.

2020 RESULTS

The fence installed for our winter paddock in 2019 created a secure easy to use space for our sheep all winter. This space also served as an excellent temporary holding area whenever we needed to shear or otherwise work with our flock.

In the spring we continued our frost seeding program and finished stretching the remainder of the fence line. We were able to set up multiple paddocks within the pasture and quickly rotate the sheep. We did learn a few things this year.

Even if the sheep escaped their internal paddock they were contained within the permanent fence and safe from wandering into our neighbor's farm. We kept our ram and wether along the exterior perimeter of our permanent fence. This kept them better separated from the ewes and helped keep the grass down along the exterior of our fence line.

The individual fencing around each tree we installed kept the sheep from grazing our apple trees. However, eventually the sheep would rub against them and knock them over, then they would graze them. We were forced to keep the sheep in an area without trees. Once the trees reach 1-2 inches in diameter, we will remove the fencing and should be able to graze the sheep though the orchard.

2021 RESULTS

In 2021 we were able to rotate our sheep within small paddocks set up on five acres of unplanted orchard. We discovered we were able to move our sheep into our young orchard for four to six hours during the day without damage to the trees, then move them back to their usual rotational paddock.

Due to an intense drought, our grazing area was insufficient for our growing flock. We were able to use the exterior areas

Soil Health Summer Field Day in 2019.

of the installed woven fencing to expand our grazing area using electronet fence and start to clear brush land for future expansion.

Profitability Improvements

Man-hours for our farm were reduced from eight hours a month for mowing to half an hour a week to move the sheep between paddocks.

We have grown our flock to 10 ewes, a ram, a weather, and up to 20 lambs a year. We are able to sell these lambs for both breeding stock and meat - the market has been strong for both. We are also able to stud out our ram, and we will continue to explore the market for wool fleeces and yarn.

Soil Health Improvements

Soil testing in 2019 followed by repeated testing in the fall of 2021 suggest increases to four soil health parameters and/or nutrient indicators important to our pasture and orchard development:

- total living microbial biomass
- total organic carbon
- water extractable (bioavailable) nitrogen
- potassium.

In the winters of 2018-2019, we cleared paddocks for grazing by snapping off alder plants that were present in the overgrown field. We did this using a bulldozer blade on frozen conditions, and then frost-seeded the bare parts of the paddocks with a recommended mix from the University of Minnesota Extension.

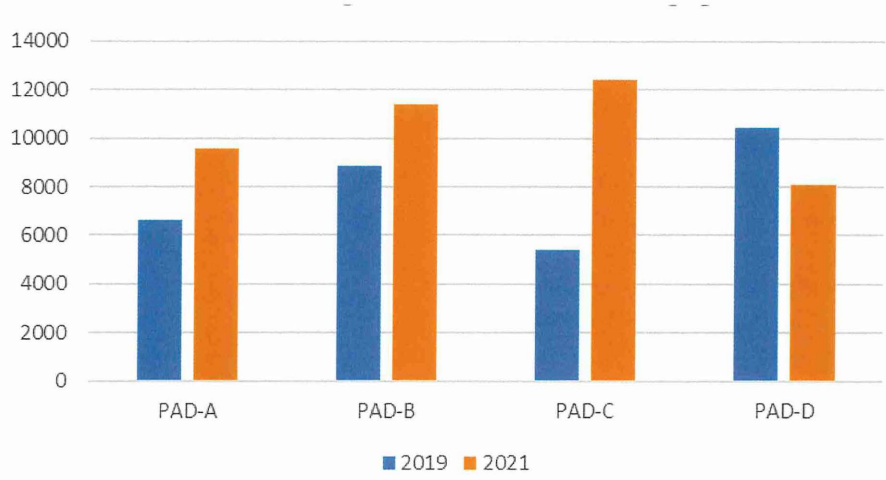


Figure 1. Total living microbial biomass during repeated sampling of four paddocks.

The following figures present a comparison between 2019 results (in blue) and 2022 results (in orange) for four paddocks that underwent different degrees of grazing during the summers of 2020 and 2021. Very little to no grazing took place in any paddocks prior to 2020 (we had only a small flock confined to a paddock located near the barn rather than out in the field). The degree of grazing was as follows:

- PAD-A: lightly grazed every year
- PAD-B & PAD-C: Moderate rotational grazing
- PAD-D: Heavy rotational grazing each year.

Therefore, the figures to the right reflect the effects of increased grazing from left to right. The results show increased

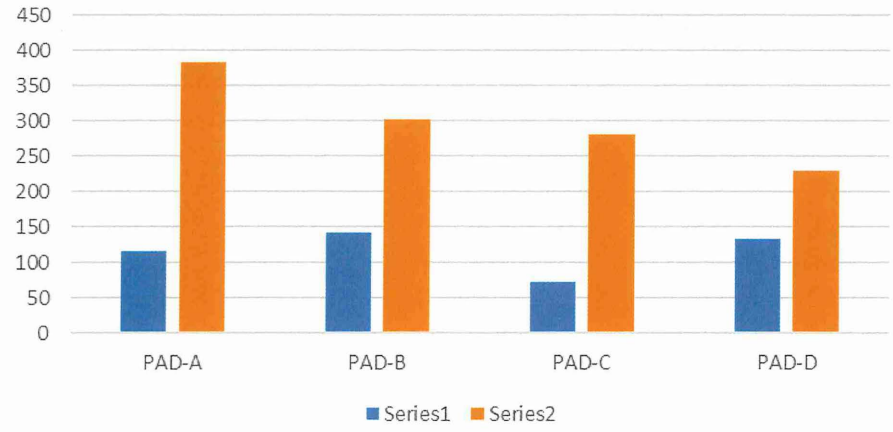


Figure 2. Water extractable total organic carbon biomass repeated sampling of four paddocks.

microbial biomass, a key soil health indicator, likely because of increased breakdown of organic matter due to the presence of grazers. The increased total organic matter is potentially attributable to the increased trample effect accomplished by the grazing animals. There is a big increase in bioavailable nitrogen. This is important because usually tilled fields cannot be planted immediately because of lack of nitrogen – this shows that no-till and grazers improved nitrogen availability rapidly. Lastly, our orchard has insufficient potassium (less than three parts per million) compared to other orchards. We were encouraged to see an overall increase in potassium, including at at least one measurement over three parts per million. The only potential source of potassium input is from the sheep manure.

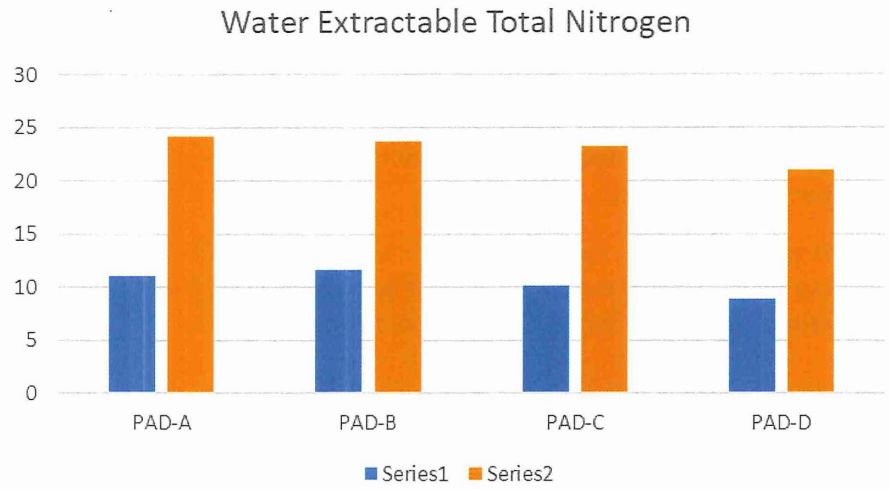


Figure 3. Water extractable nitrogen during repeated sampling of four paddocks.

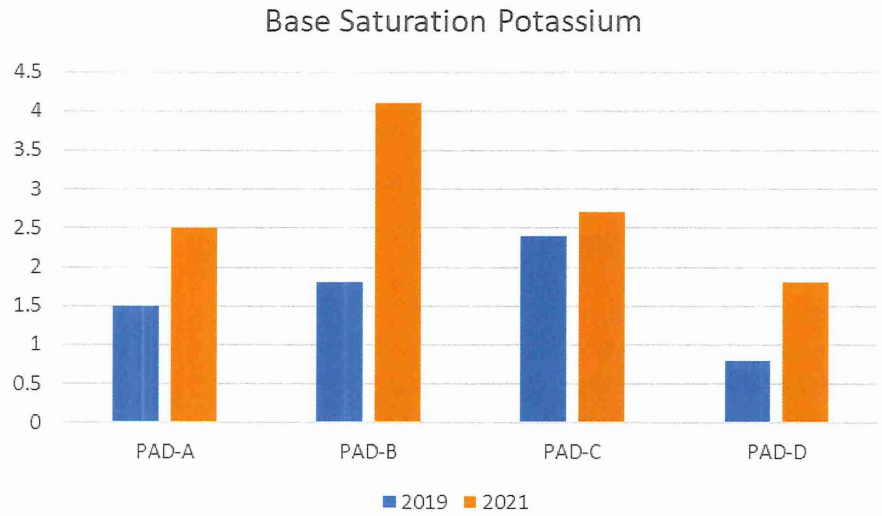


Figure 4. Base saturation potassium during repeated sampling of four paddocks.

MANAGEMENT TIPS

1. For planning fencing projects, budget appropriately for gates and H-braces.
2. For projects involving chemical analysis and measurements, find a lab that has knowledgeable staff to help with sampling and analysis design.
3. Setup grant metric tracking systems early in the project. Find a system that works for you - whether it is hand notes in a field book or using a tablet, get used to using the system, and make it a habit to take lots of notes.
4. Plastic carabiners allow for easy connections between electronet fencing and woven wire fence.
5. Proper fencing tools are a must. Don't use cheap substitutes.
6. Trees need to be large enough to have their leaves above the browse line of sheep and have a large enough diameter to avoid sheep chewing on bark.

COOPERATORS

Thaddeus McCammant, PhD, Department of Horticulture, Central Lakes College: Thaddeus visited the farm several times over the summer to assess orchard plant communities, tree growth and pest pressure.

Brian Williams, Agricultural Services Representative, Minnesota Valley Testing Laboratories: Brian consulted on laboratory analyses, sent valuable resources for data interpretation, provided high-quality data reports in a timely fashion, and was generally available for questions.

Julie Allen & Kent Solberg, Sustainable Farming Association: Julie coordinated a Fall 2019 field day at our farm which was focused on soil health. Kent provided leadership during the field day and demonstrated field techniques for assessing forage quality and soil health.

The Farmer Veteran's Coalition provided additional support for fence design and installation.

Troy Salzar, Extension Educator, Ag production Systems, University of Minnesota Extension Service

Bobcat of Duluth, Inc.

Non-Chemical Methods for Managing Colorado Potato Beetle: Feasibility for Diversified Farms

Farmers spread mulch on newly planted rows of potatoes.

PRINCIPAL INVESTIGATOR

Natalie Hoidal
University of Minnesota Extension
Dakota County Extension & Conservation Center
4100 220th Street West Suite 100
Farmington MN 55024
651-395-1492
Hoida016@umn.edu
Chisago and Washington Counties

PROJECT DURATION

2020 to 2021

AWARD AMOUNT

$15,439.00

KEYWORDS

Leptinotarsa decemlineata, organic, small farm, insect management, pest

PROJECT SUMMARY

Colorado potato beetle (CPB) management is an important priority for diversified vegetable farmers in Minnesota. With increasing insecticide resistance, non-chemical methods are needed for long-term success. Potatoes are an important crop for fresh market growers because customers expect them, and because they provide low-cost season extension. However, they are not a highly profitable crop, and thus farmers need quality information about not just the efficacy of treatments, but the costs, labor requirements, and timing of treatments.

Organic potato growers across Minnesota have relied on the insecticide Entrust (spinosad) for years to manage the Colorado potato beetle. However, spinosad resistance has been documented in other states, and in 2019 extension educators identified a population of Spinosad-resistant potato beetles in Washington County. A diversified approach that includes preventative management strategies is critical for potato farmers, especially organic potato farmers, as they navigate Colorado potato beetle management.

In this study, we aimed to assess five promising cultural control methods for Colorado potato beetle from the perspectives of labor hours, cost, effectiveness in reducing beetle populations, and final plant damage effects. We also aimed to gather qualitative data on how to best implement these strategies, lessons learned, and how the timing of these strategies fits into the flow and workload of a diversified vegetable farm. These strategies included trenches around fields, flaming young plants, using trap crops, row cover, and straw mulch, alongside control plots.

PROJECT DESCRIPTION

While crop rotation reduces Colorado potato beetle infestations, small-scale growers often do not have enough land to adequately rotate away from overwintering populations. Additional preventative control methods are needed; research has shown that various cultural methods effectively reduce Colorado potato beetle populations and increase marketable yield. These include surrounding fields with plastic lined trenches, using straw mulch, planting trap crops around fields, and flaming potato plants when they are young to kill larvae. However, many of these tools have been developed for large-scale systems (growers with hundreds of acres), and no studies have assessed these methods from a labor and cost perspective. Understanding the amount of time and money required to implement each treatment is vitally important for producers as they make management decisions.

The project objectives included:

1. Develop realistic best management practices for potato beetle that consider time, money, labor, and efficacy. The primary goals of these best management practices are the reduction of pesticide applications in potatoes and increased profitability for small-scale potato producers.
2. Engage Big River Farms' cohort of beginning farmers in the process of on-farm research. The goals of this collaboration are to build relationships between beginning farmers and Extension, inspire future experimentation and collaboration, and demonstrate the process of on-farm research.

