GREENBOOK 2012

MINNESOTA DEPARTMENT OF AGRICULTURE

Greenbook 2012

Program Vision Statement

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

Program Mission Statement

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

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

MINNESOTA DEPARTMENT OF AGRICULTURE
AGRICULTURAL MARKETING AND DEVELOPMENT

September 2012

Thank you to the MDA's Agricultural Marketing and Development Staff who helped to make *Greenbook 2012* a reality. They include: Cassie Boadway, Jean Ciborowski, Alison Fish, Mary Hanks, Wayne Monsen, Meg Moynihan, and Mark Zumwinkle. A special thanks to Stacy Gulden, Information Technology Division, for the layout and design of *Greenbook 2012*.

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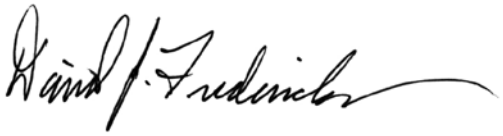
Introduction to the *Greenbook 2012*

I am pleased to present the 23rd edition of the *Greenbook* highlighting Sustainable Agriculture Demonstration Grant projects of Minnesota farmers, ranchers and researchers. These grants support on-farm practices that promote environmental stewardship, conservation of resources, and help to improve profitability and quality of life in rural areas.

The annual *Greenbook* has showcased hundreds of innovative and creative grant projects that have contributed to important advances in Minnesota agriculture. From the state's small specialty crop farmers to the large commodity crop farmers, all are working to make Minnesota's agricultural sector a success.

Greenbook 2012 contains articles on each project with personal observations and management tips from the participants, as well as practical and technical information. The grantees are excited to share their knowledge and experiences with you. Feel free to give them a call about their projects.

I hope you will find *Greenbook 2012* interesting and full of new and useful ideas.



Dave Frederickson, Commissioner

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Sustainable Agriculture Grant Program

Program Purpose

The Grant Program has provided 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 received over 1,080 grant applications and 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 2012.

When funding is available, 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 make recommendations to the Commissioner of Agriculture for approval. The Technical Review Panel includes farmers, university agricultural researchers, extension agents, and educators with assistance from the Agricultural Marketing and Development staff. Funding has not been available since 2010.

Grant Summaries

The project summaries that follow are descriptions of objectives, methods, and findings of individual grant projects funded in 2008-2010. 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 (1989-2012)

Year	Number of Grants Funded	Total Funding	Average Grant Size	Ranges
1989	17	$280,000	$16,500	$3,000-25,000
1990	14	189,000	13,500	4,000-25,000
1991	4	46,000	11,500	4,000-23,000
1992	16	177,000	11,000	2,000-25,000
1993	13	85,000	6,000	2,000-11,000
1994	14	60,825	4,000	2,000-10,000
1995	19	205,600	11,000	2,000-25,000
1996	16	205,500	12,900	4,000-25,000
1997	20	221,591	11,700	1,000-25,000
1998	19	210,000	11,100	1,000-24,560
1999	23	234,500	10,200	3,000-21,000
2000	17	150,000	8,800	4,600-15,000
2001	16	190,000	11,875	5,000-25,000
2002	18	200,000	11,000	4,300-20,000
2003*	---	---	---	---
2004*	---	---	---	---
2005	10	70,000	7,000	2,000-11,600
2006	8	70,000	8,750	4,600-12,000
2007	9	70,000	7,777	2,700-12,000
2008	10	148,400	14,800	4,500-25,000
2009	7	103,000	14,700	5,000-20,000
2010	11	77,000	7,000	3,600-10,000
2011*/2012*	---	---	---	---
Total Funded	**281**	**$2,993,416**		

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

Growing Cherries in Central Minnesota

Principal Investigator

Pat Altrichter
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Morrison County

Project Description

2009 to 2011

Award Amount

$5,000

Staff Contact

Meg Moynihan
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Keywords

ali, birds, cherry, 'Evans', fruit, sour cherry, Zone 3

Project Summary

Overwhelming interest in a Saskatoon berry U-pick operation that we began several years ago encouraged us to look for other new crops, which led us to cherries. We want to expand our picking season, offer more variety, and increase our income. In comparison with traditional crops we hope cherries will be sustainable and require less physical labor. We want this project to involve family members and provide a healthy product for the community.

Project Description

I'm Pat Altrichter. I raise hay and 100 head of beef brood cows on a 226-acre beef farm near Randall in central Minnesota. I'm doing this project with my sister, Judy Heiling, who operates a 4 acre nursery about eight miles away from me, between Randall and Browerville. Judy grows and markets all her plants locally, both off the farm and at local farm and flea markets.

In the mid 2000s, we received demonstration grants from the Minnesota Department of Agriculture and North Central SARE to try establishing several varieties of commercially available Saskatoon berries developed in Canada (see the final article in *Greenbook 2008*). We found several cultivars we liked and that grew well. Our success enabled us to start a Saskatoon berry U-pick operation. We were interested in exploring other fruits, too. Fruit trees and berries may be expensive to establish but they are a good long-term investment. Plus, we have a lot of rocks, so I really like the idea of not turning the soil over or having to pick rocks after we establish them.

We live in USDA Plant Hardiness Zone 3, where sweet cherries and most sour cherries are not hardy. Sweet cherries are only used for fresh eating as they lose much of their flavor when cooked. Sour cherries are the ones that make the flavorful pies, sauces, jams, jellies and wines. After hearing about how vigorous and hardy a cherry variety called 'Evans' (also sold in the U.S. under the name "Bali") was in Canada and seeing how they thrived in Judy's nursery, we decided to try them as a U-pick. 'Evans' is sour cherry that has an excellent, sweeter taste if left on the tree to ripen. They make a great tree for landscaping also, maturing to about 10' to 12' tall with a nice oval form. Cherry trees have beautiful clusters of fragrant white flowers in spring and are self-pollinating. The fruits start out as orangey-red drupes and change to showy red cherries through mid-summer. They are reportedly heavy producers and can reportedly yield 50-100 lb of fruit per tree, far surpassing other sour cherries in yield.

A big, beautiful bowlful of 'Evans' cherries.

A fine looking little cherry tree.

'Evans' cherry trees have a life expectancy of 20-30 years. According to our research, it is possible to harvest 50 lb of cherries from one tree. We estimated that we can fit 150 trees on 1 acre. At $3.00/lb, the orchard would gross more than $20,000/A! Even after factoring in establishment costs, low production for the first few years, and a bad year now and then, we think the cherries have the potential to generate a lot more income than traditional crops. Pat participates in farm business management (FBM) education through a local college. According to FBM data for the state (www.finbin.umn.edu), the average net income per acre for traditional field crops in our area for 2010 was $186 for alfalfa, $223 for corn, $158 for soybeans, and $16 for oats.

2009

We planted 115 'Evans' cherry trees in late April and early May in the fenced grass hayfield near the Saskatoon bushes. We used grant funds to plant 15 3' to 4' trees that were about three years old and used our own funds to plant assorted 2-5 year old trees that Judy had propagated.

We prepared the ground by hauling well rotted cow manure and spreading it with beet lime (to provide calcium). We dug the holes with a post auger, spacing the trees 15' apart in 18' rows - wide enough to allow us to cut hay in between them. We mulched all the trees well with woodchips.

Summer 2009 was dry. We watered our cherries a couple of times, noting that they seemed pretty drought tolerant, like the Saskatoons. The cherries grew slowly because of the drought, but bushed out nicely and looked very healthy by fall. There was a lot of moisture in fall 2009, and we hoped that would help get the trees well established.

In an effort to thwart nibbling mice and rabbits, we sprayed the trunks with an Irish Spring® soap solution before it snowed. (We had found this mixture effective for protecting our Saskatoons -- see Management Tips). We also put out some bait stations for mice.

2010

Every one of our cherry plants survived the winter but spring 2010 proved challenging. A late frost hurt the blossoms and then temperatures hit the 60s in late March and early April. As a result, our fruit and berries bloomed two weeks earlier than expected. In early May, overnight temperatures plummeted to the mid 20s and blossoms on most of our plants in the orchard froze.

A good summer with plenty of rain followed, and the cherry trees made excellent progress. At the beginning of spring, they were about 4' high, and by the end of the season they had grown at least another foot and had branched out a lot. A couple of trees had even suckered. 'Evans' grows on its own root so we left the suckered ones in the row to see if productivity is greater in a hedge situation (as observed with the Saskatoon berries), or if they do better as single trees.

We used many of the same weed control strategies we found to be successful with Saskatoons –mowing between the rows and mulching the cherry trees. Some trunks split from sun scald but they seemed to heal up and do all right through the summer.

Birds turned out to be a problem – there were a lot robins and cedar waxwings and they ate what few berries and cherries were produced this year. Apart from a few web worms, there were no other insects and diseases to speak of.

With the frozen blossom problem and young trees, the overall average yield was pretty minimal, but we picked almost two ice cream buckets full (12-18 lb) off the best tree. Plus, the birds also got a few. We have been keeping track of weather effects and survival rates on the Saskatoons and the cherries. Some of this information could be used in the future for federal crop insurance, in the "non-insurable" program for specialty crops, for example.

2011

The trees grew well this year, gaining about 2' with lots of suckering and bigger fruits than in 2010. The farm received a lot of rain in the spring and early summer. Then it got dry and stayed dry. I think the dry weather ended up being good for the cherries by helping them go dormant for the winter. Having just been through a number of dry years, I still think irrigation is a good idea that we might pursue at some point, since our sandy soil can dry out fast when it doesn't rain for a while. Plus, studies have shown that water at fruit set time increases berry size and quality dramatically.

Birds were a big problem again in this year, so we ordered a bird caller that randomly emitted hawk calls and distressed bird calls. We returned it because the machine didn't work at all; a hawk hung around for about a week calling to the bird caller and flying around, but even that didn't seem to scare the robins or waxwings. We tried making loud noises to scare them off and even let the grandkids run around the rows with ATVs and cap guns, but the waxwings just flapped over to the next row.

Next, we tried netting. We bought some inexpensive, damaged rolls of baler net wrap. We tried draping that over the Saskatoon rows and cut pieces to wrap the cherry trees that had the most cherries on. Although it kept the birds off, it became really tangled in the branches and leaves. The yields on the netted trees were very good, however, and next spring we plan to start putting in posts and a high tensile wire to make a trellis system we can hang the netting on. We have observed how some grape growers do their netting, but will have to experiment with what will work best in our situation.

About 40 people attended a very warm field day in late July when the trees were bearing. Attendees picked and purchased about 80 lb of cherries. Quite a few visitors were so intrigued that they ordered some trees from Judy.

In the fall, we sprayed again with our Irish Spring® soap solution and put out bait stations. We mowed close to the trunks in late fall but it's been getting difficult as the trees sucker. We haven't yet decided what to do about those suckers, so for now, we just mow around them, leaving a bit more grass which, unfortunately, provides hiding places for rodents.

We also followed through this year on our plan to take a four-week integrated pest management class offered by Wisconsin and Michigan. It was an excellent learning experience, and when we had an outbreak of Saskatoon sawfly, we were able to identify the pest thanks to taking the course. We found a couple of worms while scouting the cherries, but it was far from any economic threshold. Now we have a better idea of what insect pests to watch for (and when), we can control them with minimal chemical use.

We continue to get calls and e-mails from people who ask about the cherries or the Saskatoons. (Most people say they found the contact information on the internet in the Greenbook!) We have had inquiries from North Dakota, South Dakota, Iowa, and Wisconsin, and continue to give presentations about the cherries at meetings and conferences like the 2012 Minnesota Fruit and Vegetable Growers Association Conference.

We tried using net wrap to protect the trees from bird damage, but it was kind of a mess.

Looking to the future

While 2011 was the last year of the MDA grant funding, it's just the beginning of fruit trees for this farm. Canada has developed six varieties of dwarf sour cherries known as the "Romance" series ('Carmine,' 'Jewel,' 'Crimson,' 'Passion,' 'Cupid,' 'Romeo,' 'Juliet,' and 'Valentine'). These are reportedly more of a bush than a tree and are hardy to zone 2. I've heard they are heavy yielders and if left to ripen some will reach brix (sugar) ratings of up to 20+, making them suitable for fresh eating. They have not all been released in the U.S. yet, but we think they might make a great addition to our U-pick in the future.

Management Tips

1. Protect plants from wildlife, including deer, rabbits, mice, etc. Mow around plants in the fall and use fencing, sprays, poison, or our favorite soap solution: shave a couple of bars of Irish Spring® soap into a kettle of 1 to 2 quarts of hot water until you have slurry. Dilute 2 cups of the slurry with 4 gallons of water. Spray plants in late fall to reduce mouse and rabbit chewing.

2. Mulch heavily. It not only helps control weeds, but will help hold moisture during dry periods.

3. Do not water or fertilize cherries in late summer or fall. Cherries do not get the photoperiodic message to shut down, so need to be hardened off to avoid winter injury.

4. Plan well ahead for bird problems and implement a netting system or other strategy to protect the fruit.

Cooperators

Farm Business Management Program, Central Lakes College, Staples, MN
Morrison County Soil and Water Conservation District Staff, Little Falls, MN
USDA Farm Service Agency

Project Location

We are located 3 miles west of Randall or 18 miles east of Browerville on Cty. Rd. 14. We are on the north side of the road just east of the Cty. Rd. 14 and 11 intersection.

Other Resources

Edmonton Journal. 2006. Alberta's little cherry miracle. August 17. *www.canada.com/topics/lifestyle/gardenersguide/story.html?id=dca25d83-e932-4154-9a9d-898a17eeda44&k=2136*1

FINBIN farm financial data. Minnesota State Colleges and Universities and University of Minnesota. *www.finbin.umn.edu*

Hardy plants for northern climates: *www.northscaping.com*

Information about 'Evans' cherries: *www.dnagardens.com/Articles/cherry_evans_tips.htm*

Kalb, Tom. 2011. The finest fruit tree? NDSU Extension Service. *www.dakotagardener.com/stories/evansbali.pdf*

Video about 'Evans' cherries: *www.youtube.com/watch?v=qvy4jHJou3o*

Tree/Shrub Establishment by Direct Seeding on Red Clay Soils

Principal Investigator

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Project Duration

2010 to 2012

Award Amount

$3,704

Staff Contact

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Keywords

direct seeding, conifer, hardwood, shrubs, timber reforestation, upland erosion control

Project Summary

This project will demonstrate direct seeding of trees and shrubs on red clay soils in the Lake Superior Watershed. The traditional tree establishment method of transplanting trees requires expensive, labor intensive deer damage control measures, as well as expensive weed control measures. Direct seeding with seedbed preparation is an established method in southern Minnesota, but is untried in northeastern Minnesota. On tillable soils direct seeding may be a less expensive and less labor intensive seeding method. It may also provide for more diversity, quicker establishing, and higher quality timber reforestation than transplanting trees.

Project Description

The purpose of the project is to evaluate and demonstrate the potential for the direct seeding of a hardwood/conifer/shrub mixture in northeastern Minnesota. Reforestation can be challenging in this watershed due to the heavy soils, dense grass competition, and high deer damage potential. The conventional transplanting of trees has grown more expensive as increasing deer populations require expensive, labor intensive deer deterrents.

Water quality of streams in the area is largely a factor of sediment loading from bank erosion. Bank erosion amounts are strongly affected by runoff events. Runoff is generally modified and less erosive of streambanks when higher percentages of the contributing watershed are forested. Reforestation of fields no longer farmed is an ongoing conservation objective in this area for water quality protection purposes.

The 1.7 acre project site, owned by John Murray, is a grass/legume hay field on moderately drained, rolling, loam to loamy clay soils. There is also a high deer population in the area. The farm was formerly forested, then a beef operation, and now is being reforested. It is located in the red clay hills above the St. Louis River. This farm is typical of others in the area. Lessons learned here will be applied to other properties.

The seeding plan for this project will follow the Tree/Shrub Establishment practice standard (612) of the Natural Resources Conservation Service (NRCS). Most tree and shrub seed need a cold treatment, such as overwintering in the soil, to germinate. Late fall seeding is usually considered optimal and will be used in this project.

Seeding site as hay field in August 2010.

We will also compare the costs of this seeding method with the costs the NRCS Environmental Quality Incentive Program (EQIP) cost share program use for tree and shrub establishment.

2010 Results

The 2010 season was a challenge for seeding and establishing a good crop. Wet weather in November delayed the seedbed prep and the seeding so that the nurse crop of oats did not sprout. We will see next year if this caused any problems.

On August 3 and 17, the field was clipped to improve effectiveness of the herbicide. August 30 the field was sprayed with a glyphosate/water/ammonium sulfate solution at recommended rates; 2.5 gal of 41% glyphosate and 2 lb of ammonium sulfate used. The grass and legume control was generally good. On September 12 follow up spot spraying was done on green spots in the field, using the same amounts of chemical. October 14 the field was plowed. Heavy rains and wet fields delayed disking until November 11.

On November 12 the field was rototilled, seeded, and dragged, with the harrow teeth up, to cover the seeds lightly. All but the Red Oak seed was obtained from Williams Tree Seeds in Bemidji, MN. See Table 1 for the seeding mixture.

The Red Oak seed was obtained locally, but because of a regional acorn crop failure we were only able to seed 3 lb. We might be able to plant more Red Oak acorns next fall. Usually acorns are broadcast with a cyclone seeder and disked in an inch. Due to the small amount of acorns, John walked a grid pattern over the field, dropping and stepping on an acorn every two paces. John planted the Wild Plum seed the same way as the Red Oak but seeding at smaller paces.

Table 1: Tree/shrub seeding mixture

White Spruce	2 oz
White Pine	10 oz
Green Ash	12 oz
Red Osier Dogwood	1 oz
Highbush Cranberry	3 oz
Choke Cherry	4 oz
Wild Plum	7.5 oz
White Cedar	1 oz
Balsam Fir	5.5 oz
Red Oak	3 lb

The other seeds were planted with a walking cyclone seeder. Seeding 1/3 of the seed at a time, alternating a down and across pattern to ensure even coverage. However, the Green Ash seed did not spread well in the cyclone seeder as it was too light. John spread these by hand, walking a grid, tossing five seeds at a time. Fewer Green Ash seed were available to plant than were planned. However, the ash was sown mostly as filler trees which are to be mostly thinned out as the trees grew.

Fifty pounds of oats was mixed with the seed for the seed carrier. We originally had planned to use floor dry as the seed carrier, but it got wet and did not work in the cyclone seeder.

We had planned on the oats sprouting in the fall to act as a cover crop to prevent soil erosion and tree seed desiccation. Due to the late planting date the oats did not sprout but did work well mixed in the cyclone seeder along with the seed.

The costs for the project in 2010 were $1,153.34 (Table 2). There will be added costs for weed control and more acorn seeds in 2011 and 2012. We will be able to assess the total actual costs over the next 2 years.

The costs were compared with the 2010 payment schedule for NRCS EQIP for direct seeding and two methods of tree plantings. The typical cost for direct seeding is $510/A.

Table 2. Project costs during 2010

Seed	46 oz	$67.00
Glyphosate herbicide	5 gal	$110.70
Ammonium Sulphate	4 lb	$3.95
Oats	50 lb	$5.75
Floor Dry	50 lb	$6.94
Mowing	4 hours	$180.00
Spraying	4 hours	$180.00
Plowing	3 hours	$180.00
Disking	2 hours	$120.00
Rototilling	2 hours	$120.00
Seeding	3 hours	$135.00
Dragging	1 hour	$45.00
Total 2010 Costs		$1,153.34

The cost for conventional planting 605 trees/A along with using tree mats and tree tubes for protection is $4,575/A. The conventional tree planting of 605 trees/A with mowing, spraying, and deer repellent is $1,645/A. These costs are for an acre, whereas our costs of $1,153.34 are for 1.7 acres.

2011 Results

This spring we were both surprised and very disappointed with the sprouting percentages of the trees planted in November 2010. By June 10 only 17 tree sprouts and one or two oat plants were found from last fall's planting.

On July 14, with still no significant tree sprouts, John applied glyphosate to control the weeds, as per the label. On August 1 John broadcast 41% glyphosate at 3 to 5 qt/A. An August 5 inspection resulted in just a smattering of tree and oat sprouts, and about 60% weed coverage, mostly annual broadleaf and horsetail. We remain baffled by the poor germination, as the weed control, seed quality, seed amount, species diversity, seed bed prep, seeding method, and weather conditions seem to have been near optimal.

With the poor stand of trees, we decided to reseed the entire field in November. On August 22, John prepared the seed bed by rototilling to a 6" depth. We obtained more seed from Williams Tree Seed, who kindly donated this batch of seed (Table 3). John also gathered the acorns locally.

We decided to plant right before soil freeze, to ensure no early germination. Unfortunately, a surprise batch of rain and cold froze the field, making planting impossible. We placed seeds in freezer bags and put them in a freezer for a spring 2012 planting. We intend to roll the field with a cultipacker after seeding to improve seed to soil contact; hopefully this will help get a better stand.

There will be more costs in 2012 for planting and weed control. We will be able to assess the total actual costs over the next few years.

Table 3. Cleaned Seed for 2012 Planting

White Spruce	2 oz
White Pine	10 oz
Highbush Cranberry	3 oz
Choke Cherry	4 oz
White Cedar	2 oz
Yellow Birch	2 oz
Red Oak	5.5 lb
Bur Oak	22 lb

Seeding site on November 12, 2010 between disking and rototilling.

Management Tips

1. Tree and shrub seed collection can be done locally or purchased from vendors.

2. If harvesting seed, select seed from within neighboring counties and on the same soil type for best adaptation.

3. Order seed from multiple vendors to reduce the chance of seed unavailability.

4. Prepare a weed free, firm seed bed.

5. Seed on the heavy side of standard recommendations to reduce weed and deer browse problems.

6. Pay close attention to seeding depth to avoid seeding too deep. Roll or cultipack after seeding for better seed to soil contact.

7. Seed early enough in the fall (before November 1) so the oats cover crop has a chance to grow.

8. Planting a wide diversity of species will reduce the risk of crop failure.

9. Seed late in the fall to avoid germination before the next spring.

Cooperators

John Murray, Land Owner, Carlton, MN
Dana Raines, Onanegozie RC&D, Mora, MN
Bruce Schoenberg, MN DNR Forestry, Cloquet, MN
Kelly Smith, Carlton SWCD, PO Box 29, Carlton, MN

Project Locations

From Carlton go south 2 miles on Cty. Rd. 1. Then east on Leimer Rd. ¼ mile to the planting site, on your left, just past the RR tracks.

Other Resources

Planning & Cost Share Assistance: Contact your local Soil & Water Conservation District or Natural Resources Conservation Service office in the white pages.

The Minnesota Department of Natural Resources pamphlet, Direct Seeding of Native Hardwood Trees. This pamphlet also describes seed collection. Available at: *www.dnr.state.mn.us/treecare/maintenance/collectingseed.html*

The Natural Resources Conservation Service direct seeding of trees standard. Available at: *efotg.sc.egov.usda.gov/references/public/MN/612mn.pdf*

Tree & Shrub Seed Vendors:

Williams Tree Seeds	Bemidji, MN	218-751-7957
Cass Lake Tree Seed Co.	Cass Lake, MN	218-335-2336
F.W. Schumacher Co.	Massachusetts	508-888-0659
Scheffield Seed Co.	New York	315-497-1058
One Stop Forestry	Iowa	563-864-3586
Lawyer Nursery	Montana	406-826-3881
Cascade Forest Nursery	Iowa	319-852-3042
Smith Nursery Co.	Iowa	515-228-3239

Seeds ready for planting in 2012.

Organic Mushroom Cultivation and Marketing in a Northern Climate

Principal Investigator

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Project Duration

2009 to 2011

Award Amount

$8,680

Staff Contact

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Keywords

inoculating, marketing, oyster mushrooms, shiitake mushrooms, substrates

Project Summary

This project was designed to address several questions and goals. The first was to attempt to grow shiitake mushrooms on a variety of hardwood trees. Shiitake mushrooms are known to grow best on oak species, however in northern Minnesota oak trees are not abundant. Is the lack of oak trees a deterrent to shiitake production, or could another hardwood species such as maple provide an adequate substrate for shiitake cultivation?

Also of interest was how well shiitake mushrooms would grow in a northern climate and what strains of spawn would perform the best in a cold climate.

The third goal was to develop a market in the Duluth, MN area for organically/locally grown mushrooms (farmers' markets, restaurants and/or grocery stores). Oyster mushrooms were grown on straw and on locally available tree species and marketed along with shiitake mushrooms.

The outcomes for both cultivation and marketing showed some surprising results.

Project Description

The site of this project was in rural Duluth where I grow a variety of organic vegetables and fruits, primarily for my own consumption. It was in the late 1990s when my friend and mentor, Rob Aptaker, introduced me to the idea of growing shiitake mushrooms on oak logs. Rob grows shiitake mushrooms in an urban setting in Allentown, PA and taught me how to inoculate logs. I inoculated a few of my own logs and found that I enjoyed growing mushrooms. Rob Aptaker has been a cooperator on this project.

This project is important because the answers gleaned from it will assist others in determining if shiitake cultivation is a viable specialty crop from a socio-economic and consumer acceptance standpoint, as well as climate and tree species relevant to cultivation.

The project began in 2009, and it is important to note that both shiitake and oyster mushrooms take at least 12 months from inoculation to fruiting, which puts data collection about one year behind the project start date. In other words, logs that were inoculated in the spring of 2011 will not appear in this final report. This is unfortunate, because my personal learning curve as well as the quality of logs retrieved for this project both improved over time.

Data collected and displayed in the results section of this report were measured in grams.

Birch log showing mycelium growth of shiitake mushrooms.

Grams were used as a unit of measurement because grocery store containers of mushrooms are available in 100 gram (3.5 oz) units. One container of shiitake mushrooms from a grocery store (not organically grown) costs about $4.30 in Duluth, MN. By displaying results in grams, it is easy to determine the net value of the product.

For shiitake mushrooms, the results compare grams of mushrooms harvested from different tree species and from different spawn strains. Oyster mushroom data compares spawn strains only, as results presented are for mushrooms grown on aspen logs (the preferred wood species for oyster mushrooms).

Obtaining Logs

Each new season begins with obtaining winter cut logs for both shiitake and oyster mushroom inoculation. Trees that are cut in winter have more nutrients and sugars in the wood than trees cut in the growing season, and that is beneficial to the mushrooms. Trees cut after sap begins to rise may easily loosen bark and mushroom yield may be lower. This season I obtained 100 oak logs from a logger located in Brule in northwestern Wisconsin and 100 maple logs from a second logger north of Two Harbors in northeastern Minnesota. I also obtained two large aspen trees with diameters of 12 – 15", which were used for oyster mushrooms. In 2010, I used 61 oak, 39 maple, 18 aspen and 17 birch trees for shiitake cultivation. In 2009, I utilized 25 oak, 13 maple, 32 aspen and 15 birch trees for shiitake cultivation. The logs used for shiitake were in the range of 4 - 7" in diameter.

Inoculating Shiitake Logs

The shiitake logs were inoculated between April 21 and May 7, 2011. Two volunteers from the University of Minnesota Duluth's Sustainable Agriculture Club assisted with inoculations on April 21. Holes were drilled into the logs using a modified angle grinder (which has more power than a drill) and a 7/16" drill bit with a stop that makes a precise hole to a 1" depth. A palm inoculator was used to deliver the spawn into the hole, which was then sealed with melted cheese wax. Logs were then set out under large spruce trees.

Shiitake Spawn

A variety of spawn strains were purchased from Field and Forest Products, Inc. located in Peshitgo, WI. This company offers a wide range strain that fruits between 55 - 75°F; a cold weather strain that fruits between 45 - 70°F; and a warm weather strain that fruits between 50 - 85°F. Each year of this project I have used different strains from these three different temperature ranges to determine what works best for a cold climate. For 2011 inoculations I used:

Rob Aptaker inoculating logs with shiitake mushroom spawn.

Miss Happiness - cold range – 39 oaks and 6 maples
Snowcap – cold range – 34 oaks
Native Harvest – wide range – 40 maples (suggested for use with maple logs)
New Moon – warm range – 46 maples (suggested for use with maple logs)
West Wind – wide range – 21 oaks and 5 maples

In previous years, I split the spawn between the various tree species, but for 2011 I wanted to go for maximum harvest potential which is why I used only maples for the two spawn strains that were suggested for maple logs (New Moon and Native Harvest). All logs were labeled with the spawn name and date of inoculation.

Oyster Mushroom Inoculation

I used the two common methods of growing oyster mushrooms: the "totem" method, which is used with large diameter (12 – 15") aspen trees, and the "straw in cardboard box" method. As the totem name implies, this inoculation technique places log sections one-on-top of another. I started with a large black plastic trash bag. I placed two big handfuls of spawn in the bottom of the bag, and then a log section about 2' tall is placed on top of the spawn. Next I added another handful of spawn and another log, which is then topped with another handful of spawn. Totem sections were labeled with the spawn name and date of inoculation. The plastic bag is then tied closed and left to sit in a shady spot. Totems were inoculated on May 7 and the bags were

open on August 17, 2011. A total of 13 totem sections were inoculated and all showed mycelium growth upon opening the bags. Generally, these totems will produce mushrooms the following year, although as the results show, I did get some oyster mushrooms in the fall.

Additionally, I inoculated straw in cardboard boxes on May 12 and 16 (opened on June 24) and on June 5 (boxes opened on July 9). The use of straw for inoculation is good for summer flushes of oyster mushrooms (whereas totems generally produce in the fall). Straw provides a quick method for growing oyster mushrooms, but the tradeoff is that you get fewer mushrooms than from the totem method. The method for inoculating straw is much like making lasagna. First the bale of straw is soaked in water (I use a large stock tank) for 3 days to kill any competing spores and weed seeds. Spawn and straw are layered until the straw fills the box. Boxes were labeled with the spawn name and date. I placed a clear plastic sheet on top of the straw and then put the entire box in a black plastic trash bag. The boxes were placed in shady areas. This year I used three strains of spawn; PoHu in three boxes, Italian in five boxes, and Blue Dolphin in one box.

2009 Results

In April 2009, I ordered the equipment and mushroom spawn required to inoculate logs. For this first year I purchased nearly all of my logs from local loggers. My need for logs coincided with a severe ice storm in the Silver Bay area and the aspen, birch, and maple logs I used were salvaged from this ice storm. The oak logs were cut in Wisconsin and purchased through a local logger. I requested winter cut oak logs that were from 4 - 6" in diameter and 30 - 36" in length. Contrary to popular belief, mushroom cultivation must be done on live, healthy logs and the logs should be cut in the winter before the tree uses energy for leaf production.

Shiitake Mushrooms

The logs were inoculated for shiitake mushrooms between April 17 and April 21. Inoculation of shiitake logs consists of drilling 7/16" diameter holes into the logs 1" deep and spaced at 6" intervals along the length of the log and in rows about 1½" apart to create a diamond pattern. The holes are then filled with spawn, which is a mixture of sawdust and mushroom mycelium (purchased commercially). The holes are covered with melted food-grade wax to reduce moisture loss. I inoculated 25 oak, 13 maples, 32 aspen, and 15 birch logs with three different strains of shiitake spawn. The three strains I used fruit under a variety of temperature ranges chosen for a northern climate. Each log was labeled with the type of spawn used and the date of inoculation and then was laid out in a lean-to stacking configuration under the shade of large spruce trees to allow the mycelium to run throughout the logs.

I noticed that either woodpeckers or chipmunks removed some of the wax covering the inoculation holes on the shiitake logs. I plan to use a thicker coating of wax on the holes to prevent this from reoccurring next year.

Shiitake logs generally take 6 months to a year before they are ready to fruit so I will not have results until next year. Next year I will try forcing fruiting to have mushrooms ready for a specific event such as a Saturday farmers' market. I plan to use a stock tank to soak the shiitake logs for 24 to 48 hours (depending on air temperature) and then place the logs in a vertical position for fruiting and picking. I expect it to take about 2 weeks to have mushrooms available for the farmers' market.

