TWENTY YEARS of Farmers Growing Ideas

GREENBOOK 2009

MINNESOTA DEPARTMENT OF AGRICULTURE

Greenbook 2009

20th Anniversary Edition

Program Vision Statement

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

Program Mission Statement

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

MINNESOTA DEPARTMENT
OF AGRICULTURE
AG DEVELOPMENT & FINANCIAL ASSISTANCE

June 2009

Thank you to the MDA's Agricultural Development and Financial Asssistance Staff who helped to make *Greenbook 2008* a reality. They include: Linda Bougie, Jean Ciborowski, Alison Fish, Mary Hanks, Wayne Monsen, Meg Moynihan, and Mark Zumwinkle.

Minnesota Department of Agriculture
625 Robert Street North, St. Paul, MN 55155
651-201-6217

Introduction to the 20th Anniversary *Greenbook 2009*

I am pleased to introduce the 20th anniversary edition of the *Greenbook*, a publication of the Minnesota Department of Agriculture's Agricultural Development and Financial Assistance Division. The *Greenbook* highlights the project results of creative and innovative farmers and researchers involved with the Sustainable Agriculture On-farm Demonstration Grant Program.

The Grant Program and this *Greenbook* celebrate the 20 years of hard work and effort of 270 grantee farmers and researchers who have participated in the program. I am proud of our MDA staff members who have worked diligently to help these farmers and innovators accomplish their project goals. We have come a long way in the past 20 years. Many advances have been made in agriculture. The key, however, to quality farming is the work of Minnesota farmers who work tirelessly to produce some of the finest agricultural commodities in the nation. We are proud of the diversification of our farming community – from small specialty crop farmers to the large commodity crop producers. They all work to make our agricultural community a successful industry that is a major contributor to Minnesota's economy.

Greenbook 2009 contains articles highlighting the results of the grantees' projects and provides practical and technical information. Each article includes personal observations and management tips from the participants. Additionally, these grantees are willing to share their knowledge and experiences with you. They are all dedicated to making Minnesota agriculture more profitable and environmentally friendly. Feel free to give them a call about their projects.

Congratulations on a job well done!

Gene Hugoson, Commissioner
Minnesota Department of Agriculture

Table of Contents

Sustainable Agriculture Grant Program

Alternative Markets and Specialty Crops

Cropping Systems and Soil Fertility

Energy

Fruits and Vegetables

Livestock

Program Information

Sustainable Agriculture Grant Program

Program Purpose

The Grant Program provides a unique opportunity for farmers, nonprofit groups, agricultural researchers, and educators across the state to work together to explore ways of enhancing the sustainability of a wide range of farming systems.

Program Description

The Department has received over 1,080 grant applications and has approved over $2.9 million in funding for 270 projects since the program began in 1989. Project categories include: Alternative Markets and Specialty Crops, Cropping Systems and Soil Fertility, Energy, Fruits and Vegetables, and Livestock. The grant projects, located throughout the state of Minnesota, are described in *Greenbook 2009*.

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

Grant Summaries

The project summaries that follow are descriptions of objectives, methods, and findings of individual grant projects funded in the past 3 years. To find out more details about these projects, contact the principal investigators directly through the listed telephone numbers, addresses, and email addresses.

Summary of Grant Funding (1989-2009)

Year	Number of Grants Funded	Total Funding	Average Grant Size	Ranges
1989	17	$280,000	$16,500	$3,000-25,000
1990	14	189,000	13,500	4,000-25,000
1991	4	46,000	11,500	4,000-23,000
1992	16	177,000	11,000	2,000-25,000
1993	13	85,000	6,000	2,000-11,000
1994	14	60,825	4,000	2,000-10,000
1995	19	205,600	11,000	2,000-25,000
1996	16	205,500	12,900	4,000-25,000
1997	20	221,591	11,700	1,000-25,000
1998	19	210,000	11,100	1,000-24,560
1999	23	234,500	10,200	3,000-21,000
2000	17	150,000	8,800	4,600-15,000
2001	16	190,000	11,875	5,000-25,000
2002	18	200,000	11,000	4,300-20,000
2003*	---	---	---	---
2004*	---	---	---	---
2005	10	70,000	7,000	2,000-11,600
2006	8	70,000	8,750	4,600-12,000
2007	9	70,000	7,777	2,700-12,000
2008	10	148,400	14,800	4,500-25,000
2009	7	103,000	14,700	5,000-20,000
Total Funded	**270**	**$2,916,416**		

**No grants were awarded in 2003 and 2004.*

Hardwood Reforestation in a Creek Valley Dominated by Reed Canarygrass

Principal Investigators

Timothy and Susan Gossman
31924 Ninebark Rd.
Chatfield, MN
55923
507-867-3129
timg@fmwildblue.com
Fillmore County

Project Duration

2007 to 2009

Award Amount

$5,395.00

Staff Contact

Wayne Monsen
651-201-6260

Keywords

hardwood reforestation, healthy understory, reed canarygrass removal

Project Summary

Thirty years ago the 20 acres of creek bottom land on our farm was dominated by a floodplain forest comprised mostly of American elm. As these trees were killed by Dutch elm disease, and the shade disappeared, reed canarygrass (RCG) (*Phalaris arundinacea*) began to move into the area. RCG is an aggressive perennial grass that threatens wetland and riparian areas where it forms a monoculture, eventually smothering the native grasses and forbs and preventing any regeneration of trees or shrubs. It now dominates most of the 20 acres except for pockets of natural stands of native hardwoods and trees that were planted before it moved in. RCG provides almost no wildlife benefits, makes poor pasture or forage if not intensely managed, and provides little economic gain.

Returning this area to forest will provide food and habitat for birds and wildlife and provide short-term economic returns from nut and acorn harvesting and hunting opportunities, and long-term economic benefits from the sale of timber. The trees will shade Lost Creek, a designated trout stream, providing better trout habitat. We have planted spruce, pine, and fir trees on our farm and have been selling Christmas trees for over 10 years. We have also planted hardwood trees in appropriate areas of our farm and restored native grasses and wildflowers in other areas. These have increased the wildlife benefits as well as current and future income on our farm. This project is a continuation of that process.

Project Description

Due to RCG persistence and its resistance to control by non-chemical practices, we were faced with an environmental decision: whether it was better to leave the creek valley and RCG untreated and allow the RCG to dominate and spread but not expose the area to herbicides, or to explore several alternatives including treating an area with chemical herbicides for several years in an attempt to reforest the area. After much research and deliberation, we believe the more sustainable and environmental decision would be using effective herbicides with low environmental impact at rates no higher than would be used in a field of soybeans for a period of only 3 or 4 years to reestablish a forest that should remain for over 100 years. We think of this as a transition period that will provide long-term environmental benefits to our farm and to the Lost Creek and Root River Watersheds. We plan to reach the goal of reforestation by testing four alternative plans using different techniques of suppressing the RCG and growing trees.

We realize that this is a long-term project and plan to complete the project over 7 to 10 years. This long-term plan exposes no more than 2 acres of tilled soil to erosion in any year. Over the past 20 years we have planted tree seedlings and tree seeds such as walnuts

Tim discussing hardwood reforestation at field day.

and acorns in the creek valley with fair survivability in the areas not yet overtaken by RCG, and near 100% failure in the RCG areas.

The four strategies that we are using to control the RCG and return the area to a mix of bottomland forest with a healthy understory and open areas of sedges, reeds, and native forbs are:

- **Plan A:** Control RCG with a combination of prescribed burning, herbicide application, mowing, and tillage followed by direct seeding a diverse mix of bottom land trees and shrubs.
- **Plan B:** Plant fence post sized poles of willow and cottonwood in areas that are not accessible by machinery to eventually shade out the RCG.
- **Plan C:** Plant a diverse direct tree seeding in areas where the shade of boxelders has already controlled the RCG followed by killing the boxelder trees.
- **Plan D:** Follow a controlled burn with 1 year of herbicide treatment and tillage adjacent to stands of mature boxelder to encourage a natural seeding by the boxelders to shade out the RCG.

All four methods utilize the fact that RCG does not reproduce or survive in heavy shade. We will repeat the four plans over the 3 years of the grant to test the procedures in different weather conditions.

2007 Results

Plan A: The area for this practice was about 1½ acres. To prepare the area, a prescribed burn was completed in April 2006 to remove a layer of thatch. The site was then sprayed with sethoxydim herbicide in late May 2006 to kill the grasses including RCG. Sethoxydim kills grasses without harming the forbs.

A second burn was planned for the spring of 2007, but a late winter flood deposited a layer of mud on the site preventing us from burning. In 2007, the area was treated with sethoxydim herbicide in early June, mowed in late June, and treated with glyphosate herbicide in late August to kill all plants in the areas to be direct seeded. The herbicide treatments killed most of the RCG.

The site was mowed and tilled in mid-September and direct seeded to a mixture of burr oak, white oak, swamp white oak, walnut, butternut, bitternut hickory, Kentucky coffee tree, Ohio buckeye, chokecherry, wild plum, dogwood, redbud, ninebark, and false indigo in late September and early October. The larger seeds were disked in followed by the smaller seeds with oats as a cover crop and finished with a cultipacker. Warm wet weather allowed the oats to grow well, hopefully minimizing the effects of creek flooding.

Prescribed burn in progress.

Plan B: Willow and cottonwood poles, 4" to 6" diameter and 6' to 8' long were gathered while still dormant in March 2007 and stored in a root cellar to keep them cool and moist. As soon as the frost was out in April the pole cuttings were planted in holes made with a post hole digger into a stand of solid RCG in an area of about 1/8 acre.

Most of the poles of both species sprouted, but deer browsed on the shorter poles causing some trees to die. Some of the taller poles, above the browse level, put on new growth of up to 3'. We will reassess the survival rate of this area when trees leaf out next spring.

Plan C: The thick stand of young boxelder trees in this ¼ acre area was thinned so that trees are at least 4' apart. The lower branches on the remaining trees were removed to a height of 7' to allow the area to be worked up by a small tractor and tiller. The site was tilled in mid-September and direct seeded to a mixture of burr oak, white oak, swamp white oak, walnut, butternut, shagbark hickory, Kentucky coffee tree, horse chestnut, chokecherry, wild plum, dogwood, redbud, ninebark, and false indigo in late September and early October. The larger seeds were worked in with the tiller running at a slow speed with the smaller seeds sown on top of the ground.

This winter the boxelder trees will be cut, with the trees dropped onto the seeded area. The removal of the canopy will allow sunshine to reach the new tree seedlings and we hope that the tangle of branches will discourage the deer from browsing the new trees. In April 2008, willow, cottonwood, and tamarack seedlings will be planted. Silver maple seed will be sown on the area when that seed is ripe in June.

Plan D: A prescribed burn was conducted in April 2007 on about ½ acre. The area was treated with sethoxydim herbicide in early June, mowed in late June, and treated with glyphosate herbicide in late August. The herbicide treatments killed most of the RCG. The site was mowed and tilled in mid-September. The site was as is and should be a good area to germinate volunteer boxelder seeds.

2008 Results

Plan A: Most of the species planted last fall were found growing throughout the area when observations were done from April to June. In April 2008, we planted willow, cottonwood, tamarack, and hackberry seedlings in this area. Silver maple seeds were sown in June. We mowed this area in July with the tractor mower set at a height of 1' to control weeds without clipping the seedlings.

The new area selected for the 2008 planting was treated with sethoxydim herbicide in early June, mowed in late June, and treated with glyphosate herbicide in late August. The herbicide treatments appear to have killed most of the RCG. The site was mowed and tilled in September and direct seeded to a mixture of burr oak, white oak, swamp white oak, walnut, butternut, shagbark hickory, Kentucky coffee tree, ginkgo, black cherry, hackberry, green ash, Ohio buckeye, chokecherry, wild plum, dogwood, ninebark, and false indigo seeds in October. The larger seeds were disked in followed by broadcasting the smaller seeds and then the entire area finished with a cultipacker.

In April 2009, willow, cottonwood, and tamarack seedlings will be planted. Silver maple seed will be sown in June 2009 when the seed is ripe.

Plan B: Unfortunately, the willow and cottonwood poles planted in 2007 had less than a 10% survival rate after the first winter. This was due mostly, I believe, to deer browse. We dug up the dead posts and most had grown roots below ground as well as sprouts above, so they had started to grow. The trees that did live put on growth ranging from a few inches to several feet the first year. During the 2008 growing season they grew several more feet, not yet forming a central leader, but beginning to look more like young trees and less like fence posts!

Ohio buckeye tree seedling.

New growth on cottonwood and willow poles.

In 2008, we planted more willow and cottonwood poles. These poles were longer than the 2007 poles, ranging from 8½' to 10' long and were 4" to 6" in diameter. We gathered the poles in March while they were still dormant and stored them in a root cellar to keep them cool and moist. We planted these poles into solid RCG in April as soon as the frost was out of the ground. With a post hole digger we made holes 1½' to 2½' deep depending on the depth to rock. These taller poles had reduced deer browse so many more trees of both species were alive at the end of the growing season. We will reassess the survival rate of this area when trees leaf out next spring.

Plan C: In February 2008, we treated the boxelder trees with Garlon herbicide to kill them. Our original plan was to then cut the trees and let them lay to discourage deer from coming into the area. However, we decided that this would also make future plantings and weed control very difficult, so we left the dead trees standing. The insects and woodpeckers have taken advantage of this decision.

Seedlings of most species seeded in the fall of 2007 were found growing throughout the area. We planted willow, cottonwood, tamarack and hackberry seedlings in April 2008. Silver maple seed was sown in June. In July, we weed-whipped the taller weeds before they went to seed that were shading the seedlings.

Plan D: The 2007 burn area had a good germination of volunteer boxelder trees in 2008. We thinned this stand of young boxelder trees to about 4' apart. We removed the lower branches to a height of 7' to allow the area to be worked up by a small tractor and tiller. The site was mowed and tilled in September. We broadcast seeded a mixture of burr oak, white oak, swamp white oak, walnut, butternut, shagbark hickory, Kentucky coffee tree, ginkgo, black cherry, hackberry, green ash, Ohio buckeye, chokecherry, wild plum, dogwood, ninebark, and false indigo seeds in October. We used the tiller running at slow speed to work in the larger seeds. The smaller seeds were sown on top of the ground and not tilled.

This winter the boxelder trees will be girdled. This method of killing the boxelder may take longer than using Garlon™ herbicide, but this experiment will let us know if it will be as effective. The removal of the canopy will allow sunshine to reach the new tree seedlings. In April 2009, we will plant willow, cottonwood, and tamarack seedlings. We will plant silver maple seed in June 2009 when the seed is ripe.

Management Tips

1. Acorns should be kept moist and cool to maintain viability. Soak acorns in cold water prior to storing to chill and hydrate them.

2. Store early collected seed at 40°F.

3. A chest freezer can be used for seed storage by installing an override thermostat to convert it to a refrigerator. When you add the first seeds to an empty freezer, set the thermostat 10°F colder than the current temperature of the seed and lower it 10°F daily until you reach 40°F. This will allow the interior of the seed to get chilled without freezing the seed at the edges. Look for the freezer/refrigerator override thermostat where wine and beer making supplies are sold.

4. Oak, dogwood, chokecherry, plum, and other early collected seed may need to be stored for up to six weeks before other later maturing seeds, such as walnuts, are ready for planting.

5. The use of the Nut Wizard saves considerable time and effort compared to picking by hand or raking. It is available in several sizes for various sized nuts to collect acorns, hickory nuts, butternuts, and walnuts.

6. Use cottonwood and willow poles that are at least 8½' tall. This will leave over 6½' of the pole above the ground, keeping the new growth that sprouts from the top above the RCG and protect the new growth from browsing by deer.

7. Cottonwood and willow poles will not grow if planted upside-down. Make sure they are oriented the way they were growing when you cut them. You may want to mark the tops when harvesting the poles.

8. If your seed planting is near an existing forest, provide an easy food supply for squirrels by making several piles of walnuts around the edge of the planting. Hopefully, the squirrels will take these and leave your planted tree seeds in the ground.

9. Monitor your tree plantings weekly, monthly at least. This will allow you to do your maintenance on a timely basis and to deal with problems that arise such as finding varmints damaging trees and getting rid of them before they do severe damage to the plantings.

10. Contact your local DNR forester and county Soil and Water Conservation District for information on direct seeding, tree planting, and weed control in your tree planting.

Cooperators

Fillmore Soil and Water Conservation District, Preston, MN
DNR Forestry, Preston, MN
Jon Alness, Zumbro Valley Forestry, Elgin, MN

Project Location

From the traffic lights in Chatfield, MN, go 5 miles west on Cty. Rd. 2 then 1.5 miles south on Cty. Rd. 101, also known as Ninebark Rd. Farm is on the east side of the road at #31924.

Other Resources

Cottonwood and willow pole planting website:
www.nm.nrcs.usda.gov/news/publications/pole-cutting-solution.pdf
This web site provides basic information about pole planting in riparian areas.

Direct seeding hardwood trees websites:
www.dnr.state.mn.us/treecare/maintenance/collectingseed.html
and *www.dnr.wi.gov/forestry/Publications/articles/HardwoodDirectSeeding-2004.pdf*

A detailed description of this project can be found on the Fillmore SWCD website: *www.fillmoreswcd.org*
"Hardwood Reforestation in a Creek Valley Dominated by Reed Canary Grass." Go to "Projects" and select "Other Special Projects."

Reed canarygrass control websites:
www.phalaris.pbwiki.com/ and *www.lrrb.org/pdf/200436.pdf*
where best management practices are summarized on pp. 92, 93, and 94.

Seed collecting website: *www.nutwizard.com*

Introducing Cold-hardy Kiwifruit to Minnesota

Principal Investigators

James Luby
University of MN
Department of Horticultural Science
1970 Folwell Ave.
342 Alderman Hall
St. Paul, MN 55108
612-624-3453
Lubyx001@umn.edu
Project sites are in Hennepin County

Robert Guthrie
University of MN
Volunteer Actinidia Curator
1810 Alameda St.
Roseville, MN 55113
651-488-7122
bobguthrie@comcast.net

Eric Theship-Rosales
9201 Audubon Rd.
Chanhassen, MN 55317
952-361-9691
Kathleenandsig@earthlink.net

Project Duration

2007 to 2010

Award Amount:

$7,943.00

Staff Contact

Meg Moynihan
651-201-6616

Keywords

cold-hardy, kiwi, kiwifruit, orchard, pergola, trellis

Project Summary

The goal of this project is to introduce Minnesota growers to kiwifruit and provide them with information about the culture and management of growing this tasty and nutritious cold-hardy crop using two trellising approaches, pergola and T-bar, that prevent soil erosion, conserve soil moisture, and integrate natural biological measures.

Project Description

Cold-hardy kiwifruit is a deciduous vine that contains small, delicious, smooth-skinned berries and deserves greater attention in Minnesota. Kiwifruit are native to eastern Asia; there are about 70 different kiwifruit species. The most cold-hardy is *Actinidia kolomikta*, sometimes referred to as "Arctic Beauty" due to its colorful tri-color leaves. Native to Siberia, this particular species performs well throughout Minnesota when its cultural considerations are met. *A. arguta*, another species of merit, has a more vigorous growth habit, is sun-tolerant, and can be grown in southern Minnesota where winter temperatures are not expected to fall below -23°F. The University of Minnesota Horticultural Research Center (HRC) in Victoria, MN has been growing cold-hardy kiwifruit on a T-bar trellis since 1988 (Figure 1).

Kiwifruit prefers well-drained, silty soil that contains ample organic matter and retains moisture. The plants perform best in a partially shaded and sheltered location that provides protection from both late afternoon winter sun and strong summer winds. Generally the east side of a windbreak will satisfy the shade and wind protection conditions, but shallow tree roots may compete for soil moisture and nutrients during the growing season. The site should also have good air movement to avoid damaging frost pockets.

Year 1

We began construction of a pergola-type trellis structure at the HRC in fall 2007. The pergola is like an arbor, where the vegetative canopy grows in a single, horizontal plane. This system protects the berries from wind-rub scarring. Our site occupies a north facing slope. Because of this orientation and shading from nearby trees, the location is not suitable for most other fruit crops, but the kiwifruit actually benefits from the shading.

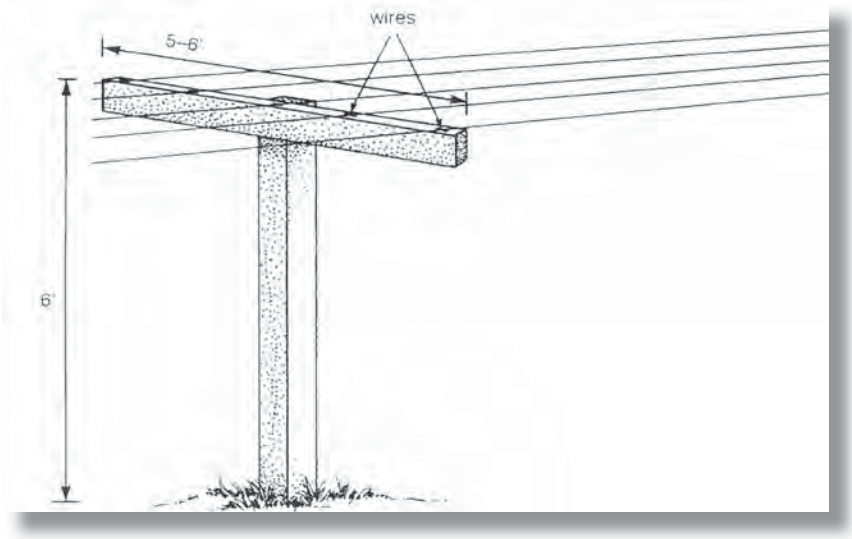


Figure 1. Standard T-bar trellis system for kiwifruit.[1]

[1]*Trellis system illustration used with permission of the Oregon State University Extension Service from page 10 (figure 1-A) of publication PNW 507, Growing Kiwifruit (reprinted April, 2005, Corvallis).*

Prior to planting the kiwifruit and constructing the pergola, a 4" layer of woodchip mulch was placed at the orchard site. Woodchips retain soil moisture, prevent erosion, and smother most weeds until the canopy forms. They allow for the lateral extension of roots at the soil-woodchip interface, resulting in increased yields. Fallen kiwifruit leaves will encourage earthworm activity.

This new kiwifruit demonstration site at the HRC traverses a hill, so we laid out the post positions (using flags) 15' apart with 7' between rows (Photo A). We augured end posts and some of the internal posts into the ground. We planted *A. kolomikta* vines 3' apart and *A. arguta* vines 6' apart.

Photo A. The new kiwifruit demonstration at the HRC traverses a hill.

Year 2

In 2008, we installed the rest of the posts but had trouble finding a supplier for the crossbars we needed. We finally managed to obtain these and we expect to finish construction of the pergola in spring 2009. When complete, the total pergola trellis area will exceed .25 acres.

After the pergola is finished, we will train the kiwifruit vines to high-tensile steel wires clipped to rectangular steel tubes mounted on the wooden posts. We are using steel tubing because it is stronger than wood, lacks knots and other defects, and will not deteriorate. At the ends of the pergola, the wires will be fastened to a braided steel cable. One end will have an in-line tightener to adjust wire tension. Generally, wires should be supported at distances of 20' or less to prevent line sag as the plants mature and vegetation and fruit loads increase.

Photo B. A tree shelter tube protected the new shoots from rabbits.

An Oregon State University publication called *Growing Kiwifruit* offers excellent drawings of pergola designs. It is available free on the Internet. See the "Other Resources" section at the end of this article.

2008

An August 2007 storm with straight-line winds in excess of 80 mph broke posts on the existing 25-year-old T-bar trellis at the HRC, where kiwifruit have been growing since 1988. After making those repairs, we pruned many of the old *A. arguta* trunks so that new growth could be trained to the trellis wires. To train each kiwifruit plant, we selected a vigorous new shoot and loosely fastened it to a support stake, and a tree-shelter tube was slipped over the stake to protect the young trunk from cottontail rabbits that might feed on it during the winter months (Photo B). This shoot and a secondary side shoot located at a height of about 4' grew in a "Y" configuration from this junction. These became the two main cordons (branches). As growth continued, the two cordons were trained to cross-over each other in two arcs, then loosely looped around the overhead support wire (Photo C). After growing about 4' more in each direction along the support wire, the tips were pinched to encourage lateral side branching. When the lateral branches reached about 2.5', we secured them to the outer wire in a broad arc using a nylon clip (Photo D). Throughout the remainder of the growing season, we snipped off any stray side shoots emerging from the trunk or cordons with a pruner. Because of the well-established root systems, we accomplished 3 years worth of training in a single growing season. In 2009, we plan to train the established *A. kolomikta* plants to the T-bar trellis in a similar fashion.

In 2009, we will also train vines on the pergola using the same split-crossover "Y" cordon method described for the T-bar system, except that the laterals will be laid down "flat" and fastened to the horizontal high-tensile steel wires using the nylon clips.

On-farm Location – *A. kolomikta*

Five miles away from the HRC, cooperator and organic grower Eric Theship-Rosales is also working with kiwifruit. He became interested after seeing and tasting it at the HRC.

In 2008, Eric set out more than 250 *A. kolomikta* kiwifruit plants provided by cooperator Bob Guthrie and the HRC in a northeast-facing hillside orchard. These consisted of both seedlings and propagated cuttings.

Eric had hoped to plant as many as 1,000 seedlings he tried to start himself from a large fruited (for the species) Russian variety called "Krupnopladnaya." Unfortunately, most of the seeds he tried to did not germinate, probably because the double-dormancy was not met.

So far, Eric has encountered some problems from rabbits and deer and consequently placed protective cages over each plant. He will eventually use a T-bar training system.

Photo D. We secured lateral branches to the outer wire in a broad arc using a nylon clip.

Photo C. Two cordons are looped around the support wire.

Our project's outreach activities included a half-hour talk by Jim about the project at the Upper Midwest Regional Fruit and Vegetable Growers Conference in St. Cloud in February 2008. About 30 people attended the session. We also held a field day on August 30, which four people attended. This was probably not a good date, since it fell on Labor Day weekend, but due to the cold spring and the very late ripening in 2008, we thought it presented the best chance for visitors to see ripe fruit.

We plan to do a summer 2009 field day, when the HRC pergola will be completely assembled. We have also propagated additional kiwifruit cuttings and will distribute them free of charge to field day attendees, giving interested growers the opportunity to try kiwifruit in their own orchards on a trial basis.

Management Tips

1. To germinate *A. kolomikta* seeds, subject them to extended periods of a warm-cold-warm cycle to satisfy the double-dormancy requirement. Be sure to use a sterile, high-porosity planting medium kept moist and not wet. An alternative method involves soaking the seeds in a 1,000 ppm gibberellic acid (GA3) solution for 24 hr, then chilling the seeds for a few weeks prior to germination. Regardless of which method is used, if germination rates are poor, stratify the seeds with an additional chilling cycle, and try again.

2. Choose a partially shaded, sheltered location with rich, well drained but moisture retentive soil that is neutral or slightly acid in pH. North and east facing gentle slopes are preferred with shelter from strong winds provided by woodlots, windbreaks or shelter belts.

3. Use a thick layer of woodchip mulch to retain soil moisture, prevent erosion, and smother weeds until the vine canopy closes. Replenish every 3 years.

4. Protect the newly planted vines with plastic tubes to protect them from rabbit damage.

Project Location

The HRC site is located in Victoria, MN near the Minnesota Landscape Arboretum. Travel 0.3 miles northwest of the intersection of MN State Hwy. 5 and Rolling Acres Rd.

The Theship-Rosales farm is located about 4 miles south and east of the Minnesota Landscape Arboretum on Audubon Rd., approximately 1 mile south of MN State Hwy. 5.

Other Resources

Growing Kiwifruit. 1995. Oregon State University. Available at: *extension.oregonstate.edu/catalog/pdf/pnw/pnw507.pdf*

How to build fences with USS Max-10 200 high-tensile fence wire. 1980. United States Steel, Pittsburgh, PA, 75 pp. (Out of print but some of the information it contains is available at: *www.kencove.com/Guide.php*)

Dream of Wild Health Farm Indigenous Corn Propagation Project

Principal Investigator

Peta Wakan Tipi - Sally Auger
459 N. Wheeler St.
St. Paul, MN 55104
651-646-8167
odawa@comcast.net
Washington County

Project Duration

2006 to 2008

Award Amount

$6,600.00

Staff Contact

Jean Ciborowski
651-201-6217

Keywords

corn, heirloom, indigenous, Native American Indian, propagation

Project Summary

Peta Wakan Tipi is a 24 year old nonprofit organization which owns and operates the Dream of Wild Health farm in Hugo, Minnesota. The Dream of Wild Health (DWH) is an American Indian agricultural and educational program. We have a collection of several hundred heirloom seeds that have been gifted to us by elders, reservations, and seed savers around the Upper Midwest. Our purpose for the Indigenous Corn Propagation Project is to explore the process and costs of growing and protecting the integrity of indigenous heirloom food crops. Specifically, we proposed to regenerate nine varieties of near-extinct indigenous corn in order to serve the rural American Indian communities in our area.

Hand pollination and bagging in process.

Cultural leader Ernie Whiteman provides teachings about indigenous corn.

Indigenous corn.

Project Description

In 2006, after meeting with a variety of community members, we selected nine varieties of indigenous corn seed to propagate based on seed availability, viability, and community needs. Working closely with the Department of Horticulture as well as the Department of Food, Science and Nutrition at the University of Minnesota, we have gone through a careful and rigorous process of hand pollination and hand harvesting with photographic as well as data documentation of results.

Seeds can be started in the greenhouse and then transplanted in the field or sown directly into warm field soil. Although it is unusual to transplant corn, it can be very successful if done when the seedlings are about 7 days post germination. It was decided to start a portion of the corn in the greenhouse and sow the other portion directly into the field.

The total seed stock of each variety available for planting from 2007 was weighed using a digital scale. On May 19, half of the corn seed was planted in the greenhouse in 50 cell flats using Hsu's organic potting mix or Organic Sustane soil mix. Most of the seed germinated very well. Quapaw Red

and Cherokee Flour had lower than expected percent germination (Table 1). On May 28, the plants were set outside to harden off and transplanted in the prepared seed beds the following day. The remaining corn seed was sown directly in the field on May 29. The nine varieties were planted at least 150 yards away from each other with squash, beans, buckwheat, or clover planted in between to minimize the risk of cross pollination.

The plants were pollinated by hand. Individual cobs were trimmed and bagged; pollen was collected from several plants of the same variety, combined, and used to pollinate silks that had emerged overnight. Plants were watered and fertilized daily with high calcium fertilizer. Plants were taken to maturity and cobs harvested when plants turned brown and cobs drooped. Cobs were taken into the lab, allowed to dry until seed was easily removed from

Table 1. Corn seed variety, number of seeds provided, and percent germination of each lot.

Variety	2006		2007		2008	
	No. of Seeds	Germination (%)	No. of Seeds	Germination (%)	No. of Seeds	Germination (%)
Chip Amber	34	44	10	90	522	98
Mandan Red Clay	8	50	20	90	232	73
Mandan Blue	18	22	20	75	250	72
Bear Island	55	50	20	60	200	80
Cherokee Flour	19	10	10	100	250	52
Lenape Blue	4	50	10	100	200	93
Quapaw Red	10	40	10	90	166	49
Red Lake Hominy	61	5	20	90	174	96
Cree	62	2	3	67	290	79

Table 2. Peta Wakan Tipi indigenous corn seed increase for 2006.

Variety	Seeds Supplied	Harvested Dry Weight (g)	Weight per 10 Seeds (g)	Harvested Seed (Est.)	Seed Increase (%)
Chip Amber	34	503.8	2.15	2,343	6,892
Mandan Red Clay	8	92.15	2.2	419	5,238
Mandan Blue	18	43.2	2.8	154	856
Bear Island	55	237.3	2.1	1,130	2,054
Cherokee Flour	19	118.2	4.5	263	1,384
Lenape Blue	4	139.5	3	465	11,625
Quapaw Red	10	97.4	2.6	375	3,750
Red Lake Hominy	61	150	4.3	349	572
Cree	62	---	---	10	---

the cob. Since the amount of corn planted in the field was significantly increased from previous years, we were unable to hand pollinate every stalk due to labor constraints. At least 20 plants of each variety were hand pollinated. Most of these plants were on the perimeter of each plot since they were the most at risk for cross pollination. Two to three strong plants in the center of each plot were also hand pollinated.

Results

Plants were not harvested until they were sufficiently dry in the field regardless of frost. The short season corn including Bear Island, Mandan Red Clay, Mandan Blue, and Amber Chip were harvested on September 22. Red Lake Hominy and Cree were harvested on October 3. Quapaw Red, Lenape Blue, and Cherokee Flour were harvested after the frost on October 8. A significant seed

Table 3. Peta Wakan Tipi indigenous corn seed increase for 2007.

Variety	Seeds Supplied	Harvested Dry Weight (g)	Weight per 10 Seeds (g)	Harvested Seeds (Est.)	Seed Increase (%)
Chip Amber	2,343	413	2.0	2,046	-13
Mandan Red Clay	429	348	2.0	1,746	307
Mandan Blue	201	262	3.3	793	295
Bear Island	1,104	172	1.5	1,156	5
Cherokee Flour	550	286	1.7	1,633	197
Lenape Blue	649	185	1.9	986	52
Quapaw Red	453	98	1.2	803	77
Red Lake Hominy	698	273	2.0	1,364	95
Cree	10	281	1.9	1,448	14,380

Table 4. Peta Wakan Tipi indigenous corn seed increase for 2008.

Variety	Seeds Supplied	Harvested Dry Weight (g)	Weight per 10 Seeds	Harvested Seeds (Est.)	Seed Increase (%)
Amber Chip	2,046	1,436	1.0	14,360	701
Mandan Red Clay	1,746	585	2.0	2,925	167
Mandan Blue	793	4,038	4.0	10,095	1,273
Bear Island	1,156	3,933	4.0	9,832	850
Cherokee Flour	1,633	14,173	4.0	35,432	2,169
Lenape Blue	986	5,096	2.0	25,480	2,584
Quapaw Red	803	1,598	3.0	5,326	663
Red Lake Hominy	1,364	6,590	4.0	16,475	1,207
Cree Corn	1,448	9,945	2.0	49,725	3,434

increase was achieved for all varieties from 2006 through 2008 (Tables 2-4).

Temperatures were lower than average in June leading to slow growth rates for the corn in the early season. Once the temperatures started to rise the corn responded quickly, growing to average height by the end of August. Overhead irrigation was used early in the growing season during periods of insufficient rainfall. All corn plants were foliar fed with fish emulsion three times during the growing season. Plants were sprayed with Bt once corn earworms and corn borers became active. Raccoons were very persistent this year, affecting all varieties of corn and significantly decreasing yields in Amber Chip, Mandan Red Clay and Mandan Blue. Two scarecrows were hung in the field to try to deter the raccoons. For all varieties, the transplanted plants matured faster than plants sown directly into the field.

Given the results that we obtained over the 3 years of this project, we would recommend this process to small-scale farmers who are interested in preserving specialty or heirloom crops. This process is not feasible for large-scale production because of the time-consuming and detailed processes of propagation involved. We will continue these growing practices on our farm to protect the integrity of our indigenous food crops as our resources permit. It is critical that these rare, near-extinct varieties are brought back for the health of American Indian people in the region.

Management Tips

1. To protect the integrity of the crops, grow out only three varieties per year. These varieties should have different silk and tassel dates, reducing the risk of cross pollination.

2. Build a raccoon proof fence to protect the corn from future crop loss.

3. Take detailed notes and pictures throughout the growing season.

4. Fertilize corn at least three times during the growing season.

5. Continue to plant at least half of the corn in the greenhouse and transplant it into the field. The corn should be planted at the end of May or the first week of June.

Cooperators

Craig Hassel, University of Minnesota, St. Paul, MN
Albert (Bud) Markhart, University of Minnesota, St. Paul, MN
Lynn Keller, Master Gardener, Volunteer, and Documenter of Project, St. Paul, MN
Donna LaChappelle, Ceremonial Advisor and DWH Program Coordinator, St. Paul, MN
Diane Wilson, Director of Dream of Wild Health, St. Paul, MN

Project Location

From St. Paul, take I-35W north to Cty. Rd. 14 (Exit 123) and turn right (east) onto Hwy. 61 in Hugo. Turn left onto Hwy. 61 (north – 2.6 miles) to 170th St. (CR4) and then turn right (east – 3.2 miles) onto Jeffrey Ave. N. (you can only turn right (south) onto Jeffrey Ave. N.) Take Jeffrey Ave. N. (south – 0.9 miles) to 16085 Jeffrey Ave. N. The Dream of Wild Health farm will be on the left when driving south on Jeffrey Ave. N. from 170th St.

Other Resources

For further information on the earlier years of this project go to: *Greenbook 2007 and 2008*. Dream of Wild Health Farm Indigenous Corn Propagation Project. Website: *www.mda.state.mn.us/protecting/sustainable/greenbook.htm*

Hsu's Compost & Soils - Greenhouse & Landscape Supplies, Erosion Controls. Wausau, WI. 715-675-5856. Website: *www.hsuscompost.com/composts.shtm*

Growing the Goji Berry in Minnesota

Principal Investigators

Koua Vang and
Cingie Kong
7862 – 465th St.
Harris, MN
55032
651-387-9246
tuajncigntuj@
yahoo.com
Chisago County

Project Duration

2008 to 2011

Award Amount

$21,117.00

Staff Contact

Jean Ciborowski
651-201-6217

Keywords

goji berry,
raspberry

Project Summary

This past summer, we planted goji berry seedlings on our farm in east-central Minnesota to determine if goji berries can be a viable crop in Minnesota. The seedlings grew rapidly and produced a small crop the year of planting. Our next goal is to find varieties with uniform fruit quality, high yields, and vigor that can grow in the central Minnesota climate.