Project Design

At least four of the six treatments (control, trench, flaming, straw mulch, row cover, and trap crops) were implemented on two partner farms each year. In 2020, Clover Bee Farm and Big River Farms participated, and in 2021, Clover Bee Farm and Shepherd Moon farm participated. Farmers calculated the costs associated with each treatment and kept records of the time spent managing each treatment. The principal investigator and a student intern visited each farm weekly for six weeks once the first potato beetles arrived and conducted weekly beetle counts. This was not a fully replicated trial, as the primary goal was to understand the labor and time requirements of each treatment. In addition to labor and time, the farmers noted the pros and cons of each management strategy.

A field day was held in summer of 2021 at Shepherd Moon Farm and Big River Farms to share what we learned.

Andrew digs a trench around the potato field using disks mounted on the tractor at Clover Bee Farm.

2020 RESULTS

In 2020, row cover, trap crops, and straw were used at both farm sites along with control plots. At Clover Bee Farm, the farmers created a trench around the entire treatment area (encapsulating all other treatments) and maintained an un-bordered control plot also. At Big River Farms, an additional flame treatment was included. The cost of supplies and labor hours for each treatment are reported in Table 1, adjusted for a 100-foot row (three-foot beds, six feet on center).

Table 1. Cost, labor, and farmer perceptions of treatments.

Treatment	Cost of supplies per 1,000 row feet	Labor hours to install per 1,000 row feet	Labor hours to manage
Row Cover	$150	30 minutes - 1 hour depending on wind	3 hours total
Straw	$500 for new straw, laid on fairly thick (1 round bale per 300 row feet), cheaper if reusing	2 hours by hand	0 minutes
Trench*	$12	45 minutes	20 minutes - removal
Trap Crop**	$50	15 minutes	5 minutes
Flaming	Backpack flame weeder + 2.4-gallon tank $317 Propane for 1000' row feet <$10	40 minutes	0 minutes

**Trench was created around the entire 9,000 square foot area (perimeter 420'). Cost only factors in plastic and assumes the grower already has a tractor and potato hilling implement. Labor is primarily attributed to preparing the equipment and labor time would only increase marginally with a larger field.*

***Trap cost crop calculated assuming farm is already starting other transplants indoors, and so additional marginal labor for eggplants is minimal. $50 accounts for the opportunity cost of not selling the eggplants. Management time attributed to planting and maintaining seeds (5-10 plants/100 ft row).*

Row Cover worked well on both farms. At Big River Farms, row covers were left in the field until July 22nd. At this point, beetles had begun to break through the fabric, so it was removed. The farmers determined that this was too much time to leave row cover on potatoes, as the humidity was substantially higher than normal, and the potatoes succumbed to greater disease pressure. At Clover Bee, the farmers removed the row cover on June 23rd to allow for better weed management. Beetles emerged in the plot almost immediately after removing the row cover, but it successfully kept beetles off the plants for the first 1.5 to 2 months of development.

Straw mulched plots had less beetle pressure than control plots or plots with trap crops. At both farms, the straw plots became weedy, and the farmers wished they had applied it slightly later, allowing for an initial cultivation pass. While the straw was effective at suppressing annual weeds, it was not effective at suppressing perennial thistles; this treatment would be best suited to an area with relatively few perennial weeds. Overall, it was affordable and easy to install on a small-scale.

Trench: The trench installed at Clover Bee was quite simple and affordable to install. The farmers simply used disks on their tractor to dig a trench around the field (two passes in both directions), lined it with 4 feet by 1,000 feet four-millimeter plastic mulch, buried the edges, and filled dirt or rocks into the trench every four to five feet to weigh down the bottom. Landscape staples were also used in the base of the trench every four to five feet to keep the plastic in place. Following installation, the trench did not require any maintenance. While we did not notice a substantial number of beetles caught in the trench, there were approximately half the number of beetles in the trenched control area compared to the un-trenched plot at all potato collection dates. We deduced that the trench may have acted more as a deterrent than an actual trap.

Trap Crop: At each farm we planted a trap crop of eggplant seedlings along the edge of the plot that was closest to the prior year's potato planting. While simple enough to install, the trap crop was entirely ineffective. There were often no beetles at all on the trap crop, and there were never more beetles in the trap crop than in the main crop.

Flaming: Flaming was only implemented at Big River Farms, but it was unsuccessful. Overall, the plants appeared to be more damaged than the beetles.

Beetle Counts

Colorado potato beetles were collected weekly with a sweep net, based on one pass through the entire treatment area. Planting occurred on May 6, 2020 and counting began when the first beetle was detected. Flaming occurred at Big River Farms on June 15th. At Big River Farms, the farm team began manually removing beetles in each plot every two days starting on June 20th, and so counts became relatively unreliable after that point. It was determined by the team that the beetle populations were so high that all the plants would be lost if an additional intervention was not performed. At Clover Bee Farm, neem was applied to all plots on June 13th and Azera was applied on June 20th for the same reason.

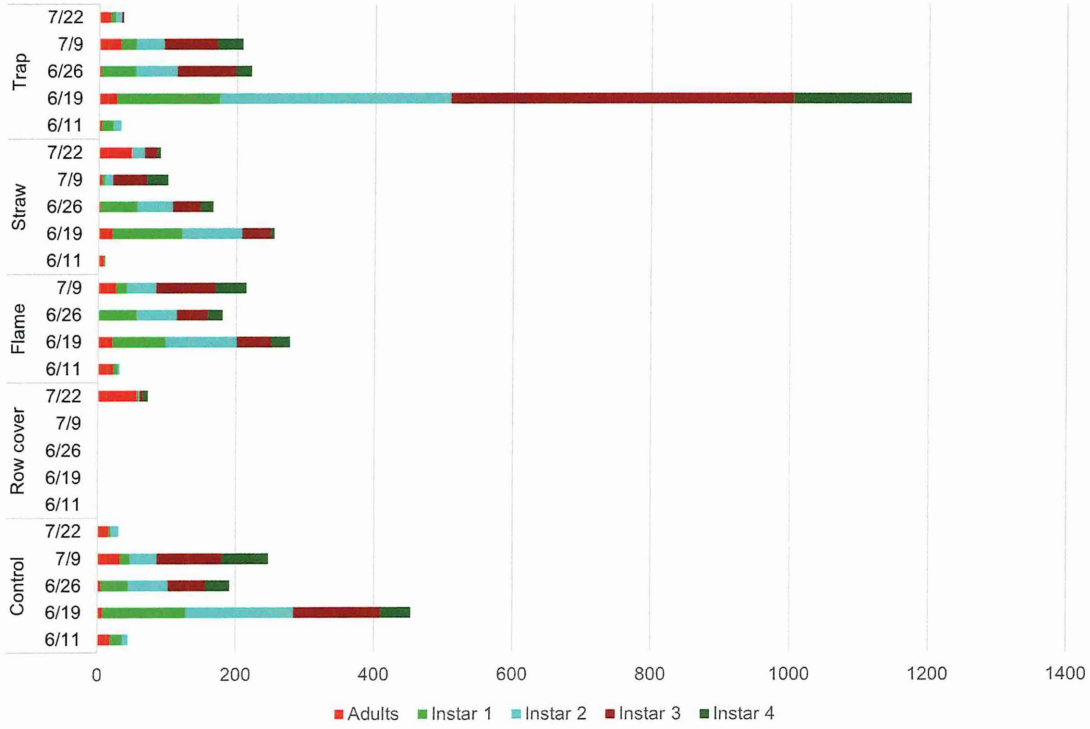


Figure 1. Weekly potato beetle counts by management strategy, Big River Farms 2019

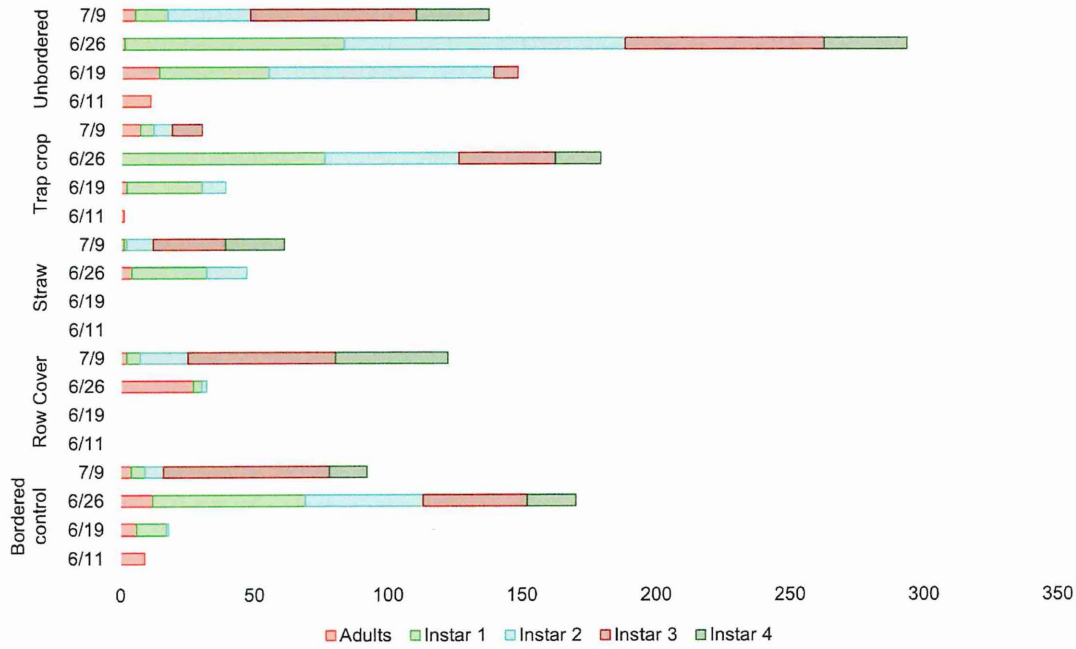


Figure 2. Weekly potato beetle counts by management strategy, Clover Bee 2019

Yields and Leaf Area Index are not reported for a few reasons. At Big River Farms, yields were virtually zero for all treatments as a result of nearly total defoliation. At Clover Bee Farm, the plots were quite weedy compared to the un-bordered plot, and the treatment plots had poorer soil with less consistent irrigation. As such, while the team did measure yields, we did not feel that the yield data could be adequately attributed to potato beetle.

2021 RESULTS

Row Cover

Row covers were used at both farms starting soon after seeds were planted. They were kept on at Shepard Moon Farm until July 8th, and Clover Bee farm until July 13th. The row covers were removed due to the potato crops growing too large to be covered. When the row cover was being used, it was not always properly secured, leading to beetles being able to access the potato crops. Care must be taken to make sure row covers are properly secured, preferably with landscape stables, due to the beetles being able to crawl under the covers if there are any small gaps underneath. The row cover also tended to rip very easily, which decreased the effectiveness of it. When row cover was secured successfully, potato beetles were not able to get inside to the crops. However, it was theorized that for the beetles already in the area that was covered (i.e., beetles that overwintered in the covered area that then emerged underneath the row cover), they matured faster due to warmer temperatures under the fabric. Potato plants under the row cover were more wilted than the other crops, and at Clover Bee Farm, the crops under the row cover were very small and very far apart, which may have led to inaccurate results for beetle counts. With proper maintenance, the row cover was seen to be successful at keeping beetles off the plants, if multiple treatments (trench and straw) are also used.

Trenches

The trench at Shepard Moon Farm took 27 minutes to dig by hand. It took two hours to lay plastic in the trench with two people, and dirt clods were used to hold the plastic down. The dirt clods were ineffective at keeping the trench down, and holes were not made in the plastic, so it filled with water regularly. This trench was ineffective and did not prevent beetles from reaching the potato plants. The field with the trench was also closer to where last year's potato crops were than the un-trenched crops. These factors led to the trenched crops having higher potato beetle counts than the un-trenched crops.

At Clover Bee farm, trenches were dug using a tractor, which took approximately 20 minutes. It required two passes in both directions with disks, and the trenches were lined with 4 feet by 1,000 feet four-millimeter plastic mulch, taking about one hour with four people. The plastic was held down with landscape staples every four to five feet. The trench did not require any additional maintenance. No beetles were found in the trench, however, when placed in the trench they were not able to crawl out as easily. The trench was deduced to work as a deterrent for the beetles instead of being a trap and was found to be more successful than the trench at Shepard Moon Farm. However, all the potato crops were surrounded by a trench, so they were not able to be compared to an un-trenched area at Clover Bee Farm.

Straw Mulch

Most of the effects of using straw mulch were not seen until the second generation of adults emerged. The mulch was effective at preventing the larvae from being able to drop into the ground and pupate, leading to fewer adults and therefore fewer larvae. It was theorized that there were more beneficial insects in the straw, leading to less beetles during the first generation of potato beetles. Beneficial insects were seen eating the potato beetle larvae in straw mulch areas. The farmers reported that they would use straw to retain more moisture in the soil, especially due to how dry the growing season was in 2021, making this treatment a versatile and multifunctional solution for more than just the issue of potato beetles, when used in combination with other treatments (row cover and trench).

Trap crops

Eggplant trap crops were ineffective at both farms.

Flaming

Flaming (using a flame weeder to burn beetles) was also ineffective. One farmer reported that it felt satisfying to torch the beetles but conceded that the actual benefits were negligible.

Yield Data

Table 1. Harvest data in un-trenched area from Shepard Moon Farm (Red Prairie Potatoes).

