

USDA Biomass Crop Assistance Program

## Annual Report 2016

Project Area 10  
New York State Shrub Willow



Justin Heavey and Timothy Volk  
State University of New York College of Environmental Science and Forestry

Michael Buckley  
ReEnergy Holdings LLC



## Contents

I. Crop Area.....	1
II. Crop Utilization .....	1
III. Administration .....	2
IV. Meetings with Stakeholders and Developers.....	2
V. Supply Chain Development .....	3
VI. Extension Services .....	4
VII. Education and Outreach.....	6
VIII. Future Activities .....	13



ESF staff and tour participants in a willow planting in August, 2016

## 2016 Summary

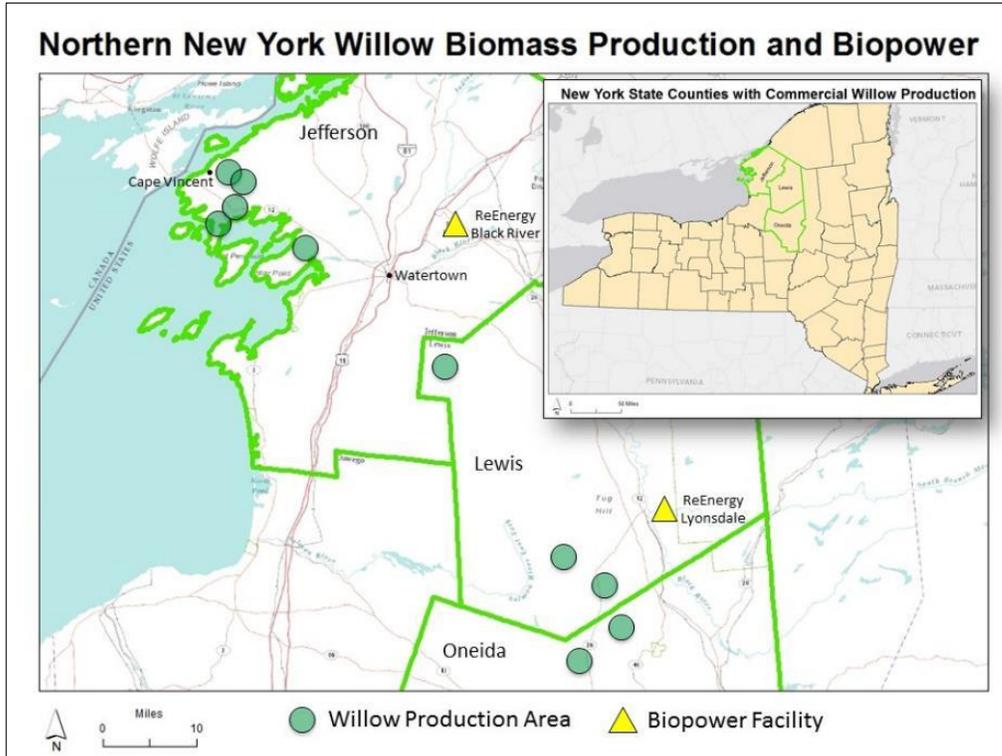
- ❖ 186 field acres of BCAP crops harvested across five sites
- ❖ 2,510 tons of biomass delivered to two ReEnergy facilities and converted to power and heat
- ❖ Over 7,300 tons of biomass delivered to ReEnergy facilities since 2013
- ❖ Additional 39 acres outside of the BCAP acreage harvested across the northeast using shared equipment
- ❖ Numerous meetings with five stakeholder groups including growers, end users, commercial partners, government officials, industry experts, researchers and others.
- ❖ Two initiatives to enhance the supply chain through lifecycle/techno-economic analysis and pellet production from willow grown on a former industrial site
- ❖ Willow equipment access program providing harvesting equipment to producers at a reduced cost
- ❖ Crop scouting across 1,188 acres of willow BCAP crops assessing problems and harvest readiness
- ❖ EcoWillow financial analysis tool applied to assessment of willow nutrient buffers in corn fields
- ❖ Seven extension publications completed and made available
- ❖ Eight additional publications or contributions to media coverage
- ❖ Six peer-reviewed journal articles completed
- ❖ Numerous contributions to social media platforms including blog, e-newsletter and twitter
- ❖ 9,371 views of the ESF willow web site
- ❖ 937 downloads of willow brochure in the past year for a total of 2,222
- ❖ New willow YouTube channel created
- ❖ Four new YouTube videos published with combined 1,329 views
- ❖ Three popular videos posted in 2015 generated a combined 2,247 views in 2016
- ❖ Eight public field events and guided tours with over 650 participants
- ❖ Three regional presentations with over 50 participants
- ❖ Five national presentations with over 175 participants
- ❖ Support provided to numerous bioenergy research projects that are occurring on willow BCAP acreage



Harvesting shrub willow crops in the BCAP Project Region in October, 2016

## I. Crop Area

There are currently 1,188 acres of willow biomass crops enrolled in USDA BCAP Project Area 10, in central and northern New York State (Figure 1, Table 1). Of these 1,188 acres, 837 were planted in 2013, and an additional 351 acres of previously established crops (planted 2008 and prior) were also enrolled in the program. Acreage has not increased since the initial acreage enrollment in 2013.