Figure 1. Goji fruit.

Project Description

Goji berries (*Lycium barbarum L.*) are a small fruit native to the mountainous regions of western China to Mongolia. Other names for goji berries include wolfberries, lycium berries, and matrimony vine. Goji berries are in the Solanaceae family and are related to tomatoes, peppers, and potatoes. Goji plants are perennial vines, similar to the poisonous climbing nightshade or woody nightshade that is common in parts of southern Minnesota. Unlike the climbing nightshade, goji fruit are not found in clusters, but as single berries along the branch (Figure 1). Both goji fruit and leaves are edible, but we are only interested in harvesting the small, red oblong fruit. The berries have a unique, sweet flavor with a pleasant sugar-acid balance.

Goji berries can be consumed fresh, dried, or made into juice. In China, goji berries have been used in herbal remedies for nearly 2,000 years to treat diabetes and impaired vision, and improve longevity. The color of the fruit is due to several different carotinoids, including zeaxanthin dipalmitate. The carotinoids have been used to reverse age-related macular degeneration and other problems with the eyes. The berries contain an unusual polysaccharide-peptide complex that may promote the formation of T-cells and help the immune system.

Worldwide, most goji berries are grown in the mountainous areas of northwestern China, where total production exceeds 5 million kg. In the U.S., there are small fields in Utah and Iowa, but berries have not been tested in Minnesota. Currently there is little reliable information on varieties, yields, or climate requirements for growing goji berries in the U.S. For example, some sources say the vines die when the temperature falls below -10ºF, other sources say -15ºF. Ningxia, an autonomous province of China, which is the leading producer of goji berries, has a continental climate with midwinter temperatures that often fall below -25ºF.

This project will determine if goji plants can become a commercially viable crop in central Minnesota. We will be looking at all aspects of growing goji berries, from starting the plants to measuring yields. As the vines mature and as production increases, we will market goji berries to the Asian community in St. Paul.

We own a 20 acre farm near Harris, MN with loamy sand soil. Currently, we farm 2 acres of vegetables for personal consumption and for selling at local farmers' markets. We have a small greenhouse to start plants for our own garden and we raise chickens for personal consumption.

We started all of our goji plants from seeds. Potted plants cost up to $20 each, which is not economically viable for commercial production. The seeds came from the Fountain of Youth Goji Vineyard in Winterset, IA and from Timpanogos Nursery in Utah. Goji seeds are similar in size and shape to tomato seeds. In February, we planted the seeds in 4" pots. After germination, we moved the plants to a greenhouse until late May.

We prepared the field for the goji plants by spraying the field with Roundup® and by rototilling several times before planting. Next, we built a fence with small mesh chicken wire around the site. The field with the gojis had been used for wintering livestock and is extremely rich in phosphorus and potassium. The fence proved to be critical because we placed a few plants outside the fence, and all the plants outside the fence were eaten by rabbits. We planted 600 seedlings on May 31 on a 4' by 6' spacing. Weeds were controlled by hoeing, and all watering was done by hand. In the middle of summer, we tied all the plants to wooden stakes. In the fall, we mulched the plants with woodchips to reduce weed competition in 2009.

Figure 2. Goji vines in September.

Figure 3. Goji flower and green fruit.

Results

The plants grew fast in the greenhouse and some were over 1' tall by the time we transplanted in late May. Like other solenaceous plants, gojis transplanted easily and all the transplants survived. Some plants grew exceptionally fast this year and the tallest plants were more than 5' tall by early September (Figure 2). Unlike most fruit crops grown in Minnesota, gojis can produce flowers on first year wood and some plants bloomed and started setting fruit at the end of August. The flowers are primarily white but each plant had a few purple flowers as well (Figure 3). Most of the fruit on the vines this summer did not ripen by late fall but we were able to harvest a pint of fruit for personal consumption. Most plants had no major diseases this year but a few plants appeared to have Septoria leaf spot, the same disease that hurt our tomato crop.

Flower induction in gojis is entirely different than other fruit crops. In most woody plants, flower buds are formed in late summer and bloom the following spring so that fruit is only produced on wood that is at least 1 year old and fruit ripens over a short period of time. Gojis, by contrast, produce fruit on current season's growth similar to primocane blooming raspberries. Since gojis flower on current and previous season's growth, they should produce fruit continuously throughout the summer.

One of the difficulties of starting trees from seed is that seedlings often show tremendous genetic variation. One way of looking at the genetic variation is to see each seedling as a different variety. Although some variation in plant vigor is expected in all seedlings, the difference in our goji seedlings was excessive. About 1/3 of the plants were extremely vigorous, growing more than 6', while a few plants grew about 1'. The short plants were scattered randomly through the plot, and their low vigor appeared to be genetic rather than due to poor soil or lack of water. Two plants have started sending out root suckers. Most plants had one leader, but a few of the vigorous plants had multiple trunks. Even in the first year, we could see differences in fruit set between plants. Some had large, red fruit while others had orange fruit. Some plants produced ample fruit (Figure 1), while other plants had 2 or 3 fruit per plant.

The extreme genetic diversity of our seedlings was inconvenient. Weed control is difficult when a tiny plant is next to another plant the size of a small tree. We staked all plants, even though some plants did not need staking because they were so short. When we start marketing the fruit, we will have fruit with different colors and different sizes that could confuse customers.

On the other hand, with nearly 600 varieties, we can choose 1 or 2 plants to expand our planting.

Next year, we will determine which plants have the best combination of winter hardiness, fruit quality, and vigor, and take cuttings from the best plants for future plantings.

Management Tips

1. Goji berries are best started from seed. The seed is relatively inexpensive and the seedlings grow rapidly.

2. Staking goji vines proved to be important, especially on the vigorous seedlings.

Project Cooperator

Thaddeus McCamant, Northland Community and Technical College, Detroit Lakes, MN

Project Location

We are 2 miles north of Harris, MN on Forest Blvd. (Hwy. 30). Take a right turn on 465th St. and we are the last house at the end of the street on the left hand side.

Other Resources

Dharmananda, Subhuti. Lycium Fruit: Food and Medicine. 2007. Website: *www.itmonline.org/arts/lycium.htm*

Fountain of Youth Goji Vineyard, Winterset, Iowa. Website: *www.fountainofyouth-gojiseed.com*

Timpanogos Nursery specializes in goji berry production and is located in the Rocky Mountains of Utah. Website: *www.timpanogosnursery.com*

Environmentally and Economically Sound Ways to Improve Low Phosphorus Levels in Various Cropping Systems Including Organic with or without Livestock Enterprises

Principal Investigator

Carmen Fernholz
2484 Hwy. 40
Madison, MN
56256
320-598-3010
Lac qui Parle County

Project Duration

2006 to 2009

Award Amount

$10,720.00

Staff Contact

Mark Zumwinkle
651-201-6240

Keywords

manure, organic farming, rock phosphate

Project Summary

The primary goal of this project is to seek viable alternative sources of phosphorus for farm operations where animal manures are not available or where commercial NPK fertilizers are not an option. Many organic farmers and others contemplating a transition to organic production do not have livestock and, consequently, do not have access to approved, readily available sources of phosphorus that are affordable.

The land included in the project has not been manured for over 40 years and has now completed transitioning to organic production. Yields have been diminishing steadily over the last 5 years, even with the abundant use of legumes, both as cash crops and as cover crops. The project is located a significant distance from any animal manure source. If we can begin to show how the organically approved sources of phosphorus impact yield and raise the phosphorus levels in fields without the use of animal manures, we can provide more opportunities for farmers without animals to transition to organic production. We can also become more creative in our crop rotations with improved soil phosphorus levels.

Carmen explains the organic phosphorus study at a field day.

Project Description

Over time, it is becoming increasingly evident that many organic producers without livestock on their farms are facing phosphorus shortages in their fields. This can be explained in part due to the growing trend in the use of alfalfa as a cash crop in organic systems.

For non-livestock producers, alfalfa is an excellent tool for weed management. For example, inclusion of alfalfa in the rotation helps control Canada thistle. Alfalfa is also a well known soil building crop.

The cropping systems on my farm are a constantly evolving and complex rotation of corn, soybeans, oats, winter wheat, barley, flax, dried field peas, and alfalfa. Presently, I have no livestock. However, I do have access to hog manure from a neighbor who is renting one of my buildings to finish hogs.

Our farmland is gently rolling with some terraces and a fair amount of tile drainage. Our soils are primarily silty clay loam which allows me to use most conventional equipment to do my field work. The farm consists of about 400 acres, 350 which are tillable. This size operation, using the diverse crop rotation, assures me that I can accomplish most of the work by myself especially given the fact that the crop rotation provides an evenly spread workload over most of the growing season.

The inspiration for this project came from extensive soil testing of a troubled field in the fall of 2006. For several years, production in this field dwindled. My primary complaint about the field was poor productivity. There was also inconsistent crop performance across the field. The soil samples were taken based on crop growth patterns. The soil test results showed very low phosphorus (3 to 5 ppm) uniformly across the entire field. These levels are low enough to easily explain the low crop productivity. The soil tests also showed a dramatic variation in pH. It is commonly known in the soil science community that soil pH is very influential in phosphorus availability to plants. What is unique about this site is that it has a range of pH values from slightly acidic (6.5) to strongly alkaline (8.3) all within the same field.

After consulting with several researchers and crop specialists, I decided the only two options available to me as an organic grower were animal manures and raw phosphate. In the fall of 2007, we applied two types of raw phosphate at a rate of 400 lb/A on GPS marked areas of the field and hog manure at a rate of 10,000 gal/A on a third area to begin the demonstration.

This project will allow us to assess the effectiveness of two different types of rock phosphate minerals, one originating in the southeast part of the U.S. and the other originating in the northwest part of the U.S. against one manure source (hog manure). It will help us to determine how these different phosphorus sources will effect crop production across a wide range of soil pH levels and which should be used where.

Results

Soil tests are being taken each fall on the GPS marked areas throughout the field to match the test results from year to year. Manure is being analyzed along with application rates. We are taking yields and tissue samples from the growing crops to determine the effect of the three phosphorus amendments.

2007

Preliminary results after the first year showed very little movement in the soil test phosphorus levels. However, it is my intention to continue the project for another two growing seasons to fully determine any change in phosphorus availability.

The dried field peas planted in the phosphorus treated areas yielded 10 bu/A. Part of this low yield can be attributed to the low soil phosphorus levels. A very hot spell right at blossom time also significantly curtailed the yield. As a result, our yield data is not directly correlated to the phosphorus issue. Alfalfa yielded 2.9 tons/A from four cuttings. A very hot and dry spell in late July and early August impacted the third cutting significantly. However, a wetter late August and early September contributed to a good fourth cutting.

As I mentioned above, phosphorus levels across the field have moved very little over the past growing season. Consequently, we have applied an additional 4,000 gallons of hog manure on the alfalfa area of the field and have left the remainder of the area without any additional applications of raw phosphate.

I will be working with my crop consultant to better analyze what may or may not be going on regarding the phosphorus. In 2008, I am seriously considering planting a strip of buckwheat diagonally across the phosphorus treatments after taking the oats crop off to see if this may be an additional and more economical practice to free up phosphorus. I think this would be an appropriate action to take seeing as this is a demonstration grant and not a strict research project.

2008

At this point in time, I am quite puzzled at the results of the soil tests over the last 2 years. I was hoping to see a lowering of the soil pH and an increase in the levels of available phosphorus over time. However, neither activity is occurring. I am especially concerned about the phosphorus levels. Some fields have received 15,000 gal/A of hog slurry over a 2 year period without any significant change in available phosphorus.

This points to several research questions for further study:

1. Does heavy application of liquid hog manure significantly impact available phosphorus levels in the soil especially where there are higher pH levels?

2. Do different manure types and sources impact soil phosphorus in different ways?

3. Are there other ways to positively impact both soil pH and available phosphorus other than commercial NPK applications?

There is a subset study that I am keeping track of. In the fall of 2007, I installed a significant pattern tile drainage system in areas with high soil test pH levels. I will be following future soil tests to see if this installation begins to impact the soil pH in these areas and not in other areas and, if so, to what extent.

Again, let me emphasize that the information I am seeking relates to practices that are acceptable in organic management systems. At this stage of the project I am not certain I can offer any answers. I am hoping the third year will really start to show some significant results. Following the third year of the study, I am hoping to continue the study with a more concerted effort in tracking the impact of cover crop legumes and buckwheat on various soil quality traits.

Given the information gathered so far, I think that more intensive scientific research is needed. The goal of maintaining or building phosphorus levels in organic systems that have not had access to livestock manures may be more difficult than first thought.

Cooperator

Glen Borgerding, Ag Resource Consulting, Inc., Albany, MN

Location

From Madison, MN go east on MN Hwy. 40 1.5 miles and look for the A-frame house on the left.

Other Resources

ATTRA – National Sustainable Agriculture Information Service. 2001. Alternative Soil Amendments. Available at: *http://attra.ncat.org/attra-pub/PDF/altsoil.pdf*

Brady, Nyle C. and Ray R. Weil. 2000. Elements of the Nature and Properties of Soils. Prentice Hall, New Jersey. Pp. 391-411. Refer to p. 398, Figure 13.5 (the phosphorus cycle in soils).

Rotational Use of High-quality Land: A Three Year Rotation of Pastured Pigs, Vegetable Production, and Annual Forage

Principal Investigator

Gale Woods Farm
Three Rivers Park District
Tim Reese
7210 Cty. Rd. 110 W.
Minnetrista, MN 55364
763-694-2002
treese@threeriversparkdistrict.org
Hennepin County

Project Duration

2006 to 2009

Award Amount

$10,000.00

Staff Contact

Meg Moynihan
651-201-6616

Keywords

diversify, forage, integrated, lambs, pig tillage, pigs, rotation, vegetables

Project Summary

Gale Woods Farm is a working educational farm owned and managed by Three Rivers Park District. We raise vegetables and fruit, hay, sheep, cattle, pigs, and chickens and engage more than 20,000 visitors a year in agriculture education. This project demonstrates a 3-year rotation of pastured pigs, annual vegetable production, and annual forage for finishing market lambs.

Project Description

We divided an existing pasture located on very productive soils into three sections of approximately 1.5 acres each. Each section is in production for one of the three components. The order of rotation is 1) pastured pigs, whose tillage prepares the soil for the 2) next season's garden crop and finally 3), an annual forage for finishing market lambs. The cycle then starts again with pigs.

We expected to gain a number of environmental and economic benefits from this project. Some of our original expectations as listed below were met and some were not.

- ***Reduced off-farm inputs including purchased grain, tractor fuel, and labor***
  We did see a slight, but unquantified, reduction in grain as the pigs did get some nutrition from rooting in the pasture. However, tractor use for tillage was not reduced, since we needed to till frequently to deal with weed pressure. Managing the pigs certainly required more labor than just preparing the gardens mechanically, but the pigs also provide the benefits of becoming the pork that we sell.

- ***Reduced need for chemical de-wormers through a rotation that reduces the parasite load on pasture***
  The cover/forage crop that the lambs grazed had a much lower parasite load than the sheep pasture they would otherwise graze. We reduced the need for de-worming by one or two treatments each season. However, multiple factors including better management of the other pastures, also played a part in this reduction.

- ***Increased efficiency in pasture use by maximizing use of the pasture and making better use of areas of high soil fertility for garden production***
  The production of hogs and gardens alternately on the same ground seems to be an effective and, from a fertility standpoint, sustainable and highly productive use of this pasture.

- ***Expanded organic vegetable production with fewer inputs***
  It appears that we are maintaining fertility on these plots with less applied fertilizer. Time and continued soil testing will tell for sure.

- ***Diversified farm products***
  The pasture-raised pork is a very popular product and has certainly diversified our product sales.

During the first year of this project, we established required fencing and watering infrastructure. We subdivided the existing pasture with temporary electronet fencing to create three separate sections. We also installed a single strand of electrical fencing tape inside the permanent perimeter fence in the pig section to prevent pigs from digging under the perimeter fence. We added a seasonal irrigation line along the perimeter of the pasture for livestock water and crop irrigation.

In the second year of this project, we focused on managing the pigs more intensively to accomplish a more complete "rooting up" of

the paddock that will be put into garden production next. We also found sturdily-mounted automatic waterers to be useful.

In the final year of the project, we fine tuned our pig moving strategy in order to better manage weed problems. We also implemented the annual forage component of the project, grazing spring lambs on oats and rye seeded the previous fall, and in the fall, grazing pigs on oats that we seeded in mid-August. We concluded that changing from a 3-year to a 2-year rotation will improve the performance of the entire system.

Results

Component 1 - Pastured Pigs

In the first 2 years of the project, we purchased feeder pigs from the Van Der Pol family at Pastures A Plenty Farm in Kerkhoven, MN. They were a Duroc/Berkshire cross with a trace of Chester White. In 2006, we purchased ten pigs, approximately 2.5 months old. In 2007, we purchased nine pigs, approximately 1.5 months old upon arrival. In 2007, they were put out on pasture on April 30, about 2 weeks earlier than 2006.

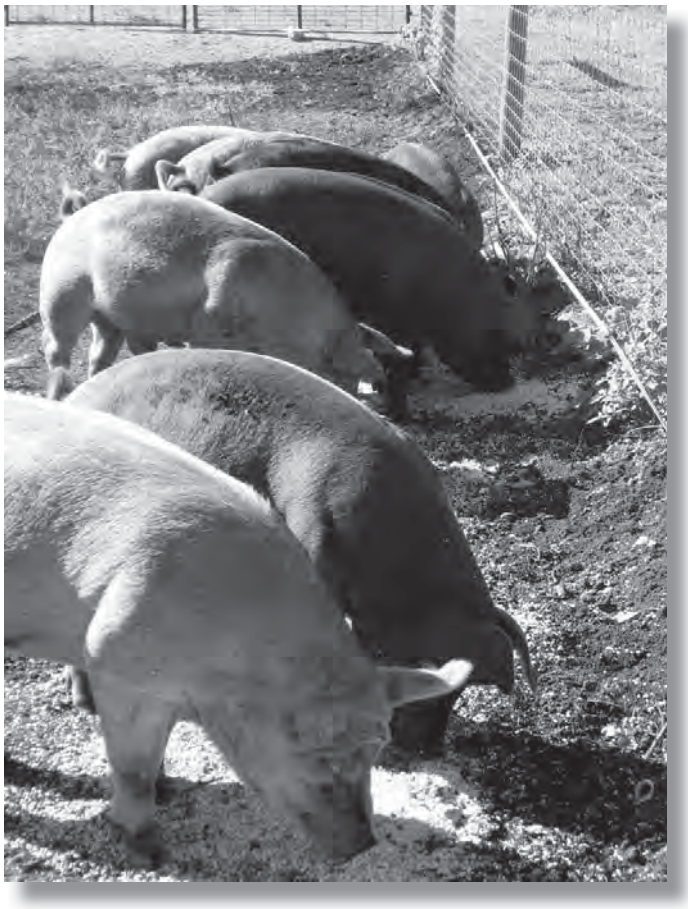
In 2008, we purchased nine feeder pigs from the Polzin Farm in Glencoe and put them out on pasture on May 5. These pigs had been raised for a barn production system and were Duroc/Berkshire/Landrace cross. They were approximately 1.5 months old upon arrival. They had been bred for sale to a finisher and were noticeably different from the animals we bought in the two previous years, which had been bred for farrow to finish pasture production. The 2008 pigs were noticeably more muscled and had longer bodies. They also had docked tails and were more aggressive eaters. We noted no difference in their interest or ability to dig.

In 2007 and 2008, we fed 1.5 tons grower ration and 1.5 tons finisher ration until the final 3 weeks, when we finished the pigs on approximately 500 lb of corn. In 2008, they received 2.5 tons of grower ration for 14 weeks. In mid-August, we switched them to cracked corn; they consumed 2 tons of cracked corn between mid-August and butchering on October 24, 2008. In all 3 years, the pigs also received ample quantities of garden waste and expired food from a local grocer.

In all 3 years, we sold the pork on-site through shares and as individual cuts.

2006

We provided one Port-A-Hut shelter on the pasture and moved it as needed to spread out the digging of the pigs. The pigs rooted up approximately 40% of the 1.5 acre field during 5 months on pasture. At slaughter, they weighed 225 to 275 lb. Their rate of gain was just less than 2 lb/day.



Pigs are adept at finding good things to eat. In 2008, we bought pigs bred for a confinement system, but noted no difference in their ability to dig.

2007

In 2007, we reduced our animal costs by raising one less animal and reduced our feed costs by switching to a lower protein feed (cracked corn) earlier in the season.

To guide the pigs' rooting activities, we used the Port-A-Hut shelter again and focused on keeping them in a smaller area than we had in 2006. We used electronet fencing to make strips that were approximately .33 acre in size and placed all nine pigs in the strip. With this more intensive pasture stocking rate, the pigs rooted the entire 1.5 acre field very well.

The pigs were sent for processing at about 6 months of age, weighing between 175 and 275 lb. They gained an average of just under 2 lb/day, but their rate of gain varied greatly. Two of the pigs were "runts" and didn't gain as well, which we assumed was due primarily to genetics, rather than management. Butchering costs increased compared to 2006 because we processed the pork into more expensive items such as sausage.

Table 1. Cost of raising pigs on pasture.

Costs *(excluding capital and labor)*	2006	2007	2008
Butchering	$977.00	$1,637.00 (incl. sausage making)	$1,449.00 (incl. sausage making)
Animal Purchase	$806.00	$450.00	$408.00
Feed	$850.00	$682.00	$1289.00
Total Weight (lb of pork)	892	960	1,220
Total Costs	**$2,633.00**	**$2,769.00**	**$3,146.00**
Value of Pork to Be Sold	**$2,670.00**	**$2,685.00**	**$4,604.00**
Avg. Retail $/lb	$2.99	$2.79	$3.77

2008
In 2008, we again used the Port-A-Hut shelter and electronet fence, forcing the pigs to graze strips that were approximately 1/3 of an acre in size. We varied strip size depending on the age and size of the pigs. We started out grazing a portion of pasture that we expected to put into garden production in 2009, but part way through the season we found we had a lot of weed pressure in the garden where they had grazed the previous year. The pigs finished the 2008 season by grazing off the cover crop we'd planted on the 2006 and 2007 garden in preparation for gardening in 2009.

Based on our experience, we decided to modify the project design, reducing the time from 3 years to 2. Originally, we thought the pigs would graze one complete area of 1.2 acres that would be garden the next year, however, this method left too much bare exposed soil in which weeds were able to take over. Now we have decided to plant cover crops in the garden as soon as vegetable crops are harvested. At the end of the season, the pigs graze and till that same area, which will be planted to cover crops or vegetables in the spring.

Costs and returns of the pig enterprise are summarized Table 1. In the first 2 years, the annual operating costs and revenue for the hog component were nearly equal - without including capital and labor. The only year we realized a profit was 2008. Although feed costs were significantly higher, the value of the final product was greater due to more consistent and higher finish weights and an increase in retail price. However, a couple items are worth noting: 1) these figures do not include labor; and 2) a simple cost/revenue analysis is incomplete in this setting as it is hard to assign a dollar amount to the value of the tillage pigs provided and their added value as part of our educational programming.

Component 2 - Garden Production
2006
In the project's first year, we planted pumpkins, potatoes, popcorn, and winter squash on a loamy peat soil with an organic matter content of 17%. Eliminating the thick sod in this pasture (mainly reed canarygrass and bluegrass) before planting required approximately 30 hr of tractor time with a disk and field cultivator.

We then established garden beds and planted clover and buckwheat in the walkways. The cover crop didn't take very well due to the lack of moisture during establishment. Qualitative evaluation indicated very good vegetable yields which we credited to high quality soil and low pest/disease pressure. It was fairly dry during the middle part of the growing season. However, due to the nature of the soils, we only had to irrigate once or twice during August. We saw very few Colorado potato beetles and the ones we did see arrived very late. Striped cucumber beetles and squash bugs have been a problem in other areas of the farm but were present in relatively small numbers in this demonstration plot.

2007
In 2007, we planted the garden in the same field that was established in 2006. Since we wanted to keep the pigs in place another year, we did not rotate these fields as we had originally planned. Planting was much easier this year as the pasture sod did not need to be removed. After harvest, most of the garden plots were planted to annual rye and oats late in the fall, and were grazed by cattle in early November when other pastures had stopped producing for the year.

2008
In 2008, we planted the garden in a plot that had been grass pasture in 2005 and tilled by pigs in 2006 and 2007. The sod had been completely eliminated by the pigs, so we expected that perennial weed pressure would be greatly

reduced. We had tilled this plot with a 3-point hitch rotovator in the fall of 2007 and then spaded it in spring of 2008, prior to planting. We grew a variety of crops including potatoes, tomatoes, zucchini, winter squash, pumpkins, sweet corn, and cole crops for our CSA.

Garden production in the plot was moderately good. Soil fertility was excellent and the plants were healthy. However, weed pressure was extremely heavy in this garden. We concluded that two factors contributed to the weed pressure: 1) this garden had been in continuous pasture for many years prior to the first pig tillage in 2006; and 2) in 2006 and 2007 while the pigs were tilling the garden, bare soil was exposed for most of each season, encouraging weed germination. In addition to rhizomatous grasses, bindweed and Canada thistle were particular problems.

Component 3 - Annual Forage
During the first 2 years of the project, we did not implement the forage component of our plan because the plot where the forage was to go had not yet been tilled by the pigs nor planted to the garden rotation.

In September 2007, we planted most of the plot that had been in garden in 2006 and 2007 to annual rye. Any portions not planted to rye in the fall were seeded to oats in early spring 2008. Spring born lambs grazed this plot in spring of 2008. We tilled three times between July and August. In late August, we planted oats at a rate of about 100 lb/A. The pigs grazed and tilled this oat cover crop in late September and October, then we lightly roto-tilled the plot in early November.

Rotation of Three Components
In the initial plan for this project we intended to rotate the sections every season and take 3 years of developing the system for all three components to function as part of the rotation. We adjusted our management as we learned from the project:

Year 1: (2006)
- Garden plot established by tractor tillage only.
- Grazed pigs in grass pasture plot. Discovered that ten pigs couldn't adequately till 1.25 acres of sod pasture in one season.
- No annual forage plot established.

Year 2: (2007)
- Garden plot same location as 2006.
- Grazed the pigs a second time in the same plot, concentrated in smaller areas.
- Established an annual forage/cover crop in the garden plot in the fall.

Year 3: (2008)
- Gardened where pigs had tilled for 2 years and experienced significant weed pressure.
- Grazed the pigs on plot that was to become a garden (third rotation) from May to August then abandoned the third rotation and grazed the pigs on the annual forage plot to prepare it for the 2009 garden.
- Annual forage plot was grazed by spring born lambs, tractor tilled and planted to cover crops, grazed/tilled by pigs, and tilled in preparation for garden.

As a result of our experiences doing this project, we have decided to switch from the three-cycle rotation originally planned to a two-cycle rotation. There will still be productive ground in garden and annual forage, and we will continue to raise pigs on pasture and for tillage. However, we plan to modify the system as follows:

Original plan:
Year 1: pigs;
Year 2: vegetable garden; and
Year 3: annual forage for lambs.

Modified plan:

Year 1 Vegetable garden, followed by cover/forage crop planted as the vegetables are removed - half (see Plot A in Year 2) to be planted by fall.

Year 2 Divided in half.
(Dates are approximate based on conditions.)

Plot A 5/1-6/15: Graze prior year's cover/forage crop with lambs then graze/till with pigs. Finish with tractor tillage.

6/15-8/1: Plant summer cover crop (buckwheat).

8/1-9/1: Graze summer cover with lambs then graze/till with pigs. Finish with tractor tillage.

9/1-winter: Plant fall cover crop (oats).

Plot B 5/1-6/15: Plant spring cover crop (oats).

6/15-7/1: Graze with lambs then graze/till with pigs. Finish with tractor tillage.

7/1-8/15: Plant summer cover crop (buckwheat). Till in with tractor.

8/15-10/1: Plant fall cover crop (oats).

10/1-11/1: Graze with lambs then graze/till with pigs. Finish with tractor tillage to be ready for spring garden.

We intend to continue this practice. It seems to be working to provide tillage and fertility for our gardens while also allowing us to raise pigs on pasture and provide forage through the cover crops. We believe this system could be easily adopted by anyone producing both hogs and a garden, provided they have the labor and the interest necessary to make it work. In this article, we have already described how we changed the system from what we originally envisioned to a new system. Some questions that further research would be helpful to refine and improve this system include:

How much do pigs gain nutritionally from grazing/tilling various cover/forage crops?

Which cover/forage crops provide the most nutrition and garden fertility in this system?

What age or maturity should cover crops be for pigs to graze for the most nutritional value?

How do the increased labor inputs balance out with the economic value gained from this combined system?

We are unaware of any other farmers who have adopted this system based on our demonstration. However, we know that our demonstration has had a significant impact on the visitors who have come to the farm. These are mainly urban residents who know very little about farming. By viewing the system here, they get some idea of how farming can occur with an integrated systems approach that strives to reduce purchased inputs. Our visitors buy the vegetables and pork on-site and are more connected to and aware of how their food is raised.

Management Tips

1. Force the pigs into an area of 6-8 ft^2/lb of animal. This equates to about 350 ft^2 for a feeder pig at 50 lb and 1,750 ft^2 for a 250 lb pig nearing finish weight. When the pigs are moved once every 2 weeks with this level of grazing intensity, they are very successful at rooting up the sod in an entire 1.5 acre paddock.

2. Provide shade and a wallow when it is hot and dry and move both the shade and water 2-3 times/week to spread out the digging.

3. Find a very sturdy automatic waterer and mount it on something the pigs can't tip over. Pigs are very curious and, especially when they are larger, will tip over the waterers, chew through the water hose, and make a mess if the water isn't managed properly.

4. Plant a quick growing annual crop on the recently rooted up areas to prevent weed growth. Weeds are nature's way of covering bare soil. If the rooted areas are left bare for more than a couple of weeks during the growing season, seeds will begin to germinate and these areas will become quite weedy.

5. Use pigs to graze and till cover crops and previously tilled and planted garden plots. The amount of feed required for pigs is noticeably reduced when grazing a stand of oats that is less than 8 weeks old, but not noticeably reduced when grazing sod grasses.

Cooperators

Wayne Martin, University of Minnesota, St. Paul, MN
Jim and LeeAnn Van Der Pol, Kerkoven, MN
Polzin Farm, Glencoe, MN
University of Minnesota Service Learning Students contributed to this article.

Project Location

From Minneapolis/St. Paul take I-394 west. I-394 turns into US 12. Follow US 12 until the exit for Cty. Rd. 15 west. Follow Cty. Rd. 15 for approximately 8 miles until the town of Mound. At the intersection (stoplight) with Cty. Rd. 110, take a left. In approximately 2 miles, turn right at the sign for Gale Woods Farm. This road/driveway dead ends at the farm.

Keeping it Green and Growing: an Aerial Seeding Concept

Principal Investigator

Andy Hart
R., C. and
A. Hart Farms
10723 Cty. Rd. 11
NE
Elgin, MN 55932
507-876-2269
Olmstead County

Project Duration

2006 to 2008

Award Amount

$9,000.00

Staff Contact

Mark Zumwinkle
651-201-6240

Keywords

aerial seeding, cover crops, grazing, nitrogen cycling, soil erosion, winter rye (Secale cereale)

Project Summary

The goal of this project is to promote cover cropping in row crops in the Zumbro River watershed in SE Minnesota. We hope to reduce soil erosion and reduce nitrogen leaching through the soil by aerially seeding winter rye into fields of standing row crops – corn, soybeans, and sweet corn. Plant residue on these fields will be increased. Cover crops will remove carbon dioxide from the atmosphere and store it as soil organic matter. Cover crops will also provide additional fall and spring forage for livestock.

Project Description

My wife and I farm with my parents on our family farm. We have four children who love growing up on a farm. We raise corn, soybeans, hay, sweet corn, and peas. I have been involved with conservation work on our farm for several years including cover cropping, CRP, and installation of terraces and grass waterways. We use minimum till, no-till, and strip-till farming practices.

Our overall goal in our farming operation is to be good stewards of the land that we have been blessed with. We want to leave it to the next generation in as good or better condition than we have had the privilege of farming. We are working to accomplish this goal by reducing soil erosion, reducing tillage, and trying to improve the soil by adding more cover crops. Cover crops build organic matter, reduce nitrate movement in the soil, and increase crop residue on our fields. For several years we have been planting cover crops with a grain drill in our sweet corn and pea fields in July and August and we have seen good results. We felt our next step was to get a cover crop established on the corn and soybean fields at the right time and without a lot of expense.

We are using a helicopter to aerially seed winter rye into fields of standing row crops. The helicopter easily negotiates the small fields and rolling terrain in southeastern Minnesota. The row crops are field corn, sweet corn, and soybeans. The field corn includes fields that are harvested for grain and fields that are harvested for silage. We believe that we can establish the winter rye cover crop from 2 to 8 weeks earlier than normal by aerially seeding into crops before they are harvested.

The rye is seeded at a rate of 50-75 lb/A between August 1 and September 1. Normal harvest of the row crops occurs from 2 to 8 weeks later. The average date for harvesting is October 10 for soybeans and October 30 for corn. Corn silage harvest occurs in early September.

The Hart Family.

Winter rye is an excellent cover crop because it grows in cold weather, it overwinters, and it grows rapidly the following spring. On many of the participating farms, the rye cover is being grazed in late fall and again in spring.

Results

In 2005, we successfully established rye on August 30 using a helicopter. In 2006, we promoted the aerial seeding concept in SE Minnesota and had good farmer participation. Fifteen farmers participated in Dodge, Goodhue, Olmsted, and Wabasha counties, aerially seeding 1,026 acres. In Winona and Fillmore Counties, ten farmers aerially seeded a total of 435 acres.

2006

The rye was seeded on September 6, 7, and 8, 2006. This was later than we planned. The helicopter was not available until this time due to a commitment to spray for mosquito control in the Twin Cities metro area. The cover crop was seeded on top of the ground in the standing crop and relied on rain and heavy dew for germination and early growth. It is important to seed the rye before early leaf drop in the soybeans so the soybean leaves cover the rye seed. A dry period at this time of year or a later planting date will affect the stand and growth of the cover crop. Fortunately, we did receive some rain after it was seeded.

The helicopter spread pattern at a 50 lb/A seeding rate was not as good in 2006 as it was in 2005. We had gaps in some of the fields and we planned to address that issue in 2007. Some growers used a 75 lb/A seeding rate and had a more even seeding pattern and better stand.

The farmers particularly liked the efficiency of the aerial seeding. Each farmer lined up their own winter rye seed and had it in a pickup or wagon ready to go the day the helicopter came to seed their field. Once the helicopter landed and instructions were communicated to the farmer, the helicopter was loaded and seeding commenced. The average seeding rate was 100 A/hr. Most farmers had their fields completely seeded in less than an hour. Field conditions are not an issue with aerial seeding. The fields can be very wet but this will not stop the aerial seeding. However, the helicopter cannot fly in rain or windy conditions.

2007

In the spring of 2007, we had good winter rye growth and this made excellent forage for the livestock producers. They were able to graze the winter rye fields and delay the grazing of their summer pasture by 2-4 weeks. This allowed for a better summer pasture growth and helped carry the pasture longer into the summer.

Soybean harvest with rye growing in the understory.

The helicopter coming in to reload.

By early August 2007, we were eagerly anticipating another good year of aerial seeding in SE Minnesota. We had 14 farmers and 800 acres lined up to aerially seed in Olmsted, Wabasha, and Goodhue counties. We planned to increase the seeding rate to 75 lb/A and seed the winter rye between August 15 and August 31. But the summer weather turned against us. The day we had planned to start aerial seeding it rained and it seemed to continue to rain every day.

August 2007, was one of the wettest months on record in SE Minnesota. It included a big rain event that produced wide spread flooding. We had several days of rain and many days of high winds that prohibited the helicopter from seeding. Even the helicopter had mechanical issues on one day. Finally, on September 15, we decided to cancel the aerial seeding for the 2007 season. The participating farmers were disappointed but they understood things just did not go right. Even with all the disappointments, the farmers were very interested in trying aerial seeding again in

2008. We addressed the problems we had in 2007 and think the 2008 season will go much better.

Farmers in SE Minnesota know that the best laid plans do not always work out. When this happens you just switch over to plan B. Most farmers know a cover crop can be established several ways. Several farmers simply switched from aerial seeding to using their tried-and-true systems they have used in the past. The cover crops were planted after sweet corn, field corn, or soybean harvest using a grain drill or fertilizer spreader. With the soils moist from the August and September rains, the farmers had a good seed bed to plant the rye. Fortunately, the fall weather was warm and the rye grew quickly.

The winter rye was seeded at 50 to 75 lb/A depending on the intended purpose. If the farmer wanted to graze it, he may have planted a higher seeding rate to get more forage for grazing. If the farmer was using it solely as a cover crop, he might have used a lesser rate so he can no-till into it in the spring without having excess residue to work through.

The helicopter cost $10.00/A. The winter rye cost $5.50/A at 50 lb/A. The aerial seeding concept has proven to be a good choice. With this system, we can aerial seed a cover crop on a field before it is harvested, usually in late August when we are not so busy on our farm. When the field is harvested, the cover crop is already growing and we are done with that field until the following spring.

The benefits of cover cropping are many. We feel that we have nearly eliminated soil erosion on the soybean and corn fields that were aerially seeded in August and not tilled until the following spring. We raised the amount of residue on our fields with the addition of the rye cover (Table 1 and Table 2). The added residue helps to build more organic matter in the soil.