Oyster Mushrooms

I used two different growing methods for the oyster mushrooms: the totem method, which is used with large diameter soft hardwood tree species, and the "straw in cardboard boxes" method. The power company was clearing trees from a nearby right of way and I was fortunate to obtain winter cut, large diameter (8 - 10") aspen logs cut in about 2' lengths. These logs were inoculated between April 20 and April 24 with the totem method. This involves placing a handful of spawn in the bottom of a large plastic bag, then placing the largest diameter log upright on top of the pile of spawn, then another handful of spawn on top of that log, then the next largest diameter log on top of that one, capped with more spawn. The idea is to create a totem pole of logs, using the largest diameter first for stability and then alternating logs and spawn, using two lengths of logs. Then the black plastic garbage bag is drawn up and over the entire structure and closed loosely at the top.

The logs need to incubate in temperatures of 60 - 80°F for at least 4 months and up to 1 year. I uncovered the logs on September 13 and found that they were covered with white fuzz which indicates mycelium growth. Because I used large diameter logs, I suspect it will be at least 1 year before the logs fruit. Similar to the shiitake mushrooms, I used several strains of oyster spawn to cover a wide range of temperatures and inoculated 30 logs with oyster mushroom spawn. I will have data on mushroom yield next year.

I also wanted to try inoculating straw to have mushrooms in the current season. Straw is a quick way to grow oyster mushrooms with a faster spawn run, but you sacrifice quantity for speed. I purchased one oat straw bale (oat straw is recommended) and set up two cardboard boxes and one wood cold frame growing chamber. Before the straw could be used, it was soaked in a stock tank of water for 3

Totem method of inoculating aspen logs with oyster mushroom spawns.

days to kill other fungi and bacteria. Inoculating straw is like making lasagna, alternating layers of spawn and straw until the box is full. I placed two big handfuls of spawn on the bottom of the box, then straw, then more spawn, until I reached the top of the box. Then I used a clear, heavy plastic over the top, folded the box tops back into place, and placed a black plastic bag over the entire box to prevent any seeds in the straw from sprouting. The boxes are set in a shady location to rest for 1 month. After a month, I took off the black plastic, puffed the clear plastic up to make a little tent and every other day I misted the top of the straw with water. The three boxes were all started on May 10 and fruiting began on June 23 in the cold frame and July 8 and 10 in the cardboard boxes, and continued through September (Table 1).

Table 1. 2009 Oyster Strains and Straw Production

Oyster Strain	Total Grams Produced
Grey Dove (cold frame)	1,951.8
Grey Dove (cardboard box)	1,352.2
Italian (cardboard box)	1,320.9

As a point of reference, a container of oyster mushrooms purchased in a grocery store in Duluth weighed 100 grams (3.5 oz) and cost $3.49. The expense for this method of growing included the straw ($6.00), the spawn ($46.00), and a stock tank ($150.00) for soaking the straw in water. So, theoretically, if I sold all the oyster mushrooms that I grew from these three boxes of straw my income would have been $161.40 and my expenses would have been $202.00. Next year's expenses will only be for straw and spawn. The stock tank will be used for many years.

It was interesting to note that the cold frame produced more mushrooms than the two cardboard boxes. The cold frame was placed in a different location from the two cardboard boxes, but was still under a big tree for shade and received the same amount of misting as the cardboard boxes. I believe the humidity was better regulated in the cold frame because there was more space between the straw and the plastic top. There were more spotted beetles in the cardboard boxes than in the cold frame. This leaves me to consider building more cold frames for next season as well as trying floating row covers on the cardboard boxes.

2010 Results

There were many different results to report for 2010. Activities ranged from obtaining and inoculating logs with both oyster and shiitake spawn, as well as harvesting and selling mushrooms.

Obtaining Logs

Obtaining logs is labor intensive and is the aspect of this project that requires the most thought on my part. Purchasing logs from local loggers creates an expense and requires me to travel in order to pick up the logs and bring them to my inoculation site. The spring of 2010, as in 2009, provided an opportunity to obtain some free logs. Just about 6 miles from my home there was a large parcel of land being cleared primarily of aspen, with some birch as well, for future development. I introduced myself to the loggers and told them of my mushroom growing project, and came away with enough aspen for growing this year's oyster mushrooms, and some birch which I used with shiitake spawn. Additionally, I purchased maple, birch, and smaller diameter aspen from a logger in northern Minnesota, and oak from a logger in northwestern Wisconsin. These logs were used for shiitake production.

I am learning the importance of building relationships with loggers and explaining what is required for mushroom logs. The oaks that I had purchased in 2009 were cut, limbed, and

Oyster mushrooms growing in straw in a cardboard box.

Table 2. Oyster Mushrooms on Straw – 2010 Inoculation

Oyster Strain	Date Inoculated	Total Grams Produced
Italian 1	4/26/10	953.9
Italian cold frame	4/26/10	1,291.0
Italian 2	7/3/10	112.5
Italian 3	7/3/10	509.2
Italian 4	7/3/10	66.0
Grey Dove 1	4/26/10	156.6
Grey Dove 2	4/26/10	82.8
Grey Dove 3	4/26/10	0
PoHu 1	6/4/10	1,727.2
PoHu 2	6/4/10	1,520.4
PoHu 3	6/4/10	1,033.3

Table 3. Oyster Mushrooms Grown on Totem Logs – 2009 Inoculation

Oyster Strain	Date Inoculated	Grams Produced in 2010
PoHu 1 – Aspen	4/23/09	510
PoHu 2 – Aspen	4/23/09	74.5
PoHu 3 – Aspen	4/23/09	869.9
Summer Blue 1 – Birch	4/23/09	24.8
Summer Blue 2 – Birch	4/23/09	208.3
Summer Blue 1 – Aspen	4/23/09	572.9
Summer Blue 2 – Aspen	4/23/09	289.3
Summer Blue 3 – Aspen	4/23/09	372.9
Summer Blue 4 – Aspen	4/23/09	741.7
Summer Blue 5 – Aspen	4/23/09	50
Blue Dolphin 1 – Aspen	4/20/09	309.1
Blue Dolphin 2 – Aspen	4/20/09	327.7
Blue Dolphin 3 – Aspen	4/20/09	534
Blue Dolphin 4 – Aspen	4/20/09	436.7
Blue Dolphin 5 – Aspen	4/20/09	473.5

moved mechanically – all of which injured the bark of those trees. A wound to the bark causes moisture loss, which can be detrimental to the mushroom growing process. Therefore, I had several conversations with my oak supplier to see how I could obtain logs that were cut by hand and treated gently! The log supply I received in 2010 was smaller in diameter and better treated, but they were still not the ideal logs in size and condition. My hope for 2011 is to be able to cut my own oak trees, or at least be present to supervise the cutting. The maple, birch, and aspen logs purchased in northern Minnesota were treated very well and I have had no problems with bark damage.

Inoculating Shiitake Logs

Inoculation for shiitake mushrooms occurred from April 15 to 18. An important difference between this year and last was the use of a drill bit with a stop on it, which allowed for drilling a hole to the exact 1" depth needed for use with the inoculation tool. Inoculating at this depth will help prevent chipmunks from getting at the spawn.

This year I used four strains of shiitake spawn that provides for a range of fruiting temperatures. I used a warm weather strain that was developed specifically for use with softer woods on some of the maples, birch, and aspen. All totaled I inoculated 61 oak, 39 maple, 18 aspen, and 17 birch logs.

On 12 of the largest diameter birch, I experimented with a "kerf" type of inoculation. Kerf inoculations are made by cutting across the log with a chainsaw to a depth of about 1", and then packing the cut with spawn and covering with melted cheese wax. I chose to do this because there were a few cuts in the bark of the larger birch logs. All other logs were inoculated with a palm inoculator and sawdust spawn and the holes were covered with melted cheese wax.

Inoculating Oyster Mushrooms

Once again I used the two common methods of growing oyster mushrooms: the totem method, which is used with large diameter aspen, and the "straw in cardboard box"

Soaking shiitake inoculated logs to stimulate fruiting.

method. I used large diameter (6 - 8") aspen trees, which were logged before the buds began to swell from an area that was being cleared for development. I set up 11 totem configurations (spawn, log, spawn, log, and spawn, all in a large plastic trash bag) on April 24. The totems stayed covered in the plastic bag (which maintains both moisture and warmth) until August 19 when they were uncovered. All of the totems had white mycelium growth. The totems were labeled with the name of the spawn used and the date. The totems should produce mushrooms in 2011.

Additionally, I inoculated a total of 11 cardboard boxes and one cedar cold frame by alternating layers of spawn and straw. The bales of straw must first be soaked in water for 3 days as a way to sterilize and pasteurize it. After layering spawn and straw, I placed clear plastic over the top of the box and placed the entire box in a large black plastic trash bag to retain moisture and temperature. These bags were opened 1 month later and the clear plastic was puffed up to create a little tent to retain humidity. I used three different strains of oyster mushrooms (Italian, PoHu, and Grey Dove) that fruit over different temperatures. I inoculated the straw at various times throughout the spring and summer to match the preferred temperature ranges. These strains were chosen because of good production in 2009 for Italian and Grey Dove and because PoHu is a strain designed especially for use with straw.

Fruiting Results - Straw
The results are given in grams to provide a reference point for market (Table 2). A container of oyster mushrooms purchased in a Duluth grocery store weighs 100 grams (3.5 ounces) and costs $3.49. The Italian strain planted in the spring produced more volume of mushrooms than in the summer. For a second year, the cold frame produced a higher volume than most of the cardboard boxes. Grey Dove did not perform as well in 2010 as in 2009 and this could have been a result of temperatures or moisture (locations were identical for both years). The super performer of 2010 was the PoHu strain, which was specifically developed for use on straw. It is interesting to note that when box #1 was opened on July 4, mushrooms were found growing all over the box and in one picking produced 1,221.7 grams or 2.69 pounds of mushrooms!

Fruiting Results – Oyster Totem Logs Inoculated in 2009
The fall of 2010 was fairly wet and this was very beneficial to the totem logs inoculated in 2009. Fruiting of the totem logs began on October 2 and continued on some logs until November 11 (Table 3). Most of the logs were large diameter (7 - 10") aspens that were winter cut and inoculated between April 20 & 23, 2009. I also inoculated a few birch logs to see if they worked.

Not all logs inoculated in 2009 bore fruit in the fall of 2010 (none of the Italian inoculated logs fruited) and those that did produce fruit provided a relatively small amount for totem log cultivation. This leads me to believe that the logs that did produce fruit will fruit again in 2011 and those that did not fruit at all very likely will this upcoming year.

The largest profusion of mushrooms was found closest to the ground around the base of the logs and in the leaf litter. Fewer mushrooms were produced on top of the log or in between the two logs. The mushrooms produced from the totem logs seemed to dry up faster than those produced in boxes (with plastic over the top) and this provided a smaller window for picking. It wasn't uncommon for me to note a small mushroom one day and find that it had dried up by the next day. Therefore, I picked these mushrooms at a smaller size than I did the mushrooms grown on straw.

Fruiting Results – Shiitake Logs Inoculated in 2009
Oak, aspen, maple and birch logs were inoculated in 2009 with three strains of spawn to cover a range of temperatures. The log diameters were about 5 - 6" which were on the large end of what is typically used for shiitake cultivation and I anticipated that mycelium runs would take longer, hence a delay of at least 1 year for mushroom production.

On April 19, I noticed shiitake mushrooms starting to develop on 1 oak log, 2 maple logs, and 1 birch log. I placed these logs upright against a large spruce tree and watched daily for additional growth. I was able to pick just a few mushrooms from each log and when no more mushrooms came, I decided to soak those logs in a tank of water to attempt to stimulate more fruiting. The logs were soaked in a stock tank for 24 hours and then reset upright against a large spruce tree. The oak log and two birch logs responded to the soaking, but again only with a

few mushrooms. I will watch these 2009 inoculated logs closely for signs of fruiting in 2011 and will attempt to stimulate fruiting by soaking the logs in a stock tank.

Marketing Mushrooms

I had enough oyster mushrooms at the right time to attend three farmers' market days. I attended the market held on Wednesdays at the University of Minnesota, Duluth twice and attended the Brimson Farmers' Market once on a Saturday. Although I made very little money from my mushrooms, I learned some valuable information that will help me at future farmers' markets.

The first thing I learned is that oyster mushrooms do not have a long shelf life. I can hold them in my refrigerator for two days if they are picked just before their prime. This becomes a difficulty if market day is held once a week. Attending various markets on different days will help with this problem. Additionally, mushrooms do not like sun, requiring an umbrella or tent-like structure to shade them during market.

I spoke with some blueberry marketers at a market and they shared with me that they take orders in advance and when the berries are ready they call their customers. I thought this would be useful for my marketing and would help eliminate the short shelf life dilemma. I plan to try this next year.

Another problem I ran into was the flush of mushrooms produced from the totem logs in late fall. All of the markets were closed for the season and I had several pounds of mushrooms. I called a restaurant that uses local and organically produced foods and told her about my mushrooms and I asked for $30.00 for the 2 pounds that I had. She told me that her supplier in Minneapolis sells them to her for $21.00 for 5 pounds. An industrial mushroom grower undercut my prices! I ended up drying the mushrooms in a food dehydrator, and realized this will provide a good way to save mushrooms I can't sell immediately.

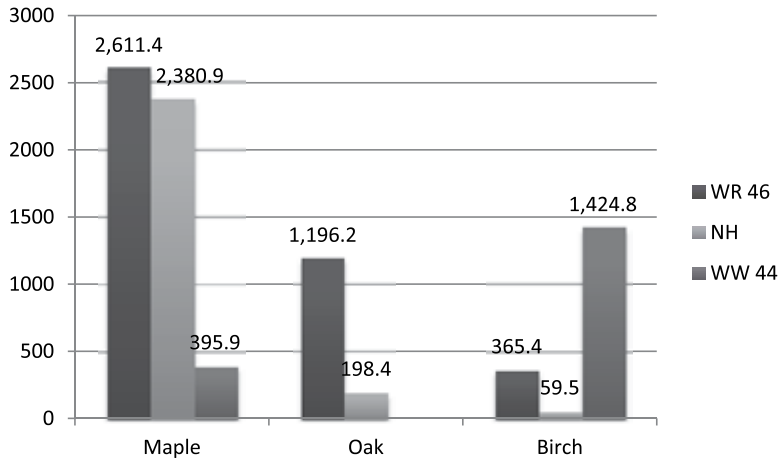
Shiitake mushrooms on oak logs.

2011 Results

Keeping in mind that logs inoculated in 2011, the third year of this project, will not fruit until 2012. The following results for shiitake and oyster mushrooms include those logs that were inoculated in years 1 and 2, in 2009 and 2010 respectively. Both shiitake and oyster mushroom logs will produce for several consecutive years.

Mushrooms were picked daily when present, allowing for each mushroom to reach a maximum size. Each producing log was numbered and labels provided the spawn type and date of inoculation. In this manner, I was able to keep records of each log's productivity. Weight measurements were made using an Acculab Vicon scale.

Table 4. Shiitake Mushroom Production in 2011 from Logs Inoculated in 2009

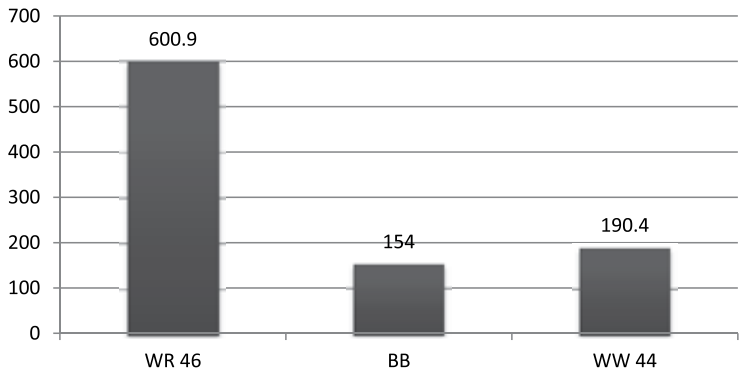


Shiitake Mushrooms Production

In 2011, I collected shiitake mushrooms from logs inoculated in 2009 and 2010. Oak, maple, birch and aspen logs were inoculated with a variety of shiitake mushroom strains in 2009 and 2010. Unfortunately, there were no shiitake mushrooms produced on aspen logs. These logs are too soft of a wood and dried out quickly, never giving the mycelium the opportunity to run.

The oak logs that were obtained in 2009 were not appropriate for mushroom production and this had impacted the data and results for year

Table 5. Shiitake Mushroom Production in 2011 from Logs Inoculated in 2010



one. It is important for interested mushroom growers to learn from my mistake. Many loggers use heavy equipment to drag logs from the forest and then place the logs in a mechanical de-limber that damages the bark. Bark that is split or has holes in it will dry out and not provide a good host environment for the mycelium. Despite the damage to my logs in year one, I went ahead with inoculation in the spirit of experimentation. However, a true comparison of spawn types and tree species is hard to obtain for 2009 logs because of the condition of these logs. Table 4 shows the various types of spawn strains and tree species used in 2009.

The spawn strain WR 46 was superior to other spawn for oak and maple species. This is a wide range spawn that produces mushrooms in the 55 - 75°F temperature range. The fact that shiitake production in maple was higher than in oak was most likely a result of the poor condition of the oak logs. However, the fact that WR 46 did well in maple is encouraging for mushroom production in areas without oak trees.

Also of interest is that WW 44, a warm weather strain, grew mushrooms in birch, a tree species not used for shiitake production. It may be possible to add birch as a mushroom producing log; this is encouraging as birch is readily available in northern regions.

Despite soaking logs from all tree species (soaking stimulates mushrooms to fruit) from the 2010 inoculation, only oak logs produced mushrooms this year (Table 5). These oak logs were in good condition and had not been mechanically manipulated like those from 2009. I anticipate that additional maple, oak, and birch logs will fruit in 2012 as the spawn continues to run throughout the logs. It is not unusual for logs to require more than 12 months before they fruit. As with the 2009 logs, WR 46 was again the most productive strain of spawn. Spawn strains used in 2010 included: WW 44 - a warm weather strain that fruits between 50 and 85°F, New Moon (NM) - also a warm weather strain, Bolshoi Breeze (BB) - a cold weather strain that fruits between 45 and 70°F, and WR 46 - a wide range strain that fruits between 55 and 75°F.

Unfortunately, I must conclude that due to the time required for logs to go from inoculation to production, this data really is incomplete at this time. The condition of the 2009 oak logs do not allow for a conclusive assessment of spawn in oak logs. Year 2 logs, which were inoculated in 2010, will likely produce vigorously in 2012. Year three logs were inoculated in 2011 and no data is available.

Total shiitake mushroom production in 2011 came to 10,036.2 grams or 100 boxes weighing 100 grams. At the prevailing market price of $4.30 per box, that would have a net market value of $430.

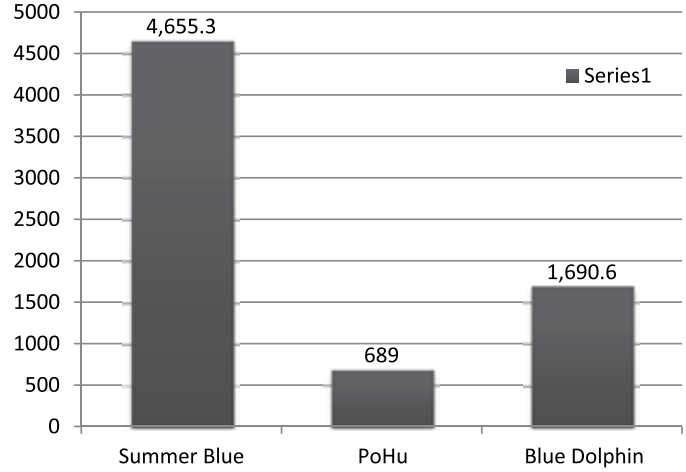
Oyster Mushrooms Grown in Straw
Similar to the shiitake mushrooms, the year 2011 produced mushrooms from logs inoculated in 2009 and 2010. A few mushrooms were obtained from the PoHu and Blue Dolphin strains of spawn, but not enough to market. The spring weather was cold and rainy which caused all but two boxes to become moldy.

Oyster Mushrooms Grown on Aspen logs – Totem Method
This year's production occurred from aspen logs inoculated in 2009, 2010, and 2011. The total weight in grams for the 2011 production of the 2009 inoculated logs was 1,527.8

Table 6. Comparison of Oyster Mushroom Production in 2011 from Logs Inoculated in 2009 and 2010 - Totem Method

Summer Blue (grams)		**PoHu** (grams)		**Blue Dolphin** (grams)	
2009	2010	2009	2010	2009	2010
1,527.8	862.2	2,233.5	1,454.4	3,051.7	1,607.5

Table 7. Oyster Mushroom Production in 2011 from Logs Inoculated in 2010 – Totem Method



grams from Summer Blue, 2,233.5 grams from PoHu, and 3,051.7 grams from Blue Dolphin.

For comparison, these same logs produced mushrooms in 2010, but in smaller amounts. Summer Blue produced 862.2 grams, PoHu 1,454.4 grams, and Blue Dolphin produced 1,697.5 grams (Table 6).

Mushrooms are sensitive to a variety of factors including temperature, humidity, and amount of rainfall. Any one of these factors could have resulted in the fruiting differences.

Logs that were inoculated in 2010 also fruited in 2011 (Table 7). The strain Summer Blue was a proven winner producing 4,655.3 grams, vastly outperforming PoHu and Blue Dolphin. In addition to being productive, these mushrooms are a beautiful shade of blue turning to blue-grey as they mature.

A few logs that were inoculated with the strain Grey Dove in the spring of 2011 produced a flush of mushrooms of 641.1 grams in the fall of 2011.

The oyster mushroom strains Summer Blue and Blue Dolphin were the most productive compared to all strains that produced in 2010 and 2011. Mushrooms produced were big, firm, beautiful, plentiful, and tasty!

The downside of the totem method for Oyster mushrooms is that this method produces fall mushrooms. All of the 2011 mushrooms came in October, well after the local farmers' markets closed for the season.

Oyster mushroom production in 2011 came to 14,489 grams. Theoretically, in terms of marketing, this amounts to 144 boxes at 100 grams each, with a value of $3.50 each (the going grocery store rate), or a total net value of $504. Realistically however, mushroom fruiting occurs at the will of the mycelium; sometimes a few mushrooms at a time, other times the day after market, or in the fall after markets close. I provide more information on this in the marketing section.

Marketing Mushrooms

As I alluded to earlier, small-scale mushroom production created some difficulties with marketing. Growing oyster mushrooms on straw helped to provide summer flushes, which could be taken to market. To be more financially viable, many more boxes of straw would need to be inoculated. The main problem I contended with in growing oyster mushrooms in straw was not having enough mushrooms that were ready for market day. The shelf life of oyster mushrooms is about 5 days in the refrigerator. If a farmers' market occurs once a week, these mushrooms would not be fresh. Having more boxes and spacing out the timing of inoculation may assist with this problem.

Oyster mushrooms grown on aspen logs tend to fruit in the fall (October and November in my case) and this is well after farmers' markets have closed for the season. Both years forced me to use a food dehydrator to dry the oyster mushrooms. It could be possible to develop a market for dried mushrooms in the future.

I ran into similar volume and market day readiness issues with the shiitake mushrooms. However, when all 3 years of my logs are producing, I will have more volume and this should eliminate not having enough mushrooms ready for a market day.

The total volume of oyster and shiitake mushrooms produced in 2011 would have amounted to a market value of about $900. In reality though, I only had enough volume to make marketing worthwhile on three occasions. My income for 2011 was about $105 dollars. I have been developing an email list that will allow me to send out alerts when I have mushrooms and this will facilitate selling small quantities.

While attending farmers' markets I found that many people were not familiar with oyster or shiitake mushrooms. I spent a fair amount of time educating potential consumers about how I grow mushrooms (people thought they were wild mushrooms) and how to cook them. For 2011, I created two "science fair" type of display boards showing the various procedures in growing shiitake and oyster mushrooms. I used these displays at my field day held in

July and found that it provided a backdrop for teaching about mushroom cultivation. I now take these displays with me to farmers' markets and find that it creates a bridge to dialogue with potential customers.

Management Tips

1. Use a thick coating of wax to cover the inoculation holes to prevent damage from woodpeckers or chipmunks.

2. Use floating row covers on oyster mushroom boxes. These will protect the mushrooms from damage from spotted beetles.

3. The logs are hard to identify as they age. To keep track of the logs, write the tree species, strain of mushroom, and date on the log with a permanent marker. Metal labels decompose, fall off, and bend and therefore are not reliable.

4. Use a drill bit with a stop on it to make the correct size hole in the logs.

5. Pay attention to oyster mushrooms fruiting on totem logs so that they don't dry up.

6. Build relationships with loggers so that they understand what is needed for mushroom logs.

7. If you cannot sell all of the mushrooms you can dehydrate them in a food dehydrator to use or sell later.

8. Store mushrooms in a plastic container rather than a plastic bag. This will help them keep longer.

9. Mushrooms do not like sun and heat. Bring a shade structure, a cooler and ice packs to help keep mushrooms cool.

Cooperators

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David Abazs, Round River Farm, Finland, MN

Project Location

This project is located on the edge of Duluth and Rice Lake Township. Take I-35 north to the 21st Ave. E. exit. Take 21st Ave. E. to Woodland Ave. and bear right (north). Take Woodland Ave. to the three way stop sign at Calvary St. and turn left. The next street you come to is Arnold, turn right. Take Arnold to Rehbein and turn left.

Other Resources

Field and Forest Products, Inc. Mushroom spawn, instructions, and growing supplies. Peshtigo, WI. 800-792-6220. Website: *www.fieldforest.net*

Fungi Perfecti. Mushroom spawn and growing supplies. Olympia, WA. 800-780-9126. Website: www.fungi.com

Kozak, M.E.; Krawczyk, J. (1993). Growing shiitake mushrooms in a continental climate. Peshtigo: Field & Forest Products, Inc.

Feasibility of Small Farm Commercial Hop Production in Central Minnesota

Principal Investigator

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Project Duration

2009 to 2011
Award Amount
$12,535

Staff Contact

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Keywords

beer, bines, brewing, cones, hops, lupulin, trellis

Project Summary

A restaurant that supports locally grown foods asked us about supplying locally grown hops and herb ingredients to a newly formed local brewing company. Preliminary review indicated that established hop rhizomes are known to survive winter temperatures down to -35°F and that the hop plant is compatible with soil types occurring in the Central Minnesota Lakes area. Locally grown hops for local and regional craft and microbreweries and brew pubs could be a market for small and medium-sized sustainable farming operations. Further review suggested that modification of our existing 10' deer fence and line posts could support hop trellises while protecting hop bines from deer damage. This project studies the feasibility of using existing farm infrastructure to develop a market for locally grown hops while increasing the return on investment made in deer protection.

Project Description

The Farm on St. Mathias (The Farm) is an 80-acre fruit and vegetable farm located near Brainerd, Minnesota. We grow a variety of hybrid and heirloom vegetables on approximately 30 acres, with eight of these located inside a newly constructed woven deer fence. Local markets include an on-farm market and country store, a 50 member community supported agriculture (CSA), a local restaurant supply store, and fall activities like pumpkin sales, a corn maze and hayrides.

Hops are a perennial vine that grows from a crown and rootstock. Runners from the crown, called rhizomes, grow just under the soil surface. Cuttings from these rhizomes serve as planting stock for new hop vines. Hops produce shoots called "bines" that can grow as much as 25' in one season and that wind clockwise around whatever support is provided.

The hop plant is dioecious, meaning that it bears both male and female flowers on separate plants. The female flowers form papery "cones," which are 1" to 4" long and bear seeds. It is these cones that are used in brewing. They contain a compound called lupulin, which is made up of the essential oils and resins that impart hops' unique aroma and bitter flavor. Our research suggested that in prime hop growing areas, mature hops can yield from 1 to 3 lb of dry cones per bine.

We set out to determine which hop varieties would grow best in north central Minnesota and to test the suitability of using existing deer fence for hop trellises. Commercial hop

Hops are a perennial vine.

production typically uses 18' vertical trellises, but recent studies have investigated a new management technique that could save 30% in labor costs when harvesting hops. This method involves growing the hops on lower trellises – about 10' high – with 15' diagonal trellis runs. Lower trellises eliminate the need for expensive mechanical support and labor for stringing, training, and harvesting of hop plants.

The basic design of this project involves establishing three planting areas within the existing deer fence and using the fence posts as trellis supports. We selected the planting locations based on radiant exposure and soil types in order to create distinct comparisons between planting areas. We are testing seven hop varieties: Cascade, Chinook, Fuggle, Kent Golding, Mt. Hood, Nugget, and Willamette.

We are evaluating six specific measures for each hop variety:

- yield;
- winter survival;
- incidence of disease or pests impacting rhizome survival;
- analysis of hop cones and associated plant structures;
- standardized brew testing; and
- marketability of hop cones.

We tried and liked a new trellising system in 2011.

Lupulin glands in a hop cone. This is the compound that imparts hops' unique aroma and bitter flavor.

2009

Since hops prefer well drained soil, we dug furrows approximately 5' long and filled them with black dirt mixed with peat from a local wild rice bog production farm. At each fence post, we formed two hills approximately 3' apart, 6' in from the deer fence. We planted two rhizomes of the same variety per hill (four of the same variety per post). We planted 10 hills (20 plants) of Fuggle, 8 hills (16 plants) of Chinook, and 6 hills (12 plants) each of Kent Golding, Mt. Hood, and Willamette along the north fence, creating the southern exposure that is recommended by most reference materials. We planted 6 hills (12 plants) of Cascade on the west fence (eastern exposure) and 4 hills (8 plants) of Nugget on the south fence (northern exposure). You can find a layout of our design in the 2010 Greenbook.

In 2009, we planted the hop rhizomes on May 4. By May 17, hops were up and growing, with Fuggle and Kent Golding being the most vigorous. The vigor may have been due to the moist soil, since these varieties prefer a more moist growing condition. By May 25, approximately five Chinook and five Mt. Hood plants had disappeared – lost either to frost or rabbits. We mulched the remaining hop plants with a mixture of llama and chicken manure combined with straw from our farm.

In July, we trellised the hops using 1/2" and 3/8" biodegradable sisal rope. At the bottom of each hill, we drove two 3' garden stakes into the ground. We cinched a rope to the garden stake, and anchored it to the fence post with fence nails or U shaped nails. This technique proved technically simple and provided strong, yet sustainable, support for the hop bines.

We sealed the hops in airtight plastic bags.

In their first year, many of our plants did not grow much more than 4'. We suspect they were investing energy in establishing roots, rather than producing above-ground vegetative growth. Only two varieties, Cascade and Nugget, produced any cones at all. We harvested them on September 25 and, due to the small amounts, air-dried them for about 2 weeks rather than using a commercial dryer. Cascade and Nugget, each produced four cups of cones after drying. We stored the hops in an airtight container in the freezer.

In October, we mulched the hills with at least 2' of straw on top of each mound. While several local ornamental hop growers do not mulch their hops at all, we felt we needed to provide some straw mulch to protect the plants. We were also hoping for good, insulating snow cover during this first critical winter.

2010

This was the first time we tried overwintering the hop rhizomes. In spring, the bines surfaced through the straw mulch. We had a survival rate of 90% (five mounds had no rhizomes). The varieties that struggled to survive include Chinook and Mt. Hood. It is interesting to note that both of these died after initial planting in 2009 and had to be replanted.

We allowed the vines to grow without interference until they were about 1' long. At that point, we left 2 to 6 vigorous vines growing in each hill and removed the rest. We did not remove the straw mulch we had applied last fall to protect the hop plants over the winter; it proved valuable in weed control and moisture preservation during the growing season. We conducted soil testing in April and again fertilized the hops using a mixture of black dirt, peat from a local wild rice bog, and llama/chicken manure.