**Figure 1:** Willow biomass production areas enrolled in USDA BCAP Project Area 10, and ReEnergy biopower facilities in central and northern New York.

	Area Contracted	Planted 2013	Harvested 2013	Harvested 2014	Harvested 2015	Harvested 2016
New Acreage	837	837	0	0	0	56
Previously Est. Acreage	351	0	130	40	90	130
Total	1,188	837	130	40	90	186

**Table 1:** Summary of willow biomass crops enrolled in the USDA BCAP project area in NYS.

## II. Crop Utilization

Between August and December, willow crops were harvested from five sites in the project region, totaling 186 field acres, or about 149 planted acres (excluding ~20% headlands). Harvests were completed using a combination of the Celtic Energy and ESF New Holland harvesters. Biomass was delivered to the ReEnergy Lonsdale (1,350 tons) and Black River (1,160 tons) facilities to produce renewable biopower and heat. Since 2013, about 7,300 tons (14,600,000 lbs) of biomass has been harvested from the BCAP fields and delivered to ReEnergy facilities.



**Figure 2:** Harvesting willow biomass in the Tug Hill Plateau region of the BCAP project area in September, 2016.

### **III. Administration**

In May, USDA FSA announced funding availability for the New York willow BCAP project region to plant up to 200 additional acres. The enrollment period was between June 15 and September 16. At the time, ReEnergy was unable to commit to signing additional contracts with growers for increased acreage, due to low electricity prices, which resulted in the temporary closure of the Lyonsdale facility. ESF advertised the opportunity through their website and other outlets, and an announcement was sent to 75 stakeholders that had previously expressed interest in growing willow or sharing information about opportunities with their networks. Producers wanting to receive BCAP incentives were required to show a viable end user for their crop, and no additional acreage was enrolled. ESF engaged in talks with one potential producer who also manufactures wood pellets in the region and was interested in being a producer/end user, but was unable to commit to growing the feedstock at the time because of a slowdown in the pellet market. Talks are continuing with this stakeholder around using willow as one feedstock in the production of a blended hardwood/softwood premium quality pellet.

### **IV. Meetings with Stakeholders and Developers**

- Throughout 2016, ESF met with growers in the field and conversed via phone and email as necessary to support crop management and harvesting activities.
- Throughout 2016, ESF spoke with various stakeholders in the BCAP project region across NYS by phone and email about using willow for various purposes including biomass, furniture making, sound barriers, and living snow fences.
- ESF continued efforts started in 2015 to provide information and assistance to a remediation project using willow near Niagara Falls, NY. The project, conducted in collaboration with researchers from the Army Corps of Engineers, is studying the potential of willow to control the water flow on a previously remediated site. A one-acre trial planting was installed at the site with

ESF's assistance in May of 2016. The site is being monitored and ESF will continue to assist this trial planting and potential scale-up as requested.

- In April, ESF staff met in Cape Vincent, NY with town officials including the mayor, the head of public works, county engineers, local willow growers, and experts in the field of using willow for treatment of municipal wastewater and sludge. Discussed was the possibility of using the willow fields that are across the road to treat wastewater from the treatment plant. The wastewater would provide both nutrients and irrigation to the fields. There are 100 acres of willow acreage directly adjacent to the treatment plant that could benefit from the water and nutrient additions (Figure 3), and several hundred additional acres within a five-mile radius.



**Figure 3:** Aerial photo of willow fields in the BCAP project region showing proximity to Cape Vincent Waste Water Treatment facility

The town currently hauls waste about 25 miles one-way and pays for disposal, so dispersing the waste on willow fields could be a financial benefit to the town. ESF has requested and received nutrient concentration from the material, and is following up with growers and other stakeholders to explore the possibility of conducting a research and demonstration trial on this site. Many similar sites exist across New York State in rural areas where small towns lack secondary and tertiary water treatment systems and must truck waste long distances and pay for disposal.

- In July, ESF staff met with university and industry stakeholders at the NEWBio annual meeting in State College, PA. Topics discussed included data collection and contacts for techno-economic and lifecycle assessments of biomass supply chains in the BCAP project region, harvesting and equipment use, extension publications, crop scouting, interactions with stakeholder groups, etc.