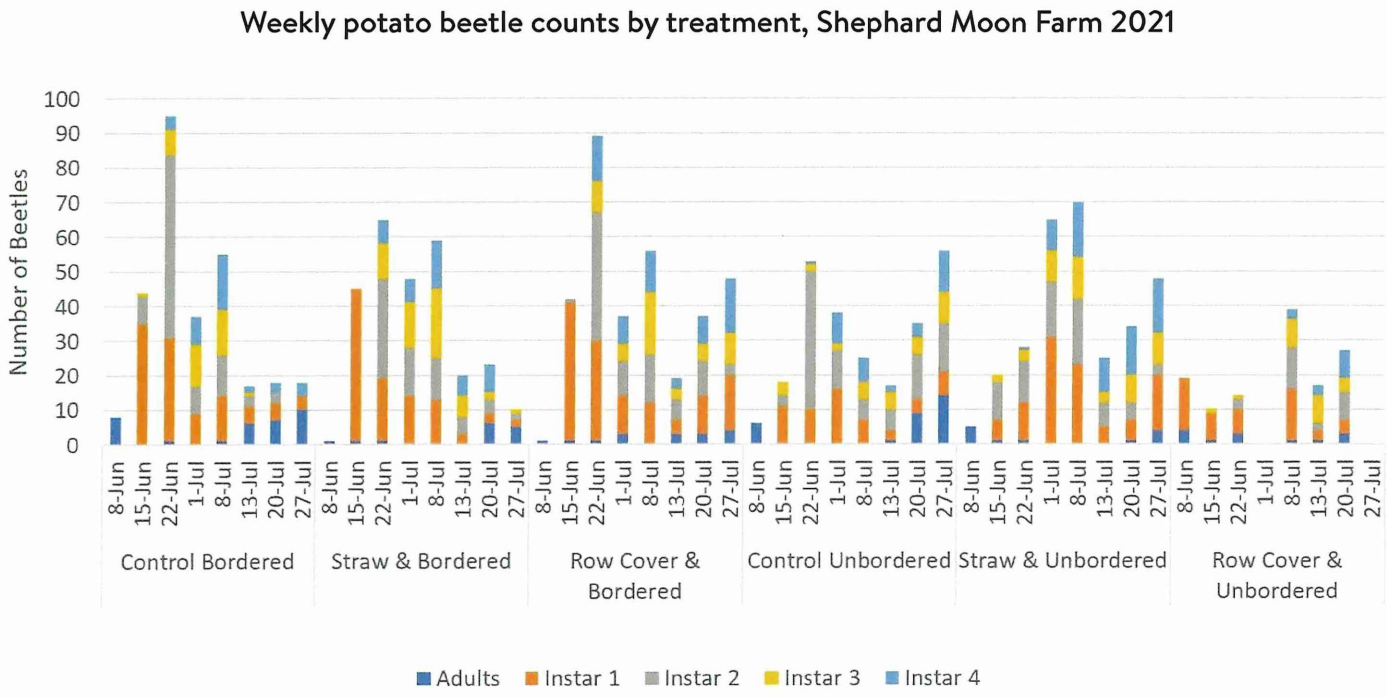
Treatment	Average number of potatoes in a 1.78 sq. ft. area ± standard error	Average total weight of potatoes (grams) ± standard error
Control	7.33 ± 0.88	539.00 ± 65.36
Straw	8.67 ± 3.48	689.83 ± 234.48
Row cover	11 ± 1.83	764.00 ± 104.53
Row cover + Straw	6 ± 2	519.00 ± 263.52

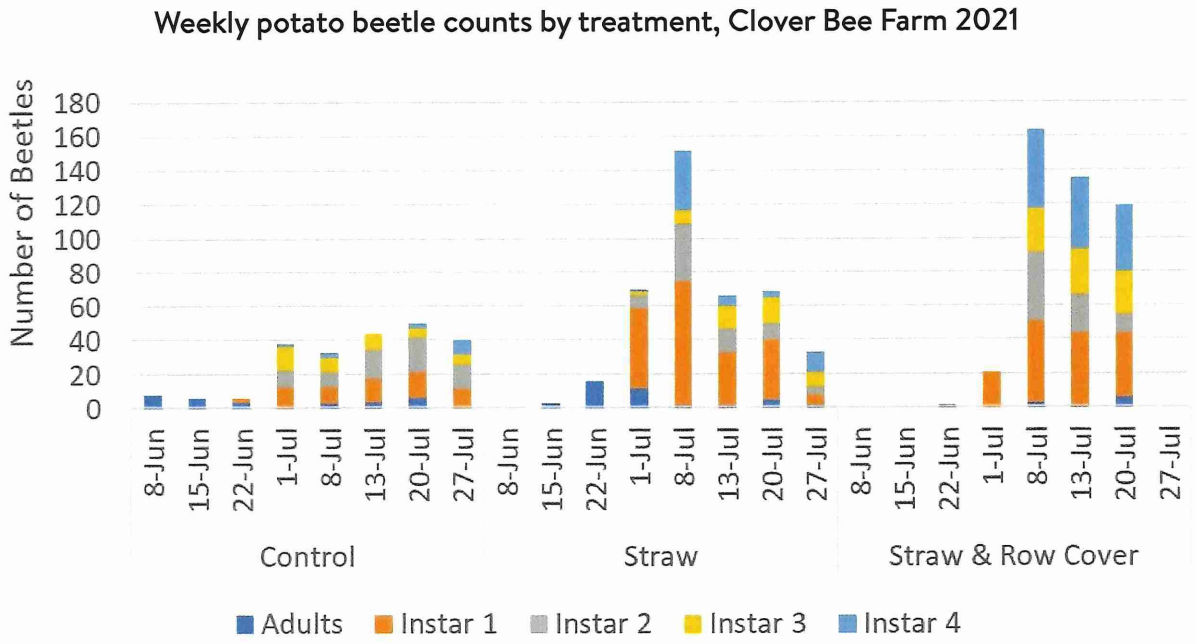
Table 2. Harvest data from Clover Bee Farm (Adirondack Blue Potatoes).

Treatment	Average number of potatoes in a 1.78 sq. ft. area ± standard error	Average total weight of potatoes (grams) ± standard error
Straw	3 ± 0.57	321.00 ± 28.20
Row cover + Straw	4 ± 1.15	205 ± 73.50

Potato Beetle Counts

Colorado potato beetles were collected weekly with a sweep net, based on fifty sweeps through each treatment area. While this data can theoretically give us a sense of how potato beetles responded to the different treatments over time, farmers in the trial also manually removed the beetles from each plot on a regular basis. They determined the yield risks to be too significant since no treatment provided sufficient potato beetle control on its own. At each farm, potato beetles were removed by hand weekly from each plot.





MANAGEMENT TIPS

1. Using eggplant as a trap crop and flaming were not effective in our trial; we do not recommend these strategies for managing potato beetles.
2. Using trenches around fields is a simple, low-cost practice that seems to reduce potato beetle populations. Growers should consider implementing this strategy as a basic preventative measure. However, it is not sufficient on its own and should be combined with additional management strategies.
3. Row cover and straw mulch show some promise for beetle management but need to be studied further and incorporated thoughtfully in the broader context of weed and disease management.
4. Straw mulch and row cover provide some degree of control for Colorado potato beetles. Straw mulch provides the additional benefits of weed control and moisture retention. Plants under row cover should be monitored for disease pressure, which may increase under row cover if it is retaining humidity in the plant canopy. Farmers had different feelings about whether large or small sheets of row cover were easier to work with.
5. We were unable to deduce whether trenches provided a benefit. However, they were quick to dig with the right equipment (a tractor with disks).
6. Crop rotation remains the most important strategy for managing potato beetles. None of the treatments we trialed were sufficient for managing potato beetles on their own, but straw mulch, row cover, and trenching can be beneficial tools to add to a potato management program.

COOPERATORS

Andrew and Margo Hanson-Pierre, Owners-managers of Clover Bee Farm, 952-261-3312, 35145 Reed Avenue, Shafer, MN 55074. Andrew and Margo maintained the plots at Clover Bee Farm, implemented the treatments, and provided feedback on all of the treatments they used.

Molly Shaus, Farm Manager, Big River Farms, 651-433-3676, 14220 Ostlund Trail North Suite B, Marine on St Croix, MN 55047. Molly maintained the plots at Big River Farms, implemented the treatments, and provided feedback on all of the treatments used at the farm.

Sam Kamats, Intern, University of Minnesota, kamat069@umn.edu. Sam was the summer intern working on the project in 2021. She visited each farm weekly to complete beetle counts, helped organize our field day, compiled the video for the project, and helped write the report.

Julie Arnold, Owner-manager of Shepherd Moon Farm, shepherdmoonfarm@gmail.com. 16987 - 260th Street, Lindstrom, MN 55045. Julie oversaw the potato trial at her farm, cared for the potatoes over the summer, assisted with yield data collection, hosted a field day, and provided feedback on the treatments.

OTHER RESOURCES

University of Minnesota. Colorado Potato Beetles: Organic Management Strategies for Vegetable Farmers. www.youtube.com/watch?v=h8ioz6FWeZA. A video of farmer perceptions about the different treatments used in this study, and their recommendations for using them effectively.

Towards Forever Green Poultry Rations

PRINCIPAL INVESTIGATOR

Jane Jewett
WillowSedge Farm
54852 Great River Road
Palisade, MN
218-670-0066
Jane@Janesfarm.com
Aitkin, Ramsey, and Rice Counties

PROJECT DURATION

2019 to 2022

AWARD AMOUNT

$23,773.28

KEYWORDS

Kernza®, poultry, ration, Forever Green

PROJECT SUMMARY

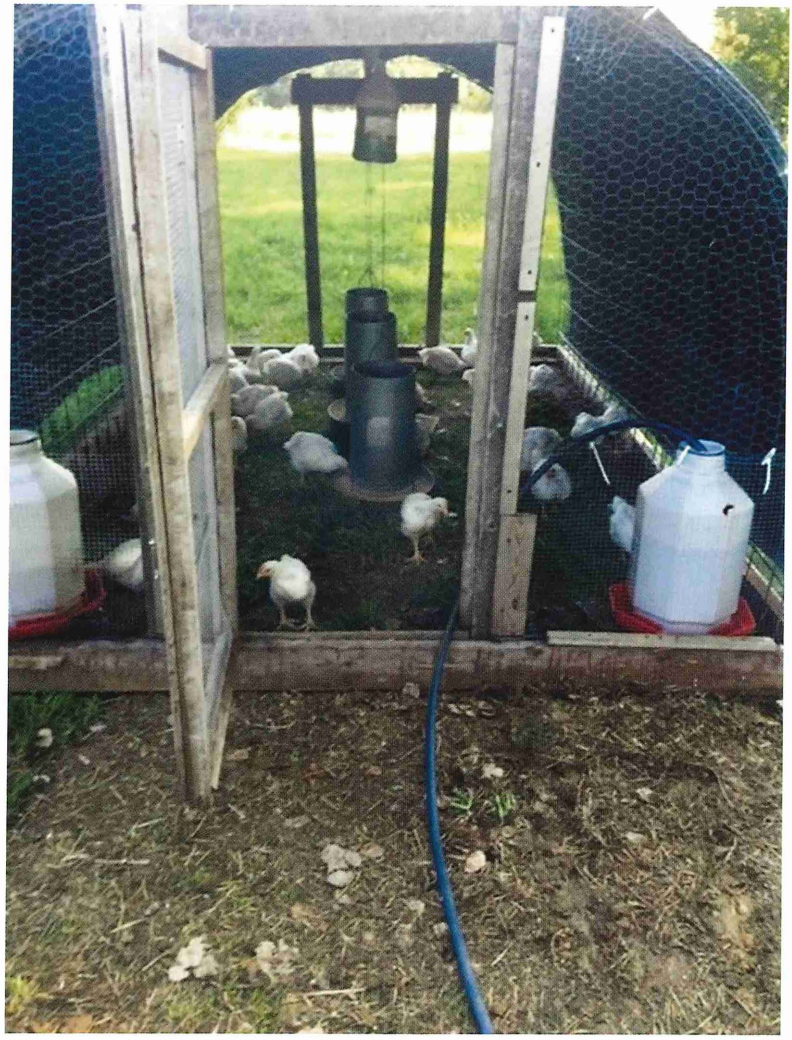
We used three small-flock, seasonal chicken production systems already operating in Minnesota to compare a Forever Green poultry ration to a standard conventional or standard organic poultry ration. Forever Green is a University of Minnesota initiative seeking to maximize continuous living cover on agricultural production fields through crop rotations and perennial cropping systems. The Forever Green ration used in this project was built on small grains (wheat), oilseeds (soy oil) and perennials (alfalfa); some of which could eventually be replaced by Forever Green crops that are currently under development. For example, wheat could be replaced by Kernza® perennial grain, and soy oil could be replaced by oil from camelina, a winter annual oilseed. We conducted paired comparisons of bird batches in each of three production systems, including carcass weights, ration disappearance, and meat-eating quality. We also conducted economic analysis of the Forever Green versus standard rations to determine whether a Forever Green ration is economically viable and produces a good bird. Success of a Forever Green poultry ration could help drive perennial cropping system adoption on Minnesota acreage.

There has been a lot of interest in this project, from farmers and customers who have heard of the project, but also from people connected to the Forever Green Initiative at the University of Minnesota. The researchers working on new crops have been focused on getting the crops out of the laboratory and into farmers' fields. As this is starting to happen, there is an uptick in interest in how the crops could be used. Kernza® is intended primarily as food for humans because that allows a higher price point than animal feed, but there is also recognition that not every lot of Kernza® will be suitable for human food.Consumers who are concerned about the environmental impact of their diet love the story of the Forever Green ration. The ability to sell the ration to customers could have a downstream effect on building local demand for small grains and perennial crops and help drive farmer adoption of these crops.

