

Sustainable Agriculture Place-based Project Grant Proposal

Erik E. Nordman, Ph.D.

Associate Professor, Natural Resources Management

Project Description and Abstract

Michigan has a long history of agriculture and forestry. Demographic, economic, and environmental changes have stressed rural communities across Michigan. At the same time, Michigan's energy system is shifting to low-carbon sources. Biomass energy, such as short-rotation woody crops like willow shrubs, could provide an opportunity for Michigan farmers to grow a carbon-neutral, sustainable energy crop that does not compete with food crops. Willow biomass is a sustainable input for energy and biorefinery processes which can produce a range of useful bio-based products (Krzyżaniak et al. 2014). Willow energy crops are now commercially grown in New York but little is known how these crops would perform in West Michigan. Therefore we are conducting a trial of four commercial-quality willow varieties to determine: 1) the biomass production potential; 2) the environmental effects of willow cultivation; and 3) the economic benefits, costs, and economic development impact of the biomass energy system. Each of the 16 trial plots consists of six rows of nine plants each (54 plants/plot). The total area needed is approximately 7,500 ft² (0.17 ac). The project has a ten-year study period which includes three harvest cycles. We request \$612 to cover the willow cuttings and planting equipment.

Engagement of Undergraduate Students

This project was initiated by undergraduate students involved in the Sustainable Agriculture Project (SAP), namely Farm Club president Matthew DeJonge. Matt has an interest in bioenergy crops and approached me about establishing field trials on campus. I also had several conversations about willow biomass crops with Youssef Darwich when he was a student (and now is the SAP farm manager). Matt, Youssef, and other students associated with the SAP have been active in the project planning. The project will be closely linked to a course, NRM 380 Renewable Energy Management and Modeling (offered in Spring 2016). Students in this class will use the biomass trials, the Consumers Energy Solar Garden, and other local renewable energy facilities as case studies in the technical, economic, environmental, social, and policy dimensions of renewable energy management. The trials also present an opportunity for student research in other areas, such as the study of birds and other creatures that use the plots as habitat; insect and fungal pests; soils; biochemistry; and business development. These and other research projects could be supported by Student Summer Scholars in 2017. The willows can also be used for basketry and other crafts.

Budget Justification

The total requested amount is \$611.31 (Table 1). This includes the cost for planting equipment and the willow cuttings. The willows are vegetatively propagated – they are planted as 10-inch dormant sticks. The willow cuttings come from a commercial supplier as 20-inch cuttings. They will be cut in half before planting. Three of the four willow varieties are proprietary clones developed by the State University of New York – College of Environmental Science and Forestry (SUNY ESF 2016). Therefore there is a royalty fee for these. I also signed a license agreement that prohibits the unlicensed propagation of the willows. The wire stakes will be used to demarcate where each cutting will be planted. The wooden stakes are

used to hold the ropes that marked with the planting distances. The dibble point planting bars are used to plant the cuttings. They poke a hole in the prepared soil into which a cutting is inserted. We purchased two dibbles so that the entire trial can be planted in one day. The willows are perennial shrubs so there is no need to plant again. Most of the equipment is durable and can be used for other purposes at the SAP. Grand Valley State University has agreed to allocate approximately 7,500 ft² of space at the SAP to accommodate the trial. This is a non-monetary in-kind contribution by the university to the project.

Table 1: Budget details for willow trial establishment.

Item	Price per unit (\$)	Number of units	Total amount (\$)
Equipment			
Yellow wire stake flags (bundle)	5.35	3	16.05
Orange wire stake flags (bundle)	5.35	3	16.05
Pink wire stake flags (bundle)	5.35	3	16.05
Lime wire stake flags (bundle)	6.05	3	18.15
12" wooden stakes (bundle)	11.60	1	11.60
Flagging tape	1.50	2	3.00
Dibble point planting bar	62.95	2	125.90
½" nylon utility rope	0.50/foot	150 feet	75.00
Shipping			56.17
Equipment subtotal			337.97
Willow cuttings			
"Fabius" 20-inch	110	0.50	55.00
"Fish Creek" 20-inch	110	0.50	55.00
"Millbrook" 20-inch	110	0.50	55.00
"SX64" 20-inch	110	0.50	55.00
Research Foundation of the State of New York Royalty Fee	15%	Applies to Fabius, Fish Creek, and Millbrook	24.75
Shipping			28.59
Willow cuttings subtotal			273.34
Total cost			611.31