The trellising we built in 2009 was still good in 2010, and we again trained the bines to grow clockwise on the trellis. We harvested the cones on August 30 and September 1, about 1 month earlier than the previous year. We dried the cones using a Lem stainless steel dehydrator with ten trays, then used a Food Saver to vacuum seal each ounce of dried hops in a separate plastic bag.

We conducted brew tests in January with our restaurant partner and other cooperators. Sample brews included Lefse Blonde, Smashing Pumpkin Ale, Kolsch, Irish Draught Ale, Pale Ale Deconstructed, 13th Apostle Barleywine and Peat Smoked Porter. Approximately 70 tasters were on hand. The amount of hops to use during beer brewing depends on the variety of beer being made and personal taste preference. Typically, 1-2 oz of dried hops per 5 gal of brew is considered a moderate amount. Less can be used if the brewer prefers a milder, less bitter flavor. A true "hoppy" brew can use as much as 4 oz of dried hops per 5 gal. The highlight of the tasting was the pouring of the pale ale over the dehydrated hops for an extra kick of fresh hop flavor.

2011

This was the third and final year of our project. In spring, we found rhizome survival rate was approximately 85% (with six mounds devoid of any rhizomes at all). Chinook and Mt. Hood performed poorly again this year. If used at all, they should be planted with full southern exposure.

As in 2010, we waited until the bines surfaced through the straw mulch and reached about 1' long. At that point, we selected 2 to 6 vigorous bines and removed the rest. The bines grew independently on a new trellising system, described below. We fertilized them with the black dirt, peat, and llama/chicken manure mixture and left the straw mulch in place.

Table 1. Soil Analyses, 2010 and 2011

Sample #	Soil Texture	Organic Matter 2010	Organic Matter 2011	pH 2011	pH 2012
1 (southwest field)	Course	1.3	2.0	6.7	6.1
2 (northeast field)	Course	1.9	2.2	6.8	6.1

Table 2. Hop Yields (per variety), 2010 and 2011

Variety	Dry Weight 2010 (oz)	Dry Weight 2011 (oz)	Increase in Yield (oz)
Cascade	20.5	51.5	31.0
Chinook	2.1	11.0	8.9
Fuggle	15.3	16.0	0.8
Kent Golding	1.9	5.3	3.4
Mt. Hood	1.4	9.0	7.6
Nugget	7.8	27.0	19.3
Willamette	2.0	9.5	7.5
TOTAL	**3 lb, 1.8 oz**	**8 lb, .08 oz**	**4 lb, 8.8 oz**

We took soil samples from hop yards in late April (Table 1). We still think our soils are almost ideal, and that with the mulch and other organic nitrogen and micro-nutrient sources we have been applying, our soil organic matter will increase and benefit hop production.

This year, we tried something new: we trellised hops using 10' wide polypropylene mesh. For each mound, we used two 3' steel garden stakes to anchor rope. It was cinched at the bottom and anchored to the post with fence nails or U-shaped nails. This technique proved technically simple and provided strong, yet sustainable support for the hop bines. It was also a beautiful display as the hop bines grew across the mesh support.

We harvested the hop cones on September 2. While typically hop bines are cut down and harvested off the bine, with the polypropylene mesh, we gently pulled down the mesh and harvested the cones off the bine. It should be noted that in the vein of sustainability and utilization of the entire plant, the bine itself can be used as an art form by making hop wreaths as well.

We dried and packaged the hops using the same method as described in 2010. Yields are reported in Table 2. Once again, we made the hops available to our cooperators for brewing, with a brew tasting scheduled for February, 2012. We are continuing to work with some of our cooperators to research the feasibility of constructing a brewery which will, of course, use locally grown hops!

Conclusions

The greatest barrier we experienced in our hop study was not whether they could make it through Minnesota's seasons (most could), but the labor intensity of harvesting and the immediate processing required for the stability of the product. In addition, the new trellis system we erected in 2011 took a lot of labor hours, but it is ultra violet radiation resistant, and substantially more durable than the sisal rope system, having an estimated three to four year durability (vs. a single year for rope).

We now have a tremendous hop system established. Establishing a cash crop return on investment requires intensive market development for new local commercial micro-brewers, who in our current market are also launching new product. While there is marketability in the fact that we grow a seasonal ingredient and can demonstrate proven growing techniques, we have found it is quite difficult to market hops to local breweries, because they are interested in the consistency of the alpha and beta acid lupulin content for a branded beer and are not micro brewing with local ingredients like hops. Their preference for consistency has proven to be a significant marketing barrier in the return on investment for growing hops. We think some marketing solutions might include projected advanced sales of "wet hops" for labeled fall seasonal brewing and dry hops for spring seasonal products—specifically labeled as "using locally sourced hops." There is also the local home brew enthusiast who values local hops as a premium ingredient.

Our product availability has allowed us to partner with both local home-brew enthusiasts and emerging local commercial micro-brew operations for marketing and demonstration events necessary for market development. We will continue in our endeavors at marketing and will continue working with local community members interested in micro brewing with local ingredients (herbs, spices and hops). For example, cooperator Patrick Sundberg has successfully secured licenses from the

State of Minnesota and City of Baxter to open a tap room attached to his microbrewery, Jack Pine Brewery. We will be working to scale up production of the varieties of hops and herbs Patrick may want to use.

While lovely to grow, we wouldn't currently recommend them for the return on investment as a cash crop, and while many local community members who come to the farm to tour the hop trellises, we are not aware of any local farmer who is interested in pursuing hops as a cash crop.

Management Tips

1. When the young vines are about 1' long, select 2 to 6 vigorous vines for each hill and remove the rest. Train the vines clockwise on the trellis. Lateral side arms will extend from the main vine and produce flowers. The main concern is to support the vines and prevent the side arms from tangling. Most cones are produced on the upper part of the plant.

2. In midseason, remove the lowest 4' of foliage and lateral branches to increase air circulation and reduce the opportunity for fungal disease. After pruning, allow additional bottom growth to remain, to promote hardiness of the crown and plant vigor for next year. This procedure is critical in years where cool, moist summers promote fungal disease.

3. As they approach maturity, hop cones can become overripe and desiccate rapidly. It is crucial to observe the hops with increasing frequency as harvest approaches in order to avoid over-maturity, reduced productivity, and an inability to use the fruiting bodies for the desired bittering.

4. At the end of the season, bury healthy bottom vines for propagating new plants next spring. Simply bury the vines in a shallow trench and mark their location. In the spring, dig them up and cut them into pieces about 4" long. Make sure each new cutting has an eye or bud, then plant the cuttings in a new hill.

Cooperators

Kevin Happke, Sustainable Farming Association of Minnesota – Central Chapter, and Rolling Hills Greenhouse, Pierz, MN
Jesse Grant and Dan Stanifer, Brainerd Lakes Brewery, Inc., Brainerd, MN
Erik Sjoberg and Patrick Sundberg, Independent Homebrewers

Project Location

From Brainerd, travel south on Business 371 and turn left on Cty. Rd. 21/St. Mathias Rd. and travel about 3 miles.

Other Resources

Agricultural Research Service. 2009. Hops – New Markets and Better Storage. United States Department of Agriculture. Washington DC and Beltsville, MD. *www.ars.usda.gov/is/ar/archive/jan08/hops0108.htm*

Ale and Artifacts. 2009. Hop Rhizomes – Harvest and Drying. Alternative Beverage. *ebrew.com/primarynews/hop_rhizomes_harvesting.htm*

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Government of Alberta. 2001. Soil organic matter. *www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex890*

Hiller, S.M, G.A. Gingrich and A. Haunold. 1996. Growing Hops-In the Home Garden. In The Draught Notice. *http://oregonhops.org/culture2.html*

Hop Research Council. Aurora, OR. *www.hopresearchcouncil.org*

Oregon Hop Commission *www.oregonhops.org*

Richardson, Renee. 2012. Jack Pine Brewery gets approval from Baxter Tuesday. Brainerd Dispatch. May 12. *brainerddispatch.com/news/2012-05-15/jack-pine-brewery-gets-approval-baxter-Tuesday*

Fertilizing with Alfalfa Mulches in Field Crops

Principal Investigator

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Lac Qui Parle County

Project Duration

2010 to 2012

Award Amount

$9,056

Staff Contact

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Keywords

Nitrogen, mulch, organic farming

Project Summary

Providing the nutrient needs for corn and small grain on an organic farm without livestock is a challenge due to a lack of on-farm forage and manure cycling. My project is an attempt to determine if on-farm produced alfalfa hay mulch can supply an adequate and reliable source of nitrogen and other plant nutrients to corn and small grain. In the spring, alfalfa hay is green chopped, analyzed for nutrients, and spread on the row crop ground. A secondary goal is to determine the efficiency of recycling farm produced nutrients through the mulch process.

If the project is successful, it will go a long way in alleviating the growing issue of low fertility on my farm. The alfalfa mulch should also improve weed management and enhance soil structure. On-farm production of fertility should reduce input costs and increase income by allowing me to maintain my certified organic status.

Project Description

In our current agricultural climate, many organic and conventional producers have operations without livestock. Alfalfa is grown for its soil building attributes. However, when the alfalfa is harvested as hay and sold off the farm, nutrients essential to plant growth are also exported in the hay.

I lost my livestock enterprise several years ago and have since been without a reliable source of hog manure. I previously used the manure to replenish soil nutrients needed for corn and small grain production.

Alfalfa is an ongoing component of my crop rotation. This demonstration is using a portion of my alfalfa hay crop to enrich the soil for grain crops.

On August 23, 2010, following the harvest of winter wheat, alfalfa hay was spread as mulch in preparation for a crop of barley to be planted in the spring of 2011. A side delivery hay processor was used to shred 1 ton round bales of alfalfa and distribute the mulch (see photo). The hay processor is normally used to feed cattle in feed bunks or on open range. The distribution of the mulch was reasonably uniform. The mulch was worked into the soil using a chisel plow.

Field corn will follow the barley in 2012. Fertility for the corn crop will be supplied by a second application of alfalfa hay mulch after barley harvest in August of 2011.

Alfalfa round bales spread as mulch using a side delivery hay processor.

Table 1. Plot Layout for Alfalfa Mulch Demonstration (individual plots are 30′ x 200′)

CONTROL	FULL RATE MULCH	CONTROL	HALF RATE MULCH	CONTROL	HALF RATE MULCH	CONTROL	FULL RATE MULCH

In order to determine the value of the alfalfa mulch to the following crops and soil, replicated strips are being applied to the field (Table 1). The treatments include:

- full rate application of mulch;
- half rate application of mulch; and
- no mulch control.

A forage analysis revealed that the alfalfa hay contained approximately 20% protein or 7.5% nitrogen (% crude protein/2.65 = % nitrogen). This means the full rate mulch treatment received 465 lb N/A. Due to the slow release nature of the mulch fertility, only a portion of this will be available to the barley crop.

Results

Selected plots were sampled in late fall for soil analysis. This provides a baseline for future reference for soil attributes expected to change slowly over time such as organic matter, pH, and micronutrients. A positive trend in nitrogen and potassium levels had already been detected due to the addition of the alfalfa mulch (Table 2). The same was not true, however for phosphorus.

Due to a narrow window for harvest, no yield data were collected from the barley plots in 2011. However, visual differences in the plots were easily observed prior to harvest. The full rate mulch plots were darker green, had fuller grain heads, and plants were fully 6" taller than the control plots. The half rate mulch plots were visibly different from both the full rate plots and the controls in both height and density. In 2012, actual yield data will be taken at corn harvest.

I am considering using green chop alfalfa as another alternative to dry hay. I plan to use high protein (high nitrogen) alfalfa for mulch and low protein alfalfa for hay. Although the mulch spread was fairly even, I am considering trying an even finer chop for a more even spread.

This project has initiated interest in more detailed scientific study of alfalfa as a nitrogen source for corn. The University of Minnesota has established replicated plots at Becker and Lamberton for this purpose.

Management Tips

1. A hay processor can deliver an even spread of alfalfa mulch.

2. Fine chop the alfalfa for the most even coverage.

3. An alfalfa forage sample analysis determines protein and, therefore, nitrogen in the mulch.

Cooperator

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

Project 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

Fernholz tests hay as alternative fertilizer, mulch. Agrinews, 9-15-2011. *www.agrinews.com/fernholz/tests/hay/as/alternative/fertilizer/mulch/story-3898.html*

Table 2. Available Major Plant Nutrients in 6″ Soil Sample After Application of Alfalfa Mulch, Fall, 2010

	NO3 Nitrogen (ppm)	Bray Phosphorus (ppm)	Potassium (ppm)
Control	4	13	182
Full Rate Mulch	15	10	308
Half Rate Mulch	17	17	276

McNamara Filter Strip Demonstration

Principal Investigator

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Project Duration

2010 to 2012

Award Amount

$7,094

Staff Contact

Mark Zumwinkle
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Keywords

grass buffers, grass waterways, soil and water conservation, native grasses, feed quality

Project Summary

In southeastern Minnesota, grass waterways and grass buffers provide a stable, cost-effective way to convey and filter storm water before entering perennial streams. Some landowners use these waterways as a hay source for livestock, while others neglect these areas and see them as an annoyance. A well maintained grass waterway can provide large amounts of forage for livestock, as well as reduce erosion in an agricultural setting.

The intent of this demonstration is to compare the amount of forage and feed value produced in four buffers using different seed mixes. Test plots in a waterway and buffer setting have been established for this purpose.

The erosion control, soil filtering, and flood reduction capacities of grass waterways and buffers are extremely important. To test the water quality performance of the seed mixes, we will use a rain simulator to measure water runoff and sedimentation rates exiting each test plot. The seed mixture producing the greatest forage value while still retaining soil stability may be marketed locally.

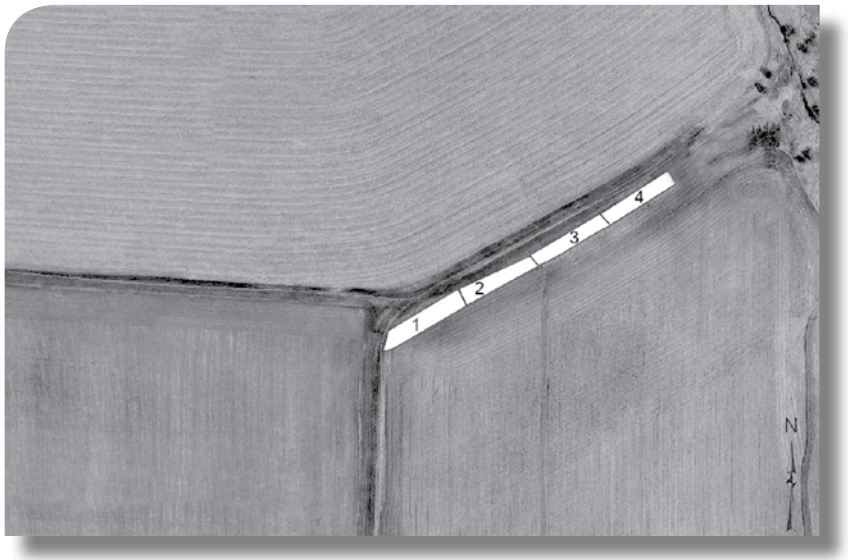
Project Description

This project is located in Goodhue County, roughly 4 miles west of the town of Goodhue. The four test plots are located in an existing grass waterway on Ed McNamara's farm. Ed is interested in improving the overall performance of the grass on his farm. He would like to explore ways to make his waterways and buffer areas produce harvestable forage while still protecting the soil.

The aerial photo shows how the four test plots are situated on the landscape. The seeding was done in corn stubble. We offset the test plots adjacent to an existing grass waterway. They are all approximately one tenth of an acre in size. The dimensions of each plot are roughly 150' x 30'. For the most part, the entire length of the test plots receives the same amount of sheet and rill erosion. We selected this site because the soil characteristics of the cropland are similar to the waterway. These soils have the same productivity indices and similar drainage characteristics. The grass waterways leading to the plot sites are hayed throughout the growing season, allowing easy access during the summer months for data collection and maintenance. Waterways are used throughout the county to help convey runoff in a safe manner. In most cases they flow into an intermittent or perennial stream.

Results

Three of the four test plots were seeded with a John Deere no-till drill operated by the Goodhue County SWCD. Plot 4 was seeded using a Truax broadcast spreader.



Aerial view of four buffer mix test plots adjacent to grass waterway on McNamara farm.

Table 1. Seed Mixes Planted in Buffer Test Plots on July 13, 2010 on McNamara Farm

PLOT 1 Ed's Mix 1 (drilled)		**PLOT 2** SWCD Mix (drilled)		**PLOT 3** BC-17 Native Mix (drilled)		**PLOT 4** CP 21 CRP Mix (broadcast)	
	lb/A		lb/A		lb/A		lb/A
Alfalfa	8	Timothy	2	Big Bluestem	3	Indian Grass	1.5
Orchardgrass/Brome	15	Perennial Ryegrass	3	Canada Wild Rye	3	Big Bluestem	2.5
Winter Wheat cover	30	Kentucky Bluegrass	2	Switchgrass	4	Little Bluestem	1
Total	**53**	Smooth Bromegrass	10	Western Wheatgrass	4	Sideoats Gram	1
		Winter Wheat cover	36	Perennial Ryegrass	4	Canada Wild Rye	1
		Total	**53**	Red Fescue (late)	3	Blue Grama	0.5
				Winter Wheat cover	32	Switchgrass	0.5
				Total	**53**	Oat cover	25
						Total 33	

- **Plot 1** is a typical pasture mixture found in Goodhue County.
- **Plot 2** is the SWCD grass waterway seed mixture we sell in our drill. Plot 1 and plot 2 are acting as controls during this project since they are the most prevalent buffer mixes used in our landscape.
- **Plot 3** is a mix that was created by SWCD staff with direction from other various state agencies. The SWCD wanted to test a grass mixture that had a native component with deep root systems and would hopefully still be fast growing and provide a respectable forage quantity in the establishment phase. We included Big Bluestem and Switchgrass for the deep rooted, warm season grass component. Canadian Wild Rye, Perennial Rye, and Fescue were chosen for early spring growth and persistence throughout the growing season. This mixture, if viable, may be marketed in our seed drill for waterways and buffers. We hope it will also provide winter cover for wildlife.
- **Plot 4** is a CP-21 CRP mixture. This is a typical native mixture used in most CRP buffer acres.

As of the fall of 2010, all plots were well established. In 2011, we harvested and measured each test plot for biomass production and relative forage value in order to determine the cost-effectiveness of these traditional, native, and alternative buffer and waterway mixes. On June 29, the height and variety of plant species was recorded. Then, the first cut of each plot was harvested with a round baler. Bales were weighed and sampled for forage quality (table 2).

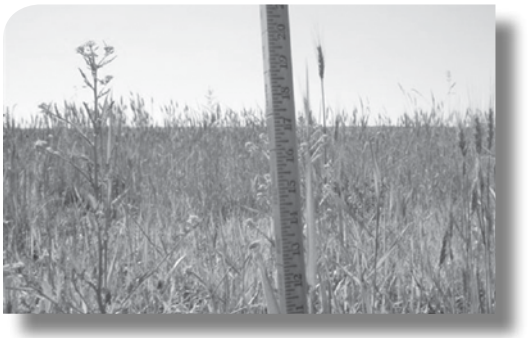
Table 2. Forage Yield and Quality of Four Buffers Harvested on June 29, 2011

Test Plot	Biomass (lb/A)	Adjusted Crude Protein (%)	Acid Detergent Fiber (%)	Neutral Detergent Fiber (%)	Relative Feed Quality
Plot 1 - Ed's Mix	4,959	11.36	39.5	55.3	102.4
Plot 2 - SWCD Mix	4,253	5.95	40.7	59.3	91.6
Plot 3 - Native Mix	3,846	5.60	38.8	59.4	87.9
Plot 4 - CRP Mix	2,732	6.50	35.9	55.6	107.6

The photographs below show the vegetated stands in the four test plots on June 29, 2011 just before harvest. Labeled below each picture is the list of plants that were identified. The plant species are listed in order of dominance.

Plot 1 - Alfalfa, Brome, Orchard

Plot 2 - Perennial Rye, Timothy, Brome, Winter Wheat



Plot 3 - Winter Wheat, Western Wheat, Perennial Rye, Red Fescue, Switchgrass, Big Bluestem

Plot 4 – Oats, Clover, Switchgrass, Big Bluestem, Indiangrass

Plot 1 had some of the highest rates of seeding application and is evident of a typical hay stand for a dairy operation. This plot showed the highest biomass yield and the highest available crude protein. Second was the standard SWCD waterway mix that we are currently promoting through our SWCD office. This plot had similar biomass but lower available crude protein. Perennial rye in Plot 2 was very dominant. Plot 3 had little available crude protein with a relatively low biomass. Plots 3 and 4 have a larger native component, making the minimal first year of growth somewhat expected. Just uphill from Plot 3, a side-hill seep is keeping the plot wetter than the other plots. Stress is evident in the vegetated stand.

In June of 2012, all plots will be harvested again and subjected to simulated rainfall to assess runoff quantity and quality. Our hope is that in 2012 and 2013 our test results show more forage quantity and quality available throughout the growing season.

Management Tips

1. The 2011 spring was an extremely wet and cool season. This may have stunted some of the native plant growth in plot 3. An active spring located up gradient from the test plot sites became more active this year. Wet conditions will affect plant species not tolerant of hydric soil conditions.

2. The test plots were only cut and harvest once during the 2011 growing season. I would recommend a minimum of three cuttings to suppress weeds, warm the ground, and stimulate low plant growth.

3. Mixes with a strong native component should be clipped at 6 to10" in height to assure that the native component of the seed mix is not negatively affected.

4. Any tractor/truck traffic should be avoided for at least one growing season (except for cutting/harvesting).

Cooperators

Ed McNamara, Farmer, Goodhue, MN
Mark Zumwinkle, Minnesota Department of Agriculture, St. Paul, MN

Location

From St. Paul, take Hwy. 52 through Cannon Falls. 5 miles south of Cannon Falls, turn left on Goodhue Cty. 9. Go 7 miles and turn left on Twp. 171. The McNamara farm is second on the left.

Other Resources

Iowa State University Extension. Stewards of the Stream, Buffer Strip Design, Establishment, and Maintenance. Website (PDF): *www.extension.iastate.edu/Publications/PM1626b.pdf*

Minnesota Department of Agriculture. Conservation Funding Guide. Grass Waterway. Website: *www.mda.state.mn.us/protecting/conservation/practices/waterway.aspx*

Optimizing Alfalfa Fertilization for Sustainable Production

Principal Investigator

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Project Location: Otter Tail County

Project Duration

2010 to 2012

Award Amount

$7,926

Staff Contact

Meg Moynihan
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Keywords

alfalfa, boron, forage, persistence, potassium, sulfur, yield

Project Summary

Alfalfa is a key component of sustainable cropping systems in Minnesota. It is a perennial crop that fixes its own nitrogen, improves soil health, reduces soil erosion, and provides high-quality forage for ruminant livestock. Economic analyses have consistently shown alfalfa to be a profitable crop for haying and grazing. In many years, it has been more profitable than subsidy-supported corn or soybean production. We are interested in identifying fertilization strategies that economically optimize alfalfa production. We are confident that this information could help maintain alfalfa in crop rotations on Minnesota farms, enhancing overall farm profitability and sustainability.

Project Description and Results

Good soil fertility is known to be important to productive and persistent alfalfa. Potassium has generally been the nutrient recommended in greatest quantities due to the large amount of potassium removed when alfalfa is harvested as hay or haylage. Boron and sulfur have been recommended when alfalfa is grown on sandy soils, but there is increasing evidence that these nutrients may benefit alfalfa and other crops more often than previously thought. Our specific objectives are to test alfalfa response to various levels of:

1. Potassium fertilization;
2. Boron fertilization;
3. Sulfur fertilization; and,
4. These three nutrients interactions observed with timing applications.

2010

This first year of the study was the establishment year. We set up the study, prepared the site, applied treatments, and documented existing soil fertility. On May 17 2010, we planted a replicated small plot experiment on the Paul Beckman farm in Otter Tail County. We used a split, split-plot restriction of a factorial arrangement of treatments to evaluate fall and spring applications of potassium, sulfur, and boron at different rates (Table 1). The total of all timings, fertilizers, and rates combined made for 48 different treatments, and replicating them three times required 144 plots. We seeded 'Rebound 5.0' alfalfa in 3' x 20' plots with a special small plot research planter, choosing this variety because it has performed well in recent University of Minnesota alfalfa variety testing. The seeding rate was 16 lb/A.

In June, we sprayed Raptor® herbicide because of heavy weed pressure from lambsquarters and redroot pigweed. We bulk harvested twice: on July 13 and again on August 16 with no yield data collected, a common practice with establishment year

This is our research site just after its 144 individual plots were freshly harvested.

Table 1. Timing, Fertilizer, and Rate Treatments

Main Plot	Subplot	Sub-subplot	Sub-sub-subplot
Spring	Potassium at 0, 150, 300, 450 lb/A	Boron at 0 or 4 lb/A	Sulfur at 0, 30, 60 lb/A
Fall	Potassium at 0, 150, 300, 450 lb/A	Boron at 0 or 4 lb/A	Sulfur at 0, 30, 60 lb/A

forage research. Soil samples taken in June and again in August demonstrated slight increases in organic matter and pH, with gradual decreases in fertility levels for potassium, boron, calcium, magnesium, and phosphorus. In September, we applied lime at 1,140 lb/A effective neutralizing power to raise the soil pH from 5.8.

2011

In spring 2011 we took soil samples from all 48 treatment combinations conducted to determine costs, returns, and profitability potential of the various fertility treatments. We applied the fertility treatments on July 6 and again on October 4. We harvested the alfalfa four times (June 3, June 30, July 5 and October 10) with a small plot research flail harvester, documenting maturity, height, and weed content data at all harvests. We also took several representative forage samples to determine dry matter content. Fresh weights of harvested material were measured on site, and then adjusted to a dry matter basis based on content of the representative samples (Table 2).

To document stand survival, we'll estimate stands in Spring 2012 when spring growth is approximately 6" high to document stand survival. Soil samples analyzing K, P, pH, O.M., S, B, Ca, and Mg will continue throughout the life of the study across treatments and referenced with harvested data.

It's important to note that the 2011 results are representative of only one growing season for four harvest dates at a single location. We need another year of data in order to determine whether there are treatment effects and/or interactions before we can come to any conclusions or make recommendations. To increase data reliability, we established a second research site (not supported by this grant award) on the U of MN St. Paul campus in 2011.

In 2012, we'll hold a forage field day at the Beckman farm to feature this study along with an alfalfa variety evaluation test.

Management Tips

1. If alfalfa isn't producing the way you think it should, start by taking soil samples. Nutrient availability and/or pH are often factors that limit production.

2. Continually monitor alfalfa and forage fields for insect and disease pests. Properly identifying pests timely allows for timely management decisions if problems warrant action.

3. Pound for pound, not all agricultural lime is created equal. Check the label for "effective neutralizing power (ENP)" to figure out the correct application rate.

Cooperators

Paul Beckman, Crop Farmer/Retired Dairy Producer, Underwood, MN
Paul Peterson, University of Minnesota Extension Forage Specialist, St. Paul, MN

Project Location

From Underwood, go north on Cty. Rd. 35 for ¾ mile. Turn right on 230th. Continue for ¼ mile. Site is on the south side of the road.

Other Resources

Minnesota Agricultural Experiment Station. 2012. Alfalfa variety trials and resources. *www.maes.umn.edu/vartrials/alfalfa/index.asp*

Table 2. 2011 Season Yield Data for Various Treatments

Treatment	Yield (dry matter)
Timing	Spring: 6.3 T/A ; Fall: 6.4 T/A (no significant difference)
Potassium	6.1 to 6.6 T/A (no significant difference)
Boron	6.4 T/A (no significant difference)
Sulfur	6.22 to 6.46 T/A (significant at 95% confidence level)

Growing Blackberries Organically Under High Tunnels for Winter Protection and Increased Production

Principal Investigator

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Project Duration

2009 to 2011

Award Amount

$19,445

Staff Contact

Jean Ciborowski
651-201-6217

Keywords

blackberry, drip irrigation, fertigation, high tunnel, primocane, trellis, winter protection

Project Summary

Can organic blackberries be grown commercially in southeast Minnesota? Scenic Valley Farms (SVF) previously grew blackberries on a limited scale, and with limited success, using the labor intensive practice of tipping the plants and covering them with mulch for winter protection.

During this project, numerous blackberry cultivars were planted under high tunnels to determine which berries best survive the winter and produce the highest yields. The project successfully determined that blackberries can be organically grown for commercial production in a zone 4a hardiness zone by using high tunnels with auxiliary heat. Since full production will not be reached until 2012 or 2013, the project has yet to determine if high tunnels increase blackberry yields.

Project Description

Scenic Valley Farms was started in 2008 in Rosemount, MN with the goal of growing blackberries for commercial production in a northern climate. Our farm designs and manages high tunnels, climate control systems, and subterranean solar thermal heating systems. SVF maintains five semi-automated high tunnels that produce blackberries, raspberries and tomatoes.

While the regional demand for organic blackberries is large, growing commercial grade blackberries in hardiness zone 4 or colder without winter protection is virtually impossible. Commercial blackberry farms grow blackberry cultivars that are viable in zones 5 –10. In Zone 5 and above, the practice of tipping blackberry plants and covering them with mulch for winter protection is commonly used. However, we have found that this practice in zone 4 provides only minimal winter protection and results in the loss of more than 75% of blackberry plants (results from 2007). Poor winter survival and the resulting poor yield, combined with the high labor costs to cover and uncover the canes, makes growing blackberries in a zone 4 or colder climate unprofitable.

The *primary objective* of the project is to determine the viability of growing organic blackberries under a high tunnel for commercial production in a zone 4 climate. The *secondary objective* is to research, record and evaluate the crop production

Primocane berry cluster on November 14.

High tunnel T/V trellis system.

processes required to grow organic high tunnel blackberries for commercial production.

In 2009, we worked with Poly-Tex of Castle Rock, MN and consulted with Terry Nennich to design a high tunnel suitable for blackberry production. Our requirements included straight side walls with sufficient height clearance to support a 7' trellis system; a gothic peak for optimal snow load capacity; and a price that is competitive with other high tunnels on the market. Poly-Tex designed and developed the Field Pro using these specifications.

We prepared the land for the high tunnel using black plastic to smother the weeds. The soil was amended by mixing in equal parts mushroom and dairy manure compost and applying one wheelbarrow/10' row. After applying, the compost was tilled into the soil using a hand rotor tiller. Once the canes were planted, we mulched each plant with a combination of straw and woodchips. In between the rows, we laid down 24 mil polyester weed guard.

Due to unavailability, the floricane blackberry canes were not planted until May 15, 2010 in the 30' X 60' gothic style high tunnel, which contains Triple Crown, Arapaho, Chester, Apache, Ouachita, and Natchez varieties. The canes were planted in four rows spaced at 7', with the outer two rows 4.5' from the side walls. The plants are spaced 3' apart with 80' total in the tunnel. The primocane varieties, Prime Jim and Jan, were planted in a smaller high tunnel constructed with PVC.

In the east facing row that borders the floricane high tunnel side wall, we planted indeterminate tomatoes in 2011. The plants were shaded and the tight space between the row of tomato and blackberry plants made harvesting difficult. Although we did not record the yields on these tomato plants, intercropping is one possible method to earn extra income while waiting for the blackberries to reach full production.