## V. Supply Chain Development

In January, ESF assisted in gathering information for life cycle assessments (LCA) and techno-economic analysis (TEA) being conducted by for the willow fields in the BCAP region. ESF provided researchers with information about the logistics of BCAP willow operations in central and northern NY, suggested assumptions, and discussed other details necessary for analysis. ESF made contact and connected researchers directly with ReEnergy and other stakeholders to obtain the necessary information for these analyses. The TEA and LCA scenarios will evaluate the production and use of willow with economic and environmental metrics through various supply chains and conversion processes.

In August, ESF began working with partners on developing the supply chain for utilizing willow biomass harvested from the vegetative cover planted at the Solvay settling basins near Syracuse, NY. The site is a former industrial area where willow biomass crops have been established on the salty substrate left behind from nearly 100 years of soda ash production. The willow shrubs protect human health and the environment by preventing salts from leaving the site and entering ground and surface water. The system provides a range of biodiversity benefits, including supporting a broad array of pollinators. The willow biomass from the site has been tested and has the same chemical composition as willow grown on agricultural soils in the region and can be utilized for renewable energy. ESF met with a commercial pellet manufacturer about producing a premium quality pellet using a blend of willow along with other hardwoods and softwoods. ESF is working with Honeywell International, who owns the site, about the use of the biomass for this purpose. ESF currently is using wood pellets in a combined heat and power (CHP) system on its main campus and in a smaller boiler at one of its remote campuses in the Adirondacks. ESF is working internally with physical plant staff and administration on the logistics of utilizing willow pellets from this and potentially other sites in the biomass CHP system on the main campus and for heat at its remote campus.

## **VI. Extension Services**

To assist BCAP growers and other stakeholders in the expanding willow industry in New York State, ESF, with support from NYSERDA and NEWBio, is providing a range of technical, analytical and educational extension services. Some highlights of these activities from 2016 are provided below.

### **Willow Equipment Access Program**

ESF continues to manage the willow equipment access program for NEWBio, coordinating the use of harvesting equipment owned by Celtic Energy Farm, Double-A-Willow, and ESF. Updates of the program are discussed on a monthly NEWBio conference call, and regular email and phone conversations with stakeholders facilitate the coordinated use of machinery. An online spreadsheet of pending and completed harvest sites is maintained for planning and to track use, progress and scheduling. In addition to the 186 acres harvested in the BCAP region, an additional 39 acres were harvested across two sites in NY and one in VT. More harvests are being planned for early 2017.

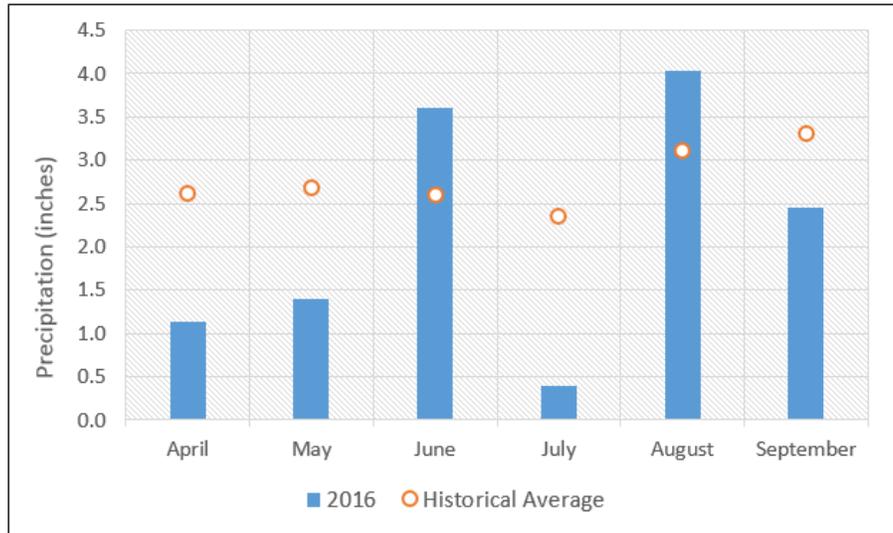
### **Crop Scouting**

ESF has provided crop scouting services to willow growers in the BCAP region each growing season since 2013. Initial efforts in 2013 focused on collecting data on soil characteristics, crop survival rates and first-year growth across 837 acres of newly-planted crops. The following year, efforts focused on assessing coppice regrowth on newly planted and harvested crops, assessing underperforming areas in combination with soils data, and making recommendations to growers on fertilizers and weed control. Also in 2014, an assessment was conducted across all 1,188 acres to evaluate the percentage of tillable acreage planted with willow and the land area left unplanted for headlands or other reasons. In 2015, the complete 1,188 acres was scouted by a team of student research assistants on foot and assessed for willow growth, persistent weed competition, pests and diseases, and particularly low-growing areas. Observations were documented and provided to growers in a formal report, and low-growing areas were mapped using handheld GPS units to assess the soil conditions for possible nutrient deficiencies or other factors limiting growth. An infestation of leaf sawfly was also closely monitored in 2014 and 2015, and was found to cause substantial defoliation in some fields. ESF was able to provide advice to growers and the outbreak was treated

