



## **Northern NY Agricultural Development Program 2012-2013 Project Report**

### **Sustainable Establishment of Shrub Willow for Bioenergy in NNY**

#### **Project Leaders:**

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#### **Collaborator:**

- Dr. Michal Davis, Farm Manager, Cornell University Agricultural Experiment Station, Willsboro Research Farm

#### **Cooperating Producer:**

Dennis Rak, Double A Willow, Fredonia, NY, Chautauqua County

#### **Background:**

The Northern New York (NNY) region has great potential for biomass feedstock production for bioenergy on agricultural land that is otherwise underutilized and unsuitable for commodity crops. Shrub willow bioenergy crops are well suited for sustainable biomass production in the NNY region, producing high dry matter yields on typical marginal ag soils with minimal need for amendments or pesticides.

With prices for propane, natural gas, fuel oil, and electricity currently high, willow biomass is an excellent, low-cost fuel alternative for small-scale and industrial heating and renewable electricity generation that does not contribute to global climate change, since it is carbon neutral.

The dollars spent on willow production, transport, and conversion are cycled in the local economy and will stimulate job growth and sustainable use of marginal ag land.

With three wood-fired power plants in NNY, a large number of wood chip boilers in NNY schools, and a pilot cellulosic ethanol plant in the region, there are many potential markets for willow producers.

However, little is known about which willow cultivars are best suited for the soils and environmental conditions in NNY or what yields can be expected from the best cultivars. Accurate yield estimates are critical to plan any agricultural project, so without data from unbiased, replicated yield trials, there is little chance that any willow projects will be financed and initiated.

The goal of this project was to establish a willow yield trial at Cornell's Willsboro Research Farm and initiate experiments to test new methods for more sustainable site conversion and establishment in fields typical of the NNY region. These plantings will be useful for extension educators, producers and researchers. Extension educators and producers will benefit from these plantings through trial results, field days at the trials, and extension publications. For researchers, a willow yield trial will provide valuable data on cultivar selection and improvement that will advance Dr. Larry Smart's willow breeding program and support planting stock production at Double A Willow in Fredonia.

In future years, data from this demonstration/research trial will be used in modeling sustainability of these bioenergy farming systems, and data from NNY would ensure that regional producers will be represented in determining the best fit for bioenergy crops in the Northeast.

Typical land that is targeted for willow cultivation is low value hay land or fallow land that may include shrubs and perennial weeds. The conversion of this fallow or marginal ag land into a vigorous willow planting can be challenging and currently relies heavily on multiple applications of herbicide to kill weeds. This land typically has an extensive weed seed bank and may be rocky with shallow soils that are difficult to plow. Thus, we have begun testing the use of minimal tillage using an Unverferth Zone-Builder subsoiler, which only tills a ~10" strip where the willows will be planted, leaving the majority of the 5-foot alleys and 2.5-foot inter-row space undisturbed. This has advantages in maintaining a stale seed bed and in keeping the soil health intact. This project will expand on this initial work by incorporating various cover cropping systems that may reduce the need for herbicides, lessen soil erosion, and contribute to soil health and nutrition.

In the summer of 2012, the USDA approved funding for a Biomass Crop Assistance Program (BCAP) area to plant shrub willow in a nine county region across NNY, which will be harvested and delivered to one of three wood-fueled power plants owned by ReEnergy Holdings. Within the BCAP area, there are currently established shrub willow yield trials in Jefferson (2005 Belleville), St. Lawrence (2009 Potsdam), Oneida (2009 Verona), and Lewis (2006 Constableville) Counties. The willow trials in Jefferson County and Oneida Counties are paired with switchgrass trials at the same site. This project funded the establishment of a willow yield trial in Essex County (2013

Willsboro), which will serve as a focal point for research and extension in the eastern region of the North Country. This local research, demonstration, and extension are critical for the adoption of new bioenergy crops and the long-term success of the bioenergy crop industry. These demonstrations are necessary to support growers who enrolled in the BCAP program in 2012 (Celtic Energy Farm, Cape Vincent) or may in the future, since \$125 M of mandatory funding for BCAP was included in the 2014 Farm Bill.

This project will leverage grant funding already received from USDA-NIFA to Larry Smart through the Northeast Sun Grant Initiative and through a USDA-NIFA Coordinated Agricultural Project subcontract from Penn State University as a part of a \$9.9M Northeast regional bioenergy feedstock development center (NEWBio). This USDA funding paid some of the establishment costs for the Willsboro trial. These projects are focused on planting trials in western NY, Pennsylvania (PSU), Michigan (MSU), and West Virginia (WVU). The funding from NNYADP allowed us to extend our network of field trials and extension/demonstration activities to the North Country.

### **Methods:**

The research activities were focused at the Cornell E.V. Baker Research Farm at Willsboro on a field that is representative of typical marginal agricultural land in the region (poorly drained, untilled, clay). The field, which was in sod, was prepared for planting by Mike Davis and staff at Willsboro by first killing the sod with glyphosate, then ploughing using only a zone tillage attachment. The field soil was sampled in two plots in each of the four blocks and tested using the Cornell Soil Health Testing Protocol for pH, N, P, K, Al, Ca, organic matter, soil texture analysis, compaction, and biological activity.