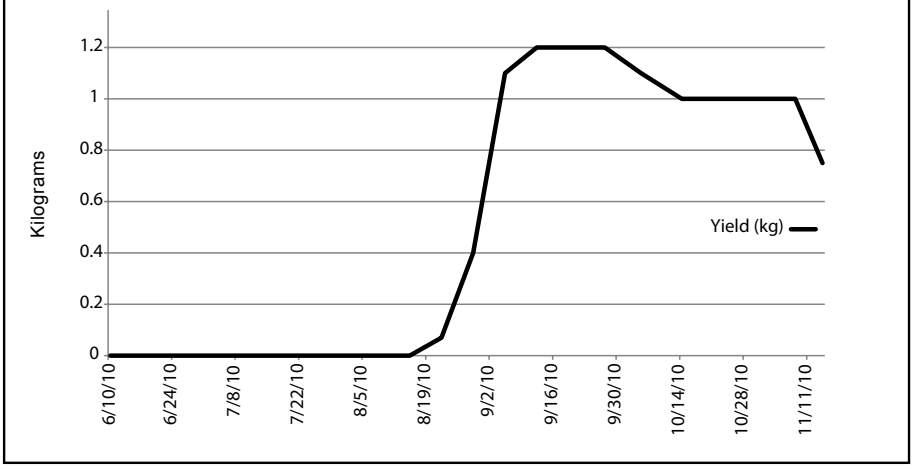
Inside the floricane high tunnel, we installed a wooden "T/V" trellis system to support the berry canes. We ran two strands of wire at the tip of each crossbar "T", for a total of four runs containing two wires each. The posts should be spaced 10' apart. The primocanes were tied to one side of the strand and produce fruit as floricanes during their second year of growth. At the end of the growing season, the floricanes are pruned to the ground to make room for the following year's primocanes.

The sturdiest 2-3 primocanes that grow from the crown of each plant are pruned once they reach 4-5' and the trailing canes are pruned at 4-6'. We allowed the leaders to grow to 3-4' before they were pruned back to 18". This increases the sturdiest of the laterals and helps boost yields.

The primocane varieties were trellised using metal T-posts spaced at 5' intervals and strands of wire between each post. As soon as the new canes reached 5', they were tipped and within 2 weeks laterals appeared that supported blossoms.

Drip irrigation and fertigation system.

Figure 1: Weekly 'Prime Jim' and 'Prime Jan' Blackberry Yields (kg), 2010



Continual pruning during the entire season supported new blossoms. They are all pruned to ground level at the end of every growing season.

Both high tunnels employ in-line drip irrigation and moisture sensors to regulate irrigation and fertigation cycles. In addition to moisture content as a percentage, the sensor provides soil temperature and EC. The controller has up to six zones controlling six values, each with six separate watering times.

The ventilation system in the floricane high tunnel consists of hay loft style vents, an exhaust fan mounted into one of the end walls, motorized side wall winders, and gable end motorized ventilators. All of these systems are controlled using sensors.

In order to winter protect the canes, we installed a thermostatically controlled 170,000 BTU propane heater that is set to fire when the temperature drops to 5°F (set point) and turn off when temperatures reach 9°F. These are the minimum temperatures of a zone 7b climate.

Project Results

The 2010 weekly yields from the primocane high tunnel (12 Prime Jim and 12 Prime Jan blackberry brambles) are displayed in the graph above. The plants began fruiting in early August. The individual fruit size averaged between 6-15 grams. The fruit was often difficult to pick at optimal ripeness because of its softness. The thorns also required that pickers wear gloves and flannel shirts.

The major problem was maintaining temperatures inside the high tunnels at the optimal range of 80-85°F. Temperatures in excess of 100°F prevented proper drupelet formation in some cases. This problem is easier to remedy in the larger high tunnel because of its superior ventilation capabilities. In early September 2010, a small amount of the primocane berries experienced Botrytis fruit rot due to cool and moist conditions. We started closing the tunnel at night to raise the temperature. The fungus mostly cleared up as the result of the warmer temperatures.

The final harvest of the primocane berries occurred on November 18. After that date, the auxiliary heat was suspended and the brambles were allowed to enter the dormant phase.

During the summer of 2010, the floricane high tunnel contained a few brambles that bore small amounts of fruit (several berries or less per plant). The next year, approximately 100 clams (5.6 oz) were harvested. The harvest period ran from August 1 – September 7.

During 2010, the floricanes displayed no visible signs of disease or pests throughout the growing season. This is typical during the first year when foliage development is relatively minimal. During 2011, we experienced a spider mite outbreak. While awaiting delivery of the biological control, we controlled the outbreak by spraying the foliage with water. Once the spider mite predators arrived (*Neoseiulus californicus*), they were released into the high tunnel, resolving the issue within a couple of weeks.

Acclima SC6 controller.

Motorized Side Wall Winder.

Primocane High Tunnel.

Floricane High Tunnel.

During the winter of 2010-2011, we experienced problems with rabbits entering the high tunnel and girdling the canes. Roughly 10-15% of all the canes were either destroyed or badly chewed. We blocked off the possible entrances and set two traps inside.

The plants took a long time to freeze out in the late fall due to the increased warmth of the high tunnel. The snowfall in December 2010 also created an insulation effect and warmed the tunnel by 10-15°F compared to the outside temperatures.

Market Potential for Blackberries

Market research indicates an annual demand for one million pounds of organic blackberries in the Upper Midwest. We have received interest from several U.S. organic wholesale food distributors, including Organic Valley Coop, Naturite Farms, and Sun Belle Inc. We plan to produce 3 acres of blackberries under high tunnels, anticipating a yield of 30,000 lb/acre/yr.

In the summer of 2011, we began marketing small quantities of the thornless floricane blackberries. The Rosemount blackberries were used for personal consumption while the Readstown blackberries were either sold at the Viroqua Farmers' Market or Viroqua Co-op. Demand far exceeded supply. The blackberries marketed at the Farmers' Market were usually sold out by early morning. Next year, as we get closer to full production, we will begin distributing to more grocer co-ops and potentially wholesale dealers. Nearly every buyer we have approached has expressed strong interest in purchasing the blackberries.

Overall, the lack of locally grown blackberries creates a tremendous opportunity for any grower capable of bringing blackberry production closer to major cold weather markets. The local, organic aspect of the blackberries, along with their exceptional taste and freshness, should be emphasized in any marketing campaign.

Management Tips

1. If annual and perennial weeds are problems where you plan to erect a high tunnel, we recommend using a layer of 6 mil black plastic to smother and kill the weeds and roots. This will allow planting in 2-3 months.

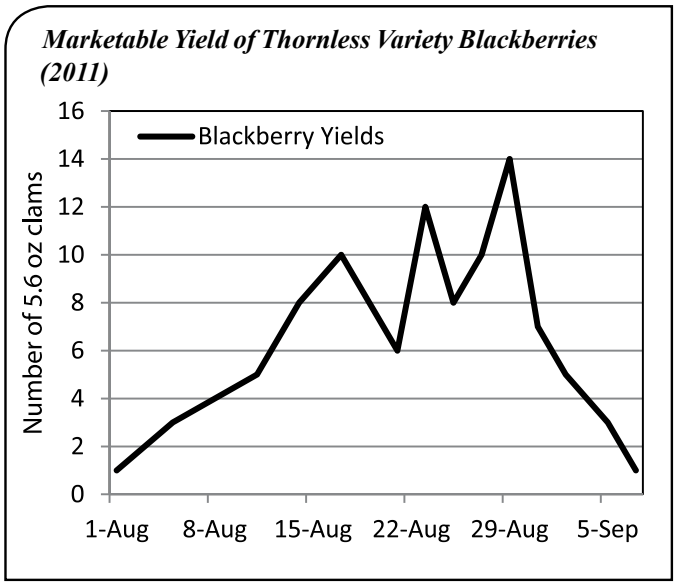
2. Allow leaders to grow to 3-4' before pruning back to 18". This technique promotes sturdier canes and increases overall yields.

3. Laying black polyester material between the rows is the most effective weed management technique. We recommend though leaving sufficient space between the material and the base of the plant in order to allow new canes to form.

4. Be careful to monitor and manage internal temperatures. Attempt to keep the temperatures inside the optimal range of 80-85°F. High temperatures increase the risk of improper drupelet formation, Botrytis blossom rot, and fruit rot.

5. Do not use fish emulsion based liquid fertilizer in a drip irrigation system with emitters as it will clog them.

6. When ordering brambles such as blackberries, order plants early, no later than February.



7. Using mulch for winter protection for 'Doyle' has had limited success on cane winter survivability in zones 4 and 5.

8. Continually pruning of Prime Jim and Jan resulted in continual blossoming.

9. The most significant modification we recommend growers adopt is to affix a second layer of poly to their high tunnels. At our Readstown, WI high tunnel farm, we have affixed a second layer of poly over the high tunnels and used a small fan to inflate the air pocket. The extra insulation has increased average air temperatures by 6-8°F compared to high tunnels with only a single layer of poly. This means that the blackberry plants will be better protected because the risk of sub-zero temperatures in the winter is reduced. It also means that we will need to spend less on propane fuel heating costs and reduce risks to the plants.

Cooperators

Terry Nennich, University of Minnesota Extension, Crookston, MN
Brad Becker, Dakota County SWCD, Farmington, MN
Craig Gundacker, Scenic Valley Farms, Rosemount, MN
Rebecca Harbut, University of Wisconsin, Madison, WI
Kathy Demchak, Penn State University, University Park, PA

Project Location

From I-35E, exit at Pilot Knob Rd. (exit 97A) and go south about 5 miles to McAndrews Rd. Go east .7 miles to Danbury Way. Turn south. Scenic Valley Farms is .6 miles on the west side of the road.

Other Resources

Growing Raspberries and Blackberries in a High Tunnel – Iowa State University.
www.extension.iastate.edu/NR/rdonlyres/BA5DB27B-4472-4D15-89A0-185DD532C4DF/95187/Hitunnel09.pdf

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

High Tunnel Raspberries and Blackberries - Cornell University. R2012. Heidenreich, Cathy, Marvin Pritts, Kathy Demchak, Eric Hanson, Courtney Weber, and Mary Jo Kelly.
www.fruit.cornell.edu/berry/production/pdfs/hightunnelsrasp2012.pdf

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

Pruning and Trellising Brambles.
agresearch.umd.edu/RECs/WREC/files/MDBayAreaBramble%20Pruningv2%202-18-09-Demchak.pdf

Safley, C. D., O. Boldera, and G. E. Fernandez. 2006. Estimated Costs of Producing, Harvesting, and Marketing Blackberries in the Southeastern United States. HortTechnology 16: 109-117. *www.ncsu.edu/project/berries/extension/blackberry_budget.pdf*

University of Minnesota High Tunnel Production. Website: *hightunnels.cfans.umn.edu*

Photo taken on November 14 in Primocane High Tunnel.

Extended Season Marketing of Asian and Latino Ethnic Vegetables Grown in Quick Hoops and a Moveable Greenhouse

Principal Investigator

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Project Duration

2010 to 2012

Award Amount

$6,000

Staff Contact

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Keywords

Asian, high tunnel, Latino, season extension, quick hoops, vegetables

Project Summary

Our project is researching the profitability of growing ethnic vegetables and season extension. A population shift over the last generation has brought change to our southwest Minnesota community. More than 30% of Mountain Lake's population consists of families of Asian and Latino origin. Community gardening has shown that Lao and Latino families want to raise traditional ethnic vegetables. Since first frost brings an end to most gardens and accessibility to fresh produce, we are exploring ways to increase and extend the availability of fresh produce to our ethnically diverse community. In developing the market we network with CSA share members, community gardeners, local retail businesses, schools, and other facilities.

Project Description

Our 20 acre farm is located in southwest Minnesota, within the city limits of Mountain Lake. It includes 1 acre of fruit and vegetable production nestled in a restored prairie. The remaining land is in alfalfa, on which we don't use herbicides or pesticides. In June 2010 we started a business called *Jubilee Fruits and Vegetables*. We use two movable high tunnels, traditional outdoor gardens, and rows of quick hoops (sometimes also called "low tunnels"). We market a large variety of fruits and vegetables from May through December to CSA members, local schools, a hospital, a nursing home, and in our farm market.

The overall goal of our project is to find out how several varieties of Asian greens grow in two locations: 1) in a traditional garden setting in early spring and late fall under quick hoops and row covers, and 2) in a high tunnel for spring and fall harvest.

Our high tunnels are 30' x 48' and on V-tracks, which rotate among 7 plots. We plant in 30" wide raised beds, with 8 beds in each plot. We also have a 7' x 48' plot in our outdoor garden.

2010

It was challenging to find seeds for the plants that ethnic grocers and local community members recommended. We purchased seeds from a variety of sources but found that the best germination rates came from well-known companies such as Johnny's Selected Seeds. Descriptions of all the varieties we planted are provided in Table 1.

The high tunnels are on tracks, so we can move them to cover different plots.

Table 1: 2010 Performance of Asian Greens

Variety	Observations
"Black Summer" and "Joi Choi" (large pac choi)	These are not a "cut and come again" crop like the other greens. We left one "Black Summer" in to observe its cold tolerance (Figure 3). When this report was submitted in December 2010, it had no signs of cold damage yet.
"Green Lance" (Asian kale)	Grew to be a large plant with its head about 1' above the ground and had a 1" diameter stem at ground level. In 2010, it never produced the flowers that are to be eaten along with its young leaves. The leaves were huge and tasty.
"Tokyo Bekana" (like Chinese cabbage)	Midrib separates from the outside layer but is still usable. It does not brown or decompose. The taste remains crisp and sweet.
Hon Tsai Tai (Asian green related to mustard)	Produced the largest harvest of leaves. Again, there were supposed to be flowers along with small leaves to market which never occurred. The base of the plant is at ground level and seems to tolerate the cold. New sprouts of leaves and flowers started to show.
"Kyona" Mizuna (Asian green related to mustard)	Seems to toughen as the season lengthens. Many leaves decomposed and had to be removed. It would not be marketable in winter.

In June, we direct seeded two varieties of Pac Choi (Black Summer and Joi Choi) and one variety of Asian kale (Green Lance) outdoors. We placed quick hoops over the rows of greens and covered them with a floating row cover, anchoring it down to prevent flea beetle damage. We had a run of very hot and dry days and decided a soil moisture monitoring system would have been helpful. In June we also started Poblano and Serrano peppers, but they did not germinate.

At the end of July, we started more Black Summer, Joi Choi, and Green Lance, along with Hon Tsai Tai and Kyona mizuna in soil blocks indoors. In August, we transplanted them into one row of a high tunnel plot. Since we did not observe any flea beetle damage, we didn't use a row cover. At the end of August, we also made a direct seeding of the greens into a high tunnel plot. We used quick hoops for protection from cold temperatures and wind.

In September, we had heavy rains. We moved the high tunnel over the plantings the first week of October.

In November, before temperatures dropped into the 20s, we placed wickets (square wire structures) over each row in the tunnel and draped a large sheet of row cover over them. In order to have a good harvest through December 1 for our CSA boxes, we used supplemental heat for 3 days at the end of November, maintaining an inside temperature of 20°F when outside temperatures were in the single digits.

The transplanted Pac Choi plants grown in the high tunnels grew 2 to 3 times larger than those in the summer garden and were much tastier. The flavor may have improved due to cooler weather and adequate soil moisture provided by the drip irrigation in this area of the high tunnel. We were able to harvest the other tunnel greens many times; they, too, were twice the size of the outdoor plantings and much sweeter in flavor. The Asian greens were a new treat and well received by our CSA members, who enjoyed their flavor fresh in salads and cooked them in stir-fries.

These greens all proved to be fairly cold tolerant. During November the plants froze and thawed many times. We were still able to harvest the greens after the sun warmed up the high tunnel, removing the row covers for harvesting and replacing them afterwards. Some observations about these greens are offered in Table 1. Our final harvest occurred on December 6.

2011 Results

Asian Greens

In 2011, we planted outdoors under quick hoops and in the tunnel in both spring and late fall. This year, we started much earlier, seeding into soil blocks the third week of March using a mixture of 20 qt compost, 30 qt peat moss, 20 qt perlite, 10 qt soil, and 3 C green sand/blood meal. We added water to make the correct consistency. We seeded 36 blocks each of Black Summer, Pac Choi, Joi Choi, Tokyo Bekana, Kyona Mizuna, Tatsoi, and Hon Tsai Tai. Half of the plants were transplanted into the high tunnel the third

Mizuna (top) and Tokyo Bekana (bottom).

week of April, intercropped with tomatoes. The remaining plants were transplanted into the outdoor beds in late May.

The high tunnel Asian greens really took off. In fact, we suspect they took nutrients away from the tomatoes, since these had a difficult start. We harvested greens for the first CSA pickup June 1, and they were a bit past their prime. We harvested the outdoor greens during the second and third weeks of June.

Peppers

We made our first attempt to start Serrano and Poblano peppers in tiny soil blocks in late February. It failed when their heating mat overheated. We purchased a thermostat and reseeded the peppers the second week of March. About a dozen Serranos and half a dozen Poblanos germinated. We transplanted half into the high tunnel the last week of April and the remaining half outside the first week of June.

Inside the tunnel, we clipped the axial suckers of the peppers after they formed two main branches and anchored them to overhead twine for support. Those high tunnel Serranos grew to 4' and the Poblanos to 5'! We waited to harvest the peppers until they were red. Those in the high tunnel were a month earlier than those outdoors. Both varieties yielded well, although we had a bad case of aphids inside the high tunnel. (We used a pyrethrin spray at too weak of a dose and the aphids got ahead of us.) The outdoor plants outdoors were stubby, with small fruits and harvests.

We did a second planting of Asian greens in late summer again using soil blocks. We planted one tray each of Black Summer Pac Choi, Joi Choi, Tokyo Bekana and Kyona Mizuna beginning the first of August through the second week of September. We chose these four varieties for their storage quality, customer acceptance and eye appeal. Each of these trays was transplanted into four beds a month later. Three of the beds were outside under quick hoops for insect control and protection from the cold. The fourth bed was in the high tunnel for comparison. We had excellent harvests from all the beds.

After our difficult experience the first year, we moved our quick hoops to a more protected site from the wind and it decreased our stressful events of anchoring loose plastic to zero. We found it takes advance planning in order to have bed space available for transplanting Asian greens in August, keeping in mind rotation principles and efficient irrigation options.

We hosted a "Coming Up Squash" event for our CSA members on a perfect October day. About 30 people attended and, since we hadn't had a killing frost yet, the plants looked great and provided us a wonderful opportunity to talk about season extension. It was a great way to build community.

We harvested the greens on November 21 after two single-digit hard freezes and found a surprise waiting for us. While we knew the greens in the high tunnel would be twice as vigorous as their counterparts outdoors, we did not expect to find any marketable plants under the quick hoops, but we did! There were overflowing market boxes for all the CSA members at our season finale.

Poblano (L) and Serrano (R) peppers. Two leaders from each plant are clipped to twine for support.

Future Plans

So far, we have learned that Asian greens can be harvested early with great results, so we will be starting our 2012 season even earlier in the spring in order to include a May CSA share. To date, our retail sales of Asian greens have been disappointing; we find that other options are necessary to continue developing the market. We also plan to promote our own farm market at the same time as CSA pickups. We have found the number of stir-fry events in our area has expanded exponentially, since Asian greens were not familiar to any of our CSA members prior to this project. Area schools, retirement centers, and hospitals are getting the message that Pac Choi is the "new green on the chopping block."

Since starting the project, we've built another movable high tunnel, which will give us even more options for 2012 and beyond. We will want to try increasing the successional plantings of Asian greens for our early spring CSA shares and to increase awareness of them in the surrounding communities.

Serrano and Poblano peppers are not well known in southwest Minnesota except in the Latino/Hispanic community. We checked seed germination viability for the first time this winter; we have our heat mats and thermostat in place and hope for a better germination outcome. As far as marketing goes, we hope to expand sales by publicizing our farm market and sharing the marvelous recipes we enjoyed. We also plan to study the feasibility of marketing our own processed items.

Next year we want to invite even more people to a field day and highlight our distinctive ethnic greens and peppers. We're even toying with the idea of hosting separate events in the Spanish and Lao languages.

Management Tips

1. Test seed germination rates and always use a heat mat thermostat.

2. Monitor soil fertility closely when intercropping.

3. Learn languages of the community to build relationships.

4. Test new recipes to share with customers so they have a multitude of options.

Cooperators

Dave Birky, Ag Resource Inc., Detroit Lakes, MN
Lee Erickson, Bluestem Farm Supply, LLC, Mountain Lake, MN

Project Location

Our farm is located in the town of Mountain Lake, between Mountain Lake Road and Highway 60, and to the west of Cty. Rd. 1 at 1310 Mountain Lake Rd.

Other Resources

Coleman, Eliot. 1999. Four-Season Harvest. Chelsea Green Publishing.

Coleman, Eliot. 1995. The New Organic Grower. Chelsea Green Publishing.

Minnesota Department of Agriculture. Greenbook 2009 - 2011. *www.mda.state.mn.us/protecting/sustainable/greenbook.aspx*

High Tunnel Primocane Blackberry Production in Minnesota

Principal Investigator

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Project Duration

2009-2011

Award Amount

$23,932

Staff Contact

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Keywords

blackberry, fertigation, high tunnel, primocane fruiting, thornless blackberries, winter protection

Project Summary

This is the third season of the high tunnel blackberry project at the North Central Research and Outreach Center (NCROC). Primocane fruiting blackberries were planted in the south high tunnel and in a field trial in the late spring of 2009. Blackberries were grown conventionally. The cultivars/selections included were Prime Jan, Prime Jim, MNPF1001, MNPF1002, APF41, APF45, and APF48. Additionally, three thornless primocane fruiting selections, APF136, APF138, and APF139, were planted for demonstration purposes. Tunnel temperatures in mid-winter approached -17°F, while outside temperatures reached -35°F. In the prior season (2009-10), some winter die-off occurred among several varieties in the tunnel and in the field, and plants were replaced to make up the deficits. For the 2010-11 winter season, straw and snow mulch were applied to the tunnel plants to provide additional insulation and to avoid problems with winter die-off. Plants grew vigorously early in the spring and throughout the season; however, spider mites became a problem in midseason. Small quantities of berries began to be harvested in early August from the tunnel. Fruit production reached its peak in late August. Field fruit was slower to mature, and none was harvestable. By mid-October, plants in the tunnel continued to flower and produce small quantities of fruit, while immature fruit on the field plants had shriveled and dried from a hard freeze in mid-September and cooler nighttime temperatures. The quality of the fruit from the tunnel was high, but the quantity was less than expected, despite an unusually warm fall season after a mid-September hard freeze.

Project Description

Blackberries are a high value crop that could provide revenue for small farmers in the fall. Blackberry production in Minnesota, however, is not very common due to the fact that floricane fruiting varieties are not typically hardy enough for Minnesota. In 2005/2006, primocane fruiting blackberries were grown in a field setting at NCROC, but no berries matured in 2006 due to the early frost. All the plants were killed after the winter of 2006/2007 during which there was no snow cover. Primocane fruiting raspberries have been a very successful crop in the north high tunnel at NCROC; therefore, a trial of primocane fruiting blackberries in the south tunnel seemed a reasonable next step. Primocane fruiting varieties were planted in the tunnel in May, 2009 to evaluate their potential as an alternative fall crop, using the high tunnel to extend the growing season later into the fall. An identical field planting was established in June, 2009.

Plants cut back to 3", Nov 30, 2010.

Straw and snow mulch added.

Left: Spider mite damage in the tunnel.

Right: HOBO data loggers.

In 2010, T-tape irrigation was drained and irrigation terminated in the tunnel at the end of October. The sides of the tunnel were closed, and the plants were allowed to go dormant for the winter season. Plants were cut back to approximately 3" in late November. At that time, approximately 6" of straw mulch topped with 6" to 8" of snow was applied for winter protection. The snow cover was redressed 3 to 4 times during the winter to maintain adequate insulation. As outdoor temperatures approached -35°F in January, 2011, adequate snow cover was available to insulate the field planting.

Grand Rapids experienced a somewhat colder than normal winter with greater than normal snowfall. Snow cover began in mid-November, 2010 and persisted until late March, 2011. After the added tunnel snow melted, straw mulch was removed at the end of April. Temperatures warmed in May with a few unusually warm days, but June brought below normal temperatures and above normal rainfall. Because the adjustment of tunnel sides to regulate heat had become a problem during the growing season of 2009, gable end vents and fans were added to the tunnel in March, 2010. Regulating the temperatures by adjusting the tunnel sides requires an on-site staff member to be present early in the morning and late into the afternoon, and that was not always possible at our site. For 2011, the vents and fans were adjusted to activate at 85°F in order to provide more heat for the developing blackberries. Tunnel sides were generally left open when the temperatures had warmed sufficiently later in June and July, with the vents removing excessive heat. Excessively hot and humid conditions in July caused tunnel temperatures to spike to high levels, despite the ventilation. When nighttime temperatures began to cool in September, tunnel sides were closed in midafternoon to capture the heat of the day and reopened in the morning to remove accumulated moisture. Supplemental heat was provided during a sudden hard freeze that occurred on September 15 and 16. Temperatures then warmed unseasonably through mid-October and no additional supplemental heating was required.

Soil fertility was quite good, as the high tunnel had been used to grow tomatoes, peppers and lettuce in 2007 and a cover crop of Sudan grass in 2008. Upon review, fertilizer rates used in 2009 were decided to be adequate for the 2010 growing season and were continued for the 2011 season. Additional snow was added in April to pre-moisten the soil. After an initial pre-soak, fertilizer was applied by weekly fertigation in the tunnel, beginning June 10. Nitrogen at the rate of 30 lb N/A was supplied by alternating applications of Ca(NO3)2 and urea (70% of N from Ca(NO3)2 and 30% of N from urea). Micronutrients were added on June 24 and August 5. Field plantings were fertilized with 40 lb N/A in the form of Ca(NO3)2 on May 16. Irrigation in the tunnel was initially supplied weekly and increased to twice per week as temperatures warmed. Approximately 100 gal were provided twice per week, once for fertigation and once for supplemental water. Supplemental water was provided beginning in July as temperatures climbed, rainfall decreased and tunnel temperatures increased. Supplemental field irrigation was seldom needed as the summer rains exceeded normal patterns early in the season but was supplied on 3-4 occasions as needed during the hotter part of the summer.

Left: Tunnel growth on June 9, 2011.

Right: Field growth on June 9, 2011.

Height and spread measurements were taken four times. Since plants in the tunnel grew quite vigorously, a trellis system was used to contain the large and expanding canes. No thinning of canes was done, but canes were pruned in mid-July since the vigorous growth was reaching the ceiling of the tunnel.

During the 2011 season, flower and fruit development, as well as insect and disease pressure, were monitored throughout the growing season. Spider mites had been quite aggressive in the raspberry tunnel this season, and they also were found in the blackberry tunnel. The infestation was most severe in the south, middle section of the tunnel. A chemical spray of the insecticides Brigade and Actara were each applied in a spot spray on August 4. On August 11, one thousand *Neoseiulus fallacis* predatory mites at a rate of 1,000/row were released in the blackberry tunnel. Because the infestation was more severe than previously experienced, the predatory mites were not able to control it. An additional application of Brigade and Actara was applied for better control.

Temperatures were recorded inside and outside the tunnel by automatic data loggers (Onset Computer, HOBO H08 and Pro v2. series). Some fruit was harvested starting on August 10. Harvesting was discontinued on October 17, and the plants will be allowed to go dormant for the winter. A determination will be made in the spring of 2012 as to whether to continue the blackberries in the tunnel for future seasons.

Results and Conclusions

The added heat in the tunnel during a cold and rainy June spurred on the growth of the tunnel plants, and they were consistently larger, bloomed earlier and produced more fruit than field plants throughout the season. Additional winter protection over the 2010-2011 cold months greatly improved plant survival in the tunnel, and tunnel plants were dramatically larger than their field counterparts in early June. Due to the winter mulch, plant size was noticeably larger in the tunnel than in the field at the beginning of June.

Outdoor temperatures in June were several degrees below normal, which delayed field plant growth at the beginning of the season. The high tunnel provided an important advantage in terms of additional heat (554 corn degree days for June inside the tunnel vs. 371 outside) during this cool start to the growing season. Note that one way to quantify the heat advantage is to measure heating units using corn degree days (calculated as the average of the minimum of either 86°F or the actual maximum temperature and the maximum of either 50°F or the actual minimum temperature, minus 50°F). Tunnel plants grew so vigorously throughout June and early July that it was necessary to prune some of the tallest growth, which was reaching the ceiling of the tunnel.

Both field and tunnel plants generally grew well throughout the season, but the tunnel plants continued to outpace the growth of the field plants throughout August and September. For the period June 1 through September 31, corn degree days inside the tunnel totaled 2,410, while outside the total was 1,842. The high tunnel structure provided nearly a 30% increase in heating units for the heat-loving blackberries. Supplemental heat was provided in the tunnel during the nights of September 15 and 16 when a sudden hard freeze occurred (field temperatures reached 25°F). Several cool nights followed and then temperatures warmed to well above normal readings for the next several weeks.

Since the plants in both the field and tunnel were even more established this season as compared to last, it was too difficult to count the actual number of canes or branches. Instead, a rating for branching was done, using a 1 to 5 scale (5 = most branching). Additionally, two ratings for vigor and one for sturdiness were done. A zero rating for vigor was given to those plants that showed no growth in

June. Most plants grew quite vigorously both in the tunnel and field, but tunnel plants started the season with better growth and continued to outpace the field plants due to this initial size advantage and the additional heat provided by the tunnel in June. Among those in the tunnel, the cultivars "Prime Jan", "Prime Jim", and APF-41 were most vigorous. In the field, the selections APF-45, APF-41 and MNPF1001 had the best ratings.

While plant growth was encouraging, overall fruit yield was disappointing. Tunnel cultivars/selections began to flower during the week of June 27, while field plants were nearly 3 weeks behind. Green fruit was evident in the tunnel starting the week of July 17, and during the week of August 7 for the field. Red fruit appeared in the tunnel starting in the early part of August, and ripe fruit began to be harvested on August 10. The varieties "Prime Jim", APF-48, MNPF1001 and MNPF1002 were among the earlier producers. As of mid-October 2011, the best tunnel plot, variety "Prime Jim", produced nearly 1.5 lb of fruit while several other plots produced approximately 380 grams of fruit, or approximately 15% less than 1 lb. In the field, no measurable harvest had occurred. Only the occasional berry had been found. Much green fruit developed in both the tunnel and in the field, but the majority of that fruit did not fully develop into harvestable fruit. Oftentimes, the green fruit dried and shriveled on the plant, and it appeared the fruit was not pollinated. Although the plants grew well, most fruit did not develop completely in any year of the study. In 2009, only a few flowers and fruits developed, as the plants were becoming established. During the 2010 season, nearly 6 lb of high-quality berries were harvested from the tunnel, while production for the 2011 season was 9.3 lb.

The fall 2011 season had been an unusually warm one, except for the freeze that occurred in mid-September. Field blackberries were not able to develop fully, while the tunnel blackberries were still flowering and producing harvestable fruit throughout October, but not in quantities that would justify the cost of their maintenance. Harvesting was discontinued on October 17, when a period of cold nights that would require supplemental heating began. The quantity of berries was low, but the fruit quality was high. Harvested berries were generally large and well-formed.

Work with primocane blackberries has been an interesting experiment, but additional research for cold-hardy varieties needs to continue. Even with winter protection in the tunnel, and an early start to the growing season, yields are less than desired. The development of cultivars/selections that mature earlier also would be beneficial to growing primocane blackberries in high-tunnels in cold climates.

Elm Tree Farm - Postscript

The farm cooperator planted three rows of Primocane Blackberries in a 30' x 96' high tunnel in the spring of 2009. The cultivars selected were Prime Jim and Prime Jan. Both varieties looked good in the late fall of 2010 with cane growth being as long as 8'-9'. The fall of 2010 was a very mild fall, so growth continued into early November. Unfortunately, in the early winter tragedy struck and the high tunnel collapsed because of snow load, however the plants were still protected by the high tunnel. Because of the high tunnel collapse the blackberries were not pruned down or mulched with straw and snow as planned. The collapsed high tunnel was removed as early as possible in the spring, and was not rebuilt for the 2011 growing season.

Left: Tunnel growth, mid-July, 2011.

