Farmer Rancher Grant Program

Final Report Form

Please fill out the final report form and return it to the North Central Region-Sustainable Agriculture Research and Education (NCR-SARE) Missouri office. The report may be prepared on a computer or handwritten (please write or print clearly) but electronic reports are preferred. The final payment of your grant will be awarded when the final report and final budget report are received and approved.

Use as much space as needed to answer questions. You are not limited to the space on this form. The more details the better.

I. PROJECT IDENTIFICATION

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- City, State, Zip Code: Rosemount, MN 55068

- Phone: (563) 650-3654
- Website: www.scenicvalleyfarms.com
- Project Title: Growing Blackberries Under High Tunnels for Winter Protection and Increased Production
- Project Number: FNC09-749
- Project Duration: 2 years
- Date of Report: March 14, 2012

PROJECT BACKGROUND

Scenic Valley Farms (SVF) specializes in growing organically certified produce in high tunnel greenhouses. We currently manage a total of five high tunnels in Rosemount, Minnesota and Readstown, Wisconsin (the testing location for this project) that produce blackberries, raspberries, strawberries, tomatoes, peppers, and melons. Our primary markets are wholesale dealers, grocer cooperatives, farmer's markets, and restaurants in Wisconsin and Minnesota. In order to extend the growing season, SVF has designed, developed, and tested a subterranean solar thermal high tunnel. We have also been awarded and successfully administered several state and federal grant projects related to high tunnel agriculture and high tunnel climate control systems. As a result of our efforts, we are aware of at least four other growers that have adapted high tunnels for blackberry production in Minnesota, Wisconsin, Iowa, and Maine.

This grant coincided with our start in high tunnel farming. However, on the properties where the high tunnels are currently located, we practiced organic gardening and fruit tree production (for personal consumption). We also had established windbreaks and promoted biodiversity through the planting of wildflowers.

PROJECT DESCRIPTION

GOALS: Growing commercial grade blackberries in 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 higher the practice of tipping blackberry plants and covering them with mulch for winter protection is commonly used. However, we have found tipping blackberry canes in a zone 4 region and

covering them with mulch provides minimal winter protection and results in more than 75 percent blackberry plant loss (results from 2007). Not only is blackberry production drastically reduced but the added labor to cover and uncover the canes with mulch, makes growing blackberries in a zone 4 climate or colder unprofitable.

Objective One: Determine the viability of growing organic blackberries under a high tunnel for commercial production in a zone 4 climate and the amount high tunnels will increase yield compared to traditionally grown organic blackberries. This proof of concept project will determine if the capital investment and labor involved in growing organic blackberries for commercial production under a high tunnel is economically justifiable.

Objective Two: Research, record and evaluate the crop production processes required to grow organic blackberries for commercial production. Specifically, the amount of irrigation and feeding required as well as the most efficient schedule; the heating/cooling processes needed to increase the temperature to a zone 7 climate; the ventilation needed to disperse the excessive heat and humidity generated by the enclosed high tunnel; and the security required to protect the crops from deer, turkey and other wild life.

Objective Three: Test the following sustainable agricultural practices: (1) organic farming (2) Integrated Pest Management (IPM) that employs black plastic as an alternative weed control and weed elimination; drip irrigation, anti-condensation and rainfall protection to reduce pests; high tunnel cover and beneficial insects to control insects; and motion sensors and electric fences to prevent wildlife intrusions to insure wildlife preservation (3) bumblebees for pollination (4) nutritional management

PROCESS

As part of the project, six varieties of floricane blackberry cultivars were planted in a 96 foot X 30 foot high tunnel in Readstown, WI. For a separately funded project, two high tunnels were constructed in Rosemount, MN to test the viability of winter protecting both primocane and floricane blackberries. At the Rosemount site, floricane varieties were planted in a 30 foot X 60 foot gothic style high tunnel and primocane varieties in a 12 foot X 40 foot PVC high tunnel.

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 foot trellis system; a gothic peak for optimal snow load capacity; and a price that is competitive with other high tunnels on the market. Using these specifications, Poly-Tex designed and developed the Field Pro high tunnel that is now installed at our farm in Readstown.