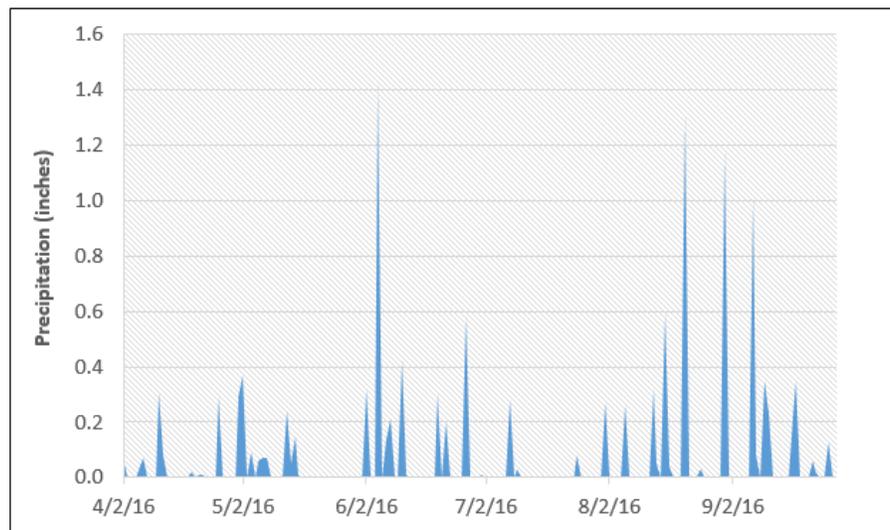
with pesticide where possible and was contained, so it did not cause widespread mortality or decreases in yield.

In 2016, fields harvested the previous year were assessed for coppice regrowth, and the remaining acreage was assessed for maturity and harvest planning. This was accomplished through a combination of on-the-ground observations and the use of a small unmanned aerial vehicle (UAV). The UAV proved extremely useful in assessing the general condition of mature willow on large acreage that is otherwise difficult and time consuming to assess from the ground.

The information gained from aerial crop scouting was used to identify potential fields for harvest. This was then followed up with on-site field visits with growers to develop a tentative harvest schedule for the 2016 season and beyond. The western region of the BCAP project area around Cape Vincent, NY was faced with drought conditions through an extended period of the growing season. Average monthly precipitation was below historical averages in April, May, July and September (Figure 4). July was particularly dry, with less than one-half inch of rainfall during the month, and little rainfall in late June or early August (Figure 5) putting additional drought stress on the willow plants. Aerial images showed large areas within these fields with defoliated willow (Figure 6), likely from drought stress. Some of these areas were inspected on foot, and some were harvested in the fall. It is unclear the extent of the impact the drought had on the



**Figure 4:** Monthly precipitation data and historical averages for the 2016 growing season from Watertown International Airport near Cape Vincent, NY where the majority of BCAP willow crops are planted



**Figure 5:** Precipitation data for the 2016 growing season near Cape Vincent, NY where the majority of BCAP willow crops are planted

willows. The affected areas have been documented and will be closely monitored during the 2017 growing season.



**Figure 4:** Large areas of willow have defoliated and may also have dead stems, likely due to the drought that occurred in the Cape Vincent area in 2016.

### **Financial Analysis Tool**

Throughout 2016, ESF worked with a group from Argonne National lab to run EcoWillow scenarios that model the use of willow as a nutrient buffer being grown in corn fields in the Midwestern U.S. The results of this work were published in an open-access journal article listed in the publications below.

## **VII. Education and Outreach**

To assist BCAP growers and expand the knowledgebase of current and potential willow stakeholders, ESF continues to provide a variety of educational and outreach programming in and around the project region. The following is a summary of the content produced and activities undertaken in 2016.

### **Extension Publications**

1. **Fact Sheet: Site Preparation for Willow Bioenergy Crops**
  - <http://www.esf.edu/willow/documents/Willow7SitePrep.pdf>
2. **Fact Sheet: Planting and Maintenance**
  - <http://www.esf.edu/willow/documents/8Planting.pdf>
3. **Fact Sheet: Harvesting**
  - <http://www.esf.edu/willow/documents/9Harvesting.pdf>
4. **Research Summary: EcoWillow 2.0: An Updated Tool for Financial Analysis of Willow Biomass**
  - <http://articles.extension.org/pages/73580/>