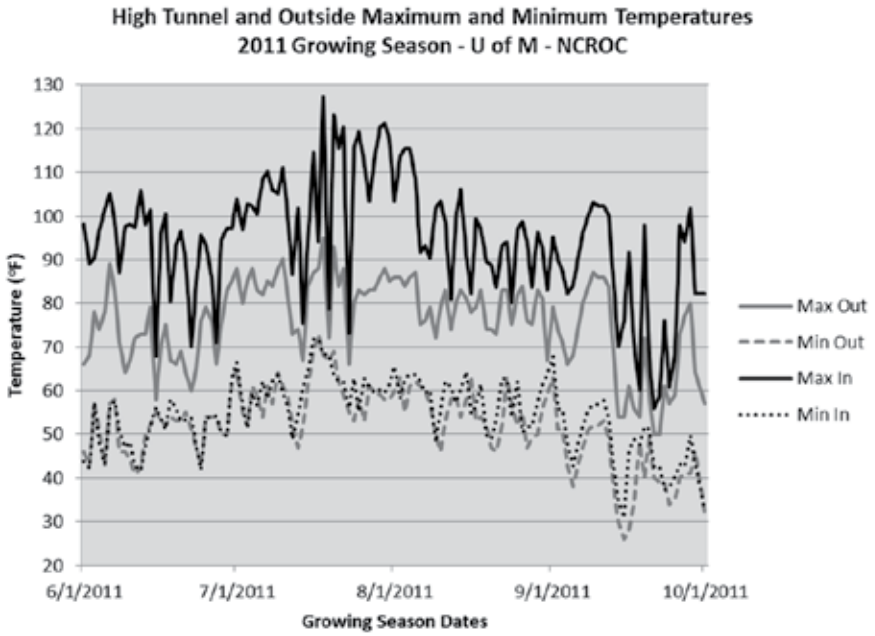
Right: Field growth, mid-July 2011.

NCROC Field Blackberry Plant Height & Spread

	Height (inches)				Spread (inches)			
Cultivars	6/8/2011	7/19/2011	8/17/2011	10/4/2011	6/8/2011	7/19/2011	8/17/2011	10/4/2011
APF-41	6.8	29.6	45.3	49.6	7.1	20.6	29.4	38.6
APF-45	6.6	34.8	53.4	54.6	8.9	23.2	35.1	44.1
APF-48	10.4	35.9	38.1	41.0	12.7	30.0	34.4	40.1
MNPF1001	9.1	38.9	41.6	48.6	11.8	23.6	28.8	33.1
MNPF1002	4.9	30.2	37.7	40.5	7.9	21.0	25.9	30.4
Prime Jan	10.6	35.1	46.4	47.7	13.9	29.7	40.6	55.0
Prime Jim	10.0	41.1	49.9	47.3	11.8	22.8	31.1	40.3
Average	8.4	34.5	44.2	46.3	10.5	24.3	32.1	40.0

NCROC High Tunnel Blackberry Plant Height & Spread

	Height (inches)				Spread (inches)			
Cultivars	6/8/2011	7/19/2011	8/17/2011	10/4/2011	6/8/2011	7/19/2011	8/17/2011	10/4/2011
APF-41	29.7	64.5	75.5	79.0	25.8	52.5	42.0	43.0
APF-45	25.0	60.0	78.0	84.3	21.6	46.3	41.7	45.0
APF-48	30.6	58.3	72.0	76.3	30.7	48.3	42.0	43.7
MNPF1001	30.3	57.7	63.7	71.0	27.4	49.3	40.7	42.3
MNPF1002	21.8	59.5	62.9	62.1	24.5	44.3	39.0	40.5
Prime Jan	34.2	58.7	72.7	81.0	32.2	56.0	45.3	47.3
Prime Jim	34.3	57.7	65.0	73.0	31.2	45.0	39.3	42.0
Average	29.8	59.1	70.1	75.3	27.7	48.6	41.5	43.5



Temperature differences inside and outside of the tunnel.

NCROC Field & Tunnel Vigor Ratings

	FIELD				TUNNEL			
	Vigor		Branching	Strudiness	Vigor		Branching	Sturdiness
Cultivars	6/8/2011	7/19/2011	8/17/2011	10/4/2011	6/8/2011	7/19/2011	8/17/2011	10/4/2011
APF-41	2.0	3.2	3.8	4.0	4.3	5.0	4.0	4.0
APF-45	2.5	3.8	4.1	3.9	3.2	4.6	4.8	4.0
APF-48	3.2	3.8	3.8	3.8	4.6	4.8	4.2	4.0
MNPF1001	3.2	4.1	3.8	4.0	4.4	4.7	4.2	4.2
MNPF1002	2.4	3.3	2.9	3.7	3.6	4.2	3.8	3.9
Prime Jan	3.2	3.9	3.7	3.3	4.7	4.9	5.0	4.5
Prime Jim	3.3	3.9	3.7	3.8	4.7	4.9	4.2	4.2
Average	2.8	3.7	3.6	3.7	4.2	4.7	4.3	4.1

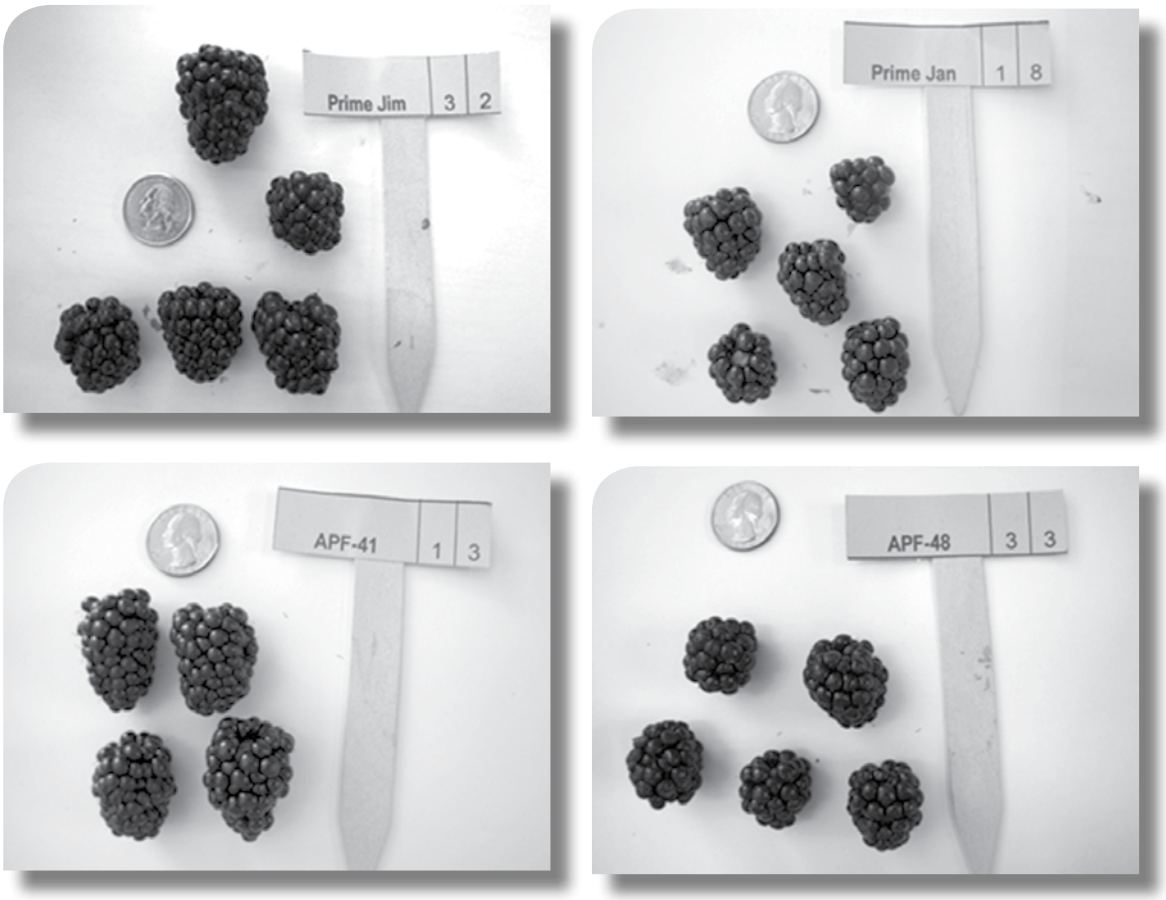
Ratings are on a 0-5 scale, 0=no growth, 1=least to 5=most

Left: Blossoms turning to green fruits.

Right: Ripening tunnel fruit on August 3.

NCROC 2011 High Tunnel Blackberry Yields

Cultivars	% Early Harvest by Aug 30	Total Grams	Total Pounds	Average g/Berry
APF-41	58	377	0.83	1.56
APF-45	22	211	0.46	2.38
APF-48	60	871	1.92	1.08
MNPF1001	47	175	0.39	1.56
MNPF1002	55	397	0.87	1.62
Prime Jan	29	579	1.28	1.82
Prime Jim	72	1,610	3.55	1.07
Average	56	4,220	9.30	1.21



Samples of ripe fruit from late August harvests.

Early in the spring, roots and crowns from each variety were dug and examined for winter injury. Even though the winter was very cold there was no visible crown or root damage, however the flora canes that were allowed to produce showed moderate damage. The spring of 2011 was much cooler and wetter than normal and growth of both varieties was extremely slow. Some flora canes from each variety were left to see if they would bear early. They started to flower in early June, however only 5% of the plants flowered. The project at Elm Tree Farm was discontinued.

Management Tips

1. Temperature regulation in the high-tunnel can be problematic. The installation of temperature-controlled ventilation can be effective for dissipating excessive heat. Supplemental heat may need to be provided in order to extend the growing season and enhance production.

2. A layer of mulch in the high-tunnel can be effective for weed prevention and for the retention of soil moisture. Wood chips were used in our tunnel for these purposes.

3. Providing adequate winter protection for tunnel-grown plants is important, as winter injury can result from lack of snow cover. An insulating layer of straw and snow applied before winter temperatures plunge below 0°F may prevent winter-kill and give plants a beneficial head start for summer growth.

4. Berry crops grown in high tunnels appear to suffer from lack of pollination, thereby reducing productivity. Portable beehives are becoming available for use in high tunnels, and may be a way to make marginal berry plantings more productive.

5. Existing primocane cultivars may not be suitable for the cold climate of Minnesota, but growers should keep informed about new cultivars that incorporate a higher degree of winter-hardiness and an earlier maturity date.

Cooperators

Patricia Bliska, Berry Grower, Elm Tree Farm, Afton, MN
Dr. Jim Luby, Professor/Breeder, Department of Horticulture, U of MN, St. Paul, MN
Dr. John Clark, Professor/Breeder, Department of Horticulture, U of AR, Fayetteville, AR
Dr. Emily Hoover, Professor, Department of Horticulture, U of MN, St. Paul, MN

Dr. Carl Rosen, Professor, Department of Soil, Water, and Climate, U of MN, St. Paul, MN
Patricia Johnson, M.S., M.Ag., U of MN - North Central Research and Outreach Center, Grand Rapids, MN
Keith Mann, Plot Coordinator, U of MN - North Central Research and Outreach Center, Grand Rapids, MN

Project Locations

Elm Tree Farm is located at 14726 Afton Blvd. S., Afton, MN. From St. Paul, travel about 11 miles east on I-94. Merge onto MN Hwy. 95 S/Manning Ave. (Exit 253) toward Hastings. Go about 4 miles then turn left on 40th St. S/CR-18. Follow CR-18 for about 3 miles and the farm is on the left.

North Central Research and Outreach Center – From St. Paul, take I-35E north about 110 miles. Merge onto MN Hwy. 33 N (Exit 237) toward Cloquet. After traveling about 11 miles, take the exit for US Hwy. 2 toward Grand Rapids/Duluth. Turn left (west) onto US Hwy. 2 and travel about 60 miles. Turn slightly right onto US Hwy. 169/NE 4th St. and go 1.7 miles to our location on the left.

Other Resources

Dr. John Clark, Professor/breeder, Department of Horticulture, University of Arkansas, Fayetteville, AR 72701, 479-575-2810, jrclark@uark.edu

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

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*

Nourse Farms, 41 River Rd., South Deerfield, MA 01373, 413-665-2658.
Website: *www.noursefarms.com*

University of Minnesota. High tunnel research.
Website: *http://hightunnels.cfans.umn.edu*

Comparison of Strawberries Grown in a High Tunnel and Outside for Quality and Profitability

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Project Duration

2010 to 2012

Award Amount

$5,000

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Keywords

day-neutral strawberries, grow bags, high tunnel, hydroponic, Verti-Gro

Project Summary

For the past 2 years, we have been trying different ways to grow day-neutral strawberries at our farm in northwest Minnesota. Half of the strawberries are grown in a high tunnel and half are grown outside. A third of the strawberries are grown hydroponically in towers, a third on a table with a peat mixture, and a third are grown directly in our alkaline soil. In 2011, there was not a big difference in harvested crop between the high tunnel and the outside. The hydroponically grown strawberries have suffered from nutrient deficiencies both years, and in 2001, we had no crop. The strawberries grown in the soil had iron chlorosis, but the plants still grew quite large and produced a small crop. We were able to control spider mites and tarnished plant bugs this year with organically approved insecticides. So far, the table appears to be the best way to grow strawberries in our operation.

Project Description

Several years ago, we started raising and selling vegetables and bedding plants at our dairy farm in Middle River in the northwestern corner of Minnesota. In 2011, we sold our dairy herd, and we are relying on the vegetables to replace some of the income from the cows. We are looking into growing different crops, including strawberries.

We want to find the most profitable system for growing day-neutral strawberries in our part of the state. Few people grow strawberries in the northwestern counties of Minnesota because many of the soils are too alkaline. Strawberries do best in well drained soils with a neutral or slightly acidic pH. We wanted to try day neutral strawberries instead of June bearing berries because their harvest peaks at the same time as our vegetables, and the demand for strawberries is quite high in late summer.

We wanted to experiment with different growing systems to find out what would work best for our site. There are many challenges to growing day-neutral strawberries in Minnesota. Late season thunderstorms can cause the berries to crack or allow anthracnose to spread. Growing the berries in high tunnels can keep water from damaging the fruit, but high tunnels make the plants more susceptible to spider mites. Tarnished plant bug pressure is very high

Iron chlorosis in strawberry plants grown in grow bags on the table inside the high tunnel. Iron chlorosis occurs when strawberries are grown in soil with a pH above 7.4.

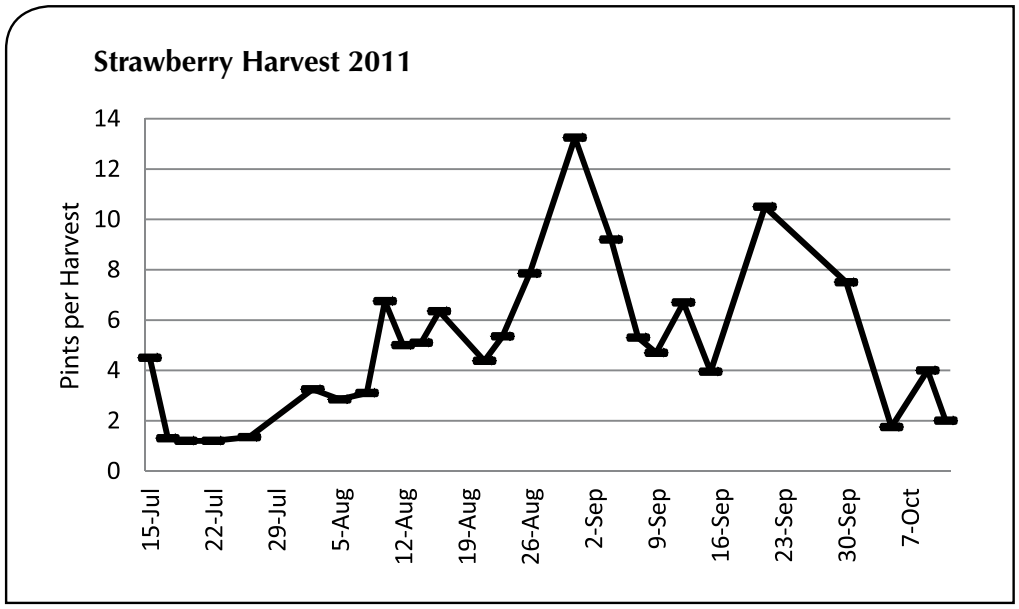

Figure 1. Strawberry Yield on Each Harvest Date for All Treatments Combined (Strawberries were picked once every 2 or 3 days.)

in the late summer. Warm nights can prevent plants from making new blossoms.

We are comparing three different growing systems, both inside and outside a high tunnel: hydroponic growing, growing on a table and growing in soil. The hydroponic growing system consists of four vertical towers from the Verti-Gro company (www.vertigro.com). Each tower has four styrofoam containers stacked on a metal pole. Growing strawberries in the vertical system allows more plants to be grown in a small space and we can avoid problems with alkaline soil. In 2010, we used the substrate and the fertilizer supplied by the company. The substrate supplied by the company was cocoa hulls, but plants in the top container grew much better than the plants in the second tier so we were afraid the nutrients were being caught by the cocoa hulls. This year, we used vermiculite as a substrate, and we used Miracle Gro® Water Soluble All-Purpose Fertilizer. We started the growing season with the water and fertilizer in a closed system in the towers where we could recycle the water.

On the tables, we mixed local peat, compost, and garden soil and placed the soil in landscape fabric on a table 4' wide by 12' long. Our tables were designed to be similar to grow bags used for strawberry production in Britain. We planted 80 plants on each table. The grow bag was grown on a table supported by pallets and irrigated with trickle tape. We kept most of the soil from last year, but added a little new soil around each plant.

For the third growing system, we planted strawberries directly into the soil. The plants were spaced 8" apart and were free to runner and root.

On May 11, we planted strawberries. In each table and tower, half of the plants were the variety Seascape, while the other half were the newer variety Albion. Half of the plants were in a high tunnel and half were planted outside. We sprayed the plants four times with malathion to minimize damage from tarnished plant bugs, and we sprayed neem oil to reduce damage from spider mites.

Results

We started harvesting strawberries on July 15 and continued picking every 2 or 3 days until October 11 (Figure 1). The harvest peaked at the end of August and continued through the middle of September. Over the season, we harvested 128 pints of strawberries. The yield was down from 2010, primarily because there was almost no production from the hydroponically grown plants (Figure 2). Regular sprays of neem oil did appear to prevent a spider mite outbreak and we had green leaves until the end of the season.

The hydroponically grown plants were stunted. The strawberry plants in the towers were a third the size of the plants grown on the table or in the soil (Figure 3) and were too small to form a decent crop. There were a few berries on plants in the towers, but the berries were too small to sell.

According to a leaf analysis, the limiting nutrient in plants in the tower was sulfur (Table 1). When we checked the ingredients of Miracle-Gro, we found that the product has few sulfur containing chemicals, and thus the fertilizer is not suitable for hydroponic production. Our water is very hard and alkaline, and we add vinegar to acidify the water in order for the nutrients to dissolve. Both summers, we

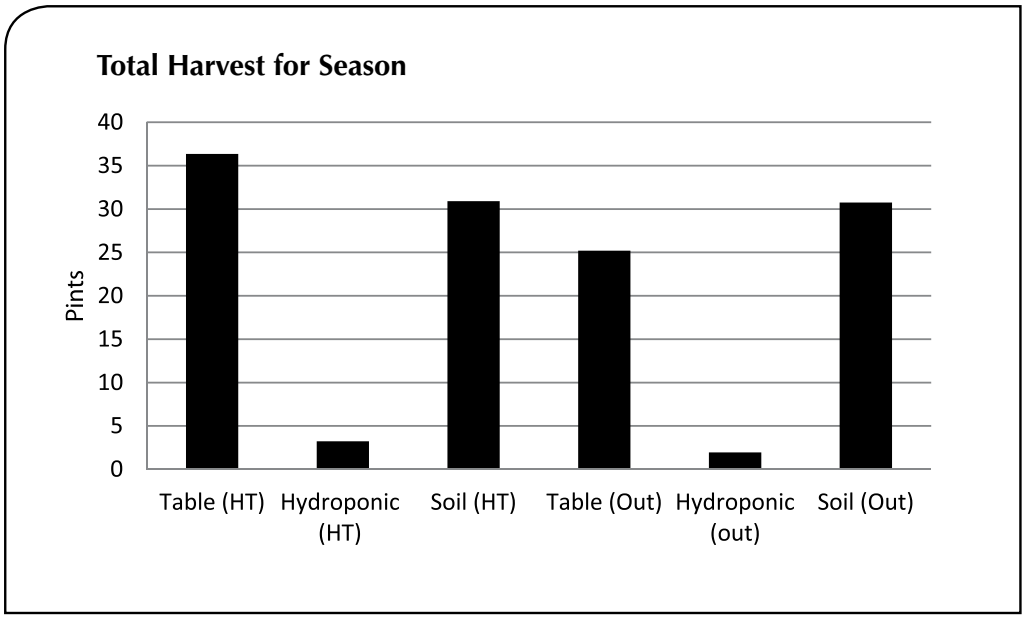

Figure 2. Total Yield for the Entire Picking Season (HT = plants grown in the high tunnel. Out = plants grown outside.)

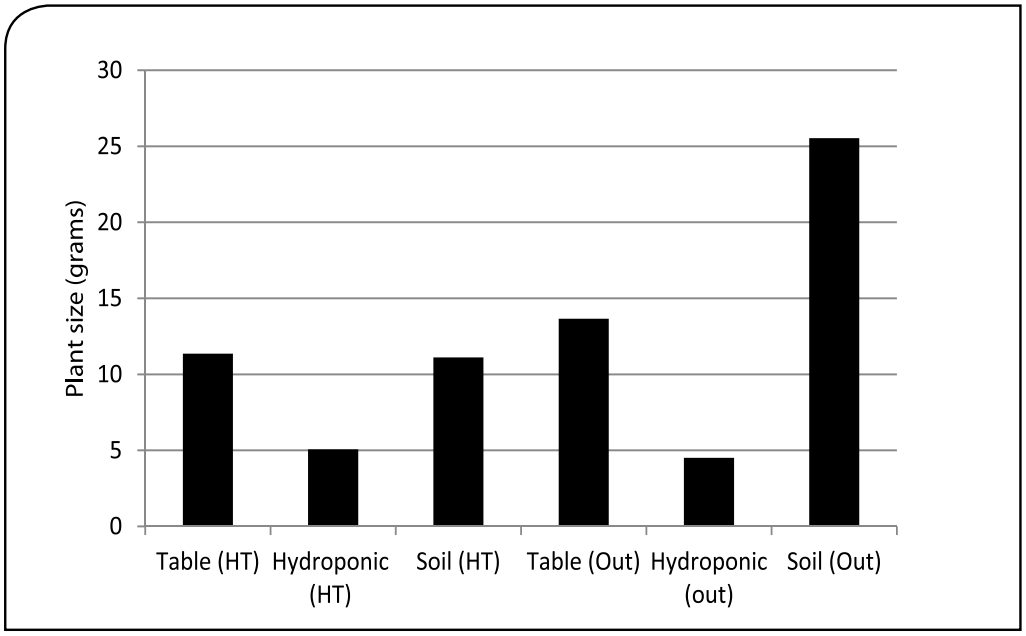

Figure 3. Plant Size in Grams of Plants Grown in Different Growing Media (HT = plants grown in the high tunnel. Out = plants grown outside.)

Table 1. Major Nutrients in Leaves of Different Plants. (Average of inside and outside plants.)

Growing Method	Nitrogen (%)	Phosphorous (%)	Potassium (%)	Sulfur (%)	Iron (PPM)
Hydroponic	2.02	0.47	1.54	0.06	72
Table	2.48	0.37	1.86	0.16	50
Soil	2.65	0.46	2.08	0.18	56

have spent more money on vinegar to acidify the water than we have harvested in strawberries. Over the course of the summer, we used 60 gal of vinegar for 110 plants.

There was not a big difference in yield between the plants grown in the high tunnel and those grown outside, but late summer and fall were very dry. The primary advantage of growing strawberries in high tunnels is to protect the fruit from rainfall that can spread anthracnose and cause the strawberries to crack. Without the normal late fall thunderstorms, there is little advantage of growing day neutral strawberries in a high tunnel.

The towers use less space than those on the table or in soil, but they used more water. We irrigated until the water ran out the bottom of the tower, and we ended up using almost double the water in the hydroponic system than in the grow bags. In a typical watering, the plants in the towers used 40 gal of water while those in the soil needed 20 gal.

Nutrient deficiencies were not just a problem in the towers. Plants grown in the soil or on the table had an entirely different nutrient deficiency. In the middle of summer, the leaves of the plants in the soil started to turn yellow due to iron chlorosis. Moderate iron deficiency does not stunt the leaves, and the plants in the outside soil were the largest plants of the experiment, but it does cause the leaves to turn yellow.

We sold the berries locally for $2/pint and demand was high in our neighborhood. The tables still appear to be the most economical for our operation, producing $130 worth of berries on 60ft^2, without the large financial investment or the special watering system of the hydroponic system. In addition, the plants on the table can be picked and weeded without bending over. The plants in the native soil were not economical due to the yellowing of the leaves.

Management Tips

1. Make sure the pH of the soil is correct when planting strawberries.

2. Watering the tables is tricky with drip irrigation because it is easy to overwater.

3. Planting strawberry plants 6” apart in a bed is too close. Planting strawberry plants 8” apart appears to be better.

Cooperators

Thaddeus McCamant, Northland College, Thief River Falls, MN

Project Location

We are exactly 1 mile north of Middle River on the west side of MN 34. We are the first house on the left going north out of Middle River. You can see the dairy barn and silo. Turn left and cross the railroad tracks into our driveway.

Other Resources

Verti-Gro Company, Summerfield, FL. *http://vertigro.com/*

Minimizing the Environmental Impact and Extending the Season of Locally Grown Raspberries

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Project Duration

2009 to 2011

Award Amount

$13,346

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Keywords

fall bearing raspberry, high tunnel, pesticides, primocane fruiting, red raspberry, season extension

Project Summary

Our project looked for ways to eliminate fungicide use in raspberry production and minimize insecticide use with cleaner water and safer food as a result. In addition, we will evaluate primocane-fruiting (fall-bearing) raspberry cultivars grown in high tunnels at both the University of Minnesota West Central Research and Outreach Center (U of M WCROC) at Morris and at Berry Ridge Farm in Alexandria to increase producers' knowledge about potential markets for locally produced fruit crops. The project invited growers to observe our research through our website http://hightunnels.cfans.umn.edu/ devoted to high tunnel crop production as well as through field days and educational conferences.

Raspberry production in Minnesota faces many challenges. Producers growing summer-bearing cultivars can have low fruit quality due to hot temperatures during July harvest, or injury from extremely low winter temperatures. An alternative to summer-bearing cultivars are fall-bearing cultivars; harvested when temperatures are cooling in late summer and fall. A disadvantage of these cultivars is that peak production may occur after the average first frost date. High tunnels offer added frost protection, which allows some producers to continue harvesting into early November.

Project Description

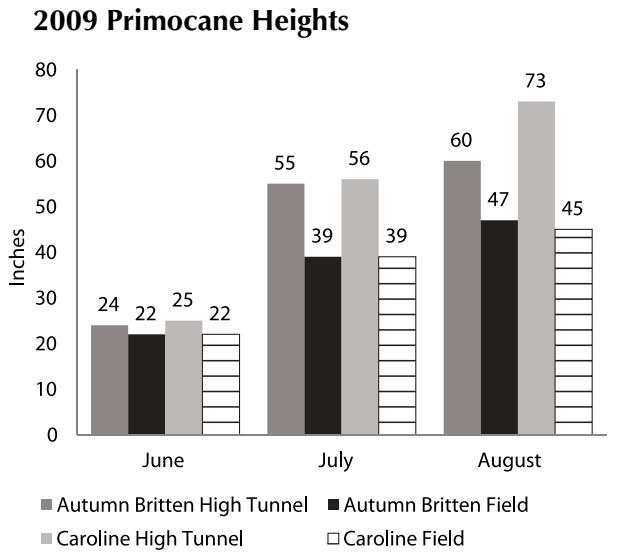
The objectives for this project are:

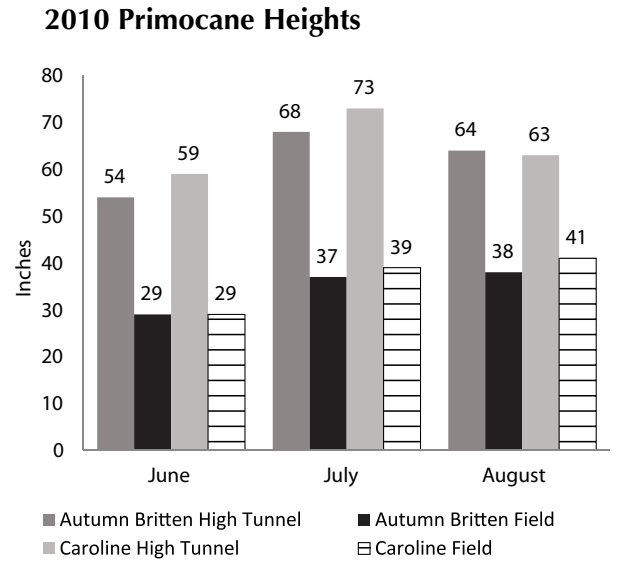
- Eliminated fungicide and herbicide use and minimized insecticide use in high tunnel raspberry production.
- Extended our raspberry season with high tunnels and worked with local food markets to establish new potential relationships to benefit farmers.
- Evaluated vegetative growth, pest incidence, and yield of high tunnel primocane-fruiting red raspberries.
- Provided high tunnel raspberry production and marketing information to farmers through field days, University of Minnesota extension websites, http://hightunnels.cfans.umn.edu/ and Facebook social media.

This research focused on the potential market of growers interested in extending the raspberry season in the Upper Midwest. The high-value raspberry industry in this part of the country consists of small farms selling their product directly to the consumer with little wholesale marketing or processing. In 2002, USDA estimated that 1,300 acres of raspberries were grown in the Upper Midwest (IN, IL, IA, MI, MN, and WI) on 830 farms. Specifically in Minnesota, there are an estimated 189 farms producing raspberries on 284 acres.

The public health community encourages Americans to consume more fruit as part of a healthy diet rather than as an occasional "healthy indulgence." As a result of nutritional research and improved cultivars, raspberry consumption is increasing in the United States. Many of the berries contain high concentrations of antioxidants important to reduce certain human diseases. Raspberries have excellent nutritional qualities being high in vitamin C, and containing soluble fiber and elegiac acid, a potential anti-cancer agent. Diets containing raspberries have been shown to lower blood cholesterol and slow the release of carbohydrates into the bloodstream of diabetics. Total consumption of raspberries has increased by one-third in the United States from 16 million lb in 1996 to 24 million lb in 2002.