All high tunnel manufacturers provide well written instructions and we recommend following them as closely as possible. When laying out the tunnel make sure to orientate the end of tunnel into the prevailing wind. Ideally, the side walls should be facing south to maximize solar radiation. Pound a single corner stake into the ground and use a 3-4-5 ratio to square the other corners 30 feet and 96 feet on center. Attach a string line at the desired top of ground post and another string line 6 inches beneath. Pound the remaining post approximately 2 feet in ground and 1 foot above ground. Other suggestions to make the construction go smoother include:

- Use string line and 1 ¼ inch tek screws set into stakes when sliding bows onto ground stakes
- Use tek screws to secure connectors to bows and end of purlins
- Duct tape all purlin connections at end of bows to prevent ripping of the plastic

- Use 1x6 pine boards for curtain and base boards and drill 1 ¼ inch tek screws to secure board to frame.
- Install u-channel and wiggle wire on side walls
- Install plastic on calm morning or evening (less than 5 mph)
- Attach plastic to 5 -2x4 x12 foot lengths of lumber and pull over side walls
- Allow at least three hours of calm wind to secure plastic

The semi-automated high tunnels are composed of sensors and controllers that monitor the crop production processes, thereby reducing on-site management and better facilitating the commercialization of blackberry production. All the high tunnels employ in-line drip irrigation and Acclima moisture sensors to regulate irrigation and fertigation cycles. The emitters were spaced no more than 8 inches on either side of each bramble. 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.

We prepared the land for the high tunnels using black plastic to smother the weeds. The plastic should be applied a minimum of 2.5 months before setting plants in the ground in order to properly destroy the weed seeds and rhizomes.

The ventilation system consists of end doors, motorized side curtains, circulation fans, and gable end motorized ventilators. All of the activation ventilation systems have controllers driven by sensors.

The soil was amended by mixing in equal parts mushroom and dairy manure compost and applying one wheelbarrow per ten row feet. After, the compost was tilled into the soil using a hand rotor tiller. Once the canes were planted, we mulched each plant with woodchips.

Figure 1: Site Preparation (Readstown)

Inside, the floricane high tunnels, 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 4 runs containing two wires each. The posts should be spaced 10 feet apart. Primocanes (first year growth) were tied to one side of the strand and they will bear fruit as floricanes (second year growth). After producing fruit, the floricanes are pruned to the ground to make room for the primocanes. By utilizing this system, we

ensure that floricanes in separate rows are facing each other, which facilitates easier fruit harvest.

The sturdiest 3-4 canes that emerged from the crown were pruned at 4-6 feet. The trailing canes were also pruned at 4-6 feet. We allowed the leaders to grown 3-4 feet before pruning back to 12-18 inches. This was done based on the advice of Kathy Demchak who has conducted research on high tunnel grown blackberries at Penn State University. This technique promotes sturdy laterals and since only the 3-4 fruit blossoms as measured from the lateral tip actually bear fruit, it also is supposed to increase yields.

Figure 2: High Tunnel T/V Trellis System (Rosemount)

Figure 3: Drip Irrigation and Fertigation Emitters (Readstown and Rosemount)

Figure 4: Acclima Moisture Sensor (Readstown and Rosemount)

The floricane blackberry canes were planted in Rosemount on May 15th and in Readstown on June 10th of 2010. Both tunnels contain Triple Crown, Arapaho, Chester, Apache, Ouachita, and Natchez varieties. The canes were planted in four rows with a between-row spacing of 7 feet and the outer two rows 4.5 feet from the side walls. The in-row spacing is 3 feet.

Initially, the plants in Rosemount were provided 3 gallons per day per plant in two 1.5 hour cycles at 7:00 a.m. and 6:00 p.m. The brambles in Readstown were provided 4 gallons per day per plant in two 2 hour cycles at 7:00 a.m. and 6:00 p.m. The higher irrigation levels in Readstown were due to its sunnier location. Frequently, the water moisture content of the soil failed to drop below the preset threshold of 40 percent, and the sensors suspended an irrigation cycle. In late fall, irrigation levels were increased to 6 gallons per day per plant in order to provide extra moisture to the brambles throughout the winter when they would have no access to water.

We used a one gallon EZ flow fertigation system and a liquid organic fertilizer. The organic brands we experimented with were Algoflash, FoxFarm Big Bloom and Pure Blend Pro Bloom. It is not recommended to use fish emulsion as it has a tendency to clog the emitters but is acceptable with drip tape.

Winter protection of the brambles was accomplished by using the high tunnel itself and a thermostatically controlled 125,000-170,000 BTU/hour forced air propane heater (Mr. Heater brand). We established 5 degrees F as the set point of the heater with a differential of 5 degrees F. This means that the heater activates once the air temperature drops to 5 degrees F, continues running until the temperature reaches 10 degrees F and then deactivates. A large differential results in higher fuel consumption. A small differential, however, requires that the heater activate more frequently which increases the risk of damage to the brambles. This is because if the heater fails to ignite, it does not have the ability to reignite.

