

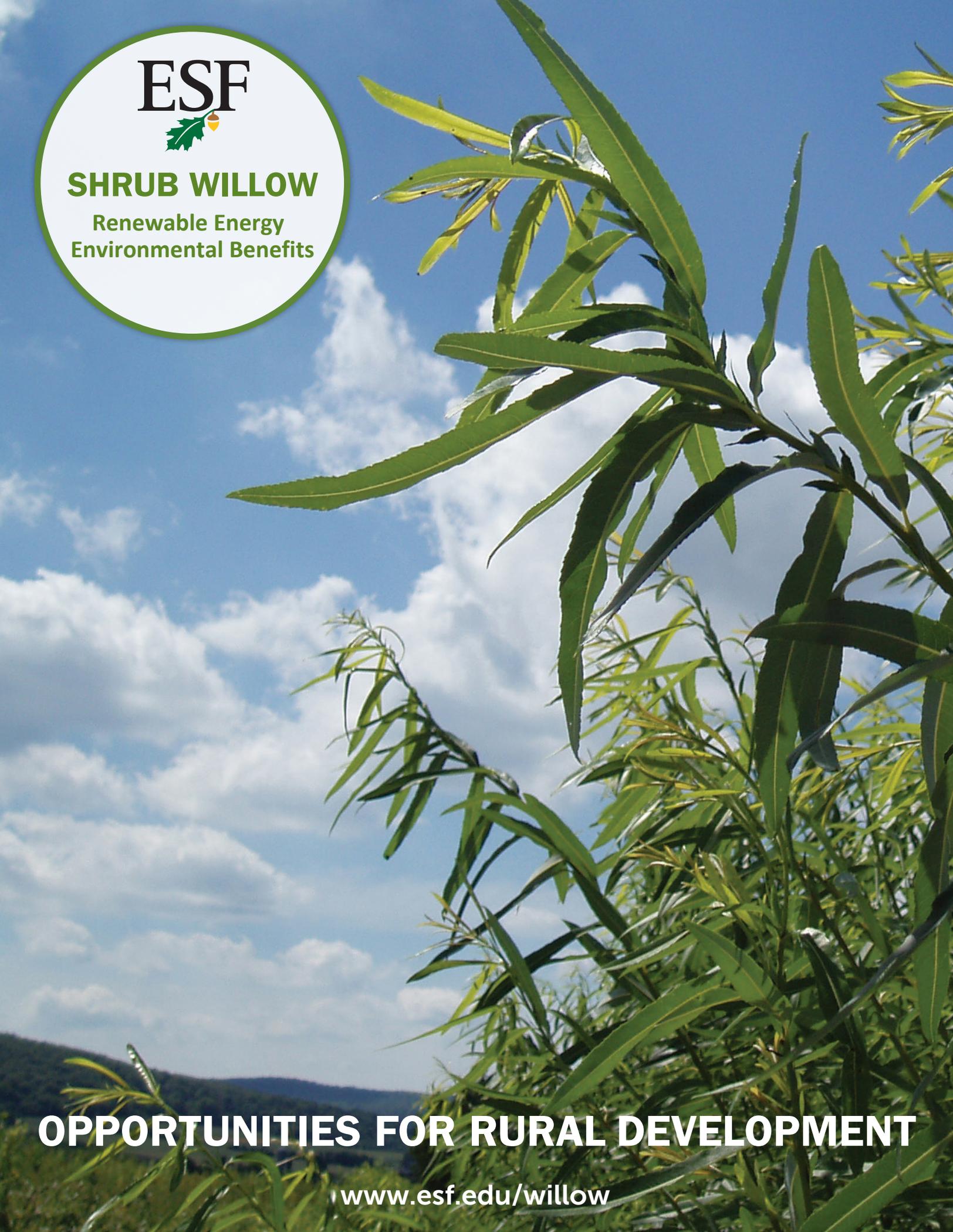


ESF



SHRUB WILLOW

**Renewable Energy
Environmental Benefits**



OPPORTUNITIES FOR RURAL DEVELOPMENT

www.esf.edu/willow

An alternative crop with multiple benefits

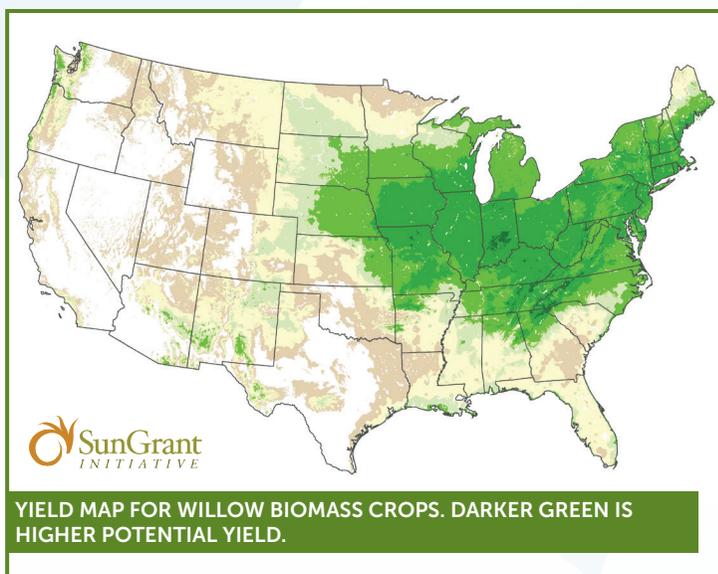
Driven by the challenges of rural development, energy independence and environmental sustainability, research on willow biomass crops for renewable energy and environmental applications has been ongoing at SUNY College of Environmental Science and Forestry (ESF) since 1986. SUNY-ESF has teamed up with more than 20 universities, commercial partners and non-profit organizations throughout the U.S. and Canada to conduct research and facilitate the commercialization of willow biomass crops.

- Willow biomass crops are planted once and harvested every three to four years, up to seven times.
- Improvements to the willow production system are increasing potential returns for landowners.
- It is now possible to achieve internal rate of return (IRR) up to 10 percent, with a payback period of three to four harvests (10 to 14 years after planting). If incentive programs such as USDA BCAP are available to establish and grow willow, returns may be 20 percent or greater with a payback as short as one or two harvests (four to eight years).