Another of our study's objectives was to minimize pesticide use in raspberry production. Even though there are many compounds labeled for use, commercial raspberry growers have limited availability





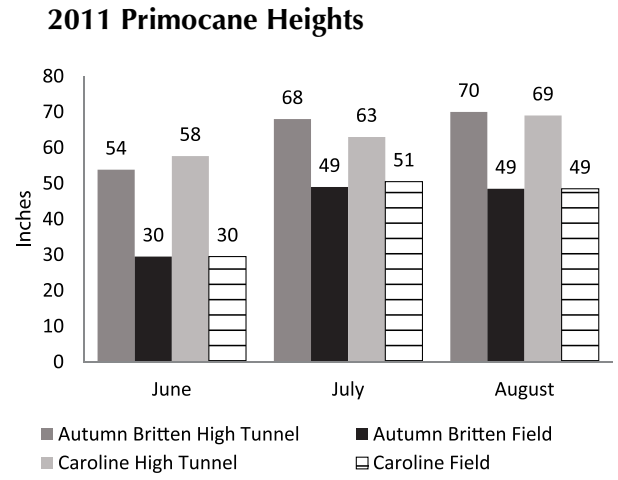
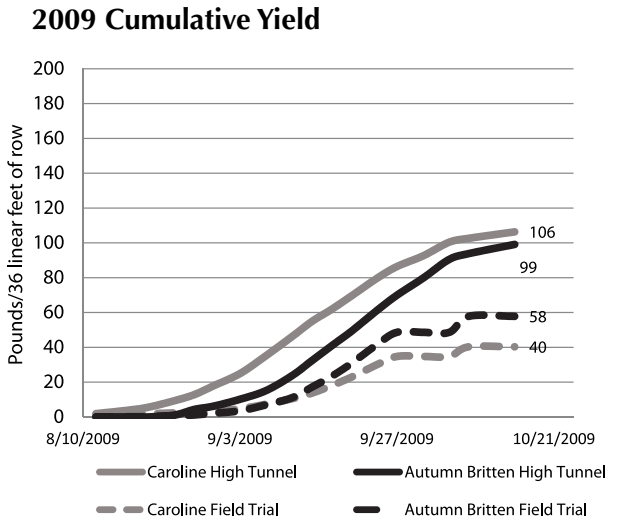
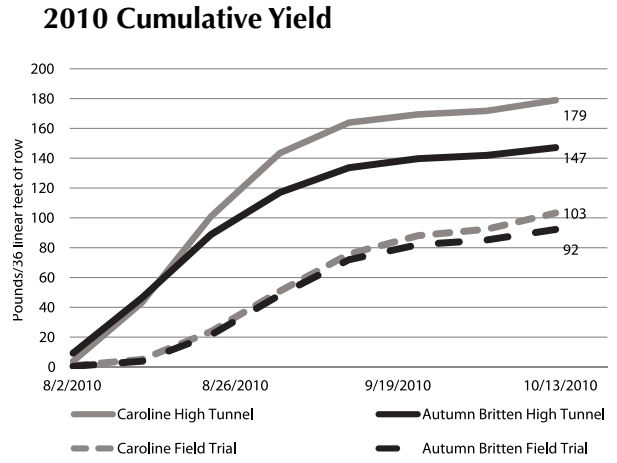


Figure 1. 2009-2010 Growth in inches of two primocane-fruiting raspberry cultivars grown in either a high tunnel or field at WCROC.





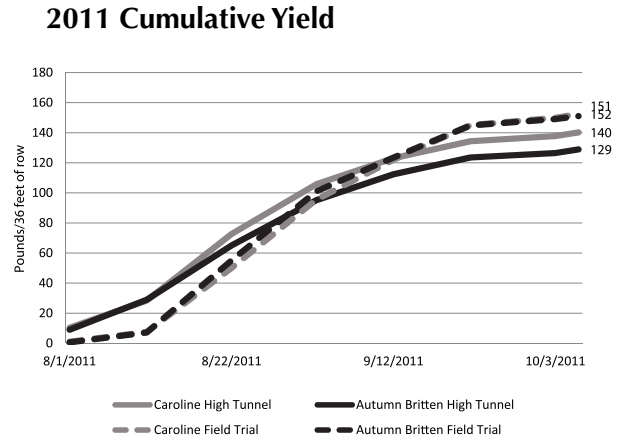
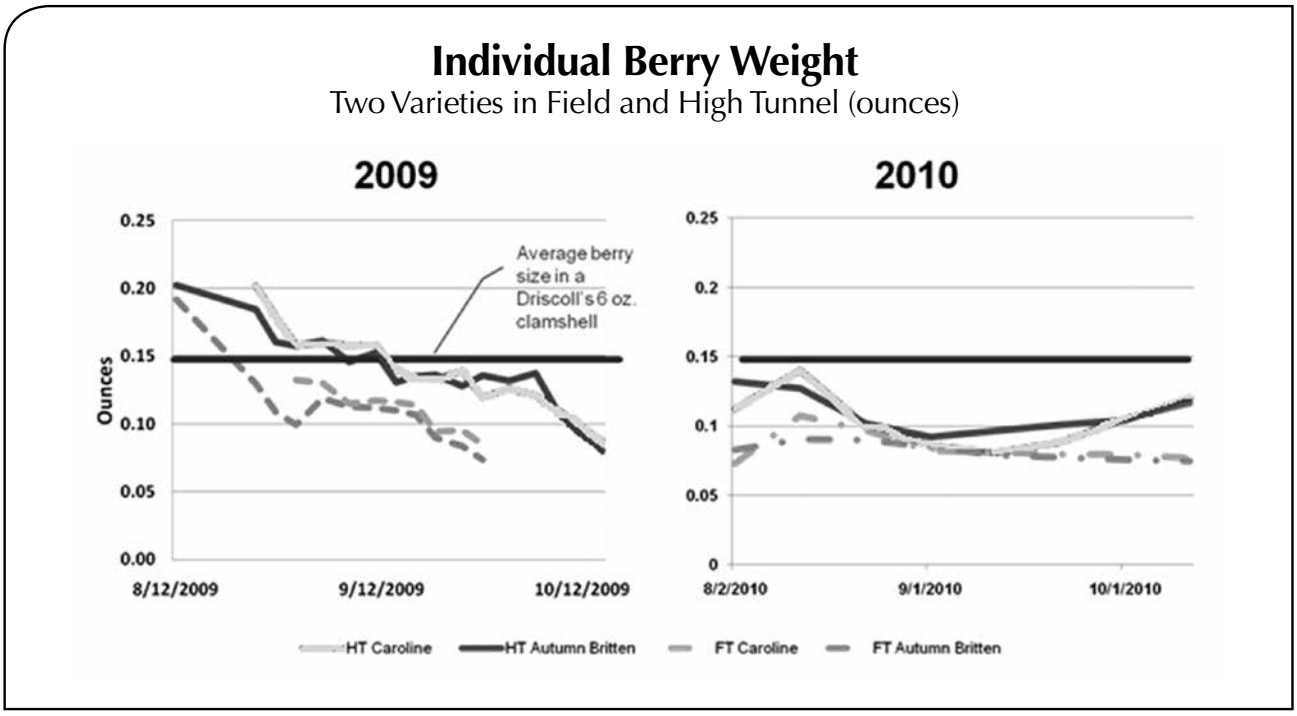


Figure 2. 2009-2011 Production (lb/36' row) of two primocane-fruiting raspberry cultivars grown in a high tunnel or field at WCROC. Numbers on the graphs are total yield in pounds.



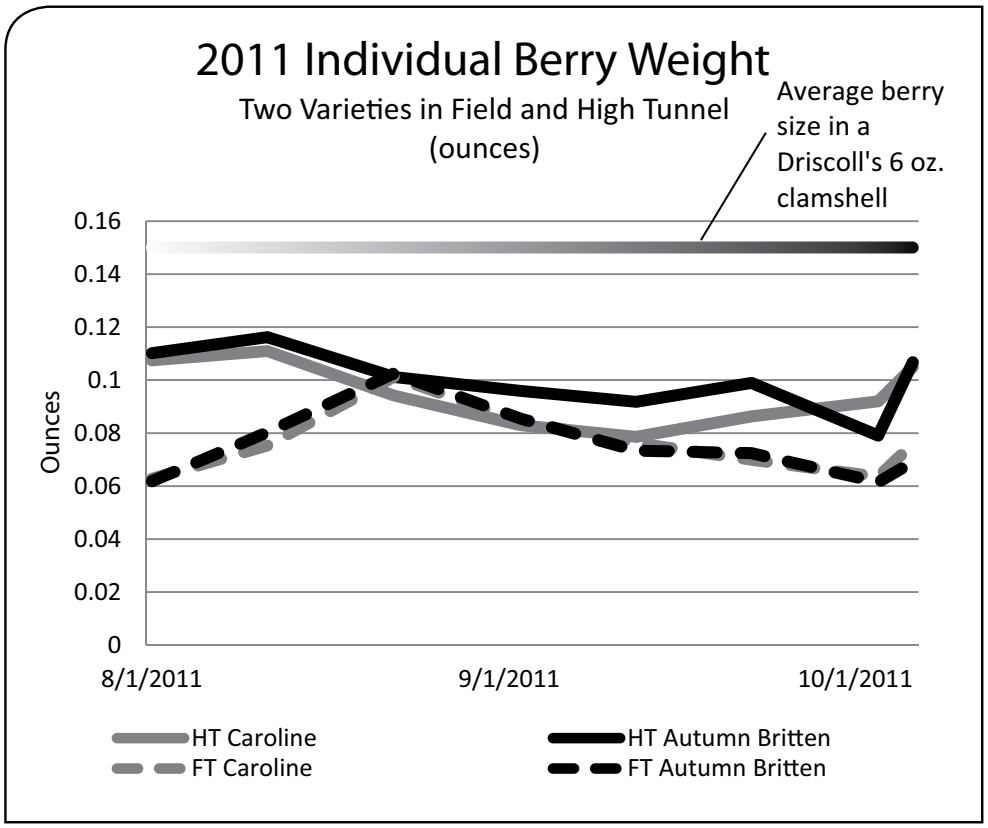


Figure 3. 2009-2011 Average weight per berry of two primocane-fruiting raspberry cultivars grown in either a high tunnel or field at WCROC.

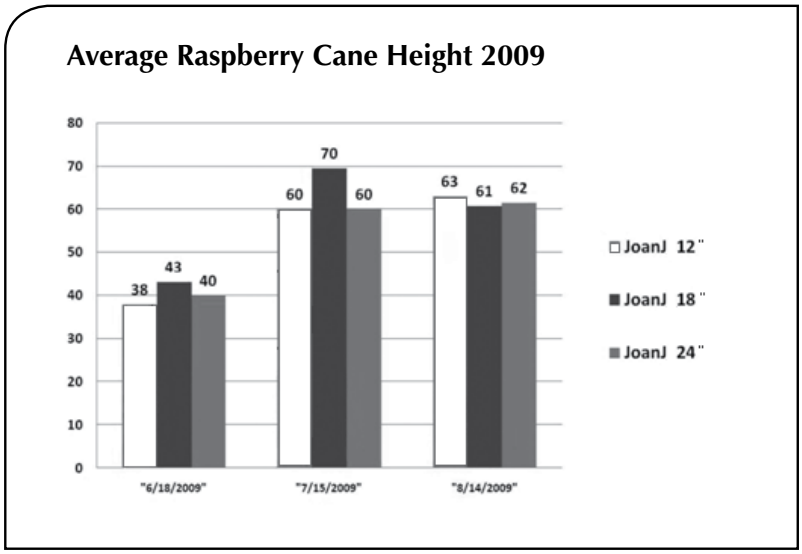
of pesticides to control insects, diseases, and weeds in traditional systems. Diminishing availability and increasing costs of these compounds is causing growers to seek non-chemical methods to reduce economic loss due to pest infestations. Investigating new methods of producing raspberries is desirable as growers are looking to eliminate synthetic chemicals in their production systems. Non-chemical replacements via new production methodologies will not only eliminate the need for fungicides, but will also curtail ill-advised use of off-label chemicals, and ultimately provide a safer product for human consumption. Our goal was to eliminate fungicide use in raspberry production and minimize insecticide use resulting in cleaner water and safer food.

Raspberry production in the Upper Midwest has a number of challenges. If producers grow summer-bearing cultivars, the fruit quality is low due to hot temperatures during July harvest. Some producers have tried fall-bearing cultivars. These cultivars are harvested as the temperatures are cooling in late summer and fall. The disadvantage of these cultivars is that peak production may occur after the first average frost date. For example, in Minnesota in 2007, the first freeze occurred the night of September 17. Fall-bearing raspberries that were not harvested at that point were lost to the freeze. Some growers estimated 80% of their crop was not harvested. With the protection of high tunnels, fall-bearing cultivars made it through this freeze event and harvest continued into early November with the associated increase in income and profitability. The other disadvantage of summer-bearing cultivars is the need to apply fungicides to reduce fruit loss due to fungal infection. Raspberries grown under high tunnels have very little fungal growth due to the lack of moisture on the fruit. Therefore, raspberries in high tunnels can be grown without fungicides.

Our high tunnel raspberry plots were established in May 2008 at two sites: The U of M WCROC at Morris and the Berry Ridge Farm in Alexandria, owned by Ron Branch.

The WCROC high tunnel is a 30' x 48' unit with thermostatically controlled roll-up sides. We evaluated the effect of cultivar and row spacing (12" and 18") on vegetative growth and yield. The two cultivars we tested were 'Autumn Britten' and 'Caroline', chosen for their outstanding fruit size and flavor. We also grew the same two cultivars outside in a deer fence enclosure to compare non-high tunnel vegetative growth and yield to high tunnel production. We used standard production practices for field production of primocane-fruiting raspberries.

At the second site, Ron Branch has three established high tunnels used primarily for vegetable production. The trial planting was a row of the fall-bearing raspberry cultivar 'Joan J', chosen to determine its suitability for growth in high tunnels. Bare-root plants were set at three spacings (12", 18", and 24").



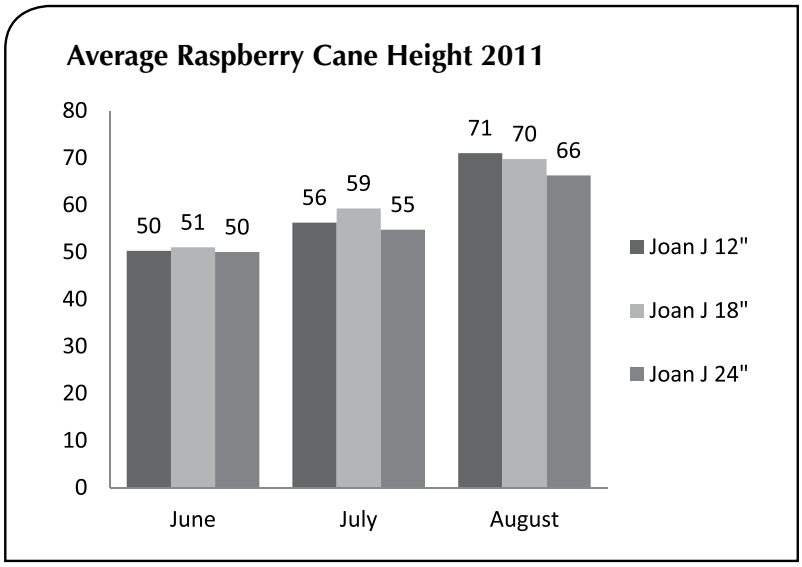


Figure 4. 2009 and 2011 Growth of primocane-fruiting raspberry cultivar 'Joan J' at Berry Ridge in Alexandria, MN at each of the different spacings. Numbers on top of the bars in the bar graph are the average growths in inches.

Results

At the WCROC we measured plant growth, berry weight, and total yield for primocane-fruiting raspberries in high tunnel and field settings during 2009-2011. Both cultivars tested had substantially more growth in the high tunnel during all growing seasons (Figure 1). In 2009, high tunnel grown berries were larger and yields were almost double for cultivar 'Caroline' and almost three times higher for 'Autumn Britten' than the same cultivars grown outside the tunnel. In 2010, high tunnel grown berries were again larger and yields were higher than the same cultivars grown outside the tunnel (Figures 2 and 3). Interestingly in 2009, 'Autumn Britten' had a higher total yield than 'Caroline' but in 2010 the opposite occurred (Figure 2). In 2011, field trial grown berries had higher yields than the high tunnel. The baseline for berry size was based on Driscolls clamshell which contains 40 berries per 6-oz container.

In 2009, berry size began large and quickly decreased until berry size for both cultivars in both settings fell below the Driscoll's berry size (Figure 3). In 2010, berry size was always less than the average berry size in a Driscoll's clamshell. In the high tunnel there was a sharp decline in average fruit size in early August 2010 which may have been due to temperatures in the 80's. In 2011, berry size was again less than the average berry size in a Driscoll's clamshell.

In 2011 high tunnel grown berry yields were the complete opposite as compared to 2009-2010. The raspberries grown outside the high tunnel had higher yields. We attribute that difference to abundant rainfall during May, June, and July on the 2011 field trial as compared to 2009 and 2010. Rainfall amounts during those 3 months in years 2009-2011 were: 2009=3.61", 2010=8.99", and 2011=15.98".

At Berry Ridge, we wanted to determine if cultivar 'Joan J' was suitable for use in a high tunnel and what row spacing resulted in best growth and yield. We measured plant growth, berry weights, and yields for each of the 12", 18", and 24" plant spacings. Row spacing did not have a major influence on plant growth 2009 and 2011; by the last measurement, there was not a difference in growth between the three spacings. (Figure 4). In 2009, 'Joan J' at all three spacings produced berries larger than the average berry size in a Driscoll's clamshell through the end of September. In 2011 the berries were smaller than the average berry size in a Driscoll's clamshell (Figure 5). However, the 24" row spacing in 2009 and 2011 yielded substantially fewer pounds of berries than the other two closer spacings (Figure 6).

Soil Moisture

Irrigation at WCROC was based on readings taken from watermark moisture sensors in the high tunnel and field trials. The sensors were placed at 3" and 6" soil depths in the raspberry plant row. Readings were taken twice per week. Irrigation was turned on for 2 hours when the average reading was at 30 centibars. The irrigation system was a drip line tube with emitters every 12" and two tubes placed down each plant row with a flow rate of 1 gal/hr.

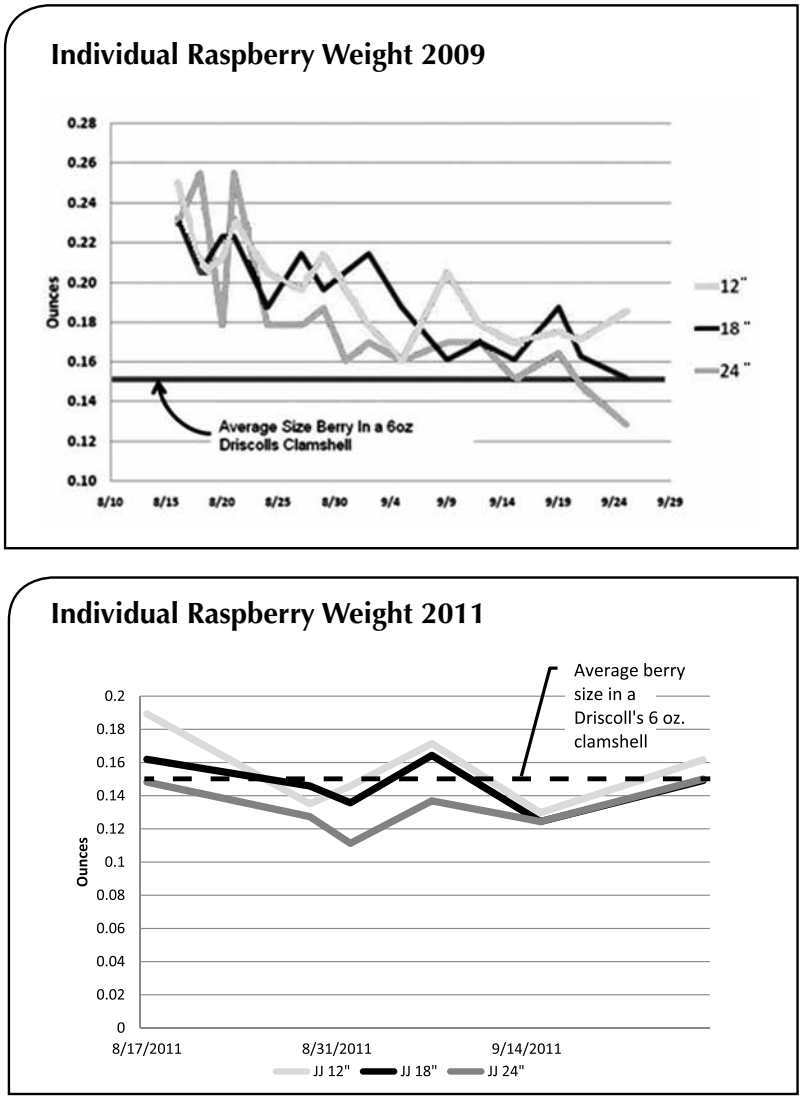


Figure 5. 2009 and 2011 Average berry size of 'Joan J' grown in a high tunnel at Berry Ridge Alexandria, MN at different initial plant spacings.

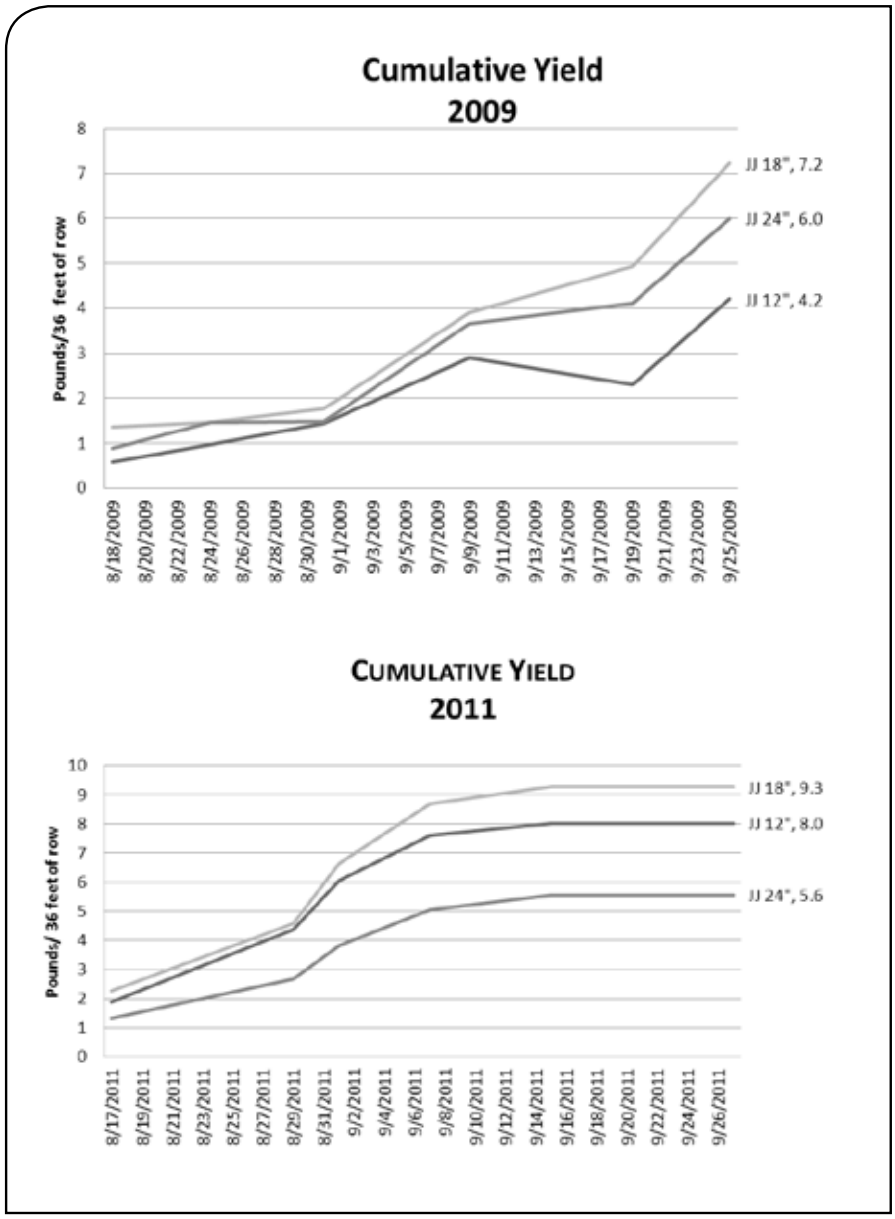


Figure 6. 2009 and 2011 Production (lb/36' row) of 'Joan J' grown in a high tunnel at Berry Ridge in Alexandria, MN at different initial plant spacings. Numbers on the graphs are total yield.

Plant Nutrients

Plant tissue analysis samples were taken 2010 midseason to determine plant nutrient deficiencies for 'Caroline' and 'Autumn Britten.' The plant lab completed the analysis and determined the nutrient levels were reasonably normal with the exception of a low level of Potassium (K). Potassium is important for maximum raspberry yields. In the spring of 2011 a soil analysis was done and compared to the plant tissue analysis. The analysis showed no need for any additional nutrients.

Pest Incidence

Weeds were not a problem for either 'Caroline' or 'Autumn Britten' and only a small amount of hand-weeding took place in the high tunnel. Weeds were minimal because of the shading effect of the large plants. Weeds in the field trial raspberries were generally controlled with a granular herbicide called XL2 G (Surflan) which was applied once in early spring of 2010 and 2011. The granular herbicide was applied at a rate of 6.9 lb/1,000 ft^2 at a cost of \$20.70/1,000 ft^2.

Plant diseases were monitored during all growing seasons. No apparent diseases were noticed and plants remained in good health in both high tunnel and field planted raspberries.

Insects were monitored very closely during all growing seasons. A 10X magnifying glass was used twice per week to scout for insects, especially red spider mites. Early in the 2009 season a very small number of spider mites were detected and we used high pressure water to knock them off the foliage. This method worked extremely well for low spider mite infestations early in the season. Starting in mid-June of all years, we applied organic horticulture oil for red spider mite and sawfly control. The product used was Pure Spray Green and used at a rate of 2.5 oz/gal of water. This natural product was used until mid-September at a cost of \$45.00 for eleven spray applications. In August of 2011 we felt that another insecticide was needed with a different mode of action for sawfly and spider mite control. We used Dipel insecticide at a rate of ½ lb/100 gal of water. Dipel is a biological insecticide listed by the Organic Materials Review Institute (OMRI) for use in organic production.

Harvest Labor and Markets

Another aspect of this research project was to expose University of Minnesota, Morris (UMM) students to production practices of locally-grown raspberries at WCROC. In partnership with student garden volunteers at UMM and building on past successful relationships, we exposed these students to our science-based experimental project. Raspberries were harvested by volunteer student

organizations and taken to UMM Dining Services. Dining Services served the fresh fruit, processed and froze the remaining product for future use in their menus.

The UMM Food Service is managed by Sodexho Campus Services, Inc. Their contract with UMM mandates that they purchase and use local foods in their meals, when available, and that they expose UMM faculty, staff, and students to locally-produced, wholesome food products. This project connects to the Pride of the Prairie Local Foods initiative and a new program enhancing healthy eating on campus and in the community. Engaging student leaders and volunteers in the harvest and consumption of the raspberries will hopefully stimulate increased interest in local foods and future marketability for area growers.

In addition, to involving UMM Food Service and UMM students we also shared our knowledge with the community. On the last Thursday in July of 2009-2011 WCROC had a Horticulture Night. Community members were invited to learn about the raspberry high tunnel and the important role that plants have in our lives.

Management Tips

1. Monitor heat inside high tunnel because excessive heat can have detrimental effects. The use of shade paint, shade cloth or increased ventilation can reduce temperatures.

2. Additional cooling should also be considered when growing raspberries in a high tunnel. Our high tunnel had side air vents but no end vents for temperature cooling. Modifications should be made to install additional venting on the ends to hopefully cool the tunnel more when outside temperatures are high.

3. Monitor for red spider mites twice a week in high tunnels. If left unchecked, they can be devastating.

4. Normal early raspberry harvest intervals should be twice per week; however, when temperatures increase harvest three times per week for better quality fruit.

5. Have a reliable supplemental heat system with fans to extend your picking season.

6. Our high tunnel raspberry research at Morris demonstrated spacing of plants within the row affects total yield but not average berry weight. Plant spacings of 18" is a better choice than 24" spacings.

Cooperators

Ron Branch, Berry Ridge Farm, Producer, Alexandria, MN
Emily Hoover, University of Minnesota Department of Horticultural Science, St. Paul, MN
Emily Tepe, University of Minnesota Department of Horticultural Science, St. Paul, MN
Sandra Olson-Loy, Vice Chancellor for Student Affairs, University of Minnesota-Morris, Morris, MN

Project Location

UMN West Central Research and Outreach Center (WCROC) at Morris is south on Hwy. 59 from Hwy. 28. From Hwy. 59, watch for a large sign indicating University of Minnesota (right) and West Central Research and Outreach Center (left). Turn left. The administration building will be on your left.

Berry Ridge Farm is located at 1301 Firemen's Lodge Rd. SW, Alexandria, MN. From I-94, take exit 100 (Hwy. 27), going north, cross Hwy. 27 to Cty. Rd. 45. Go about .5 miles and turn left (west) on Latoka Lane. Go .6 mile then turn right (north) at lake. This is Fireman's Lodge Road. The farm is .8 miles and on the right.

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*

University of Minnesota High Tunnel Production
Website: *http://hightunnels.cfans.umn.edu*

Growing Fresh Cabbage for Markets using Integrated Pest Management Strategies

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Project Duration

2009 to 2011

Award Amount

$20,000

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Keywords

cabbage, cabbage looper, diamond -back moth, Dipel DF insecticide, imported cabbageworm, integrated pest management, row cover, trap crop, weed mat

Project Summary

The purpose of this project is to demonstrate the effectiveness of timely pest management strategies using integrated pest management (IPM) and to demonstrate other agronomic production practices that will hopefully increase yields and cabbage quality. The Association for the Advancement of Hmong Women in Minnesota (AAHWM) project focuses on two Hmong women growers, Dia Xiang in Rosemount and Chue Vang in Vermillion, who produce cabbage for the local fresh market. Chue replaced Yer Vang who participated in the project in 2009 and 2010.

Kevin Cavanaugh, the project consultant, provided technical expertise in IPM strategies, safe pesticide use, and general vegetable production practices. He also trained Chianeng Thao, the AAHWM farm educator. The project consultant and farm educator worked together to translate materials and procedures into the Hmong language.

Project Description

Cabbage produced in the Rosemount and Vermillion areas of Minnesota are subject to several Lepidoptera pests that can cause serious damage to fresh market cabbage. These pests include cabbage looper (*Trichoplusia ni*), imported cabbageworm (*Pieris rapae*), and diamondback moth (*Plutella xylostella*). Working collaboratively, the project consultant and the farm educator set up cabbage demonstration plots at each of the two farms to demonstrate effective low impact pest management methods and show how some general vegetable production methods can increase yields.

Each farm had a demonstration plot consisting of four single rows of cabbage, each row receiving one of four treatments. There were no replications of treatments at either farm as these were demonstration plots. The four treatments included:

1. Control - no treatment.

2. Dipel DF - a Bt (*Bacillius thuringiensis*) bacterial-based insecticide. This insecticide is specific to the larval stage of three cabbage insects and does not harm beneficial insects. It is inexpensive and has a very low toxicity so it is safe for the applicator and environment. Dipel DF was applied using a Hudson 4 gallon backpack hand pump sprayer.

Cabbage planted in biodegradable weed mat. Cabbage in weedmat and row cover at left.

3. Row Cover - a spun-bound polyester fabric placed over the rows and supported with wire hoops. The row cover was anchored to the soil by applying soil over fabric edges at the soil line. Row covers allow light, air, and water to penetrate but keep aboveground insects out.

4. Trap Crop - two rows of collard greens planted adjacent to a cabbage row. A trap crop serves as a food source that attracts Lepidopteron insect pests drawing them away from the main crop. Research indicated that collard greens act as a trap crop for diamondback moths. The farmers tested this to determine if a trap crop would have any success in attracting imported cabbageworm and cabbage looper.

A small handful of starter fertilizer (about 1/4 cup) was soil incorporated at the time of planting near each cabbage transplant. The project consultant calculated and weighed out the proper amount of nitrogen fertilizer to deliver 120 lb N/A. The "Midwest Vegetable Production Guide for Commercial Growers, 2009" was used as a guide for cabbage fertility requirements. The project consultant reviewed the calculation process with the farm educator so that he could demonstrate the procedure in Hmong for each farmer. Fertilizer amendments were made using a split application of fertilizer incorporated along the side of each cabbage row and applied at 2 and 4 weeks after cabbage plants were transplanted.