PROJECT DESCRIPTION

The Forever Green initiative is working to develop crops and cropping systems that will contribute to continuous living cover: keeping agricultural fields covered with a crop and with living roots in the ground for 100 percent of the year to improve soil health and reduce soil erosion, surface runoff, and ground water pollution. The crops and cropping systems require market demand in order to drive adoption on significant acreage. Human food is one pathway to build demand. Livestock feed is another pathway. Trialing and promoting Forever Green livestock rations with projects and field days is a first step to build demand. It's important to note the first word of the title of this project: "Towards a Forever Green Poultry

Ration." Some Forever Green crops are still under development and not available for use in livestock rations when this project started. This project used available crops that are the closest analogs to Forever Green crops, with the idea that these analogs could be swapped out as Forever Green crops become available. For example, instead of the Kernza® that is not currently available, we used wheat. We used alfalfa as a partial protein source, which is a widely available perennial that fits into Forever Green cropping systems. We used soybean oil to raise the energy level of most of the wheat-alfalfa rations, but in 2019 we were able to obtain camelina oil for some of the rations. Camelina is a winter annual oilseed that fits into the "relay" cropping system under development by Forever Green: camelina is planted into corn stubble after harvest, grows a low rosette of leaves in the late fall, survives the winter, then flushes up with spring growth and matures quickly to allow harvest of the oilseed and planting of soybean into the camelina residue. If this project demonstrates viability of a Forever Green ration for poultry production, this could be very beneficial to growers of small grains like wheat, barley, and oats, and growers of perennials like alfalfa. It could also help drive markets for farmers who are early adopters of new crops like Kernza® and camelina. Increased market demand for small grains and perennial crops will be positive for seed producers of those crops. A viable Forever Green poultry ration would also benefit poultry producers who are interested in marketing to customers who want ecological values attached to the food they buy. This project was conducted with small-flock producers, but viable Forever Green rations could also be adopted by larger-scale poultry producers.



Notable differences in feed ration texture. Top is coarse Forever Green ration; bottom is finely textured standard ration.

2019 RESULTS

In 2019 the Forever Green ration birds did not perform as well as the Standard ration birds on either Jane Jewett's farm or the Student Organic farm. We think this was at least partly due to too coarse of a grind on the Forever Green ration. Jane observed there were many whole kernels of wheat remaining in the ration. We offered a lot of grit to chicks, but whole wheat kernels were still too challenging for young chicks that did not yet have well-developed gizzards and set them back. For the second batch on Jane Jewett's farm, feed was requested with a finer grind. The feed received still had too many whole or mostly whole wheat kernels, but the birds getting the Forever Green ration did come closer to the control ration birds in terms of average weight.

Table 1. Economics of chicken production 2019.

	Jane Jewett Farm				Student Organic Farm		Kathy Zeman Farm			
	Batch 1		Batch 2		Batch 2		Batch 1		Batch 2	
	Forever Green ration	Standard ration	Forever Green ration	Standard ration	Forever Green ration	Standard ration	Forever Green ration	Standard ration	Forever Green ration	Standard ration
Total lb ration fed to birds†	869	802	790	775	2,100	2,050	1,405	1,370	1,412	1,353
$ value of feed	$166	$182	$149	$176	$831	$537	$445	$496	$443	$420
Total dressed weight of batch (lb)	175	270	253	272	343	422	487	493	527	506
Average dressed weight per bird (lb)	3.24	4.58	3.56	3.88	3.58	4.3	6.09	6.57	6.76	6.32
Batch basis										
Lb feed/lb total dressed weight	4.97	2.97	3.12	2.85	6.12	4.86	2.88	2.78	2.68	2.67
$ feed/lb total dressed weight	$1.09	$0.84	$0.75	$0.84	$2.42	$1.27	$0.91	$1.01	$0.84	$0.83
Per-bird basis										
Lb of feed per bird (excluding starter ration)	16.1	13.6	11.1	11.1	21.9	20.9	17.6	18.3	18.1	16.9
$ of feed per bird (excluding starter ration)	$3.54	$3.85	$2.66	$3.25	$8.66	$5.48	$5.56	$6.61	$5.68	$5.25
Feed cost as % of $ sales of chicken ǂ	27%	19%	17%	18%	56%	30%	23%	25%	21%	21%

† Jewett: 35-36 days, Chickens were on starter ration for three weeks before being split into Forever Green and standard ration groups and placed on finishing rations. Student Organic Farm: 63 days, Chickens were on starter rations for 14 days and then switched to Forever Green ration. Kathy Zeman farm: 60-61 days, Chickens were split into Forever Green and Standard rations upon arrival.

ǂ Sale price of chicken = Jewett $3.55 per pound.; Student Organic Farm $4.30 per pound; Zeman $4.05 per pound.

On Kathy Zeman's farm, the Forever Green ration birds performed very similarly to the Standard ration birds. Ration textures were similar and both rations were certified organic. In the first batch, the Forever Green birds averaged about half a pound lighter in average weight, or about seven percent lighter. The Forever Green birds all survived a 126-degree heat index event that occurred 10 days prior to butchering. Seven of the Standard ration birds died during that heat event. If those losses were accounted for in the average weight calculation, the average weight per bird for the Standard ration would be 493 pounds per 82 chickens equals 6.01 pounds average. In the second batch on Kathy Zeman's farm, the surviving Forever Green ration birds performed slightly better than the Standard ration birds, but mortality was a bit higher for the Forever Green birds. If we account for mortality losses in the average weight calculation, there is hardly any difference between the two groups:

Notable differences in feed ration texture. Top is coarse Forever Green ration; bottom is finely textured standard ration.

1. Forever Green ration: 527 pounds total per 82 birds equals 6.43 pounds average weight
2. Standard ration: 506 pounds total per 81 birds equals 6.25 pounds average weight

On Jane Jewett's farm, the economic performance of the first Forever Green batch reflected the relatively poor growth and carcass yield of that batch (Table 1). Feed costs were 27 percent of chicken sales income, which is unacceptably high for Jane's system. In the second batch, feed costs as a percentage of chicken sales were very similar between chickens fed Forever Green ration and chickens fed the standard ration. This suggested that further improvements in the ration grind could result in the Forever Green ration outperforming the standard ration in economic terms.

On the Student Organic Farm (Table 1), feed cost for the Forever Green ration was about 1.5 times the cost of the standard ration. Forever Green feed costs were 56 percent of chicken sales income compared to standard feed costs at 30 percent of chicken sales income. Both ration types resulted in higher per-bird and per-pound feed costs than were seen on either of the other farms, despite bird average weights on the Kathy Zeman farm being about two pounds heavier than average Student Organic Farm bird weights. Some of the discrepancy may be due to the breed choices: the Student Organic Farm used the Red Rangers slower-growing breed, while Kathy Zeman used the faster-growing Cornish Cross hybrid.

On Kathy Zeman's farm, the economic performance of the Forever Green ration was the same or better than the standard ration (Table 1). In the organic system, organic Forever Green ration cost less per ton than standard organic ration and resulted in similar weight gain of the birds. Higher price of the organic rations was offset by higher per pound prices for birds, so the Forever Green ration in the organic system appears viable.

Taste testing in 2019 was supervised by Helene Murray, MISA's Executive Director. It was conducted on the University of Minnesota's St. Paul campus with volunteers from the Department of Agronomy as taste testers. Beth Dooley, an experienced culinary professional, prepared the chicken. Beth said she could detect differences between the Forever Green ration birds and the Standard ration birds, but she thought they were subtle and not likely to be picked up by members of the public. We knew the kind of chicken people grew up eating and the way they shop and prepare chicken now would have a large influence on their perception of the chicken in the taste test. We chose to have the chicken for taste testing prepared with basic seasonings – salt, pepper, oil, and lemon juice – because of previous experience with taste testing at the University of Minnesota that involved no seasoning at all, which gave testers a negative experience. Taste testing was done on three different days, one farm featured per day. The volunteer taste testers were not the same people from day to day. Results were mixed and difficult to interpret. The Forever Green ration chicken was generally rated "Best" by fewer people than the store-bought chicken, although the Forever Green chicken was rated "Best" by more people on several sub-components like texture and juiciness.

2020 RESULTS

The entire project was paused in 2020. COVID-19 resulted in a shut-down of the Student Organic Farm on the University of Minnesota St. Paul Campus. Unfortunately, the Student Organic Farm was not able to operate in summer of 2021 either, due to ongoing restrictions on campus. Therefore, the Student Organic Farm was dropped from the project, and we proceeded with just the Jane Jewett farm and Kathy Zeman farm in 2021.

2021 RESULTS

Average weights per Forever Green bird on the Jane Jewett farm were much more acceptable in 2021 than in 2019. This was likely due to a finer grind on the Forever Green ration in 2021, achieved by a different feed mill. The texture of the Forever Green ration and the standard corn-soybean ration were similar in 2021.

On Kathy Zeman's farm, all bird weights were lower in 2021 than in 2019, because Kathy had birds butchered at a week younger in 2021. Younger birds and lighter weights reduced the risk of bird mortality if a heat event would occur close to the end of the growth period. Average bird weights were higher on the organic Forever Green ration than on the regular ration in 2021.

Table 2 shows that the standard ration outperformed the Forever Green ration for both groups of chickens on Jane Jewett's farm in 2021. The second batch of Forever Green birds, with feed cost at $0.87 per pound of dressed weight, would be viable if customers were willing to pay a premium for the environmental benefits of chicken raised on perennial crops. The Forever Green organic ration performed as well or better than standard organic ration on the Kathy Zeman farm in 2021. There was no downside or cost in performance to the Forever Green ration on this farm, and Kathy intends to adopt it as her regular ration.

Histograms of bird weights from Batch 1 in 2021 show variation among birds of the same batch for performance on both the Forever Green and Standard ration, with some birds that did quite well on the finer-textured Forever Green ration. This indicates the potential for breeding work to take advantage of genetic variation and develop a chicken that performs well on the Forever Green ration. A combination of a good Forever Green ration formulation and texture plus a Cornish Cross bird bred to do well on the Forever Green ration could result in a truly viable Forever Green poultry production system.

The tables of economic data (Tables 1 and 2) do not show the entire economic picture for these production systems, only the feed costs and ratio of feed to chicken carcass weight. The three farms had differences in customer types and bird weight preferences among their customers, and this influenced their overall costs. Butchering costs for chickens are typically on a per-bird basis, so heavier birds are more economical for the farmer to produce – unless there are mortality losses on the heavier birds.

Table 2. Economics of chicken production 2021.

	Jane Jewett Farm				Kathy Zeman Farm			
	Batch 1		Batch 2		Batch 1		Batch 2	
	Forever Green ration	Standard ration	Forever Green ration	Standard ration	Forever Green ration	Standard ration	Forever Green ration	Standard ration
Total lb ration fed to birds†	1,000	1,000	1,200	1,000	656	632	552	496
$ value of feed	$300	$235	$360	$235	$235	$200	$198	$158
Total dressed weight of batch (lb)	250	464	412	352	205	177	185	153
Average dressed weight per bird (lb)	4.63	5.52	4.96	6.06	5.25	4.80	5.43	4.64
Batch basis								
Lb feed/lbs total dressed weight	4.00	2.16	2.92	2.84	3.20	3.56	2.99	2.67
$ feed/lb total dressed weight	$1.20	$0.51	$0.87	$0.67	$1.15	$1.13	$1.07	$0.83
Per-bird basis	N=54	N=84	N=83	N=58	N=39	N=37	N=34	N=33
Lb of feed per bird (excluding starter ration)	18.52	11.90	14.46	17.24	16.82	17.08	16.24	15.03
$ of feed per bird (excluding starter ration)	$5.56	$2.80	$4.34	$4.05	$6.03	$5.40	$5.82	$4.79
Feed cost as % of $ sales of chicken ǂ	34%	14%	25%	19%	28%	28%	27%	25.5%

† Jewett: Chickens were on starter ration for three weeks before being split into Forever Green and standard ration groups and placed on finishing rations. Kathy Zeman farm: 53-54 days, Chickens were split into Forever Green and Standard rations upon arrival.

ǂ Sale price of chicken = Jewett $3.55 per pound; Zeman $4.05 per pound.

MANAGEMENT TIPS

1. Attend to feed texture in addition to crude protein, energy, and other ration components. Feed a ration that is not overly coarse. In 2019, the chickens fed Forever Green ration on the Student Organic Farm and Jane Jewett's farm did not gain weight as well as chickens fed a standard ration. The Forever Green ration on Jane Jewett's farm was observed to be coarse with many whole wheat kernels. Kathy Zeman used an organic feed source that had the same grind for both the Forever Green organic and standard organic rations, and she saw little or no difference in average bird weight between the two rations.
2. Take steps to mitigate excessive heat. Climate change is resulting in more days with a high heat index in Minnesota. Kathy Zeman lost seven heavy birds due to a high heat index event during this project. Prior to this project, Jane Jewett had the experience of losing 60 birds during a high heat index event. High heat index is an unfamiliar situation to many Minnesota poultry producers, and we have to learn to adapt. For outdoor poultry, shade structures and misting devices can help reduce mortality risk. Scheduling loading and hauling activities for late evening and early morning hours is also beneficial. If chickens are hauled in a stock trailer, placing blocks of ice, or scattering ice cubes in the stock trailer can help maintain bird comfort and improve survival on hot days. Reducing age and weight of birds at butchering can reduce mortality losses, too. Survival through heat events is more likely with a lighter bird.
3. Protect chickens from predation. On the Kathy Zeman farm, chickens are kept in chicken tractors which eliminated predation entirely during this project. On the Student Organic Farm, chickens are in movable small hoop houses fully enclosed in chicken wire, but hawks and other predators were able to reach through chicken wire to kill or injure birds resting against the wire. On the Jane Jewett farm, chickens day-range and are protected through a combination of overhead netting, electro-netting fence, and night-time enclosures; but if all three of those are not diligently attended to at all times, predators will break through and take birds.