Willow biomass crops have been tested on a range of sites throughout the Northern U.S. and Southern Canada. The crop consistently yields four to five dry tons of wood chips per acre per year (green areas on map). Continued research and development will further increase these yields in future years.

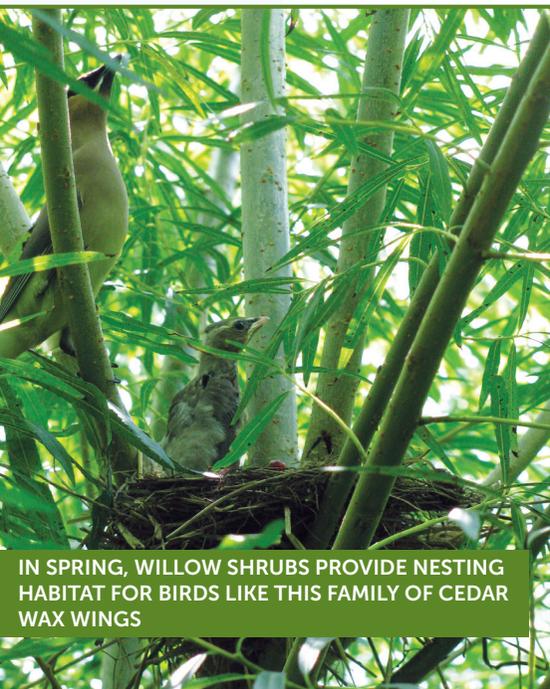


A FIELD OF ONE-YEAR-OLD WILLOW RESPROUTING IN SPRING



YIELD MAP FOR WILLOW BIOMASS CROPS. DARKER GREEN IS HIGHER POTENTIAL YIELD.

Promoting Rural Development and the Environment



IN SPRING, WILLOW SHRUBS PROVIDE NESTING HABITAT FOR BIRDS LIKE THIS FAMILY OF CEDAR WAX WINGS

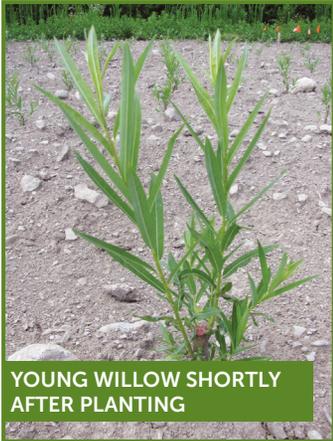
Willow biomass is a low-maintenance crop that stimulates rural economies and enhances the local environment in several ways:

- Shrub willow crops generate income for landowners and create jobs in the local community when converted into renewable energy and products.
- Shrub willow can be grown on marginal farm land so production does not directly compete with food or feed crops.
- Willow is a "carbon neutral" fuel source, meaning no additional CO₂ emissions are created in the production and use of the crop.
- Shrub willows can improve biodiversity, mitigate pollution and provide other environmental benefits to local ecosystems.
- Bird diversity and density in willow biomass crops is similar to natural shrub land and forests.

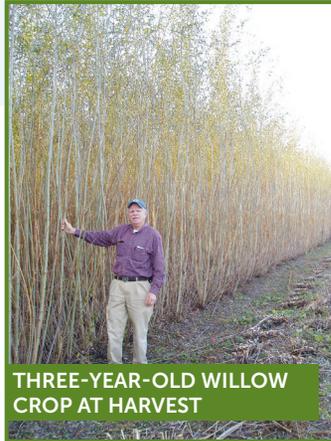
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Energy, green products and environmental services

Why Grow Shrub Willow?