A late flathead cabbage variety was planted in all plots in 2009 and the cabbage variety Bronco was planted in 2010 and 2011. Seeds were first planted in flats and grown in a greenhouse for 4 weeks before being transplanted into the field plots. Cabbage rows were 100' long and plants were spaced 3' apart. The soil was prepared by rotary tillage and the center row area was leveled using heavy garden rakes.

Biodegradable paper weed mats were laid down the row center and anchored by placing soil along paper edges. Marking off at 18" intervals on the paper weed mat, an X-slit was cut into the weed mat to insert the cabbage transplants. Each row had 80 plants. No paper weed mat was used in the trap crop (collard greens) rows.

Table 1. Mean Cabbage Head Weight (lb), Years 2009-2011

	2009		2010	2011		Mean wt. across all years and locations
	Dia Xiang	Yer Vang	Dia Xiang	Dia Xiang		
Treatment	Fall	Fall	Fall	Spring	Fall	
Control	3.7	5.7	3.7	3.5	3.9	4.1
Dipel DF (Bt)	3.2	5.2	3.5	3.7	5.4	4.2
Row Cover	4.3	6.5	3.5	3.1	3.7	4.2
Trap Crop	5.2	5.1	3.7	3.5	4.3	4.4
Mean Wt./Year	4.1	5.6	3.6	3.5	4.3	4.2

Farm educator Chianeng Thao shows Dia Xiang's husband the quality and weight of cabbage.

Table 2. Cabbage Head Quality Parameters for Row Cover Treatment, Measured at Fall, 2011 Harvest

Cabbage head	Weight (lb)	Outer leaf	Sun scald	Head split	Quality
1	5.6	negative	negative	negative	
2	4.11	negative	negative	negative	
3	4.12	negative	negative	negative	
4	2.9	negative	negative	negative	
5	3.6	negative	negative	negative	
6	2.1	negative	negative	negative	
7	4.2	negative	negative	negative	
8	3.11	negative	negative	negative	
9	3.9	negative	negative	negative	
10	3	negative	negative	negative	
Total	36.64				
Average	3.664	100%	100%	100%	Excellent

Table 3. Cabbage Head Quality Parameters for Control Treatment, Measured at Fall, 2011 Harvest

Cabbage head	Weight (lb)	Outer leaf	Sun scald	Head split	Quality
1	4.11	positive	negative	negative	
2	5.1	positive	negative	negative	
3	3.12	positive	negative	negative	
4	3.15	positive	negative	negative	
5	4.5	negative	negative	negative	
6	4.8	negative	negative	negative	
7	3.14	positive	negative	negative	
8	4.4	positive	negative	negative	
9	4.12	negative	negative	negative	
10	3.15	positive	negative	negative	
Total	39.59				
Average	3.959	70%	100%	100%	Very Good

Spring cabbage was planted in late May or early June to avoid peak early spring activity of cabbage maggots. The IPM practice of delaying the first planting date until after the first generation of cabbage maggot resulted in no cabbage plantings being destroyed. The second planting occurred at mid-July to obtain a harvest date in September before the first frost date. At harvest time, ten cabbage heads per row were randomly selected and weighed using a hand held digital scale.

Results

Throughout the summer, the project consultant and farm educator made weekly visits to each farm to monitor pest pressure and review with each farmer the progress of the cabbage. Both farmers were pleased with the results of using a row cover and quickly recognized its value in preventing insect damage on cabbage plants.

In 2009, the installation of the row cover was not done immediately at planting. This delay allowed adult imported cabbageworms to lay eggs on cabbage leaves before the row cover was installed. At the time of the row cover installation, many eggs and larvae of the imported cabbageworm were observed on the underside of the cabbage leaves. An attempt was made to remove any eggs or larvae from the cabbage leaves. Despite this effort, it was impossible to remove all eggs and larvae. During the course of the growing season, the row cover was lifted twice

to remove any adult imported cabbageworm butterflies. Dia learned that it is imperative to install the row covers immediately after transplants are planted. The row covers were closed immediately after setting the transplants in 2010 and 2011 to prevent egg laying by insects.

During the growing season, the collard greens harbored numerous eggs and small larvae of the imported cabbage worm and diamondback moth. Additionally, larval leaf feeding was observed on the trap crop. Visual observations showed less leaf feeding on the cabbage adjacent to the trap crop.

Dipel DF was applied during the cupping to early head growth stage when the IPM threshold was at 20% (20% of plants have eggs or larvae).

The average cabbage head weight per treatment and overall head weights for all locations and years 2009-2011 appear in Table 1.

Yer Vang opted out of the project in 2011 and was replaced by Chue Vang. In July of 2011, a devastating flood occurred at Chue Vang's farm site destroying the cabbage demonstration plots preventing any harvest data from being collected. No second planting of the cabbage demonstration plots was conducted at this location for 2011.

In the fall of 2011, three leaf quality parameters were recorded at harvest. The parameters included:

- outer leaf foliar feeding damage;
- sun scald and;
- head split.

Leaf damage was recorded as positive (present) or negative (absent). No severity scale was created and deemed not necessary since the damage was of a cosmetic nature and the leaves could be removed before being sold at the market. No split heads were observed in the first or second plantings.

Table 2 and Table 3 show the contrast in quality between the row cover protected cabbage and the control treatment with no protection. The row cover protected the cabbage heads and no blemishes were observed whereas the control did display some minor leaf blemishes.

Soil test analyses from 2010 showed soil pH at 5.0 and 5.3, at Dia Xiang and Yer Vang farms respectively. Though cabbage can be grown at this pH, phosphorus can become less available, leading to a lower quality and quantity of product. In 2011, a lime plot using cabbage plants was added at each grower's field to demonstrate lime application and determine if any measurable effects could be observed at harvest. The project consultant calculated that two tons of lime was needed to adjust the pH and amounts were calculated for the plot size. At each farm site, five 30' rows, with three feet between rows were established. The lime treated row received 20 lb of lime and was incorporated with a roto-tiller. A control row received no lime. Ten cabbage plants at harvest were weighed separately from the lime and control rows. The lime treated row had an average head weight of 1.2 compared to the control of 0.8 lb. The overall low weights associated in this demonstration plot may be attributed to poor soil fertility and soil disturbance that occurred in this field during a 2010 road construction project. Additionally, the plot was located down slope from the main cabbage plots and was subject to heavy erosion from 2011 rain events.

Row cover and weed mat materials used in this project varied by vendor and saw yearly price increases. The row cover purchased in 2009 cost $29.35 (5' x 250'). In 2011, row cover purchased from a different vendor was $48 (6' x 250'). Calculating the cost of these materials for rows 100' x 3', the 2010 row cover cost was $0.14/head compared to $0.24/head in 2011. Weed mat materials also increased. In 2011, weed mat costs increased to $0.32/head, up from $0.20/head in 2010. Dia Xiang sold her cabbage heads for an average price of $2.50/head, leaving her with a profit of $1.94 profit/head after subtracting the combined costs of row cover and weed mats. Costs for Bt insecticide application remained constant for the three years of this project. A 5 lb bag of Dipel DF was purchased in 2009 for $86.60, or $17.32/lb. This was sufficient to cover the needs of the three year project. The Bt treatment and the trap crop (collard greens) were sprayed once in July of 2011. The same treatment rows were sprayed at second planting date location. Dipel DF was applied at 1-2 teaspoons/gallon at a cost of $0.17-$0.34/gallon. One gallon was enough to cover at least two rows, so the cost/row was $0.09-$0.18.

Conclusions

In this project, the Hmong farmers learned that by delaying their cabbage planting until the end of May or early June, they could avoid serious cabbage losses from cabbage maggots. The growers learned that by planting cabbage at this time, the cabbage transplants would not be subject to heavy cabbage maggot egg laying pressure and subsequent larva feeding injury on transplant roots. Dia Xiang could see side by side comparison when she observed her April cabbage planting being destroyed, adjacent to her late May/early June planting that grew to harvest without destruction.

The row covers did an excellent job of protecting the cabbage from Lepidopteron pests during the growing season. Although cabbage harvested from the row cover were blemish free, the average weight was 0.4 lb lower

than the other treatments. It was learned that the row cover used in 2011 had a weight of 3.25 oz/square yard as opposed to previous years when the row cover had a weight of 0.55 ounces per square yard. After communicating with the University of Minnesota Vegetable and Small Fruit Extension Specialist, the project consultant learned that the heavier row cover may have intercepted more light causing a slightly lower cabbage weight.

The weed mats provided many advantages:

- eliminated in-row weed competition for water, nutrient, and light throughout the growing season;
- eliminated many hours of hand weeding, freeing up time for other activities;
- moderated soil temperature;
- trapped soil moisture;
- harbored beneficial beetle insects that feed on soil inhabiting insect pests;
- reduced soil erosion sloping land; and
- were cost effective.

The biodegradable mats were easily turned into the soil at the end of the season.

The trap crop reduced insect pressure on the adjacent cabbage but took up extra space in the field.

Management Tips

1. Conduct soil analysis of production field in advance of planting to determine soil pH and nutrient status for intended crop and plan soil amendments accordingly.

2. Delay planting of cabbage or similar crops until late May or early June in Minnesota to avoid cabbage maggot injury on transplants.

3. If using row covers, apply a pre-emergent soil herbicide, mulch, or weed mat to control the weeds before planting the cabbage. Heavy weed pressure will push the row cover up as well as rob water, light, and nutrients from the cabbage.

4. Purchase row covers that have a fabric weight no more than 0.55 to 0.75 oz/square yard which provides adequate sunlight and water penetration to reach crop.

5. Apply row covers immediately after setting cabbage transplants to prevent Lepidoptera insects from laying eggs on young leaves.

Cooperators

Dia Xiang, Farmer, Rosemount, MN
Yer Vang, Farmer, Vermillion, MN
Kevin Cavanaugh, Independent IPM Consultant, St. Paul, MN
Chianeng Thao, Farm Educator, St. Paul, MN

Project Location

Dia Xiang Farm: Travel on US 52 south and exit at Dakota Cty. Hwy. 42 west. Follow Hwy. 42 to Dakota Cty. 73. Turn north on Cty. Hwy. 73 (Akron Ave.), just past Dakota County Technical College. Proceed on new gravel road until you see the "Railroad Crossing" sign. Turn right off of the gravel road and follow the field roadway up the hill to the farm buildings.

Other Resources

Growing Broccoli, Cabbage, and Cauliflower in Minnesota. 2009. University of Minnesota Extension Publication. M1247. Website: *www.extension.umn.edu/distribution/horticulture/M1247.html*

The Good Guys Natural Insect Identification Cards. Website: *www.inhs.illinois.edu/chf/outreach/eduresources/good/guysframes.htm*

Immigrant Farming Programs and Resources. Website: *smallfarms.wsu.edu/wsu-pdfs/ImmigrantFarmingGuide.pdf*

Midwest Vegetable Production Guide for Commercial Growers. 2011. Website: *www.btny.purdue.edu/Pubs/ID/ID-56/*

Minnesota Fruit and Vegetable Growers Manual for the Beginning Grower. 2004. University of Minnesota Extension. Website: *smfarm.cfans.umn.edu/mfvgmanual.pdf*

Nutrient Management for Commercial Fruit & Vegetable Crops in Minnesota. 2009. University of Minnesota Extension Bulletin. WW-05886. Website: *www.extension.umn.edu/distribution/cropsystems/DC5886.html*

Perimeter Trap Cropping Works! University of Connecticut – Integrated Pest Management. Website: *www.ipm.uconn.edu/IPM/veg/htms/ptcworks.htm*

Row Cover Vegetable Production Techniques. 2004. New Mexico State University Extension. Guide H251. Website: *aces.nmsu.edu/pubs/_h/H-251.pdf*

University of Minnesota Extension Commercial Vegetable and Fruit Production Website: *www.extension.umn.edu/Vege&Fruit/*

Solar Energy Storage and Heated Raised Beds

Principal Investigator

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Project Duration

2010 to 2012

Award Amount

$8,000

Staff Contact

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Keywords

community supported agriculture (CSA), season extension, solar-heated water, vegetables

Project Summary

The goal of our project is to be able to supply local vegetables earlier in the season when demand from our customers is high. We have designed a system that will use a wood boiler to heat water. We will store the heated water in an insulated 10,000 gallon underground steel barrel and then pump it through PEX-AL-PEX tubing to warm the soil in spring. This will allow us to plant outdoors sooner. In addition, we have also designed 3' high growing tables that will house the tubing and allow for less labor-intensive vegetable growing. We are calling the tables that will be used for vegetable production X-beds. Our system has been operational since March 2012.

Project Description

We operate a market garden/community supported agriculture (CSA) called Gardens Gourmet in East Otter Tail County in central Minnesota. We grow many different types of vegetables and berries to supply our customers with produce all season long. Over half of our produce is sold from the farm, and about a third is sold through the CSA. The rest of our produce is sold through farmers' markets.

The average last date of frost in our area is May 12. The soil is often not warm enough to plant warm season crops like peppers and melons until Memorial Day, so we cannot start harvesting these profitable crops until late August or early September. The biggest limiting factor in spring production is often low soil temperatures. Low soil temperatures in the spring delay seed germination, cause nutrient deficiencies and stunt plants. Even cool season crops like lettuce and spinach will respond to warm soil early in the spring.

We designed a system of growing plants that will both allow us to plant and harvest vegetables earlier in the spring and help us work more efficiently. In order to plant and harvest earlier, we are heating the soil with hot water that runs through tubes in raised beds. Our heated beds are all outside. *Greenbook 2011* describes the process we used to set-up the heated water tank and X-beds.

Completed X-beds. The house containing the water pumps is in the background.

View of the X-beds facing south before filling beds with soil, with the Pex-al-Pex tubing. The soil we used to fill the beds is in piles on the left.

The X-beds after filling with soil.

Results

Water is heated and pumped into a 10,000 gallon steel tank. The water tank is insulated with 2" styrofoam (r value = 15) insulation on the sides of the tank and 1" styrofoam insulation on the bottom. We backfilled outside the insulation with sand because it is a better insulator than soil. When the water temperature rises 22°F above the ambient temperature, the tank will be able to store 1,760,000 BTU's.

In 2011, we installed one pump inside the shed to pump water to and from the wood boiler. Another pump was installed to move heated water into the outdoor raised beds. Inside the tank, a water system flows through 500' of ½" Pex-Al-Pex coiled tubing that acts as a heat exchanger. Heated water stored in the tank will be pumped out through ½" Pex-Al-Pex tubing to the raised beds and back into the tank.

The raised beds, which we call "X-beds" are about 3' off the ground. The sides of the beds are made from pallets and are supported with 2'x 4' framing. We placed 1 ½" styrofoam insulation at the bottom and sides of the beds and installed four lines of Pex-Al-Pex tubing on the insulation. We then covered the insulation with 9" dark, high organic matter soil that we dug next to a nearby swamp. We placed two lines of drip tubing on top of the soil and covered the soil with plastic. There are two X-beds that are 3' wide and 100' long.

On the east side of the X-beds, we built two traditional raised beds in the soil. The traditional raised beds are 10" high. One raised bed has four heating tubes with no styrofoam insulation. The other raised bed has no heating tubes and will act as a control. The traditional raised beds will also be irrigated with drip tape and covered with plastic.

The X-beds will be used for high value, labor intensive crops such as lettuce and green beans that require workers to constantly bend over. We will start planting beans, lettuce and strawberries in the X-beds in March, with the goal of selling green beans by Memorial Day. In the heated traditional raised bed, we will raise heat loving crops like cantaloupes, which respond to heat in the month after planting, but spread to unheated soil after the warm weather arrives. We will also plant bell peppers in the traditional beds. Half of the unheated control bed is planted to garlic, while the other half will be bell peppers and cantaloupes so that we can compare harvest dates and yields for cantaloupes and peppers in heated and unheated beds.

Currently, we have enough tubing to heat 950 ft^2 of soil between the X-beds and the traditional raised beds. If we find that we can heat a larger area with our current heat storage system, we will buy more Pex-al-Pex tubing and increase the heated area.

As of early January, our project was 95% complete. We need to install a pump flange, a pump, and mixing valve, which should be done by the end of January. Also, we will be insulating and sheeting the interior of the X-shed. After planting, we will also cover the beds with Typar® row covers which will be held up by small hoops over the rows.

Traditional raised beds that will have heated soils.

Management Tips

1. Shop around for equipment and ask questions of suppliers.

2. Add in 10% to your budget for "wiggle room," as it always costs more than you anticipated.

3. Place the beds close to wells and electricity to reduce costs such as trenching.

Cooperators

Thaddeus McCamant, Northland Community and Technical College, Detroit Lakes, MN
Keith Olander, Central Lakes College, Staples, MN

Project Location

Gardens Gourmet is located on State Hwy. 29, 1 mile south of the intersection of Hwy. 29 and State Hwy. 210. We are on the east side of the highway.

Other Resources

Information is available at the following websites for:
Wood boilers: *www.centralboiler.com*
Pex Superstore: *www.pexsupplier.com*

Determining the Cost of Raising Pastured Pork on a Diet Including Whey and Finishing on a Diet Including Acorns

Principal Investigator

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Carver County

Project Duration

2010 to 2012

Award Amount

$8,000

Staff Contact

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Keywords

feeding acorns and whey, heritage pig breeds, meat flavor, niche marketing, rotational grazing

Project Summary

I am raising heritage breeds of pigs, including Red Wattles and Large Black Hogs on pasture. My first objective is to implement an intensive grazing plan for the pigs. I will compare the grazing characteristics of all of the pigs in the project. Red Wattles and Large Black Hogs, which are the main focus of the project, are described as efficient grazers by many who raise them. I also raise Hampshire and Berkshire pigs and will use them as a control group as they do not have the reputation as grazers.

In addition to raising the pigs on pasture, I will also be finishing them on an alternative diet, including acorns and cow milk, and determining how a varied diet affects meat flavor. It is my hope that a varied diet including acorns and milk will enhance the quality and flavor of the pork and will open markets for the product. Through my success, I hope to increase awareness of alternative production systems in Carver County and the potential economic, environmental, and social benefits they offer.

Project Description

In 2010, we decided to sell our dairy cattle. This sale will definitely affect our farm's income. I plan to use this project to demonstrate a transition from commodity based marketing to local and niche marketing to support the income on small farms as well as to provide environmental and social benefits to the local communities.

It is my goal to produce a high quality pork product while demonstrating a successful grazing plan using Red Wattle pigs and Large Black Hogs. I also added a small group of Hampshire and Berkshire pigs to use as a control group of pigs not noted for their grazing habits. I will be testing the feasibility of incorporating alternative feeds, including acorns, into the pigs' diets to determine the effect diet has on the flavor of the meat.

2010 Results

My first year in implementing my project was a year of learning experiences. I had many questions to answer for myself including: What type of fencing am I comfortable with? What forage do pigs prefer? How do I handle farrowing? And, what is the best marketing approach?

Our boar grazing in the pasture.

I decided to focus this first year on developing markets for our pork and becoming familiar with raising pigs in general, not just on pasture. In March, I purchased a small group of three Hampshire feeder pigs to raise and market. I also worked towards establishing a herd of heritage hogs by purchasing two Red Wattle gilts and bred them to farrow in July and August.

Feeder Pigs:
I raised the pigs on a diet including a 5 lb ration of grain and mineral ration, 3 lb fresh alfalfa, 4 lb cow milk and 2.5 lb windfall apples from a local orchard. The alfalfa was fresh and hand harvested every day. Apples were added to the diet during the last 6 weeks before butchering. I was allowed to have the apples for free if I gathered them. The pork from the pigs finished on apples will allow me to test any difference in the flavor of pigs finished on apples vs. acorns.

The pigs were ready for market in 208 days. The live weights were 240 lb for one pig and 230 lb each for the other two. The hanging weights were 170 to 160 lb.

Windfall apples are an alternative feed source that I plan to include in some of the pigs diets in the future. I like using apples because they are easy to collect and store. Feeding apples is also an intriguing selling point. Many people I spoke to about the pigs finished on apples seemed to have an immediate vision of a good pork product and showed interest in purchasing pork in the future. By the end of the season the orchard owner mentioned charging me a price if I collected apples in the future. The price for collecting windfall apples may limit the number of pigs I can finish on apples in the future.

While I secured agreements to harvest acorns from oak trees throughout Carver County, I did not pursue finishing the pigs on acorns this year. The Red Wattle pig litters that will farrow in January 2011 will have a finishing date which coincides with acorn harvest. Increased efficiencies in raising the pigs in the coming year will allow more time to adequately measure the results of the acorn harvest.

I did not have enough pigs this year to make a good assessment of pasture use, but I do have some observations. By having both grass and clover pastures, I observed that clover is much more palatable to the pigs. I also noted more rooting when the pigs were on grass. I will follow this observation in subsequent years to test its reliability. In the coming year, feeder pigs will be placed on legume pastures and sows and boars will be placed on grass pastures.

Marketing:
I used a blanket approach for marketing in 2010, including a local farmers' market, direct marketing to a local restaurant, a booth at the Carver County Fair, becoming a member of MN Grown, and developing a website and a Facebook page.

Most of our customers were very happy to find someone in Carver County who is raising both pigs and chickens, as we are. Some had been driving farther distances to purchase products. We invited our customers to our farm and always offered them to see how the animals were raised. It was a very positive experience.

The farmers' market was not successful due to poor customer participation. I think participation in a farmers' market has good potential and I will be getting involved in organizing a different farmers' market in a residential setting in 2011.

The Carver County Fair offered some good contacts and the opportunity to talk to interested customers one on one. I have not decided if I will have a booth at the fair in 2011. The website was successful in gaining exposure, but I feel I can gain the same exposure with continued membership in MN Grown and maintaining the Facebook page.

We were very fortunate that a restaurant named Terra Waconia opened in Waconia in February 2010. They source local foods for their menu and we hope for their continued success as it will fuel our success. It has been a good starting point in learning about sourcing to restaurants and we hope to expand that in 2011.

We have had very positive feedback on the quality and flavor of our pork during the first year. The pigs processed in 2010 were three Hampshire piglets purchased in March 2010 for just $15 each. It was difficult to set a price for the pork I sell. To assist me I have researched what other farms charge and found a price my clientele and I are comfortable with. I have enjoyed a profit from each pig sold and with expanded marketing I hope to see a profit in the near future which will sustain our farm.

Farrowing Red Wattles:
In 2010, I farrowed two Red Wattle sows in July and August. Both farrowed in pens were allowed to move freely about in their pens. I feel summer was not an ideal time of year to farrow due to the heat. However, I bred them when I did because the gilts were of breeding age at 12.5 and 8 months of age when I purchased them in February. I did not want to put off breeding allowing the gilts to get too large.

One of the Red Waddle gilts.

Each gilt farrowed in a pen by herself. A heat lamp was used to lure the piglets away from their mother to reduce the risk of crushing. The first gilt farrowed 15 piglets and weaned 8. There were 3 stillborn, 2 runts, and 2 were crushed. The second gilt farrowed and weaned 8. Despite the losses experienced with the first litter, I will pen farrow while allowing the mother access to outdoors again in 2011 and may experiment with pasture farrowing.

I gave the first litter iron shots and they thrived. When I let them go out on pasture, I noticed the piglets perked up their energy levels. So, for the second litter instead of giving iron shots, I put in 5 gal of soil while they were in the pen. These piglets rooted in the soil and thrived without the iron shots.

Fencing and Watering:
I did not have enough pigs to gather reliable data on implementation of a grazing plan. Instead, I experimented with different fencing for different groups of pigs. Five foot high panels pounded to wood posts worked well for pigs from 30 lb and over, but small piglets seemed to constantly find a way out. Our first litter of piglets earned the title of 'free range' rather than 'pastured'.

Electric wire fencing proved to be very effective for our feeder pigs greater than 60 lb. Smaller pigs either found a way under, over, or through the electric fencing. I constructed an electric fence training area surrounded by a cattle panel perimeter to restrict the pigs from getting out entirely. I don't have a good explanation of why the younger group challenged the electric fence so consistently. I will observe things again next year to make a better determination.

I also noted that although the electric fence alone is very effective once pigs are trained to it; the pigs are very intelligent and tried various attempts at shorting out the wire. They would root up soil along the fence line to form a mound which would touch the lowest wire. They also pushed up large rocks, watering tubs, and feed tubs to short out the fence.

I have decided that the fence I am most comfortable with is a high tensile woven or welded wire fence with holes small enough to contain piglets with a strand of electric wire around the inside perimeter and portable electric wire between paddocks. The woven or welded wire is less expensive than cattle or hog panels and the electricity offers an additional security measure. I want to avoid building a negative reputation of pastured pigs getting out of their fencing.

I used two different watering systems in 2010, nipple waterers attached to a watering hose and water tubs. Both had good points and bad. I liked the nipples because the pigs had a consistent supply of fresh water. However, the pigs had a tendency to run the water to create a mud hole at the watering location. I liked the tubs because they were portable so if one watering location got too muddy, I could easily move it. The problem with the tubs is that some pigs like to step into them muddying the water. Next year I will try a portable nipple system which will allow consistent cold, fresh water and avoid unwanted mud holes.

While I am mentioning mud holes, I will insist that they are absolutely necessary. On the hottest days during the summer of 2010, they were a savior to the health of the pigs. I would highly recommend implementing them into a pasturing system. In 2011, I will have a central mud hole much like a dry lot and the pigs will have the freedom to go back to that location as they are rotated through the paddocks.

In 2011, I plan to farrow the two Red Waddle sows in January, and possibly again in August or September. I also plan to breed some of the gilts that were born in 2010 for farrowing in August and September. I plan to get a few Large Black gilts to add that breed to our farm. I will have a greater number of pigs and more experience managing them by then.

2011 RESULTS

Marketing:
We again focused a great deal of time on marketing. Our markets continue to grow. We feel we are well established in direct consumer outlets. We have secured agreements with three restaurant buyers. We are also working on an

agreement with a local supermarket. We will continue consumer outreach, especially to individuals who are not familiar with the local foods movement.

MN Grown, our website, social networking, and word of mouth are very effective methods of reaching new clientele. There is a large community of local food advocates helping the movement grow. We had the privilege of participating on the MN Cooks stage at the MN State Fair along with one of our restaurant buyers, Terra Waconia, and were featured in the 2012 MN Cooks calendar. Red Wattle pork was the featured ingredient. We also had the privilege of having our farm featured in the MN Cooks segment on TPT-Channel 2 in November.

In spite of all this press, it is interesting to discover that there is a large segment of the population still not aware of the local foods movement and the vast opportunities to support a local farmer. We plan to do more outreach to this segment of the population in 2012.

Feeder Pigs on Pasture:
A group of 60 feeder pigs were given access to 1.2 acres of alfalfa pasture as well as a .5 acre wooded lot in June. Since we no longer have cows, cow milk has been removed from the hog diet. I researched purchasing dry whey from our local creamery and since they only sell it in one ton totes it was not a feasible option. Storage of the whey was a concern as well as keeping the product pest free. I also removed apples from the diet because I didn't want to segregate just a couple hogs from the alfalfa pasture during the growing season.

When the hogs were on pasture, we reduced our grain supplement to 3 lb/hog/day. We experienced comparable finishing weights and ages.

Our hog pasture has a woven wire fence with an interior hot wire placed 6" above the ground. A hot wire also runs along the top of the woven wire mesh. By going with the top wire design, we were able to save on fencing costs as we didn't need the wire mesh to be as tall.

Because our stocking density was only 60 pigs to 2 acres, we did not attempt rotational grazing this year. Instead, we allowed them to roam freely throughout the pasture. We learned that pigs are extremely efficient grazers. They often graze in groups, selecting one area to graze and moving forward as a group. While the heritage breeds are thought to be more efficient grazers than conventional breeds, I did not note a difference in grazing behavior. We did not have any rooting in the alfalfa pasture. This could be due to the fact that the pigs also had access to a wooded lot and they displayed their rooting behaviors in the woods. There was always an ample supply of fresh alfalfa for them to graze.

Acorn Harvest:
We harvested acorns from two different sources in 2011. The first was a cattle pasture and the second was from an individual's backyard.

While Carver County is abundant with cattle pastures with a number of oak trees, I discovered that this will not be a feasible source for acorns. Cattle like to eat acorns as much as pigs do. The acorns harvested from the pasture were from a low area within the pasture. The acorns were protected from the cattle because they had fallen into holes created by their hoof tracks. All other acorns in the pasture had been eaten. Harvest was very tedious.

The harvest of acorns from a neighborhood backyard was simple, fruitful, and well accepted. While acorns are a great food source, many people view them as a nuisance. Getting permission to remove the acorns from backyards was not a problem. We simply raked the acorns together in piles, scooped them with shovels and placed them in 5 gallon pails to transport. Within 2 hours, we had collected 260 pounds of acorns.

The acorns were stored in gunny sacks in our granary until they were fed to the selected hogs.

Acorns in the Hog Diet:
The acorns were added to the diet of three Red Wattle/Large Black Hog crosses. Each hog received 3 lb of acorns/day along with 2 lb of our grain mix. We wanted to see how the pigs would handle the acorns since cupules were included in the acorn mix and we had heard that they can be harmful to the digestive system of the animals. We did not witness

Feeder pigs grazing alfalfa pasture.

any problems with digestion. The hogs continued to gain at their previous rate and developed an extremely shiny coat of hair. I can only assume that it was due to the oils in the acorn. The meat will be included in a tasting event our farm is holding on January 21, 2012 at Terra Waconia.

Farrowing:
We continue to pen farrow with great success. We have eliminated iron shots as long as the piglets have access to soil for rooting. We are working on a farrowing schedule which includes farrowing a couple hogs each month and will have hogs ready to market throughout the year.

Management Tips

1. When pen farrowing, allow access from outside of the pen so you can safely assist with farrowing. Mother pigs are very protective.

2. Provide a warming lamp while piglets are very young. This helps keep the pigs away from the mother when she lies down preventing crushing.

3. Put 5 gal of soil in the farrowing pen so the piglets can root in the soil. This gives them enough iron so iron shots are not needed.

4. Mud holes in the pastures are needed on hot days.

5. Allow hogs free access to pasture at all times as long as your pastures can support your stocking density. I believe that part of our success is that our hogs live stress free and feel comfortable in their surroundings.

6. Acorn harvest is accomplished easily by using a rake and a shovel.

7. Consumer outreach is constant and always evolving. Take advantage of every opportunity.

Cooperator

Dr. Yuzhi Li, Assistant Professor, Alternative Swine Production, University of MN, St. Paul, MN

Project Location

From Young America go west on MN Hwy. 212 approximately 2 miles to Cty. Rd. 135. Turn right onto Cty. Rd. 135 and go 1.5 miles to Cty. Rd. 34. Turn left on Cty. Rd. 34 for .5 miles and turn right on Yale Ave. Take Yale Ave. north for 1.5 miles to 102nd St. Turn left, west, on 102nd and go to 18980 - 102nd St.

Other Resources

Alternative Swine 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. 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.

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.

Determining the Pasture Restoration Potential and Financial Viability of Cornish Cross vs. Red Broilers for a Small Pastured Poultry Operation in Northeast Minnesota

Principal Investigator

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Project Duration

2010 to 2012

Award Amount

$4,000

Staff Contact

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Keywords

broilers, Cornish Cross, Red Broilers, pasture poultry, pasture renovation

Project Summary

This project will measure the ability of two chicken breeds (Cornish Cross and Red Broilers) to improve the quality of an unproductive hay field. We will monitor the relative changes in plant composition and productivity after grazing alone and by a combination of grazing and seeding over three years. The financial break-even point will be determined for each breed on pasture enhanced by grazing alone vs. that enhanced by grazing and seeding in order to demonstrate which breed will be more economical to grow for the long-term profitablity and growth of our operation, and to demonstrate whether or not seeding is needed to achieve the best results. We will also survey our customers who buy both breeds to get feedback on the perceived differences in flavor or value between Cornish Broilers and Red Broilers. We expect our results to be widely applicable to small-scale diversified pastured poultry operations in the western Great Lakes region.