### **2013 Willsboro Yield Trial:**

A willow cultivar yield trial with 24 genotypes was planted by hand on May 23, 2013 using 8- or 10-inch cuttings in a randomized design with four replicates of each genotype. Most of the cuttings were provided by Double A Willow in Fredonia. The total field size is ~0.8 acres. The site includes soils classified as Churchville loam and as Kingsbury silty clay loam, which are somewhat poorly drained with depth to water table at 6 to 18 inches. Pre-emergence herbicide (SureGuard) was applied immediately after planting for weed control and mowing was done as needed in mid-season to control grass and broadleaf weeds. Assessments of establishment success were conducted after 30 days and any failed cuttings were re-planted. Pest and disease surveys were conducted in mid-July according to standardized protocols to assess local pressure and varietal susceptibility, although the recently established plants were too small to provide any true pest resistance evaluation.

### **2014 Willsboro Willow Cover Crop Trial:**

We attempted to establish fall annuals, including cereal rye (*Secale cereal*), wheat (*Triticum aestivum*), and triticale ( $\times$ *Triticosecale*) in replicated plots with unplanted plots as a control. Unfortunately, the planting occurred too late in the season for the plants to get well established and there is not much cover crop biomass on the plots. Since

requested NNYADP funding was not approved for 2014, the cover crop trial at Willsboro will be terminated.

### **Results:**

The 2013 Willsboro Yield Trial was successfully established (plot map attached as PDF), although there were 19 of 96 plots with less than 80% cutting establishment when surveyed after 30 days. This is likely due to poor drainage on the site, inadequate deep tillage using the zone tiller that was available, and heavy rain for weeks after planting, resulting in significant flooding in the field. Those cuttings were replanted and final establishment success will be determined soon after spring bud break in 2014. Soils were sampled at a single depth from two plots in each of the four blocks and those samples were analyzed by the Cornell Soil Health Protocol. Soil microbes will also be sequenced in John Carlson's lab at Penn State as a part of the Northeast Sun Grant and NEWBio projects.

### **Conclusions/Outcomes/Impacts:**

While it is far too early to report any results regarding yield potential or cultivar rankings, the establishment year growth of willow was close to what was expected. There was greater cutting mortality due to flooding than we have observed on other sites, suggesting that deep ripping may have been beneficial on this site.

### **Outreach:**

A field tour presentation was made by Ph.D. student, Eric Fabio, during the Willsboro Field Day in mid-July. A fact sheet describing shrub willow bioenergy crops and the Willsboro trial was distributed to attendees. CCE Intern Lauren Frazier helped prepare this fact sheet and attended and captured high quality images of the trial. This work was highlighted in extension exhibits presented at Empire Farm Days in Seneca Falls, NY and Ag Progress Days in Pennsylvania Furnace, PA in August. This trial was highlighted in a presentation given by Larry Smart at CCE In Service Training in Ithaca in November that was well attended by NNY CCE educators.

Finally, this work was presented in short talks by Larry Smart at the NNYADP meetings in Watertown, NY in January 2014 and in Chazy, NY in February 2014.

Fact sheets, information about willow, and links to other willow sites are provided on our Willowpedia web site (<http://willow.cals.cornell.edu>), which typically receives over 100 new visits per month. Videos of willow planting, harvesting, and features of the crop are available on our Willowpedia Channel on YouTube (<http://www.youtube.com/user/Willowpedia?feature=watch>), which has received over 36,000 views. Finally, we distribute news updates about willow and announce field days through a Constant Contact mailing list, which has 137 subscribers.

### **Next steps**

#### **2013 Willsboro Yield Trial:**

The willow plants will be coppiced (cut back) with a sickle bar mower prior to spring 2014 bud break. These plants will vigorously resprout in the spring of 2014 to start a

three-year growing cycle. Mid-season pest and disease surveys will be conducted as often as staff time permits. End-of season stem diameter and height measurements will be collected annually. Harvest and dry matter yield measurements will be planned for December 2016. This work will be accomplished by Ph.D. student, Eric Fabio (supported by a USDA grant assistantship) with added help from technicians supported by ongoing grants.

**Cover crop trial:**

Since cover crop establishment at Willsboro was not uniform nor vigorous and requested NNYADP funding was not approved for 2014, the cover crop trial at Willsboro will be terminated. Two cover crop trials were successfully established in Geneva, where they are funded by a USDA Hatch Federal Formula Funds grant awarded to Smart, Reiners, and Ryan. Key parameters we will test will include 1) ease of establishment using no-till systems; 2) relative growth and weed suppression; and 3) ease of killing or cessation of growth for spring establishment of willow, and 4) sequestration of N in cover crops relative to bare soil. Some of the crops will winter kill, while others will require mowing or rolling in the spring to kill the crop. It is expected that well established cover crops will sequester N, provide a mulch barrier that impairs weed establishment, then slowly release organic N as the cover crop biomass degrades, thus reducing weed competition and lessening the need for herbicides.

**Acknowledgments:**

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**Reports and/or articles in which results of this project have been published.**

Smart, L.B., Rak, D., and Davis, M. (2013) Willowpedia Fact Sheet: “Demonstrating Yield of Shrub Willow Bioenergy Crops - Willsboro Research Farm”, Cornell University, College of Agriculture and Life Sciences, Geneva, NY.

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**Photos**

2013 Willsboro YT-Planting\_2013 05 23\_0022.JPG - Aaron Palmieri and Jeffrey Springmeier planting the 2013 Willsboro Yield Trial

2013 Willsboro YT-Planting\_2013 05 23\_0012.JPG - Example of a poorly drained region of the field.

2013 Willsboro Field Day--094.JPG - Eric Fabio surveying willow establishment and for pest incidence in July 2013.