Project Description and Timeline

Alignment with SAP mission

The SAP's mission includes seeding sustainable food practices; cultivating leadership and learning; nurturing place; and growing community. The willow biomass energy crop trial aligns with this mission. First, it expands the diversity of plants and projects at the SAP. Willow crops, unlike corn for ethanol biofuel, complement rather than compete with traditional food crops. Willows diversify the SAP's biological community; as perennial shrubs, they diversify the temporal aspects of the farm; and they diversify the farm's economic opportunities. Second, the willow trial offers opportunities for leadership and learning. This project was initiated by students, students are assisting with the planning and planting, and student researchers from biology to business will have opportunities to study various aspects of biomass energy crops. Third, the trials nurture place. The main hypothesis is to determine the biomass production of the four varieties in this particular West Michigan environment and compare it to

trials in central Michigan, New York, and elsewhere. Students will learn how the site's climate, soil, history, and ecological community affects plant growth. Fourth, the willow crops offer opportunities to grow community through sustainable rural development. Biomass energy crops have potential as another income stream for farmers with idle farmland. This will have economic benefits that ripple through the community.

GVSU owns agricultural property including land that is under cultivation of *Miscanthus* bioenergy crops through MSU Extension. The SAP is the preferred location for the trials for three reasons. The willow trial demonstrates the sustainable bioenergy cropping system developed by SUNY ESF. The proximity to the Consumers Energy Solar Garden enables visitors to see two different energy systems at work. The fast-growing shrubs provides a visual barrier between the SAP and the neighboring house.

Involvement of the SAP community

The SAP community has been involved in the project from the beginning. Student volunteers at the SAP initiated this effort. The plans were reviewed and approved by the SAP advisory board and their recommendations were incorporated into the plans (such as using mulch for weed control instead of synthetic herbicides).

Positive impact on SAP uses

The willow biomass energy trial will have a positive impact on other uses of the SAP. The willows will be planted in a location that does not displace other SAP vegetable crops. The trial is primarily a research project testing the following hypotheses:

- The four willow varieties will produce commercially-viable yields of woody biomass in West Michigan.
- The willow varieties will perform similarly to trials in central Michigan (Wang and MacFarlane 2012) in terms of biomass production and pest resistance.
- Proprietary varieties (Fabius, Fish Creek, and Millbrook) will produce more biomass than the unimproved variety (SX64).
- Willow biomass can, under certain conditions, be an economically viable feedstock for energy and biorefinery systems.

Project timeline (2016-2026):

- May 2016: Plant willow cuttings
- Summer 2016: Monitor willow establishment, prevent weed growth
- January 2017: Cut willow shoots to encourage coppice growth
- Summer 2017-2019: Monitor willow growth and utilization by birds, etc.
- January 2020: Harvest biomass from measurement plots, report results
- Summer 2020-2022: Monitor willow growth and utilization by birds, etc.
- January 2023: Harvest biomass from measurement plots, report results
- Summer 2023-2025: Monitor willow growth and resource by birds, etc.
- January 2026: Harvest biomass from measurement plots, report results

The following section provides specific answers to the nine questions listed in the Request for Proposals.

1. The willow trial requires 7,344 ft² (0.17 ac) divided into 16 plots (Figure 1).
2. The project will last ten years beginning in May 2016. After the first growing season, shrubs will be cut back to the stump to encourage multiple shoot growth. The plants will thereafter be harvested on three-year cycles. After the third harvest at the end of year ten, the project will be

assessed. The plants can either be removed by pulling up the stumps in the spring or the trials may be allowed to continue for additional harvest cycles.