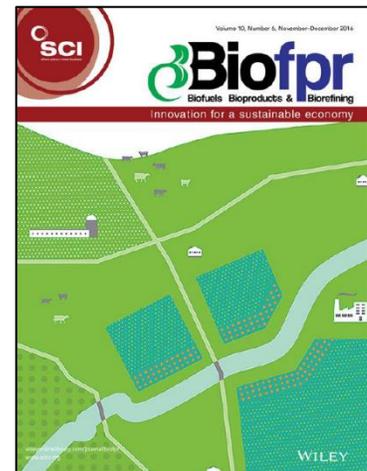
5. **Research Summary:** Maximizing Planted Area and Biomass Production in Shrub Willow Bioenergy Fields
  - <http://articles.extension.org/pages/73581>
6. **Case Study:** ReEnergy Holdings Offering Markets for Biomass in the Northeast
  - <https://articles.extension.org/pages/73637/>
7. **Safety Manual:** Safety and Health Management Planning for Biomass Producers
  - In cooperation with NEWBio Project with input from BCAP willow growers.
  - <http://extension.psu.edu/publications/agrs134>

### Peer-reviewed Journal Articles

1. Changes in feedstock quality in willow chip piles created in winter from a commercial scale harvest. Mark H. Eisenbies, Timothy A. Volk, and Aayushi Patel. *Biomass and Bioenergy*. Volume 86, March 2016, Pages 180–190.
  - <http://www.sciencedirect.com/science/article/pii/S0961953416300253>
  - Storage and handling are important to biomass logistics. There are associated costs and biomass properties can change as wood chips proceed through the supply chain. This paper provides important information to stakeholders in the industry with implications about handling procedures and impacts on chip quality when willow is harvested and stored in piles over several months.
2. Recently Bred Willow (*Salix* spp.) Biomass Crops Show Stable Yield Trends Over Three Rotations at Two Sites. Nathan J. Sleight, Timothy A. Volk. *Bioenerg. Res.* (2016) 9:782–797.
  - <http://link.springer.com/article/10.1007/s12155-016-9726-2>
  - Yields of willow biomass crops have large impacts on production, economic, energy, and environmental assessments of these systems. There are very few studies that report data for three or more rotations and the ones that do show various yield levels and changes over rotations. This is the first study to highlight changes over three rotations using willow cultivars that have been developed and are used commercially in North America, including many of the willow BCAP fields. This paper provides important information to stakeholders on the long term yield trend of willow plantings over time, which can be in the ground seven or more harvest rotations over 20+ years.
3. Genotype by environment interactions analysis of North America shrub willow yield trials confirms superior performance of triploid hybrids. Fabio, E.S., T.A. Volk, R.O. Miller, M.J. Serapiglia, H.G. Gauch, K.C.J. Van Rees, R.D. Hags, B.Y. Amichev, J.A. Kuzovkina, M. Labrecque, G.A. Johnson, R.G. Ewy, G.J. Kling, L.B. Smart. *Global Change Biology Bioenergy*. DOI: 10.1111/gcbb.12344
  - <http://onlinelibrary.wiley.com/doi/10.1111/gcbb.12344/full>
  - Development of willow systems will require accurate yield estimates to determine the associated environmental and economic benefits of production. This study analyzed first-rotation shrub willow yields of 16 genotypes across 10 trial environments in the U.S. and Canada, including the willow BCAP region, for genotype-by-environment interactions. These results provide useful information about what cultivars have the best yields in

different environments, which has implications for our commercial nursery partner on what cultivars to scale up and for future growers.

4. Incorporating bioenergy into sustainable landscape designs. Dale VH, KL Kline, MA Buford, TA Volk, CT Smith, I Stupak. 2016. *Renewable and Sustainable Energy Reviews* 56:1158-1171.
  - <http://www.sciencedirect.com/science/article/pii/S1364032115014215>
  - This paper focuses on integrating production of energy crops such as willow with other landscape components for environmental, social and economic benefits. This type of landscape-level planning for bioenergy systems can increase opportunities for stakeholder engagement, adoption, and multifunctional value-added systems, increasing viability.
5. Volk T.A., J.P. Heavey and M.H. Eisenbies. 2016. *Advances in Shrub Willow Crops for Bioenergy, Renewable Products and Environmental Benefits*. *Food and Energy Security*. doi: 10.1002/fes3.82
  - Open Access: <http://onlinelibrary.wiley.com/doi/10.1002/fes3.82/full>
  - Summary of recent willow developments in the northeast, good introductory publication to have on hand at outreach events. Includes sections on current production in BCAP area, extension, economics, harvesting, chip quality, and multifunctional systems
6. Ssegane, H., Zumpf, C., Cristina Negri, M., Campbell, P., Heavey, J. P. and Volk, T. A. (2016), The economics of growing shrub willow as a bioenergy buffer on agricultural fields: A case study in the Midwest Corn Belt. *Biofuels, Bioprod. Bioref.* doi:10.1002/bbb.1679
  - Open access: <http://onlinelibrary.wiley.com/doi/10.1002/bbb.1679/full>
  - This paper was a collaboration with Argonne National Lab, using the EcoWillow 2.0 model developed in this projects, to assess the economics of interplanting willow with corn for ecosystem services and subfield management.
  - This article was featured on the cover of Volume 10, Number 6, November-December 2016 (Figure 7)