COOPERATORS

Jane Jewett, Owner and farmer, WillowSedge Farm, Palisade, MN

Kathy Zeman, Owner and farmer, Simple Harvest Farm Organics, Nerstrand, MN

Wayne Martin, Student Organic Farm Supervisor, University of Minnesota, St. Paul, MN

Helene Murray, Executive Director, Minnesota Institute for Sustainable Agriculture, St. Paul, MN

Beth Dooley, James Beard award-winning chef, St. Paul, MN

Jeff Mattocks, President, Fertrell, Middletown, PA

Evaluating Hazelnuts as a Soy-Protein Replacement in Free-Range Poultry Systems

PRINCIPAL INVESTIGATOR

Wyatt Parks
Sharing Our Roots
(Main Street Project)
4905 315th St W
Northfield, MN 55057
425-760-2764
wyatt@sharing-our-roots.org
Rice and Dakota Counties

PROJECT DURATION

2019 to 2021

AWARD AMOUNT

$24,168.76

KEYWORDS

poultry, soy-replacement, hazelnut

PROJECT SUMMARY

We are testing the viability of feeding hazelnuts and hazelnut processing by-products to chickens within our poultry production methods as a substitute for soy-based protein. We want to know if the hazelnuts can provide usable protein in high enough density to maintain the growth and vigor of the birds. We also are exploring the economic potential of feeding waste hazelnuts (small/non-retail quality) to poultry and whether hazelnuts as feed can be price competitive with soy meal or if the chickens can command a higher retail price due to quality.

PROJECT DESCRIPTION

Alternatives to soy-based poultry feeds are critical in the development of sustainable food systems in the Upper Midwest. Market conditions through consumer choice and feed cost variations have created conditions favorable to alternative protein sources in poultry feed. Hazelnuts offer a viable alternative in protein content, nutritional value, as well as the potential for value-added products created in conjunction with poultry feed. Various studies have confirmed the general viability of replacing up to 50 percent of the protein feed in a confinement poultry operation with hazelnut meal but no research could be found that pertained to free range/paddock raised chickens. Trial groups need to be performed in Minnesota and in non-confinement conditions to validate existing research.

In this grant we want to determine the viability of feeding hazelnuts and their by-products to chickens as a soy-protein replacement. Due to unforeseen conditions, we will be altering the trial group feed regiments to better represent likely situations that farmers would experience. As such we will be running two trial groups with the first being fed the planned 100 percent hazelnut soybean replacement and the second being fed a much more conservative 40-50 percent replacement rate. The hazelnuts fed to the chickens will be run through a chipper that has been adjusted to crack open the hazelnuts. The whole nuts will represent small or deformed nuts that would normally be waste products.

To implement this research, we will be raising three flocks, one control and two trial flocks. All three flocks will receive the same starter feed for the first four weeks of life and will transition feed sources when they begin to roam in the paddocks. All three groups will also receive a blended mix of sprouted grains as a portion of their daily feed. The control group will receive the normal, corn and soy based non-GMO, feed that Main Street Project uses for all flocks. The trial groups will also receive the corn base of the feed with the correct proportion of soy removed. The hazelnuts will be mixed in with the normal feed to limit selection bias when the chickens are fed.

Poultry live scale system installed in a coop.

The final evaluation will consider the economic results, comparing normal soy-based feed to hazelnut replaced feed. It will also include evaluations of the animal's health and vigor and if they reach target market weight on time. We are also considering the overall product quality and whether a premium product is being reached which consumers will want to buy.

The initial logic behind this proposal was the desire to capture the full value of everything grown at our 100 acre research and development farm. Hazelnuts, in particular, have been planted on approximately 30 acres of our farm and all of the paddocks where the chickens will be raised are planted out with hazelnuts. Due to the genetic diversity of the plant stock, we know that once harvest begins on the hazelnuts 10-20 percent of the total yield will not be a high enough quality for retail markets and we do not want to waste the value that those nuts represent.

As hazelnuts become a more viable crop for Midwestern farmers access to these waste products will become much more available and we want to help develop ways for farmers to capture the value in their by-products rather than

simply disposing of them. This is especially valuable if the chickens that are raised on these by-products can command a premium in the marketplace as soy-free or sustainable raised animal protein.

2019 RESULTS

Due to circumstances outside of our control we were unable to begin our grant in 2019 and received an extension for grant completion in 2021.

2020 RESULTS

In the process of working to obtain the needed materials for the implementation of this grant it became very clear to us that our previous experience and understanding of the local hazelnuts processing capacity was incomplete. The primary example of this was in trying to source pressed hazelnut meal for the use in our trial groups. What we discovered was that the hazelnut meal that is available is either already spoken for and not available for new outlets or is entirely dedicated to supplying human food chains.

These two factors make sourcing enough meal economically unrealistic with the funds available in this grant. It also suggests that farmers who have the capacity to generate hazelnut meal should avoid using it for livestock feed when at all possible. Hazelnut meal can retail for upwards of $15 per pound while the conventional soybean meal that we use is roughly $.30 per pound. The increased cost of feed cannot be absorbed by the farmer or transferred to the customer in any market we are familiar with. We do believe a premium price can be secured for chickens raised with no or reduced soybean feed consumption making the prospect of feeding B-grade hazelnuts promising but the economics suggest it will only be cost-effective to a point.

We plan to conduct the amended trial and control groups during the 2021 spring and summer.

Our goal is to still gain valuable information about the economic and productive viability of hazelnuts as a soy replacement in poultry systems. We feel these changes will also better reflect the potential situations the farmers in the Upper Midwest are likely to experience when exploring soy alternatives for livestock feed.

2021 RESULTS

Our original proposal had us testing two different types of hazelnut products. The first was a hazelnut meal that is a by-product of the oil pressing process. This meal is the same product that is made into hazelnut flour for human consumption and can either be left as pellets straight from the press or milled into a fine flour. We attempted to source both in the hope that we could test the palatability of each and discovered a major barrier. After a variety of attempts to source meal, we concluded that unless a farmer was interested in having on-farm oil pressing capacity where meal would be available, they would be much better served in working towards producing a food grade product and avoiding livestock

PTO driven woodchipper used to process hazelnuts.

feed entirely. In the current market the meal product is too valuable as a human food product for domestic processors to be interested in selling to livestock feed markets without suitable compensation. The cost difference is pretty stark when you see hazelnut flour retailing for around $15 per pound and soybean meal selling for $0.36 per pound at the local elevator.

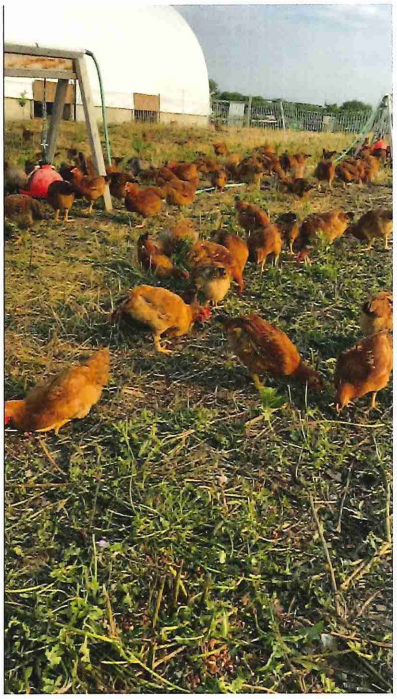
The second hazelnut product we worked to source was a coarse milled whole kernel product. Ideally, we wanted both with shell and without, again to test the palatability for our chickens. Because we do not have de-shelling equipment on farm, we were forced to look for custom de-shelling from one of the few processors with the needed equipment. The long and short is we either got no response or limited enthusiasm for custom processing. My understanding is that American hybrid hazelnuts, what we have available locally and what we grow on our own farm, are still in their infancy as a commercial product and as such are difficult to process at scale. They lack consistent shell sizing, they need to be dehulled, and the equipment being used in our region is all custom made and still being refined. The cost to have our hazelnuts de-shelled and coarsely milled was likely to be an issue even if we could find a processor.

With all of these barriers we went back to the drawing board and tried to think what is realistic for farmers. The situation we envision most farmers being in was they have a buyer for whole, in-shell raw nuts. The farmer has dehulling and sizing equipment on site but not much else. This level of processing is generally where food safety regulations start to get involved so farmers wanting to increase the value of their product without getting bogged down by expensive equipment or regulation are likely to stop here. What they would be left with regularly as a by-product is small, split, and otherwise not food grade nuts. These have little to no market value and are a waste product for most operations. Adding the waste to a compost pile would be great for organic matter but for folks who don't have a managed pile it is going to take a long time to decompose. Feeding the waste to hogs is probably the most recognized alternative considering the value of mast fed pork. No extra processing of the nuts would be required but you have to have hogs, something many small farmers choose to avoid. Chickens are a more ubiquitous livestock option and are demonstrated to be able to eat hazelnuts when processed correctly.

In our quest to evaluate hazelnuts as feed we started looking at our options for processing on farm. We had sourced 1,800 pounds of whole in-shell hazelnuts that were partially de-hulled from a local farmer and started experimenting. We started with a small bench mounted mill in hopes that would illuminate some options for processing and quickly realized that was not even remotely feasible. The shells were simply too hard for the non-commercial grade equipment and would jam up the mill. We were using it in hand-crank mode and working out the motor sizing to run it off electricity. Results indicated we would need an unreasonably large motor to generate the force needed to smash the shell and break up the kernel with that type of mill.

The next iteration involved a large jump in capacity but also expense. Moving up from the benchtop mill we went to a PTO-driven woodchipper behind one of our tractors. The design of this chipper has a large rotating flywheel with a cutting edge that is close enough to the intake shoot that most of the material entering the machine has to come in contact with the cutting edge. The result of this is that small material like hazelnuts which would normally be able to pass through untouched take the full force of fly wheel. Granted, some still pass through untouched, and a single pass doesn't break down the material enough for chickens. We found two to three passes through the chipper resulting in material that was equivalent in size to the largest pieces of corn and soybean in the conventional feed.

Knowing that we were able to create a feed material that was generally suitable for chickens did not address the fact that it was not reasonable for a farmer to invest the needed time in processing. On average it took roughly 15-20 minutes to process 25-30 pounds of hazelnuts in this way and needed to be done every few days to prevent spoilage. We do not currently have a tractor that can be dedicated solely to running the chipper, so it needed to be cleaned and stored after each use, unhooked from the tractor, and stowed undercover. Farmers also chronically undervalue their time, so I want to be clear in saying that for something like this you have to assume a value of $15-$20 per hour like you are paying an employee. The reason it is important to value the time involved is because the hazelnut processing can cost $0.50 per pound in labor alone. This is also only enough hazelnuts for 300-400 chickens. That is an extra $900 of labor expense! Most consumers are not excited about paying $12 more per chicken simply for hazelnut fed poultry, a market item that doesn't have the same allure as mast fed pork.



Chickens foraging for sprouted grains in a paddock.

Of that $12 cost increase roughly $10 is represented in the hazelnuts themselves and another $2 per pound is the labor to process. An additional expense can also be attributed to the increased labor of mixing the processed hazelnuts into the feed ration, something that is done by the elevator when ordering bulk feed but has to be done by hand in this system. The expense of the tractor, fuel, and chipper are also not accounted for in this expense breakdown. Our small tractor can easily burn four gallons of diesel an hour at PTO speed adding another $120-$150 of expense. We paid roughly approximately $10,000 for the tractor and approximately $3,000 for the chipper. All told the expense of processing hazelnuts is difficult to fully quantify but from personal experience, it was neither easy nor cheap.

Before we had ever even fed a chicken, the cost of feeding hazelnuts was economically infeasible in our situation. The key levers in our case were the purchase of hazelnuts and the labor to process them. For farms who have a ready source of free hazelnuts the margin is much more reasonable to pass to consumers, especially if you have buyers who are insistent on soy free feed. Those farms that would have to buy in hazelnuts are going to see a sharp increase in feed expense that I don't believe can be effectively passed to the consumer and expect to retain customers.

Having identified the cost as an issue we started working on actually feeding the hazelnuts to our chickens. We kept both the control group and the trial groups on a traditional feed for the first four weeks of life. Our bulk feed supplier mills a starter feed that has both corn and soy as well as a specific mineral mix for developing chicks. For farmers looking to be completely soy free this starter mix will not work, and I hesitate to suggest that hazelnut products can be substituted for the readily available protein for such young animals. In this case we did not want to alter the known successful diet too early and create stunting issues that would persist regardless of future feed composition.

When we partitioned our coop to separate our trial and control groups, we noticed a strong behavior change in our chickens. Birds were actively trying to get to feeders outside of their group, a behavior we had not expected. We aren't sure how much of this was feed type driven and how much it was feeding order related. Our birds are kept inside a barn at night with no feed available so when they first exit the barn they tend to head straight to the nearest feeder. If our feed amounts were off slightly from the day before, some of the feeders would be empty first thing in the morning before we had fed for the day. Traditionally there would be a significant number of alternative feeders for the chickens to visit but because each group had only a dozen feeders available the likelihood of them encountering multiple empty feeders was higher.

I estimate on average 10-20 birds would escape their field and move to and from all three groups each day from week four to week six. By the time the birds were fully developed they had adjusted to the routine and had a harder time slipping through small gaps or climbing/flying over the fence. This certainly affected the group weights throughout the flock's duration, but I can't identify a clear percentage as it was nearly impossible to identify specific individuals and evaluate the number of unique crossings.

Initially we attempted to feed the hazelnuts on their own in separate feeders right by the doors to the coop. The thought being the close proximity to the door would encourage the most aggressive feeders to eat hazelnuts first then move on to the mixed feed. Chickens tend to follow by example so if a few birds started feeding at the hazelnuts more would likely follow. In the first week of feed placement, I observed only a handful of birds pecking at the hazelnuts and based on the amount left at the end of each day few other birds joined in. As a whole the flocks ignored the hazelnuts entirely.

The next attempt to encourage feeding was to mix a small portion of the ground feed in with the hazelnuts. When the chicks are young, they are fed in trays set on the ground so the thought was adding ground feed would get them started at the hazelnuts and they would inevitably eat some of the nuts and gain the experience to know

they are food. While more chickens paused at the feeders with hazelnuts and pecked at them, few stayed for any significant amount of time when other feed was available. In general, we worked to avoid situations where feed was limited as it has been well documented that free choice feed is key to good growth in chickens. Attempting to force the chickens to eat hazelnuts by making it the only feed available would not have been effective based on our observations.