Another benefit of cover crops is their capacity to reduce nitrate movement. When the current year's crop is done growing there can be leftover nitrate nitrogen in the soil which can move through the soil profile and into the ground water supply, increasing the level of nitrates in drinking water. The cover crop resurfaces deep nitrate and slowly releases it as the cover crop decomposes, fertilizing the cash crop and reducing the amount of nitrate moving down.

The cover cropped area of our test field showed less nitrate in the lower soil profile compared to the non-cover cropped area (Table 3).

Table 1. Residue in soybeans and corn on Gary Siem farm (fall 2006).

Crop	Cover	Residue (%)
Soybeans	Rye	70
	No Rye	45
Corn	Rye	80
	No Rye	65

Table 2. Residue levels for the spring crops 2007.

Crop	Cover	Residue (%)	Change from Fall Residue (%)
Soybeans	Rye	90	+ 20
	No Rye	40	- 5
Corn	Rye	90	+ 10
	No Rye	55	- 10

Table 3. Effect of rye cover crop on soil nitrate nitrogen and soil quality, April 2, 2007 (Gary Siem farm).*

			Total Nitrogen Mineralized	Carbon Mineralized	
Cropping System	Depth (in)	NO3 (ppm)	Day 0-28 (ppm)	Day 0-10 (ppm C/day)	Day 10-28 (ppm C/day)
Soybean – rye cover crop	0-6	3.9	48.9	91.2	28.0
	6-12	3.3	23.0	46.6	11.8
	12-24	4.4			
Soybean – no cover crop	0-6	3.2	34.7	51.2	18.0
	6-12	7.00	22.4	33.1	8.9
	12-24	12.1			

**mean of 3 samples*

Beef cows grazing rye in late April prior to seeding field corn.

The soil samples were moistened and incubated at room temperature to determine the slow release of nitrogen and carbon due to microbial activity over a period of 28 days. The rye cover crop increased both mineralizable nitrogen and carbon in the surface layer of soil. These measures are good indicators of soil quality, specifically reflecting the increase in biological activity in the soil. Increased biological activity leads to the formation of aggregates that improve water infiltration. The increase in mineralizable nitrogen shows that the cover crop is providing a slow release form of nitrogen that will be available to the following crop.

Livestock producers who graze these cover cropped fields can get a good return on their investment. We estimated a farmer can get between one-half and one ton of forage per acre of good grazing by fall grazing and spring grazing these fields. Hay costs were between $60 and $100/ton this year. So the farmer's return on investment was four to seven times his initial costs of $15.50/A for cover crop establishment.

Overall, most of the farmers who participated in this program were pleased with the results and are looking forward to doing more next year as we work out the "wrinkles."

2008

2008 was a better year for the aerial seeding project. We seeded about 650 acres. Most of the farmers that were lined up in 2007 seeded some fields in 2008. The seeding costs were higher than in previous years ($17.50/A for 75 lb of winter rye and $15.00/A for the helicopter). The increase in costs was due to higher fuel and commodity prices.

The winter rye grew well in the soybean and corn silage fields despite a dry summer with below normal rainfall (we were officially in moderate drought). In contrast, the winter rye stands were variable in the corn fields that were left for grain harvest. Until we understand why these rye stands were so variable, I do not recommend this type of aerial seeding except on a test plot basis.

University researchers are working with us to better determine factors affecting germination and development of the rye. It is possible that fields with a history of manure application have a better chance of producing a stand of rye. This makes sense due to the well known nitrogen and soil quality benefits associated with manure.

Although 2008 is the last year of this project, we will continue cooperating with the University of Minnesota and Minnesota Department of Agriculture to refine the promising practice of aerially seeding cover crops. We feel we have ironed out many of the details associated with seeding rates and helicopter logistics and we hope to capture a normal rainfall pattern. The cooperating farmers maintain a strong interest in the promise of the cover crop to provide added grazing forage.

Management Tips

1. In SE Minnesota seeding should be done from early August until mid-September. Aerial seeding done after mid-September can give you mixed results because the winter rye may or may not get established well enough by the aerial seeding method.

2. For later fall seeding, use a grain drill or a fertilizer spreader, working the winter rye in after spreading. The goal is to get the winter rye up and growing as soon as possible to have a good stand that will overwinter. Every year is different and it depends on what kind of a fall you have. If the fall is cold and dry, rye growth will be minimal.

3. The type of crop that you aerially seed your winter rye into will determine how much the cover crop will grow that fall. The cover crop needs sunlight. The sooner you can get sunlight to the cover crop, the faster it will grow.

4. If you aerially seed rye into a sweet corn field the last week of August and it is harvested in early to mid-September, the winter rye will grow fast and will be ready to graze in late fall.

5. We do not recommend aerially seeding into corn fields that have row spacing less than 30". The corn leaves will catch much of the rye seed. It does not shake out or blow out of the corn leaves once it is captured.

6. If you seed rye in a corn-for-grain field the last week of August and harvest the grain the first of November, there will not be much cover crop growth because the winter rye has not been exposed to direct sunlight. If you plan on grazing this cornfield, consider harvesting this field first to allow the cover crop to be exposed to direct sunlight and grow faster in the fall.

Rye growing in the sweet corn stubble in late November.

7. Corn harvested for silage or high moisture corn is a good way to get direct sunlight to the cover crop. These fields are typically harvested earlier and the corn silage field will have most of the residue removed to allow sunlight in.

8. The field conditions at harvest will determine how well your cover will grow that fall. Harvesting when field conditions are wet and muddy will kill the winter rye.

9. Soybean fields that are aerially seeded with winter rye work really well. The ideal time to seed these fields is before the soybean leaves start to drop so the rye rests under the leaves of the soybeans. The soybeans drop their leaves quickly in September, allowing direct sunlight to penetrate to the cover crop.

10. Timing is important; you do not want to seed soybean fields earlier than the last week of August in SE Minnesota. You do not want your cover crop to grow so fast that it will cause harvest issues. This has not been a problem in the past, but we have not been seeding any earlier than the last week of August.

11. Soybean fields that are no-tilled into last year's corn stalks may require higher rye seeding rates. We found that the winter rye was getting trapped in last year's corn stalk residue and not getting a good seed-to-soil contact. We did not experience this problem in conventionally tilled soybean fields. We have upped the seeding rate in these fields from 50 to 75 lb/A.

12. Do not get frustrated with your cover crop plan. Be flexible and try to have a back-up plan in place. What will you do if you get a month of wet weather? The weather does not always allow you to seed when you want to. You may have to switch to a grain drill or fertilizer spreader to get the cover crop seeded in the fall.

Cooperators

Dave Copeland, Natural Resources Conservation Service, Rochester, MN
Jennifer Ronnenberg, Zumbro Watershed Partnership, Rochester, MN
Mark Zumwinkle, Minnesota Department of Agriculture, St. Paul, MN

Location

The location of one of the aerial seeded fields:
From Rochester, take Hwy. 63 north 6 miles to Olmsted Cty. Rd. 21, travel ¾ mile and the field is on the south side of the road.

Other Resources

Ag Opportunities on the Air. Link to a Minnesota Department of Agriculture website with information and an audio clip about aerial seeding:
www.mda.state.mn.us/news/audio/default.htm

Minnesota Department of Agriculture. *Greenbook 2003*. Soil conservation of canning crop fields, pp. 69-72. St. Paul, MN.

Minnesota Department of Agriculture. *Greenbook 2003*. Aerial seeding winter rye into no-till corn and soybeans, pp. 89-91. St. Paul, MN.

Establishing Beneficial Bug Habitats in a Field Crop Setting

Principal Investigator

Noreen Thomas
12506 - 20th St. N.
Moorhead, MN
56560
218-233-8066
heirloomfarmocy@aol.com
Clay County

Project Duration

2006 to 2009

Award Amount

$11,800.00

Writer

Aisha Gomez Spiers
University of Minnesota Service Learning Student

Staff Contact

Meg Moynihan
651-201-6616

Keywords

beneficial insects, buffers, bugs, diversity, habitat, native, pests, soybean aphid, wildflowers

Project Summary

We are organic farmers near Moorhead, MN and are testing how well living borders around our fields attract and maintain beneficial insects, provide a long-term habitat for beneficial insects, create biological diversity within our cropping system, and serve as a buffer between our certified organic fields and neighbors' conventional land. We think this technique offers conservation benefits since the living borders should provide a barrier that reduces soil erosion and provides habitat. We are using native plants, perennials, grasses, and forage plants, and counting beneficial as well as pest insects.

Project Description

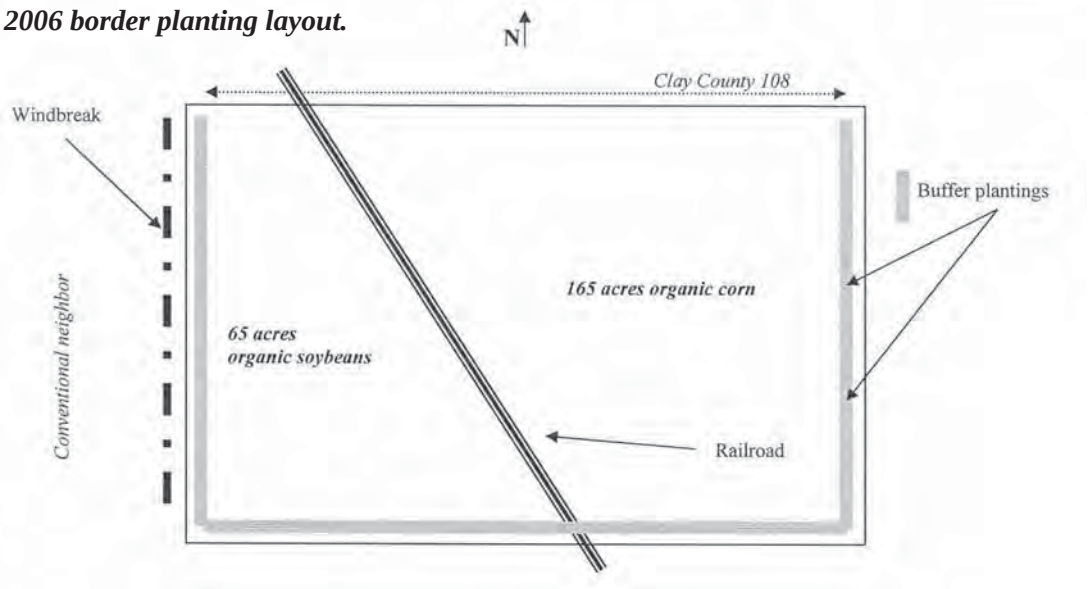
My husband Lee and I farm 1,200 certified organic acres near Moorhead, MN. Our typical rotation includes alfalfa/timothy mixture, corn, wheat, and soybeans.

Recently, soybean aphid pressure has moved into the Upper Midwest, including our part of Minnesota, where border-to-border monocultures of one or two crops adds to pest pressure problems. As organic farmers, our methods of controlling pests must be biologically and ecologically based and approved for use in organic systems. Establishing beneficial insect habitats may be one line of defense.

We believe this project has potential in several important ways. First, we want to increase the ecological diversity on our farm by providing a habitat that encourages beneficial insects to populate. Wildflowers can provide nectar sources for pollinating insects, small trees and native grasses can provide sheltered habitat for beneficial insects. We also suspect that increasing plant diversity will have a beneficial effect on micro- and macro-biological diversity in the soil. Soil organisms can help maintain low populations of many pests through natural competition.

We think using this kind of mixed planting in our buffers will provide an economic benefit as well. Organic farmers must maintain a buffer zone between themselves and adjoining conventional land. Any production from the buffer must be considered conventional and cannot be commingled with organic crops, which is harvested, stored,

Figure 1.
2006 border planting layout.



and sold separately. A buffer that helps attract nature's beneficial insects would reduce the management costs of segregating buffer zone production.

2006

This was the first year of a 3 year project. We established buffer strips on two fields (Figure 1). One field was 65 acres (planted to soybeans) and the other was 165 acres (planted to corn). We established border plantings on three sides of each field and left one side without a border planting for a control/comparison.

We had a very wet spring for planting trees in our clayey soil. We bought Juneberry, chokecherry, and ash trees from Clay County Soil and Water Conservation District (SWCD) and mudded them in along the border according to United States Department of Agriculture Natural Resources Conservation Service (NRCS) spacing guidelines in early June. We used heavy plastic tree matting to suppress weeds in the tree rows. In addition, we planted wildflowers, alfalfa, and buckwheat in between the tree rows. The wildflower seed was a mixture produced for this area that we purchased from Agassiz Seed[1]; we wanted to make sure the seed would be hardy for our growing zone. We broadcast the wildflower seed in the first part of June and worked it in gently with hand tools. We followed the same procedure for the grasses and forages. Species included alfalfa mixed with timothy and buckwheat. We had a check area where we planted nothing between the rows of trees/shrubs. Since wildflowers look like a bunch of weeds when they are just getting started, we also planted zinnias as a marker so we could monitor the area where the wildflowers had been planted.

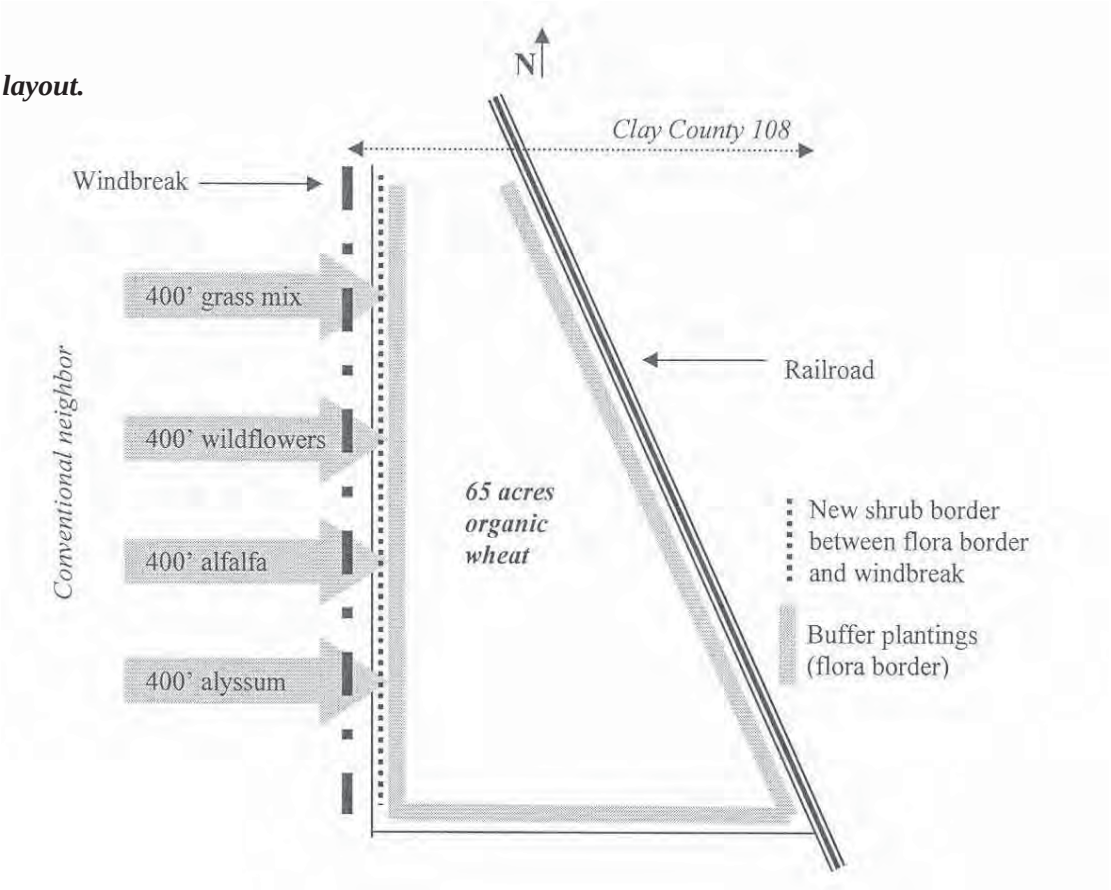
North Dakota State University entomologist Evan Lampert was a great help to us. He taught us how to use nets to sweep for bugs and how to set up beetle traps. From the initial sweep of the border around the soybeans, the population of beetles which feast on weed seeds seemed to increase. We also noticed beneficials moving in at the same time as the soybean aphids. Starting in the middle of June, we used insect nets weekly to "sweep" for counting and identification. We froze some insects that we needed further help identifying.

2006 Results

By midsummer, the conditions were extremely dry and the wildflowers had a hard time competing with the weeds.

[1]*Inclusion of a trade or business name does not imply endorsement of that product or business by the Minnesota Department of Agriculture, nor does exclusion imply non-approval.*

Figure 2.
2007 border planting layout.



The wildflowers were slow to grow and looked more like weeds themselves at times. Those wildflowers that did emerge were showy and offered many different small flowers. The various flowers seemed to attract many different insects, including beneficial insects.

Because 2006 was the first year of the project and borders were just being established, I did not have insect counts or insect inventories to report. We observed that ground beetle numbers were higher in the alfalfa and buckwheat than in any other habitat. Beneficial insect numbers appeared highest after the soybean aphids started appearing in the soybean field. Green lacewings and ladybugs increased and were noted after soybean aphid levels reached between 200-250/plant, which is a recommended threshold for treatment. We hoped some of the beneficial insects would find winter homes in the tall grasses and we would see populations early in spring 2007, but significant amounts of insect activity did not begin until June 2007.

2007

In 2007, we planted a 12' wide, 1,100' long border strip running north and south along the edge of a spring wheat field, separating it from adjoining conventional land (Figure 2). This field had been planted to soybeans in 2006. We planted about 400' each of alyssum, a grass mixture, alfalfa, and mixed wildflowers, and included zinnias with the wildflowers again this year as a marker in the border strip. The alyssum was a hardy variety that we hoped would survive through the winter. We also planted shrubs (chokecherry and Juneberry) in a 1,700' strip border 5' west of the floral border. We had to replant about 25% of the trees we planted last spring.

The weed pressure was high and until the grasses, alfalfa, and wildflower mixtures got established, we had to mow and hand weed some areas. Aggressive grasses and a mixture of grass and alfalfa were important to suppress weeds (and keep the neighbors happy).

2007 Results

Weather conditions were more favorable in 2007. We compared the tall grass, short cut grass, alyssum, wildflower mixture, and alfalfa to see how many beneficial insects they attracted. There was not a lot of bug activity in June so we did not begin collecting bugs until the first week in July. Once a week, for 6 weeks, we collected the various bugs that were in the border by "sweeping" with bug nets just before dusk and compared populations of beneficial bugs (those that eat pests) to pest populations. There was more bug activity during this time, as early morning dew and midsummer heat caused the bugs to be less active earlier in the day. Sweep results are summarized in Table 1.

The tall grasses initially were not part of the study but grew in several sections where we were unable to mow. We noticed bug activity there, so we decided to include them in our comparisons. As it turns out, the tall grass seemed a little more appealing to beneficial insects and a little less appealing to pests than the same kind of grass that we kept short. We also recorded insect activity in the native grasses that grow on our land, as we noticed activity there too.

By and large, alyssum, native grasses, and tall grasses (and to a lesser extent the wildflowers) performed the best for providing habitat for beneficial insects and showed the best results. The alyssum and wildflowers provided ongoing bloom and food for beneficials. Flowers that provided enough support for bugs to land on seemed to attract more of bugs. In addition, we observed that the alyssum and tall grass were better at choking out weeds than the wildflowers; wildflowers take a while to establish and so remain susceptible to weed pressure.

Alfalfa attracted many more pests than beneficial bugs and, when in bloom, teemed with bugs. Although alfalfa could be used as a secondary crop, our data indicate that it might attract pests that could damage crops that are sensitive to pests (e.g. corn and soybeans).

Table 1. 2007-08 insect activity by type of buffer planting.

	Pests		Beneficials		Neither	
	2007	*2008*	*2007*	*2008*	*2007*	*2008*
Short Grass	28	18	19	4	14	99
Tall Grass	5	5	27	2	31	26
Alfalfa	95	102	42	2	23	510
Wildflowers	2	72	11	4	12	215
Alyssum	12	60	68	11	15	119

2008

This was our third and final year of the project. We continued to use bug nets to sweep the borders in the evenings, when the bugs were most active. In general, we counted higher numbers of all bugs in 2008 than we did in 2007. There may be several reasons for this difference:

1. Entomologists at NDSU told us that they also collected more bugs in 2008 than in 2007 – there was much more aphid activity and just plain more bugs this year. (The Red River Valley experienced horrible aphid pressure, with some counts as high as 1,200-2,000 aphids per soybean plant!)

2. Our plants were larger. For example, the alfalfa was in its third year, so it was bigger. The grasses were taller, too, providing more area for bugs to occupy.

3. The student who did our sweeps in 2008 was an entomology student who froze all the insects after sweeping. I think this method may have resulted in more accurate counts than last year, when another student and I just counted live bugs in the net.

As in 2007, we found larger numbers of beneficial insects and a greater beneficial-to-pest ratio in the taller grasses and the wildflower/annual flower combinations. This year, we also observed higher numbers of bugs, especially pests, in alfalfa compared to the other types of buffer plantings (Table 1). While the insects we found in the alfalfa were more often alfalfa pests that wouldn't necessarily harm wheat or soybeans, the high numbers still concerned us.

In addition to beneficial flying insects, we observed some other helpful creatures in the border plantings. For example, we noticed more beetle activity in the borders. On one occasion we counted 7 beetles in 1 ft^2 in the border, compared to 3 beetles in a 1 ft^2 area out in the middle of the crop field. We also observed more field mice hiding in the tall grasses of the border plantings. Both beetles and mice eat a great many weed seeds, which could be another great benefit of this beneficial habitat system, but one we haven't quantified.

We think the border bug habitat approach may work for both large and small size farms. On our own 1,200 acre farming operation, we plan to continue the practice of using tall grass borders around the larger crop fields. We like the fact that the native shrubs and trees provide a clear border between our land and our neighbors. These visual cues play a role in not only reducing the risk of pesticide drift from conventional fields, but serve as boundary markers for summer help from area students.

We liked the alyssum, which grew short, offered good weed control, and provided good bug habitat, but it did not overwinter. In our experience, the grasses attracted the most beneficials, plus, they suppressed weeds, dried out the soil in the spring, and stood up to tire pressure from being driven over by tractors. In 2009, we are going to try timothy, which may offer the added advantage of providing hay we can sell. One question we haven't resolved yet is: once the beneficials show up, should you mow the grasses to encourage them to move out into the crop, or should you keep the grasses tall? When we mowed our grasses, most of the bug life disappeared, but we're not sure if they left, or just moved out into the crops.

We will continue using flowers and alyssum in and around our garden and think smaller operations—especially those growing vegetables—could likewise use the borders to help manage pests and perhaps reduce the need for chemical insect pest control. We think annual flowers may be more manageable in a smaller system like this - using them in a larger field crop system would only work if the annuals were densely planted around the border. In addition, annual flowers could be cut and sold for extra income. Operations with bees could benefit from flowers in a garden or small acreage, too. The man who keeps bees on our farm said he had better bee populations and "happier" bees when our flowers began to bloom.

Table 2. Estimated establishment costs for 2006 and 2007.

Item	Cost
Use of farm equipment	$1,320
Supplies (including seeds, shrubs, etc.)	$2,820
Analysis (including insect traps and identification)	$2,010
Labor	$1,740

Note: Some additional costs were funded by the USDA Natural Resources Conservation Program's EQIP program.

The overall profitability of our project is still yet to been determined. In the short-term there was a loss, due to the cost of plants, seeds, and labor (Table 2). However, in the long-term, profits from reduced crop pest pressure and/or increased pollination, along with income from associated enterprises like cut flowers, honey production, and sale of fruits from shrubs like chokecherry and Juneberry might make this an economically, as well as biologically, profitable system.

In all 3 years of this project, we incorporated this project into an on-farm field day, which attracted 100-200 people each year. Our events were covered by the local print media and featured on the television and radio news. Gardeners and wildflower enthusiasts were especially interested in the beneficial bug border idea.

Management Tips

1. If your beneficial border is going to abut someone else's land, be sure you are aware of the property line and discuss your plants with your neighbor. If you are planting along a roadway, check first into township regulations about the required distance from the road.

2. Contact your county USDA Natural Resources Conservation Service, Farm Service Agency, and Conservation District to find out if there are programs that might provide cost share payments for the tree plantings. If you receive cost share from a government program, make sure you adhere to any spacing guidelines. NRCS technicians are very helpful.

3. Inter-seed annual flowers when you plant wildflowers. Wildflowers grow very slowly and can easily be mistaken for weeds. The faster growing, showy annuals can mark the location where you can expect the wildflowers to emerge.

4. When you establish trees and shrubs, be ready to weed them or use matting to suppress weed growth.

5. Check local markets to find out whether wineries, jelly makers, or U-pickers would be interested in specific fruiting tree and shrub species.

Cooperators

Evan Lampert, North Dakota State University, Fargo, ND
Jessica Gerchak, Environmental Science Teacher, Moorhead, MN
Phil Glogoza, University of Minnesota Extension, Moorhead, MN
Kevin Kassenborg, Clay County Soil and Water Conservation District, Moorhead, MN
Sharon Lean, USDA-NRCS, Moorhead, MN
Donna Norquay, Moorhead Public Schools, Moorhead, MN

Project Location

From Moorhead, take US-75 north for about 9 miles until you reach Kragness. When you see a white house on your right, go north on Cty. Rd. 96 for about 2.5 miles. Our mailbox and drive are at the point where the power high line crosses the road. Turn right into the drive.

Other Resources

Agassiz Seed & Supply. West Fargo, ND, 701-282-8118. Website: *www.agassizseed.com*

Organic certifying agencies. Ours are Global Organic Alliance, *www.goa-online.org*, and Organic Crop Improvement Association, Minnesota Chapter #1, Website: *www.mnocia.org*

USDA-NRCS websites about selecting and establishing plantings to attract pollinators.
Website: *www.nrcs.usda.gov*
(type "pollinators" into search box).

On-farm Biodiesel Production from Canola

Principal Investigator

Steve Dahl[1]
1212 - 7th Ave.
Roseau, MN
56751
218-463-1569
srdahl@mncable.net
Roseau County

Project Duration

2007 to 2009

Award Amount

$12,000.00

Staff Contact

Meg Moynihan
651-201-6616

Keywords

biodiesel, canola, diesel, energy, oil, oil press, straight vegetable oil, SVO

[1]Steve recently retired from canola production and rents his farm to one of this project's cooperating farmers. Steve is a former president of the United States Canola Growers Association and has served on the Minnesota Canola Council. He serves on the Farmers Union Oil Company board of directors.

Project Summary

An increasing number of farmers and small business owners are interested in producing their own fuel. The ability to produce biodiesel fuel from an oilseed like canola seems like a great idea. The technology exists to make this idea a reality. However, the economics of making this idea a sustainable and viable part of rural agriculture were unknown. Through this project we discovered the cost of each component of production. After we started this project, it became clear that, in addition to transforming vegetable oil to biodiesel, it was possible to use unprocessed vegetable oil (also known as straight vegetable oil or SVO) as fuel source.

We hope our project will help those individuals who are interested in producing biodiesel make an informed decision based on the true costs and benefits of using canola to make fuel.

One direct result of this project is a new research effort at the University of Minnesota–Crookston to evaluate the viability of running a diesel engine tractor equipped with a conversion kit using SVO on a producer's farm in Minnesota. Using canola oil for heating a home or shop may also be possible.

Project Description

Canola is an oilseed crop capable of producing 80 gal of oil/A, assuming a 2,000 lb/A yield and approximately 40% oil content. Currently, canola seed is harvested and transported to large processing facilities in Canada and North Dakota where the oil is chemically extracted and refined for use as edible oil and for conversion to biodiesel. Hypothetical costs and rates of conversion are summarized in Table 1.

We set up a farm-scale production facility to produce biodiesel from canola seed. Our plan was to crush canola seed with a Komet 2-screw press, producing both oil and canola meal. We planned to feed the canola meal to livestock and sell the canola oil or process it directly into biodiesel. We thought this approach would provide us with a chance to feed the canola meal as a by-product, establish a market price for the meal, and determine the cost of processing the oil into biodiesel.

The Komet oilseed press has the potential to crush 2,000 lb of canola seed per day, or 700,000 lb/year. At this rate, production would result in 28,000 gal of oil, or enough fuel to farm 5,000 acres. One press could be used by several farms; in fact, our project had multiple farm partners whose canola was used for the demonstration.

The process of producing biodiesel from vegetable oil involves mixing the oil with a catalyst of methanol (wood alcohol) and potassium hydroxide. For every 40 gal of vegetable oil, approximately 11 gal of methanol and 2 lb of potassium hydroxide are used. The process yields 40 gal of biodiesel and 11 gal of glycerin. The biodiesel is then

The Komet press in action.

filtered to remove any contaminants. The glycerin can be used as an animal feed after the methanol has been allowed to evaporate. In our case, we added the glycerin back to the canola meal, and its value was incorporated into the value of the meal.

40 gal oil + 11 gal CH_3OH + 2 lb POH→40 gal biodiesel + 11 gal glycerin

Over the course of 2 years, this project focused on identifying the costs of producing biodiesel and SVO on the farm. We also documented the true potential capacity of a small-scale system such as this one would have.

2007 Results

In 2007, we set up a farm-scale production facility to produce biodiesel from canola seed. The Komet press arrived from Germany that summer and was delivered and set up in a building dedicated to the project in Wannaska, MN. The setup of the press was completed by July, and the crushing of canola began after harvest season was completed.

Over the course of the year we crushed canola seed, generating oil and canola meal. The canola meal was sold and fed to livestock around the region. The canola oil was directly processed into biodiesel. In this way, we gained the experience of feeding the canola meal as a by-product and establishing a market price for the meal, as well as determining the cost of processing the oil into biodiesel.

Table 1. Cost and conversion assumptions.

System Assumptions	
Diesel price	$4.00
Feedstock oil content	40%
Press efficiency	75%
Meal price ($/lb)	$0.12
Market value raw feedstock (cwt)	$12.00
Cost per kW	$0.08

Crop Production Assumptions	
Yield per acre (cwt)	16
Cost of production (cwt)	$17.00
Cost per acre	$272.00

Potential Output/A	
Oil crushed (lb)	480.0
Oil crushed (gal)	63.2
Meal crushed (lb)	1,120.0

We documented the specifics of running the canola through the press, such as how much canola oil vs. canola meal was produced per hour. Documentation also included the specifics of press setup and settings to assure the most efficient process of canola through the press. There is no doubt that the learning curve was steep, but running the press successfully for a couple of weeks enabled us to feel very comfortable in addressing any issues that came up while processing.

We found that our true processing capacity was around 1,300 to 1,400 lb/day, running 24-hours. This capacity was lower than we expected, but the slightly slower rate enabled us to maximize the amount of oil extracted from the canola. We are able to extract approximately 85% of the oil contained in the canola seed and were pleased about the final system arrangement and efficiency. We found that the press can be filled with canola seed in the morning and allowed to run without any attendance throughout the entire day. It is really a system that does not require a lot of babysitting from farm help.

Extraction also produced approximately 900 lb/day of canola meal. The energy content in the meal is very high. We fed approximately 1 lb of canola meal/head/day to beef cows owned by our producers. Results of feeding the meal to beef were favorable, and we were able to sell the meal for around $240/ton.

We began biodiesel production in the spring, when freezing temperatures would not impact production. We collected data on all costs of production of canola, including the cost of biodiesel production from canola oil.

2008 Results

In 2008, we continued to use the Komet press to crush canola seed at our facility, as well as at the University of Minnesota in Crookston, and at the Clearbrook Farmers Elevator Cooperative in Clearbrook. The additional locations provided the project with the added experience of crushing soybeans, sunflowers, and camelina for use as oil-fuel feedstocks.

During the winter months, pressing of canola, sunflower, and soybean was carried out along with biodiesel production, in the University's heated facility in Crookston. There, faculty members ran tests on the quality of the biodiesel. Crookston studied the meal as a feed in dairy cows and found that due to the extra energy in the meal from oil, the value of the meal with glycerin added is 10% higher than that of regular meal. As part of future research efforts, the University will begin to feed canola meal to the dairy herd located on campus, noting any impact on milk production, and ultimately estimating a truer value

Oil sediment tanks.

for the canola meal. Another unanticipated outcome of this project is in a new undergraduate program at the University of Minnesota–Crookston that will focus on bio-fuel production systems that use technologies similar to those we have been testing these last 2 years.

The conversion yields and costs for biodiesel and SVO that we calculated are reported in Table 2. Note that these do not include the cost of labor. According to our calculations and using costs and yields assumed in Table 1, we determined that the cost to convert canola oil to biodiesel was $0.90/gal, while the cost to convert canola oil to SVO was $0.08/gal. The total cost of producing biodiesel was $3.08/gal, while the total cost of producing SVO was $2.25/gal, resulting in a $0.92 and $1.75/gal advantage, respectively, over commercial petroleum based on $4.00/gal diesel.

The process produced about 900 lb canola meal/day.

The energy content of biodiesel and SVO are roughly the same. However, SVO must be combusted at higher temperatures in order to maximize the energy content. Therefore, conversion kits that pre-heat the SVO before it gets to the injector pump are used in many places, including Germany. Conversion and combustion are topics that the University of Minnesota–Crookston is researching.

Summary

As we began this project, the price of canola seed was around $0.12/lb. The economics of producing biodiesel on-farm at this price looked favorable. However, by the end of 2007, canola was selling for $0.20/lb. This jump in price was the impetus that forced us to look at the economics of using SVO for fuel and heating purposes. By late 2008, the price of canola was back to $0.12/lb; the volatility of commodity prices is something that a producer interested in this system needs to keep in mind.

This project also highlighted a major component in the potential profitability of this project: selling the meal for its true value. It quickly became apparent that the major by-product of this process is the meal, which contains around 7-8% oil. The meal is an excellent feed source, and maximizing its value could significantly lower the net cost of producing both canola SVO and biodiesel.

The economics of the small-scale system are highly dependent on the price of diesel fuel, the cost of production, the market price for both meal and oil feedstock (in our case, canola), and the cost of methanol. At the end of the day, what is most important is the gross value of the fuel and meal in comparison to what a producer could have made by selling unprocessed canola as a cash commodity. The real driver for most farmers will be the return per acre over, or under, what they could have gotten by selling to the local elevator.

We feel that small-scale on-farm pressing may be a good business for an individual who wants to operate on a part-time basis, crushing canola and selling the meal as feed to local livestock producers, and selling the SVO to local customers for home heating. We also suspect that, while the short-term economics may not look that impressive, what may be most attractive to a producer is the ability to produce fuel from a crop grown on his or her own farm.

Our project garnered a lot of attention. In addition to a field day in July 2008 attended by about 18 people, we counted more than ten newspaper articles and five radio stories about the project. Our project is also featured on the Northwest Region Sustainable Development Partnership website.

Management Tip

Take the time to research the current presses that are marketed and sold in North America. It may be helpful to attend a class offered by the manufacturers of biodiesel conversion equipment to become familiar with the process and by-products of biodiesel.

Table 2. Biodiesel and straight vegetable oil (SVO) processing inputs and costs.

Biodiesel Conversion Inputs	
Methanol/gal (KOH catalyst)	$4.00.00
KOH/50 lb	$38.00.00
KOH/lb	$0.7600
KOH/gram	$0.0017

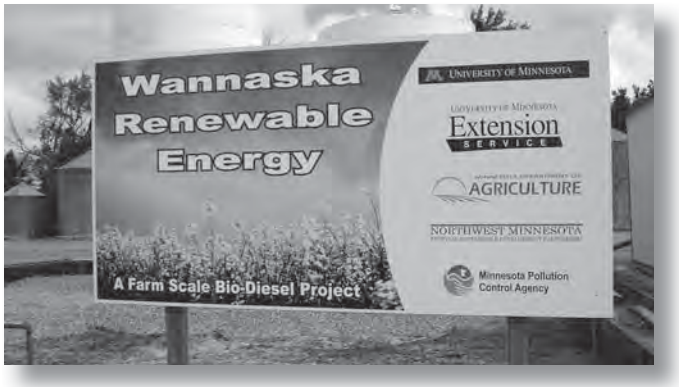
SVO Conversion	
Gallons filtered/hr	114.00
kW used/hr	4.50
Electricity for filtering (kW/gal)	0.08

Biodiesel Processing Cost ($/gal)	
Methanol @ 20%	$0.80
KOH/gal @ 20g/gal of biodiesel	$0.03
Crushing electricity use	$0.07
Total conversion cost/gal	$0.90

SVO Processing Cost ($/gal)	
Filtering electricity use	$0.01
Crushing electricity use	$0.07
Other	$0.00
Total conversion cost/gal	$0.08

Oil/Biodiesel Cost Summary	
Value of meal credit	$134.40
Meal credit/gal of oil	$2.13
Cost/gal of oil (no meal credit)	$4.31
Cost/gal of oil	$2.18
Biodiesel conversion cost	$0.90
Cost/gal of biodiesel	$3.08
Saving/gal over diesel	$0.92

SVO Cost Summary	
Value of meal credit	$134.40
Meal credit/gal of oil	$2.13
Cost/gal of oil (no meal credit)	$4.31
Cost/gal of oil	$2.18
SVO conversion cost	$0.08
Cost/gal of SVO	$2.25
Saving/gal over diesel	$1.75



A number of partners contributed resources to this project.

Project Cooperators

Branon Anderson, Farmer, Wannaska, MN
Tony Brateng, Farmer, Roseau, MN
Erik Dunham, Farmer, Wannaska, MN
Seth Fore, University of Minnesota, St. Paul, MN
Kraig Lee, Farmer, Wannaska, MN
Paul Porter, University of Minnesota, St. Paul, MN
University of Minnesota–Crookston, Crookston, MN
University of Minnesota Northwest Regional Sustainable Development Partnership, Crookston, MN

This project involved collaboration among the farmers involved with this project, the University of Minnesota, and the Northwest Regional Sustainable Development Partnership (NRSDP). The oilseed press used in this project was purchased by the NRSDP, which has allowed us to use the press throughout the course of this project. All other processing equipment, chemicals, canola seed, and labor were purchased with funds from our Sustainable Demonstration Grant.