Project Description

In 2005, we began a non-certified organic, direct to consumers, pastured poultry operation using 10' x 12' Salatin-style pasture pens which house 50 birds. We have grown from 50 Cornish Cross birds in our first year to 300 birds (mix of Cornish Cross and Red Broilers) in 2009. We move the pens 1 or 2 times/day to give new grass and ground for the chickens. We pre-sell all birds in the spring and do on-farm processing for fall delivery. We currently serve approximately 60 customers, but have much more demand. We also sell pastured eggs, ducks, turkeys, and hogs, and have a year-round solar greenhouse, vegetable gardens, and a fruit orchard enterprise.

The purposes of this study are to test the effectiveness of pasture rejuvenation using four different chicken breed-seeding combinations (Cornish Cross-clover mix, Cornish Cross-no seed, Red Broiler-clover mix, Red Broiler-no seed) compared to seeding alone, or no treatment (no chickens/ no seed); and to test the break-even point and profitability of production for each breed, over 3 years, under different pasture conditions.

Cindy collecting plant samples.

Two week old Cornish Cross chicks on pasture.

We will use a 5 acre hay field for the study. This field has had no fertilizer applied for many years. Half of the area grazed will get seeded with a 50-50 mix of red and white clover while the other half will be left as a "no-seed control." A section of the field will remain ungrazed by chickens, half of which will be seeded with the clover mix so we can compare the effects of seeding alone to seeding in combination with the different chickens.

Each year, we will compare the cost efficiency of each chicken breed based on the forage available to them and the impacts each breed has on forage quality and abundance. In year 1, all chickens will be grazing on unimproved pasture, half of which will get a seeding of clover after the chickens pass over it. In years 2 and 3, chickens will be grazed on the same area as in year 1, so half of the birds will be grazing on clover-seeded areas and half on the no-seed control areas.

Plant sampling was conducted in early June 2011, just prior to putting birds on pasture. A 4" wide x 4' long strip of vegetation was clipped down the center of each 10' x 10' sample plot and collected in a large flat. A total of 64 plots were sampled, between 8 and 13 samples were collected from each of the chicken breed and seed combinations. The samples from each plot were placed in labeled paper bags and oven dried at 60°C for 48 hours. The dried samples were weighed to determine the dried plant weights for each species/plant group in each plot. These samples will be analyzed and compared with plant samples taken in 2012, the last year of the project.

2010 Results

Since this is the first year of a 3-year study, we did not expect any differences in finished weights, feed consumption rates, or the economics for a given breed. This year's data does provide the baseline against which we measure any improvements in the coming years. It will be very interesting to see if we begin to see changes in feed consumption rates, costs, and/or finished weights in the coming years in response to any changes we may see in plant abundance or composition as a result of chicken grazing, seeding, or both.

We raised 50 Cornish Cross or Red Broilers in each pen in 2010. There were substantial differences in both the costs and finished weights between the Cornish Cross and Red Broilers. The Cornish Cross outperformed the Red Broilers in the costs/bird, finished weights, and the time to get to finished weight.

The average feed cost/bird/day was the same for both breeds at $0.10/day. However, because the Red Broilers were on pasture for 12 weeks, the average total feed cost/bird was much higher at $6.25 to $8.24. The Cornish Cross grew to market weight with only 6 weeks of feeding on pasture. It cost $3.84 to $3.98 for feed/bird for the Cornish Cross.

Also, there was a large variability in the average finished weights of the Red Broilers in each pen. They ranged from 2.9 lb/bird to 6 lb/bird. The average finished weight of the Red Broilers was significantly lower than the Cornish Cross despite the fact that they grew for 14 weeks as compared to 8 weeks for the Cornish Cross. The Cornish Cross birds were much more consistent with weights of 4.5 to 5.5 lb/bird.

Two major issues arose that we will address in the next 2 years of the project. First, we were unhappy with the growth rates and economic performance of the Red Broiler

variety in general and the variability in growth rates and finished weights between pullets and cocks. Next year, we intend to raise cocks only for 11-12 weeks (rather than 14 weeks). We will also change to the Freedom Ranger broilers which have been shown to have better growth qualities than the Red Broiler variety.

Second, we had planned to conduct plant sampling throughout the summer (i.e. each plot sampled 8 weeks after chickens grazed). However, as the season progressed we realized that the plant establishment and growth patterns over the season were very inconsistent. Therefore, we will be conducting plant sampling in all the plots in the spring. This will allow for more consistent measures of the plant response based on the chicken and seeding treatments without the confounding influence of seasonal weather conditions and/or the time since a plot was grazed or seeded.

2011 Results

Pasture Rejuvenation

In preliminary analysis of the 2011 plant sampling data to test the effectiveness of pasture rejuvenation by comparing the average total biomass of forage available and number of plant species per plot did not differ among any of the breed-seed combinations (Cornish Cross-clover mix, Cornish Cross-no seed, Red Broiler-clover mix, Red Broiler-no seed) or the no-bird/grazing, and seeded and unseeded controls. However, it appears that the relative abundance of different plants did vary with some of these treatments. We will work with Dr. Craig Shaeffer, UMN St. Paul, to do a more complete plant analysis of the 2011 data and work with him to plan the sampling protocol in 2012.

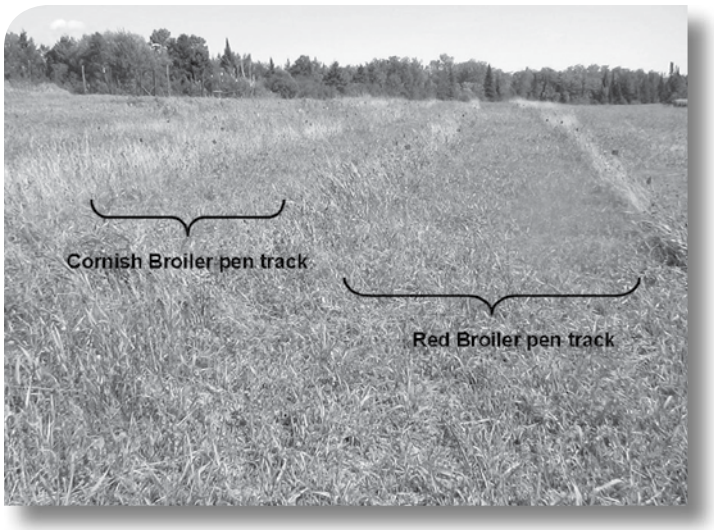
Financial Break-Even Point for Each Breed

In the second year of this study we used the same hatchery for Cornish Cross, but raised pullets only on the experimental section of the pasture. This change was in response to high mortality with cocks in weeks 6 and 7 in 2010. Due to generally poor growth rates last year with the "Red Broiler", in 2011 we used the "Red Ranger" breed which has been reported to perform better on pasture and so we could shorten their time to finish from 14 weeks to 11 weeks. For comparison, we also raised Cornish Cross cocks on an adjacent pasture not part of the seeding/grazing trial.

Cornish Cross pullets and cocks were put on pasture (out of the brooder) at 3 weeks of age. Two - 50 bird batches of Cornish pullets were processed at 56 and 63 days old (8 and 9 weeks, respectively). Four – 50 bird batches of cocks were processed at 48 or 55 days old (7 and 8 weeks, respectively). The Red Ranger cocks were put on pasture after 4 weeks in the brooder and processed at 63 and 69 days old (9 and 10 weeks, respectively).

We raised 50 Cornish Cross or Red Rangers in each pen in 2011. There were substantial differences in both the costs and finished weights between the Cornish Cross cocks, pullets, and Red Broilers. The Cornish Cross not only outperformed the Red Broilers in the costs/bird, finished weights, and the time to get to finished weight, but also in profitability.

In addition to feed costs, this year we included the cost of chicks, daily animal care and processing labor, delivery labor and mileage, and miscellaneous costs to get a good estimate of the relative profitability of each breed.



Grazing strips. The right path grazed by Red Broilers, the path on the left by Cornish Cross.

Red Ranger day-old chicks in the brooder.

Table 1: 2011 Comparison of Weight, Age, Costs, and Profits of Broilers

Breed	Market Weight (lb)	Age at Market	Cost/Bird	Sale Price/Bird	Profit/Bird
Cornish Cross: Pullets	4.3	8-9 weeks	$14.97	$16.58	9%
Cornish Cross: Cocks	3.8	7-8 weeks	$12.33	$14.82	17%
Red Ranger: Cocks	3.8	9-10 weeks	$16.37	$14.82	(-11%)

The average feed cost/bird/day was the same for both breeds at $.06/day (0.17 lb) while in brooder and $.12/day (.40 lb) while on pasture which were comparable to what the hatchery and the feed producer estimated/recommended. The processing, delivery, and miscellaneous costs were the same for each breed. While the finished weight/birds did vary, it was related to the age of the birds. Therefore, the total cost of the birds was correlated with their time on pasture and the associated increases in feed and labor costs.

The Cornish Cross pullets grew to an average market weight of 4.3 lb in 8-9 weeks; Cornish Cross cocks grew to an average market weight of 3.8 lb in 7-8 weeks; and Red Ranger cocks grew to an average market weight of 3.8 lb in 9-10 weeks (Table 1). Correspondingly, the Cornish Cross pullets had an average cost/bird of $14.97, average price/bird (at $3.90/lb) of $16.58 for an average profit/bird of 9%; Cornish Cross cocks had an average cost/bird of $12.33, average price/bird of $14.82 for an average profit/bird of 17%; and Red Ranger cocks had an average cost/bird of $16.37, average price/bird of $14.82 for an average loss/bird of 11%.

Due to unseasonably high heat and humidity when the Red Rangers were shipped, we had very high chick mortality and required two supplementary shipments to get 100 live chicks. This set our processing schedule back and forced us to process the birds 1-2 weeks earlier than anticipated with some drop in finished weight. After talking with the hatchery and other growers who have used the same hatchery in the past, we think this was an unusual event and will try using the same breed again in 2012.

Despite an almost 30% increase in organic feed in 2011 compared to 2010, by purchasing in bulk, managing feeding rates better, and shortening the time to finish our overall profitability in 2011 was higher than in 2010. We will continue to work with the Red Rangers to make them profitable since customers do like them!

Customer Preference

A large proportion of our customers purchased both Cornish Cross and Red Ranger broilers. In the 2011 winter, prior to ordering birds and sending out customer order forms, we surveyed approximately 120 customers. We received responses from 78 customers. One question asked them if we should keep offering both Cornish Cross and Red Ranger broilers. The majority responded "yes" and a large proportion of them ordered both breeds. Only one customer ordered the Red Rangers exclusively.

Informal questioning of customers when they picked up their birds in the summer indicated that they liked both breeds, but that there were definite differences in flavor, the color of the meat, and the shape of the carcasses. Those who purchased both reported using them in different ways and for different dishes (i.e. Cornish Crosses for traditional roasting, Red Rangers for ethnic dishes). In the 2012 customer survey, we plan to ask for more specifics on what differences they perceived in each breed, and how those differences affected their use of the birds, and how this may affect their purchasing preferences in the future.

Management Tips

1. Know the breeding of the birds you buy! Whether Cornish Cross or others.

2. Buy chicks from hatcheries that breed the chicks. They know the genetics of the chicks.

3. Depending on the breed and your management goals, you may want to raise pullets only, cocks only, or straight run. Cocks and pullets mature at different rates. Also, cocks have a higher mortality during the last 2 weeks before processing.

4. Provide fresh pasture during the day and feed rations in the evening for best performance. When birds eat feed, their metabolism ramps up, generating a lot of body heat which can stress the birds during the day.

Cooperators

Cree Bradley, Lake Superior Sustainable Farming Association, Lake Superior Farm Beginnings Program Coordinator, Two Harbors, MN
Ryan Cox, University of Minnesota, Department of Animal Science, St. Paul, MN
Wayne Martin, University of Minnesota, Integrated Livestock Production Systems Program, St. Paul, MN
Craig Sheaffer, Professor, University of Minnesota, Department of Agronomy and Plant Genetics, St. Paul, MN

Project Location

Drive 14 miles NE of Duluth on Hwy. 61 to Homestead Rd., turn left and travel 4.2 miles to Clover Valley Farms.

Other Resources

Alternative Broiler Breeds in Three Pastured Poultry Systems. Kim Cassano. 2009. Sustainable Agriculture Research and Education (SARE) at: *www.sare.org*

APPPA grit. Newsletter of the American Pastured Poultry Producers Association at: *www.apppa.org*

Raising Poultry on Pasture: 10 years of success. Published by the American Pastured Poultry Producers Association at: *www.apppa.org*

Perfecting the day-range pastured-poultry system through on-farm replicated feeding trials. Melissa Fischbach. 2009. Project Number: FNC08-729. Sustainable Agriculture Research and Education (SARE) at: *www.sare.org*

Fall Forage Mixture for Grass Finishing Livestock Late in the Fall

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Project Duration

2010 to 2012

Award Amount

$10,000

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Keywords

annual cover crops, finishing beef on grass, grazing corn

Project Summary

With the short growing season in NE MN, it is challenging to grow enough pasture forage to finish beef on grass. Adding annual forage crops into the pasture rotation may help by providing more available forage at both the beginning of the grazing season and extending the grazing into the fall and winter. By growing winter rye for early grazing and grazing corn in late summer followed by a planting of turnips and oats you may be able to graze late into the fall and winter.

The goal of this project is to demonstrate an economically efficient way to grass finish beef in late fall by grazing non-typical crops such as corn, turnips, and oats. This will be done by grazing immature corn from mid-August through mid-September, after the cattle are out of the perennial pasture rotations. After the corn is grazed, a fall forage mixture of oats and turnips and a seeding of annual ryegrass will be sown to be grazed later in the fall. We hope to also demonstrate that planting late forage mixtures will take up nitrogen and other nutrients that may be lost to runoff and leaching.

We have been working on getting an early start to the grazing season by planting winter rye in the fall. Winter rye greens up early in the spring and can be grazed earlier than other forages. We plan to compare the planting costs and the amount of gain for early and late season cover crops and grazing corn. By increasing the length of the grazing season we can reduce feed costs which will allow us to be more profitable in the future. This project will provide information we need to increase our marketing window of grass finished beef by extending the grazing season earlier in the spring by grazing winter rye and later into fall by grazing corn, annual ryegrass, oats, and turnips.

Project Description

The project will be conducted on the Troy Salzer and Abe Mach farms. Both operations keep a portion of the calves and grass feed them to market weight. Grass production is the focus of both operations and they use the livestock to convert it to marketable products. They also incorporate winter rye and annual ryegrass cover crops in crop rotation with the pastures to keep the pastures in prime growing condition. The Salzer site has very sandy soils and the Mach site has a loam soil.

The two cooperators are interested in adding corn for grazing followed by a fall seeding of turnips and oats to increase the yield of dry matter per acre. The annual crops in

Cattle grazing corn on the Salzer farm.

Table 1: 2010 Seeding rates and costs of cover crops at both the Salzer and Mach farms

Treatment	Seeding Rate	Seed Cost/A	Seeding Cost/A
Winter rye	2 bu/A	$19.00	$26.50
Corn	29,000 seeds/A	$35.00	$205.00
Annual ryegrass	20 lb/A	$12.40	$19.90
Oats – Turnips	Oats . . . . . .1.5 bu/A Turnips. 3lb/A	Oats . . . . . $8.78 Turnips. $5.40	$21.68

Please refer to Tables 2 and 3 to see the comparisons of the different cover crops on the Mach and Salzer farms.

Table 2: 2010 Comparisons of grazing annual forages on the Mach farm

Crop Type	Cost/A	Avg Daily Gain (lb)	Lb Gain/A	Grazing days/A*	Cost of Gain
Corn	$205.00	1.8	472	262	$0.43
Winter rye	$26.50	1.8	64	36	$0.41
Annual ryegrass	$19.90	1.5	26	17	$0.77
Oats - turnips	21.68	1.8	58	32	$0.37

Table 3: 2010 Comparisons of grazing annual forages on the Salzer farm

Crop Type	Cost/A	Avg Daily Gain (lb)	Lb Gain/A	Grazing days/A*	Costs of Gain
Control (corn)	$205.00	2.0	405	202	$0.51
Winter Rye	$26.50	1.7	66	38	$0.40
Annual ryegrass	$19.90	1.5	28	20	$0.71
Oats - turnips	$21.68	1.7	79	46	$0.31

*Grazing days is a calculated number described to help readers use the number for planning purposes on their farm.

the rotation helps breakdown the sod which improves the seedbed for the new pasture. The corn is grazed from mid-August through September.

After the old pastures are tilled to prepare for planting, a conventional planter is used to seed the corn. Once the corn is grazed, we will use a no-till drill to plant the turnips and oats directly into the corn stubble. The drill is equipped with a cutting coulter to cut up any remaining corn stalks.

The project consists of monitoring the cattle gain during each of the management aspects of them grazing on each of the treatment areas. Each farm will graze about 20 head of finishing cattle on the plots. From the data and the costs of each of the treatments we will calculate the cost of gain for each of the treatments.

2010 Results

The weather during the 2010 growing season in NE MN consisted of a very dry spring followed by a very wet summer and fall. The temperatures were above normal for the growing season.

The grazing corn was planted on May 17 at the Salzer farm and May 28 at the Mach farm. The seeding rate was 29,000 seeds/A. Manure and starter fertilizer were added for nutrient needs. The corn yielded better at the Mach farm with 21.6 tons/A at 19% dry matter. The yield at the Salzer farm was 16.35 tons/A with 18% dry matter. There was more soil moisture early in the season and warmer conditions throughout the growing season at the Mach farm.

Oats and turnips cover crop.

These are very good corn yields for this part of the state. Because of the large yields it took longer for the 20 cattle to graze the corn than planned. This longer grazing period affected the timing of grazing on the other cover crops in this project. The cattle grazed the corn at the Salzer farm until September 3 for an equivalent of 202 grazing days, and until September 9 at the Mach farm for an equivalent of 262 days. We found that it is important to take into account the amount of time it will take to graze the corn. With such large yields we could have easily grazed more animals.

The cover crops were seeded on September 3 at the Salzer farm and September 9 at the Mach farm after the corn was grazed. These dates worked well this year because of the good moisture levels this fall, but may be too late in northern MN on a typical fall. The delay in grazing the cover was due to starting late because we did not correctly calculate the amount of time it would take to graze an acre of corn.

We were pleasantly surprised with the low costs of gain on each of the treatments, with oats – turnips the lowest and annual ryegrass the highest (Tables 2 and 3). We had assumed the costs would be higher on the cover crops due to the high seed cost. But, the investment in the tillage was already accounted for in the corn crop so the cover crop was planted with one pass of a no-till drill, saving a lot of costs. Seed costs were high on this project because of the small plot sizes of the plantings. If planting larger acreages, prices should get lower due to buying in volume.

This extra grazing should help in reducing feed cost. The current average feed cost of production for finishing cattle today is around $.86/lb of gain. In our case the treatments ranged in cost from $.31 -.77/lb of gain. So the added value to our farms is $2.34/A with annual ryegrass up to $43.45/A with oats - turnips. These calculations are only based on cost of gain and do not consider the environmental or grazing season extension benefits.

Production per acre varied among the cover crops. The annual ryegrass was the lowest yielding based on the lb of gain/A, average daily gain and the number of grazing days. This suggests that even though the cost for the seed is less, it is not your best choice, as it takes longer to establish than the other crops.

Table 4: 2010 & 2011 summer and fall soil test results for nitrate nitrogen for the Salzer and Mach farms

Salzer Farm	2010	2011	Mach Farm	2010	2011
	Nitrogen	Nitrogen		Nitrogen	Nitrogen
Summer	88	78	**Summer**	64	70
Fall			**Fall**		
Corn	60	73	Corn	41	62
Winter rye	52	54	Winter rye	38	44
Annual ryegrass	50	66	Annual ryegrass	37	50
Oats - Turnips	49	53	Oats - Turnips	34	46

The use of the cover crop treatments seems to reduce the amount of nitrate nitrogen in the soil due the plant growth occurring later in the season. The soil tests taken on both farms in the summer and fall show a significant reduction of nitrate nitrogen in the fall (Table 4). This suggests that a cover crop reduces the risk of nitrogen being transported by rain into lakes and rivers as well as the drinking water.

2011 Results

The project was carried out in the same manner as 2010 other than both cooperators started grazing the corn in the first week of August. We tried to keep the plants younger, allowing the animals to do a better job cleaning up the corn as well as giving more time for the cover crop plants to grow. We did not think the cover crop plants had adequate time to produce forage in 2010.

The 2011 growing season was nearly opposite of 2010. The summer of 2011 was very wet to begin with, but about the time we started grazing the corn, the rain stopped and we did not get any more rain until it snowed. This caused poor germination and growth on the cover crops, especially for the annual ryegrass. This was more evident on the sandier Salzer site as compared to the loamy soil Mach site.

The grazing corn was planted May 21 at Salzer's and May 26 at Mach's. Grazing started the first week of August on both farms. The corn yielded 18 tons/A at Mach's and 16.6 tons/A at Salzer's. The corn was grazed until September 2 at the Salzer farm and September 9 at the Mach farm.

The largest hurdle that was encountered this year was the lack of rain late in the summer. This caused poor germination and poorer growth on the cover than expected. Annual ryegrass was the crop most affected by the lack of moisture by having the fewest grazing days and the highest cost of gain/day of all of the cover crops (Tables 5 and 6).

All of these cover crops are considered cool season crops and therefore the reason that we selected them for our planting was in hopes that they would keep growing late into fall. We didn't think much about the need for moisture to germinate them as NE MN typically will have enough rainfall, especially in fall, and the cool nights allow for heavy dews which often is enough to keep the plants growing.

Even with the dry conditions and the 2% to 4% increase in costs of seed we still were able to feed the cattle cheaper on the cover crops than if we fed stored feed. It cost between $.32 and $1.10/head/day to feed on the cover crops. Whereas, it costs $1.15 to $1.30/head/day to feed stored feed.

Table 5: 2011 comparisons of grazing annual forages on the Mach farm

Crop Type	Cost/A	Avg Daily Gain (lb)	Lb Gain/A	Grazing Days/A*	Cost of Gain/Day
Corn	$208.00	1.9	428	225	$0.49
Winter rye	$27.50	1.7	59	35	$0.47
Annual ryegrass	$21.90	1.5	29	19	$0.76
Oats – Turnips	$22.18	1.7	55	32	$0.40

Table 6: 2011 comparisons of grazing annual forages on the Salzer farm

Crop Type	Cost/A	Avg Daily Gain (lb)	Lb Gain/A	Grazing Days/A*	Cost of Gain/Day
Control (corn)	$208.00	2.0	394	197	$0.53
Winter rye	$27.50	1.6	58	36	$0.47
Annual ryegrass	$21.90	1.3	20	15	$1.10
Oats - Turnips	$22.18	1.8	69	38	$0.32

**Grazing days is a calculated number described to help readers use the number for planning purposes on their farm.*

Cattle ready to graze the next strip of corn.

The data from the two years of nitrogen tests suggests that planting a cover crop of any sort will help with reducing the nitrogen levels in the soil (Table 4). As the data suggests, the grazing corn had higher nitrogen levels due to being grazed early and not having any plants growing to take up the nitrogen as the soil organisms continued to release them.

The data also suggests that the levels in general were high in all treatments in 2011 due to perhaps less plant growth and no rain. This also suggests that with less rain there is less chance of Nitrogen loss due to leeching which we know from previous research to be the case.

Management Tips

1. The earlier you can plant any of the cover crops the better. This includes moving the cattle off a strip and sowing it. Every day counts.

2. Stagger the corn planting so the corn is at optimal maturity at grazing. If the corn gets too mature it gets tough and is not as palatable.

3. If corn gets too mature and tough use a different class of animals to at least do a cleanup of the residue.

4. Annual ryegrass needs to be planted the earliest as it takes a long time to get established. If planting later, winter rye is a better option as it can also be utilized in the spring if enough growth doesn't occur in the fall.

5. Look at using a staggered planting to allow for a more optimum corn maturity at grazing. If the corn gets too mature it gets tough and the animals, especially younger ones, don't like the stalks. If corn gets too tough use a different class of animals to at least do the cleanup.

6. Match the amount of forage corn produced with the size of the herd to efficiently graze corn.

7. The use of the cover crops can be extremely useful in small grain stubble and after silage corn as the crop is removed early and could be quickly drilled.

8. Using higher seeding rates helps keeps the stalks smaller and easier to chew.

9. Graze the cover crops before they mature.

10. There is a lot of flexibility with winter rye; it can be used for either a fall or a spring planting.

Cooperators

Russ Mathison, Agronomist, University of Minnesota North Central Research and Outreach Center, Grand Rapids, MN
Tom Gervais, NRCS Grazing Specialist, Duluth, MN
Grazing Lands Conservation Association, MN Chapter, Clarence Caraway, President, Lake Benton, MN

Project Locations

Troy Salzer's farm 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.

Abe Mach's farm is located east of Sturgeon Lake, MN. From Sturgeon Lake go east on Hwy. 46 to the T. Turn right to stay on Hwy. 46 and go 3/4 of a mile. The site is on the left side.

Other Resources

Farm and Ranch Guide. 2401 - 46th Ave. SE, Mandan, ND 58554, 701-255-4904, email: office@farmandranchguide.com. Website: *www.farmandranchguide.com*. Farm news and information published every other Friday.

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

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.

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

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

Completed Grant Projects...

Final Greenbook Article	Title of Project	Grantee
Alternative Markets and Specialty Crops		
2011	Growing Cherries in Central Minnesota	Pat Altrichter
	Organic Mushroom Cultivation and Marketing in a Northern Climate	Jill Jacoby
	Feasibility of Small Farm Commercial Hop Production in Central Minnesota	Robert Jones
2009	Hardwood Reforestation in a Creek Valley Dominated by Reed-Canarygrass	Timothy Gossman
	Introducing Cold-hardy Kiwifruit to Minnesota	James Luby
	Growing the Goji Berry in Minnesota	Koua Vang/Cingie Kong
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

Final Greenbook Article	Title of Project	Grantee
2000	Converting a Whole Farm Cash Crop System to Keeping an Eye on Quality of Life and the Bottom Line in Sustainable Agriculture by Using Key Farm Economic Ratios to Aid in Decision-making	Red Cardinal Farm
	Dry Edible Beans as an Alternative Crop in a Direct Marketing Operation	Bruce/Diane Milan
	Native Minnesota Medicinal Plant Production	Renne Soberg
1999	An Alternative Management System in an Organic, Community Supported Market	Candace Mullen
	Cultural and Management Techniques for Buckwheat Production and Marketing	Tom Bilek
	Pond Production of Yellow Perch	John Reynolds
1998	Establishing and Maintaining Warm Season Grasses (Native Grasses)	Pope County SWCD
	On-farm Forest Utilization and Processing Demonstrations	Hiawatha Valley RC&D
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

2009	Environmentally and Economically Sound Ways to Improve Low Phosphorus Levels in Various Cropping Systems Including Organic with or without Livestock Enterprises	Carmen Fernholz
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

Final Greenbook Article	Title of Project	Grantee
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
	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

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2001	Applying Manure to Corn at Agronomic Rates	Tim Becket/Jeremy Geske/Dakota County Extension/SWCD
	Cereal Rye for Reduced Input Pasture Establishment and Early Grazing	Greg Cuomo
	Establishing a Rotational Grazing System in a Semi-wooded Ecosystem: Frost Seeding vs. Impaction Seeding on CRP Land and Wooded Hillsides Using Sheep	James Scaife
	Living Snow Fences for Improved Pasture Production	Mike Hansen
	Managing Dairy Manure Nutrients in a Recycling Compost Program	Norman/Sallie Volkmann
	Reducing Chemical Usage by Using Soy Oil on Corn and Soybean	Donald Wheeler
	Techniques for More Efficient Utilization of a Vetch Cover Crop for Corn Production	Carmen Fernholz
	Using Nutrient Balances to Benefit Farmers and the Environment	Mark Muller/IATP
2000	Forage Mixture Performance	Itasca County SWCD
	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

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	Weed Control and Fertility Benefits of Several Mulches and Winter Rye Cover Crop	Gary/Maureen Vosejpka
1995	Annual Medics: Cover Crops for Nitrogen Sources	Craig Sheaffer
	Integration of Nutrient Management Strategies with Conservation Tillage Systems for Protection of Highly Eroded Land and Lakes in West Otter Tail County	Harold Stanislawski
	Manure Management/Utilization Demonstration	Timothy Arlt
	Reducing Soil Insecticide Use on Corn through Integrated Pest Management	Ken Ostlie
	Taconite as a Soil Amendment	Donald E. Anderson
1994	Biological Weed Control in Field Windbreaks	Tim Finseth
	Energy Conserving Strip Cropping Systems	Gyles Randall
	Fine-tuning Low-input Weed Control	David Baird
	Flame Weeding of Corn to Reduce Herbicide Reliance	Mille Lacs County Extension
1993	Chemical Free Double-cropping	Jeff Mueller
	Cooperative Manure Composting Demonstration and Experiment	Rich Vander Ziel
	Early Tall Oat and Soybean Double Crop	Charles D. Weber
	NITRO Alfalfa, Hog Manure, and Urea as Nitrogen Sources in a Small Grain, Corn, Soybean Crop Rotation	Carmen M. Fernholz
	Nitrogen Utilization from Legume Residue in Western 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
1992	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

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Energy		
2009	Evaluation of the Potential of Hybrid Willow as Sustainable Biomass Energy Alternative in West Central Minnesota	Diomides Zamora
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
Fruits and Vegetables		
2011	Growing Blackberries Organically under High Tunnels for Winter Protection and Increased Production	Erik Gundacker
	High Tunnel Primocane Fruiting Blackberry Production in Minnesota	Terrance Nennich
	Minimizing the Environmental Impact and Extending the Season of Locally Grown Raspberries	Steve Poppe
	Growing Fresh Cabbage for Markets Using Integrated Pest Management Strategies	Vang, Ly (American Association for Hmong Women in Minnesota)
2010	Using Solar Energy to Heat the Soil and Extend the Growing Season in High Tunnel Vegetable Production	Dallas Flynn
	Extended Growing Season for Lettuce	Michael Hamp
	Organic Day-neutral Strawberry Production in Southeast Minnesota	Sam Kedem
	Winter Plant Protection of Blueberries in Northern Minnesota	Al Ringer
2009	Intercropping within a High Tunnel to Achieve Maximum Production	Mark Boen
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

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	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
	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		
2010	Increasing the Profitability of Raising Livestock: An Evaluation of Two Methods to Extend the Grazing Season	Dean Thomas
	Methods to Establish Grazing of Annual Forages for Beef Cows on Winter Feeding Areas	Walker/Mathison
2009	A Comparison between Cornstalk and Soybean Straw for Bedding Used for Hogs and Their Relative Nutrient Value for Fertilizer	John Dieball
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

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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
	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

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	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
	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

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	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
	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 2011

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 $40,000 per farmer or up to $160,000 for joint projects (four applicants) 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 and temporary structures such as high tunnels or hoop houses and for making 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 340 farmers have borrowed over $3.6 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 crop production including season extension. 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, milking 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, on-farm processing and handling equipment, and fruit and vegetable 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.

Jean Ciborowski, Quarantine Officer and Sustainable Agriculture. Jean provides oversight to the Plant Containment Facility operated by the U of MN/MDA on the U of MN St. Paul campus. In addition, Jean coordinates the Sustainable Agriculture Demonstration Grant program and is the Greenbook editor. She has worked in sustainable agriculture and integrated pest management at the MDA since 1997.

Alison Fish, Adminstrative Support. Alison provides administrative clerical support to the staff and the program.

Wayne Monsen, Grazing Specialist. Wayne provides rotational grazing planning services for livestock producers. He is assisting the Minnesota Department of Natural Resources by designing grazing plans that help identify ways of improving wildlife habitat on conservation lands. He began working for the MDA in 1992 after farming for 12 years near St. James, MN.

Meg Moynihan, Principal Administrator, Organic/ Diversification. Meg 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 worked professionally as an educator and evaluator and as a community development extension specialist with the U.S. Peace Corps in northern Thailand. She is also a certified organic dairy farmer.

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