The only chickens that tended to linger near the hazelnut feeders were the small and sickly birds that tended to not stray far from the coop. These birds were regularly forced out from feeding at the main feeders, so they tended to look for less competitive feed sources, in this case that was the hazelnut feeders. More birds would also linger near the hazelnuts when other feed was not available though they didn't appear to be eating much from the feeders. Generally, when feed was not easily available birds would transition to foraging or return to the coop to rest until more feed was available.

The only success in feeding hazelnuts came when we began to mix the hazelnuts with our sprouted grain mix. Our mix includes a variety of different grains depending on availability and price but almost always includes wheat, sorghum, oats, sunflower, and buckwheat. The grain is mixed together and soaked for 24 hours in water with vinegar added. This mix is then broadcast around the paddock each day during feeding for the chickens to forage for. In previous flocks there was always a mix of birds who favored the sprouted grains and those who favored traditional ground feed, but the majority of the chickens would immediately favor the sprouted grains when feeding of grain and ground feed happened simultaneously.

From our observations, it appeared that a few factors played a role in the chickens eating the hazelnuts. First, by mixing, we softened and moistened the hazelnuts somewhat prior to feeding. This made the hazelnuts more palatable to the chickens who had been ignoring them. Second, the hazelnuts had become coated in the water vinegar mix that the chickens already knew and identified as feed. This in a sense tricked the chickens into believing they were eating sprouted grains. Third, changing the feeding method and timing was associated with a behavioral switch to more aggressive foraging. By feeding a more forage-based feed prior to the regular ground feed the birds started each day being encouraged to scratch and peck rather than eating at the feeders.

An interesting observation that is hard to connect to feed but is nonetheless worth noting was that the group fed only corn meal and no soy tended to range to the full extent of their paddock while the group fed only 50 percent of the soy and the control groups ranged very little as a whole flock. Some individuals would range the whole paddock, but it appeared that only a dozen or so birds from each flock engaged in this behavior each day versus the inverse in the corn only group.

It is hard to quantify exactly what percentage of hazelnuts fed in this way were ultimately eaten by the chickens. By spreading, much less of the feed is visible during observation and thus can't be easily accounted for. Where spreading happened on open ground or in feed trays a majority of the hazelnuts appeared to be eaten except for the excessively large pieces.

A major issue with feeding hazelnuts mixed in this way though is that sprouted grains only represent a portion of their diet. By volume it would be incredibly difficult to mix all of the hazelnuts needed for a full replacement ration in a large flock. For reference the sprouted grain ration for each research group (roughly 200 birds) included one full five-gallon bucket per day. The traditional ground feed needs were over four buckets per day as the birds approached full size. A radical change in feed infrastructure would need to happen within our operation to support a larger shift to sprouted grains and hazelnuts that would be difficult to justify.

Poultry live scale system installed in a coop.

The mixing process was necessarily an additional daily chore. Due to our system for sprouting grains being designed for grains only, we did not have the capacity to soak larger mixed batches and thus had to do so each morning for that day's feed. The labor requirement for this additional mixing and handling was difficult to justify as it added roughly 10-15 minutes of additional time each morning to the general feeding chores for only 400 chickens. Over the course of the flock this adds upwards of eight hours in labor, a number that would more than triple if done to feed the full 1,500 bird flock.

For the rest of the flock duration, we continued to employ a variety of the feeding techniques described above to ensure maximum exposure to hazelnut feed. There were a handful of discussions regarding other methods that could be employed to encourage feeding but none were deemed to be worth testing. The economic reality of feeding chickens hazelnuts felt compelling enough on its own to discourage future experimentation.

Weight Data

Due to a material ordering error our poultry live scale was not fully operational throughout the duration of the flock. We believed we had ordered a unit that included a battery system as our coops do not have grid power, but we discovered that the battery system needed to be ordered separately. After talking with our original supplier and the manufacturer we learned that the factory battery system would need to be ordered from Germany and delivery would likely not be available until after the flock had finished due to Covid shipping delays. We were able to set up a temporary system that allowed us to collect some data but we had significant issues with power failures and unusable data.

The data we were able to collect showed an average weight of 3.5 pounds for the group fed no soy at day 60. This was based on 1,145 discrete weigh-ins indicating that each bird was weighed multiple times throughout the collection period. The flock fed 50 percent of the soy ration had an average weight of 3.7 pounds on day 61. This group registered only 208 discrete weigh-ins. The placement of the scale within the coop space appeared to have a significant impact on the number of collected weights during any given period. The control group had an average weight of 4.79 pounds on day 63 and 64 from 890 discreet weigh-ins and a slightly higher average of 4.83 pounds on day 65 from 562 discrete weigh-ins. Due to the nature of the scale it could only record results from one group in any 24 hour period.

All previous and future data was determined to be unreliable as the scale either failed to collect sufficient data, in most cases only taking a single reading and then stopping recording, or power failures causing loss of stored data. We believe these issues would not be present in facilities with consistent grid power.

We also were unable to collect final weights for each group post processing as a communication error meant none of the carcasses were kept separate but rather were mixed together. While we sell our chickens in a community supported agriculture model where individual weights are not a concern, we recognize that many producers rely on strong carcass weights to meet revenue goals. The best we are able to offer is clear data showing that the no-soy and partial soy fed chickens were substantially smaller of frame between the eight and nine week marks. Some variation is common within the Freedom Ranger breed but the differences observed in this project were much greater than previous flock variation.

MANAGEMENT TIPS

1. Confirm the availability of needed inputs at the scale required if sourcing from an off-farm supplier. If we had known how difficult it would ultimately be to source pressed hazelnut meal, we would have explored the potential of including other protein sources in our trial groups. With this knowledge we can tentatively recommend that farmers not plan on being able to source pressed hazelnut meal for livestock feed in the near future.
2. If looking to transition to alternative feed sources to meet specific goals, like soy-free, continue to offer known successful feed types while experimenting. This allows you to make personal observations about how well your animals are taking to a new feed source without risking a significant loss of quality of slaughter weights. We suggest using a 50/50 rule in determining if a new feed type will be successful; if given the free choice in feed if 50 percent of the animals choose the new feed type you will not have negative results from rejection. This isn't to say that the new feed type will perform equally but success will not be hampered by selection.
3. Live weight poultry scales are a worthwhile investment for farmers hoping to project carcass yield in a large flock. Previously we had employed a hand scale to collect weights once a week. This yielded results from only 10-20 birds per week and ultimately was not a hugely helpful tool in predicting final carcass weights. The live scale allowed for the collection of weights from many more individuals on a daily basis which, over time would allow us to make much more informed decisions about the ideal processing time. A .25 pound difference at processing time in a 1,500-bird flock can pay for a quality live scale and help increase annual profits by approximately $2,000 per flock.
4. Pre-mixed bulk feed is worth investing in at nearly any scale. The time required to mix feeds on a daily or weekly basis is substantially more valuable than the mixing fee paid to the elevator when ordering bulk. The incorporation of all feed elements including minerals ensures minimum feed rejection and equal intake between animals.
5. When employing a coop and paddock system try to ample feed 24 hours, 7 days per week. Our system makes indoor feeding challenging but from close observation it appears that this is costing us in small and more aggressive birds. At each morning feeding there is significant competition to get access to feeders that is non-existent later in the day. By providing feed overnight in the coop it would reduce this competition and allow smaller, less aggressive birds to gain weight equally with their larger more aggressive counterparts.

COOPERATOR

Wil Crombie, Organic Compound, Faribault, MN

Using Sheep and Cover Crops in a Strawberry Rotation

4-H tour group at Brouwer Berries looking at the sheep grazing cover crop between strawberry field rotations.

PRINCIPAL INVESTIGATOR

Sarah Brouwer
Brouwer Berries
12951 105th Street SW
Raymond, MN 56282
320-905-0529
Sarah@brouwerberries.com
Kandiyohi County

PROJECT DURATION

2019 to 2021

AWARD AMOUNT

$11,952.48

KEYWORDS

sustainable, crop cover, sheep, strawberries

PROJECT SUMMARY

We tested the effectiveness of sheep grazing on grass cover crops during fallow periods between strawberry rotations as a method of improving soil health, reducing weed pressure, and increasing strawberry poundage per acre. We had tested grazing with cattle on cover crops over a period of three years and determined that using broadleaf cover crops gave us too much weed pressure and thistle growth in our strawberry fields. We used a mix of broadleaf and grass cover crops because of the valuable nutrients they'd add to the soil. Cattle did successfully contribute to increased organic content in the soil, and many of our soil nutrient level readings increased. However, the wet soil around the water troughs was heavily compacted by the cattle, and baby strawberry plants would not grow in those areas.

We hoped to increase the profitability of our farm by grazing sheep on cover crops between rotations of strawberries. Sheep, being smaller, would not compact the wet soil around the cover crops, and using strictly grass cover crops, we would be able to reduce weed pressure. Sheep are more suitable for small acreages, like ours, compared to cattle. We hoped the sheep for meat would be profitable as an enterprise, and that the combination of sheep and a specialty crop would be useful for educational outreach.

PROJECT DESCRIPTION

We are a pick-your-own strawberry farm in west central Minnesota. For years, we picked between one and two acres of strawberries, but in 2013, we started to expand. Currently we have 15 acres in our rotation.

Each year we plant about three acres with new strawberry plants, harvest about eight acres of mature strawberry plants, and have about four acres that are in cover crop, resting before being planted again with strawberries.

Strawberry fields must be rotated on a regular basis to reduce weed pressure and to minimize the replant diseases called black root rot. We have our strawberries in the ground a little more than three years. The first year is the establishment year, the second and third years are used for production. At the end of the third picking season (early July), the strawberry plants are plowed under and are planted into a series of cover crops for the end of summer and for the following growing season. Most strawberry growers plant cover crops into their fallow ground between strawberry rotations. We hoped to show that grazing sheep on the cover crops would be a profitable use of the strawberry ground in the fallow years while reducing strawberry plant disease and improving the soil for our strawberry plants.

All Minnesota farmers have faced increasingly negative weather events over the past two decades, including drought, extreme rain events, deep winter kill, and powerful winds. Each weather event cost us thousands of dollars in lost revenue. About five years ago, we enrolled in classes with Thaddeus McCamant at Central Lakes College to learn how to grow stronger plants that could withstand extreme weather and remain productive. These classes led us to believe that healthy soil is the key to healthy plants, and that healthy plants can withstand adverse weather conditions.

We have a silt loam soil with a pH above 7.2, so we have to be careful with our soil. In some areas of our strawberry field, the plants occasionally become chlorotic due to the high pH. Chlorosis is a major problem for strawberry growers in western Minnesota, where the soils are heavier and often have a pH above 7.0. We know that chlorosis is due to a high pH, but other factors like soil compaction, soil health, and organic matter can either aggravate or minimize chlorosis.

The cattle grazing the cover crops caused some problems. Their heavy bodies caused compaction in the areas around the water troughs, leading to poor strawberry plant establishment. While compaction is a problem in all soils, it is worse for us, because soil compaction increases chlorosis. The cattle grazed selectively, leading to heavy weed pressure in new strawberry beds. In fall 2018, we sold the cattle and purchased a flock of sheep.

For our project, we looked at the feasibility of grazing sheep in the cover crops that are planted between strawberry rotations. Immediately after plowing a strawberry field down, we seeded the field to sorghum-sudangrass. Sorghum-sudangrass is an ideal cover crop because it is a warm season grass that grows extremely fast, and it has shown to be one of the most effective cover crops for reducing replant diseases. Since sorghum grows so fast, it also crowds out many weeds. We carefully stewarded this flock, in order that the sheep will be profitable as a separate enterprise, to balance out any losses we incur on our strawberries.

There are many farmers in Minnesota with only a small parcel of land, all facing unpredictable weather. All those farmers are looking for ways to increase production per acre while minimizing risk. We hoped the sheep would improve the soil, thus profits, while at the same time being profitable as a side business.

EVALUATION AND RESULTS

Poundage per acre should steadily increase through our use of sap and soil tests to target nutrient deficiencies.

Poundage per acre dropped dramatically, likely due to extreme weather events. The plants were not strong enough to withstand the extreme weather. We do feel that our diminishing poundage per acre is related to a reduction in nutrients in the soil as we re-use blocks of land, and we will continue to experiment methods of replacing them. Our next experiment will be to give the land an additional year of cover crop before planting strawberries. Organic

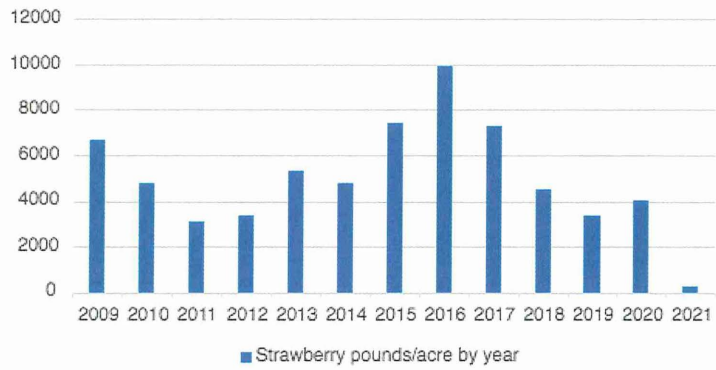


Figure 1. Strawberry pounds per acre 2009-2021. Poundage per acre dropped dramatically due to extreme weather events and possibly a reduction in soil nutrients.

content should increase, pH level should drop, chlorosis and black root rot should be reduced through cover cropping and grazing.k

pH levels dropped marginally, organic content increased marginally, and chlorosis and black root rot were non-issues.

Weeding hours per acre should drop through use of sheep and grass cover crops.

As we eliminated the fields impacted by grazing cattle and broadleaf cover crops, our weeding hours per acre dropped down to reasonable levels. Our thistle problem was also alleviated as we got rid of the cattle-grazed acreage.

Dan checking sheep grazing cover crops.