Project Location

From Roseau, travel 13 miles south on Hwy. 89 to building site on the Kraig Lee farm, ½ block west of the Lee's Hardware Store.

Other Resources

Utah Biodiesel Supply.
Website: *www.utahbiodieselsupply.com*

Canola Council.
Website: *www.canola-council.org/grow_canola.aspx*

Derek S. Crompton, University of Minnesota Extension. 218-463-0295. Derek can provide contact information for biodiesel product manufacturers and companies to people interested in getting started.

Evaluation of the Potential of Hybrid Willow as a Sustainable Biomass Energy Alternative in West Central Minnesota

Principal Investigator

Diomides S. Zamora
Assistant Extension Professor
University of Minnesota Extension
322 Laurel St. Ste. 21
Brainerd, MN 56401
218-828-2332

Project Duration

2007 to 2009

Staff Contact

Mark Zumwinkle
651-201-6240

Keywords

biomass energy, carbon sequestration, hybrid willow, phytoremediation, renewable energy

Project Summary

The overall objective of this project is to evaluate the potential of hybrid willow as an alternative energy crop for west central Minnesota. Willow offers economic and ecological potential for landowners. It serves as a bio-energy crop that has potential market value because of the increasing demand by biomass burning plants for bio-energy production. The ecological benefits of planting willow include improved wildlife habitat, improved water quality, and carbon sequestration. Specifically, this project is being conducted to:

- determine the hardiness of willow varieties from New York and compare them to the local or native varieties of willow growing in the Wadena County area;
- establish demonstration trials that can be used to guide future research and development in Minnesota;
- provide a western Minnesota clonal trial to compare to similar plantings in Martin and St. Louis counties; and
- compare yields between willow and hybrid poplar at the end of the project.

Project Description

Renewable sources of energy are becoming more important as the state strives toward independence from fossil fuel energy. Woody biomass offers an important option for the production of biomass for energy. Short rotation woody crops like willow provide both economic and ecological benefits.

Markets for biomass are developing in this region of the state. For instance, the Central Minnesota Ethanol Cooperative in Little Falls, MN has recently shifted its focus toward using biomass as a heat source in their boiler system for ethanol production. Willows are an appropriate option in this situation and can turn a profit in 3-4 years. Willows excel in various environments. Hybrid willows have proven to be a very high yielder of biomass in New York and surrounding states.

Willows are often planted along riverbanks at the edge of row crop fields to prevent erosion while improving water quality. In west central Minnesota, high levels of nitrate in soil water exist due to intensive agricultural production. Willows provide a perennial system that utilizes excess nitrate before it reaches surface or ground water (a process called phytoremediation). If planted in such sites as a biomass crop, willow can provide a source of income for landowners while realizing these ecological benefits. Willows are also used to sequester carbon in other parts of the county. This research could serve as a carbon sequestration pilot project in Wadena in the future.

This project is a partnership among Minnesota farmer/landowners, researchers at the University of Minnesota Extension, the Center for Integrated Natural Resources and Agricultural Management (CINRAM) of the University of Minnesota, and the

Willow cuttings ready for transplanting.

State University of New York. The 4 acre project is being conducted at a farm located in North Germany Township in Wadena County. The farmer owns 240 acres of land in the area.

Table 1 lists the willow varieties planted in Wadena. To compare willow production with hybrid poplar at the end of the project, we also set up four plots of hybrid poplar (NM6 variety) using 5'x 5' plant spacing.

In addition to hybrid willow cuttings from New York, we also included three native willow varieties growing in Wadena County in our experimental design (Figure 1). This will allow us to compare biomass production of hybrid willows to that of native willows in Minnesota. Overall, there are 11 willow species/varieties being tested in our experiment.

Table 1. Varieties used in planting trials.

SV1	*Salix dasyclados*
SX 64	*Salix miyabeana*
S25	*Salix eriocephala*
Fc185 (94001)	*Salix purpurea*
9882-34	*Salix purpurea*
9879	*Salix purpurea x S. miyabeana*
9871-31	*Salix sachalinensis x S. miyabeana*
SX 61	*Salix sachalinensis*
Black Willow	*Salix nigra*
Laurel Willow	*Salix pendantra*
Sandbar Willow	*Salix sessilifolia*

Results

In late May of 2008, willow cuttings were received from State University of New York, and were planted immediately to avoid desiccation of the cuttings. Also, in May of 2008, we received cuttings of native Minnesota willows from Lincoln Oak Nursery. Prior to planting, our farmer cooperator prepared the land intensively by tilling the soil and applying Roundup® herbicide in order to have a weed-free environment. Willow plants survive well in areas without weeds.

Willow survival was measured twice during the first year of the project. Measurements were taken 1 month after planting the willows and again at the end of the growing season. The first survival count revealed plant survival ranging from 61.8% to 98.9%. However, survival rates significantly decreased (ranging from a 2.6% to a 52.1% reduction) at the end of the first growing season based on the second survival measurement (Table 2). Based on first year survival, willow varieties from New York outperformed native Minnesota varieties. Generally, the rate of survival of willows from New York was above 90%.

We discovered that, despite the intensive preparation of the land, rapid weed growth affected the growth and survival of the willows. In addition, severe drought had a negative effect on establishment of the willow planting. We initially employed mechanical weed control, cultivating between rows of plantings. However, the planting design developed by the State University of New York did not allow us to proceed with such control through the growing season. Instead, we hired laborers to manually weed for 2 days to clean up the entire 4 acre site.

Table 2. First year survival rate and biomass production of willow plantings.

Variety	Number of Plants Planted	Early Growing Season	Late Growing Season	Survival Change (%)	Biomass (kg/ha)
SV1	384	377 (98.2*)	360 (98.8*)	4.5	40.5
SX 64	384	317 (82.3*)	251 (65.4*)	20.5	88.6
S25	384	353 (91.9*)	230 (59.9*)	3.5	38.8
Fc185 (94001)	384	380 (98.9*)	338 (88.0*)	11.0	61.4
9882-34	384	371 (96.6*)	315 (82.0*)	15.1	88.1
9879	384	377 (98.4*)	321 (83.6*)	15.0	35.0
9871-31	384	368 (95.8*)	343 (89.3*)	6.8	62.1
SX 61	384	377 (82.3*)	360 (65.4*)	17.1	27.6
Black Willow	384	269 (70.0*)	262 (68.2*)	2.6	44.0
Laurel Willow	384	340 (88.1*)	312 (81.3*)	7.7	121.2
Sandbar Willow	304	188 (61.8*)	169 (29.6*)	52.1	12.6

**Number in parenthesis represents survival rate (%).*

We plan to apply Roundup® in the spring of 2009 before the start of the growing season in order to minimize occurrence of this problem during the second year of the project. Willow plants will be covered with a thin metal shield prior to application of Roundup® to make sure that the plants will not be affected. Further, there is a need to revisit the design of planting willows based on the weed control problem we have experienced in this experiment. We learned that the planting design should be based on suitability of equipment employed by our farmer cooperator in doing mechanical weed control.

In November of 2008, after the willow plants went into their dormant stage, they were coppiced at 2" above the top of the stool. The biomass was collected, dried, and weighed to provide an estimate of biomass production (data presented in table 2). Despite a significant reduction in survival of native willow varieties, their biomass production, particularly black willow and laurel willow, was comparable with the New York varieties.

There was considerable deer damage but stems generally remained over 3" in height. We performed insect and disease surveys focusing on rust and defoliation caused by insects. We found that some of the plants were infected by rust, which is a common problem with willow species. Further, we found insect larvae attacking the plants but the larvae were not identified.

Soil chemical properties of the planting are being analyzed at the State University of New York. Soil sampling was done at the middle of the growing season. Soil samples were collected in 6" increments to a depth of 24" using a soil auger. Information from these soil cores will give us baseline information on the amount of carbon stored in the soil. Sampling will be repeated again at the end of the project.

Based on our findings in this establishment year, there is real potential for willow, especially the New York hybrids, to become established even in drought conditions. By the end of next growing season, we will have a better understanding of the capacity for biomass production in west central Minnesota.

Management Tips

1. Design your willow planting to facilitate your weed program.

2. Once established, the young willow saplings should be scouted for insects and disease pressure.

Cooperators

Curtis Krelau, Farmer, Wadena, MN
Dean Current, Center for Integrated Natural Resources and Agricultural Management – University of MN, St. Paul, MN
Tim Volk, State University of New York, Syracuse, NY

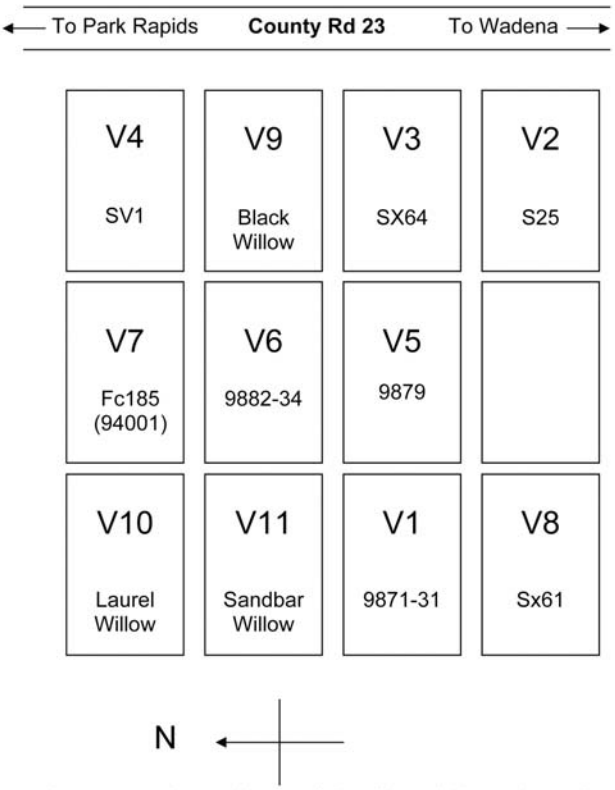


Figure 1. Experimental design of the willow trial in Wadena. Plot size is 22.5'x 35'. 3 double rows run the length of the plot. 2.5' spacing within double rows. 5' spacing between sets of double rows. 16 trees/row x 6 rows = 96 trees/plot. This design is randomized and replicated three times.

Location

From Vendale, MN, take Cty. Rd. 3 North 13.5 miles to the project site on the left.

Other Resources

Minnesota Department of Agriculture. *Greenbook 2008.* Testing the potential of hybrid willow as a sustainable biomass energy crop in northern Minnesota, pp. 47-51. St. Paul, MN.

United States Department of Agriculture – Forest Service, Northern Research Station. 2008. Evaluation of the potential of hybrid willow as a sustainable biomass energy alternative crop in northern and west central Minnesota, General Technical Report NRS-P-31, p74. US Forest Service Northern Research Station, Newtown Square, PA.

Short Rotation Woody Biomass Program. State University of New York – College of Environmental Science and Forestry. Syracuse, NY.
Website: *www.esf.edu/willow*

Willow Biomass Producer's Handbook. 2002.
State University of New York, Syracuse, NY.
Website: *www.esf.edu/willow/pdf/2001%20finalhandbook.pdf*

Chokecherry *(Prunus virginiana)* Production in Western Minnesota

Principal Investigators

Todd and Michelle Andresen
West View Berries
21832 - 240th St.
Detroit Lakes, MN 56501
218-439-6149
Becker County

Project Duration

2006 to 2008

Award Amount

$4,600.00

Staff Contact

Jean Ciborowski
651-201-6217

Keywords

chokecherry *(Prunus virginiana)*, chokecherry variety "Garrington," Farmers' Market, jelly, root suckers, "wild black cherry"

Project Summary

We planted one-half acre of chokecherries beginning in 2006 and finishing in 2007 to see if chokecherries are a commercially viable crop that will help our strawberry farm. Our young trees grew little the first 2 years. In 2008, the plants grew quite well and we expect to start harvesting chokecherries for our own jelly making operation in 2009. Seedlings bought from nurseries in Montana and Minnesota were the cheapest and easiest way to plant. We did a taste test where we asked people to compare chokecherry jelly with the same jelly called "wild black cherry." People like chokecherry jelly regardless of whether it is called chokecherry or "wild black cherry", and we recommend keeping the name chokecherry. For a second test, we compared chokecherry jelly from wild plants in Montana, Minnesota, and the domesticated variety "Garrington." People preferred the jelly from wild Minnesota plants.

Project Description

Over the last 3 years, we have planted one-half acre of chokecherries from three different sources in one of our cattle pastures. Two hundred fifty trees are seedlings from a nursery in Montana and 50 are seedlings from a nursery in northwest Minnesota. Both the Montana and Minnesota nurseries used local seed sources for their trees. Twenty-four trees are the variety "Garrington," which was selected in Canada for its high quality fruit.

Since chokecherries are typically picked from wild trees, we had to design our own system for growing chokecherries. We wanted to grow chokecherries similar to the way raspberries are grown. Like raspberries, chokecherries spread underground through rootsuckers. In chokecherries, rootsuckers sprout close to the mother plant and they are not aggressive. Unlike raspberries, chokecherry trunks live for decades and can grow to the size of a small tree. By growing a hedge, we will be able to control the size of the trees either by cutting the tops or cutting the trees at ground level and allowing the plants to resprout from root suckers. We controlled weeds with wood mulch and a fall Roundup® spray. We hand watered the trees during the planting year.

Our farm is just northwest of the town of Detroit Lakes. We started out as a wheat, corn, soybeans, and cattle farm. In 2002, we planted strawberries to increase our on-farm income and allow Michelle to stay home with our young son. Michelle also started selling jellies and jams at the local farmers' market. In addition to strawberry jam, she sold chokecherry jelly. She had a difficult time finding enough chokecherries to supply her small business. Other businesses in the area have expressed an interest in buying chokecherries for wine or syrup, and many have trouble finding enough fruit, or their fruit is dusty from being picked near roads. Chokecherries appear to grow well on our property which has a clay loam soil and a pH near 7.5 in some areas.

Results

Obtaining Plants

Finding plants proved to be quite difficult. In 2006, we tried digging up rootsuckers from wild plants near our house in the spring and planting them in a row. All the rootsuckers we dug from wild trees died. We realized that in order to propagate wild plants, we would have to start in the summer and dig the plants in the winter, which would put the cost in labor over $1 a tree. We wanted to try the varieties in Canada that had been selected for fruit quality, but stone fruit cannot be shipped from Canada into the U.S. The only named variety we could buy from U.S. nurseries was "Garrington", which cost $8 each. We planted 24 "Garrington" trees. In 2006, there were no Minnesota chokecherry seedlings at any nursery, so we ordered 150 seedlings from a nursery in Montana at $1 a piece. In 2007, we did find 50 trees from Minnesota that we could compare with the Montana seedlings. Since the seedlings from Montana were inexpensive and healthy, we ordered another 100 Montana seedlings.

Figure 1. Chokecherry hedge. After three growing seasons, the chokecherries started to form a hedge.

Figure 2. Mother plant (right) and rootsuckers. The rootsuckers had very fast growth rates and are almost as tall as the mother plant.

Growth and Yield

After 3 years, our hedge had started to fill in (Figure 1), but we had hoped that the plants would sucker and fill in the rows in the first year or 2 after planting. For the first 2 years, the chokecherry plants grew very slowly; many plants only grew 4" and none of the plants had started to sucker. The slow growth is the main factor reducing the economic potential of the plants on our farm. With most fruiting crops, the plants should grow rapidly the first few years so that by the third or fourth year, the plants have both the flower buds and the leaf canopy to support a full crop.

In 2008, seedlings planted 2 years earlier grew quite well (Table 1). Seedlings from Montana planted in 2006 grew an average of 6.2" this past summer, and 60% of the plants had rootsuckers. Each mother plant had an average of 3.2 root suckers. The average rootsucker grew over a foot, with some growing 2' (Figure 2). The Montana seedlings showed a great deal of variability. Some seedlings grew 1" in 3 years, while others grew 2'. Many had no rootsuckers while others had ten small trees. The "Garrington" in the same row averaged 4" of growth and 15% had rootsuckers. Seedlings from Montana planted in 2007 grew an average of 3.5" this past year, with less than 10% with rootsuckers. The Minnesota seedlings grew 8" the second year but the plants started out small and are still smaller than the Montana seedlings.

Overcoming Slow Growth

We were worried for a while that plants grew slowly because they were from Montana. Many plants native to harsh climates grow very slowly even when placed in a greenhouse. The nursery assured us that the seedlings came from northwestern Montana, which has a milder climate than Minnesota. Although the nursery indicated that the stock came from tall chokecherry trees, the trees grew like the stunted trees from the high plains. In 2007, we planted 50 seedlings from Minnesota in order to determine if plants from Minnesota would grow faster than Montana plants. The Minnesota seedlings did not grow significantly faster than the Montana seedlings, and they were smaller when planted. In the fall, the tallest Minnesota plants were about 20" tall. Montana appears to be a good source of plant material.

We tried to stimulate growth in the chokecherry plants in the Montana seedlings by pruning and fertilizing with nitrogen. In 2007, we cut ten trees down to ground level to encourage rootsuckers to sprout. Two years later, the plants that had been cut at ground level were only 3" tall, compared to an average of 4' on the uncut plants. On another set of plants, we applied calcium nitrate fertilizer in late May. The nitrogen made no difference in growth rates. Trees receiving the nitrogen looked no healthier than unfertilized trees.

The higher growth rates this past year were due to a combination of crop load, better weed control, larger plant size, and older age. In 2007, the plants bloomed and set fruit. The crop load may have been too high for such small plants, and could have slowed plant growth in 2007. There was too much weed competition in 2007. Our wood chip mulch did not control quack grass and thistles. In November 2007, we sprayed Roundup® to kill both the thistles and the grasses next to the chokecherry trees. The Roundup® did not hurt the chokecherries, but it did keep the grasses from competing with the chokecherries during the period of plant growth early this summer. Plants that were larger at planting appeared to be better equipped to compete with weeds than smaller plants. Some of the small Minnesota seedlings disappeared from weed competition.

The main reason why our trees grew faster in 2008 was because the plants had been in the ground a long enough time to become established. Montana seedlings planted in

2007 had half as much growth as seedlings planted in 2006. Although the plants did not appear to be growing in 2007, they could have been expanding their root system. A study in Saskatchewan also showed similar slow growth in the first 2 years after planting, with rapid growth after 3 years.

Pest Management

So far, we have had no insect pests and only one disease. The one disease is plum knot, or black knot, a fungus that infects the branches and trunks. Plum knot is best controlled by pruning. This year, we pruned infected branches during late spring and in the middle of summer. The best time to cut the disease out is in the middle of the summer, when the branch is swelling. We can prune the plum knot out in 15 minutes.

Taste Tests

During the course of the study, we conducted two taste tests. For the first test, we wanted to see if the name "chokecherry" should be changed to something more palatable. Chokecherries get their name because, when eaten raw, the fruit causes a drying sensation in the mouth. The drying sensation is not a flavor but a physical reaction. Although the drying sensation disappears when the fruit is processed into jelly or wine, the name "chokecherry" has the potential to scare off new customers. Several Canadian researchers have proposed changing the name to "wild black cherry."

We conducted a survey both at our business and at the Detroit Lakes Farmers' Market to see if chokecherry jelly tasted better when called by a different name. We gave people four jellies to taste on crackers or fresh bread. Two of the jellies were actually chokecherry jelly from the same jar, but one was labeled "chokecherry" while the other was labeled "wild black cherry." Each year we did the survey, the first jar was wild plum. In 2006, the third jar was red currant. In 2007, the third jar was Michelle's strawberry jam, and in 2008 we used black chokeberry (*Aronia melanocarpa*), which we labeled "aronia." Aronia is being promoted as a new product high in antioxidants.

Survey Results

About two-thirds of the people taking the test had eaten chokecherry jelly prior to the test. People preferred the chokecherry jelly over the other jellies in 2 of the 3 years we did the survey, regardless of whether the jelly was called "chokecherry" or "wild black cherry" or whether people were trying chokecherry jelly for the first time (Table 2). Everyone who took the survey in 2007 preferred Michelle's

Table 1: Growth of plants from different nurseries.

Plants	Year planted	Original height (feet)	Growth in 2008 (inches)	Rootsuckers per plant	Height in 2008 (feet)
Montana Seedlings	2006	3-4	6.2	.60	4-6
Montana Seedlings	2007	3-4	3.4	0.11	3-4
Minnesota Seedlings	2007	1	8.0	0.05	0.5-2
"Garrington"	2006	3-4	2.0	0.12	3-4

Table 2. Results of jelly taste tests on a numeric scale – 3 years.

Tasting chokecherry jelly for the first time

Type of Fruit	Average Rating*
Plum	1.63
"Wild Black Cherry"	1.45
Red Currant/Aronia	1.88
Chokecherry	1.52

**Jellies were rated from 1 to 5, with 1 being the best*

Had previously tasted chokecherry jelly

Type of Fruit	Average Rating*
Plum	2.15
"Wild Black Cherry"	1.82
Red Currant/Aronia	2.23
Chokecherry	1.67

**Jellies were rated from 1 to 5, with 1 being the best*

Table 3. Taste test of jellies from different locations.

	No	A little	A lot
Question 1: Did you taste a difference between the three jellies?	0%	66%	33%
	Montana (wild)	**"Garrington"**	**Minnesota**
Question 2: Which jelly was your favorite?	22%	46%	52%

strawberry jam and the rating of her strawberry jam was not included in the table.

Several jelly producers have commented that the market for chokecherry products is declining. The most common explanation for this decline is that chokecherries are an acquired taste and people who don't grow up eating chokecherry products will not buy them as adults. Our surveys contradict that explanation. People loved chokecherry jelly, even when trying it for the first time. Out of 70 people who took the taste test, only 2 rated chokecherry jelly as a 4 or 5 on the survey. By contrast, 5 of the 19 people who tasted aronia jelly in 2008 rated it a 4 or 5. Sixty percent of the people tasting chokecherry for the first time rated the jelly a 1 or 2. The decline in chokecherry consumption is most likely due to poor promotion, not because it is an inferior product or an acquired taste.

The name "chokecherry" did scare off two potential customers. One taster rated the "wild black cherry" a 1, while giving the "chokecherry" a 4. Another woman refused to do the taste test because she had heard that chokecherries were poisonous. Two people out of 70 who disliked the name is too small to warrant changing the name especially since there is no guarantee the two people would eat the jelly under any name. Changing the name would risk alienating the majority of consumers who have a positive opinion of chokecherries.

This year, we conducted a second taste test to see if consumers preferred chokecherry jelly from one region of the country over another region. We made jelly from fruit picked from wild cherry trees in Montana, wild trees in Minnesota, and from mature "Garrington" trees picked from the property of one of the cooperators. All the jellies were made with the same amount of sugar and pectin. We ran a blind taste test where consumers compared the flavor of the three different chokecherry jellies. First, tasters were asked if they noticed a difference among the three jellies (Table 2). All of the testers noticed a difference among fruit from different sources. The jellies did look different. The Montana jelly was red, the Minnesota jelly dark red, and the "Garrington", a dark purple. Most people preferred the jelly made from Minnesota fruit. Many people who marked "Garrington" as their favorite mentioned that they liked its dark purple color.

Single clone vs. multi-clone

Usually, when people remove plants from the wild and start growing them in cultivated fields, they plant one or two good varieties or clones that either have high fruit quality or good yields. Rarely have people chosen to plant seedlings of wild plants for commercial fruit production. Planting seedlings carries a number of risks. Some fruit trees go through a juvenile non-reproductive stage that can last up to 10 years. During the juvenile stage, plants cannot form flowers or bear fruit. Seedlings show variability in growth rates, leaf size, and number of rootsuckers. Fruit on chokecherry seedlings ripen at different times and vary in color from black to red.

At this point, using seedlings appears to be a viable, if not a preferable option to finding certain beneficial varieties. The current chokecherry market is being met through wild plant material. Our second taste test showed that most people prefer jelly from wild plants than from a variety selected for fruit quality. Established varieties are prohibitively expensive. Chokecherries do not go through a juvenile stage that prevents plants from forming flowers. The seedlings we planted had a 100% survival rate. Our plants do show a great deal of variation in height and vigor, but with the hedge slowly filling in the more vigorous plants will slowly take over the hedge. Some seedlings will show resistance to plum knot.

Management Tips

1. Weed control is important the first few years after planting. The wood chip mulch helped but was not good enough. Always kill all the thistles before planting a crop like chokecherries.

2. Watering is also important during the establishment years. Water does not appear to be a big factor when the plants become large.

3. Watch for plum knot disease. Cut out plum knot whenever you see it and either remove the pruned branches from the property or burn the branches.

4. We would recommend amending or fertilizing the soil prior to planting.

Cooperator

Thaddeus McCamant, Northland Community and Technical College, Detroit Lakes, MN

Project Location

West View Berries is located north of Detroit Lakes. Take U.S. 59 north for 7.5 miles to the old town of Westbury. Take a left on 240th St. The berry patch is a mile down the road on the north side.

Other Resources

Manitoba Agriculture, Food, and Rural Initiatives. February, 2006. Chokecherry Production in Manitoba. Website: *www.gov.mb.ca/agriculture/crops/fruit/bla01s00.html*

Intercropping within a High Tunnel to Achieve Maximum Production

Principal Investigator

Mark Boen
26060 Cty. Hwy. 18
Fergus Falls, MN
56537
218-736-2563
Otter Tail County

Project Duration

2007 to 2010

Award Amount

$11,165.00

Staff Contact

Mark Zumwinkle
651-201-6240

Keywords

high tunnels, lettuce, onions, tomatoes

Project Summary

For many Minnesota vegetable growers, the growing season is too short! Just when the season's harvest enters the profit zone, cold weather storms in and the party is over. High tunnels provide a wonderful solution to this problem by greatly extending the season. High-value primary crops such as tomatoes, cucumbers, and pole beans have proven to be very lucrative in high tunnels. However, by the time a high tunnel is built, considerable expense is involved. Is there a way to make the high tunnel even more productive and profitable?

High tunnels have not only extended the growing season, they have also created a climate of curiosity. Experiments abound as growers explore many potential ways to get the biggest bang for the buck from each high tunnel. Our question in this investigation is, "What if we add a secondary crop to the primary crop in the high tunnel? Can we squeeze more income out of each row?"

The purpose of this project is to measure the profitability of planting secondary crops along with the primary crops of tomatoes and cucumbers. Generally, secondary crops such as onions, lettuce, radishes, spinach, beets and carrots are of lesser economic value and would not occupy space alone in a high tunnel as the primary crop. But, if they were planted along with the primary crop, the added income would be a bonus. We also wanted to find out which of the secondary crops would do well in the high tunnel. We learned a lot from our first 2 years of the project and found that some secondary crops do have a place in a high tunnel.

Project Description

We started Bluebird Gardens in 1978 on a few acres of land near Fergus Falls, MN. We began selling vegetables directly to customers from a stand on Main Street in Fergus Falls. As our customer base grew, our operation did as well. We now raise vegetables on 110 acres and have six self-serve vegetable stands in Fergus Falls and the surrounding area.

We built two high tunnels measuring 30' x 96' in the spring of 2006. The high tunnels immediately allowed us to provide our customers with tomatoes and cucumbers over a much longer season. Even though we got a late start planting, we saw such potential that we leveled our old dairy barn in the fall of 2006 and used that land to build the frames for four more high tunnels along with a starting greenhouse. We are finding that the secondary crops enable us to bring even more crops to our customers earlier in the season.

Results

2007. In each high tunnel, rows were 24" wide with 18" pathways. The primary crop planted in the first high tunnel was Estiva tomatoes. Plants were spaced 18" apart. In row one, we planted D'Avignon radishes on each side of the tomato row. This brand of radish was promoted to do well in high tunnels. The radishes were planted with a walk behind planter. Row two was planted with Tyee spinach in a similar fashion. Row three was planted with Hybrid Sweetness III carrots. Row four had no secondary crop (to serve as the control group). Row five had Walla Walla onion plants planted 4" apart. Row six was planted with Grand Rapids Red Romaine lettuce plants that had been started 4 weeks earlier in the starting greenhouse. They were planted 4" apart. Row seven had hybrid Scarlet Supreme beets. The second high tunnel followed the same pattern except that the primary crop was Tasty Jade cucumbers.

In any experiment, one can expect the unexpected. Often the mistakes provide the best learning. We learned many exciting things that should have a profound effect on next year's profit!

1. The radishes grew well, but were extremely hot in flavor, almost too hot to sell. The late planting may have been a factor since harvest did not occur until early June. By that time, the outside radishes were ready and had good flavor. Nevertheless, each 96' row produced about $45 worth of radishes.

2. The Grand Rapids Red Romaine lettuce, planted as transplants, produced very well. Each row grossed $350. Like the radishes, the last lettuce we harvested was very strong in flavor. I personally like it that way but I think we lost some sales due to the strong flavor. Once again, the late planting was a factor. Next year, with the high tunnels already up, planting should occur in late March or early April instead of the second week of May.

High tunnel tomatoes at the Boen's produce stand.

3. Spinach, beets, and carrots were all planted from seed. They germinated very poorly, likely due to the lumpy soil from a wet start. We have learned that the use of transplants maximizes the precious time there is to grow in the high tunnels. The use of lettuce transplants proved that.

4. The onion plants did poorly compared to the same ones planted outside. We learned from the tour of University of Minnesota high tunnels in late August that we had not applied enough nitrogen. In fact, the professors have found the most common mistake made by high tunnel growers across the state was underestimating the need for fertility. High tunnel production is intense and takes more fertilizer than one might expect. With an earlier start and more nitrogen, the onion plants should perform better next year.

5. We decided not to use plastic mulch and that decision invited a battle with weeds that never ended. The enormous time we spent weeding wiped out any benefit of secondary cropping. The more painful the lesson, the better it is learned!

In our operation, the high tunnels supply the strong demand for tomatoes in June and July. After that, the outside tomatoes take over. So far, we have planted indeterminate tomatoes. In 2008, we plan to plant determinate varieties in some high tunnels.

2008. The high tunnels again allowed us to provide our customers with tomatoes and cucumbers over a much longer season. The secondary crops enabled us to bring even more crops to our customers earlier in the season.

We are continuing to narrow down the search for the best secondary crops for a high tunnel. This year we considered new crops such as green beans and peppers. We gave the onions one more chance to see if they have a place in the high tunnel. We also tried many varieties of lettuce in an attempt to find ones that carry the best flavor in the midst of the high tunnel heat.

On the outside rows of the tunnels, where there is little space above for trellising, we planted a shorter, determinate tomato Northern Exposure (Burpee). Plants were spaced 18" apart and Walla Walla onions (Dixondale) were fit 6" apart in the remaining space. We thought onions would do better by the side where it is cooler with more light. In High Tunnel One, we planted Sweeter Yet cucumbers (HPS) a foot apart with Snapper peppers (Rupp) in between the cucumbers but on the side of the row closer to the path. Mountain Spring tomato (Rupp) was the primary crop in High Tunnel Two planted 18" apart. Three Jade green bean plants (Jordan Seeds) were planted halfway between the tomato plants close to the pathway. High Tunnel Three had Early Girl tomatoes (Rupp) with Snapper peppers planted in the same fashion. High Tunnel Four grew Sweet Slice cucumbers (Rupp) with various kinds of romaine lettuce (Johnny's) and spinach (Rupp). In High Tunnel Five, we

had Tasty Jade cucumbers (Johnny's) with Jade green beans as the secondary crop. In High Tunnel Six, we planted three rows of TomatoBerry grape tomatoes (Johnny's) and the remaining rows were Cobra tomatoes (Johnny's). Snapper peppers were the secondary crop there.

It seems that spring comes later each year. April of 2008 brought one snowstorm after another right to the end of the month. The cost of emergency heat to keep the plants in the six high tunnels alive in April was a staggering $3,000. Next year I plan to drape clear plastic over the netting posts to make a tent within a tent. This should diminish the cost for emergency heat and enhance the health and earliness of the primary and secondary crops. Having tried the full gamut of emergency heaters, I found the simple propane canister to be the best. It needs no electricity and, unlike the others, doesn't need frequent maintenance.

Last year we learned that we needed more nutrients in the soil with the intense growth that occurs in a high tunnel. So this year we added ten truckloads of a nutrient-rich peat called Dick's Super Soil to the six high tunnels. With that soil, we made raised beds. We also added composted chicken manure pellets to each raised bed.

With the added fertility and improved soil condition, the soil was ready to support growth. Last year, we harvested 200 Tasty Jade cucumbers every other day from the high tunnel. This year, the number grew to over 1,000! We also added plastic mulch to avoid the weed problem we faced last year. We covered the pathways with newspapers topped with a layer of hay.

I have grown vegetables for 31 years and have never experienced such an outpouring of tomatoes and cucumbers from such a small area. The quality of the Mountain Spring and Early Girl tomatoes from the high tunnels was stunning and those varieties will be back next year. The TomatoBerry grape tomatoes, in the unique shape of a strawberry, were highly sought after by our customers. The sparkling, eye popping flavor brought customers back again and again.

The tremendous yield from the primary crop also means much plant growth. This spelled bad news for any secondary crop growing below. The peppers, which started out strong, were soon dwarfed by the primary crops. Since peppers also produce the entire season long, they may not be the ideal secondary crop. The peppers only made $350 per high tunnel. If we hadn't had peppers in the field as well, we would have had a slim year on peppers.

I thought green beans would have been an early crop. Unfortunately, they, too, were caught in the stranglehold of a towering primary crop. Since they weren't strong like our outside beans, they became a tangled mass in the walkway. The energy we spent on beans was not worth the $280 made per high tunnel.

Leaf and romaine lettuce growing at the base of sweet slice cucumbers.

The lettuce was the major success story. The superb quality of the many kinds of lettuce we tried garnered an exciting following of customers. Coastal Star and Nevada, both very similar, make a most beautiful heavy head of romaine! There were no brown or yellow leaves. Once cut, the lettuce was clean (due to the protection of the high tunnel) and ready for market. Each had a crispy, rugged texture making superb eating compared to other limp lettuces. Cherokee, a beautiful red romaine, also performed well. It had a finer, lighter texture than Coastal Star and Nevada. Magenta lettuce produced a heavy head of incredible lettuce and was also a favorite. Concept produced a smaller head of lightly crispy lettuce and was a favorite by many.

Tyee and Melody Spinach were also a success in this high tunnel. Since all the lettuce and spinach were done by the end of June, they were not dwarfed by the primary crop. We produced 180 heads of romaine lettuce per row. At a mere price of $1.50 per head, this high tunnel still made $1,890.

If each head were $3.00, as it should be, the secondary crop income would have been $3,780.

The onions once again performed poorly. Since the beautiful field onions were soon ready, we pulled the small high tunnel onions and bunched them together making only $50.00 per row. Since Walla Walla onions are a relatively early crop, I don't understand why they don't flourish in the high tunnel like lettuce.

Next year we should have enough demand to raise two high tunnels of lettuce as the secondary crop. We will also do one high tunnel of spinach. Each year I find a stray cabbage in the high tunnels determined to grow. Since those stray heads of cabbage seem to do well, I think they are trying to tell me something. We will do one high tunnel with Golden Cross Hybrid cabbage (HPS). It is a 40 day cabbage that should do well. We will also try a few rows of early kohlrabi and eggplant. We plan to begin marketing cut flowers. We will try some short early cut flowers in the remaining high tunnel space. We built a new high tunnel last fall. Primary crops next year will be three high tunnels of tomatoes, three of cucumbers, and one of Fortrex (Johnny's) pole beans.

Management Tips

1. Unless the soil in the high tunnel is totally free of weeds, plastic should be used. The warm, wet conditions provide a deluxe environment for germination and growth. Having newspaper on the pathway covered with hay also makes working in the high tunnels much more pleasant. We spent very little time weeding this year.

2. If at all possible, transplants should be used instead of direct seeding. Transplants maximize the use of time in high tunnels.

3. It is vital to watch the supply of nutrients. In addition to soil testing, watching the plants is a key to finding the balance between excessive leaf growth and good production.

4. Radishes, carrots, and beets do well outside and are of a lower economic value. We will not grow them in the high tunnel again.

5. It appears that the successful secondary crops are those that are done before the primary crop gets too big.

Cooperators

Terry Nennich, University of Minnesota Extension Service, Crookston, MN
David Birky, Ag Resource Inc., Detroit Lakes, MN

Location

We are located 4 miles NE of Fergus Falls on Cty. 1 and 3 1/2 miles east on Cty. 18.

Other Resources

"Minnesota High Tunnel Production Manual for Commercial Growers" University of Minnesota Extension Service, 2004. You may obtain copies from Marilyn Johnson, Minnesota Fruit and Vegetable Growers Association, 763-434-0400.

"The Hoophouse Handbook" edited by Lynn Byczynski. Growing for Market. Fairplain Publications Incorporated, P.O. Box 3747, Lawrence, KS 66046, 800-307-8949.

Using Solar Energy to Heat the Soil and Extend the Growing Season in High Tunnel Vegetable Production

Principal Investigator

Dallas Flynn
48677 Rice Lake Rd.
Frazee, MN
56544-8908
218-841-6380
drusadal@hotmail.com
Otter Tail County

Project Duration

2008 to 2011

Award Amount

$17,692.00

Staff Contact

Jean Ciborowski
651-201-6217

Keywords

high tunnel, mushrooms, solar heat, tile lines, tomatoes, vegetables

Project Summary

This past year we installed a high tunnel that uses solar heat to warm the soil below the tunnel. We pump hot air from three solar panels through a series of corrugated tile lines buried beneath a 30' x 48' high tunnel. The hot air warms both the soil and dramatically increases nighttime air temperatures in the high tunnel. By December, the temperature in the high tunnel was too low and the light too dim for tomatoes and cucumbers. We were able to grow and harvest lettuce, spinach, and radishes in December.