YOUNG WILLOW SHORTLY AFTER PLANTING



THREE-YEAR-OLD WILLOW CROP AT HARVEST

Shrub willow is easy to establish, grows quickly and provides multiple benefits:

- Adapted to a wide range of site conditions.
- Easily propagated from stem cuttings which grow new roots, shoots and leaves.
- Rapid growth rate, produces hardwood biomass 10-15 times faster than local forests.
- After each harvest, new stems quickly re-grow from the remaining plant.
- Limited maintenance between harvests.
- Willow wood chip properties are similar to forest residue chips and suitable for mixing.
- High ornamental and landscape aesthetic value.

Producing Shrub Willow Crops



PLANTING WILLOW CROPS IN SPRING



MULTIPLE STEMS ON MATURE WILLOW PLANT

Willow biomass crops can be planted on marginal agricultural land. A grower can harvest shrub willow up to seven times from a single planting.

- Land is prepared in fall prior to planting by clearing existing vegetation, plowing and disking.
- Unrooted stems are inserted into prepared ground using a tractor-mounted planter.
- Planting stock is available for purchase from Double A Willow (www.doubleawillow.com).
- Stems are cut back (coppiced) once to encourage more stems and vigorous growth.
- Each plant produces numerous woody stems with diameters approximately 1 - 2 inches at harvest.



HARVESTING AND CHIPPING A WILLOW CROP

Planting and harvesting equipment for shrub willow crops is currently available at reduced costs through the NEWBio program. (www.newbio.psu.edu).

Harvesting and Utilizing Shrub Willow Crops



A WAGON UNLOADS HARVESTED WILLOW CHIPS

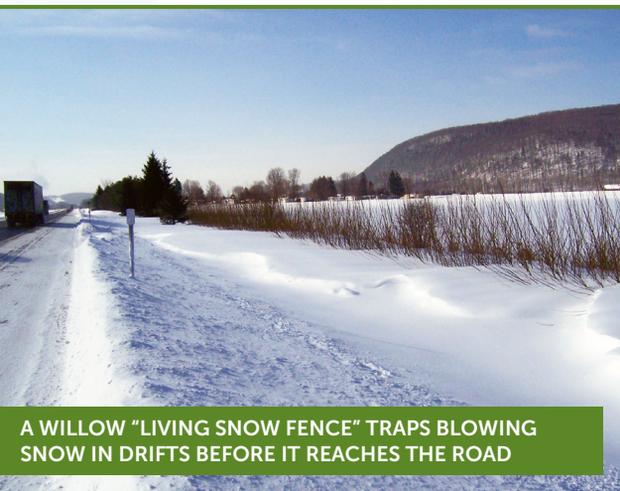


SHRUB WILLOW CHIPS HAVE CHARACTERISTICS SIMILAR TO FOREST RESIDUE CHIPS AND CAN BE INTEGRATED INTO EXISTING SUPPLY CHAINS AND UTILIZED AT BIOWATER FACILITIES SUCH AS REENERGY TO PRODUCE RENEWABLE HEAT AND POWER

Woody biomass from shrub willow can be converted into different forms of renewable energy and environmentally friendly products that offset the use of non-renewable fossil fuels.

- After planting and coppice, the crop can be harvested once every three to four years.
- New Holland Agriculture has developed an effective woody crop header (FB 130) that fits on their FR 9000 series of forage harvesters and is now available.
- The harvester cuts and chips the crop in one pass while chip collection vehicles follow beside it.
- Heat and electricity can be produced from harvested wood chips by direct combustion, co-firing with other fuel sources, or gasification.
- For every one unit of fossil fuel energy used to produce shrub willow crops, about 15 units of renewable electricity are produced, or about 30 units of renewable heat and electricity via co-generation.
- Wood pellets, liquid “biofuels”, biodegradable plastics, and other green products can also be produced from willow.
- All end uses provide local and regional economic benefits.

Other Uses for Shrub Willows



A WILLOW “LIVING SNOW FENCE” TRAPS BLOWING SNOW IN DRIFTS BEFORE IT REACHES THE ROAD

In addition to being a source of renewable energy and green products, the unique characteristics of the shrub willow make it ideal for a wide range of environmental applications:

- **Living Snow Fences** - prevent blowing snow on roadways
- **Vegetated Buffers** - prevent fertilizers and chemicals from entering streams, ponds and waterways
- **Protect Soil Resources** - prevent erosion and stabilize stream banks
- **Environmental Remediation** - clean up and restore former industrial sites
- **Vegetated Cover** - a green alternative for effectively capping landfills

For more info visit www.esf.edu/willow or contact The Willow Project at SUNY-ESF willow@esf.edu or 315-470-6775

Justin P. Heavey and Timothy A. Volk. © 2014 The Research Foundation for the State University of New York College of Environmental Science and Forestry, Syracuse, NY.

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