**Figure 5:** Journal cover image depicting research on using willow in corn fields.

### Other Publications and Media

1. *Shrub Willow Can Be a Productive Option for Open Land*. The Overstory, Volume 27, Spring 2016. Justin Heavey authored the cover story for the quarterly newsletter of the New York Forest Owners Association Southeastern Adirondack Chapter in connection with presentation given at their annual meeting
  - [http://www.nyfoa.org/docs/chapter\\_docs/sac/newsletters/sac\\_2016\\_03\\_newsletter.pdf](http://www.nyfoa.org/docs/chapter_docs/sac/newsletters/sac_2016_03_newsletter.pdf)
2. Collaboration between ESF and Penn State University around bioenergy harvesting was documented and publicized by the NEWBio project and picked up by several local media outlets. ESF facilitated use of the New Holland harvesting system and provided technical assistance for transport and

operation of the machinery. The equipment was used to cut about 30 acres of shrub willow at this site in Pennsylvania.

- <http://nebioenergy.blogspot.com/2016/01/penn-state-harvests-first-crop-of-willow.html>
  - <http://www.centredaily.com/news/local/education/penn-state/article55122830.html>
  - <http://wjactv.com/news/local/new-penn-state-project-uses-willow-shrubs-as-fuel-source>
  - <http://www.wearecentralpa.com/news/mystery-crop-discovered-along-i-99>
3. Collaboration between ESF and The University of Tennessee (UT) around bioenergy harvesting was documented and publicized by UT's Institute of Agriculture and the USDA NIFA funded Southern Partnership for Integrated Biomass Supply Chains (IBSS), a sister project to NEWBio. ESF facilitated use of the New Holland harvesting system and technical assistance for transport and operation of the machinery. The equipment was used to cut about 60 acres of hybrid poplar, a short-rotation woody crop similar to shrub willow that uses the same harvesting system, across two sites in Tennessee and Mississippi.
- <https://ag.tennessee.edu/news/Pages/NR-2016-03-PoplarHarvest.aspx>
4. *ESF Harvests Shrub Willow for Biomass Fuel*. Time Warner Cable News. 5/28/16.
- <http://www.twcnews.com/nys/central-ny/news/2016/05/28/esf-harvests-shrub-willow-for-biomass-fuel.html>
5. *Working on making willow the energy crop of the future*. WRVO Public Media (NPR). 6/6/16.
- <http://wrvo.org/post/working-making-willow-energy-crop-future#stream/0>
6. *Foraging for Efficiency: New Holland is plowing the path to commercial use of woody biomass crops for bioenergy*. Biomass Magazine. 5/21/16.
- <http://biomassmagazine.com/articles/13264/foraging-for-efficiency>
7. *Fast Fuel: Short-Rotation Willow Biomass*. The Forestry Source, May 2016 – Vol. 21, No. 5.
- [http://www.nxtbook.com/nxtbooks/saf/forestrysource\\_201605/index.php#/1](http://www.nxtbook.com/nxtbooks/saf/forestrysource_201605/index.php#/1)
8. *Forestry is Big Business in New York State*. Empire State Farming. 6/24/16.
- <http://nyfarm.blogspot.com/2016/06/forestry-is-big-business-in-new-york.html>

### **Northeast Bioenergy Blog**

Throughout 2016, ESF contributed to several blog posts willow-related topics of the Northeast Bioenergy Blog. Most notably, ESF created a *Willow Frequently Asked Questions* (FAQ) blog post in March. This FAQ gave questions and answers on 15 topics that ESF staff often receive inquires on via phone, email, at presentation or field events, and at meetings or discussions with the public and stakeholders. FAQ's included topics such as: Are willows invasive? Will shrub willow grow in my area? Where can I buy willow cuttings?

- <http://nebioenergy.blogspot.com/2016/03/frequently-asked-questions-shrub-willow.html>

### **Social Media**

Continued contributions to the NEWBio Twitter feed:

- <https://twitter.com/NEWBioProject>

## Stakeholder E-News Letter

Continued regular contributions and announcements featured in the NEWBio electronic newsletter.