Project Description

My wife and I raise vegetables and shitake mushrooms at a small farm just south of Frazee to sell at a nearby farmer's market. Several years ago, I started raising vegetables in a small 20' x 24' high tunnel. The high tunnel immediately improved my sales at the farmer's market because I was able to sell tomatoes and cucumbers 2 months earlier than from my outside garden. With the high tunnel, I was able to expand my growing season from 120 frost free days to 150-170 days.

Although the high tunnel was a big benefit to my market garden, I soon saw several weaknesses of traditional high tunnels which rely on passive solar heat. High tunnels heat up quickly at sunrise, but at night the air temperature falls to only a few degrees warmer than the outside air. As a result, we had to install an electric heater to keep our plants alive during long cold snaps in early spring. We tried a propane heater, but our heater released ethylene gas into the tunnel that caused

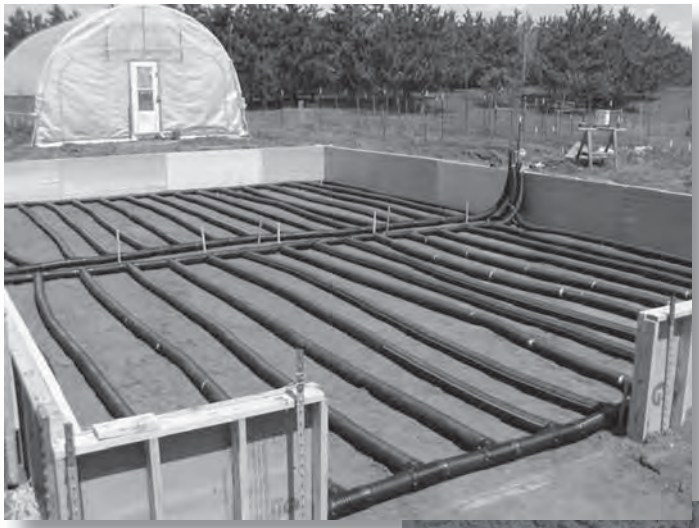


Figure 1. The lowest layer of tile line with the traditional high tunnel in the background.

Figure 2. The second layer of tile line. The tile line was hooked up to the solar panels in the center of the picture.

the tomato blossoms to fall off. Both the electric heater and sunlight warmed the air in the high tunnel, but they did a poor job of heating the soil. This past spring, cool soil temperatures caused both the cucumber and the tomato plants to become deformed. With my traditional high tunnel, I can't even grow cool weather crops like spinach past the middle of November. We wanted a high tunnel that could expand our growing season to 270 days for frost tolerant crops like tomatoes and longer for cool weather crops like spinach. I would like to plant tomatoes at the end of February and take advantage of the long, warm days and stronger sun in March and continue picking tomatoes until early December.

Figure 3. The interior of the high tunnel after it was completed.

Figure 4. The new high tunnel. The smaller traditional high tunnel is in the back.

Figure 5. Solar panels on the south and east side of the high tunnel.

I designed a way of heating high tunnels where hot air from solar panels is pumped into tile line buried beneath the tunnel. This past spring, I excavated an area next to my old high tunnel that is 4' deep. My soil is sandy loam over a sand subsoil. The excavator put the topsoil and the sand subsoil in separate piles. I covered the bottom of the hole with 2" styrofoam insulation. I installed 2" thick insulation on the bottom 2' of the sides, and 4" thick insulation on the top 2' of the sides. I covered the insulation at the bottom of the excavation with 1' of sand and placed one layer of 4" corrugated plastic drain tile over the sand (Figure 1). After covering the tile with sand, I installed a second layer of drain tile 8" above the first line, with the lines perpendicular to the first line. The line was covered with sandy subsoil. I used 2,000' of tile line for the two layers (Figure 2). The corrugation in the tile increased the surface contact between soil and tile so that there is 8' of surface area for every 5 linear feet of tile. On top of the sand, I put 18" of "Dicks Super Soil," a decomposed peat topsoil bought from a nearby dealer. The topsoil was supported on the outside with 2" x 12" white oak boards. The special soil had a higher nutrient holding capacity than my native soil. I formed the soil into raised beds and covered the raised beds with black plastic (Figure 3).

We used hot air instead of water to transfer the heat from the soil to lower the cost. The cost of a solar panel that heats water is significantly higher than the solar panel we are using. Pipes would have been more expensive and have required more maintenance than plastic tile line.

We put a 30' x 48' FarmTek high tunnel over the heated soil area (Figure 4). The covering for the tunnel consists of two layers of plastic with an insulating air chamber between the layers. Finally, we installed solar panels to heat air going into the tile lines (Figure 5). Small fans in the tile lines move the heated air from the panel through 4" plastic pipe into the soil. The thermostat kicks on when the temperature of the air in the solar panel reaches 125ºF and turns off when the temperature falls to 95ºF.

In September, we planted tomatoes, cucumbers, spinach, Swiss chard, lettuce, and onions in the heated high tunnel. In late winter, we will plant warm season crops such as tomatoes and peppers for both the farmer's markets and restaurants.

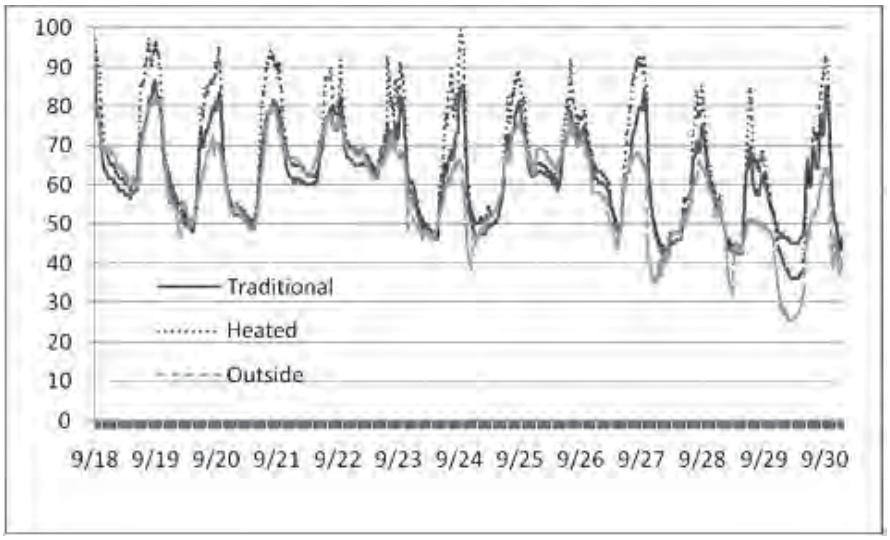


Figure 6. Temperature in the soil-heated and traditional high tunnels before the heating system was hooked up. Nighttime temperatures were similar in the traditional high tunnel and the new high tunnel, except during the heavy frost on September 30, when the temperature in the new high tunnel was lower than the traditional high tunnel.

Results

The new high tunnel took more time to construct than we had planned. The time when we wanted to install the high tunnel corresponded to the peak of our workload for our market garden. Many high tunnels were built in 2008, and the people who installed the high tunnels had previously contracted with other jobs. We finished the excavation in June and the installation of the tile lines by July 1. During July, we constructed the high tunnel and we finished installing the plastic over the tunnel in late August.

In September, the new high tunnel was heated with passive solar heat like a regular high tunnel. We were still installing the solar panels and air pumps and we had not started heating the soil. Using passive solar heat, the daytime highs in the new tunnel were slightly higher than in our other high tunnel, but at night the temperature in the larger tunnel was the same or even lower than the traditional high tunnel (Figure 6). The old high tunnel was filled with mature cucumber and tomato plants, while the new tunnel was largely empty at the time. The vegetation in the traditional tunnel kept daytime temperatures lower and nighttime temperatures higher than in the new high tunnel before we started pumping hot air below the tunnel.

On October 2, I hooked up the tile lines to the solar panels and began pumping warm air into the soil beneath the tunnel. Daytime temperatures in the two tunnels remained similar, but the nighttime temperature in the heated high tunnel fell to 53ºF shortly after sundown and remained at the same temperature the rest of the night (Figure 7). The air temperature in the old high tunnel continued to rise and fall in a typical diurnal pattern, with overnight lows near 40ºF just before sunrise. Nighttime lows outside the tunnel were near freezing every night the first week of October. Following a cool, cloudy and rainy spell between October 10 and 12, the nighttime temperature in the heated high tunnel fell to 46ºF every night, while temperatures in the traditional high tunnel were falling into the low 40's and high 30's.

At night, the air is heated by the soil whether in a field or a high tunnel. By heating the soil, we were able to keep the nighttime air temperature in the high tunnel from falling to levels that hurt warm season crops during the month of October. Growth in cucumbers and tomatoes will slow when the temperature at night falls below 45ºF.

In November, we went through a long, cloudy spell. We only had 10 days during the entire month when the temperature in the solar panels was high enough to trigger the thermostat to pump hot air through the soil. From November 4-24, there were only 3 days with sun. In spite of clouds and below freezing weather, the heated high tunnel stayed above freezing the whole month. We were losing considerable heat in the tile lines between the solar panel and the soil, so we covered the tile lines with foam insulation in late November. The soil temperature in the traditional high tunnel dropped to near freezing the month of November, while the temperature in the heated high tunnel remained in the mid 40's (Figure 8).

Plants

We planted cucumbers, tomatoes, lettuce, spinach, kale, Swiss chard, onions, and radishes in the heated high tunnel in early September. The cucumbers were stunted by the end of October and died in the middle of November due to a lack of light and cool weather. The tomatoes were still alive, but the temperature was too cool and the light too weak for the plants to set fruit. The greens are growing quite well. I have been able to fill 9 weekly orders of lettuce, spinach, kale and Swiss chard to a local restaurant.

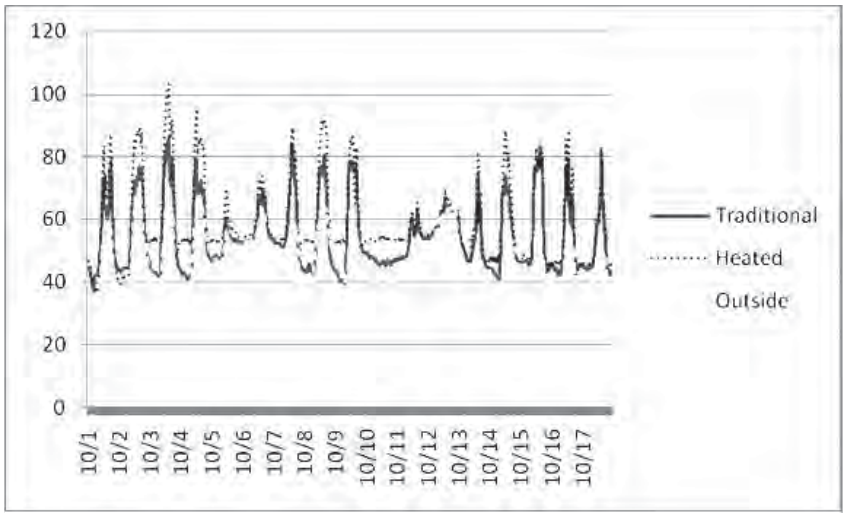


Figure 7. Air temperature in the soil-heated and traditional high tunnels in October. Neither high tunnel had supplemental heat. The temperature in the soil-heated high tunnel dropped to 53ºF each night from October 3 through October 12, regardless of the outside temperature.

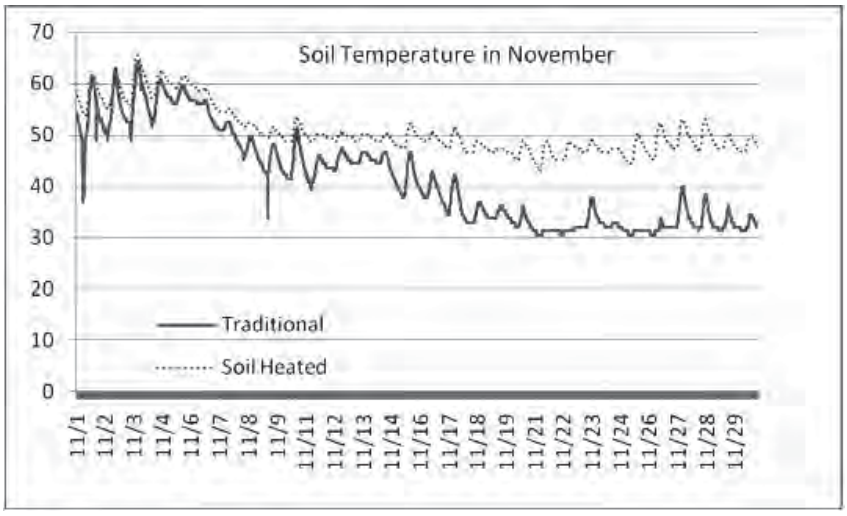


Figure 8. Soil temperature (2 inches) in the traditional and soil-heated high tunnels during the month of November. We used an electric air heater in both tunnels from November 1-15. We shut the electric heater off in the traditional tunnel on November 16 and kept the air heater on all month in the soil-heated tunnel.

Management Tips

1. Heating the soil does keep the air temperature from cooling at night.

2. The forced air adequately transfers heat from solar panels to the soil. The 4' of soil provides an adequate heat sink.

3. We do not recommend using a timer to turn the drip irrigation system on and off. Instead, we manually turn the water on and off. Water use decreases sharply when days get shorter and the timer does not adjust to the lower usage on its own.

4. Always use raised beds, because they keep the soil softer and allow for faster root development. Root crops are especially easier to harvest from a raised bed.

5. We would have preferred to hook up the system in early September instead of early October.

Cooperators

Terry Nennich, University of Minnesota Extension, Bagley, MN
Thaddeus McCamant, Northland Community and Technical College, Detroit Lakes, MN

Project Location

Forest Glenn Farm is 4 miles southeast of the town of Frazee. Take Hwy. 10 east of Frazee and go south on Black Diamond Rd. approx. 1.5 miles. The road will "T". At the "T", go right on Rice Lake Rd. approx. 2 miles. Our farm is located at the end of the road. Go through the public access and then you are at our farm.

Other Resources

FarmTek high tunnels.
Website: *www.farmtek.com/farm/supplies/home*

High Tunnels website sponsored by Kansas State Research and Extension, University of Missouri Extension, and University of Nebraska Cooperative Extension.
Website: *www.hightunnels.org/*

Nennich, T., David Wildung, and Pat Johnson. 2004. Minnesota High Tunnel Production Manual for Commercial Growers.
Website: *www.extension.umn.edu/distribution/horticulture/M1218.html*

Pennsylvania State University High Tunnel
Website: *http://plasticulture.cas.psu.edu/H-tunnels.html*

Extended Growing Season for Lettuce

Principal Investigator

Michael Hamp
32251 Bunny Hill Rd.
Sebeka, MN 56477
218-472-3395
calico@wcta.net
Wadena County

Project Duration

2008 to 2010

Award Amount

$4,556.00

Staff Contact

Meg Moynihan
651-201-6616

Keywords

cooling, lettuce, season extension, shade, water misters

Project Summary

The reason for the project is to see if using shade cloth houses and jet fog misters to lower the air temperature over lettuce beds will create an environment that will provide a continuous supply of lettuce throughout the growing season here in Central Minnesota. I farm near Sebeka in Central Minnesota and sell lettuce and herbs to several area restaurants. In spring and fall, my lettuce is of very high quality. The problem is that in July and August, high temperatures (above 80°F) can cause lettuce to bolt or taste bitter. Seeing the use of water misters in local grocery stores and how effective they were sparked my interest in other possible applications.

Project Description

In the fall of 2007, I prepared two 10' wide by 25' long lettuce beds. I used a weed burner over the area to burn any weed seeds in the soil. Then, I hauled and spread organic material (llama pellets) to a depth of 3" to 4" over the lettuce plots. I used a garden tiller to mix the material into the soil to a depth of 8". The beds were then leveled with a hand rake. Next, I pushed 1/2" by 20' long pipe into the soil to form semi-circular indentations 1/2" to 3/8" deep. These long, straight indentations then received a sprinkling of lettuce seeds along their length. I filled the indentations with peat and tamped lightly then used a common garden spray hose to keep the seeds damp.

I ordered two shade cloth houses from Farm Tech in April of 2008: one that provided 50% shade and one that provided 70% shade. I also ordered the jet fog misters and filters from the same place. My original plan was to install them over the lettuce beds in late May or early June. Well, what a spring! Snow and low temperatures in May did not permit planting until the last week of May. During the first 2 weeks of June, the temperatures were around 50°F which was perfect for lettuce growing, so there was no need for the shade houses at that time. I placed the houses over the beds during the last week of June. I used a total of 16 misters in each house, two rows of 8 misters placed 2" apart. Temperature gauges were used inside and outside the houses to record temperature changes. I did not want temperatures over 80°F in the shade houses. My plan was to turn on the misters once that temperature was reached and they would remain on until the temperature fell below the 80°F mark.

As a control, I left 5' of beds without shade cloths or misters so I could compare performance of my old system (no shade, no misters) and two versions of the experimental system (50% shade plus misters and 70% shade plus misters).

Results

In my part of the state, last summer was very cool for most of the growing season. The temperature was only hot enough to

Michael's shade cloth houses.

require use of the mister system on 11 days. However, the shade houses proved to be a great barrier to the persistent winds here in the summer. The lettuce beds retained their moisture much better than the control beds. The result was approximately 20% better growth in the shade houses, which was an unexpected benefit of using the shade cloth alone.

I noticed that the house with 70% sun reduction seemed to outperform the other with a 50% reduction. I also observed that 16 misters per house was too many. My plan for the 2009 growing season is to reduce the system to 8 misters/20' of row, for a total of 10 misters/house.

So far, the system does work as I had hoped. On the few days that it had to be used to reduce air temperatures, it worked very well. The system lowered temperatures over the lettuce by 15°F on the days it was in use. Another great benefit is that it lowers water usage by upwards of 60%.

Management Tips

1. Using shade cloth really seems to conserve moisture in windy areas.

2. The rate of misters that commercial suppliers recommend may be too high. I found that using 8 misters per 250 ft^2 of growing area (or about 1 mister/31 ft^2) is about right.

3. Depending upon your soil type, your soil may need to be amended with organic material before you put the shade cloth house in place. Select materials like peat or grass clippings that will hold moisture.

Cooperators

Malinda Dexter, Terry Nennich, and Linda Ulland have not really participated in the project so far. I hope to involve them more this summer.

Project Location

From Sebeka, travel east on MN-227 to Nimrod. Turn left (north) on Cty. Rd. 18 for 6 miles. Then, turn east on 320th St. for 1 mile.

Organic Day-neutral Strawberry Production in Southeast Minnesota

Principal Investigator

Sam Kedem
12414 – 191st St. E.
Hastings, MN 55033
651-437-7516
info@kedemroses.com
Dakota County

Project Duration

2009 to 2012

Award Amount

$13,695.00

Staff Contact

Jean Ciborowski
651-201-6217

Keywords

anthracnose, Brix reading, day-neutral strawberries, June-bearing strawberries, strawberry cultivars, tarnished plant bug

Project Summary

In 2008, we planted three day-neutral strawberry cultivars and five June-bearing strawberry cultivars. The June-bearing strawberries were trained into matted rows, while the day-neutrals were planted either in ribbon rows in plastic or as matted rows in straw mulch. The day-neutral berries started ripening in August, but yield was reduced by tarnished plant bug damage, which continued to become worse through the fall. In August, the berries in the straw mulch had less insect damage than berries in the plastic mulch. Production declined in plants grown in the plastic mulch during September due to tarnished plant bugs and anthracnose, while plants in the straw mulch stopped producing berries due to competition by volunteer wheat that sprouted from the straw.

Project Description

Sam Kedem Nursery and Garden is an organically certified farm and garden center. We sell roses, perennials, and bedding plants as well as vegetables and many different types of fruit both on the farm and at the St. Paul Farmers' Markets. Strawberries have been a profitable product for us at both the farm and the farmers' market. We have noticed that customer demand for strawberries remains fairly high throughout the summer, but June-bearing strawberries are only available for 3 weeks each summer. Day-neutral strawberries show the possibility for a faster return on investment than June-bearers and will attract more customers during late summer and fall when we are picking raspberries and apples.

In 2008, we planted .20 acre of day-neutral strawberries, and .80 acre of June-bearing strawberries. We measured the yield and quality of day-neutrals this year, and in 2009, we will compare the fruit quality, yields, and profitability of day-neutral berries with June-bearing strawberries.

Nearly all the strawberries grown in Minnesota are June-bearing plants, which ripen from mid-June to early July in the Twin Cities Metropolitan area. There are a number of risks associated with relying only on June-bearing strawberries: the entire crop can be wiped out by one frost, hot weather during picking can ruin the market, and the market is often saturated during the peak of the season. Because of the limitations of June-bearing strawberries, much of the world primarily plants day-neutral strawberries which ripen over a 3 or 4 month growing season.

Day-neutral strawberry production faces a number of challenges in Minnesota, especially when growing the berries organically. Because day-neutral berries set fewer runners than June-bearers, they are planted in ribbon rows, which consist of plants spaced 8" apart in two lines per row. Weed control is more of a challenge in ribbon rows than in the matted rows of June-bearing strawberries. In June-bearing strawberries, weeds can be controlled from planting to the time runners start to set with different types of cultivation equipment. After the rows have filled in at the end of July, June-bearing strawberry plants can crowd out most weeds. Few types of cultivation equipment have been designed for day-neutral strawberries. Even with the tighter spacing of ribbon rows, the plants rarely become vigorous enough to crowd out weeds. Most strawberry growers plant day-neutral strawberries through a plastic mulch to reduce weed pressure.

Day-neutral strawberries have more insect and disease pests than June-bearing strawberries. Tarnished plant bug (TPB) is the primary insect pest in strawberries nationwide. They feed on strawberry flowers, leading to smaller berries. Under severe pressure, their feeding causes deformed or "cat faced" berries that are unmarketable. In Minnesota, the TPB population is small in May, when June-bearing strawberries are blooming. Their population rises sharply during June and July when day-neutral strawberries are blooming.

Table 1. Strawberry cultivars planted at Sam Kedem Nursery and Garden.

Day-neutrals	Year Released	June Bearing	Year Released
Seascape	1989	Jewel	1985
Albion	2006	Cavendish	1990
Tribute	1981	Itasca	2005
		Mesabi	1999
		Winona	1996

Table 2. Yield on day-neutral strawberries.

	Pounds Sold	Cost/lb
August	382	$2.97
September	265	$2.83
October	21	$2.41
Total	668	
Per acre yield	3,340	

Yield of plants in black plastic is combined with those in straw mulch.

The biggest disease problem in day-neutral strawberries is anthracnose, which forms dead brown spots on the fruit. Anthracnose only spreads during warm weather with heavy rains, especially thunderstorms. Thunderstorms are more common in July and August than in May. The black plastic used to control weeds appears to increase anthracnose.

In May of 2008, we planted three different cultivars of day-neutral strawberries and five cultivars of June-bearing strawberries (Table 1). Our day-neutral plants included the new 'Albion' cultivar, the older 'Tribute', and the older 'Seascape'. We prepared the soil for all berries by using a summer fallow the previous year and applying compost in early spring before planting. Our soil is a sandy loam. Some of the day-neutral strawberries were planted in ribbon rows in a starch based, biodegradable black plastic mulch at an 8" by 8" spacing. The rest of the day-neutrals were planted in a line at an 8" spacing and received straw mulch shortly after planting. The berries in the plastic were planted by hand which required 22 hours of labor for four rows. The berries in the straw mulch were planted with a transplanter, which took 3.9 hours for 17 rows. All of the plants were watered with a drip irrigation system. We controlled weeds in the June-bearing strawberries with a field cultivator and by hoeing next to the plants. Weed pressure in the plastic mulch was minor, but we did have to pull the weeds that sprouted through the holes in the plastic by hand.

We clipped the blossoms on both day-neutral and June-bearing plants in the first 2 months after planting. By July, the day-neutral strawberry plants had enough leaf area to support a crop and were allowed to set fruit. By early August, the berries on the day-neutral plants started ripening and they continued to ripen until the end of October.

Results

The five June-bearing cultivars all grew quite well and 90% of the rows filled in by September. The 'Cavendish' had the least growth of the five cultivars. Ten percent of the new June-bearing plants died in June after I put blood meal fertilizer around the plants. Small worms moved from the blood meal and burrowed into the strawberry petioles, killing the plants. I had previously put all our leftover plants into 3.5" liners after planting and I filled in the dead spots with these leftover plants.

Figure 1. Albion (left) and Tribute (right) on black plastic. The ripe berries in this picture have little tarnished plant bug damage.

We started picking the day-neutral strawberries for our store in early August (Table 2). By late August, about one-third of the berries on the plastic mulch had tarnished plant bug damage (Table 3). Berries on the straw mulch had one-third less tarnished plant bug damage than the berries on plastic, and most of the fruit harvested for our store and farmers' market came from plants in the straw. 'Albion' had the largest fruit and 'Tribute' had the smallest fruit. On average, 'Albion' fruit was twice as big as 'Tribute' fruit. The flavor on all three cultivars was quite good, with average sugar content (Brix reading) over 8%. Strawberries need a Brix reading above 7% to have an acceptable taste for most consumers. There was no anthracnose in August.

As the summer progressed, volunteer grain started sprouting from the wheat straw, and by the middle of August, the volunteer wheat began to crowd out the strawberries. We did not have the labor to remove all the wheat seedlings from the berries.

By the end of September, tarnished plant bugs and anthracnose made most of the berries unmarketable. The reduction in size between late August and October was partly due to increased tarnished plant bug damage. By October, 'Albion' berries were smaller than 'Tribute' in the plastic (Table 2). The smaller size of 'Albion' in October was partly due to increased tarnished plant bug damage on 'Albion'. Two-thirds of the 'Albion' on plastic had tarnished plant bug damage in October, compared to 40% of the 'Tribute' plants.

September rains caused an anthracnose outbreak. As predicted, anthracnose was worse on berries planted in plastic, with nearly two-thirds of the berries having anthracnose lesions. By late September, the sugar content started to drop. Although the average sugar content at the end of September stayed above 7, we started seeing individual berries with a Brix content of 5 and 6, which is unacceptable in direct market sales. The decrease in sugar content appeared to be due to decreased sunlight.

Overall, pest pressure was less on plants growing in the straw mulch than black plastic, but unfortunately, we could not compare yields in plants grown in the two mulches.

Table 3. Fruit quality of day-neutral strawberries, August 29, 2008.

	Black Plastic Mulch			Straw Mulch		
Variety	**Wt (oz)***	**Berries with TPB damage**	**Brix****	**Wt (oz)***	**Berries with TPB damage**	**Brix****
Seascape	0.28	32%	7.5	0.24	10.5%	8.3
Tribute	0.18	48%	9.2	0.16	9.5%	7.0
Albion	0.34	26%	8.0	0.40	10%	9.3
Average	0.27	35%	8.2	0.27	10%	8.2

**Weight per berry.*
***Each number is the average of anywhere from 6 to 20 berries.*

Table 4. Fruit quality of day-neutral strawberries, October 1, 2008.

	Black Plastic Mulch				Straw Mulch			
Variety	**Wt (oz)***	**Berries with TPB damage**	**Berries with anthracnose**	**Brix****	**Wt (oz)***	**Berries with TPB damage**	**Berries with anthracnose**	**Brix****
Seascape	0.20	50%	62%	7.7	0.25	54%	0%	8.0
Tribute	0.28	39%	89%	6.7	0.24	47%	56%	6.3
Albion	0.23	67%	52%	8.3	0.26	50%	0%	9.7
Average	0.27	52%	67%	7.6	0.27	51%	19%	8.0

**Weight per berry.*
***Each number is the average of anywhere from 6 to 20 berries.*

In early August, the quality, size and yield of strawberries in straw mulch were better than berries on plastic. By September, volunteer wheat had taken over the straw mulch, and there was no production coming out of plants in straw mulch. We struggled to find enough berries to measure size and anthracnose injury.

Biodegradable mulch was a good investment. The cost of the mulch was far less than the cost of hand weeding. Our plant spacing did not correspond to the emitters of the T tape, and water did not spread enough in our sandy soil to reach all plants, so our plant mortality was fairly high. We should have increased the plant spacing to 12" or 220 to 250 plants/100' row, so that the plants could be close to the emitters. By the time the plastic started to break down in late summer, the strawberry plants were well established and weed pressure started to decline.

The potential yield for day-neutral strawberries in the establishing year is much higher than we harvested this year. We harvested the equivalent of 3,340 lb/A. Without the weeds and insect pests, our yields would have been anywhere from 100 to 300% higher. Straw mulched berries produced better quality and size early on, while black mulch performed better once the temperatures began to fall in September. Next year, we are thinking of putting straw on top of the plastic mulch so that we can have the benefits of both mulches. We will not use winter wheat straw next year.

Management Tips

1. When planting day-neutral strawberries, always have a plan for controlling tarnished plant bugs from the middle of summer through the fall.

2. Weed management is greatly enhanced when using black mulch. Wheat straw alone should be avoided unless it is completely free of grain. Be prepared to pay extra for seedless straw.

3. Applying straw seems to improve quality of the berries and keep them cleaner, which may be a good choice in organic systems. Combining the qualities of both mulches may prove to enhance quality and yield potential.

4. Public acceptance has been very good despite higher prices, which are necessary due to higher production costs. There seems to be an infinite market when berries are of a good quality.

5. Some of the new cultivars appear to be quite good but none are resistant to anthracnose.

Project Cooperator

Thaddeus McCamant, Northland Community and Technical College, Detroit Lakes, MN

Project Location

Sam Kedem Nursery and Garden. Three miles south of Hastings via Hwy. 61. Turn west on 190th St., we are 1/6 mile from Hwy. 61 on the south side of the road.

Other Resources

Guerena, Martin and Holly Born. Strawberries: Organic Production. 2007. National Sustainable Agriculture Information Service.
Website: *www.attra.org/attra-pub/PDF/strawberry.pdf*

Minnesota Department of Agriculture. IPM for Minnesota Strawberry Fields. 2007. Website:
www.mda.state.mn.us/plants/pestmanagement/berrymanual.htm

Pritts, Marvin and David Handley. Strawberry Production Guide for the Northeast, Midwest, and Eastern Canada. 1998. Northeast Regional Agricultural Engineering Service. Cooperative Extension. Ithaca, NY. Pub. #:NRAES-88. Website: *www.nraes.org*

Insect and Disease Pressure in Unsprayed Apple Orchards in Central and Northern Minnesota

Principal Investigator

Thaddeus McCamant
Northland Community and Technical College
803 Roosevelt, #303
Detroit Lakes, MN 56501
218-846-0741
Thaddeus@lakesnet.net
Becker, Chisago, Pope, Stearns, Todd Counties

Project Duration

2007 to 2008

Award Amount

$5,630.00

Staff Contact

Jean Ciborowski
651-201-6217

Keywords

apples, apple diseases, insects

Project Summary

In 2007 and 2008, we assessed disease and insect pressure in unsprayed apple trees across Minnesota to see if parts of Minnesota have natural advantages for organic apple production. While apple scab and codling moth were rare or absent in some orchards, the marketable crop was reduced by apple maggot, apple curculio, and plum curculio. Some trees were weakened by oystershell scale. As predicted, apple scab and codling moth damaged few fruit in orchards north of Little Falls, but pressure varied from year to year in every orchard. Apple scab and codling moth were more common in 2007 than in 2008 while apple maggot was far more common in 2008 than in 2007. Leafrollers were found at roughly the same level in every orchard, but primarily damaged fruit in May and June. Late season leafroller damage was quite rare.

Project Description

In most parts of the U.S., the two biggest apple pests are apple scab and codling moth. Apple scab is a fungus that infects both leaves and young fruit. Codling moth larvae are worms that burrow into the center of the fruit (Figure 1). Both pests are difficult to control, and many guidebooks recommend spraying Midwest orchards once every 2 weeks with fungicides and insecticides throughout the growing season. Apple scab appears to be rare in parts of central and northern Minnesota where susceptible cultivars like "Zestar" rarely lose more than 5% of their crop to apple scab. According to most studies, low apple scab pressure is usually due to dry weather during May and June that does not allow primary infections. Codling moths gradually decrease in numbers from southern to northern Minnesota, and appear to be absent from many parts of northern Minnesota. One of our goals was to find the northern limit of codling moth and apple scab in the state. Another goal was to find out which pest replaces codling moth as the major insect pest.

People with orchards in central Minnesota usually either spray on a regular schedule as recommended by the guidebooks

Figure 1. Typical codling moth damage. The worm burrowed into the core, ate several seeds and left through the calyx. All apples with codling moths are culls.

Table 1: Characteristics of orchards involved in the project.

Location	Tree Age	Varieties	Care	Oystershell Scale?
Shafer	25	Northwestern Greening, McIntosh	None	Yes
Forest Lake	20	McIntosh, Hazen	Standard*	Yes
St. Francis	10	Red Baron, Sweet Sixteen	Mowed	No
Redwood Falls	30+	Honeygold, Haralson	Mowed	Yes
Upsala	15	Most MN varieties	None	Yes
Glenwood	30+	Snow, Haralson	Standard	Yes
Staples	8	Most MN varieties	Standard	No
Frazee 1	8	Haralson, Spartan, Honeycrisp	Standard	No
Frazee 2	6-25	Honeygold, Honeycrisp, Red Baron, Chestnut Crab	Standard	No

**Standard care includes pruning, fertilization, weed control next to the trees and removal of all fallen fruit.*

or they don't spray their orchards at all. In 2007 and 2008, we monitored insect pests and assessed disease damage in nine unsprayed orchards north or west of the Minneapolis-St. Paul Metro area. Two orchards had no care and two orchards received an occasional mowing. The remaining five orchards received the normal apple orchard maintenance including: pruning, weed control next to the trees, watering and removal of all fallen fruit, and no spraying of synthetic fungicides or insecticides (Table 1). In early spring, we inspected all orchards for oystershell scale.

We monitored codling moths with pheromone baited "Delta" traps, and apple maggots with red balls coated with Tanglefoot glue and baited with apple essence. Each orchard had a temperature/leaf wetness monitor to determine if the orchards were having apple scab infection periods. At the end of the season, we randomly harvested apples from each orchard to determine the extent of the damage.

Results

Oystershell scale (*Lepidosophes ulmi*), was found in 5 of the 9 orchards during dormancy, usually in trees more than 30 years old (Table 1). Like other scale insects, oystershell scale attaches itself to the bark of a tree where it feeds on phloem sap. Scale weakens and slowly kills the trees. From our observations, oystershell scalespreads much slower than the more famous San Jose scale. At the

Table 2. Marketable fruit at each orchard, September 2008.

Site	#1's*	#2's	Culls	Varieties Sampled
Shafer	0	54	46	Northwestern Greening, McIntosh
Forest Lake	9	54	36	McIntosh, Hazen
St. Francis	32	53	14	Red Baron, Sweet Sixteen
Redwood Falls	13	50	37	Honeygold, Haralson
Upsala	0	0	100	Fireside, Haralson
Glenwood	12	64	26	Haralson
Staples	57	14	28	Honeycrisp
Frazee 1	93	5	2	Haralson, Honeycrisp
Frazee 2	36	42	22	Honeycrisp, Red Baron, Chestnut Crab

**#1's are blemish-free fruit, while #2's have superficial damage from plum curculio, leafrollers, minor scab lesions or apple maggot oviposition scars.*

Table 3. Specific diseases and insect pests at each orchard for the fruit listed in Table 1.

Site	CM	AS	AM	LR	PC*	AC*	Other
Forest Lake	4	54	14	4	14	0	
Shafer	8	0	31	8	8	22	Russetting
St. Francis	4	0	28	25	4	0	Cedar-apple rust
Redwood Falls	3	0	18	5	3	31	
Upsala	8	3	100	8	44	16	
Glenwood	0	0	32	8	0	0	
Staples	0	4	19	5	0	0	Birds
Frazee 1	0	0	0	7	0	0	
Frazee 2	0	0	28	9	17	0	Deformed fruit

CM = codling moth, AS = apple scab, AM = apple maggot, LR = leafroller damage from any species, PC = plum curculio, AC = apple curculio

**Curculio damage includes both oviposition scars and circular scars from summer feeding.*

Forest Lake orchard, scale was found in one corner of the orchard, but was slowly spreading. Unlike San Jose scale, oystershell scale rarely infects fruit. The only orchard with scale on the fruit was at Shafer.

In 2008, the cull apples varied from 2% in a young orchard near Frazee (Frazee 1) to 100% in the Upsala orchard (Table 2). In two northern orchards, over half the fruit was marketed as #1's, which is a blemish free fruit. In most orchards, over 50% of the fruit was #2's, which includes apples with a normal shape and no internal pests like codling moth or apple maggot. One of the southern orchards, St. Francis, had over 75% marketable fruit both years, which shows that orchards in areas with codling moth can produce fruit without being sprayed. The two other southern orchards had more marketable fruit in 2008 than in 2007 due to a decrease in apple scab in 2008. In every other orchard, the percentage of marketable fruit decreased sharply from 2007 to 2008. Staples, for example, had 90% marketable fruit in 2007 and 70% in 2008 due to increased apple maggot pressure.

