

RENEWABLE AND ALTERNATIVE ENERGY FACT SHEET**NEWBio Energy Crop Profile: Shrub Willow**

Willow comprises over 400 species in the *Salix* genus. The species ranges from large weeping willow trees to dwarf alpine shrubs. Willows are naturally found in cold to temperate climates, including the northeastern United States. It is commonly found along streams and areas with moist soils because willow has characteristics that give it a competitive advantage in these environments. In the nineteenth and early twentieth centuries, willow was used to make baskets and furniture. It also has strong analgesic properties (salicylic acid) in the bark from which aspirin was derived.

Shrub willow is a very attractive biomass crop because it is high yielding, fast growing, requires few inputs, has multiple stems, and resprouts after being cut. The shrub willow reaches heights of 15 to 25 feet in 3 years and 4 to 6 tons per acre per year. Substantial breeding and research trials in recent years show promise for higher-yielding cultivars in the near future.



Shrub willow in first year after coppice. Photo courtesy of Daniel Ciolkosz.

“NEWBio” is the Northeast Woody/Warm-season Bioenergy Consortium, a regional project funded by the United States Department of Agriculture’s National Institute of Food and Agriculture (USDA-NIFA) to promote next-generation bio-energy production in the northeastern United States.

Willow grows successfully in a range of drainage conditions, from poorly to well drained, with textures ranging from sandy loam to silt or clay loams. It can also enhance soil properties over time as the roots break up hard soil, add organic matter, and provide conditions for beneficial microbes to grow.

Planting

Willow planting is done using pieces of live stems—dormant unrooted cuttings 6 to 10 inches in length—in late spring at a density of about 6,000 per acre. Planting is done with mechanized planters specifically designed for planting this material. To facilitate the management of the site with farm machinery, willows are planted in a double-row system with 6 feet between double-rows, 2.5 feet between rows, and 2 feet between plants within rows.



Willow cuttings are made from one-year-old stems and are kept dormant in cold storage until they are planted. Photo courtesy of Daniel Ciolkosz.

Establishment of the Crop

Willow sprouts need weed control initially, but once the willow stand closes canopy during the second year, weeds become much less of a problem.

After the first growing season, plants should be cut back (coppiced) close to the ground with a mower equipped with sharp blades for a clean cut. The willows resprout the next spring, grow multiple shoots, and take on a characteristic shrub form.

Some pests and diseases such as Japanese beetles, potato leafhopper, and rust are known to damage willow. Care is needed in areas of high deer browse. Since willow is a perennial woody species, it sequesters more carbon than other crops and provides other important wildlife and biodiversity benefits.

Harvest

Harvesting occurs in the third year after coppice, and every third year thereafter for up to seven cycles (21 years). No annual maintenance of the crop should be necessary, and compared to other crops, willow requires few fertilizer inputs, but nitrogen fertilizer can be applied as needed. Harvesting requires a specialized cutting head attached to a forage harvester.



Harvesting willow biomass crops with a specially designed cutting head attached to a forage harvester. Photo courtesy of Tim Volk.

Crop Uses

The harvested wood is usually sold in chip form, and as such it has multiple uses and is generally more marketable than perennial grasses. Wood chips have low ash and are easily stored for relatively long periods. Typical uses include direct combustion for heat or heat and power, or conversion to cellulosic biofuel. Nonenergy uses include, mulch, animal bedding, and fiberboard. One great feature of willow is that it can be “stored on the stump,” or held over for a year if the market is poor or conditions are not favorable for harvest. This is not possible with perennial grasses, which must be harvested annually.

Economics

The largest expenses of growing willow are establishment and harvesting costs. One can expect to pay about 12 cents per cutting, and total site preparation and planning costs will average about \$1,000 per acre. Depending on yields and the distance the material needs to be hauled, breakeven prices range from \$30 to \$50 per ton at the farm gate.

NEWBio Project Work

In the United States, planting stock of varieties bred and tested by researchers at the State University of New York (SUNY) College of Environmental Science and Forestry and Cornell Uni-

versity are available through a NEWBio consortium partner, “Double A Willow” (www.doubleawillow.com).

Summary

Shrub willow is a short-rotation woody crop that provides multiple bioenergy products and environmental benefits, especially in more northern climates where other energy crops do not grow as well. They grow very well on underutilized and marginal fallow land and can improve soil conditions and microbial diversity. Significant gains have been made in breeding cultivars for improved yields. Although the establishment and harvesting costs are relatively high, once the crop is established, very little maintenance is required and rate of returns over more than twenty years can be favorable.

References

Cornell University. “Willowpedia.” willow.cals.cornell.edu.
State University of New York (SUNY) College of Environmental Science and Forestry. *Shrub Willow Biomass Producers Handbook*. www.esf.edu/willow/documents/ProducersHandbook.pdf.

For more information on the NEWBio project, visit www.newbio.psu.edu and Penn State Extension’s Renewable Energy website, extension.psu.edu/natural-resources/energy.



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