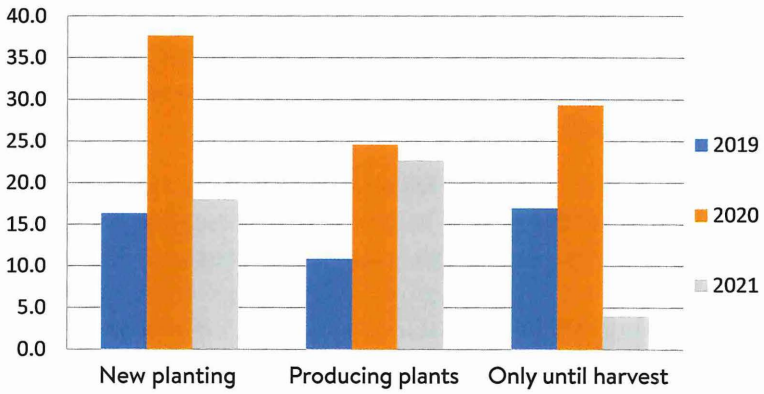


Figure 2. Weeding hours per acre. Weeding hours decreased as the cattle-grazed acreage corrected was corrected.

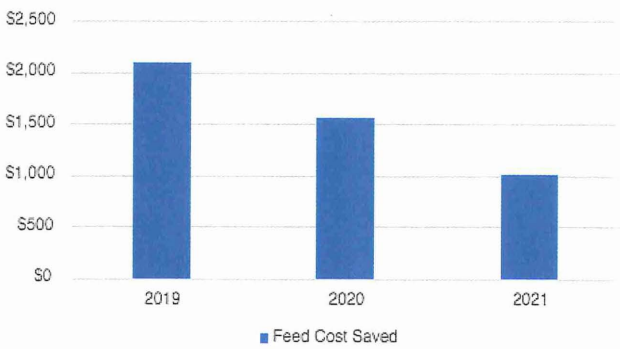


Figure 3. Feed costs saved. An average of $1,500.00 was saved per year on feed costs.

Feed cost savings should be realized in sheep enterprise.

An average of $1,500.00 was saved per year on feed costs. From a purely financial point of view, this is not worth the labor hours necessary to move sheep and fencing each day. From a more subjective point of view, the sheep enjoyed grazing, and the family enjoyed watching them move from place to place. Past research indicates that their hoofing action stimulated soil biology, which will be beneficial in the long-term.

2019: 150 grazing days with 56 sheep at $0.25 per head for maintenance hay ration with the result of $2,100.00 saved in sheep feed cost.

2020: 102 grazing days with 85 ewes at $0.18 per head for a maintenance hay ration with the result of $1,560.00 saved in sheep feed cost.

2021: 52 grazing days with 75 ewes at $0.26 per head for a maintenance hay ration with the result of $1,014.00 saved in sheep feed cost. (2021 drought = fewer grazing days.)

Sheep will be profitable as a separate enterprise.

Of all our goals, this one was the most surprising and wonderful. We bought and grew our flock in 2019 and 2020 and didn't have ewes to sell until 2021. This worked very well since we had a near-complete strawberry crop failure in 2021. As a bonus, sheep prices went through the roof, due to the meat shortages caused by the COVID-19 pandemic. All income lost on the strawberries in 2021 was replaced by sheep sales, thus proving once again the farmer's maxim "Don't put all your eggs in one basket."

Students and other farmers should be educated through tours and online engagement on the topics of this grant.

Many customers and other farmers were intrigued by what we were doing and read and commented on our social media. Sarah's 86 middle school science students had exceptional outdoor lab experiences. Students collected soil samples from each soil block and measured pH, salinity, and infiltration rate using our classroom tools. They were taught about the Minnesota Department of Agriculture research programs and shown how the scientific method is applied on the farms around them.

MANAGEMENT TIPS

1. 'Don't put all your eggs in one basket.' We have no strawberry crop insurance, and we lost the potential of six figures in gross sales. We would be in a very tough spot if we hadn't had sheep sales in 2021. A crop loss can happen to any farmer. Diversify your income streams and have an emergency savings account.
2. Save educational social media posts for the lead-up to harvest so that it doubles as education and advertisement.
3. If you choose to graze and cover crop, use only grass cover crops, and carefully spray all broadleaves to prevent weeds and thistles.

COOPERATORS

Thaddeus McCamant, specialty crop advisor, assisted us by interpreting the data in the sap and soil tests and telling us what nutrients to spray to make up for deficiencies. thaddeusmccamant@gmail.com

The late Dell Christianson of Agro-K assisted us by advising us what sap and soil tests to take, interpreting test results through phone conversations, and coming up with purchasing lists of Agro-K products to fix nutrient deficiencies. Agro-K 8030 Main Street Minneapolis, MN 55432 763-780-4116.

Pipestone Lamb & Wool Program: Philip Berg visited our farm yearly as a flock advisor. He assisted us by providing advice and data to increase profitability of the flock. Minnesota West Community and Technical College PO Box 250 Pipestone, MN 56164, www.pipestonesheep.com

OTHER RESOURCES

Brouwer Berries blog entries: www.brouwerberries.com/new-posts-page

Brower Berries Facebook posts: www.facebook.com/brouwerberries

Agro-K crop nutrient programs and sap analysis: www.agro-k.com

Completed Grant Projects

Final Greenbook Article	Title of Project	Grantee
	Alternative Markets and Specialty Crops	
2022	Exploring Hull Less Seed Pumpkins as a Specialty Crop	Pluck Flower Farm, Rachel Sannerud
	Exploring North Star Farm Tour as a Sustainable Agri-Tourism Model for Small Producers	North Star Farm Tour, Melodee Smith
	Integrated Hemp and Heritage Farm	Anishinaabe Agriculture Institute, Winona LaDuke
2021	Peonies for Profitable Cut Flower Production in Northeastern Minnesota	Owl Forest Farm, Kate Paul
2020	Minnesota Hops Terroir Identification and Promotion	Mighty Axe Hops, Eric Sannerud
	Effects of Drip Irrigation on the Yields of Native Seed Production Plots	Blazing Star Gardens, Dustin Demmer
2018	Developing a Network for Environment and Weather Applications	Minnesota Apple Growers Association, JP Jacobson
	Evaluation of Hybrid Hazel (Corylus) Woodchips as Mushroom Substrate	Wholesome Harvest, Sue Weigrefe
2017	Using Compost Tea in Organic Farming	Seeds Farm, Becca Carlson
	Creating Beneficial Habitat for Weed Management & Wildlife Enhancement on Farm Waste Land	Melissa Nelson
	Preserving and Attracting Native Bees while Providing a Habitat that Adds Value to Small Acreage	Noreen Thomas
2016	Reducing Chemical Use and Inputs in a Cold Climate Grape Harvest by Creating New Uses Other than Wine	Locust Lane Vineyards, Chad Stoltenberg
	Evaluating Different Depths and Types of Mulches in Blueberry Production	Redfern Gardens Kathy Connell
2012	Growing Cherries in Central Minnesota	Pat Altrichter
	Organic Mushroom Cultivation and Marketing in a Northern Climate	Jill Jacoby
	Feasibility of Small Farm Commercial Hop Production in Central Minnesota	Robert Jones
2010	Hardwood Reforestation in a Creek Valley Dominated by Reed Canarygrass	Timothy Gossman
	Introducing Cold-hardy Kiwifruit to Minnesota	James Luby
	Growing the Goji Berry in Minnesota	Koua Vang & Cingie Kong

Completed Grant Projects

Final Greenbook Article	Title of Project	Grantee
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

Completed Grant Projects

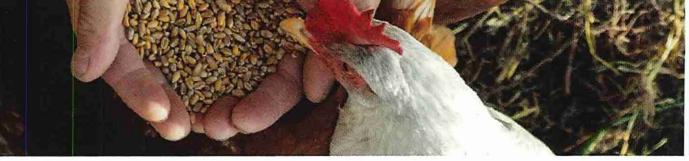
Final Greenbook Article	Title of Project	Grantee
	Cultural and Management Techniques for Buckwheat Production and Marketing	Tom Bilek
	Pond Production of Yellow Perch	John Reynolds
1998	Establishing and Maintaining Warm Season Grasses (Native Grasses)	Pope County SWCD
	On-farm Forest Utilization and Processing Demonstrations	Hiawatha Valley RC&D
1996	Permanent Raised Bed Cultivation for Specialty Crops	Terry & Jean Loomis
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	
2022	Grazing Intermediate Wheatgrass (Kernza®) as a Dual Purpose Crop for Forage and Grain Production	Clean River Partners Inc (formerly Cannon River Watershed Partnership), Alan Kraus
	Regenerative Agriculture: A Pathway for Greater Farm Profitability and Practice Adoption.	Clean River Partners Inc (formerly Cannon River Watershed Partnership), Alan Kraus
	Using sheep and cover crops in a strawberry rotation	Brouwer Berries, Sarah Brouwer
2021	Agrophenology Project	Wolf Ridge Environmental Learning Center, David Abazs
	Cover Crop Effects on Soil Temperature and Soil Moisture	Jerry and Nancy Ackermann
	Headwaters Agriculture Sustainability Partnership	Environmental Initiative, Sacah Seymour

Completed Grant Projects

Final Greenbook Article	Title of Project	Grantee
	Perennial farming and carbon sequestration, ecosystem services and innovative entrepreneurship.	Mashkiikii Gitigan- contract w/ Pillsbury United Communities, Michele Manske
2020	Using Precision Ag Data to Maximize Economic and Environmental Benefits	Pheasants Forever, Tanner Bruse
	Impact of Two Tillage Types on Yield, Economic Profitability, and Soil Health in Polk County, MN	Minnesota Wheat Research and Promotion Council, Melissa Geiszler
2019	Interseeding Cover Crops and In Season Nitrogen Application in One Pass	Keith Hartmann
2018	Raising Soil pH Effectively in Acid Soils	David Abazs
	Soil Health Research in Southwest Minnesota	Jerry & Nancy Ackermann & Jan Voit
	Maximizing Profitability in a Modular Moveable Cathedral Hoop House	Megan Henry
	Perennial wheatgrass and legumes for cropping, grazing, and soil health	Mike Jorgenson
	Interseeding Cover Crops into Standing Corn in June	Alan Kraus
	Evaluation of Winter Annual Small Grain Cover Crops for Forage Production	Daniel Ley
	Demonstrating Vermicomposting for Soil Health in the Upper Midwest	Robin Major & Caroline Devany, Stone's Throw Urban Farm
	Use Sub-Surface Irrigation to Increase Crop Profitability	Russell Martie & Dan Nadeau, Wright Co SWCD
	How Much Can You Afford To Pay For Hay?	John & Lisa Mesko, Lighthouse Farm
	Cover Crops to Replace Fall Tillage in Shakopee Lake Bed	Robin Moore
2017	Nitrogen Capture using Cover Crops in a Cash Grain Rotation	Sherburne County SWCD, William Bronder
	Developing Low-cost Planting Materials and Establishment Methods to Accelerate Agroforestry Adoption for Function and Profit	Happy Dancing Turtle, Jim Chamberlin
	Legume Cover Crops	Paul Kruger
	No-till Cover Crop Rotation vs. Intensive Tillage in Corn-Soybean Rotation	Chad Rollofson
	Planting Short Season Corn for Cover Crop Success	Caroline van Schaik

Completed Grant Projects

Final Greenbook Article	Title of Project	Grantee
2016	The Effects of Cover Crops on Water and Soil Quality	Hmong American Farmers Association
	Correcting Soil Structure to Reduce Erosion by Using a Cover Crop Mix with Diverse Root Systems	Bios de Sioux Watershed District
	A Demonstration of Biological Primers on Drought Prone Soils	Sustainable Farming Association of Minnesota
2015	Weed Control in Soybeans	Floyd Hardy
	Comparing the Productivity & Profitability of Heat-Loving Crops in High Tunnel and Quick Hoops Systems	Stone's Throw Urban Farm
2013	Fertilizing with Alfalfa Mulches in Field Crops	Carmen Fernholz
	McNamara Filter Strip Demonstration	Goodhue SWCD, Beau Kennedy & Kelly Smith
	Optimizing Alfalfa Fertilization for Sustainable Production	Doug Holen
2010	Environmentally and Economically Sound Ways to Improve Low Phosphorus Levels in Various Cropping Systems Including Organic with or without Livestock Enterprises	Carmen Fernholz
2009	Establishing Beneficial Bug Habitats in a Field Crop Setting	Noreen Thomas
	Keeping It Green and Growing: An Aerial Seeding Concept	Andy Hart
	Rotational Use of High-quality Land: A Three Year Rotation of Pastured Pigs, Vegetable Production, and Annual Forage	Gale Woods Farm – Three Rivers Park District, Tim Reese
2008	Field Windbreak/Living Snow Fence Yield Assessment	Gary Wyatt
2006	Gardening with the Three Sisters: Sustainable Production of Traditional Foods	Winona LaDuke
	Feasibility of Winter Wheat Following Soybeans in NW MN	Jochum Wiersma
2005	Chickling Vetch-A New Green Manure Crop and Organic Control of Canada Thistle in NW MN	Dan Juneau
	Treating Field Runoff through Storage and Gravity-fed Drip Irrigation System for Grape and Hardwood Production	Tim Gieseke
	Use of Rye as a Cover Crop Prior to Soybean	Paul Porter
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