3. Volunteer labor is required during the establishment year for planting. Once the plants are established, they need very little additional care. The dense spacing prevents weed competition. Additional inputs are usually not required.
4. The trial includes four varieties in four replications (16 plots). Each plot is configured with three double rows and nine plants in each row (Figure 1). The fourteen measurement plants are highlighted in the white box.

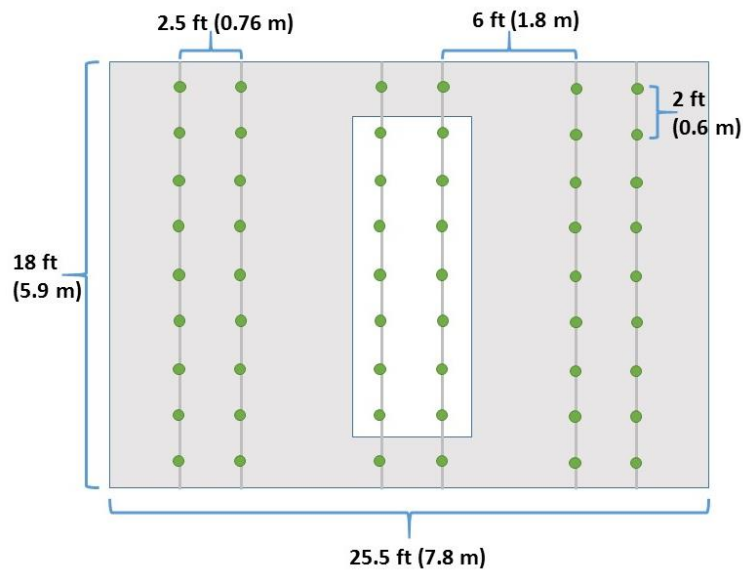


Figure 1: Willow biomass trial plot layout. The green dots are the willow plants.

5. The trial plots' biomass yield is too small for commercial sale. The willow shoots from the outer plot rows may be used for basketry, crafts, or other purposes. The wood may be chipped, dried, and used for heating fuel or mulch. Wood from the sample plots will be chipped, dried, and weighed.
6. The willow varieties were bred using traditional methods for insect and disease resistance. Since the varieties vary in their resistance mechanisms, the randomized plot locations will discourage the rapid spread of insect and disease pests. If pest problems are encountered, this will be valuable information to report on and is not considered a major problem. No synthetic chemicals will be used to control pests.
7. The perennial willow plots will help build soil. The soil will be tilled during establishment and need not be tilled again for up to twenty years. Fertilizer use is not anticipated. Willows are harvested in winter after the leaves are dropped and most nutrients are sequestered in the plant roots.
8. The willow trials will enhance student experiences through leadership, research, and creative activities. Students will be engaged at all phases from establishment to harvest to reporting. The willows are attractive plants and will provide a visual and wind barrier between the SAP and the neighboring property.
9. Project staff will create outreach materials and signs to inform visitors and students about the project. The willow plots will be featured on the digital Campus Sustainability Tour

<http://www.gvsu.edu/sustainability/digital-tour-310.htm>). We encourage visitors to see the willow plots when visiting the SAP and the Solar Garden.

References

- Krzyżaniak, M., M. J. Stolarski, B. Waliszewska, S. Szczukowski, J. Tworkowski, D. Załuski, and M. Śnieg. 2014. Willow biomass as feedstock for an integrated multi-product biorefinery. *Ind. Crops Prod.* 58:230–237.
- SUNY ESF. 2016. The Willow Biomass Program at SUNY-ESF. Available online at: <http://www.esf.edu/willow/>; last accessed April 25, 2016.
- Wang, Z., and D. W. MacFarlane. 2012. Evaluating the biomass production of coppiced willow and poplar clones in Michigan, USA, over multiple rotations and different growing conditions. *Biomass Bioenergy*. 46:380–388.