We also strongly recommend that high tunnel blackberry growers install a second layer of poly and inflate the air gap with a small fan (high tunnel manufacturers have the necessary supplies and

instructions). The pocket of air insulation results in nighttime low air temperatures that are typically 7-10 degrees F higher than a high tunnel fitted with only a single sheet of poly. We determined this by placing data loggers in single and double layer poly high tunnels and then recording the results for 12 months.

In order to control weeds, three techniques were employed. A layer of wood chips was spread on the PVC high tunnel floor. In the gothic style tunnel, we laid down sheets of cardboard before spreading wood chips. In a third high tunnel at our farm in Wisconsin, we rolled out 14-24 mil black polyester material in widths of 3 and 6 feet. The most effective technique appears to be the black polyester material, which also has the added benefit of controlling soil erosion and reducing labor.

PEOPLE

Terry Nennich, University of Minnesota Extension, Crookston, MN
Role: Terry assisted in the design of the high tunnel. He also provided advice on fertility management and weed control.

Kathy Demchak, Penn State University, University Park PA
Role: Kathy was an invaluable source of information. She provided assistance with variety selection, climate management, pest identification and control, fertility management, and pruning methods.

Rebecca Harbut, University of Wisconsin, Madison WI
Role: Rebecca provided some assistance with variety selection

Jesse Down, Local Farmer, Readstown, WI
Role: Jesse assisted with tending to the brambles and also sold at the Viroqua Farmer's Market the small quantities of blackberries that were available

RESULTS

Overall, the project has reduced labor and input costs but the full economic impact cannot be measured until the brambles produce full yields. Full production will not occur until the summer of 2013 or 2014.

The moisture sensors provide automatic irrigation and fertigation in the high tunnel. The black polyester material and wood chips dramatically decreased the amount of time devoted to weed management. The major inputs of labor occurred during site preparation, pruning, and harvest. The high tunnel construction required approximately 200-220 hours of labor spread out over two weeks. Certain stages of the construction process, especially securing the poly on the high tunnel, go much smoother with a minimum of 4 workers. Highly accurate data was not recorded, but we estimate on average 4-5 hours per week for 20 weeks was spent pruning the brambles in a 30 foot X 96 foot high tunnel. Harvest labor requirements are difficult to estimate because full production has not been reached.

The drip emitters reduced the amount of water required and the in-line fertigation provided precise amounts of liquid fertilizers. It should be noted that the same management techniques that reduce input costs also have a net positive environmental impact by conserving water and reducing soil erosion.

A major problem was maintaining temperatures during the warm season months inside the high tunnels at the optimal range of 75-85 degrees F. Temperatures in excessive of 100 degrees 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.

Throughout the winter of 2011-2012, we also encountered problems with heat buildup in the high tunnels. During the dormancy period of blackberries, the temperature should be kept below 70 degrees F in order to prevent bud swell and possibly even bud break. The extremely warm winter though meant that temperatures were often in excess of 70 degrees F. We set the exhaust fans to activate once temperatures reached 60 degrees F and opened the hay loft doors on days when the risk of nighttime temperatures dropping below 10 degrees F were small. But ventilating the side walls was the only method that proved truly effective. Using the motorized side wall curtains, however, was difficult because snow build up along the sides of the high tunnel prevented them from retracting.

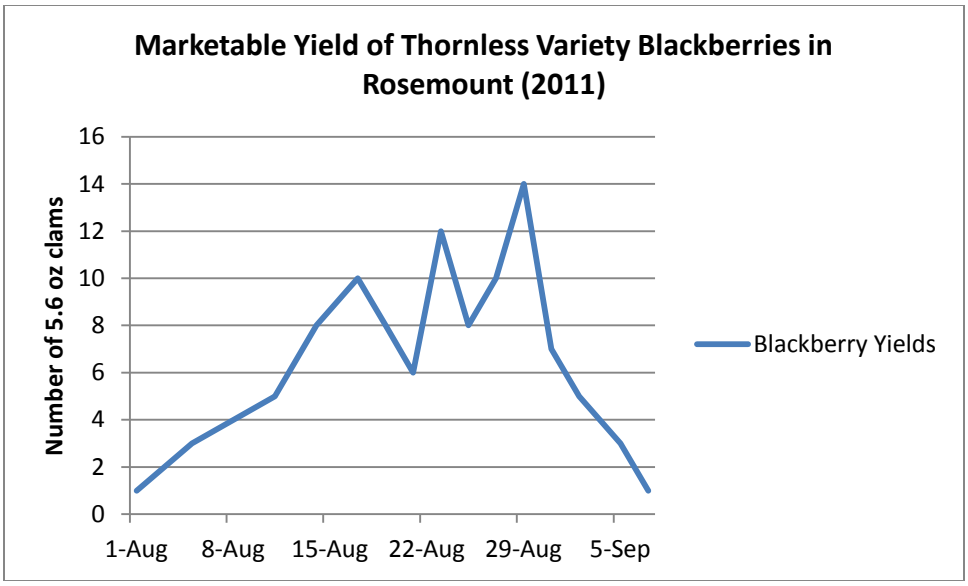
The warm weather did promote bud swell and some new leaf development. We expect this will negatively impact yields for 2012. We also expect the harvest to occur much earlier (possibly even in June) than normal.