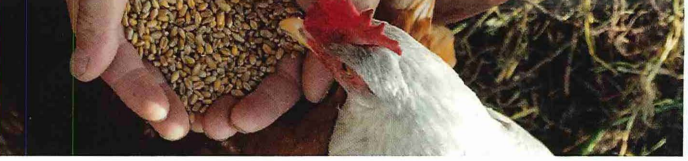


Completed Grant Projects

Final Greenbook Article	Title of Project	Grantee
	Native Perennial Grass - Illinois Bundleflower Mixtures for Forage and Biofuel	Craig Sheaffer
	Northwest Minnesota Compost Demonstration	John Schmidt & Russ Severson
	Potassium Rate Trial on an Established Grass/Legume Pasture: Determining Economic Rates for Grazing/Haying Systems	Dan & Cara Miller
	Woolly Cupgrass Research	Leo Seykora
	Yield and Feeding Value of Annual Crops Planted for Emergency Forage	Marcia Endres
2003	Aerial Seeding of Winter Rye into No-till Corn and Soybeans	Ray Rauenhorst
	Manure Spreader Calibration Demonstration and Nutrient Management	Jim Straskowski
	Replacing Open Tile Intakes with Rock Inlets in Faribault County	Faribault County SWCD
	Soil Conservation of Canning Crop Fields	Andy Hart
	Using Liquid Hog Manure as Starter Fertilizer and Maximizing Nutrients from Heavily Bedded Swine Manure	Dakota County SWCD, Brad Becker & Johnson
2002	Agricultural Use of Rock Fines as a Sustainable Soil Amendment	Carl Rosen
	A Low-cost Mechanism for Inter-seeding Cover Crops in Corn	Tony Thompson
	Annual Medic as a Protein Source in Grazing Corn and Weed Suppressant in Soybeans	Joseph Rolling
	Dairy Manure Application Methods and Nutrient Loss from Alfalfa	Neil C. Hansen
	Evaluation of Dairy Manure Application Methods and Nutrient Loss from Alfalfa	Stearns County SWCD
	Increased Forage Production through Control of Water Runoff and Nutrient Recycling	James Sovell
	Land Application of Mortality Compost to Improve Soil and Water Quality	Neil C. Hansen
	Turkey Litter: More is Not Always Better	Meierhofer Farms
2001	Applying Manure to Corn at Agronomic Rates	Tim Becket & Jeremy Geske, Dakota County Extension & SWCD
	Cereal Rye for Reduced Input Pasture Establishment and Early Grazing	Greg Cuomo
	Establishing a Rotational Grazing System in a Semi-wooded Ecosystem: Frost Seeding vs. Impaction Seeding on CRP Land and Wooded Hillsides Using Sheep	James Scaife

Completed Grant Projects

Final Greenbook Article	Title of Project	Grantee
	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
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

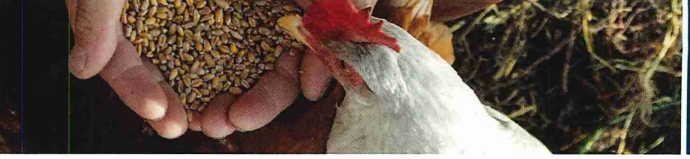


Completed Grant Projects

Final Greenbook Article	Title of Project	Grantee
	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
1994	Reducing Soil Insecticide Use on Corn through Integrated Pest Management	Ken Ostlie
	Taconite as a Soil Amendment	Donald E. Anderson
	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

Completed Grant Projects

Final Greenbook Article	Title of Project	Grantee
	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
	Energy	
2020	Economic Feasibility of Spray Foam Insulation in a Hog Finishing Barn	Vande Ag Enterprises, Ryan Vandendriessche & Jordan Vandeputte
2016	Increasing Dairy Farm Profitability Through an Energy Efficiency Implementation Model	Fritz Ebinger
	Solar-powered Rainwater Catchment & Distribution System Using Drip Irrigation	Hammers Green Acres, Sharon Utke
2010	Evaluation of the Potential of Hybrid Willow as a Sustainable Biomass 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	
2022	Non-chemical methods for managing Colorado Potato Beetle: feasibility for diversified farms	University of Minnesota, Natalie Hoidal
	Regenerative Agriculture: A Pathway for Greater Farm Profitability and Practice Adoption	Canosia Grove LLC, Robert Blair
2021	Cover crop and intercropping alternatives during the establishment period of perennial fruit crops	Richard Traugott
2020	Testing of a Non-traditional Process for Cleaning and Sorting MN Wine Grape Varietals	KISS LLC dba Brookview Winery, Arlyn Wall
	Testing Different Training Systems and Varieties to Improve the Profitability of Gooseberries	Good Courage Farm, Jen Blecha
	Evaluating Effectiveness of Sap Analysis to Increase High Tunnel Tomato Yield and Quality	The Good Acre, Andrew Bernhardt & David Van Eeckhout

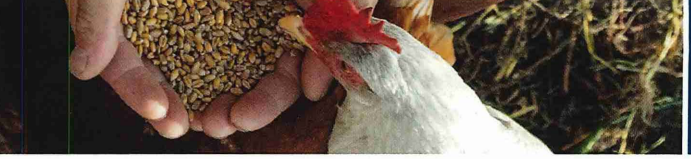


Completed Grant Projects

Final Greenbook Article	Title of Project	Grantee
2019	Developing an Annual Day-neutral Strawberry Planting System with Biodegradable Mulches	Steve Poppe, University of Minnesota
	Using Essential Oils to Repel Spotted Wing Drosophila in Blueberries	Blueberry Fields of Stillwater, Bev O'Connor
	Using Juneberries as a Cold Hardy Rootstock for Minnesota Pears	Thaddeus McCamant, Central Lakes College
2017	Developing Profitable Apple Production along Lake Superior's North Shore of Minnesota	Clover Valley Farms, Cindy Hale
	Evaluating Different Depths and Types of Mulches in Blueberry Production	Redfern Gardens, Kathleen Connell
	Controlling Canada Thistle in Organic Blueberry Production	Little Hill Berry Farm, Aaron Wills
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

Completed Grant Projects

Final Greenbook Article	Title of Project	Grantee
	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
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



Completed Grant Projects

Final Greenbook Article	Title of Project	Grantee
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	
2022	Evaluating Hazelnuts as a Soy-Protein Replacement in Free-Range Poultry Systems	Main Street Project (Sharing Our Roots), Wyatt Parks
	Toward Forever Green Poultry Rations	WillowSedge Farm, Jane Grimsbo Jewett
2021	Two Pasture Types to Finish Lambs on Pasture and an Evaluation of Meat Quality from Each	Keith and Anna Johnson Farm, Anna Johnson
2020	Comparison of Mobile Confinement and Day-range Production Systems for Pastured Broiler Chickens	Seelye Brook Farms, Randy Kleinman
2019	Goat Grazing During Winter in Minnesota: Controlling Vegetation While Saving on Feed Costs	John Beckwith, Hiawatha Valley Resource Conservation & Development
	Integrating Silvopasture Practices into Perennial Fruit Production	Jackie & Harry Hoch, Hoch Orchard
	Testing Three Novel Sheep-specific Pasture Types to Maximize Average Daily Gains in Lambs on Pasture	Anna Johnson
2018	Breeding, Selecting and Assessing Organically Grown Nutrient Dense Corn for Poultry Production	Zachary Paige & Sue Wika, Paradox Farm
	Trials to Overwinter Nucleus Colonies with a Pause in Brood Rearing	Four Seasons Apiaries, LLC, Joseph Meyer
2017	Acclimating Heifers to Improve Cow Flow on Dairy Farms	Ulrike Sorge
	Utilization of Building for Multiple Livestock Species	Steve Stassen

Completed Grant Projects

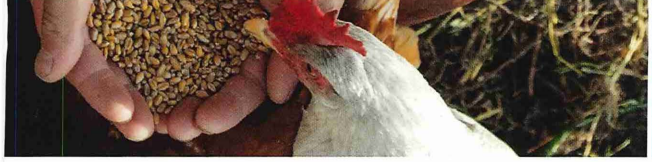
Final Greenbook Article	Title of Project	Grantee
2013	Determining the Cost of Raising Pastured Pork on a Diet Including Whey and Finishing on a Diet Including Acorns	Lori Brinkman
2011	Determining the Pasture Restoration Potential and Financial Viability of Cornish Cross vs. Red Broilers for a Small Pastured Poultry Operation in Northeast Minnesota	Cindy Hale & Jeff Hall
	Fall Forage Mixture for Grass Finishing Livestock Late in the Fall	Troy Salzer
	Increasing the Profitability of Raising Livestock: An Evaluation of Two Methods to Extend the Grazing Season	Dean Thomas
	Methods to Establish Grazing of Annual Forages for Beef Cows on Winter Feeding Areas	Walker/Mathison
2010	A Comparison between Cornstalk and Soybean Straw for Bedding Used for Hogs and Their Relative Nutrient Value for Fertilizer	John Dieball
2009	Demonstration of How Feeding In-line Wrapped High Moisture Alfalfa/Grass Bales Will Eliminate Our Fall and Winter "Flat Spot" in Grass-fed Beef Production	Donald Struxness
	Diversified Harvest of Integrated Species	Joe & Michelle Bowman
2008	Comparing Alternative Laying Hen Breeds	Suzanne Peterson
2007	Composting Bedded Pack Barns for Dairy Cows	Marcia Endres
	Managing Hoops and Bedding and Sorting without Extra Labor	Steve Stassen
2005	Performance Comparison of Hoop Barns vs. Slatted Barns	Kent Dornink
	Raising Cattle and Timber for Profit: Making Informed Decisions about Woodland Grazing	Michael Demchik
	Using a 24' x 48' Deep Bedded Hoop Barn for Nursery Age Pigs	Trent & Jennifer Nelson
2004	Comparing Performance of Hoop Buildings to an Older Conventional Building for Finishing Hogs	Kevin Connolly
	High Value Pork Production for Niman Ranch Using a Modified Swedish System	David & Diane Serfling
	Low Cost Fall Grazing and Wintering Systems for Cattle	Ralph Lentz
2003	Can New Perennial Grasses Extend Minnesota's Grazing Season	Paul Peterson
	Enhancement of On-farm Alfalfa Grazing for Beef and Dairy Heifer Production	Dennis Johnson
	Farrowing Crates vs. Pens vs. Nest Boxes	Steve Stassen
	Forage Production to Maintain One Mature Animal Per Acre for 12 Months	Ralph Stelling

Completed Grant Projects

Final Greenbook Article	Title of Project	Grantee
	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

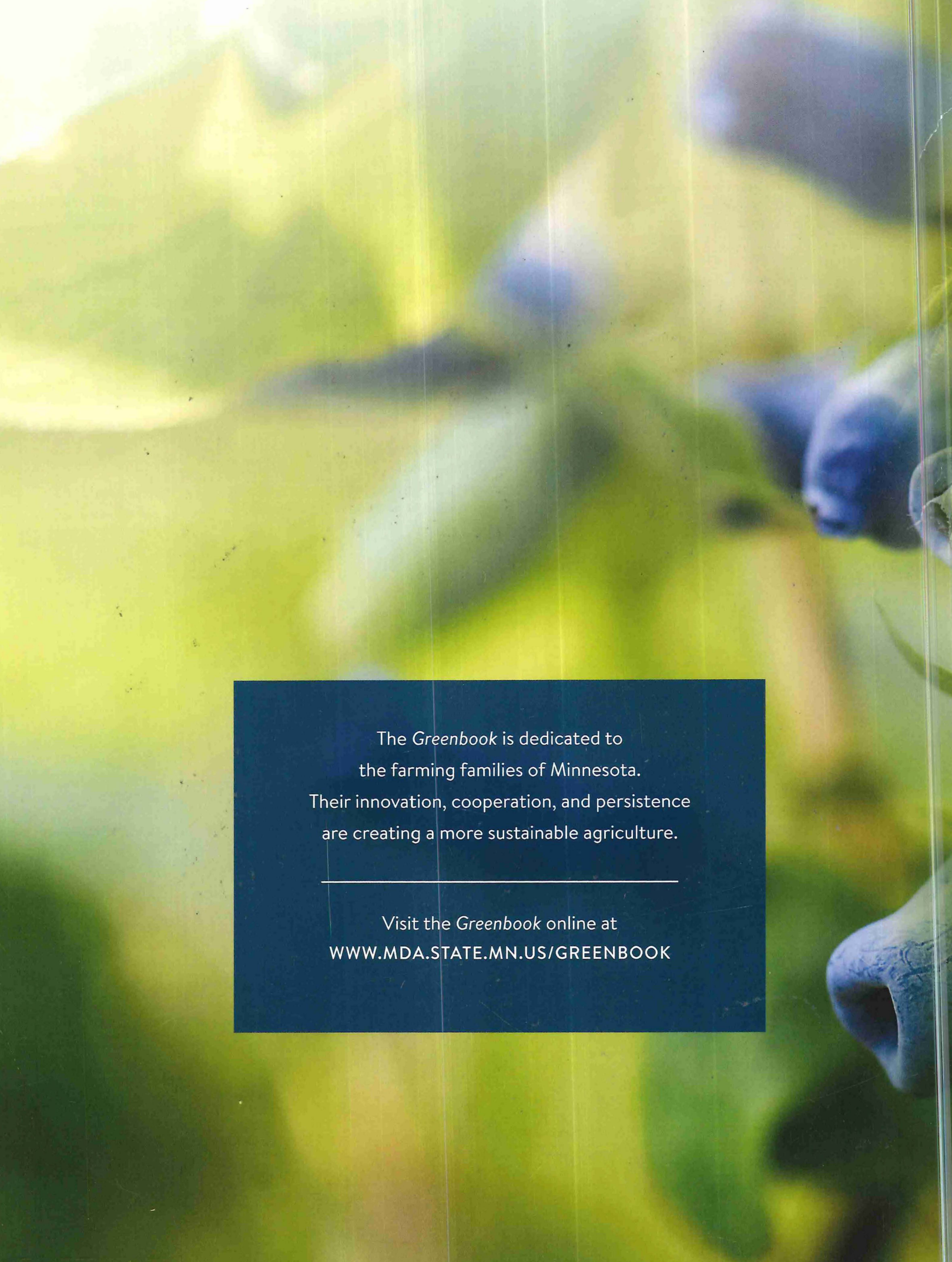
Completed Grant Projects

Final Greenbook Article	Title of Project	Grantee
	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
	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



Completed Grant Projects

Final Greenbook Article	Title of Project	Grantee
	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



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

Visit the *Greenbook* online at
WWW.MDA.STATE.MN.US/GREENBOOK