The worst insect pest in unsprayed orchards was apple maggot, with about 1/3 of all fruit sampled having some apple maggot injury in 2008, and 8 of the 9 orchards having maggots in fruit and on traps (Table 3). The only orchard without maggots in 2008 was the Frazee 1 orchard, which was in its second year of production. Apple maggot pressure was much higher in 2008 than 2007. In 2007, 3 of 9 orchards had no apple maggot. The low maggot pressure in 2007 may have been low due to a summer drought. Apple maggots pupate in the soil, and the adult flies will not emerge if the soil is too dry. In 2007, most orchards had no rain from early July until the middle of August. In 2008, there was enough rain for the maggot flies to emerge in July.

In every orchard, some trees had more apple maggots than others. The two explanations for uneven apple maggot pressure include varietal differences and proximity to source trees. Some varieties appear to be more susceptible to apple maggots than others. "Fireside" and "Honeycrisp" had maggots at every location, while apple maggots were rare in "McIntosh." A few varieties avoided apple maggot injury both in 2007 and 2008 because they matured before the maggots started laying eggs. In other cases, trees closer to the source of infestation had more flies. At the Staples orchard, all apple maggot damage was on five trees near a crabapple tree growing in a lawn on the south side of the orchard. Even the apple maggot traps on the other side of the orchard did not capture any flies until late August.

In 2007, several participants removed windfalls from orchards in late summer in order to lower apple maggot pressure. In the four orchards where all the fruit had been removed the previous year, less than 1/4 of the apples had maggots, maggots were confined to a few varieties, and infected apples only had 1-4 maggots. In orchards receiving no care in 2008, all the apples had maggots, with many maggots per apple. Removing windfalls appeared to reduce but not eliminate apple maggot pressure.

Unlike codling moth, an apple is not completely ruined by one apple maggot larva. If there are only one or two maggots in the apple, the apples have a few brown streaks that many people do not notice. Apple maggots are quite small and difficult to see in the white flesh of an apple. Most of the cooperators did not mind using apples with minor apple maggot damage for cooking, unless the apples were stored at room temperature for several days.

Figure 2. Apple maggot damage varies in severity. In the apple on the left, maggots reduced the size of the apple by about a third and had brown flesh that was inedible for any use. The two apples on the right were normal size, with small brown streaks that many people would not notice.

When apples are stored at room temperature, the maggots can grow quite rapidly and you can see the larvae. Under severe apple maggot pressure, the apples are severely deformed, the flesh is completely brown, and the apples can only be used for livestock feed (Figure 2). When assessing the damaged apples in Table 2, we considered all internal apple maggot damage to be culls.

There are two generations of codling moth in Minnesota. Overwintering moths begin to fly in late May and their larvae infect small, green apples in June. The second generation starts flying in August and their worms eat through apples during harvest. Apples infected during the first flight usually drop in the middle of summer. The number of moths caught during the first flight was similar in 2007 and 2008, but the second generation was smaller in 2008. In both years, the percentage of apples infected by first generation codling moth varied from 5% to 10% in the Shafer, St. Francis, Upsala, and Redwood Falls orchards. In 2007, the second flight was stronger than the first flight, and in the Shafer, Upsala, and Redwood Falls orchards, over 30% of the fruit had codling moth in September. In 2008, the second flight did not develop in the Upsala and St. Francis orchards (Figure 3) and codling moth damage from the second flight was minimal in every orchard sampled. Even in the abandoned Shafer orchard, only 8% of the apples had codling moth in September in 2008.

Codling moth thresholds

The threshold for codling moth stated in the IPM manual for Minnesota Apple Orchards is five moths in one trap per week. All three orchards in Figure 3 exceeded the threshold for the first flight. In the Glenwood orchard, we did not find any apples with codling moth at any time. At St. Francis, the first flight peaked at 20 moths per trap, while only 5% of the green apples had codling moth. Only 8% of the apples at the abandoned orchard at Shafer had codling moth even after trap counts approached 40 moths per week. The published codling moth threshold of five moths per trap should be considered a guideline. Growers should take into consideration the history of their orchard and their own comfort level when deciding what threshold is best for their own orchard.

Curculios

Curculios, including plum curculio and apple curculio, were the second most common insect pests. Curculios were rare or absent in four orchards, but the five orchards with curculios averaged 31% curculio damage on harvested fruit. Typically, plum curculio eggs or larvae die after being crushed by the rapidly growing fruit. The resulting fruit is often marked with superficial scars at harvest (Figure 4). In 2008, the cool spring delayed plum curculio activity, and we were still noticing oviposition scars in the middle of

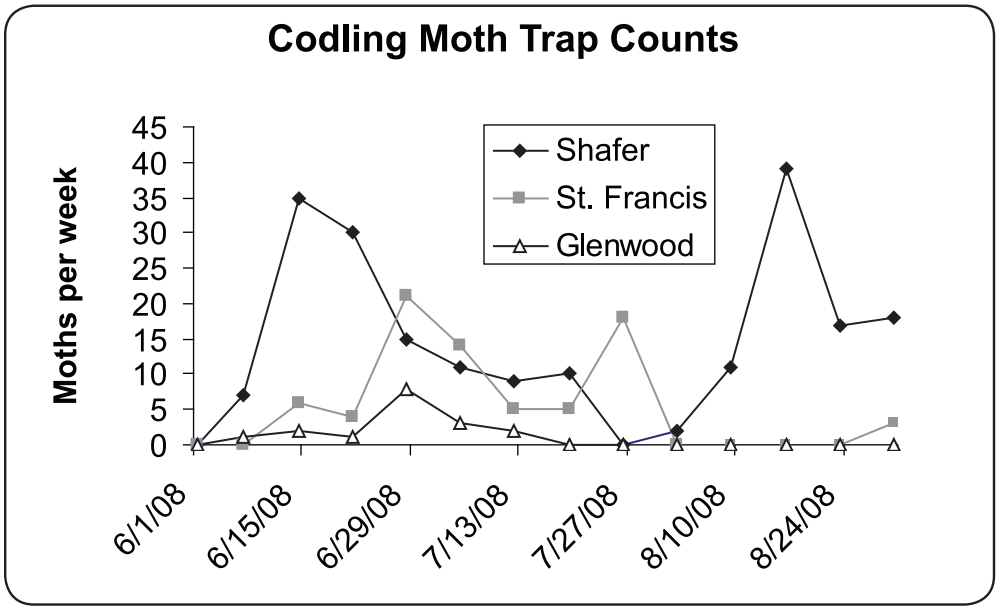


Figure 3. Weekly trap counts in pheromone-baited Delta traps in three unsprayed orchards.

Figure 4. Plum curculio damage.

June. The number of plum curculios that survived this year was exceptionally high in some cultivars, and most infected fruit aborted after the plum curculios hatched. Damage from plum curculio was worse than indicated in Table 3 because we were only counting damage to ripe fruit and we did not count fruit that aborted in June. Plum curculios are just becoming established at the Staples and St. Francis orchards.

This year, we also checked for damage from apple curculios (*Anthonomus quadrigibbus*). We found apple curculio adults in Redwood Falls and Upsala and found fruit with signs of apple curculio damage in the abandoned orchard in Shafer. Apple curculios are similar in size to plum curculios, but have a smooth back and a longer snout. Apple curculios do not play dead after being shaken off a tree and will fly away seconds after landing on a tarp. Instead of causing superficial scars, apple curculios cause the fruit to be bumpy and misshapen. One cooperator remarked that they have had apple curculio damage in their Honeygolds for the past 30 years. In other orchards, Honeygolds appeared to have more apple curculio damage than other cultivars.

Figure 5. Apple curculio damage on Honeygold.

Figure 6. Leafroller injury. The apple on the left was damaged by a leafroller in August while the apple on the right was damaged by a leafroller in June. Damage from late summer leafrollers was rare.

Leafroller damage varied from 4% to 10% in all orchards and was found on all varieties. Both redbanded and obliquebanded leafrollers are found throughout the state. Leafrollers feed on the surface of the fruit. In early summer, leafrollers eat developing fruit, causing the fruit to be deformed. Damaged fruit can be removed with hand thinning. In late summer, leafroller damage makes the fruit unmarketable (Figure 6). In both 2007 and 2008, nearly all the leafroller damage occurred on young fruit in May and June. Damage from leafrollers in late summer was extremely rare, with less than one apple per orchard showing any damage from second or third generation leafrollers.

Diseases

Apple scab was rare in 2008, but common in 2007. This year, there was no apple scab either on the leaves or the fruit in 8 of the 9 orchards. In 2007, 3 of the 9 orchards lost fruit to apple scab, and 3 more, including 2 orchards in northern Minnesota had apple scab on the leaves in late summer.

The computer models did not accurately predict which orchards would have apple scab. At the Shafer and St. Francis sites, there were more infection periods in 2008 than in 2007, but scab pressure was much lower (Table 4). Likewise, in 2008, the Forest Lake site had fewer scab infection periods than the Shafer site, but no apples in Shafer had scab lesions. Only in Upsala, did the computer model predict lower scab pressure in 2008 than in 2007.

Table 4. Apple scab infection periods (Mills) during May and June with corresponding crop loss.

Site	Wet Hours	Infection Periods	Fruit with Lesions
Shafer 2007	153	4 light, 1 med, 1 heavy	42% (NW Greening)
Shafer 2008	295	9 light, 6 med, 3 heavy	0
St. Francis 2007	263	4 light, 2 med, 2 heavy	0*
St. Francis 2008	290	4 light, 5 med, 3 heavy	0
Forest Lake 2008	144	5 light, 4 med, 2 heavy	54% (Haralson)
Upsala 2007	149	3 light, 1 med, 2 heavy	35% (Wolf River, Zestar)
Upsala 2008	199	3 light, 3 med, 0 heavy	3% (Haralson)

**Most trees in St. Francis lost some of their leaves to apple scab in 2007, but not 2008.*

Apple scab computer models have proven to be accurate predictors of apple scab in most parts of the U.S. In parts of Minnesota, other factors are determining which orchards have scab. The cool spring, in 2008, possibly delayed primary spore maturity and kept the primary infections to a minimum.

Cedar-apple rust was common in 2008. In central Minnesota, susceptible cultivars like "Wealthy" were almost defoliated by cedar-apple rust, and many fruit had small rust lesions. Honeycrisp proved to be susceptible to cedar-apple rust, especially in the fruit.

Management Tips

1. Always develop a plan for controlling apple maggot. If an orchard doesn't have maggots one year, it may have maggots the following year.

2. Monitor for pests no matter where your orchard is in Minnesota.

3. Codling moth and apple maggot traps are two of the best investments an apple grower can make. Both are reasonably priced. Place apple maggot traps in summer ripening trees like "State Fair."

4. Monitor for oystershell scale as it weakens and slowly kills the trees.

5. Many diseases and insect pests in Minnesota can be kept at low levels through pruning and other basic orchard maintenance.

6. Use cultural controls to manage pests. In small orchards, removing fallen apples will reduce apple maggot. Always prune trees to increase air circulation and decrease apple scab. Mow the orchard after the leaves have fallen to reduce overwintering scab inoculum.

Cooperators

Glenn Anderson, Orchardist, St. Francis, MN
Jim and Sam Birkholz, Orchardists, Shafer, MN
Kathy and Coleton Lahr, Orchardists, Glenwood, MN
Gary Goreham, Orchardist, Frazee (1), MN
David Holmen, Orchardist, Upsala, MN
Shirley Judd, Living Legacy Gardens, Staples, MN
Thaddeus McCamant, Orchardist, Frazee (2), MN
Natura Farms, Forest Lake, MN
Darwin Pless, Orchardist, Redwood Falls, MN

Project Location

Contact Thaddeus McCamant for various orchard locations.

Other Resources

Minnesota Department of Agriculture. Integrated Pest Management for Minnesota Apple Orchards. 2007. Website:
www.mda.state.mn.us/plants/pestmanagement/applemanual.htm

Unite Agri Products (UAP) Great Lakes, N15721 Schubert Rd., Galesville, WI 54630, 608-539-2090. Source of codling moth and apple maggot traps.
Website: *http:www.uap.com/uap*

Winter Plant Protection of Blueberries in Northern Minnesota

Principal Investigator

Al Ringer
1765 Jackpine Rd.
Brimson, MN
55602
218-848-2475
aringer@frontiernet.net
St. Louis County

Project Duration

2008 to 2011

Award Amount

$6,265.00

Staff Contact

Jean Ciborowski
651-201-6217

Keywords

blueberry varieties, snow cover, snow-making

Project Summary

Raising blueberries in northern Minnesota can be a profitable operation if adequate snow cover comes in a timely manner, and the grower has the ability to cover the plants and provide winter protection of the fruit buds. In years past, adequate snow cover has not been a problem, but for the past 5 out of 6 years, there has been little snow, or it has arrived too late in the winter to provide any protection for the plants. Our project will investigate the feasibility of using different types of winter plant protection, including the ability to make snow to cover the blueberry plants.

Project Description

Our farm is located 40 miles north of Duluth, MN where winter temperatures typically bottom out at -40°F. We raise sheep, have laying hens, a large garden, and a pick-your-own blueberry operation of 1,000 plants. Our blueberries consist of 'Northblue', 'Northcountry', and 'St. Cloud' varieties, and we can typically market 900 to 1,500 lb of berries. We use drip irrigation with water provided from a nearby creek. Fertilizing consists of one application of ammonium sulfate in the spring, and the plants are mulched with aged wood shavings.

The idea for our grant project came during the winter of 2006-07 when we had a snow cover of only 3" for most of the winter, with most of the snow coming in March 2007. Our low in February was -34°F. That berry season we picked a total of 5 lb of berries from 1,000 plants. We realized we needed to provide some sort of plant protection for those winters when snow does not cover the plants. But what sort of cover to provide? (See Table 1)

The questions we want to answer are:

- Will the loose straw blow off of the plants?
- Will the plants with straw attract rodents?
- Will the row cover cause the branches to break if we receive a large dump of snow early?
- Will it be hard to remove the straw in the spring and what will we do with it?
- Can we reuse the row cover, and if so, for how many seasons?
- And most important of all, will any or all of the treatments provide the winter protection that we are looking for?

Because our grant work has just started, we won't know the answers until next summer when berry season starts and we can measure the effects of each treatment and the feasibility of each.

Al with his snow-making machine.

Table 1. Covers types used.*

Treatment	Northblue Variety (# plants)	Northcountry Variety (# plants)
Straw alone	12	12
Straw with 1.5 oz polypropylene row cover	12	12
1.5 oz polypropylene row cover alone	12	12
Plants in 1 oz polyester drawstring plant bags	2	---
55 gal plastic barrels	4	---

**The plants were covered on November 14, 2008.*

The second part of our project involved making snow. We know that natural snow provides excellent protection. When it falls, it filters through the branches and protects the fruit buds from the cold and drying winds. Was it feasible to make snow to cover the plants? Snow is made on ski hills, but could it be made on a small farm scale? We researched snow-making on the internet and found a company in Connecticut that made small scale snow equipment, basically for families in the south to make the ground white on Christmas Eve for their kids.

We covered 25 'Northblue' blueberry plants with manmade snow. The setup is basically a set of nozzles, a pressure washer, and an air compressor. What we found out is that snow-making is an energy, water, and time intensive project. We tried using water from our well, but we had to run a hose 150' to the snow-maker and we didn't get adequate water flow. The next option was to use our irrigating pump and pump from the creek. This gave us a good flow of water and worked fairly well until a fitting on one of the high pressure hoses broke. After repairs were made, the operation worked well. There are several things that need to be considered when making snow. These are listed under the management tips.

Management Tips

1. The snow-making process uses at least 500 gallons of water/hr, and it takes quite a while to cover many plants.

2. The temperature needs to be below 27°F with low humidity for the best snow.

3. Any wind will blow the snow away from where you want it placed.

4. When any part of the operation stops, water will start to freeze in the hoses, pumps, etc. so the process needs to be monitored frequently.

Cooperators

Kathleen Anderson, Local gardener, Brimson, MN
Dave Olafson, Local berry grower, Duluth, MN
Robert Olen, University of Minnesota Extension, Duluth, MN

Project Location

Our farm is located 12 miles north of Two Harbors on Hwy. 2, then 12 miles west on Cty. Rd. 14 to Hugo's Bar, left for ¼ mile, then right on Jackpine Rd. for 1 mile to Pine Creek Farm sign.

Other Resources

Factory Direct Landscape & Greenhouse Supply. Row cover information. Palm Harbor, FL. 727-474-6226.
Website: *Factorydirectlandscape.com*

Snow at Home. Snow-making advice and equipment. Terryville, CT. 860-584-2991.
Website: *snowathome.com*

Blueberry plants in November being covered with manmade snow.

Winter Harvest of Hardy Crops under Unheated Protection

Principal Investigator

Kelly Smith
165 Korby Rd.
Esko, MN 55733
218-879-3829
kellythegreenman@yahoo.com
Carlton County

Project Duration

2008 to 2010

Award Amount

$10,589.00

Staff Contact

Meg Moynihan
651-201-6616

Keywords

greens, hoop house, row covers, season extension, vegetables

Project Summary

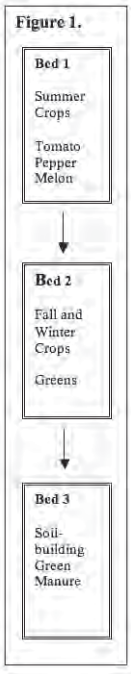
The aim of this project is to develop and demonstrate a method for growing hardy greens under unheated mobile high tunnels and floating row cover protection in Northeast Minnesota - adapting production techniques proven to work in warmer climates to our local area. Hardy greens may freeze at night but generally will thaw out at midday and can then be harvested. This was the first year of my project and I did not get the hoop house built. I intend to complete construction in spring 2009.

Project Description

My farming operation is located near Esko in Northeastern Minnesota, about 16 miles southwest of Duluth. It is a "beginning stage" market garden of less than 1 acre situated on gently sloping ground. I rotate crops on wide row beds set 3.5' on center. We use hand tools and walking tractors. Labor is provided by me, along with help from friends.

In the Twin Ports region where I live, there is a long off-season in which local fresh green vegetables are not generally available. This is a period where consumers miss out on fresh, locally-grown food and producers miss out on income from sales. Currently, some of the winter produce sold in our region is grown in heated greenhouses. More is imported from other parts of the country. Both of these strategies use fossil fuels, which result in increased production and transportation costs and in greenhouse gas-causing emissions.

Building high tunnel structures is expensive. My idea is to try using a mobile high tunnel that can be moved from bed to bed. This strategy should allow me to effectively multiply its useable square footage. My plan is to institute a 3 year rotation (Figure 1). I should be able to use the mobile high tunnel in at least two locations each year: first for spring/summer over summer crops (Bed 1), then for fall/winter crops (Bed 2). Hardy crops don't need cover when they are started in August and September, so until late summer the tunnel can cover summer crops such as tomato, pepper, and melon, then, as the weather gets colder, I can move it over to the fall/winter greens. Bed 3 will be a fallow bed



This is the framework of my hoop house. I took this picture in November.

planted to soil-building green manures and cover crops. This strategy of using the high tunnel year-round should maximize the return on investment and improve profits for producers like me.

2008 Results

This project is behind schedule. Due to time constraints, the high tunnel is not yet completed. In summer 2008, I planted tomatoes, cucumbers, and peppers and then started building the high tunnel over them, but did not finish the high tunnel in time to use it for fall-planted hardy crops.

I intend to complete the construction of the high tunnel in spring of 2009, grow tender crops in it during summer of 2009, start the fall greens wintering crops in August, and move the tunnel to cover them in October. I did not host a field day or conduct any outreach or publicity about the project this year.

Management Tips

1. Make a plan as to the time and money a project will take. Figure out every detail. Then double it.

2. Using drip tape irrigation saves water and boosts yields, but makes weeding more time consuming.

3. Fence out the deer or lose your crop.

Cooperators

Karola and Rick Dalen, Northern Harvest Farm, Wrenshall, MN
John Fisher-Merritt, Food Farm, Wrenshall, MN
Jeff Greensmith, Duluth, MN
Deb Shubat, Shubat's Fruits, Duluth, MN
Terrence Smith, Duluth, MN

Project Location

From the Esko exit on I-35, between Cloquet and Duluth, take Cty. Rd. 1 south for 1.5 miles to Palkie Rd. Go west .5 miles to Korby Rd. Go north .5 miles to #165.

Other Resources

Coleman, Eliot, Barbara Damrosch, and Kathy Bray. 1999. Four-Season Harvest: Organic Vegetables from Your Home Garden All Year Long. White River Junction, VT: Chelsea Green Publishing.

Coleman, Eliot. 1998. The Winter-harvest Manual: Farming the Back Side of the Calendar: Commercial Greenhouse Production of Fresh Vegetables in Cold-winter Climates without Supplementary Heat. Harborside, ME. Four Seasons Farm. (Note: this book has been revised and was published by Chelsea Green in April, 2009 as *The Winter Harvest Handbook: Year Round Vegetable Production Using Deep Organic Techniques and Unheated Greenhouses*.)

Diversified Harvest of Integrated Species

Principal Investigators

Joe Bowman and Michelle Gransee-Bowman
952-406-1215
gransee.bowman@gmail.com
Scott County

Project Duration

2008

Award Amount

$4,210.00

Staff Contact

Wayne Monsen
651-201-6260

Keywords

accessing farmland, beginning farmers, monitoring, multiple species rotational grazing

Project Summary

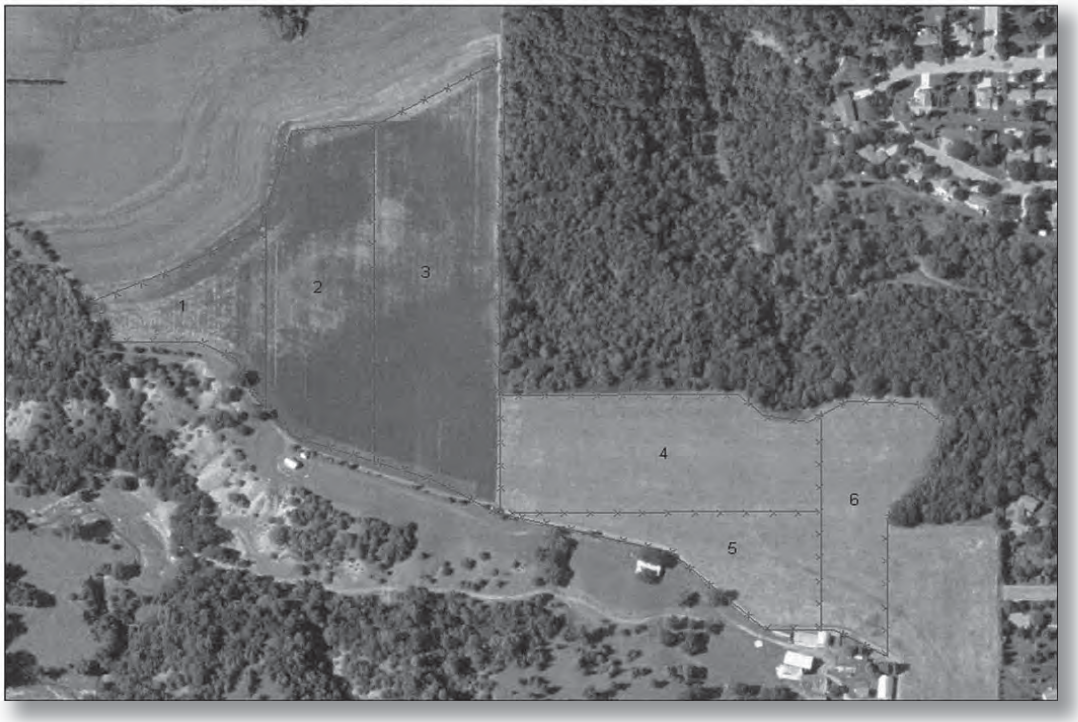
Accessing farmland is getting more difficult for beginning and existing farmers. Urban development pressures and increasing land values are making it cost prohibitive for entering the direct marketing arena on land that is close to communities. In order for farmers to overcome the challenges of access to land and transportation, they need to get more productivity on less land. In this project, we chose to address these challenges by demonstrating how farmers can increase the profitability of their land through management practices. Our goal was to show that farmers can increase profits and improve the resources on their land if they diversify their harvests.

Unfortunately, due to uncertainty about the long-term relationship with the owners of this rental property coupled with financial concerns we have decided to discontinue farming on this property. We hope to re-enter farming on another location in the near future.

Project Description

In the past, this farm site had been managed with open grazing of beef cattle and sheep. However, the absence of grazing in the last few years allowed the pastures to be transformed to more woody plants. We chose to convert the tillable acres of the farm to be the main pastures and use the existing pastures as auxiliary grazing areas.

Our objective was to research and demonstrate strategies for managed rotational grazing cattle, sheep, and poultry on the 32 acre grazing system on this farm site (see photo). The intent was to show the benefit to the health of the animals and the ecosystem while providing a diverse harvest of marketable products for farm enterprises. We monitored the impacts of grazing on the animals, the pastures, and surrounding ecosystems. We set up six pasture monitoring sites in three paddocks to measure forage yields, plant counts, and percent of bare ground.



Fence and paddock map for the Gransee-Bowman grazing system.

2008 Results

The 32 acre pasture was established in 2007 and divided into six paddocks. Paddocks 1 through 4 were seeded to perennial ryegrass (4 lb/A), timothy (2 lb/A), orchardgrass (1.8 lb/A), red clover (3 lb/A), Dutch white clover (0.9 lb/A), and Kura clover (2 lb/A). Paddocks 5 and 6 were seeded to a mixture of smooth bromegrass (2.8 lb/A), tall fescue (3 lb/A), timothy (2 lb/A), orchardgrass (1.8 lb/A), and alfalfa (9.1 lb/A). We inter-seeded all of the pastures in the spring of 2008 with 3 lb/A of timothy and 4 lb/A of meadow bromegrass to ensure that more grasses get established.

Pasture: The research during 2008 was completed on: a sheep group, a cattle group, and the integrated group with the sheep following the cattle. The original intent was to also have a poultry group follow the sheep along with a poultry control group. Unfortunately, due to predation from hawks and owls and unfinished pens for the poultry, we decided not to do the poultry portion of the study.

The pasture in 2008 still had the characteristics of a hay field because it was a young stand. Many bare soil areas appeared and many undesirable broadleaf weeds were prevalent. As the season continued, it became clear that the broadleaf weeds were declining and the desirable grasses were becoming strongly established.

One significant factor affecting the pastures this year was the very dry weather during July and August. We took Brix readings with a refractometer in August to measure the sugar content of the forages. A high Brix reading is desirable, but due to the lack of moisture in the pasture plants, we were not able to get any readings. A poor Brix reading can be used to tell you that the pastures may be lacking sufficient good quality forage.

From the six pasture monitoring sites the following conclusions can be drawn from the data collected on the pasture conditions:

1. The populations of the common weed species diminished significantly during the growing season. Some impact was from the livestock grazing it, but much was due to the canopy of legumes restricting the growth.

2. Timothy did not withstand the dry conditions of the site and the extended dry spell that persisted through July and August.

3. Smooth bromegrass and meadow bromegrass were slow to establish, but did make a better showing near the end of the summer.

4. Smooth crabgrass was selectively grazed, especially by the sheep and somewhat by the cattle.

5. Orchardgrass appeared to grow quite vigorously once the canopy of clovers and alfalfa were removed by grazing. Orchardgrass seems to be the most vigorous forage at this stage of the establishment of the pastures.

6. Much of the red clover was quite mature when it was finally grazed. A good portion of it was trampled to the ground.

7. The amount of bare soil area and points covered by dead plant residues was quite high, with many of the monitoring sites at 20-25% bare soil and plant residues. This could be because it is a relatively new stand of forages. It is expected that the bare soil area and dead plant residues will diminish in the next couple of years.

Animal Health: We began grazing the pastures on August 5 and grazed until November 3. We practiced leader-follower grazing with the cow/calf pairs grazing first followed by the sheep. Cattle grazed 21 days, ewes 70 days, 7 lambs 63 days, and 6 lambs 83 days.

In terms of animal health, the weights monitored for the cattle before and after the August grazing showed a consistent loss of weight by all of the cows. The average weight loss was 2 lb/day. At the same time, the average weight gained for the calves was .75 lb/day. The weight loss on the cows negatively impacted the entire herd. Six of the cows remained open after breeding and we decided to cull them from the herd. We kept three calves for future breeding. This weight loss by the cows and the poor gain by the calves can be attributed to the poor quality and insufficient quantity of the forage caused by the dry weather in July and August.

Although the sheep were not weighed, their appearance during the dry time was less than full and healthy. The sheep regained some of their healthier appearance during the fall after the forages started to recover from the drought.

Management Tips

1. Establish a simple and clear protocol for monitoring and recording data and stick with it.

2. Graze or mow early to remove the legume canopy to help encourage vigorous growth of grasses, especially when establishing new forage stands.

3. Use an experienced grazier as a mentor. Doing so helps improve decision making in challenging times.

4. Enlist a grazing consultant to help design an effective grazing system.

5. Make sure pasture, fencing, and water system are all well established before starting grazing. Having the infrastructure in place reduces labor and provides for better grazing.

Cooperators

Jerry Ford, Sustainable Farming Association, Howard Lake, MN
Dave and Florence Minar, Cedar Summit Dairy, New Prague, MN
Greg Harris, Harris Herefords, Jordan, MN
Laura Kieser, University of Minnesota Extension, Jordan, MN
Howard Moechnig, Midwest Grasslands, Cannon Falls, MN
Karen Stettler, Land Stewardship Project, Lewiston, MN

Other Resources

Acres USA. PO Box 91299, Austin, TX 78709-1299, 800-355-5313. Website: *www.acresusa.com/*
Monthly newspaper devoted to eco-agriculture.

Blanchet, K., H. Moechnig, and J. DeJong-Hughes. 2000. Grazing systems planning guide. MN Publication No. BU-07606-S. University of Minnesota Extension Service, St. Paul, MN, 612-625-8173 or 800-876-8636.

Graze. PO Box 48, Beltsville, WI 53508, 608-455-3311, Website: *graze@mhtc.net* Newspaper devoted to grazing. Published ten times per year.

Salatin, Joel. 1996. Pastured Poultry Profits. 1991. Available from some libraries and booksellers and from Polyface, Inc., 43 Pure Meadows Ln., Swoope, VA 24479, 540-885-3590. Website: *www.polyfacefarms.com/*

Salatin, Joel. 1996. Salad Bar Beef. Available from some libraries and booksellers and from Polyface, Inc., 43 Pure Meadows Ln., Swoope, VA 24479, 540-885-3590. Website: *www.polyfacefarms.com/*

Salatin, Joel. 1998. You Can Farm. The Entrepreneur's Guide to Start and Succeed in a Farming Enterprise. Available from some libraries and booksellers and from Polyface, Inc., 43 Pure Meadows Ln., Swoope, VA 24479, 540-885-3590. Website: *www.polyfacefarms.com/*

The Stockman Grass Farmer. PO Box 2300, Ridgeland, MS 39158-2300, 800-748-9808. Monthly publication devoted to grazing.

A Comparison between Cornstalk and Soybean Straw for Bedding Used for Hogs and Their Relative Nutrient Value for Fertilizer

Principal Investigator

John Dieball
33406 – 230th St.
Henderson, MN
56044
507-317-5522
jdballus@yahoo.com
Sibley County

Project Duration

2007 to 2009

Award Amount

$7,000.00

Staff Contact

Wayne Monsen
651-201-6260

Keywords

composting, cornstalk bedding, fertilizer values, hoop barns, soybean straw bedding

Project Summary

In this project, I am comparing cornstalks to soybean straw to determine which makes the most effective bedding material for hogs in hoop houses. I am evaluating the two materials in terms of keeping the animals dry, how easily they can be put into and removed from the hog hoop barns, the ease of composting, and the nutrient values they provide as fertilizer.

Project Description

I have two hoop barns that hold 175 hogs each. There is a 20' cement pad in each barn for the waterers and feeders. The majority of the barns are dirt based and where the bedding is used.

One hoop house will be bedded with cornstalks and the other with soybean straw. The bales are 4' x 5' round bales. I will keep track of the bales used, how long it takes to clean the barns, temperature of the compost piles, how long it takes to compost the bedding, and the nutrient values of the compost.

2007 Results

I bedded one hoop barn with corn stalks and the other with soybean straw for each batch of hogs. After the hogs were sent to market, I cleaned the barns and composted the manure from each of the barns.

Bedding:
I used 39 soybean straw and 43 cornstalk round bales for bedding in 2007. Using the Versatile 9030 tractor, I put two round bales each week into each barn. I spread the bedding around a little. It took me about 20 minutes to do the bedding. I noticed some differences between the soybean straw and cornstalks as bedding. Soybean straw absorbed moisture better than the cornstalks, so I used a few more cornstalk bales. However, the soybean straw bedding is more difficult to clean out of the hoop than cornstalk bedding and rolls up and holds its shape making it difficult to remove without a grapple on the bucket. The cornstalks broke apart and were removed easily with the bucket.

Cleaning a hoop barn took between 2.5 and 3 hours using the Versatile with a rock bucket. The rock bucket is deeper and larger than the factory bucket. I do not have a grapple for the bucket, but I plan to get one. I found the Versatile 9030 too large to clean next to the walls. I cannot feel the wall when I get close and I hit the wall a few times. I plan to use a skid loader to clean next to the walls.

Composting:
As I removed the bedding from the hoop barns I made compost piles of 20' x 20' x 10' high, one pile from the soybean straw and another pile from the cornstalks. I have found that making piles this size are much easier to turn and, if the piles are much larger, they have a tendency to get too hot and potentially start on fire. I turned the piles three or more times a week with the Versatile. I turned from one side one week and turned from another the next week.

Removing bedding with the Versatile 9030.

10' x 10' x 10' high compost pile.

The composting process is different for the two bedding types. The cornstalks heat-up really fast and will get over 200°F. When the pile gets this hot, I fill the bucket with water and dump it on top and then turn the pile. This helps keep the pile from getting too hot and burning. The cornstalk piles stay quite hot for 7 to 10 days and then cool down to 90°F and remain at that temperature. The cornstalks remain in the 90°F range for a few more weeks and break down to dirt. When the cornstalks looked like dirt, I sent the compost into the lab to see what the nutrient analysis was. The cornstalks had an analysis of 25 lb/ton for nitrogen, 45 lb/ton phosphorus, and 3 lb/ton potassium (Table 1).

The composting process for the soybean straw is much different than cornstalks. The soybean piles did not heat-up as fast or get as hot as the cornstalks. The hottest the soybean piles have gotten is 175°F. The piles stay at this higher range longer, sometimes 3 to 4 weeks. The soybean straw does not breakdown to dirt like the cornstalks do. After 6 months in the piles, you can still see stalks and hulls of the soybean plants. The nutrient analysis for the soybean compost is different than the analysis for the cornstalks. Nitrogen was 9 lb/ton, phosphorus was 44 lb/ton, and potassium was 38 lb/ton (Table 1).

I used two types of manure spreaders to spread the compost on crop fields, a Hesston 390 box spreader and a Meyers 3954 with an auger. The Hesston worked better to spread a more even amount of compost. I wanted to apply the compost using sound agronomic rates so I tried determining application rates by spreading on a tarp over a measured area. However, I could not get a consistent weight and I spread by looking at how much was applied.

Table 1. 2007 Nutrient analysis of cornstalk and soybean straw compost.

Nutrient	Cornstalks	Soybean Straw
Nitrogen	25 lb/ton	9 lb/ton
Phosphorus	45 lb/ton	44 lb/ton
Potassium	3 lb/ton	38 lb/ton

The two compost materials look much different when applied. The cornstalk compost looks like dirt and therefore is not easy to see when applied to soil. For the cornstalk compost I tried to spread the material so that it covers the soil with a light coating. The soybean compost still has a lot of stalks and hulls so it can be seen when applied. To apply enough soybean stalk compost I spread it quite thick. The soybean compost often spread in clumps which would bunch up in piles when worked into the soil with the harrow. To try to improve the soybean straw breakdown I am going to try a finer straw chopper on the combine in 2008.

I am looking at options for applying the compost. I would like to place the compost directly in the row by deep banding the compost. Using an air system on the fertilizer boxes on the planter may work well to place the compost directly in the row.

2008 Results

Two significant changes were made in 2008. The first was that the first group of hogs was older than usual weighing an average of 125 pounds when they arrived. This group spent less time in the barns than the second group which made for less bedding and smaller compost piles.

The second significant change was that I used a 1680 Case IH combine with a rotary stalk chopper for the soybeans this year. The straw was chopped much finer and was easier to work with than the longer stemmed straw used in 2007.

Bedding:
In 2008, the number of bales used for the first group was 25 cornstalk and 29 bean straw bales and 50 cornstalk and 55 bean straw bales for the second group. The first group used less bedding because they were in the barn for a much shorter length of time. The second group used more than in 2007 because they stayed in the barn a couple weeks longer.

The finer bean straw is a lot easer to work with than the long vine bean straw. It spreads out easier as bedding and is a lot easier to remove from the barn while cleaning.

I used the Versatile 9030 again to clean the barns. In addition, I used a tracked skid loader to help with cleaning one barn. This skid loader worked much better than the larger 9030 tractor because it is so much more maneuverable. However, it still took the same amount of time to clean the barn.

Composting:
The compost piles from the first group were much smaller but more manageable than the larger piles from the second group. The piles were 10' x 10' x 10' high instead of 15' x 17' x 10' for the second group. The smaller piles also

Table 2. 2008 Nutrient analysis of cornstalk and soybean straw compost.

Nutrient	Cornstalks (Group 1)	Soybean Straw (Group 1)	Cornstalks (Group 2)	Soybean Straw (Group 2)
Nitrogen	14 lb/ton	1 lb/ton	14 lb/ton	10 lb/ton
Phosphorus	19 lb/ton	15 lb/ton	49 lb/ton	14 lb/ton
Potassium	17 lb/ton	15 lb/ton	37 lb/ton	38 lb/ton

tended to have lower nutrient levels than the larger piles (Table 2). This difference may be due to the length of time that the hogs were on bedding.