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 in Readstown and a roughly similar number in Rosemount. The harvest period ran from July 7 –August 6th in Readstown and August 1st – September 7th in Rosemount. The later harvest is almost surely due to the more wooded and shady growing conditions that exist in Rosemount. So for growers looking to delay the harvest season, installing a shade cloth to the exterior of the high tunnel might be a very effective technique (it also has the added benefit of reducing high temperatures).

The berries were generally larger by 1-2 grams than varieties grown in the field. Due to high temperatures, however, we did run into problems with improper druplet formation, which will negatively impact the marketability of the berries.

All the clams were either used for personal consumption or sold at the Viroqua Farmer's Market.

Our original goal was 1,800 pounds of Grade A blackberries in year three of production (2012). We are pessimistic though that we can reach this goal due primarily to temperature management issues. We now project to harvest between 1,000-1,200 pounds in the summer of 2012 and hope to meet our original goal in 2013.



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 18th. After that date, the auxiliary heat was suspended and the brambles were allowed to enter the dormant phase.

Figure 5: Floricane High Tunnel

Figure 6: Primocane berry cluster on November 14th

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.

During the winter of 2010-2011, we experienced problems with rabbits entering the high tunnel and girdling the canes. Roughly 10-15 percent 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 degrees F compared to the outside temperatures.

DISCUSSION

We did answer the question of whether high tunnels can be used to provide winter protection to blackberries in a hardiness zone 4a. The project demonstrated that blackberries can be successfully overwintered. But we have still not addressed the economic impact because the blackberries do not generate full yields until year three or four of growth.

We would caution any grower, however, from rushing into high tunnel blackberry production. Significant management issues need to be resolved, especially with controlling high temperatures (which is sort of ironic, considering we thought that all of our problems would be related to extreme *low* temperatures).

Also, growers should have a comfortable level of farm revenue from other crop sources before embarking on blackberry production. This is because the yields do not arrive for 3-4 years and the risks are fairly high.

We have found that the most profitable high tunnel crops are still tomatoes and bell peppers. Even if our original yield projections of 2,000 pounds per 2880 sq. ft. high tunnel were achievable, the gross revenue would still be significantly less than the more dependable hybrid tomatoes and bell peppers.

But for patient growers who are willing to take on the risk, the extra farm diversity that blackberries can deliver might be worth it. When establishing new markets, we found that many produce buyers were more willing to purchase our other crops once they learned that we will be able to offer local, organic blackberries in the future (which are impossible to source in the Upper Midwest).

PROJECT IMPACTS

We are unable to assess the economic data until full production is reached in either 2012 or 2013.

OUTREACH

Scenic Valley Farms has created several pages on our company website that detail the progress of the project in both Rosemount and Readstown. The visitor is able to access data collected throughout the growing season and images of various aspects of the project. We have also prepared a monthly newsletter that is distributed to more than 200 recipients.

At the conclusion of 2010, Erik Gundacker gave a presentation at the Minnesota Fruit and Vegetable Grower's Association annual conference. The presentation was attended by approximately 40 persons. Additionally, the presentation will be posted on the company website.

Throughout the growing season, we hosted individual and small group tours for local growers of the blackberry high tunnel. Key members of the area Amish community were particularly interested in the project and several have either completed or plan to begin construction of high tunnels to produce blackberries.

In February 2012, Erik Gundacker presented at both the Pennsylvania Association for Sustainable Agriculture (PASA) Conference and Mid-Atlantic Fruit and Vegetable Conference. At each venue, he gave a presentation on our blackberry project to more than 300 attendees.

Erik also presented at the 2012 Minnesota High Tunnel Grower's Conference to more than 200 people and received strong interest from a number of regional growers about adapting blackberries for high tunnel production.

As previously mentioned, our company constructed a solar thermal high tunnel in the fall of 2010 that should significantly extend the growing season. We intend to work with the Midwest Renewable Energy Association (MREA), Minnesota Renewable Energy Society (MRES), and RENEW Wisconsin to host information sessions. At these sessions, we plan to provide education on our efforts to produce blackberries in high tunnels and how the solar thermal high tunnel fits into those plans.