## Willow Website

Maintenance and updates to the ESF willow website ([www.esf.edu/willow](http://www.esf.edu/willow)) continued throughout 2016 and site traffic remained steady. Highlights from this year include:

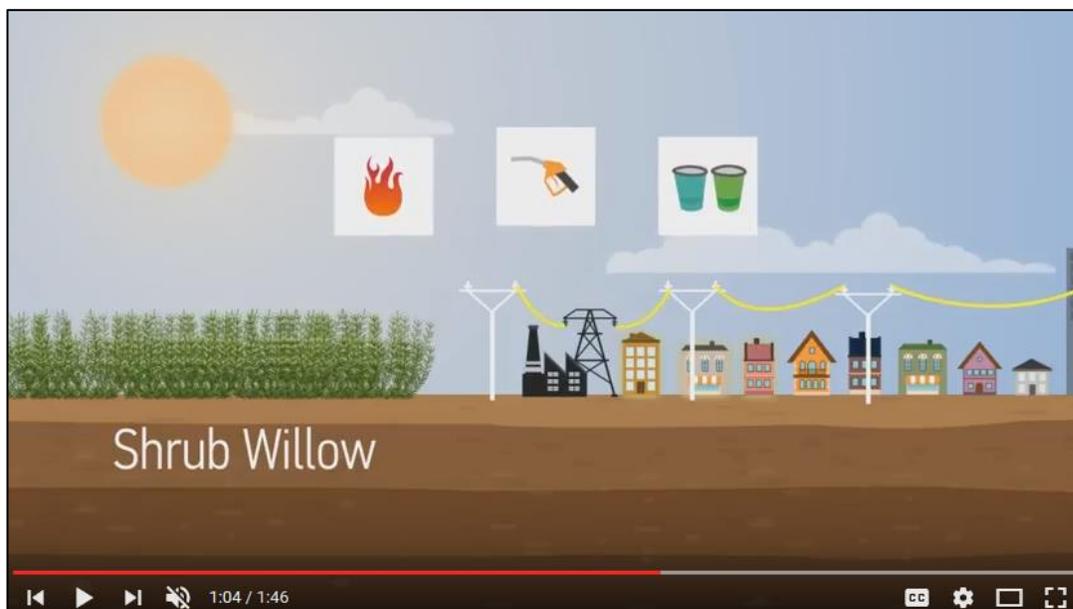
- 9,371 total page views
- 937 downloads of the popular willow brochure (2,222 to date)
- 905 views of the publications page
- 599 views of the EcoWillow page
- 166 views of the BCAP page

## Video

Created a new Willow Project video playlist under the ESF Sustainability YouTube Chanel. The playlist is a compilation of videos produced by ESF, willow webinars and presentation by project staff, and other videos related to willow and bioenergy that ESF has contributed to. Four new videos were created and added to the channel, and views on previously created videos are increasing.

- <https://www.youtube.com/playlist?list=PLWU13iUXdVlbbZErp2GAbe2aobJsPzJEa>
1. Willow Bioenergy animated short (Figure 8) (new)
    - 431 views
    - <https://youtu.be/A9zjmlqYEe0?list=PLWU13iUXdVlbbZErp2GAbe2aobJsPzJEa>
  2. Harvesting Willow on a Former Industrial Site in New York State (new)
    - 324 views.
    - [https://youtu.be/v\\_PXEQ5P\\_eA?list=PLWU13iUXdVlbbZErp2GAbe2aobJsPzJEa](https://youtu.be/v_PXEQ5P_eA?list=PLWU13iUXdVlbbZErp2GAbe2aobJsPzJEa)
  3. Shrub Willow Harvest using New Holland Forage Harvester (new)
    - 481 views
    - <https://youtu.be/QwQkXjjSQJw?list=PLWU13iUXdVlbbZErp2GAbe2aobJsPzJEa>
  4. Willow Crops in the U.S. (new)
    - 93 views.
    - <https://youtu.be/7Q0Enl6VXAo?list=PLWU13iUXdVlbbZErp2GAbe2aobJsPzJEa>
  5. EcoWillow Webinar
    - 270 views, up 140 since last year.
    - <https://www.youtube.com/watch?v=4Mf8T46Mbvq>
  6. Willow Biomass Harvest and Quality
    - 1,040 views, up 510 since last year.
    - <https://www.youtube.com/watch?v=9wv1PIw-DOA>
  7. Sustainability in Bioenergy: A Nation Connected
    - Produced in collaboration with US DOE for segments in the willow BCAP project area

- 3,250 views, up 1,597 since last year.
- <https://www.youtube.com/watch?v=e3mXOt2a5uI&feature=youtu.be>



**Figure 6:** Screenshot from new animated video aimed at introducing new audiences to the benefits of shrub willow and bioenergy crops

### Field Tours and Events

1. Symposium on Energy in the 21st Century – Woody Biomass Tour. Syracuse NY, 4/6/16, 12 participants.
2. Career Jam. Watertown, NY, 5/19/16, ~300 participants (Figure 6).
3. Willow Field Tour with Cornell Cooperative Extension and Bellville Henderson School. Copenhagen, NY, 5/26/16, 30 participants (Figure 6).
4. Tour of Willow and Woody Biomass Systems at SUNY-ESF for NYS DEC. Syracuse, NY, 6/14/16, 21 participants.
5. Sponsor and exhibitor table at Fenner Renewable Energy Education (FREE) Center. Fenner, NY, 6/5/16, 75 participants.
6. Ag Progress Days – Day 1: tabling, willow cutting head display, and daily willow planting field tour. State College, PA. 8/16/16, ~75 participants (Figure 7).
7. Ag Progress Days – Day 2: tabling, willow cutting head display, and daily willow planting field tour. State College, PA. 8/17/16, ~75 participants.