I would have liked to make the piles from the second group small, like the first group, but I did not have the space for more piles. The temperatures of the piles were very similar to those in 2007. However, the finer chopped soybean straw seems to heat more, reaching 185°F, than the longer stemmed straw used in 2007 which reached 175°F. The finer straw also breaks down into soil faster and you see less straw remnants after the heating process.

I used the Hesston 390 spreader again in 2008 and applied the compost on approximately 10 acres per spreader load. The spreading of the compost was very similar for both types of material this year. The finer chopped soybean straw was much easier to handle and spread than longer stemmed straw that I had in 2007.

2008 Corn Crop:
I applied compost on new rented land in the fall of 2007. This land was short of nutrients so I also added 100 lb/A urea to ensure enough nitrogen for the corn crop. I was pleased with the 190 bu/A corn yield on these acres.

Management Tips

1. Keep the compost piles smaller rather than larger. It is easier to manage smaller piles.

2. Turn the piles often, at least 3 times a week.

3. Keep the piles moist to help keep the temperatures from getting too hot and add water when temperatures approach 200°F.

4. Use a straw chopper on the combine when combining soybeans. This makes a finer stemmed straw which handles and composts better than long stemmed straw.

5. A large tractor with a bucket works well for cleaning the majority of the hoop barn. Use a skid loader to clean along the walls.

6. Use net wrap to wrap the bales. This material breaks down in the composting process.

7. Sell compost to gardeners for increased income.

Cooperators

Wayne Martin, Integrated Livestock Production Systems Program, University of Minnesota, St. Paul, MN

Project Location

From Belle Plaine take State Hwy. 25 north and west for 9 miles to Sibley Cty. 16. Go south on Cty. 16 (gravel) for 2.5 miles. Turn right on 230th St., the farm is the first on the right.

Other Resources

Integrated Livestock Production Systems Program, University of Minnesota Extension, 385 Animal Science Building, 1988 Fitch Ave., St Paul, MN 55108, 612-625-6224.

University of Minnesota Extension Service. Compost Barn Basics (PDF) Website: *www.extension.umn.edu/dairy/05dairydays/CompostBarnBasics.pdf*

University of Minnesota Extension Service. Compost Happens (PDF) Website: *www.extension.umn.edu/county/sherburne/mgardeners/documents/Composting101.pdf*

University of Minnesota Extension Service. 2001. Hogs your way: Choosing a Hog Production system in the Upper Midwest. Publication No. BU-7641-S. University of Minnesota Extension, St. Paul, MN, 612-625-8173 or 800-876-8636. Website (PDF): *www.extension.umn.edu/distribution/livestocksystems/components/DI7641.pdf*

University of Minnesota Extension Service. 1992/2000. INFO-U: What Can You Compost? Pub. No. BG275. Website: *www.extension.umn.edu/info-u/plants/BG275.html*

University of Minnesota Extension Service. 1999. Swine Source Book: Alternatives for pork producers. Publication No. PC-7289-S. University of Minnesota Extension, St. Paul, MN, 612-625-8173 or 800-876-8636.

University of Minnesota Extension Service. 2005. Using Manure and Compost as Nutrient Sources for Vegetable Crops. Pub. No. M1192. Website: *www.extension.umn.edu/distribution/horticulture/M1192.html*

Increasing the Profitability of Raising Livestock: An Evaluation of Two Methods to Extend the Grazing Season

Principal Investigator

Jeff Duchene
Grazing Management Specialist
900 Washington St. SW
Preston, MN 55965
507-765-3878 Ext. 3
Fillmore County

Project Duration

2008 to 2011

Award Amount

$18,176.00

Staff Contact

Mark Zumwinkle
651-201-6240

Keywords

cover crops, grazing hay fields, season extension

Project Summary

Most of the costs of producing beef cattle are associated with winter feeding. Forages need to be harvested, stored, and fed back to the animal during the non-growing season. This project addresses the costs of performing these tasks by extending the grazing season, thus reducing the amount of time spent feeding stored forages to the livestock. Extending the grazing season results in considerable labor and equipment savings associated with harvesting forages and feeding animals. These savings will increase the profits of raising beef cattle. The two primary season extension methods examined in this project are: 1) planting winter rye as a cover crop/grazed forage; and 2) grazing hay fields.

Project Description

As the Grazing Specialist for the Root River Watershed, I saw the need to examine methods to extend the grazing season. This would help livestock producers be more profitable and keep more livestock on the landscape in southeastern Minnesota, a rolling topography, with pasture and hay land as major components.

Two producers are participating in the project:

• Tom Boelter is seeding winter rye into croplands to provide fall and spring grazing forage. Tom currently grazes 70 beef cow/calf pairs and grows corn, soybeans, and hay. The winter rye is being aerially seeded by helicopter into standing corn and soybeans and drilled into corn stubble after silage has been taken off. The ground cover provided by the winter rye will also reduce run-off that normally occurs on bare crop fields during spring snow melt and heavy spring rains.
• Jeff Gillespie is grazing hay fields. Jeff grazes 80-100 beef cow/calf pairs and grows conventional and organic crops. Hay crops are being grazed in the fall in his organic operation. Jeff hopes to show that by grazing hay fields and allowing the animals to harvest their own forage, he can cut down on labor and expenses associated with mechanical harvesting and feeding.

The cost of equipment, fuel, feed, and other inputs are increasing steadily. To stay competitive in today's agricultural economy, livestock producers need to become more efficient with their resources. The proposed methods for extending the grazing season will make these farms more profitable, ensuring that they are economically sustainable in the future.

Extending the grazing season also results in environmental benefits. Seeding winter rye into crop fields reduces erosion, increases ground cover, improves soil physical properties, and increases water infiltration into the soil (Dabney et al., 2001).

Measurements

Productivity. To measure the productivity of these systems, we are clipping biomass samples (1 ft^2) in the hay field, aerially seeded rye, and drill seeded rye to determine standing yield. With this information, we will be able to determine the amount of dry matter intake the animals obtained from the pasture and compare the costs of these systems to buying or producing hay and feeding it to the animals during the time frame that they spent in their respective grazing method.

Feed quality. Samples will be tested for protein and Neutral Detergent Fiber (NDF) digestibility. These data are used to compute relative forage quality (RFQ).

Profitability. With the before and after grazing yield data, we can estimate the total animal intake from the field. We can then compare the cost of grazing to the cost of either buying or producing hay and feeding it to the animals during the time they spent grazing.

Results

Winter rye as a cover crop/graze forage. On August 28, winter rye was aerially seeded on 33 acres of soybeans on the Tom Boelter farm. The soybeans were still in full leaf stage at this time. **This is important. The rye must be flown on before the soybean leaves drop. This ensures that the rye has close contact with the soil.** The rye seeding rate was 75 lb/A. The aerial seeding took one-half hour to accomplish (66 A/hr). There were three people on hand to assist with loading the seed.

The weather after seeding remained dry with little precipitation until early November. The rye stand establishment and growth was impressive considering the drought.

Early observations showed that the seed germinated earlier underneath the full soybean canopy than in gaps in the soybeans or areas where the soybean stand was thin. Despite the lack of rain, the rye cover was uniform throughout the field, except for narrow strips missed along field edges.

Winter rye in soybeans that is approximately 7" tall on October 21, 2008.

Doug Keene, Fillmore County Resource Conservation Technician, examines excellent rye stand uniformity in soybeans. (October 6, 2008)

The stand was checked weekly. As the winter rye grew, it tillered out and filled in the interspaces between individual rye plants. The soybeans were harvested on October 10, which was 6 weeks after seeding the rye. By this time, the rye was well established and provided almost 100% ground cover. Tom Boelter reported that the young winter rye did not get in the way of soybean harvest. By October 21, the average height of the winter rye was 6-7".

The aerially seeded soybeans resulted in excellent establishment. Two-thirds of the seeds applied resulted in germination (Table 1). Approximately 31 seeds/ft^2 were seeded (75 lb/A) with an average of 20.6 plants/ft^2 observed, a 66.5% seedling establishment rate. No data was gathered for the drill seeded field. However, higher seedling germination was expected due to better seed to soil contact. A seeding rate of 50 lb/A results in approximately 21 seeds/ft^2. So, even with a higher expected seedling establishment rate, fewer plants will be present in the drill seeding. In the future, we may record the drill seeding plant populations for comparison.

The aerial seeding method had almost three times as much ground cover associated with the rye as the drill seeding method. The soybean field was aerially seeded 5 weeks before the drill seeding. This added time allowed the individual rye plants to produce many more tillers and

Table 1. Winter rye ground cover by seeding method (% cover).

Seeding Method	Rye	Residue	Bare Ground
Aerial	35	45	20
Drill	13	29	58

Table 2. Cost of aerially seeded rye system through fall.

Rye seed: $9.50/50 lb bag	Cost/A	Acres	Total cost
Seed (75 lb/A)	$14.25	32.3	$460.28
Helicopter	$20.00	32.3	$646.00
Total			$1,106.28
Cost of grazing livestock	**Time (hr)**	**Cost (hr)**	**Total cost**
Checking/moving livestock	4.5	11	$49.50
Total grazing system costs			$1,155.78
Total cost/A			**$35.78**
Rye seed: $12.00/50 lb bag	**Cost/A**	**Acres**	**Total cost**
Seed (75 lb/A)	$18.00	32.3	$581.40
Helicopter	$20.00	32.3	$646.00
Total			$1,227.40
Cost of grazing livestock	**Time (hr)**	**Cost (hr)**	**Total cost**
Checking/moving livestock	4.5	11	$49.50
Total grazing system costs			$1,276.90
Total cost/A			**$39.53**

Table 3. Cost of drill seeded rye system through fall.

Rye seed: $9.50/50 lb bag	Cost/A	Acres	Total cost
Seed cost	$9.50	33.7	$320.15
Seeding cost	$16.81	33.7	$566.50
Total			$886.65
Cost of grazing livestock	**Time (hr)**	**Cost (hr)**	**Total cost**
Checking/moving livestock	3	11	$33.00
Total grazing cost			$919.65
Total cost/A			**$27.29**
Rye seed: $12.00/50 lb bag	**Cost/A**	**Acres**	**Total cost**
Seed cost	$12.00	33.7	$404.40
Seeding cost	$16.81	33.7	$566.50
Total			$970.90
Cost of grazing livestock	**Time (hr)**	**Cost (hr)**	**Total cost**
Checking/moving livestock	3	11	$33.00
Total grazing cost			$1,003.90
Total cost/A			**$29.79**

spread laterally. Also, due to the late spring in 2008, the corn silage was harvested later than usual and led to a late drill seeding. The rye drilled after corn silage was more indicative of a seeding date after soybean harvest in an average year. Taking these factors into account, the aerial seeding will most likely lead to more forage production than waiting until after soybean harvest to seed the rye.

The helicopter cost was $20/A to perform the seeding (refer to Table 2 for projected costs). Three people assisted with loading the helicopter for a total of 1.5 hours of labor input. Another 3 hours of labor were associated with grazing the rye to accomplish: fence maintenance, moving cattle, and checking cattle. Recent market value for winter rye seed has ranged from $9.50 to $12.00/50 lb bag. Using the labor inputs from this project and the average seed prices from local seed dealers, producers aerially seeding winter rye could have expected to pay between $35.78 and $39.53/A this past summer.

On October 2, Tom Boelter no-till drill seeded rye into 33 acres of corn that had been harvested for silage. The seeding rate was 50 lb/A. The stand establishment was excellent for this field and on October 21, the average height of the rye was estimated at 4".

Tom used a no-till drill to seed the winter rye into corn silage stubble at an estimated cost of $16.81/A. Three hours of labor were associated with moving cattle, checking cattle, and fence maintenance. Using the labor inputs from this project and the average seed prices from local seed dealers, producers drill seeding winter rye could have expected to pay between $27.29 and $29.79/A this past summer (Table 3).

The livestock were turned into the winter rye on October 25 and removed November 10. The herd consisted of 25 cows weighing 1,300 lb each, 25 calves weighing 500 lb each, and 1 bull weighing 2,000 lb. The drill seeded and aerially seeded portions of the project were part of a large 66 acre field. These two fields were grazed together because there is no cross fence to separate them. This delayed the use of the aerially seeded rye this fall because the drill seeded portion needed more time to become well established. Growers should consider drill seeding and aerial seeding in separate fields unless the field can be fenced and grazed separately.

After the livestock were removed, the average stubble height of the winter rye was 3". The cattle

Cattle grazing on the aerially seeded rye in November on the Tom Boelter farm. Note the high amount of ground cover associated with the rye.

Jeff, Fillmore County Grazing Specialist, clipping hay samples on September 30 prior to grazing.

were on the winter rye for a total of 16 days and did not receive any supplemental feed during this time. In addition to the winter rye, the livestock grazed on grass along the field edges and terraces in the field, on corn stocks that were run over by the chopper during silage harvest, and on soybean residue left after harvest. The animals appeared to favor the winter rye the most because it was lush, new growth. They probably did not eat much of the other forage that was available in the field.

Due to timing constraints, the plots were not clipped for yield and forage value analysis prior to the livestock being turned out onto the field. However, the average daily dry matter needs for the herd to maintain good body condition were estimated. Each animal was projected to intake 2.5% of their body weight daily in dry matter. Thus, the entire herd needed 1,175 lb of forage daily or 18,800 lb (9.4 tons) for the 16 days that the animals were on the rye.

These estimates show that the value of the fall grazed rye has offset much of the cost of establishing the rye. It is likely that after the value of next spring's grazing has been taken into account, the grazed rye system will be significantly more profitable than purchasing or producing hay. We appear to be on target for lowering production costs and making livestock operations more profitable.

Other parts of the country with similar climate and latitude have studied the forage value of grazing winter rye in the fall and early winter. A study conducted in southern Ohio showed that several varieties of winter rye seeded in mid-September and grazed in December had crude protein contents ranging from 25.2 to 33.7%. At their peak, lactating and growing cows need between 11 and 13% (Thornton, 2004). NDF contents ranged from 27.9 to 36.7% (Samples and Sulc). So, the winter rye has shown the ability to cover animal requirements during all growth stages.

Rainfall was limited after seeding for both methods. Most of the time that the animals spent grazing was dry, except for the last 4-5 days, which saw wet, rainy weather. The aerially seeded field held up well under grazing during the wet weather because of the high amount of ground cover from the bean residue and the cover crop. The drill-seeded field, however, showed more livestock impact due to the higher amount of bare ground.

Producers should look at several sources for rye seed to find the best deal. Keeping costs low will improve the profitability of using winter rye for grazing. However, using low quality winter rye seed or seed contaminated with weed seed will negatively affect cover cropping efforts. Make sure to ask questions about seed purity and germination percentage before buying seed. Consider doing a germination test if in doubt about seed quality.

Besides the potential monetary benefits, a well established rye cover crop helps protect the soil from erosion and nutrient leaching. These benefits have strong value now and for future generations.

Grazing the hay field. Jeff Gillespie turned his cattle onto his 20 acre hay field on October 5 and they grazed for 13 days. The hay field was seeded with alfalfa and Italian Ryegrass. His herd consisted of 51 cows weighing 1,200 lb, 45 calves weighing 550 lb, and 2 bulls weighing 2,000 lb.

Table 5. Cost of buying or producing hay vs. grazing hay fields.

Method/Hay Type	Total cost/ton	Total cost/day	Total cost (13 days)
Buying hay*			
Prime (>151 relative feed quality)	$164.99	$242.54	$3,147.30
Grade 1 (125-150 relative feed quality)	$114.00	$167.58	$2,176.20
Grade 2 (103-124 relative feed quality)	$66.00	$97.02	$1,263.60
Producing hay**			
Large round	$94.14	$138.39	$1,801.80
Grazing hay fields***			
	$55.18	$81.11	$1,053.90

**Current average hay prices as of October 24, from data compiled by the University of Wisconsin Extension. Found at www.uwex.edu/ces/ag/haybuying.html. The cost of feeding the hay (Volesky et al. 2002) is also factored into the total costs.*

***Data gathered from Barnhart et al., 2008. The cost of feeding hay (Volesky et al., 2002) is also factored into the total costs.*

****Cost of grazing hay fields takes into account cost of maintaining the field as well as producer inputs while grazing. Hay field production data gathered from Barnhart et al., 2008.*

Prior to the animals entering the field, plots were clipped, dried, and weighed to determine the amount of standing dry matter per acre. After the animals left the field, plots were clipped, dried, and weighed again to determine the amount of dry matter remaining. The average height of the forage prior to grazing was just shy of 11.5" and they grazed it down to 2.5". From the yield estimates, the herd consumed approximately 19 tons of forage or almost 1 ton/A. Grazing the hay field is the cheapest method of feeding the animals when compared to buying hay at current prices or producing hay. Table 5 depicts the projected total cost per day of buying and producing hay compared to grazing the hay field.

Three different grades of purchased hay were used in the comparison. (The University of Wisconsin-Extension publishes the cost of hay for the upper Midwest.) The data compared in the table were for round bales, the most common form of hay purchased for beef cattle. In July 2008, Iowa State University-Extension (Barnhart et al., 2008) reported the average estimated cost of hay production, which took into account establishment, fertilizer, harvesting, labor, and land costs. The cost of feeding hay (Volesky et al., 2002) was also taken into account as part of the cost of producing or buying hay. In reality, the cost of feeding hay was higher than the estimates used in this report due to the rising fuel costs over the past year. Establishment, fertilizer, labor, and land costs were taken into account when determining the cost of grazing hay fields.

Forage value analysis taken from the hay field showed that the forage was of high quality. The RFQ was greater than 154, which is equivalent to prime quality hay. Buying prime quality hay and feeding it to the animals would cost almost 3 times as much as grazing it (Table 5). The alfalfa crude protein was over 23%; ADF was 28.3%; and NDF was 36.7%. All of these factors mean that the forage quality was high for the animals and well within their daily nutritional requirements.

Grazing hay fields resulted in significant savings over feeding for all methods, especially over prime quality hay. However, most beef producers would be more likely to purchase lower quality feed, such as Grade 1. Even purchasing Grade 1 feed cost over twice as much to feed than allowing the animals to graze the hay field, and harvesting the field as hay would have cost over 55% more than grazing. Overall, the first year of the study has shown a reduction in feeding costs ranging from 16-66%, depending upon the type of hay being fed.

There are some management issues to take into consideration when grazing hay fields. First, the longer livestock spend in a field, the more likely it is that they will start to develop trails. This was evident in the field, especially along fence lines. Trailing will have negative impacts upon yield the next year if you plan to keep it in hay. Further subdividing fields to give the livestock access to only a few days worth of grazing at one time will reduce the amount of trailing.

Wet weather may present problems because the animals may cause damage to the forage. This has not been evident in this project, however. If wet weather is imminent, remove the livestock to prevent damage to the hay field and return them when the field has sufficiently dried.

First year alfalfa stands may not be the best fields to graze. The animals may pull the seedlings out of the ground if their root systems aren't well developed. In our case, the field grazed was a first year seeding but this did not seem to be an issue.

With all of these factors taken into account, hay fields that are well-established or being tilled under the next year are likely candidates for grazing. Fields near existing pastures are ideal choices because parts of the field will already be fenced, reducing the cost of putting up temporary or permanent fencing. Fields next to pastures or building sites allow for easier access to water. Even if more fencing or watering systems are needed, the savings from grazing these fields will offset those costs within a few years.

Grazing hay fields has many benefits. The most prominent benefit is the potential to reduce the over-wintering cost, which accounts for most of the cost of producing an animal. A less obvious, but important benefit is the reduction in the use of fossil fuels associated with making hay and feeding livestock. Many gallons of fuel were conserved in our project by grazing instead of haying. Another potential impact is keeping more livestock on the landscape in critical areas, thus reducing erosion that is associated with intensive row-cropping.

Management Tips: Winter Rye

1. Fields that are adjacent to permanent pasture are great to work with because part of it will already be fenced. This reduces fencing and labor costs. Also, a water source is most likely nearby.

2. Rotational grazing practices will maximize the value of the winter rye and reduce the amount that the animals waste via trampling.

3. Plan ahead. Know when you want to plant your spring crop so that the animals can graze the rye and leave enough time to control the rye prior to seeding your row crop.

4. Do not graze drill and aerially seeded winter rye in the same pasture area. These will most likely be seeded at different times and be at different stages of growth. For example, the aerially seeded field used in this project was ready prior to the drill seeded field. We had to wait to graze because the two methods were being grazed together.

Management Tips: Grazing Hay Fields

1. If maintaining the alfalfa stand the year following grazing, make sure to allow 4-6 weeks of re-growth prior to the first killing frost, and then graze. Alfalfa needs this time to build its root reserves, which will help those plants survive the winter.

2. Legumes, such as alfalfa, may cause bloat. Watch the animals for signs of bloat when they are first turned into the hay field. The animals may need to be fed dry hay prior to grazing a hay field to fill the animals up. Consider providing free-choice dry hay in the field.

3. Hay fields that are adjacent to permanent pasture are great to work with because part of the field will already be fenced. This reduces fencing and labor costs. Also, a water source is most likely nearby.

4. This practice is ideal for older stands of alfalfa that have well established plants and root systems because the animals will likely cause less damage to the plants. First-year alfalfa stands may be damaged by the impacts of grazing.

5. Sub-divide the field so that the animals will only have access to no more than a 3 day supply of forage. The longer animals spend in a pasture, the more forage they will waste and the more trailing they will do.

Cooperators

Adam Herges, Minnesota Department of Agriculture, St. Paul, MN
Craig Sheaffer, Professor, University of Minnesota Department of Agronomy and Plant Genetics, St. Paul, MN
Doug Keene, Fillmore SWCD, Preston, MN
Howard Moechnig, Midwest Grasslands, Cannon Falls, MN
John Zinn, United States Department of Agriculture/Natural Resource Conservation Service, Rochester, MN
Jeff Gillespie, Producer, Fountain, MN
Mark Zumwinkle, Minnesota Department of Agriculture, St. Paul, MN
Tom Boelter, Producer, Chatfield, MN

Project Locations

Grazing hay fields: Jeff Gillespie
From Preston, go north on Hwy. 52 to Fountain (approx. 6 miles), take a right on Cty. Rd. 8, follow for approx. 4 miles and the site is on the left (long driveway) (Carrolton Township, Section 7).

Winter rye fields: Tom Boelter
From Preston, go north on Hwy. 52 for approx. 6 miles. In Fountain, take a left (West) on Cty. Rd. 8 for approx. 7 miles, take a right (North) on Cty. Rd. 5 until the road meets a stop

sign (approx. 2 miles), take a left (West) on Cty. Rd. 4 for approx. ½ mile, take a right (North) on 181 Ave. (first road). Drill and aerially seeded field on left after the first driveway on the right. (Fields located in Jordan Township 28.)

References

Barnett, Ken. 2008. Weekly Hay Market Demand and Price Report for the Upper Midwest as of October 24, 2008. University of Wisconsin Extension. Retrieved from www.uwex.edu/ces/ag/haybuying.html

Barnhart, Steve, Michael Duffy, and Darnell Smith. 2008. Estimated Costs of Pasture and Hay Production. Iowa State University Extension Factsheet: A1-15.

Dabney, S.M., J.A. Delgado, and D.W. Reeves. 2001. Using Winter Cover Crops to Improve Soil and Water Quality. Communications in Soil Science and Plant Analysis. 32:7: 1221-1250.

Lazarus, William. 2008. Machinery Cost Estimates. University of Minnesota Extension. Retrieved from www.extension.umn.edu

Samples, David H. and Mark R. Sulc. Winter Rye for Extending the Grazing Season. Ohio State University Factsheet. AGF-02-00.

Thornton, Jane. 2004. Stockpiled Forages. In: Proceedings from Manitoba Agronomists Conference 2004: 132-135.

Volesky, Jerry D., Don C. Adams, and Richard T. Clark. 2002. Windrow Grazing and Baled-Hay Feeding Strategies for Wintering Calves. 2002 Nebraska Beef Cattle Reports: 17-19.

Other Resources

Forage Info: *www.forageinfo.com*

Forage Information System:
http://forages.oregonstate.edu/index.cfm

Grazing Systems Planning Guide. 2003. Kevin Blanchet, Howard Moechnig, Jodi Dejong-Hughes. University of Minnesota Extension, Natural Resources Conservation Service, and University of Minnesota Water Resource Center. BU-07606-S. *www.extension.umn.edu*

Minnesota Department of Agriculture:
www.mda.state.mn.us/index.htm

National Sustainable Agriculture Information Service:
http://attra.ncat.org

Plant Management Network:
www.plantmanagementnetwork.org/fg

University of Missouri Forage Systems Research Center:
www.aes.missouri.edu/fsrc/research/fsres.stm

University of Nebraska-Lincoln Extension:
www.ianrpubs.unl.edu/epublic/pages/index.jsp

University of Wisconsin-Extension: Forage Resources:
www.uwrf.edu/grazing

Demonstration of How Feeding In-line Wrapped High Moisture Alfalfa/Grass Bales Will Eliminate Our Fall and Winter "Flat Spot" in Grassfed Beef Production

Principal Investigator

Donald Struxness
14015 Hwy. 40 NW
Milan, MN 56262
320-734-4877
dbstruxness@fedteldirect.net
Chippewa County

Project Duration

2006 to 2008

Award Amount

$12,000.00

Staff Contact

Wayne Monsen
651-201-6260

Keywords

baleage, forage quality, rate of gain, relative feed quality (RFQ)

Project Summary

Graziers who want to grass finish beef are in need of ways to achieve a consistent rate of gain on their market animals throughout the year. Having a way to store forage for winter feed that is close to the quality of forage during summer grazing is a huge challenge. This project demonstrated the use of an in-line round bale wrapper to seal high moisture round bales as baleage for use during the non-grazing season. Weighing animals during the grazing season and during the winter helps determine if consistent weight gains are achievable year around. Both the grazing forage and the baleage were analyzed for relative feed quality (RFQ). RFQ measures the total energy consumed by the animal.

Project Description

During the first 2 years of this project, four grassfed beef producers weighed cattle on 60-90 day intervals and tested the grazing forage and the stored forage to try to find a connection between the feed quality and the rate of gain. During the third year of the project, the focus shifted to eliminating the summer "flat spot" on the Struxness farm. During the non-grazing time, some of the farms used only high moisture wrapped baleage, some used baleage and dry hay, and one used only dry hay for the first year of the project.

All of the cattle used in the project had EID tags that identified them as they walked onto the electronic scale. The weights were automatically recorded in the scale computer which then calculated average daily gain. Information about each animal such as date of birth, breed, and other data the producer chooses to input was already recorded in the computer.

The plant species and percent of forage and baleage at the different farm sites were:

Site #1: For grazing – 65% tall fescue, 15% white clover, 5% red clover, 15% mixed grass
For baleage – 50% alfalfa, 50% tall fescue

Site #2: For grazing – 25% tall fescue, 25% Italian rye, 25% white clover, 25% Berseem clover
For baleage – 80% alfalfa, 20% orchardgrass

Site #3: For grazing – 50% wheatgrass, 25% smooth bromegrass, 15% alfalfa, 10% ryegrass
For baleage – no baleage was used, dry hay similar to grazing mixture

Site #4: For grazing – 30% smooth bromegrass, 30% orchardgrass, 20% alfalfa, 20% red clover
For baleage – mature 30% smooth bromegrass, 30% orchardgrass, 20% alfalfa, 20% red clover

2006 Results

The baleage was made at four cuttings on one farm and only at the last cutting on two farms. Two methods of cutting were used: a 14' windrower and a 10' disk mower with a conditioner. The hay was left in a wide windrow for a day. The next morning when the hay was still tough, two windrows were raked together and the round baler was right behind as we wanted to get 40% moisture hay. The bales were hauled to the storage site and wrapped as soon as possible on the same day.

We took forage samples from each field and at each cutting. The RFQ was better on the

Grassfed steers at baleage feeder.

baleage from later cuttings. We identified the rows of wrapped baleage that each sample was from so that we could use the forage that best fit the needs of the cattle. Fat cattle received the best baleage, growing calves were next, and the cows got the lowest quality usually mixed with purchased grass hay.

The RFQ samples for most of the pasture forage samples were also higher for the forage samples taken at the late summer grazing (Table 1). There was a shortage of moisture in 2006 which impacted the results of the first weight period, especially on farms #1 and #3. The RFQ at farm #4 was low due to the forage being very mature at the time of cutting and baleage wrapping. Farm #1 grazed into December and had a high RFQ of 205 on December 11.

Table 1. Comparison of relative feed quality for 2006 on four farms in western Minnesota.

Farm	Date	Forage Type	Relative Feed Quality (RFQ)
#1	7/19/06	pasture	153
#1	12/11/06	pasture	205
#2	8/15/06	pasture	162
#2	9/15/06	pasture	175-230
#2	8/11/06	baleage	182-232
#3	8/15/06	pasture	152
#3	10/06/06	pasture	208
#4	9/12/06	pasture	196
#4	10/18/06	pasture	120

The average daily gain was also higher at the winter weighing than the late summer weighing. The late summer rate of gain was 1.2 to 1.9 lb/day range. The rate of gain at the winter weighing was more at 1.94 to 2.5 lb/day range. This can also be attributed to the lack of moisture at the time of the late summer weighing which caused poorer quality forage on the pasture. Feeding baleage in winter months is proving to be successful at putting weight on grassfed cattle.

2007 Results

In 2007, all four producers were in drought disaster declared counties so pasture growth and forage production were definitely not average. It was interesting to see that in the drought limited forage production, quantity went down but quality actually increased. In the stored forage this was easy to evaluate and not a problem but, in the grazing situation, the animals were eating high quality forage but were having a hard time getting enough physically eaten in the time they were willing to spend grazing. So we saw some loose manure from not getting enough fiber in the rumen for proper digestion.

Now that we have 2 years of data on the pasture forage and stored forage we are focusing on matching the stage of the cattle growth with the quality of the forage to maximize growth. To help with this we developed a table (Table 2) called "Two years comparing forage test to daily rate of gain." This table is valuable because all the information about the quality of forages is on the table and helps us match the cattle growth stage with the feed source. This is different than the usual way of measuring performance by using gain per acre or cost per pound of gain.

We looked at which forage values relate to growth (meat and bone) and which values relate to fat production (inter-muscular and cover). In the rumen, microbes break down the Neutral Detergent Fiber (NDF) into acetic fatty acid which is important for growth of the animal. Other microbes break down the Non-fiber Carbohydrates (NFC), the pectins, and sugars, into propionic acid which is used in the production of fat.

We tracked the progress of 80 grassfed steers in 2007 to see how they performed. These steers weighed 492 lb on December 27, 2006. From December to March 31, 2007 they gained 1.90 lb/day eating stored forage. They then were rotationally grazed on orchardgrass, bromegrass, red clover, and alfalfa pasture until late June at which time the grass stopped growing.

From late June to the weighing on August 2, 2007, they open grazed in a 50 acre pasture. They gained only 1.10 lb/day in 76 days during this time. It was very hot and dry, and the grass wasn't growing, but we didn't have any place to go that was better.

On August 2, we moved them to another pasture and started supplementing with baleage that was intended for winter feed. On October 13, they had gained 1.45 lb/day for 72 days. The cattle were then fed best baleage and gained 2.35 lb/day for 77 days.

In October, we used ultra-sound to scan for meat quality. We were pleased with the ribeye area, the ribeye area per 100 lb of meat, the ribeye shape, and tenderness. The inter-muscular fat and the back fat were lower than we like. These qualities are highly inherited; however, we do not think we supplied the quality and the quantity of forage during the summer months to allow the steers to reach their potential. We also banded the steers fairly late at 650 lb average which may have caused the steers more lean growth and not so much fat.

Two examples of how to use this table:

Example 1: If the cattle are in the 500 to 800 lb range, we want to focus on growth and feed forage high in Neutral Detergent Fiber (NDF) and Neutral Detergent Fiber Digestibility in 48 Hours (NDFD 48). Sample 2 has high values in both, and also was high in sugars which makes the forage taste good.

Example 2: If the cattle are in the 800 to 1,000 lb range, we shift to focusing more on putting on fat to marble the meat. Here we want to look for forage high in Non-fiber Carbohydrates (NFC). Samples 3, 9, and 10 are good choices for cattle in this range. Samples 9 and 10 are the same baleage but were sampled at different times.

Table 2: Two year comparison forage tests to daily rate of gain on four farms in western Minnesota.

Sample No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	
Date Sampled	**Oct-07**	**Oct-07**	**Dec-06**	**Aug-06**	**Sep-06**	**Sep-06**	**Oct-06**	**Dec-06**	**Jul-07**	**Oct-07**	**Oct-07**	**Oct-07**	**Aug-07**	
Plant Description	PRG,OG,MF TF,AC,BFT	PRG,OG,MF TF,AC,BFT	TF,PRG,AC	Alfalfa	TF,AC	OG,RC	BR,CWG	1st Cut Alfalfa, OG	Alfalfa	Alfalfa	TF,AC	BR,CWG	BR,Quack Diverse	Apparent Desired Range
Established	**May-07**	**May-07**	**May-02**	**May-02**	**Aug-05**		**Aug-05**		**May-02**	**May-02**	**Aug-05**	**Aug-05**		
Forage Type	**Pasture**	**Pasture**	Pasture	Baleage	Pasture	Pasture	Pasture	Hay	Baleage	Baleage	Pasture	Pasture	Pasture	
Comment	**Mature**	**Immature**	Very Dense	3rd Cut Baleage as wrapped	Lush Pasture			Very Mature	2nd Cut Baleage as wrapped	2nd Cut Baleage as fed	2/3 of diet RFQ 155 Baleage		Mature	
CP (%)	**11.4**	**18.5**	14.3	22.2	19	22.1	25	11.3	15.94	16.1	21.7	24.7	22	14-17%
NDF (%)	**45**	**44**	40	38	39	42	38	54.53	34.3	35	40	40	49	36-52%
NDFD 48 (%)	**70**	**90**	67	58.5	74	67.9	65	35.3	45.8	49	73	73	73	70-90%
Sugar (%)	**14.4**	**16.7**	19	7	15.8	11.6	11.3	2.73	15.24	7	12	9	11.9	12-20%
NFC	**33**	**24**	36	31.75	29	23.42	23	21.91	40.48	40	26	24	19	> 25
RFS	**64.5**	**63.5**	62.8	54	57.9	51.94	47.7	41.16	57	57	55.2	53.2	54.8	> 50
RFQ	**0-167**	**0-183**	160-206	167-193	165-231	147-197	166-209	93-71	186-187	181-183	160-218	155-215	0-136	>180 RFQ
NEG (Mcal)	**37.6**	**43.3**	38.1	36.25	41.7	36.55	38	4.22	35.8	33.9	40.7	40.8	37.6	>36
Predicted DMI (% of body wt)	**2.66**	**2.7**	3.01	3.16	3.06	2.86	3.13	2.2	3.5	3.39	2.97	2.87	2.44	>2.7
Actual Gain (#/day)	**2.2#**		2.4#	2.15#	2.5#	1.9#	1.9#	0.45#		2.35#	1.45#	2#	1#	2-2.5#

	Same forage tested twice
	Same pasture, different maturity
PRG	Perennial Ryegrass
OG	Orchardgrass
MF	Meadow Fescue
TF	Tall Fescue
AC	Alice White Clover
BFT	Birdsfoot Trefoil
BR	Bromegrass
CWG	Crested Wheatgrass
RC	Red Clover

CP	Crude Protein
NDF	Neutral Detergent Fiber
NDFD 48	Neutral Detergent Fiber Digestibility 48 hours
NFC	Non-fiber Carbohydrates
RFS	Relative Feed Score
	RFS Calculation = (NDF x NDFD 48)/100 + NFC
RFQ	Relative Feed Value - Relative Feed Quality
NEG	Net Energy for Gain
Predicted DMI	Predicted Dry Matter Intake
Actual Gain	Pounds per day

Table 3: Three year forage nutrient comparisons on same field on the Struxness farm.

	2006 25% Italian ryegrass - 25% Berseem clover 50% Alice white clover	**2007** 50% Tall fescue - 50% Alice white clover	**2008** 100% Alice white clover
Crude protein	15.99%	19.29%	22.27%
ADF	31.60%	24.74%	20.18%
NDF	43.98%	39.24%	31.03%
NDFD 48	63.12%	74.29%	74.57%
IVTDMD 48	83.78%	89.91%	92.11%
Sugar	13.57%	15.77%	18.69%
RFV	136.03	165.17	219.54
RFQ	176.34	230.63	289.64

After 2 years of results the farmer participants were pleased with the rate of gain on their animals and were learning how to promote steady gains by matching forage quality with the growth stage of the cattle. They saw the value of having high RFQ in the forages for achieving improved rate of gain in the animals.

2008 Results

For the past 3 years our first cutting of forage has usually been in the 150-160 RFQ range, second cutting about 170-180 RFQ, and third and fourth cutting up to 200 RFQ. Knowing what the forage quality is of our stored feed has really helped us to eliminate one of the "flat spots" in our beef production. The cattle love the wrapped forage and the higher the sugar level the more they like it. We are now actually getting better gains on our finishing animals during the fall and winter than we do during the dry summer periods.

The source of our stored forage (Struxness farm) is an 82 acre alfalfa and orchardgrass field that has been certified organic for 2 years. The field has not had any commercial fertilizer for 6 years, only rock phosphate and trace minerals. As a result, the available phosphorus levels are not as good as we expected. We plan to use biologic foliar spray in 2009 to try and release more of the phosphorus from the rock phosphate. As a result of this project, our "flat spot" has changed from winter to midsummer when there are extended dry periods and the forage growth slows down. We've increased the number of cattle but haven't increased the acres of quality pasture we need for grazing the animals. This has led to a shortage of enough quality forage during the summer. We think we need to include some summer annuals such as grazing corn or turnips. With this information we began to focus on improving the poor forage during the summer slumps due to hot and dry weather. We added this to the study because we wanted to eliminate this "flat spot" as well.

Finishers grazing on Alice white clover.

In focusing on high quality feed in our summer pastures we looked at forage tests from the same pasture over a 3 year period (Table 3). This pasture has had three different forages with 50% Italian ryegrass and Berseem clover and 50% Alice white clover in 2006, in 2007, the forage was 50% tall fescue and 50% Alice white clover, and in 2008, 100% Alice white clover.

The 100% Alice white clover is a little better in nearly every category. This forage had no stems and was all leaves. The tall fescue - Alice white clover combination was a little better than Italian ryegrass - Berseem clover combination in all categories. All of these forages were of premium quality and were excellent forage for finishing animals.

I have never seen anything like the Alice white clover sample this year. I decided to take a soil sample to see if I could determine why the forage sample was so good. Key elements such as phosphorus, calcium, and sulfur were in the optimum range and I think these elements are keys to forage quality. If I could get all the fields to provide these nutrient levels to the forage, I may be able to repeat this high quality forage.

I'd like to share a grazing experience we had this fall. We had an exceptional stand of almost 100% Alice white

clover in one of our pastures. After some frosts, the clover was still lush and green while the alfalfa in the same area had totally frozen and dried up. The clover was 5" to 6" high and so dense it crunched when you walked on it. Its RFQ value was very high at 289. We were very concerned about bloat potential so we decided to strip graze it. We grazed 113 steers weighing 850 lb each on less than ½ A/day. We also provided all the baleage (150 RFQ) and dry bromegrass hay (110 RFQ) to help prevent bloat and to provide added forage because of the restricted amount due to strip grazing. This pasture was only large enough to provide fall grazing for 1 month. When we stopped grazing, the steers had to eat just baleage and they ate 2,000 lb/day more than they ate while grazing on the clover. I know that there was not all this extra forage available in the Alice white clover. So, with the Alice white clover RFQ almost twice as high as the baleage, the cattle did not need to eat nearly as many pounds of forage to be satisfied.

Since we started work on this grant in 2006, we have been able to eliminate the fall and winter "flat spot" in our grassfed beef production. We are now able to feed high quality stored forage to our finishing cattle and get better weight gains. Having the data on the nutrition value of the stored feed also helps us to eliminate the "flat spots" during the summer. If needed, we can supplement the pastures with stored forage with known amounts of nutrients. This enables us to feed the high quality stored forage to our finishing cattle and get better gains at all times of the year.

Management Tips

1. Forage testing at each cutting or grazing is crucial for managing to achieve good rate of gain on the animals.

2. For maximum gain, the forage must be very palatable and must be high in NDFD 48 and sugars.

3. Plan for very high RFQ pasture and stored forage. You can always let the cattle have access to lower quality forage to get the balance you want.

4. Do not let the forage get rained on as this lowers sugar content.

5. Band or castrate bull calves at a young age so they do not produce too much lean growth.

6. The use of the electronic scale is a must to keep track of the cattle and allows you to easily access information on each animal.

7. Raising high quality forage is a lot like raising high quality beef. You need to start with genetics that have the potential for what you want to produce, then you have to see that the forage gets the nutrients it needs to maximize its potential.

Cooperators

Richard Handeen, Grazier, Montevideo, MN
Luverne Forbord, Grazier, Starbuck, MN
Mark Erickson, Grazier, Donnelly, MN
Dennis Johnson, Dairy Scientist, WCROC, Morris, MN
Margot Rudstrom, Agricultural Economist, WCROC, Morris, MN
Doug Gunnink, Grazing Consultant, Gaylord, MN

Project Location

For specific locations, call Don Struxness at 320-734-4877 or email at dbstruxness@fedteldirect.net

Other Resources

Blanchet, K., H. Moechnig, and J. DeJong-Hughes. 2000. Grazing Systems Planning Guide. MN Publication No. BU-07606-S. University of Minnesota Extension Service, St. Paul, MN, 612-625-8173 or 800-876-8636.

Dairyland Laboratories, Inc., Dan Moscho, Lab Manager, PO Box 580, St. Cloud, MN 56302-9900, 320-240-1737, email: dmoscho@dairylandlabs.com

Graze. PO Box 48, Beltsville, WI 53508, 608-455-3311, email: graze@mhtc.net Newspaper devoted to grazing. Published ten times per year.

Jeranyama, P., and A. Garcia. 2004. Understanding Relative Feed Value (RFV) and Relative Feed Quality (RFQ). SD Publication N. ExEx8149. South Dakota State University Cooperative Extension Service. Access at: *http://agbiopubs.sdstate.edu/articles/ExEx8149.pdf*

Jung, G.A., A.J.P. Van Wijk, W.F. Hunt, and C.E. Watson. Ryegrasses. Pp. 605-641. In L.E. Moser et al. (ed.). Cool-season forage grasses. Agron. Mongr. 34. ASA, CSSA, SSSA, Madison, WI.

Midwestern Bio-Ag, a biologically-based agriculture consulting company. Also publishes a quarterly newsletter BIO-NEWS. PO Box 160, Blue Mounds, WI 53517, 800-327-6012. Access at: *www.midwesternbioag.com/homepage.html*

Peterson, Paul. March 16, 2006. Seeding Grasses with Alfalfa: This "Old" Idea Makes Cent$ Today. Minnesota Crop eNews. University of Minnesota Extension Service. Access at: *www.extension.umn.edu/cropenews*

The Stockman Grass Farmer. PO Box 2300, Ridgeland, MS 39158-2300, 800-748-9808. Monthly publication devoted to grazing.

Methods to Establish Grazing of Annual Forages for Beef Cows on Winter Feeding Areas

Principal Investigator

Dr. Ryon S. Walker
University of Minnesota Extension
550 Bunker Lake Blvd. NW
Andover, MN 55304
763-767-3847
Walke375@umn.edu
Carlton and Itasca Counties

Project Duration

2008 to 2010

Award Amount

$24,960.00

Staff Contact

Wayne Monsen
651-201-6260

Keywords

annual cool and warm season forages, establishment, grazing, winter feeding areas

Project Summary

This project evaluates annual forages and forage establishment methods for grazing in winter feeding areas. Winter feeding areas for beef cattle typically create buildup of manure that is often underutilized during the forage growing season and can cause some concerns with manure contaminated runoff into waters of the state. Due to the nature of most annual forages, their vigorous growth characteristics can compete with potential weed establishment in these winter feeding areas. This project will be conducted at two producer farms and a University of Minnesota research center in Grand Rapids.

We want to demonstrate that by establishing annual forages in these winter feeding areas, a producer can eliminate the additional cost and labor to haul manure from these feeding areas out to pastures and utilize the nutrients available for newly seeded forages. By comparing three different seeding methods with a cool and warm season annual forage, our goal is to evaluate the effectiveness and efficiency of these forage establishment systems so that we can provide recommendations for renovating winter feeding areas to reduce or eliminate hauling of manure to pastures, increase utilization of manure as fertilizer in the feeding area, increase total season forage production, and reduce manure contaminated runoff.

Project Description

Farm Descriptions. Troy Salzer, along with his family, owns and operates Sandy Hills Ranch consisting of a commercial beef cow/calf and backgrounding operation. Troy implements intensive management practices for grazing and forage production to improve production efficiency on his operation.

Bob Staskivige has owned and operated B&G Ranch, a commercial beef cow/calf operation, for 38 years. Bob uses intensive rotational grazing while trying new methods to improve production efficiency.

The North Central Research and Outreach Center (NCROC) is a cooperative location in this project that consists of approximately 200 acres of grazing land and 250 purebred Angus cattle. A focus of the research program at the farm is developing methods to improve grazing efficiency in beef cow/calf production systems.

Because the forage growing season is short in the Upper Midwest, beef cattle are typically fed in smaller, more confined areas for an extended period of time during the winter months. The feeding of cattle in a confined area creates excessive manure buildup. Too much manure buildup is a concern for manure contamination running off into waters of the state. Most producers haul off the manure for fertilizer in pastures; however this is not a very cost-effective practice for producers. By establishing annual forages in these winter feeding areas, a producer can eliminate hauling the manure out to pastures and use it for the forages planted. The right annual forage can also compete with weed growth, providing a substantial amount of forage for grazing to alleviate grazing pressure on other pastures.

At each of the locations, there will be six treatments established. We will evaluate two forage species (cool season annual ryegrass and warm season Brown Mid Rib (BMR)) sorghum-sudangrass using three different forage establishment methods: conventional seeding (with heavy tillage), no-till inter-seeding, and broadcast seeding followed by light tillage for seed incorporation into the soil.

Once cattle come off these winter feeding areas in late spring, soil samples will be collected and pastures will be divided and assigned to a treatment.

- Troy Salzer's winter feeding area consists of 12 acres: 6 acres for conventional seeding, 3 acres for no-till

Winter feeding plot at NCROC.

Sandy Hills Ranch winter feeding plot.

inter-seeding, and 3 acres for broadcasting.
- Bob Staskivige's winter feeding area consists of 6 acres: 2 acres for each seeding method.
- NCROC's winter feeding area consists of 12 acres: 6 acres for conventional seeding, 3 acres for no-till inter-seeding and 3 acres for broadcasting.

Evaluation of stand establishment will be measured in early summer to determine if the annual forage used and the seeding methods were successful. During the forage growing season, forage yield, stocking rate, and total grazing days will be collected for all three locations, based on forage establishment success. Pregnant beef cows and/or pairs will be used to graze each treatment paddock, one at a time. After each grazing, pastures will then be allowed to rest for a minimum of 21 days before cattle are allowed to re-graze the treatment pastures.

In addition, the costs associated with each treatment will be evaluated and used as an indicator to determine which method(s) can be recommended to effectively and efficiently provide additional grazing in winter feeding areas during the forage growing season.

Winter pastures used for this project during the summer of year one will be used for winter feeding areas the following winter and as the treatment pastures for the subsequent years.

2008 Results

Soil samples were collected to establish critical soil nutrient values prior to pasture establishment in May. In Table 1, you can see concentrations for phosphorus (P) and potassium (K) are well above the maximum levels (P=21ppm and K=160ppm) recommended for root growth and development. The pH levels for all three project sites were > 6.0 indicating that soils were not too acidic.

It is evident that wintering cattle in confined feeding areas for any length of time creates rich sources of nutrients, such as P and K that can be used as fertilizer.

Cool season pastures were seeded on May 27 at Sandy Hills Ranch and May 29 at B&G Ranch and NCROC. Warm season pastures were seeded on June 9 at Sandy Hills Ranch and June 11 at B&G Ranch and NCROC. Stand establishment was evaluated for each treatment at all three project locations in mid-July. For every location, each treatment was given a score from 1-5 (1=0 to 20%, 2=21 to 40%, 3=41 to 60%, 4=61 to 80%, and 5=81 to 100%), estimating visually the percent of planted seed that established.

- Broadcasting method - all locations were rated a 1 with 5% or less of planted seed establishing for both forages.
- Inter-seeding method - sorghum-sudangrass was rated a 1 at all three locations with 10% or less actual stand establishment. Annual ryegrass was rated a 4 (70%) at

Table 1. Soil type, nutrient concentrations, and pH of soil samples collected at all three project locations in May 2008.

Project Location	Soil Type	pH*	Phosphorus* (ppm)	Potassium* (ppm)
NCROC	Silty Loam	6.1 – 6.5	75 - 230	490 - 1,185
B&G Ranch	Clay	6.1 – 7.5	45 - 188	595 - 2,200
Sandy Hills Ranch	Sandy	6.1 – 6.4	> 100	> 300

**Nutrient concentrations and pH values show ranges from six samples collected from each project location.*

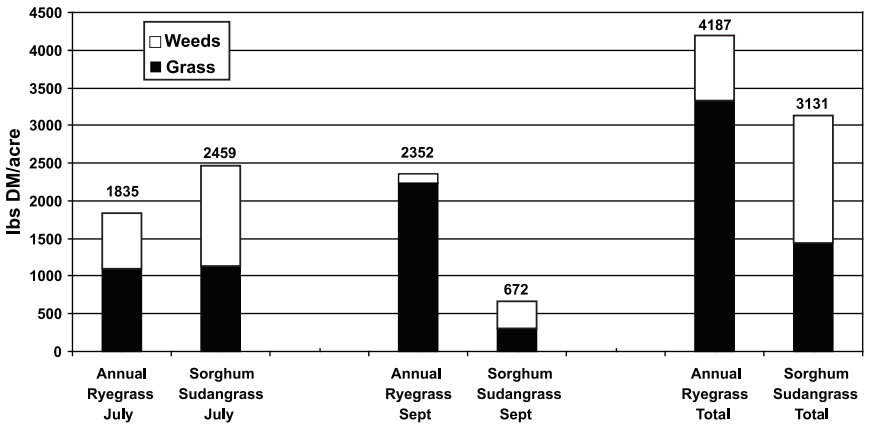


Figure 1. Forage yields of each annual forage, weeds, and combination of forage and weeds for the conventional tillage method collected prior to each grazing at the North Central Research and Outreach Center.

B&G Ranch, a 2 (25%) at NCROC, and a 1 (5%) at Sandy Hills Ranch.

- Conventional seeding method - sorghum-sudangrass was rated a 5 (95%) at Sandy Hills Ranch, a 3 (50%) at NCROC, and a 1 (5%) at B&G Ranch. Annual ryegrass was rated a 5 (90 and 80%) at B&G Ranch and NCROC, respectively, and a 4 (70%) at Sandy Hills Ranch.

It is evident that the broadcasting method did not work with either forage species in 2008 and the inter-seeding method had limited success with annual ryegrass and no success with sorghum-sudangrass. The conventional seeding method was the only method to have measurable success, therefore yield and grazing data were only collected for the conventional seeding treatments.

Forage yield was only collected at NCROC due to emergency use of pastures for grazing at the two cooperator locations because of drought. Forage yield was collected prior to each of the two grazing periods at NCROC. Figure 1 shows that forage yield of sorghum-sudangrass alone (no weeds weighed) was slightly greater (37 lb/A) than annual ryegrass in July, but significantly less (1,920 lb/A) than annual ryegrass in September. Annual ryegrass had a total season forage yield advantage of 1,883 lb/A. These numbers reflect yield of the forage species alone, without weeds.

Figure 1 also shows total forage production, including weeds, was greater for the warm season annual sorghum-sudangrass treatment during the first yield collection. This could be explained by the slow cool season annual ryegrass response to warmer temperatures, planted in late May, and its competition with weeds for establishment, therefore yielding less total pounds of dry matter/acre. Forage production of sorghum-sudangrass then tapered off due to cooler temperatures later in the summer, offering more advantage to the annual ryegrass.

Over the course of the summer, cattle were allowed to graze B&G Ranch three times whereas Sandy Hills Ranch and NCROC were only able to graze twice. Due to the setup at B&G Ranch, and with only annual ryegrass having limited success, cattle had access to all six treatments at the same time; therefore, stocking rate and number of grazing days for each treatment were not collected. Based on the stocking rate and number of grazing days recorded, and assuming that cow and calf weights are similar for both locations, we can estimate the number of grazing days/A that each annual forage provided for one animal unit (1 animal unit = 1,000 lb):

- At Sandy Hills Ranch, the sorghum-sudangrass provided 180 days of grazing for one animal unit and the annual rye-grass provided 40 days. Troy had great success with sorghum-sudangrass establishment and growth with less than 5% weed population in the stand; however, annual ryegrass established well, but growth was poor during the growing season.
- At NCROC, the sorghum-sudangrass provided 152 days of grazing for one animal unit and the annual ryegrass provided 162 days of grazing. The sorghum-sudangrass pasture provided more yield (with a high percentage of weeds) for the first grazing; however, annual ryegrass took off prior to the second grazing in the fall due to its vigorous cool season growth potential.

One of the things observed at NCROC was weed growth in both conventional seeding treatments. These areas are heavily wintered every year with an abundance of weed growth. During the grazing periods, cattle consumed most of the weeds present. There are several species of weeds that are very palatable to cattle, if grazed at the right stage of production.

In terms of economics, cost associated with each seeding method was not calculated due to establishment failure of both broadcasting and inter-seeding methods at all three locations. In terms of the conventional method, the question is still unknown, is it worth using a conventional tillage system to seed annual forages?

- At Sandy Hills Ranch, sorghum-sudangrass was the best option for Troy as sorghum was cheaper to seed

($22.50/A) vs. annual ryegrass ($26.50/A) and based on grazing data produced 140 more days of grazing/A for one animal unit.
- At NCROC, annual ryegrass was the best option. Even though sorghum was $4.00/A cheaper to seed, annual ryegrass produced 1,883 lb/A more forage than sorghum-sudangrass.

Management Tips

1. Establishment of both sorghum and ryegrass was more successful in areas with greater soil exposure vs. existing sod. Managing winter feeding areas by rotating your feeding sites evenly throughout the feeding area will expose more soil, offering more success for newly seeded forages.

2. Based on the first year's results, conventional tillage will provide you with the greatest success for forage establishment. Inter-seeding may be a good low-cost option but will depend on a couple of important factors: exposure of soil and seeding rates.

3. Based on our first year, sorghum-sudangrass and annual ryegrass work successfully under the conventional seeding method. However, match up your goals to the advantages of each forage species you are considering. Both warm and cool season annuals have different advantages.

4. Weed competition can become an issue in winter feeding areas where feeding is concentrated and sod is broken up. However, weeds may not be a disadvantage, as seen at NCROC. If you allow cattle to graze weeds at an early stage of development, the weeds are quite palatable, offering more total season forage yield.

Ryon observing the conventionally seeded BMR sorghum-sudangrass on the Sandy Hills Ranch winter feeding area.

Winter feeding plot at NCROC after conventional planting of annual ryegrass.

Cooperators

Troy Salzer, Sandy Hills Ranch, Producer and Extension Educator, Barnum, MN
Bob Staskivige, B&G Ranch, Producer, Bovey, MN
Russ Mathison, University of Minnesota North Central Research and Outreach Center, Agronomist, Grand Rapids, MN
Paul Peterson, University of Minnesota Department of Agronomy and Plant Genetics, Agronomist, St. Paul, MN

Project Locations

Sandy Hills Ranch is located east of Barnum, MN. From Barnum go 6 miles on Cty. Rd. 6. Then take Sandy Lake Dr. north for .3 miles. The field site is located on the west side.

B&G Ranch is located northwest of Warba, MN. From Warba, go west on Hwy. 2 for .5 miles to Cty. Rd. 10. Go north on Cty. Rd. 10 for 5.7 miles. Go east on Cty. Rd. 445 for .3 miles, the field site is located on the north side of Cty. Rd. 445.

The North Central Research and Outreach Center is located 4 miles south of Grand Rapids. From Grand Rapids, take Hwy. 169 south for 4 miles. Go east on Harris Town Rd. (Cty. Rd. 64) for .5 miles. The field site is on the north side of Harris Town Rd.

Other Resources

Minnesota Pollution Control Agency. A publication and power point presentation on "Best Management Practices for Supplemental Feeding Areas" at: *www.pca.state.mn.us/publications/wq-f8-45* PDF: *www.pca.state.mn.us/publications/presentations/feedlots-bmp-winterfeeding.pdf*

University of Minnesota Beef Center. A publication on "Establishing Winter Feeding Areas for Grazing" at: *www.extension.umn.edu/beef/components/pdfs/WinterFeeding_Walker.pdf*

New Demonstration Grant Projects - 2009

Alternative Markets and Specialty Crops

Growing Saskatoons and Cherries in Central Minnesota

Pat Altrichter
4176 - 230th St.
Randall, MN 56475
320-749-2154
ronpat@littlefalls.net
Morrison County
Award amount: . . . . . $5,000 for 3 years

We want to expand and diversify a previous project – Saskatoons – and look at whether cherry trees will grow in the central part of Minnesota.

Organic Mushroom Cultivation and Marketing in a Northern Climate

Jill Jacoby
3971 Rehbein Rd.
Duluth, MN 55803
218-724-9786
pumilios@aol.com
St. Louis County
Award amount: . . . . . $8,680 for 3 years

This project will research various mushroom species and growing substrates for growth in a northern climate. It will also assess and develop a market for organically/locally grown mushrooms.

Feasibility of Small Farm Commercial Hop Production in Central Minnesota

Robert Jones
The Farm on St. Mathias
4300 Lower Roy Lake Rd.
Nisswa, MN 56468
218-330-5310
thefarmonstmathias@hotmail.com
Crow Wing County
Award amount: . . . . . $12,535 for 3 years

We want to investigate growing conditions and productivity of seven hop varietals using sustainable and organic growing practices. We will select and analyze test plots for rhizome propagation and hop cultivation, tissue analysis, and pathogen identification and control. We will also expand production to meet the market expectation.

Fruits and Vegetables

Growing Blackberries Organically under High Tunnels for Winter Protection and Increased Production

Erik Gundacker
Scenic Valley Farm
12529 Danbury Way
Rosemount, MN 55068
651-423-4562
gun@usinternet.com
Dakota County
Award amount: . . . . . $19,445 for 3 years

The project will determine if blackberries can be organically grown for commercial production in southeast Minnesota, a zone 4a climate, using high tunnels. It will also determine how much high tunnels can increase blackberry yields. Several blackberry cultivars will be planted under a high tunnel to determine which berries best survive the winter and produce the highest yields.

Minimizing the Environmental Impact and Extending the Season of Locally Grown Raspberries

Steven Poppe
University of Minnesota - West Central Research and Outreach Center
46352 State Hwy. #329
Morris, MN 56267
320-589-1711
poppesr@morris.umn.edu
Stevens and Douglas Counties
Award amount: . . . . . $13,346 for 3 years

Our project evaluates primocane-fruiting (fall-bearing) raspberry cultivars grown in high tunnels and increases producer's knowledge about potential markets for locally produced fruit crops. In addition, we will try to eliminate the use of fungicides and herbicides and minimize insecticidal use.

Reducing Pesticides in Growing Fresh Cabbage for Markets

Association for the Advancement of Hmong Women in Minnesota
Contact: Ly Vang
1101 Snelling Ave. N.
St. Paul, MN 55108
651-255-0799
lyvangaahwm@yahoo.com
Dakota County
Award amount: . . . . . $20,000 for 3 years

We want to improve safety and productivity of cabbage output while increasing the use of alternative pest management methods to treat common pests.

High Tunnel Primocane-Fruiting Blackberry Production in Minnesota

Shengrui Yao
University of Minnesota - North Central Research and Outreach Center
1861 E. Hwy. 169
Grand Rapids, MN 55744
218-327-4615
yaos@umn.edu
Itasca and Washington Counties
Award amount: . . . . . $23,932 for 3 years

Primocane-fruiting blackberry is a new crop and may not produce a full crop in Minnesota because of the early frost in the fall. High tunnels could extend the growing season by several weeks. Producing primocane-fruiting blackberries in high tunnels would ensure the berries mature and extend the season in the fall, thus increasing the market potential of this fruit. We would also like to demonstrate to small-scale growers that a high tunnel environment can allow them to produce a high value organic crop in a small area with a relatively low-cost investment.

Completed Grant Projects...

Final Greenbook Article	Title of Project	Grantee

Alternative Markets and Specialty Crops

2008	Dream of Wild Health Farm Indigenous Corn Propagation Project	Peta Wakan Tipi (Sally Auger)
2007	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
	Evaluating the Benefits of Compost Teas to the Small Market Grower	Pat Bailey
	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

Final Greenbook Article	Title of Project	Grantee
1999	An Alternative Management System in an Organic, Community Supported Market	Candace Mullen
	Cultural and Management Techniques for Buckwheat Production and Marketing	Tom Bilek
	Pond Production of Yellow Perch	John Reynolds
1998	Establishing and Maintaining Warm Season Grasses (Native Grasses)	Pope County SWCD
	On-farm Forest Utilization and Processing Demonstrations	Hiawatha Valley RC&D
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

2008	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
2007	Field Windbreak/Living Snow Fence Yield Assessment	Gary Wyatt
2006	Gardening with the Three Sisters: Sustainable Production of Traditional Foods	Winona LaDuke
2005	Chickling Vetch—A New Green Manure Crop and Organic Control of Canada Thistle in Northwest Minnesota	Dan Juneau
	Feasibility of Winter Wheat Following Soybeans in Northwest Minnesota	Jochum Wiersma
	Treating Field Runoff through Storage and Gravity-fed Drip Irrigation System for Grape and Hardwood Production	Tim Gieseke

Final Greenbook Article	Title of Project	Grantee
	Use of Rye as a Cover Crop Prior to Soybean	Paul Porter
2004	Development of Eastern Gamagrass Production	Nathan Converse
	In-field Winter Drying and Storage of Corn: An Economic Analysis of Costs and Returns	Marvin Jensen
	Mechanical Tillage to Promote Aeration, Improve Water Infiltration, and Rejuvenate Pasture and Hay Land	Robert Schelhaas
	Native Perennial Grass – Illinois Bundleflower Mixtures for Forage and Biofuel	Craig Sheaffer
	Northwest Minnesota Compost Demonstration	John Schmidt/Russ Severson
	Potassium Rate Trial on an Established Grass/Legume Pasture: Determining Economic Rates for Grazing/Haying Systems	Dan/Cara Miller
	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
	Dairy Manure Application Methods and Nutrient Loss from Alfalfa	Neil C. Hansen
	Manure Spreader Calibration Demonstration and Nutrient Management	Jim Straskowski
	Replacing Open Tile Intakes with Rock Inlets in Faribault County	Faribault County SWCD/Shane Johnson
	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
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
	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

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
	Inter-seeding Hairy Vetch in Sunflower and Corn	Red Lake County Extension
	Growing Corn with Companion Crop Legumes for High Protein Silage	Stanley Smith
	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	Biological vs. Conventional Crop Systems Demonstration	Gary Wyatt
	Building Soil Humus without Animal Manures	Gerry Wass
	Controlled Microbial Composting to Improve Soil Fertility	Howard/Mable Brelje
	Living Mulches in West Central Minnesota 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

Final Greenbook Article	Title of Project	Grantee
	Integration of Nutrient Management Strategies with Conservation Tillage Systems for Protection of Highly Eroded Land and Lakes in West Otter Tail County.	Harold Stanislawski
	Manure Management/Utilization Demonstration	Timothy Arlt
	Reducing Soil Insecticide Use on Corn through Integrated Pest Management	Ken Ostlie
	Taconite as a Soil Amendment	Donald E. Anderson
1994	Biological Weed Control in Field Windbreaks	Tim Finseth
	Energy Conserving Strip Cropping Systems	Gyles Randall
	Fine-tuning Low-input Weed Control	David Baird
	Flame Weeding of Corn to Reduce Herbicide Reliance	Mille Lacs County Extension
1993	Chemical Free Double-cropping	Jeff Mueller
	Cooperative Manure Composting Demonstration and Experiment	Rich Vander Ziel
	Early Tall Oat and Soybean Double Crop	Charles D. Weber
	NITRO Alfalfa, Hog Manure, and Urea as Nitrogen Sources in a Small Grain, Corn, Soybean Crop Rotation	Carmen M. Fernholz
	Nitrogen Utilization from Legume Residue in Western Minnesota	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 Southeast Minnesota	John Moncrief
	Economically and Environmentally Sound Management of Livestock Waste	Fred G. Bergsrud
	Herbicide Ban? Could You Adapt on a Budget?	David Michaelson
	Improving Groundwater Quality and Agricultural Profitability in East Central Minnesota	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		
2008	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

Final Greenbook Article	Title of Project	Grantee

Fruits and Vegetables

2008	Chokecherry (*Prunus virginiana*) Production in Western Minnesota	Todd/Michelle Andresen
	Insect and Disease Pressure in Unsprayed Apple Orchards in Central and Northern Minnesota	Thaddeus McCamant
2007	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
2003	Research and Demonstration Gardens for New Immigrant Farmers	Nigatu Tadesse
	Root Cellaring and Computer-controlled Ventilation for Efficient Storage of Organic Vegetables in a Northern Market	John Fisher-Merritt
	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
	Integrating Livestock Profitably into a Fruit and Vegetable Operation	David/Lise Abazs
	Soil Ecology and Managed Soil Surfaces	Peter Seim/Bruce Bacon
	Value Adding to Small Farms through Processing Excess Production	Jeffrey/Mary Adelmann
2001	Bio-based Weed Control in Strawberries Using Sheep Wool Mulch, Canola Mulch and Canola Green Manure	Emily Hoover
	Biological Control of Alfalfa Blotch Leafminer	George Heimpel
	Cover Crops and Living Mulch for Strawberry Establishment	Joe Riehle
	Sustainable Weed Control in a Commercial Vineyard	Catherine Friend/Melissa Peteler
1999	Development of Mating Disruption and Mass Trapping Strategy for Apple Leafminer	Bernard/Rosanne Buehler
1998	Alternative Point Sources of Water	Joseph/Mary Routh
	Comparison of Alternative and Conventional Management of Carrot Aster Leafhoppers	MN Fruit & Vegetable Growers Association

Final Greenbook Article	Title of Project	Grantee
	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 Minnesota	John Fisher-Merritt
	Living Mulch, Organic Mulch, Bare Ground Comparison	Dan/Gilda Gieske
Livestock		
2008	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
2007	Comparing Alternative Laying Hen Breeds	Suzanne Peterson
2006	Composting Bedded Pack Barns for Dairy Cows	Marcia Endres
	Managing Hoops and Bedding and Sorting without Extra Labor	Steve Stassen
2005	Performance Comparison of Hoop Barns vs. Slatted Barns	Kent Dornink
	Raising Cattle and Timber for Profit: Making Informed Decisions about Woodland Grazing	Michael Demchik
	Using a 24' x 48' Deep Bedded Hoop Barn for Nursery Age Pigs	Trent/Jennifer Nelson
2004	Comparing Performance of Hoop Buildings to an Older Conventional Building for Finishing Hogs	Kevin Connolly
	High Value Pork Production for Niman Ranch Using a Modified Swedish System	David/Diane Serfling
	Low Cost Fall Grazing and Wintering Systems for Cattle	Ralph Lentz
2003	Can New Perennial Grasses Extend Minnesota's Grazing Season	Paul Peterson
	Enhancement of On-farm Alfalfa Grazing for Beef and Dairy Heifer Production	Dennis Johnson
	Farrowing Crates vs. Pens vs. Nest Boxes	Steve Stassen
	Forage Production to Maintain One Mature Animal Per Acre for 12 Months	Ralph Stelling
	High Quality – Low Input Forages for Winter Feeding Lactating Dairy Cows	Mark Simon
	Pasture Aeration and its Effects on Productivity Using a Variety of Inputs	Carlton County Extension
	Potential of Medicinal Plants for Rotational Grazing	Management Intensive Grazing Groups/Dave Minar

Final Greenbook Article	Title of Project	Grantee
	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
	Reviving and Enhancing Soils for Maximizing Performance of Pastures and Livestock	Doug Rathke/Connie Karstens
	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
	Grass-and Forage-based Finishing of Beef, with Consumer Testing	Lake Superior Meats Cooperative
	Learning Advanced Management Intensive Grazing through Mentoring	West Otter Tail SWCD
	Low Cost Sow Gestation in Hoop Structure	Steve Stassen
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
	Management Intensive Grazing Groups	Dave Stish
	Renovation of River Bottom Pasture	Jon Peterson

Final Greenbook Article	Title of Project	Grantee
	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
	Rotational Grazing Improves Pastures	MISA Monitoring Team
	Seasonal Dairying and Value-added Enterprises in Southwest Minnesota	Robert/Sherril Van Maasdam
	Swedish Style Swine Facility	Nolan/Susan Jungclaus
1996	Dairy Waste Management through Intensive Cell Grazing of Dairy Cattle	Scott Gaudette
	Establishing Trees in Paddocks	Dave/Diane Serfling
	Evaluating Pasture Quality and Quantity to Improve Management Skills	Land Stewardship Project
	Expanding into Outdoor Hog Production	James Van Der Pol
	Grazing Limits: Season Length and Productivity	Doug & Ann Balow
1995	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
1993	A Comparison Study of Intensive Rotational Grazing vs. Dry-lot Feeding of Sheep	R & K Shepherds

Final Greenbook Article	Title of Project	Grantee
	Controlled Grazing of Ewes on Improved Pastures and Lambing on Birdsfoot Trefoil	Leatrice McEvilly
	Improving Permanent Pastures for Beef in Southwest Minnesota	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

Sustainable Agriculture Loan Program

Loan Technical Review Panel for 2009

Gregg Bongard, Ag Lender

Robin Brekken, Farmer

Ralph Lentz, Farmer

Thaddeus McCamant, Farm Management Specialist

Bob Mueller, Farmer

Ray Rauenhorst, Farmer

Keith Schoenfeld, Ag Lender

Chuck Schwartau, Extension Educator

Program Purpose

The Sustainable Agriculture Loan Program was created to accelerate the adoption of sustainable farming information and technology in Minnesota. Loans of up to $25,000 per farmer or up to $100,000 for joint projects are made at a fixed 3% interest rate for a term of up to 7 years. These low-interest loans are made to farmers for purchasing new or used equipment or building improvements that help make the farming system more sustainable.

Background

When this program began in 1988, the concepts of sustainable agriculture were less understood and less accepted by farmers and lenders than they are today. Many farmers had difficulty obtaining the capital necessary to refocus their farm operations since lenders were reluctant to finance changes during the volatile economy of the 1980s. The state chose to assist these farmers through direct lending.

The initial $1 million appropriation from the state legislature was set up as a revolving fund. As loans are repaid, the funds are pooled and redistributed to other farmers in the form of new loans. Many farmers will benefit from this continuing program with no additional cost to the state.

Evaluation Criteria

Applications for the Loan Program are accepted throughout the year and are competitively evaluated. A review panel representing a cross-section of agricultural professionals from various regions of the state determines which loan projects to recommend to the Commissioner of Agriculture for funding.

The loan proposals are evaluated based on the following criteria:

a) **Long-term Plans for the Farm:** How does this investment fit the long-term plans for the farm?
b) **Effect on the Farming System:** How will this investment lead to a more sustainable farm system?
c) **Environmental Impact:** Is there an environmental benefit to the proposed project?
d) **Farm Income:** What is the added return to the farming operation from the proposed project?
e) **Input Reduction:** Does the project reduce or make more efficient use of inputs?

Each proposal is judged on its relative merits. A farming method considered to be highly innovative in one region of the state may be commonplace in another region.

Impact of Program

The loans have given Minnesota farmers added incentive to make changes toward more efficient use of inputs while enhancing profitability and protecting the environment. More than 330 farmers have borrowed over $3.5 million from the Sustainable Agriculture Loan Program.

As loans are repaid and the funds redistributed, approximately $250,000 is available each year for new loans. When farmers implement innovative changes, their neighbors have an opportunity to observe and decide whether to adapt changes to their farming system. In this way, the farmers are demonstrating new, innovative, and alternative ways of farming and are serving to accelerate the rate of adoption of sustainable agriculture in Minnesota.

Project Categories

Loan projects typically fall into six categories: energy savings and production, livestock management, conservation tillage, weed and nutrient management, on-farm processing, and alternative crops. Almost one-half of loans have been made for livestock management and this category continues to be the most common. Projects have included fencing, livestock handling equipment, milk parlor upgrades, and building improvements. Conservation tillage and weed management projects have accounted for about one-fourth of the loans and include the purchase of rotary hoes, flame cultivators, and ridge tillage equipment. Energy production and on-farm processing and handling equipment projects have been increasing in the past few years.

About the Staff…..

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

Linda Bougie – Office Manager, has been working for the program since it began in 1988. Linda provides administrative clerical support to the staff and the program.

Jean Ciborowski - Integrated Pest Management (IPM) Program Coordinator, has been part of the staff since 1997. During her tenure at the MDA, she has coordinated the Biological Control Laboratory (1989-91) and the Exotic Pest Program (1991-97). Jean works on development and implementation of statewide strategies for increasing the use of IPM on private and state managed lands.

Alison Fish - Secretary, does desktop publishing and word processing for the program, helps design program brochures, handles mail requests, and maintains the Sustainable Agriculture Loan and Grant files.

Mary Hanks - Program Supervisor, works with staff to develop project goals and implementation strategies. Mary's training is in plant pathology with a research focus. She came to the MDA in 1990 from private industry.

Wayne Monsen - Alternative Livestock Systems Specialist, provides rotational grazing planning services for livestock producers (in cooperation with NRCS), and cooperates with local, state and federal agencies on livestock and non-point source pollution issues. He began working for MDA in 1992 after farming for 12 years near St. James, MN.

Meg Moynihan - Organic and Diversification Specialist, joined the Minnesota Department of Agriculture in 2002. She helps farmers and rural communities learn about crop, livestock, management and marketing options, including organic. She has also worked professionally as an educator and evaluator, and as a community development extension specialist with the U.S. Peace Corps in northern Thailand.

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

Staff Resource Directory

	Jean Ciborowski	Mary Hanks	Wayne Monsen	Meg Moynihan	Mark Zumwinkle
Agroforestry			•		
Alternative Crops & Livestock			•	•	•
Community Supported Agriculture (CSA)		•		•	
Composting		•			•
ESAP Grants	•	•			
ESAP Loans		•			
Farming Systems/Tillage, Weed Control, Crop Rotation	•		•		•
Integrated Pest Management (IPM)	•	•			
Livestock Production			•		
Living Mulch					•
Manure Management					•
Organic Production/Livestock,Vegetables, Grain, Fruit				•	•
Organic Rules and Certification		•		•	
Plant Diseases/Insects	•	•			
Managed Rotational Grazing Planning		•	•		
Soil Quality and Soil Fertility, Composting					•
Vegetable Production					•