8. Ag Progress Days – Day 3: tabling, willow cutting head display, and daily willow planting field tour. State College, PA. 8/18/16, ~75 participants.

### Regional Presentations

1. Woody Biomass and Bioenergy. Justin Heavey. New York Forest Owners Association. Glens Falls, NY. 1/31/16. 25 participants.
2. Shrub willow bioenergy and environmental benefits. SUNY Oneonta, Careers for Environmental Professionals Course. Oneonta, NY, 9/20/16, 25 participants.
3. Shrub willow bioenergy and environmental benefits. Tully High School environmental science class. 12/6/16 – 7 participants.



**Figure 7:** Handing out a "grow your own willow" cutting and at "Career Jam" in the BCAP project region on 5/19/16.



**Figure 8:** Field event in the BCAP project region in cooperation with Cornell Cooperative Extension, Celtic Energy Farm and Belleville-Henderson school

## National Presentations

1. Willow Bioenergy Crops: Extension Services and Environmental Benefits for Sustainable Supply Chains. Justin Heavey. Extension Sustainability Summit 2016. Portland, OR, 4/7/16, 75 participants.
2. Development and Implementation of an Alternative Vegetative Cover System Using Shrub Willows in Central, NY. Tim Volk. Managing Poplar and Willow for Environmental Benefits and the Renewable Fuels Industry, Portland, OR, 4/13/16, 50 participants.
  - o <http://nyfarm.blogspot.no/2016/06/forestry-is-big-business-in-new-york.html>
3. Yang, S. T. Volk, M-O. Fortier. 2016. (Presentation) Spatially explicit life cycle assessment of willow biomass production in northern New York. Short Rotation Woody Crops Operations Working Group meeting, Oct. 11 – 13, 2016, St. Petersburg, FL, 50 participants
4. Bressler, A., P. Hirsch, P. Vidon, T. Volk. 2016. (Poster) Beyond bioenergy – developing a conceptual framework to assess ecosystem services in shrub willow fields. Short Rotation Woody Crops Operations Working Group meeting, Oct. 11 – 13, 2016, St. Petersburg, FL, 50 participants
5. deSouza, D.P., T.A. Volk, J. Heavey, M. Eisenbies. 2016. (Presentation) Nutrient removal in willow biomass harvested in northern New York. Short Rotation Woody Crops Operations Working Group meeting, Oct. 11 – 13, 2016, St. Petersburg, FL, 50 participants

## Research Support

ESF continued to conduct and support various research projects in and around the willow BCAP project area including harvesting and logistics, willow chip quality and variability, use of willow by insect pollinators, feedstock improvement, GIS supply chain analyses, life cycle and techno-economic analyses, willow vegetative caps, water quality and greenhouse gas emissions.

## VIII. Future Activities

ESF will continue to assist BCAP growers with crop scouting, crop management, and harvesting in 2017 and provide information and technical assistance to growers as necessary. Efforts will continue, with support from NYSERDA and NEWBio, to provide a variety of extension services and disseminate the latest information and educational materials. Ongoing research projects at ESF to support commercial willow production and improvement will continue and additional projects will be undertaken as possible. ESF will continue to work closely with ReEnergy and other potential end users for the expansion willow industry in the region. If additional BCAP funding to expand the project area should become available in 2017, ESF will again engage with ReEnergy to review the possibility of contracting for increased acreage. If an opportunity exists, ESF will work with USDA FSA and project partners to publicize the program availability, hold field and classroom events, and facilitate signups.

ESF will continue work on supply-chain development and seek out opportunities for collaborative, landscape-level assessments and stakeholder engagement to grow the base of support for willow in the region and increase efficiencies and profits across the supply chain. Numerous opportunities exist for expanding the regional willow industry and making it more profitable for producers and end users. These include the development of increased integration and synergies with other feedstocks for power, heat and cogeneration systems; the development of additional markets and end-use applications such as

pellet production and biorefinery pathways; bioremediation of municipal wastes and former industrial sites; an expanded and strengthened network of regional stakeholders; further innovations across the supply chain; applied research projects; and further integration with other elements of the regional bioeconomy for multiple environmental, economic and social benefits.